Ovation I/O Reference Manual
OW350_R1150

(For use with Ovation 3.5 systems)
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SECTION 1

Introduction to the Ovation Input/Output (I/O) Reference Manual

IN THIS SECTION

1.1 What is the purpose of Ovation I/O modules?

Ovation Distributed Control Systems provide modulating control, sequential control, and data acquisition for a variety of system applications. Ovation systems consist of a configurable mix of functional Input/Output (I/O) modules that communicate on the I/O bus to the Ovation Controller.

I/O modules provide an interface between the Ovation Controller and the processes in the plant. Ovation I/O modules are a plug-in component with built-in fault tolerance and diagnostics. They are able to operate on a wide range of signals and perform a multitude of functions.

Ovation I/O modules are seated into base units and are latched into place. These base units are housed in the Controller cabinet where they are mounted on DIN rails and wired to the appropriate field devices.

The standard modular components typically consist of the following:

- Electronics module (Emod)
- Personality module (Pmod)
- Base Unit (containing the field terminations)

The relay output modular components consist of the following:

- Electronics module
- Base Unit (containing the field terminations)

1.2 I/O reference terminology

TERM	DESCRIPTION
AWG	American wire gauge is used in the United States as a standard method of denoting wire diameter. Increasing gauge numbers give decreasing wire diameters. Outside of North America, wire sizes for electrical purposes are usually given as the cross sectional area in square millimeters.
A Side	Refers to the left side board-to-board connector of the base unit when the terminal block or AUI Cable connector is facing the viewer. Also can refer to the Controller cabinet or the "A" cabinet.

TERM	DESCRIPTION
Attention	The Ovation I/O bus cycle status when the Electronics module returns a reply requesting attention.
B Side	Refers to the right side board-to-board connector of the base unit when the terminal block or AUI Cable connector is facing the viewer. Also can refer to the Termination cabinet or the "B" cabinet.
Base Unit	The DIN Rail mounted Ovation Base serves as the mechanical means to hold & secure the Ovation I/O Electronics and personality modules while providing an electrical interface between customers field connections, Ovation I/O controller & transition panels. The Ovation Bases when connected together form the Ovation I/O bus used by the Ovation controller to communicate with its I/O subsystem and the distribute power to the I/O modules. Each standard 2-slot base can house up to two sets of electronic and personality I/O modules, while 4-slot base units can house up to four sets of I/O modules.
Base Unit, Relay Output	The Relay Output base unit houses one Electronics module.
Branch	A set of two 4-slot base units or four standard 2-slot bases configured consecutively on a DIN rail with a local Ovation I/O bus being connected to the Ovation Controller. A Maximum of eight I/O modules is supported on a branch.
Controller	Interface between the Network and the I/O. The Controller is located in the Ovation I/O cabinet. (See *Planning Your Ovation System*.)
Current Sinking Digital Input	A digital voltage input circuit made of an input voltage protection, a serial current limiting circuit and an output interface. Each channel circuit terminates the connection between the logic input and its associated high side sensor or switch. Any short circuit to the reference potential or field wire breakages are interpreted as the “off” or “0” state.
Electronics module	A plastic housing with associated lenses and labeling that contains the necessary electronics to interface between field devices and the Ovation I/O bus. Electronics modules are inserted directly into a base unit.
Event	A digital input change of state detected by the Ovation Higher Density Digital Input electronics module
Galvanic Isolation	The principle of isolating functional sections of electronic circuits so that charge-carrying particles cannot move from one section to another, i.e. there is no electrical current flowing directly from one section to the next. Energy and/or information can still be exchanged between the sections by other means, however, such as by capacitance, electromagnetic waves, or mechanical means.
IOIC Card	Generic name for the Controller PCI I/O Interface card. Options for the OCR161 Controller are PCQL, PCRL, and PCRR. The OCR400 Controller only needs the IOIC module.
I/O Module	Standard I/O modules are made up of an Electronics module and a Personality module. These modules perform the interface between the I/O Controller and the field devices. Compact modules and Relay Output modules do not contain a Personality module.
LSB	Least significant bit.
MAU	Media Attachment Unit (MAU) is an alternate name for the Attachment Unit Module and includes the Electronics module and Personality module combined. This device interfaces the PCRR card (via the AUI cable) to the RNC (via fiber-optic cable) in remote I/O applications.
MSB	Most significant bit.
Ovation Network	Local area network in which Ovation drops communicate with each other through Fast Ethernet media.

TERM	DESCRIPTION
Partial Rotation	A partial rotation is directly associated with sample. Samples, representing pulses and time elapsed for those pulses, are combined each sample period into the pulse count and time elapsed for a full rotation. Typically, a partial rotation is what is sampled.
Personality module	Portion of an I/O module that provides a plastic housing with associated lenses and labeling. It contains a printed circuit board to perform the necessary signal interconnections required for interfacing the I/O modules to particular field devices. Typically, the module contains only passive components, but the Media Attachment Unit module and Remote Node Controller module contains fiber-optic transmitters, receivers, and transceivers in their Personality modules. The Link Controller I/O module contains optical couplers and RS-232/RS-485 transceivers in its Personality module. The module plugs directly into the base.
Remote I/O	A configuration where the I/O is located remotely from the Controller.
Remote Node	A grouping of I/O modules that communicates with the Controller via media that can carry control signals over a long distance (for example, fiber-optic).
RNC	Remote Node Controller (RNC) is an alternate name for the module containing the Remote Node Electronics module and Remote Node Personality module. The RNC interfaces the I/O modules in the Remote Node to an MAU module at the Controller via a fiber-optic communication link.
Rotation Time	The time of a full rotation of the toothed wheel given in 24 MHz timer ticks. Normally the rotation time is the summation of a number of sample times.
Transition Panels	Types are: ROP - I/O transition panel. TND - Remote Node transition panel. RRP - Relay Base transition panel (top location). RRB - Relay Base transition panel (bottom location).
Watchdog Timer	A timer which, if allowed to expire, will reset the microcontroller.

SECTION 2

Electronic Module (Emod) and Personality Module (Pmod) I/O combinations

IN THIS SECTION

2.1 What are the I/O module types?

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- HART High Performance Analog Input.
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- RTD (8-Inputs).
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- Compact Digital Input.
- Contact Digital Input.
- Compact Contact Digital Input.
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- Sequence of Events Compact Digital Input Field Interface.
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- Pulse Accumulator.
- Servo Driver.
- Small Loop Interface.
- Speed Detector.
- Valve Positioner.
- Enhanced Valve Positioner
- Numalogic Fast Ethernet Remote I/O subsystem.

2.1.1 Analog Input modules

Analog Input module (13 bits) (see page 39) - (Legacy product) - provides an interface to eight galvanically isolated analog inputs with sampling rates of approximately 10 time/sec. Several voltage and current configurations are available including cold junction compensation for thermocouple inputs.

Analog Input subsystems (13-bit)[1]

RANGE	CHNLS	ELECTRONICS MODULE	PERSONALITY MODULE
± 20mV	8	1C31113G01[1]	1C31116G01
± 50mV	8	1C31113G02[1]	1C31116G01
± 100mV	8	1C31113G03[1]	1C31116G01
± 20mV Compensated (Thermocouple)	8[3]	1C31113G01[1]	1C31116G04
± 50mV Compensated (Thermocouple)	8[3]	1C31113G02[1]	1C31116G04
± 100mV Compensated (Thermocouple)	8[3]	1C31113G03[1]	1C31116G04
± 1 VDC	8	1C31113G04[1]	1C31116G01
± 5 VDC	8	1C31113G05[1]	1C31116G01
± 10 VDC	8	1C31113G06[1]	1C31116G01
0-20 mA Field powered (4-20 mA Field powered can also be selected in the I/O Builder for Solaris applications; card is configured appropriately)	8	1C31113G05[1, 2]	1C31116G02
0-20 mA Locally powered (4-20 mA Locally powered can also be selected in the I/O Builder for Solaris applications; card is configured appropriately)	8	1C31113G05[1, 2]	1C31116G03

[1] This module configurations is CE Mark Certified.

[3] This module configurations is CE Mark Certified (Non-EMC Cabinet).

[3] A ninth logical channel (does not connect to a device) is provided when using the Analog Input module with temperature sensor. This ninth point is needed for the **CJ Compensation field** of the Point Builder Instrumentation Tab when defining the eight other thermocouple points for the AI module. (See *Ovation Developer Studio User Guide* (for Windows).

Analog Input module (14 bits) (see page 53) - provides an interface to eight galvanically isolated analog inputs with a minimum sampling rate of 10 time/sec. A low cost 4-20 mA current input is available along with a 1V voltage input (legacy) configuration.

Analog Input subsystems (14-bit)

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4 - 20mA, Field or Locally powered[1]	8	1C31224G01[1]	1C31227G01
± 1 VDC	8	1C31224G02[1]	1C31227G02
[1] The 4-20mA Configuration is CE Mark certified.			

Analog Input High Speed module (14-Bit) (see page 63) **-** provides an interface to eight galvanically isolated analog inputs with sampling rates of medium speed (16/20 time/sec.) or high speed (50/60 times/sec.). Several voltage and current input configurations are available including cold junction compensation for thermocouple inputs.

High Speed Analog Input subsystems (14-bit)

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4 - 20mA, Field or Locally powered	8	5X00070G01[1,2]	1C31227G01
± 100mV, ± 250mV, ± 1V	8	5X00070G02[1,2]	1C31227G02
± 5V, ± 10V	8	5X00070G03[1,2]	1C31227G02
± 1mA 2 wire local powered	8	5X00070G02[1,2]	1C31116G03
± 1mA 4wire field powered	8	5X00070G02[1,2]	1C31116G02
± 20mV, ± 50mV, ± 100 (Thermocouple)	8	5X00070G04[1]	1C31116G04
± 20mV, ± 50mV, ± 100 (Thermocouple)	8	5X00070G05[2]	1C31116G04
[1] This module configuration is CE Mark Certified. [2] This module configuration is CE Mark Certified (Non-EMC Cabinet).			

HART Analog Input module (see page 86) - provides an interface for eight galvanically isolated HART field devices with 4-20 mA current loop analog inputs (common reference). In addition to the analog inputs, digital information can be exchanged between HART compliant devices and the Controller.

HART Analog Input subsystems (16-bit) [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4-20 mA loop powered (2 wire) or active source (4 wire)	8	5X00058G01[1]	5X00059G01
[1] This module configuration is CE Mark Certified.			

HART High Performance Analog Input module (see page 99) - provides an interface for eight galvanically isolated HART field devices with 4-20 mA current loop analog inputs. In addition to the analog inputs, digital information can be exchanged between HART compliant devices and the Controller.

HART High Performance Analog Input subsystems (16-bit)

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4-20 mA [1]	8	5X00106G01	5X00109G01 or 5X00109G02 (Ovation releases 3.4 and later)
4-20 mA[2] (Reduced radiated emissions).	8	5X00106G02	5X00109G01 or 5X00109G02 (Ovation releases 3.4 and later)
4-20 mA [1] Analog Output pin-compatible.	8	5X00106G01	5X00170G01
[1] This module configuration is CE Mark Certified. [2] This module configuration is CE Mark Certified (Non-EMC Cabinet).			

RTD module (4 Channel) (see page 114) **-** provides an interface to four galvanically isolated Resistance Temperature Detectors. Several 3 and 4 wire RTD types are supported. A 50/60 Hz filtered configuration is available for CE Mark applications.

RTD (4 Channel) module subsystems

Range	Channels	Electronics module	Personality module
All	4	1C31161G01	1C31164G01
All (for 50/60 Hz filtered inputs and CE Mark certified systems)	4	1C31161G02 [1]	1C31164G02 [1]
[1] Configuration 1C3116G02 / 1C31164G02 is CE Mark Certified.			

RTD module (8 Channel) (see page 124) **-** provides an interface to eight galvanically isolated Resistance Temperature Detectors. Several 3 and 4 wire RTD types are supported.

RTD module (8-Channel) subsystems[1]

Channels	Electronics module	Personality module
8	5X00119G01[1]	5X00121G01
8	5X00119G02[2]	5X00121G01
[1] This module configuration is CE Mark Certified. [2] This module configuration is CE Mark Certified (Non-EMC cabinet).		

16 Channel 4-20mA Analog Input module (see page 133) - provides an interface between the Ovation Controller and 16 field devices that use a 4-20mA current loop. Up to 16 4-20mA (2-wire or 4-wire) transmitters can be connected per module.

16 Channel 4-20mA Analog Input subsystems

Description	Channels	Electronics module	Personality module
16 Channel 4-20mA Analog Input, 2-wire and 4-wire	16	5X00501G01	5X00502G01
16 Channel 4-20mA Analog Input, 2-wire only	16	5X00501G01	1X00692H01

2.1.2 Analog Output modules

Analog Output module (see page 145) **-** provides an interface to four galvanically isolated analog outputs using 12-bit digital-to-analog converters.

Analog Output subsystems

Range	Channels	Electronics module	Personality module
0-5 Volts DC	4	1C31129G01[1]	1C31132G01
0-10 Volts DC	4	1C31129G02[1]	1C31132G01
0-20 mA with Diagnostics (4-20 mA with Diagnostics can also be selected in the I/O Builder for Solaris applications; card will be configured appropriately).	4	1C31129G03[1]	1C31132G01
0-20 mA without Diagnostics (4-20 mA without Diagnostics can also be selected in the I/O Builder for Solaris applications; card will be configured appropriately).	4	1C31129G04[1]	1C31132G01
4-20 mA with Diagnostics (For Redundant applications).	4	1C31129G05[2]	1C31132G02
[1] This module configurations is CE Mark Certified. [2] For Redundant applications using Windows Ovation 3.2 and above.			

HART Analog Output module (see page 156) - provides an interface for eight galvanically isolated HART field devices using 4-20 mA current loop analog outputs (common reference). In addition to the analog outputs, digital information can be exchanged between HART compliant devices and the Controller.

HART Analog Output subsystems (14 bit)[1]

Range	Channels	Electronics module	Personality module
4-20 mA	8	5X00062G01[1]	5X00063G01
[1] This module configuration is CE Mark certified.			

HART High Performance Analog Output module (see page 99) - provides an interface for four galvanically isolated HART field devices using 4-20 mA current loop analog outputs. In addition to the analog outputs, digital information can be exchanged between HART compliant devices and the Controller.

HART High Performance Analog Output subsystems (16-bit)[1]

Range	Channels	Electronics module	Personality module
4-20 mA	4	5X00167G01[1]	1X00188H01 (molded plastic cavity insert)

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4-20 mA	4	5X00167G01	5X00211G03 (Q-line migration)
[1] This module configuration is CE Mark Certified.			

2.1.3 Digital Input modules

Digital Input module (see page 182) - provides an interface for 16 current-sinking digital inputs using a Personality module. Various input configurations are available.

Digital Input subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24/48 VAC/VDC Single-ended Differential	16 16	1C31107G01 1C31107G01	1C31110G01 1C31110G02
125 VAC/VDC Single-ended Differential	16 16	1C31107G02 1C31107G02	1C31110G01 1C31110G02
[1] All module configurations listed in the table are CE Mark Certified.			

Redundant Digital Input module (see page 192) – provides 16 digital channels to monitor the states (“0” or “1”) of 16 field digital inputs. The module contains two voltage sensing circuits for each of the 16 I/O channels located on the module. Redundant power for all 16 digital input channels is either supplied by the Ovation auxiliary power supply or by an external 24V auxiliary power source. In either situation, the redundant pair module shares a common 24VDC auxiliary power source.

Redundant Digital Input subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24 V (Single Ended) Digital Input current sinking, IEC 61131-2 Compliant Type 1 digital Inputs.	16	5X00411G01	5X00414G01

Compact Digital Input module (see page 207) - provides a low cost interface for 16 current-sinking digital inputs without requiring a personality module.

Compact Digital Input subsystems

RANGE[1]	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE OR CAVITY INSERT[2]
24/48 VDC Single-ended	16	1C31232G01	1C31238H01 (molded plastic cavity insert)
24 VAC/VDC Differential 48 VDC Differential	16	1C31232G02	5X00034G01(Fused Pmod) 1C31238H01 (molded plastic cavity insert)
125 VAC/VDC Single-ended	16	1C31232G03	5X00034G01 (Fused Pmod) 1C31238H01(molded plastic cavity insert)
[1] All module configurations listed in the table are CE Mark Certified. [2] This is an insert that fits into the Personality module position and provides a wiring schematic label for the module.			

Contact Digital Input module (see page 229) – provides an interface for 16 current-sourcing digital (contact) inputs using a personality module. The following input configuration is available: 48 VDC (single-ended – channels have a common return, which is the return for the on-module 48 VDC current limited contact wetting power supply).

Contact Digital Input subsystems[1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
48 VDC On-Card Auxiliary (Legacy)	16	1C31142G01	1C31110G03
[1] This module configuration is CE Mark certified.			

Compact Contact Digital Input module (see page 240)– provides a low cost interface for 16 current-sourcing digital (contact) inputs without requiring a personality module. The following input configuration is available: 48 VDC (single-ended – channels have a common return, which is the return for the on-module 48 VDC current limited contact wetting power supply).

Compact Contact Digital Input subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	MOLDED PLASTIC CAVITY INSERT [2]
Compact Contact with 48 VDC On-Card Auxiliary	16	1C31234G01	1C31238H01
[1] This module configuration is CE Mark Certified. [2] This is an insert that fits into the Personality module position and provides a wiring schematic label for the module.			

Sequence of Events Digital Input module (see page 252) – provides an interface for 16 digital inputs using a personality module. The Sequence of Events module monitors the states of the 16 digital inputs and uses digital filtering to reject state changes less than 4 msec. It performs event tagging and chatter control for each digital input.

Sequence of Events Digital Input subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24/48 VDC Single-ended (Legacy) Differential (Legacy)	16 16	1C31157G01 1C31157G01	1C31110G01 1C31110G02
125 VDC Single-ended (Legacy) Differential (Legacy)	 16	1C31157G02 1C31157G02	1C31110G01 1C31110G02
All module configurations listed in the table are CE Mark certified unless they contain a 5FDI.			

Sequence of Events Contact Digital Input Field Interface module (see page 264) - provides 16 contact input current detecting channels with common returns.

Sequence of Events Contact Digital Input Field interface subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Contact Input w/ 48 VDC On-Card auxiliary (Legacy)	16	1C31157G03	1C31110G03
All module configurations listed in the table are CE Mark certified unless they contain a 5FDI.			

Sequence of Events Compact Digital Input Field module (see page 272) – provides a low cost interface for 16 digital inputs without requiring a personality module. The Compact Sequence of Events module monitors the states of the 16 digital inputs and uses digital filtering to reject state changes less than 4 msec. It performs event tagging and chatter control for each digital input.

Sequence of Events Compact Digital Input Field subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE OR CAVITY INSERT [1]
Compact 24/48 VDC SOE Single-ended digital input	16	1C31233G01	1C31238H01[2] (molded plastic cavity insert)
Compact 24/48 VDC SOE Differential digital input	16	1C31233G02	1C31238H01[2] (molded plastic cavity insert)
Compact 24/48 VDC SOE Single Ended digital input	16	1C31233G02	5X00034G01 (Fused Pmod)
Compact 125 VDC SOE Differential digital input	16	1C31233G03	1C31238H01[2] (molded plastic cavity insert)
Compact 125 VDC SOE Single Ended digital input	16	1C31233G03	5X00034G01 (Fused Pmod)
Compact 48 VDC SOE On-card auxiliary Contact Input w/48V wetting	16	1C31233G04	1C31238H01[2] (molded plastic cavity insert)

[1] All module configurations listed in this table are CE Mark Certified.

[2] This is a cavity insert that fits into the Personality module position and provides a wiring schematic label for the module.

Enhanced Compact Sequence of Events Digital Input module (see page 304) – provides a low cost interface for 16 digital inputs without requiring a personality module. The Enhanced Compact Sequence of Events module monitors the states of the 16 digital inputs and uses digital filtering to reject state changes less than 4 msec. It performs event tagging and chatter control for each digital input. Unlike other Ovation Sequence of Events (SOE) modules, the Enhanced Compact Sequence of Events module also offers a field digital input state change detection feature (SOE One Shot).

Enhanced Compact Sequence of Events Digital Input subsystems

RANGE	CHANNELS	ELECTRONIC MODULE	PERSONALITY MODULE OR CAVITY INSERT
24/48 VDC Single-ended Digital Input - Current Sinking	16	5X00357G01	1C31238H01[1]

Range	Channels	Electronic Module	Personality Module or Cavity Insert
24/48 VDC Differential Digital Input - Current Sinking	16	5X00357G02	1C31238H01[1]
24/48 VDC (Individually Fused Channels with Common power supply) Single-Ended Digital Input - Current Sinking	16	5X00357G02	5X00034G01
125 VDC Differential Digital Input - Current Sinking	16	5X00357G03	1C31238H01[1]
125 VDC (Individually Fused Channels with Common power supply) Single-Ended Digital Input - Current Sinking	16	5X00357G03	5X00034G01
48 VDC Single-ended Digital Input - Current Sourcing (Contact input) with On-Card 48 VDC power supply	16	5X00357G04	1C31238H01[1]
24 VDC (Differential) Digital Input - Current Sinking, IEC61131-2 Compliant Type 1 Digital Inputs	16	5X00357G05	1C31238H01[1]
24 VDC (Individually Fused Channels with Common power supply) Single-Ended Digital Input - Current Sinking, IEC61131-2 Compliant Type 1 Digital Inputs	16	5X00357G05	5X00034G01
[1] This is a plastic insert that fits into the base unit’s Personality module cavity and provides a base unit terminal block wiring label for the module.			

32 Channel 24V DC Single-Ended Digital Input module (see page 375) - monitors the state ("0" or "1") of 32 single-ended field digital inputs. The 32 Channel 24V DC Single-Ended Digital Input module is designed to meet IEC 61131-2 type 3 characteristics for 24VDC digital inputs in industrial automation.

32 Channel 24V DC Single-Ended Digital Input Subsystems

Range	Channels	Electronics module	Personality module
32 Channel 24V DC Single-Ended Digital Input	32	5X00499G01	1X00690H01

2.1.4 Digital Output modules

Digital Output module (see page 382) - provides a means to switch up to 60 VDC at moderate currents (for example, relay coils and lamps). The Digital Output module contains 16 current sinking transistor outputs capable of switching 60 VDC loads at up to 500mA.

Digital Output subsystems [1]

DESCRIPTION[1]	CHANNELS	ELECTRONICS MODULE OR PANEL KIT	PERSONALITY MODULE
5-60 VDC Single ended Direct	16	1C31122G01	1C31125G01
Relay Panel Interface: Local Power Supply Field Power Supply	 16 16	 1C31122G01 1C31122G01	 1C31125G02 1C31125G03
Relay Panels: Solid State Relay Panel (AC) Solid State Relay Panel (DC) G2R Relay Panel (Low Power Electro-mechanical) KU Relay Panel [2] (High Power Electro-mechanical)	16 16 16 16	5A22410G01 5A22410G02 5A22411G01 5A22412G01 - G03	
[1] All configurations listed in the table are CE Mark certified, unless they use AC/DC solid state relay panels. [2] Two panels (8 relays each) are included in the KU Relay Panel kit 5A22412G01, G02, and G03.			

High Side Digital Output (24 VDC) module (see page 410) - an intelligent microcontroller-based digital output module. The HSDO consists of two modules, (electronics and personality), that are inserted into an Ovation I/O module base unit. The HSDO module contains sixteen optically isolated digital output channels. Each digital output channel is capable of sourcing up to 500 mA of output current.

High Side Digital Output (24VDC) subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24VDC	16	5X00270G01	5X00273G01

Relay Output module (see page 424) - consists of an Electronics module, a base assembly, and relays. The Relay Output module provides a means to switch high AC voltages at high currents to field devices. There are two versions of the Relay Output base assembly which contain either 12 or 16 relays within each base.

The Relay Output base assembly does not incorporate a Personality module. For more information on module configuration, refer to the following topics: *Electronics modules (Emod)* (see page 424), *Base assemblies* (see page 424), and *Panel kits* (see page 425).

Fused Relay Output module (see page 447) - provides a means to switch high current and voltage devices located in the field. You have a choice between a fused low power relay output assembly and a fused high power relay output assembly for differing applications.

The Fused Relay Output base assembly does not incorporate a Personality module. For more information on module configuration, refer to the following topics: *Electronics modules (Emod)* (see page 447) and *Base assemblies - (FRO)* (see page 448).

32 Channel 24 VDC Single-Ended Digital Output module (see page 458) - contains 32 24-volt single-ended digital output channels. Each digital output channel is capable of sourcing up to 500 mA of output current with a 2A maximum total output current limit per module.

32 Channel 24V DC Single-Ended Digital Output subsystems

DESCRIPTION	CHANNELS	ELECTRONICS MODULE OR PANEL KIT	PERSONALITY MODULE
32 Channel 24V DC High-Side, Single-Ended Digital Output	32	5X00500G01	1X00691H01

2.1.5 Bus interface modules

Foundation Fieldbus module – The Ovation Foundation Fieldbus module provides a means to interface the Ovation system to industry standard Foundation Fieldbus devices. The interface to the module is through the Ovation I/O bus; therefore, this module is native to Ovation as opposed to an add-on or linking approach.
The Ovation Foundation Fieldbus module interfaces with one or two networks. The module supports redundancy and can be installed on each network. Only one module can be the master at any given time. Inter-module redundancy communication is handled through a private RS232 communication link between the redundant pair. The communication cable is connected to a RJ45 jack on the Pmod.

Foundation Fieldbus subsystems

CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
2 (non-redundant)	5X00301G01	1C31238H01 (cavity insert)
2 (redundant)	5X00301G01	5X00327G01

Profibus module – Profibus (**Pro**cess **Fi**eld **Bus**) DP (decentralized periphery) is an all digital, two-way communication system that links devices (also known as slaves) and automation systems. A decentralized periphery uses a network bus (in this instance, Profibus) between the Controller (Ovation) and its connected I/O channels. Therefore, the I/O is decentralized as compared to a programmable logic Controller (PLC) that has its I/O arranged centrally. At the base level in the hierarchy of plant networks, Profibus serves as a Local Area Network (LAN) for instruments.

Profibus subsystems

CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
2	5X00300GO1	5X00321G01

DeviceNet module (see page 466) – The Ovation DeviceNet Module provides an interface with one or two DeviceNet networks, respectively. The DeviceNet has an associated Personality Module. DeviceNet offers robust, efficient data handling based on Producer/Consumer technology that allows you to determine effectively what information is needed and when.

DeviceNet subsystems

CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
2	5X00376G01	5X00375G01

Ethernet Link Controller – The Ethernet Link Controller provides an interface with a single Ethernet link. This module uses a straight RJ45 connector which allows the port to be accessed outside of the Electronics module.

Ethernet Link Controller subsystems

CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
2	5X00419GO1	1X000569H01

2.1.6 Specialty Modules

Link Controller module (see page 497) – provides a serial RS232, RS422, or RS485 data communications link to a third-party device or system. To use this module, the appropriate SLC algorithm must reside in the Ovation Controller.

Link Controller subsystems[1]

Range	Channels	Electronics module	Personality module
RS232	One (1) Serial Port (Able to handle many points)	1C31166G01[2] or 1C31166G02	1C31169G01
RS485/RS422 Four wire	One (1) Serial Port (Able to handle many points)	1C31166G01[2] or 1C31166G02	1C31169G02

[1] All module configurations listed in the table are CE Mark Certified. 1C31166G02 pending CE Mark Certification.

[2] Not for new projects. Used for spares and replacements only.

To use this module, the appropriate SLC algorithm must reside in the Ovation Controller. (See *Ovation Algorithm Reference Manual*.)

Loop Interface module (see page 499) – provides an interface to the analog and digital I/O needed to control a single process loop (up to 2 AI, 1 AO, 2 DI, 2 DO). In addition, the loop interface can display the process information and provide for manual control via a local operator interface station (SLIM).

Loop Interface subsystems[1, 4]

Range	Channels	Electronics module	Personality module
Normal (Non-electric) Drive modules			
0-10V Analog Inputs/Output 0-10V AI/AO - user defined Digital Inputs[2]	6 6	1C31174G01 1C31174G21	1C31177G01 1C31177G01
0-5V Analog Inputs, 0-10V Analog Output 0-5V AI, 0-10V AO - user defined Digital Inputs[2]	6 6	1C31174G02 1C31174G22	1C31177G01 1C31177G01
4-20mA AI/AO Locally powered analog inputs 4-20mA AI/AO Field powered analog inputs 4-20mA AI/AO - user defined Digital Inputs[2] Locally powered analog inputs 4-20mA AI/AO - user defined Digital Inputs[2] Field powered analog inputs	6 6 6 6	1C31174G03 1C31174G03 1C31174G23 1C31174G23	1C31177G02 1C31177G03 1C31177G02 1C31177G03

Pulse Accumulator module (see page 527) – counts pulse for up to two input channels and provides the information to the Controller. The Pulse accumulator may be used to count over a defined time period to measure speed (frequency), count until instructed to stop, or can be used to measure the duration of a pulse.

Pulse Accumulator subsystems [1]

Range	Channels	Electronics module	Personality module
Field count: +5/12V (medium speed) + 24/48V (medium speed) Field controls: +24/48V	2	1C31147G01	1C31150G01
Field count: +5/12V (medium speed) + 24/48V (medium speed) Field controls: +24/48V	2	1C31147G01	1C31150G02
Field count: +5/12V (medium speed) +24/48V (medium speed) Field controls: +24/48V	2	1C31147G01	1C31150G03
Field count: +5V (high speed)	2	1C31147G02	1C31150G01
Field count: +5V (high speed)	2	1C31147G02	1C31150G02
Field count: +5V (high speed)	2	1C31147G02	1C31150G03
[1] +24/48V medium-speed configurations are CE Mark Certified.			

Servo Driver module **(see page 553)** – provides an interface to an electro-hydraulic servo actuator (servo-motor) used to control a steam turbine.

Servo Driver subsystems [1]

Range	Channels	Electronics module	Personality module
±16 Volts DC to a DC LVDT 60 mA into a 60 ohm coil (CD1) or 40 mA into an 80 ohm coil (CD2) or 40 mA into a 40 ohm (CD3) coil	6	1C31199G01	1C31201G01
19 Volts AC peak-to-peak 1 KHz to an AC LVT 8 mA into two 1000 ohm coils	6	1C31199G02	1C31201G02
19 Volts AC peak-to-peak 3 KHz to an AC LVT 8 mA into two 1000 ohm coils	6	1C31199G03	1C31201G02
±16 Volts DC to a DC LVDT (Firmware) 60 mA into a 60 ohm coil (CD1) or 40 mA into an 80 ohm coil (CD2) or 40 mA into a 40 ohm (CD3) coil	6	1C31199G04	1C31201G01
19 Volts AC peak-to-peak 1 KHz to an AC LVT (Firmware) 8 mA into two 1000 ohm coils	6	1C31199G05	1C31201G02

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
19 Volts AC peak-to-peak 3 KHz to an AC LVT (Firmware) 8 mA into two 1000 ohm coils	6	1C31199G06	1C31201G02

Small Loop Interface module (see page 610) – contains displays and keyboard inputs needed for an operator to monitor and control the I/O functions of the Ovation Loop Interface or Valve Positioner module. The SLIM is located external to the Ovation I/O cabinet and connected to the Loop Interface or Valve Positioner via cable.

For more information on module configurations, refer to *Assemblies - SLIM (see page 609).*

Speed Detector module (see page 610) – provides the Controller with frequency measurements of a sinusoidal or pulse train tachometer. A 16-bit output can be updated at a rate of 5 ms for over-speed detection, and a 32-bit output can be updated at a variable rate for speed regulation.

Speed Detector has the G01 and the G03 subsystems. For more information refer to *Subsystems - (SD)* (see page 610).

Valve Positioner module (see page 627) – provides an interface to an electro-hydraulic servo actuator. Governor valves, interceptor valves, extraction valves, and bypass valves can be controlled. The module provides closed loop valve positioning control and also interfaces to a local operator interface station (SLIM).

Valve Positioner Subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Valve Positioner Controller			
17 Volts AC LVDT: 24.9 mA	8	1C31194G01	1C31197G01
17 Volts AC LVDT: 16.8 mA	8	1C31194G01	1C31197G02
17 Volts AC LVDT: 8.3 mA	8	1C31194G01	1C31197G03
17 Volts AC LVDT: 36 mA	8	1C31194G01	1C31197G04
24 Volts Fused DC LVDT: 50 mA	8	1C31194G01	1C31197G05
23.75 Volts AC LVDT: 24.9mA	8	1C31194G02	1C31197G01
23.75 Volts AC LVDT: 16.8 mA	8	1C31194G02	1C31197G02
23.75 Volts AC LVDT: 8.3 mA	8	1C31194G02	1C31197G03
23.75 Volts AC LVDT: 36 mA	8	1C31194G02	1C31197G04
24 Volts Fused DC LVDT: 50 mA	8	1C31194G02	1C31197G05

Numalogic Fast Ethernet Remote Node (see page 708) - is a remote I/O subsystem which provides an interface to the Numalogic PC700 series Remote I/O. The NFE-RN is comprised of a base assembly, power supplies, and redundant Numalogic Fast Ethernet Remote Node Controllers (NFE-RNCs). The NFE-RNCs contain four Ethernet ports.

Numalogic Fast Ethernet Remote Node

PART	NUMBER
Numalogic Remote I/O Kit	5X00512
Numalogic Remote Node Controller	5X00467
PWSN Power Supply Assembly	5X00522
Numalogic Remote I/O Backplane Assembly	5X00468

2.2 Emod - Pmod Combinations

There are three lists of Emod/ Pmod combinations which include:

1. Standard Ovation modules:
   - ☐ Analog Input
   - ☐ Analog Output
   - ☐ Digital Input
   - ☐ Digital Output
   - ☐ Bus modules
   - ☐ Specialty modules
2. Q-Line Migration modules using the new latch numbers (e.g., G01).
3. Q-Line Migration modules using the old latch numbers (e.g., G31).

Note: *The Q-line Migrations modules ending with G31 are being phased out and replaced with the new, easier to use, new latches using the same part numbers, but replacing the G31 with G01.*

S E C T I O N 3

I/O Module general information

IN THIS SECTION

3.1 Ovation I/O module features

- Ovation I/O is available in both remote and local configurations.
- Modular, plug-in components.
- Quick installation and configuration of the modules.
- DIN Rail mounting of the I/O Base Units.
- Wiring schematic labels are provided on Personality modules and cavity inserts.
- Wiring directions (**N**ormally **C**losed, **N**ormally **O**pen, **C**ommon) are provided on the Base Unit for Relay Output modules.
- Writable surface labels are provided on Electronics modules so that up to 16 point names can be identified on each label.
- The labels on the Personality and Electronics modules are color-coded to match the appropriate modules.
- Unique base unit interconnection scheme eliminates most power and communications wiring.
- Module style, group, serial number, and revision are stored electronically on each I/O module.
- *Hot swapping* capabilities streamline maintenance. (See *Planning Your Ovation System*.)
- Status indicators that display standardized diagnostic LED color codes.
- Up to 128 Local Ovation module units per Controller.
- Up to 1024 Remote Ovation module units per Controller.
- Base Unit common to all Standard I/O modules.
- Two Base Unit styles (G2R and KUEP) are available for Relay Output modules.
- Test-point/probe holder on each field terminal of standard I/O Base Units.
- Built-in spare fuse holders and wire strip gauge, located on top of the middle plastic separator section (between the terminal strips) of a base unit.
- Most modules are CE Mark compliant.

3.2 Installing Ovation modules

DIN rails and modules are typically installed at the factory according to system requirements. If you need to replace or add Relay Output modules to your system, see *Planning Your Ovation System*.

Standard and Compact I/O Modules

The Ovation standard and compact modules are installed in base units mounted on DIN rails in Ovation cabinets. Each base unit can contain two I/O modules, and even if you only use one I/O module, you must still use a base unit that contains two terminal blocks.

Relay Output Modules

The Ovation Relay Output modules are installed in base units mounted on DIN rails in Ovation cabinets. Each base unit can contain one Relay Output Electronics module and the appropriate relays.

There are two styles of Relay Output Base Units (see page 36):

- 1C31223 (16 G2R relays)
- 1C31222 (12 KUEP relays)

3.3 Ovation Module Configuration and Status

An Ovation I/O module has 16 address locations, but a module might not use all 16 addresses.

There are four possible address locations in each I/O module that are reserved for special use. Three of these addresses provide configuration (Write) and status (Read) information.

Definitions for these locations are provided for each module in the module reference pages:

- **Address word 13** (D in Hex) is present for every module and is used for configuration and status. The module status provides diagnostic information that is read by the Controller when it is online. The status register can be read by using the Point Information window at an Ovation Operator Station. The Bit Pattern Field can be read on the Hardware Tab of the Point Information window (See the *Ovation Operator Station User Guide*.)
- **Address word 14** (E in Hex) is used as a secondary or expansion configuration register and is only used when needed.
- **Address word 12** (C in Hex) is used for reporting point specific fault information and optionally as an expansion configuration register.
- **Address word 15** (F in Hex), is used for the module Electronic ID information. This location and its use are identical for all modules.

Configuration settings for these registers for a point can be viewed in the applicable Point Builder section of your system manuals. (See *Ovation Developer Studio User Guide* for the Windows system, and *Ovation Init and Admin Tools User Guide* for the Solaris system.)

3.4 Ovation Module Diagnostic LEDs

Every Ovation module contains diagnostic LEDs. These are used to indicate the status of the module and to alert you to any module problems.

All I/O modules contain the following LEDs:

- **P** = (Green) Power OK LED is lit when the power supply to the module is good.
- **C** = (Green) Communications OK LED is lit when the Controller is communicating with the module, and when the communication watchdog timer is not timed out.
- **E** = (Red) Optional External Error LED is lit when there is a problem external to the module, such as a blown common auxiliary power supply fuse.
- **I** = (Red) Internal Fault LED is lit when a failure internal to the module has occurred. This LED is typically an indication that the Electronics module needs to be replaced.

Note: *A communication timeout also lights the Internal Fault LED and turns off the Communications OK LED.*

The other LEDs for each module vary according to the functions of the module. Definitions for LEDs are provided for each module in their individual sections.

3.5 What is involved in the Replacement of User Serviceable Fuses?

Some Electronics modules (Emods) and Personality modules (Pmods) may contain fuses. These fuses are typically 5 x 20 mm micro-fuses, and are conveniently located (see page 32) for easy replacement.

3.5.1 Electronics Module Fuses

If a fuse needs to be replaced, push the fuse cap in, turn it one-quarter turn counter-clockwise, and the fuse pops up. Replace the blown fuse with an exact replacement fuse. Fuse sizes are indicated on the Electronics module label. Refer to the following table for descriptions of fuses used by Ovation Electronics modules.

Note: *In CE Mark Certified systems, the project drawings **MUST** include any fuses and their ratings, if they are replaceable by a qualified technician.*

TYPE	RATING	MODEL	PART #
5 x 20 mm cartridge	0.50A; 250V; Fast acting	Compact Digital Input Emod (1C31232G01) Compact Sequence of Events Emod (1C31233G01)	EX06100

3.5.2 Personality module fuses

If a 5x20 mm cartridge fuse needs to be replaced, push the fuse cap in, turn it one-quarter turn counter-clockwise, and the fuse pops up. Replace the blown fuse with an exact replacement fuse. Fuse sizes are indicated on the Personality module label. Refer to the following table for descriptions of fuses used by Ovation Personality modules.

If the fuse is a micro fuse, pull the blown fuse out of its holder and plug the replacement fuse into the vacated holder.

Note: *In CE Mark Certified systems, the project drawings* ***MUST*** *include any fuses and their ratings, if they are replaceable by a qualified technician.*

TYPE	RATING	MODEL	PART #
a5 x 20 mm [2]	0.50A; 250V [1]	Digital Input Pmods Sequence of Events (1C31110G01)	EX06100
5 x 20 mm [2]	0.063A; 250V [1]	Analog Input Pmods 1C31116G02 - G03 Loop Interface Pmods 1C31177G02 - G03	EX06102
5 x 20 mm [2]	0.63A; 250V [1]	Pulse Accum. Pmods 1C31150G01 - G03	EX06071
5 x 20 mm [2]	1.0A; 250V [1]	Relay Base 16 G2R - 1C31223G01	EX06104
5 x 20 mm [2]	1.25A; 250V [1]	Loop Interface Pmods1C31177G01 - G03 Digital Output Pmods - 1C31125G01 Valve Positioner Pmods 1C31197G01 - G04 Relay Panels (Solid State) 5A22410H01 - H02 Relay Panels (16 G2R) - 5A22411H01	EX06098
5 x 20 mm [2]	2.0A; 250V [1]	Relay Panels (8 KU) - 5A22412H01 Relay Base (12 KUEP) - 1C31222G01	EX06105
5 x 20 mm [2]	3.15A;250V [1]	Digital Output Pmods - 1C31125G02	EX06101
Micro-Fuse [3]	0.5A;125V [1]	16 Point Individually fused, Digital Input Pmod - 5X00034G01 HART Analog Input Pmods 5X00063G01	1X00030H02
Micro-Fuse [3]	0.063A;125V [1]	HART Analog Input Pmods Analog Inputs - 5X00059G01	1X00030H01
Micro-Fuse [3]	0.6A;125V [1]	HART Analog Output Pmods 5X00063G01	1X00030H05
[1] Fast Acting [2] Cartridge [3] Plug-in			

3.5.3 Ovation Cabinet Fuses

In addition to Personality module fuses, there are other fuses that can also be serviced by users. Refer to the following table for descriptions of fuses used in Ovation cabinets.

TYPE	RATING	MODEL	PART #	NOTES
Micro-Fuse	5.0A; 250V; Fast acting	CBO Backplane 3A99200G01 - G02 ROP Panel 4D33922G01 TND Panel 4D33924G01 RRP Panel 3A99252G01 RRB Panel 3A99253G01	4A00120H01	Auxiliary power Branch fuses CBO: F1 -F4 ROP: F1, F2, F7, F8 TND: F1, F2, F6, F7 RRP: F1, F2 RRB: F1, F2
0001.2515 Schurter	12.5A; 5x20; 250VAC; 125VDC Type T	Power Distribution Panel 5X00489G01	1X00728H01L	AUX Power Fuse F1

3.6 Personality Module Jumpers

Most of the Ovation Personality modules do not have configurable jumpers. However, if a module does have configurable jumpers, and the default settings need to be changed, the card must be removed from the Personality module case in order to be configured. Use the following procedure to open a Personality module case:

***Note:** Be sure to observe static electricity guidelines.*

1. Use a small straight-edge screwdriver to press in one of the clips located on the side of the module until the module cap is loosened. Remove the module cap.
2. Push both clips on the module bottom outward until the card is free to slide.
3. Slide the card out the top of the module and make the desired jumper changes.
4. Slide the card back into the module case, being sure the card is positioned in the card channels, and the bottom clips are engaged.

5. Replace the module cap.

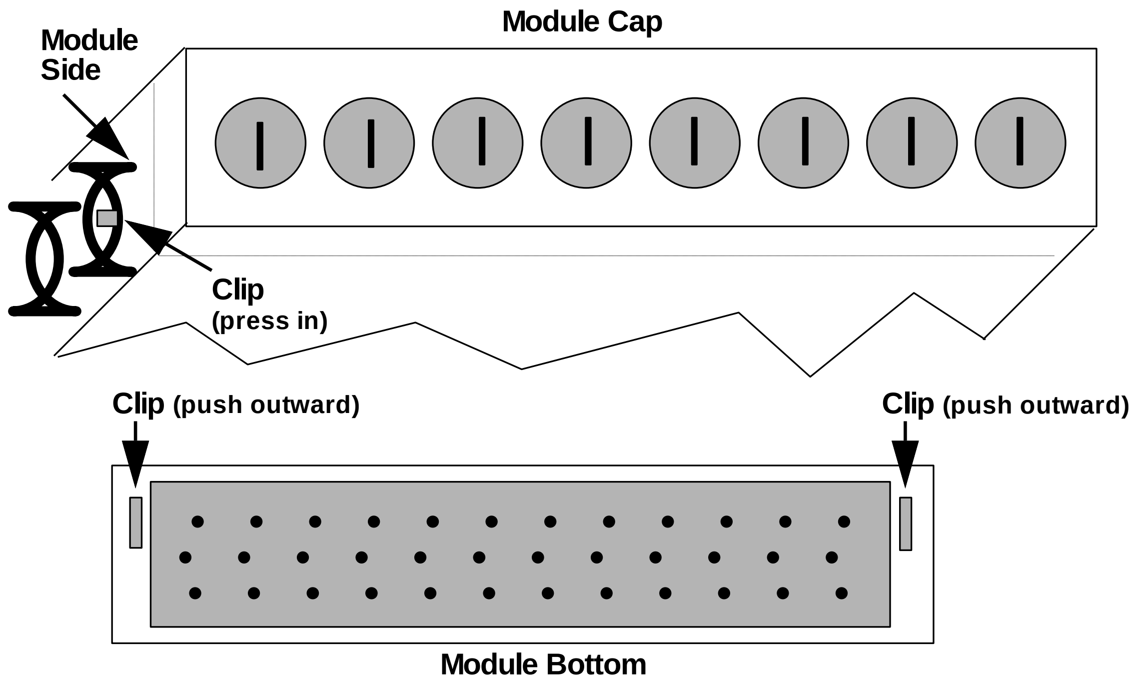


Figure 1: Module Cap

3.7 I/O environmental specifications

The following tables provide common environmental specifications for the Ovation I/O modules.

I/O Module specifications

Description	Minimum Value	Maximum Value
Temperature	0^{o}C (32^{o} F) Operating - 40^{o}C (-40^{o}F) Storage	60^{o}C (140^{o}F) Operating 85^{o}C (185^{o}F) Storage
Humidity (non-condensing)	0% Operating	95% Operating 90% Operating (CE Mark) Maximum wet bulb temp 35^{o}C

Relay Output module specifications

DESCRIPTION	MINIMUM VALUE	MAXIMUM VALUE
Temperature [1] Relay Output G2R/KUEP Form X Relay Output KUEP Form C	 0^{o}C (32^{o}F) Operating - 40^{o}C (-40^{o}F) Storage 0^{o}C (32^{o}F) Operating - 40^{o}C (-40^{o}F) Storage	 60^{o}C (140^{o}F) Operating 70^{o}C (158^{o}F) Storage 45^{o}C (113^{o}F) Operating 50^{o}C (122^{o}F) Storage
Humidity (non-condensing) Relay Output G2R Relay Output KUEP Form X/Form C	 35% Operating N/A	 85% Operating Maximum wet bulb temp 35^{o}C N/A
[1] See Relay Output Module (see page 424) for additional temperature and derating information relative to specific cabinet configuration.		

3.8 Standard module components

Standard I/O modules combine special Personality modules with Electronics modules in order to operate at a wide range of signals, and perform a multitude of functions.

The standard Ovation modules are illustrated below and consist of the following:

- Base Units (containing I/O bus power, signals, and field terminations).
- Electronics modules.
- Personality modules (foam inserts are used instead of Personality modules for some I/O modules).

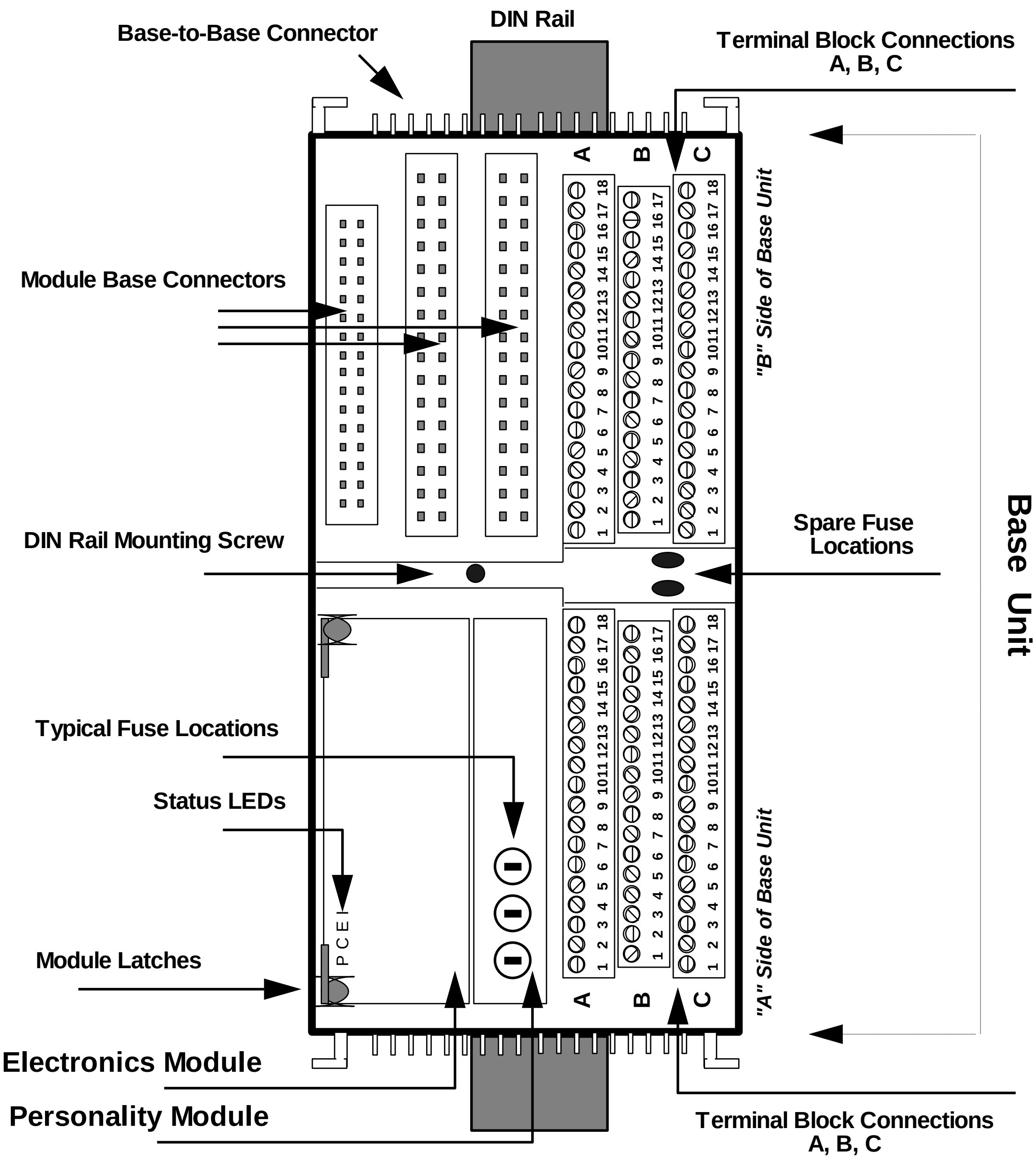


Figure 2: Ovation modules (Top View)

1. **Base Unit**

   The base unit (containing two terminal blocks) mounts onto a DIN rail. Each base unit accommodates two I/O modules.

   The footprint of the base unit (containing Electronic and Personality module) is:
   27.9 cm Long (11 in)
   12.7 cm Wide (5 in)
   16.5 cm High (6.5 in)

   If you use only one I/O module, you still must use a base unit that contains two terminal blocks.

   For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See *Marshaling Base Unit* (see page 35) for more information.

CAUTION! *For CE Mark Certified Systems:*

Base units containing differential digital input modules configuration with hazardous input voltages (>30 V RMS, 42.4 V peak, or 60 VDC) listed in the following table must include a hazardous voltage warning label (1B30025H01) on that base unit. Hazardous voltage is present on the individual module terminal blocks and module connector(s).

Differential digital input module configurations with hazardous input voltages

Configuration	Emod	Pmod
125VAC/VDC Digital Input (Diff)	1C31107G02	1C31110G02
125VAC/VDC Compact Digital Input (Diff)	1C31232G03	1C31238H01
125VDC Sequence of Events (Diff)	1C31157G02	1C31110G02
125VDC Compact Sequence of Events (Diff)	1C31233G03	1C31238H01
125VDC Enhanced Compact Sequence of Events (Diff)	5X00357G03	1C31238H01

CAUTION! Base units containing single ended or fused digital input modules with hazardous voltages (>30 V RMS, 42.4 V peak, or 60 VDC) listed in the following table must include a hazardous voltage warning label (1B30025H01) on the base unit as well as ALL base units of the branch. Hazardous voltage is present on terminal block and module connectors of bases on an entire branch. In addition, auxiliary power fuses must be removed and a fuse cover kit should be added (see page 799).

Base units containing single ended or fused digital input modules with hazardous voltages

Configuration	Emod	Pmod
125VAC/VDC Digital Input (Sing)	1C31107G02	1C31110G01
125VAC/VDC Compact Digital Input (Fused)	1C31232G03	5X00034G01
125VDC Sequence of Events (Sing)	1C31157G02	1C31110G01
125VDC Compact Sequence of Events (Fused)	1C31233G03	5X00034G01
125VDC Enhanced Compact Sequence of Events (Fused)	5X00357G03	5X00034G01

CAUTION! Hazardous labels must be placed in a visible location on the base unit, preferable above the spare fuse location. This information must be indicated in the application specific project drawings.

2. **Electronics module** (Emod)

   The Electronics module (configured by adding the appropriate Personality module) fits into the base unit.

3. **Personality module** (Pmod)

   The Personality module (configures the Electronics module) fits into the base unit beside the appropriate Electronics module.

Note: *The Personality module is installed in the base unit* ***first****. Then, the Electronics module is installed and interlocks with the Personality module. The blue corner latches on the Electronics module locks both modules into the base unit.*

Wires from customer field devices are connected to terminal block in the base unit.

The wiring connections to the terminal block for each combination of Electronics module and Personality module are printed on each Personality module, and are illustrated in each module description in the following sections.

3.8.1 Marshalling Base Unit

Marshalling Base (5X00334G01)

Cable Connector (1X00439H01)

The Ovation Marshalling Base Unit serves as an interface between the field connections, the I/O bus, and the Personality and Electronics Modules. The I/O bus is used by the Controller to communicate with the I/O subsystem via the Ovation Marshalling Base Unit Backplane. Power is also distributed to the Electronics Modules via the I/O bus.

The Ovation Marshalling Base Unit is similar to the Ovation I/O Base (1B30035) except the field termination terminal block is replaced with 17 Pin Headers. The Headers are mated to a plug with a screw flange and with a 17-position screw connection. This arrangement allows the use of pre-fabricated cables for the field wiring and provides secure anchoring of the cable.

The following figure depicts the Marshalling Base Unit identifying the Aux power terminals (+) A17 and (-) B17.

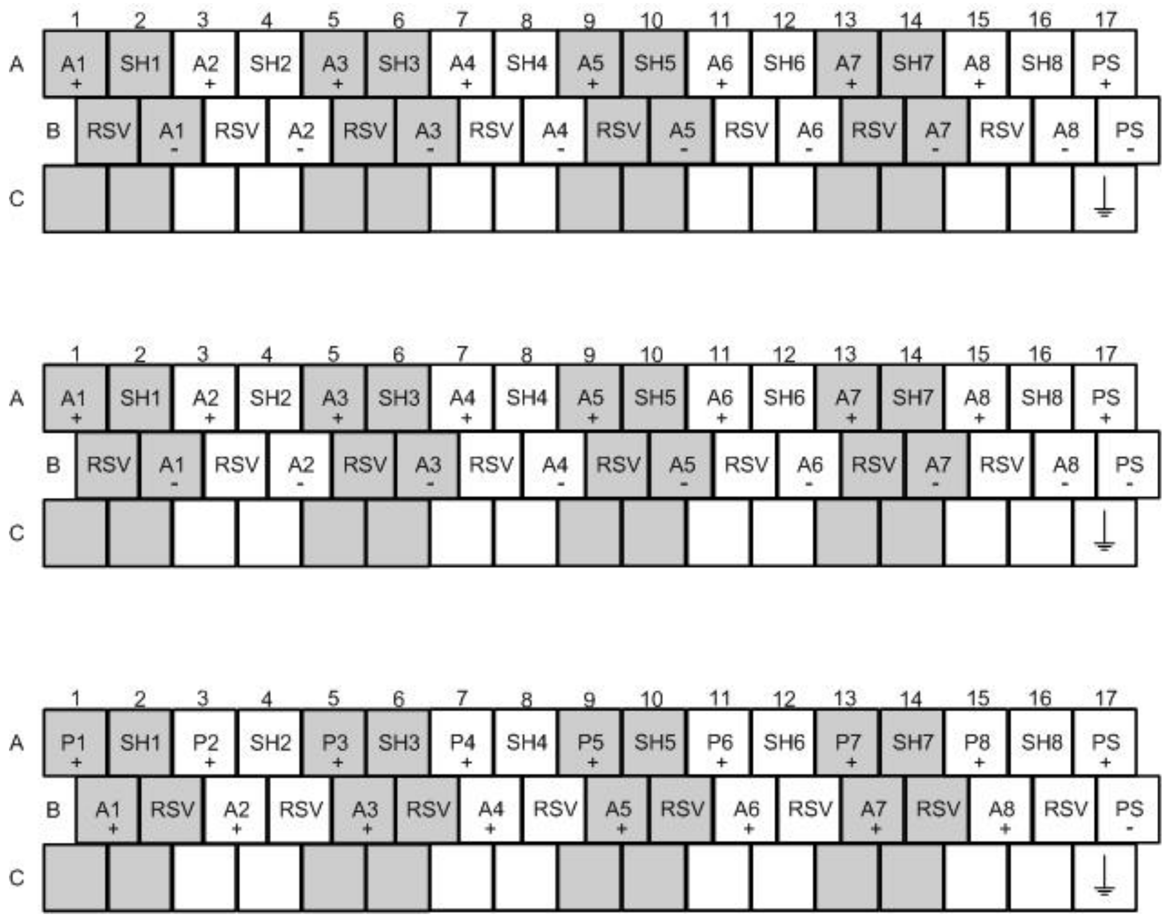


Figure 3: Marshalling Base Unit

3.9 Relay module components

The Ovation Relay module consists of two parts, refer to the following figures:

1. Base Unit

   The relay base assembly consists of a backplane with connectors, a plastic housing, and a DIN rail clamping/grounding mechanism. This unit accommodates the relays for interfacing with field devices.

2. Relay Output Electronics module

   The relay output Electronics module is an on-line replaceable module that provides the relay output circuit board. This board contains relay coil drive interfacing as well as I/O bus and bus power interface. This module plugs into the desired relay output base unit.

The wires from the customer field devices are connected to the terminal block in the base unit.

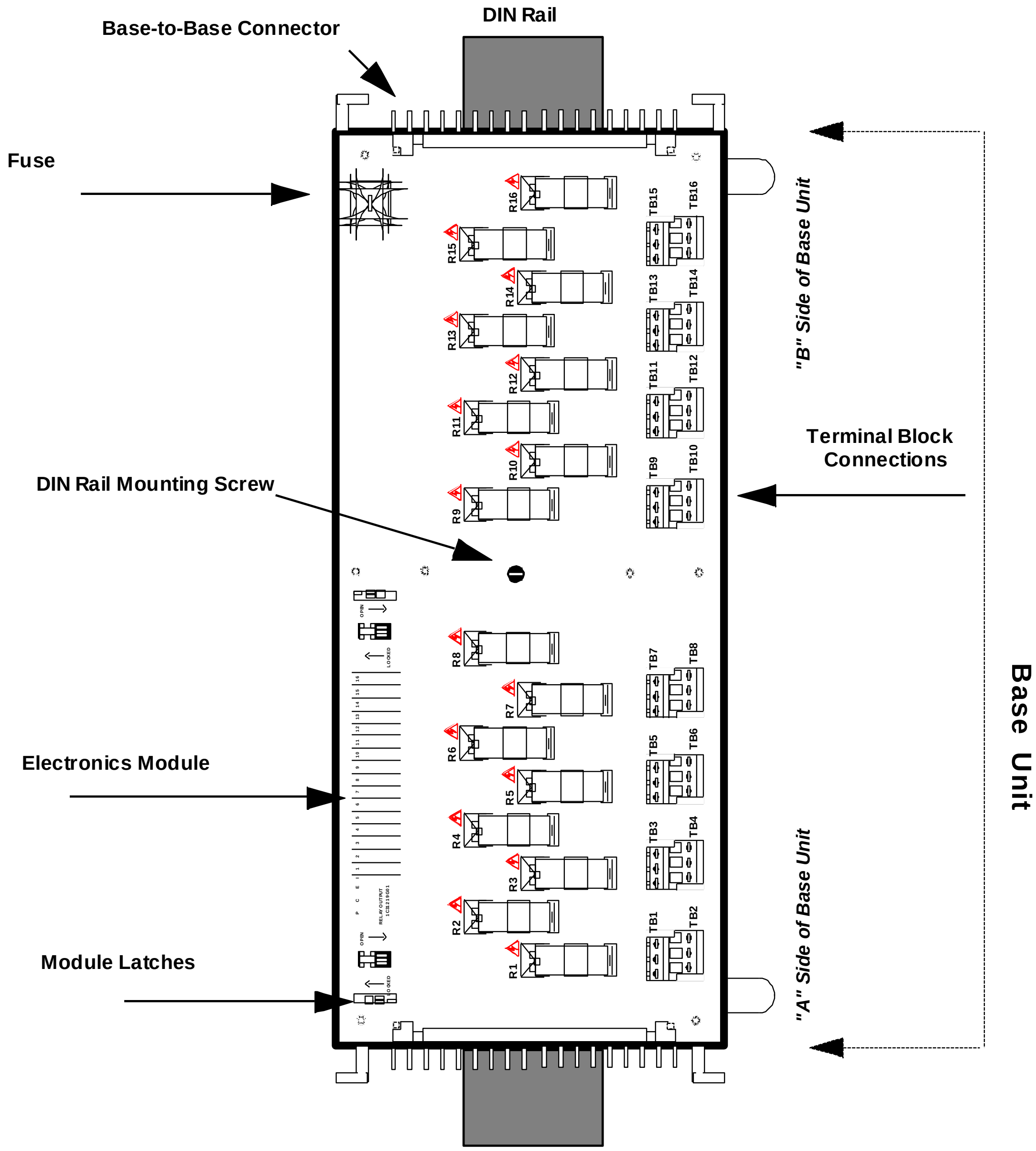


Figure 4: Relay Output Panel G2R

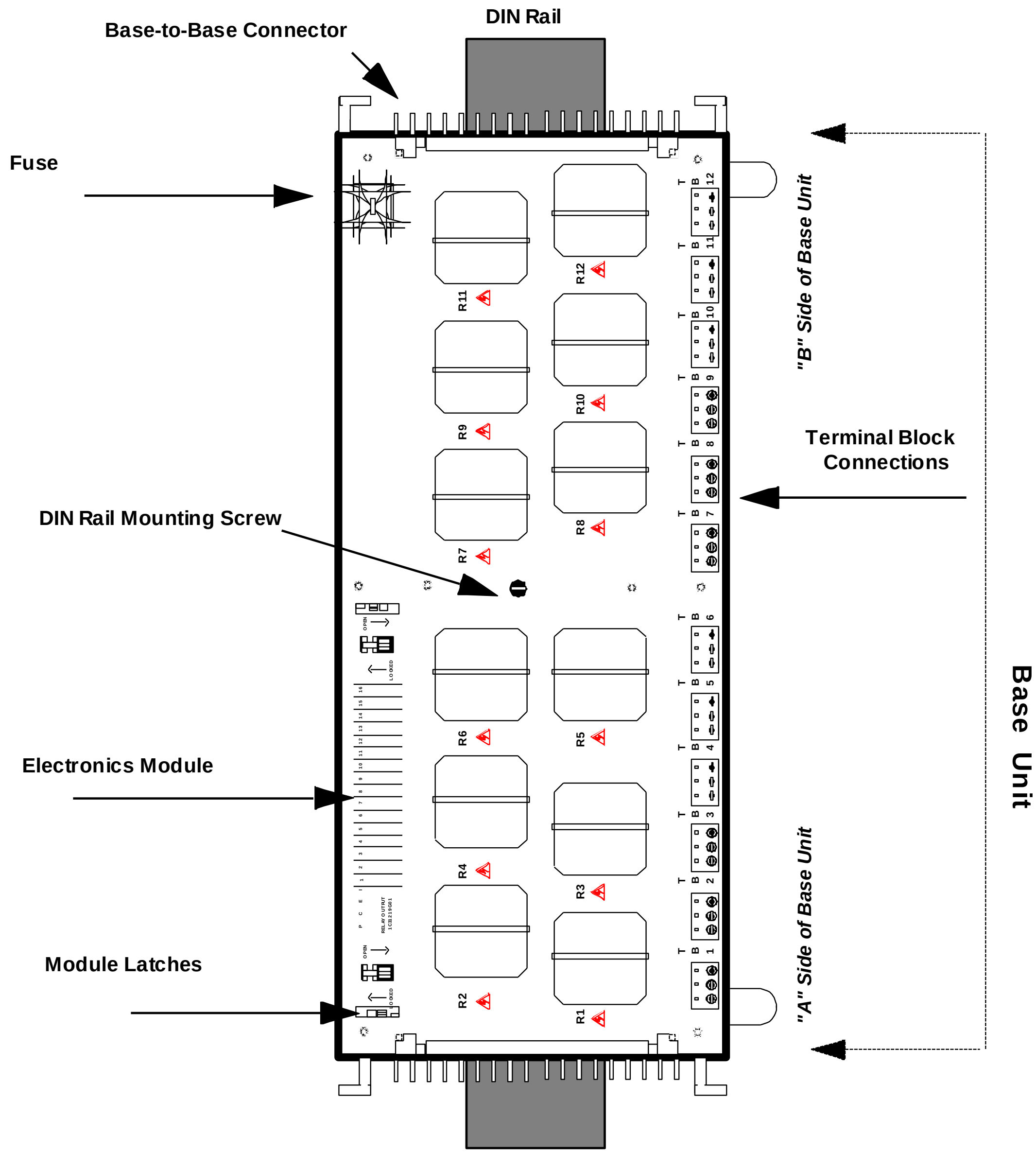


Figure 5: Relay Output KUEP

SECTION 4

Analog Input modules

IN THIS SECTION

4.1 Analog Input module (13-Bit) - (AI-13)

The Ovation Analog Input module with an associated Personality module provides signal conditioning and analog-to-digital conversion for eight galvanically isolated analog inputs. Field inputs are surge protected and routed by the appropriate Personality module and then sent to the Electronics module for conversion.

The Analog Input module (13 bits) is applicable for CE Mark Certified Systems.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

4.1.1 Electronics modules (Emod) - (AI-13)

- **1C31113G01** provides voltage input range of ± 20 mV.
- **1C31113G02** provides voltage input range of ± 50 mV.
- **1C31113G03** provides voltage input range of ± 100 mV.
- **1C31113G04** provides voltage input range of ± 1 V.
- **1C31113G05** provides voltage input range of ± 5 V.
- **1C31113G06** provides voltage input range of ± 10 V.

4.1.2 Personality modules and jumper settings (Pmod) - (AI-13)

- **1C31116G01** provides voltage analog inputs.
- **1C31116G02** provides field-powered current analog inputs.
- **1C31116G03** provides locally powered current analog inputs.
- **1C31116G04** provides voltage analog inputs with a temperature sensor for cold junction thermocouple compensation.

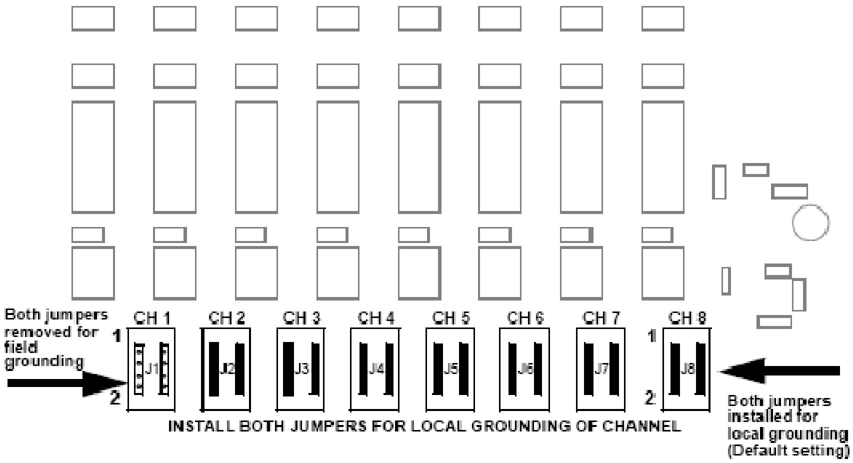


Figure 6: Jumper settings for analog input personality module (1C31116G01 & 04)

Note: *The circuit board must be removed from the module housing to access the jumpers (see page 29).*

4.1.3 Subsystems - (AI-13)

Analog Input subsystems (13-bit)[1]

RANGE	CHNLS	ELECTRONICS MODULE	PERSONALITY MODULE
± 20mV	8	1C31113G01[1]	1C31116G01
± 50mV	8	1C31113G02[1]	1C31116G01
± 100mV	8	1C31113G03[1]	1C31116G01
± 20mV Compensated (Thermocouple)	8[3]	1C31113G01[1]	1C31116G04
± 50mV Compensated (Thermocouple)	8[3]	1C31113G02[1]	1C31116G04
± 100mV Compensated (Thermocouple)	8[3]	1C31113G03[1]	1C31116G04
± 1 VDC	8	1C31113G04[1]	1C31116G01
± 5 VDC	8	1C31113G05[1]	1C31116G01
± 10 VDC	8	1C31113G06[1]	1C31116G01

RANGE	CHNLS	ELECTRONICS MODULE	PERSONALITY MODULE
0-20 mA Field powered (4-20 mA Field powered can also be selected in the I/O Builder for Solaris applications; card is configured appropriately)	8	1C31113G05[1, 2]	1C31116G02
0-20 mA Locally powered (4-20 mA Locally powered can also be selected in the I/O Builder for Solaris applications; card is configured appropriately)	8	1C31113G05[1, 2]	1C31116G03
[1] This module configurations is CE Mark Certified. [3] This module configurations is CE Mark Certified (Non-EMC Cabinet). [3] A ninth logical channel (does not connect to a device) is provided when using the Analog Input module with temperature sensor. This ninth point is needed for the **CJ Compensation field** of the Point Builder Instrumentation Tab when defining the eight other thermocouple points for the AI module. (See *Ovation Init and AdMin User Guide* (for Solaris) or *Ovation Developer Studio User Guide* (for Windows).			

4.1.4 External power supply information - (AI-13)

Note: *Module power specifications (main and auxiliary) refer to the actual power drawn by the module from the 24VDC main power supply and from the auxiliary power supply (if required) and **NOT** from the AC or DC Mains.*

If the Analog Input module uses the 1C31116G03 Personality module (configured with locally powered current analog inputs), the required voltage source may be obtained from the internal auxiliary power supply (backplane) or it may be obtained from an external power supply.

If an external power supply is used, Using an External Power Supply (see page 799) contains steps follow before connecting the external power supply to the Analog Input module base unit terminal block. The Analog Input module auxiliary supply voltage level (24 VDC or 48 VDC) depends on the external transmitter devices being interfaced to the (AI) module's analog inputs.

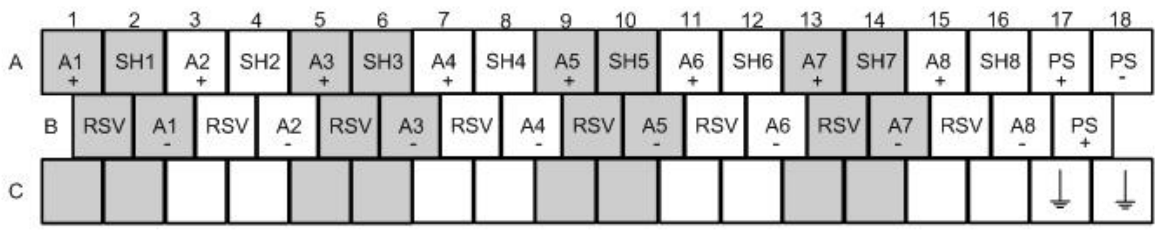
4.1.5 Terminal block wiring information - (AI-13)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

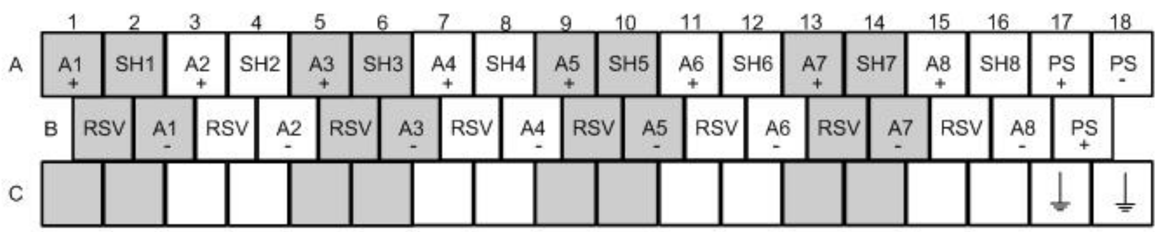
The diagrams for the analog input Personality modules are illustrated in the following figure. The following table lists and defines the abbreviations used in those diagrams.

Voltage Input: (1C31116G01)
Thermocouple Input: (1C31116G04)



Note: Internal jumpers are in this personality module for locally grounding the shield and (-) connections to earth ground.

Field Powered Current Loop: (1C31116G02)



Locally Powered Current Loop: (1C31116G03)

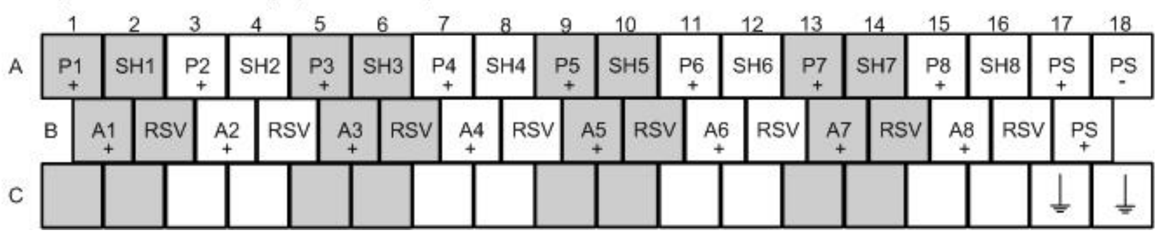
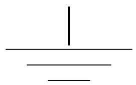


Figure 7: Terminal block connections for the Analog Input Personality modules

Shielded twisted-pair wire should be used for the field interface. For analog input signals; the (-) and shield should be tied together to earth ground either locally at the cabinet or at the field device.

Abbreviations used in diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals
A1 - A8 +	Analog Input positive terminal connection
A1 - A8 -	Analog Input negative terminal connection
P1 - P8 +	Positive terminal connection for current loop power
PS+, PS-	Auxiliary power supply terminals
RSV	Reserved terminal. No connections allowed on these terminals.
SH1 - SH8	Shield terminal connection.

Note: *Do **not** use unmarked terminal block locations.*

*Shield terminals (SH) are **not** connected in CE Mark systems.*

4.1.6 Field connection wiring diagrams - (AI-13)

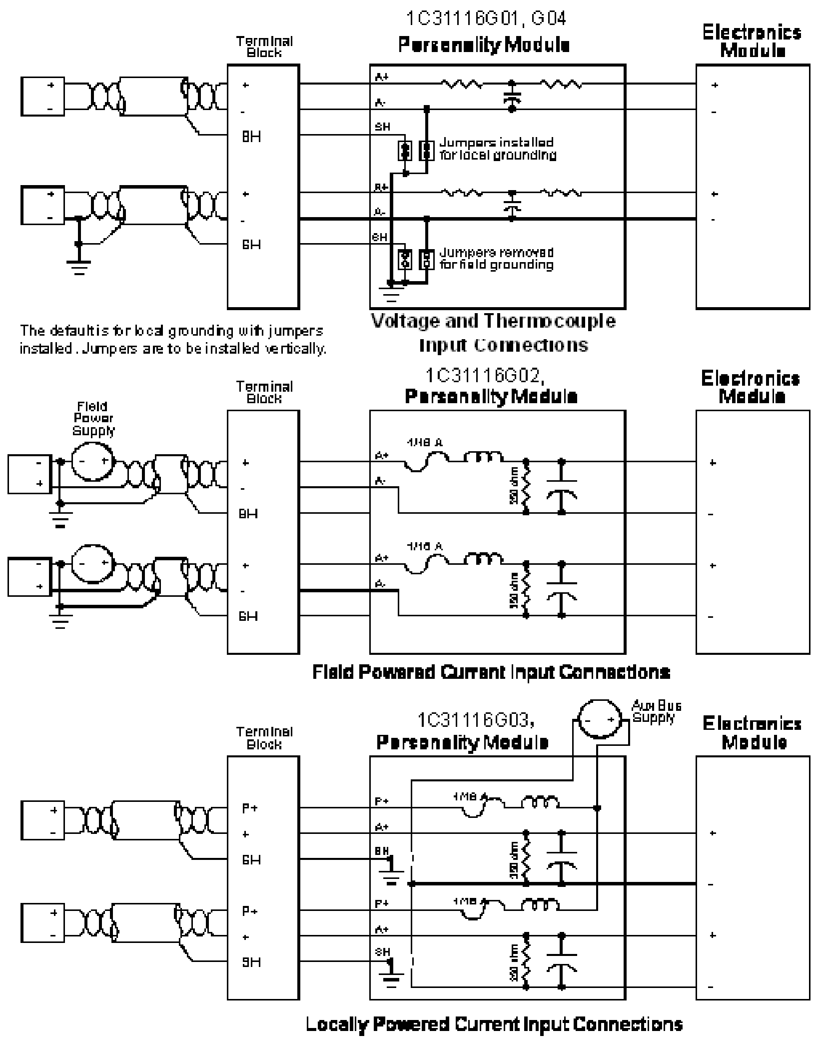


Figure 8: Field connections, Analog Input Personality module

Note: *See Personality module Jumpers (see page 29) for details on accessing the jumpers.*

4.1.7 Field connection wiring diagrams (CE Mark) - (AI-13)

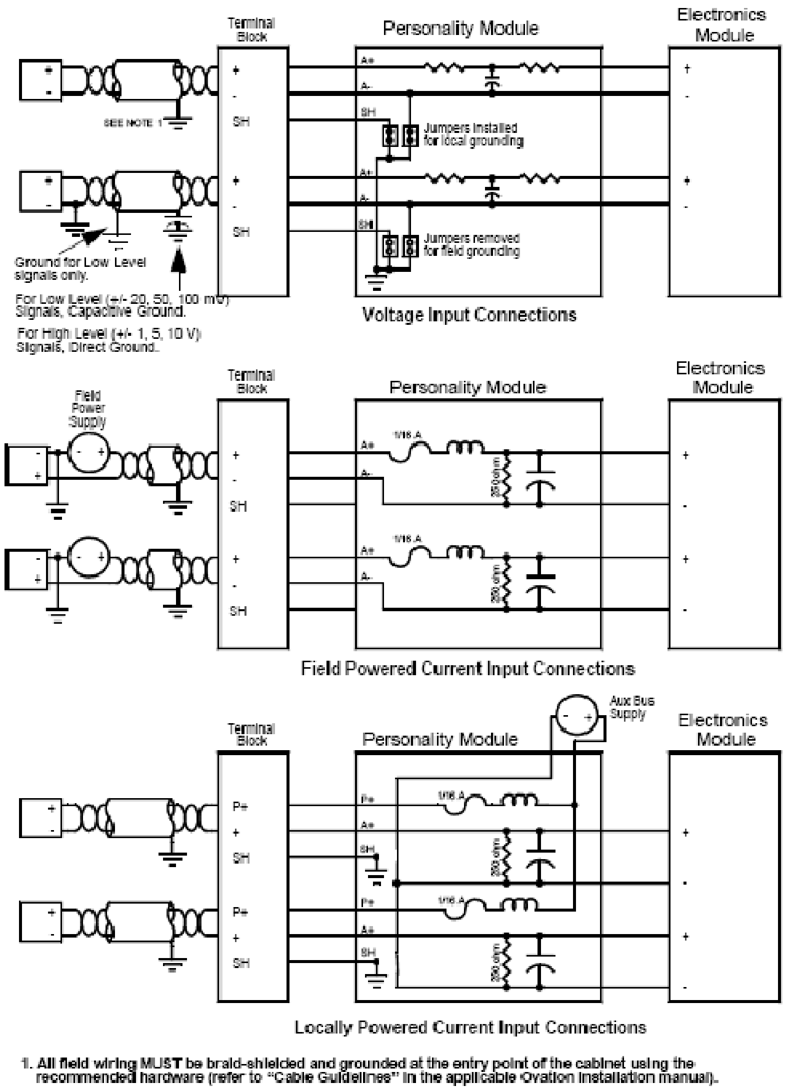


Figure 9: Field connections for the Analog Input Personality module (CE Mark)

4.1.8 Thermocouple Personality module functionality & coefficients - (AI-13) & (HSAI)

When two dissimilar metals (a thermocouple) are joined together, a voltage (the Seebeck Voltage) is generated between them. This voltage is directly related to the temperature at the junction of the two metals. The relationship between the voltage and the temperature can be best described by a fifth order polynomial, determined by the two types of metals that are joined.

To measure the voltage (Vt) between the two metals, a voltmeter (in this case, an analog input card) must be connected to each wire. Unfortunately, this produces two new junctions and voltages (V1 and V2) between the terminals and the thermocouples. The following formula is used to find Vt: Vt = Vm -V1 -V2.

It is not possible to measure V1 and V2 without inducing more junctions and voltages; therefore, the analog input subsystem has a temperature sensor on the Personality module (1C31116G04) to measure the temperature (Tj) at the terminal block of the base unit.

A conversion formula, determined from the junction metal and thermocouple metals, is used to calculate the combined voltage of V1 and V2. This is called **Cold Junction Compensation**.

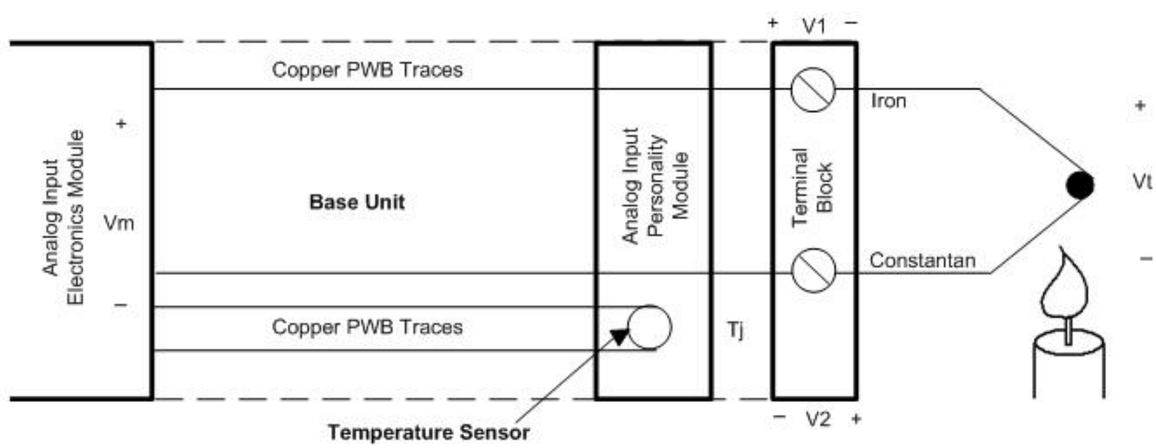


Figure 10: Thermocouple illustration

Use the Instrumentation tab of the Point Builder to select the Field Instrumentation Type (B or TB, E or TE, J or TJ, K or TK, R or TR, S or TS, T or TT). The Ovation system then assigns the default thermocouple coefficients based on the Type selected. Refer to the following table for these coefficient definitions.

If you override the default coefficients by entering new values, the new values remain **until** you select another thermocouple type. The values then return to the values for the type just selected.

Thermocouple coefficient definitions

THERMOCOUPLE TYPE	STANDARD TEMPERATURE RANGE	ACTUAL RANGE IN MV / TEMP	BEST FIT
B or TB	400 to 1100 Degrees C 800 to 2000 Degrees F	0.000 to 13.814 (0 to 1820) 0.006 to 13.814 (0 to 3308)	20 mv card 20 mv card

Thermocouple Type	Standard Temperature Range	Actual range in mv / temp	Best Fit
Fahrenheit COEF_1 = 3.5164700E+02 COEF_2 = 6.1388490E+05 COEF_3 = – 1.5397740E+08 COEF_4 = 3.3593730E+10 COEF_5 = – 4.0518260E+12 COEF_6 = 2.0039330E+14 COEF_7 = – 2.0E-06 COEF_8 = 0.0		**Centigrade** COEF_1 = 1.7758167E+02 COEF_2 = 3.4104717E+05 COEF_3 = – 8.5543000E+07 COEF_4 = – 8.5543000E+07 COEF_5 = – 8.5543000E+07 COEF_6 = 1.1132961E+14 COEF_7 = – 2.0E-06 COEF_8 = 0.0	
E or TE	– 18 to 286 Degrees C 0 to 550 Degrees F – 18 to 661 Degrees C 0 to 1200 Degrees F – 18 to 1000 Degrees C 0 to 1832 Degrees F	– 9.835 to 19.945 (– 270 to 286) – 9.835 to 19.945 (– 450 to 548) – 9.835 to 49.992 (– 270 to 661) – 9.835 to 49.956 (– 450 to 1221) – 9.835 to 76.358 (– 270 to 1000) – 9.835 to 76.358 (– 450 to 1832)	20 mv card 20 mv card 50 mv card 50 mv card 100 mv card 100 mv card
Fahrenheit COEF_1 = 3.1672830E+01 COEF_2 = 3.0306280E+04 COEF_3 = – 3.3449490E+05 COEF_4 = 6.8495880E+06 COEF_5 = – 6.9753490E+07 COEF_6 = 2.9236530E+08 COEF_7 = – 1.0939E-03 COEF_8 = 3.365E-05		**Centigrade** COEF_1 = – 1.8176111E-01 COEF_2 = 1.6836822E+04 COEF_3 = – 1.8583050E+05 COEF_4 = 3.8053267E+06 COEF_5 = – 3.8751939E+07 COEF_6 = 1.6242517E+08 COEF_7 = – 1.71E-05 COEF_8 = 6.057E-05	
J or TJ	– 18 to 365 Degrees C – 140 to 700 Degrees F – 18 to 760 Degrees C – 140 to 1400 Degrees F	– 8.096 to 19.971 (– 210 to 366) – 8.137 to 19.977 – 350 to 691) – 8.096 to 42.922 (– 210 to 760) – 8.137 to 42.922 – 350 to 1400)	20 mv card 20 mv card 50 mv card 50 mv card
Fahrenheit COEF_1 = 3.112531E+01 COEF_2 = 3.6070270E+04 COEF_3 = – 4.2886170E+05 COEF_4 = 2.2613820E+07 COEF_5 = – 5.1743790E+08 COEF_6 = 3.9727830E+09 COEF_7 = – 9.256E-04 COEF_8 = 2.862E-05		**Centigrade** COEF_1 = – 4.8593889E-01 COEF_2 = 2.0039039E+04 COEF_3 = – 2.3825650E+05 COEF_4 = 1.2563233E+07 COEF_5 = – 2.8746550E+08 COEF_6 = 2.2071017E+09 COEF_7 = – 9.76E-06 COEF_8 = 5.1516E-05	
K or TK	– 18 to 480 Degrees C 0 to 900 Degrees F – 18 to 1230 Degrees C 0 to 2250 Degrees F – 18 to 1370 Degrees C 0 to 2500 Degrees F	– 6.458 to 19.959 (– 270 to 484) – 6.456 to 19.978 (– 450 to 904) – 6.458 to 49.988 (– 270 to 1232) – 6.456 to 49.996 (– 450 to 2250) – 6.458 to 54.875 (– 270 to 1372) – 6.456 to 54.845 (– 450 to 2500)	20 mv card 20 mv card 50 mv card 50 mv card 100 mv card 100 mv card

Thermocouple Type	Standard Temperature Range	Actual range in MV / TEMP	Best Fit
Fahrenheit COEF_1 = 3.0344730E+01 COEF_2 = 4.4031910E+04 COEF_3 = 1.615839E+05 COEF_4 = – 1.616257E+07 COEF_5 = 4.4011090E+08 COEF_6 = – 3.599650E+09 COEF_7 = – 7.259E-04 COEF_8 = 2.243E-05		**Centigrade** COEF_1 = – 9.1959444E-01 COEF_2 = 2.4462172E+04 COEF_3 = 8.9768833E+04 COEF_4 = – 8.9792056E+06 COEF_5 = 2.4450606E+08 COEF_6 = – 1.9998056E+09 COEF_7 = – 8.14E-06 COEF_8 = 4.0374E-05	
R or TR	260 to 1100 Degrees C 500 to 2000 Degrees F	0.000 to 19.998 (0 to 1684) 0.089 to 19.997 (0 to 3063)	20 mv card 20 mv card
Fahrenheit COEF_1 = 8.3628480E+01 COEF_2 = 2.2737160E+05 COEF_3 = – 1.2482860E+07 COEF_4 = 1.2062540E+09 COEF_5 = – 7.4221280E+10 COEF_6 = 1.89930000E+12 COEF_7 = – 1.084E-04 COEF_8 = 3.24E-06		**Centigrade** COEF_1 = 2.8682489E+01 COEF_2 = 1.2631756E+05 COEF_3 = – 6.9349222E+06 COEF_4 = 6.7014111E+08 COEF_5 = – 4.1234044E+10 COEF_6 = 1.0551667E+12 COEF_7 = – 4.72E-06 COEF_8 = 5.832E-06	
S or TS	400 to 1100 Degrees C 750 to 2000 Degrees F	0.000 to 18.698 (0 to 1768) -0.092 to 18.696 (0 to 3214)	20 mv card 20 mv card
Fahrenheit COEF_1 = 1.1803440E+02 COEF_2 = 1.9859180E+05 COEF_3 = – 1.9730960E+04 COEF_4 = – 5.0093290E+08 COEF_5 = 4.1104880E+10 COEF_6 = – 1.1557940E+12 COEF_7 = – 1.0847E-04 COEF_8 = 3.26E-06		**Centigrade** COEF_1 = 4.7796889E+01 COEF_2 = 1.1032878E+05 COEF_3 = – 1.0961644E+04 COEF_4 = – 2.7829606E+08 COEF_5 = 2.2836044E+10 COEF_6 = – 6.4210778E+11 COEF_7 = – 4.15E-06 COEF_8 = 5.868E-06	
T or TT	-46 to 400 Degrees C -50 to 750 Degrees F	-6.258 to 19.945 (-270 to 385) -6.254 to 19.979 (-450 to 726)	20 mv card 20 mv card
Fahrenheit COEF_1 = 3.1892240E+01 COEF_2 = 4.6693280E+04 COEF_3 = – 1.3257390E+06 COEF_4 = 6.9620670E+07 COEF_5 = – 2.3278080E+09 COEF_6 = 3.3306460E+10 COEF_7 = – 7.3333E-04 COEF_8 = 2.243E-05		**Centigrade** COEF_1 = – 5.9866667E-02 COEF_2 = 2.5940711E+04 COEF_3 = – 7.3652167E+05 COEF_4 = 3.8678150E+07 COEF_5 = – 1.2932267E+09 COEF_6 = 1.8503589E+10 COEF_7 = – 1.55700E-05 COEF_8 = 4.0374E-05	

4.1.9 Register configuration/address information - (AI-13)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Analog Input configuration/status register (address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module	Module Configured (1 = configured; 0 = unconfigured)
1	Force Error	Internal or forced error (1 = forced error; 0 = no forced error)
2 - 6	Not Used	Not Used (0)
7	Not Used	EEPROM Checksum Error - Module Uncalibrated (1 = error; 0 = no error)
8	50/60 Hz Selection (0 = 60Hz, 1 = 50Hz)	50 Hz/60 Hz System (0 = 60Hz; 1 = 50Hz)
9	Use Line Sync if Present (1 = use)	Using Line Sync
10	Not Used	Line Frequency Tracking Active
11	Not Used	EE PROM Program Enabled
12	Not Used	PSD Generator Malfunction
13	Not Used	Internal Memory Error (EPROM Checksum or Static RAM Error)
14	Not Used	Temperature Sensor Failure
15	Not Used	Point Fault [1]
[1] Refer to Point Quality registers for descriptions of the Point Faults.		

Bit 0: This bit configures the module (write) or indicates the configuration state of the module (read). A "1" indicates that the module is configured. Note that until the module is configured, accessing addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write "1") forces the module into its error state, resulting in the error LED being lit. The read of bit 1 indicates the error state of the module, with "1" indicating that there is an internal error in the module or the Controller has forced the module into an error state. The state of this bit is always reflected by the module's Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when the point data is read (that is, accessing addresses 0 through 11).

Bits 2 - 6: These bits are "not used" values and are read as "0" under normal operation.

Bit 7: This bit is the result of a checksum test of the EEPROM. A failure of this test can indicate a bad EEPROM, but typically indicates that the module has not been calibrated. A "0" indicates that there is no error condition. If this error is present, the error is indicated by the module error LED being lit and the module does not process the point information. The point fault bit is also set as all the point data is uncalibrated. When this error is present, no other processing takes place. The "1" state of this bit indicates an unrecoverable error condition in the field.

Bit 8: This bit indicates if the on-board integrating timebase is 80 msec (4 line cycles of a 50 Hz system) or 83.3 msec (5 line cycles of a 60 Hz system). A "0" indicates that the timebase is 83.3 msec (60 Hz line frequency) and is the default setting.

Bit 9: This bit indicates whether to use the line frequency tracking if it is present. A write of "1" indicates to use the tracking input. A read of "1" indicates that the module is using the tracking input. The default state is a "0."

Note: *Line frequency tracking is presently* ***NOT*** *supported by the Ovation I/O system.*

Bit 10: This bit indicates whether the line frequency tracking signal is present and active for greater normal and common mode rejection. A "0" indicates that the line frequency tracking signal is NOT present.

Bit 11: This bit indicates whether the hardware EEPROM PE signal is active. A "0" indicates that the module is in normal operating mode and calibration and ID programming commands are not processed.

Bit 12: This bit reflects the detection of the internal 625 KHz PSD signal at module initialization. This verifies that the multifunction FPGA and the microcontroller's timer 0 are functioning. A "0" indicates that there is no error condition. A "1" indicates an unrecoverable error condition in the field.

Bit 13: This bit is a basic check of program and data memory, along with the microcontroller's data, address, and control buses. A "0" indicates that there is no error condition. A "1" indicates an unrecoverable error condition in the field.

Bit 14: This bit indicates the fault status of the digital temperature sensor. A "0" indicates the sensor is present and communicating properly with the microcontroller. A "1" indicates a fault exists; either there is no sensor present, or problems exist in communicating with the sensor. On an uncalibrated module, a sensor failure is always reported because the uncalibrated status prevents the sensor from being checked.

Bit 15: This bit indicates the point fault status of the module. It is the logical "OR" of the eight individual point quality statuses plus bits 1, 7, 12, and 13 of this register. A "0" indicates that all eight points have good quality and no module errors exist. A "1" indicates that at least one of the points has bad quality and is therefore in fault.

A subsequent read of the Point Quality status register at Address 12 (C in Hex) reveals which of the eight points has bad quality and the cause of the bad quality condition. The Address 12 (C in Hex) Point Quality Status Register contains data only when the module fault is due to a bad point quality; that is, bits 7, 12, and 13 of this register or the forced error bit are not set. Note that the Temperature Sensor (Address 8) status is treated separately and is not included in this module point fault bit.

Word address 12 (C in Hex) serves the purpose of reporting the point quality of the eight channel inputs. The bit definitions for this register are encoded as shown in the following table.

Point Quality register (address 12 or C in Hex)

POINT	BIT	DESCRIPTION
1 - 8	0, 2, 4, 6, 8, 10, 12, 14	Auto Calibration Reasonability Check Failed
1 - 8	1, 3, 5, 7, 9, 11, 13, 15	Overrange Input/Blown Fuse/Open Loop/Open Thermocouple

Auto Calibration Reasonability Check Failed - This bit is set when the auto calibration zero or reference reading is out of tolerance (±6% of the nominal reading).

Overrange Input/Blown Fuse/Open Loop/Open Thermocouple - This bit is set under the following conditions:

- **Voltage Input Configuration** (all groups) - when an overrange input of ±125% of the full scale value is read on the input.
- **Current Input Configuration** (Group 5) - when an input less than 2.5mA (a blown fuse or open loop condition) is detected or an overrange of greater than 25mA of full scale is present.

Secondary configuration/status register (address 14 or E in Hex)

Bit	Data Description - Current/Voltage Configuration (Write)	Data Description - Current/Voltage Status (Read)
0 - 7	Select Point 1 - 8 Current/Voltage (1 = Current)	Select Point 1 - 8 Current/Voltage (1 = Current)
8 - 15	Not Used	Point 1 - 8 Current Blown Fuse (1 = Blown)

Word address 14 (E in Hex) serves the purpose of the Current/Voltage Configuration/Status Register. The bit definitions for this register are encoded as shown in the following table.

The default state of the register under normal operation is “0” for voltage inputs. The lower 8 bits are configuration bits which are written to and read from the module. The upper 8 bits are read-only status bits indicating the blown fuse status only for those channels which have been configured as current inputs.

4.1.10 Diagnostic Logic card LEDs - (AI-13, AI-14 & HSAI)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (Red)	Internal Error LED. Lit whenever there is any type of error with the module **except** for a loss of power. Possible causes are: ▪ Module initialization is in progress. ▪ I/O Bus timeout has occurred. ▪ Internal hardware error. ▪ Module reset ▪ Module is uncalibrated. ▪ Forced error has been received from the Controller. ▪ Communication between the Field and Logic boards failed.
1 - 8 (Red)	Channel error. Lit whenever there is an error associated with a channel or channels. Possible causes are: ▪ Positive overrange: Input voltage greater than +121% of full scale value (for modules configured as voltage input). ▪ Negative overrange: Input voltage less than -121% of full scale value (for modules configured as voltage input). ▪ Current loop out of range ▪ Calibration readings out of range.

LED	DESCRIPTION
9 - 16	No LED.

4.1.11 Specifications - (AI-13)

Electronics module (1C31113)
Personality module (1C31116)

DESCRIPTION	VALUE
Number of channels	8
Input range [1]	G01: ±20 mv G02: ±50 mv G03: ±100 mv G04: ±1 V G05: ±5 V [2] G06: ±10 V
Resolution	13-Bit (including polarity)
Data format	13-bit, two's complement, and error indicator bits
Conversion type	Sigma Delta
Operating mode	Self-scan
Monotonicity	Yes
Non-linearity	0.003% of full scale
Repeatability	Within guaranteed accuracy
Guaranteed accuracy (@25°C)	Accuracy over -25% to 100% range of full scale input level: ▪ ±0.10% of upper range value ±10µV ±1/2LSB @99.7% confidence. ▪ Accuracy over -100% to -25% range of full scale input level: ▪ ±0.15% of upper range value ±10µV ±1/2LSB @99.7% confidence.
Temperature coefficient	±0.24% of the upper range value ±24µV over 0 to 60°C.
Input impedance: [3] Groups G01 through G05 Group G06 (± 10V input only)	 10 M-ohms 2 M-ohms
Maximum overload	G01 - G03: ±10 Vdc or Vrms G04 - G06: ±120 Vdc or Vrms
Sample duration time (msec)	50 Hz configuration : 80 60 Hz configuration: 83.33
Sample repetition (msec)	50 Hz configuration : 80 60 Hz configuration: 83.33
Filtering	Digital, Sinc, 3dB cutoff: 13.1 Hz for 50 Hz, 15.7 Hz for 60 Hz
Offset and gain temperature drift compensation	Automatic

DESCRIPTION	VALUE
Diagnostics	Internal module operating faults. ▪ Out of range detection. ▪ Open thermocouple detection for thermocouple inputs. ▪ Open loop/blown fuse detection for current inputs.
Dielectric isolation: Channel to channel Channel to logic	 1000 V AC/DC 1000 V AC/DC
Normal mode rejection	60 dB at 50 Hz ± 1/2% or 60 Hz ± 1/2% 30 dB (typical) at 50 Hz ± 5% or 60 Hz ± 5%
Common mode rejection and channel to channel crosstalk	120 dB at DC, power line frequency and its harmonics ± 1/2% tracking. 100 dB (typical) for nominal line frequency ± 5% and harmonics.
Module power	Main: 2.5 W typical; 3.38 W Maximum Aux: When used (1C31116G03) Aux power supply voltage = 24 V DC 3.84 W typical (8 inputs @ 20mA each)
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

[1] Ranges are available through separate modules.

[2] Current inputs when using Personality module 1C31116G02 or 1C31116G03 with ± 5V Electronics module.

The input range 0 to 20 mA is also available, but if selected, blown fuse detection will be disabled. If you select 0 to 20 mA, the software adds a suffix "A" to the Personality module identification. This "A" is not displayed, it is only used by the database to differentiate between 0 to 20 mA and 4 to 20 mA, in order to generate correct coefficients.

[3] Only for modules used with voltage input Personality modules (1C1116G01 and 1C1116G04).

4.2 Analog Input module (14-Bit) - (AI-14)

The combined Personality and Electronics modules form the 14 Bit Analog Input module. Eight sets of galvanically isolated input channels are provided. The input signals are conditioned and routed through the appropriate Personality module to the Electronics module. The Personality module also provides surge protection to protect the input circuits of the Electronics module. The Electronics module performs the analog to digital conversions and provides interfacing to the Ovation Serial I/O Bus.

No thermocouple provisions are provided for this module.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

4.2.1 Electronics modules (Emod) - (AI-14)

- **1C31224G01** provides current signals with an input range of 4 to 20 mA.
- **1C31224G02** provides voltage signals with an input range of ± 1V.

4.2.2 Personality modules (Pmod) - (AI-14)

- **1C31227G01** provides current signals with an input range of 4 to 20 mA.
- **1C31227G02** provides voltage signals with an input range of ± 1V.

4.2.3 Subsystems - (AI-14)

Analog Input subsystems (14-bit)

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4 - 20mA, Field or Locally powered[1]	8	1C31224G01[1]	1C31227G01
± 1 VDC	8	1C31224G02[1]	1C31227G02
[1] The 4-20mA Configuration is CE Mark certified.			

4.2.4 External power supplies - (AI-14)

Note: *Module power specifications (main and auxiliary) refer to the actual power drawn by the module from the 24VDC main power supply and from the auxiliary power supply (if required) and* ***NOT*** *from the AC or DC Mains.*

If the 14-Bit Analog Input module uses the 1C31227G01 Personality module, the required voltage source is obtained from the internal auxiliary power supply (backplane).

Also, Personality module 1C31227G01 supports field-powered configurations.

4.2.5 Terminal block wiring information - (AI-14)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

The diagrams for the Analog Input Personality modules are illustrated in the following figure. The following table lists and defines the abbreviations used in those diagrams.

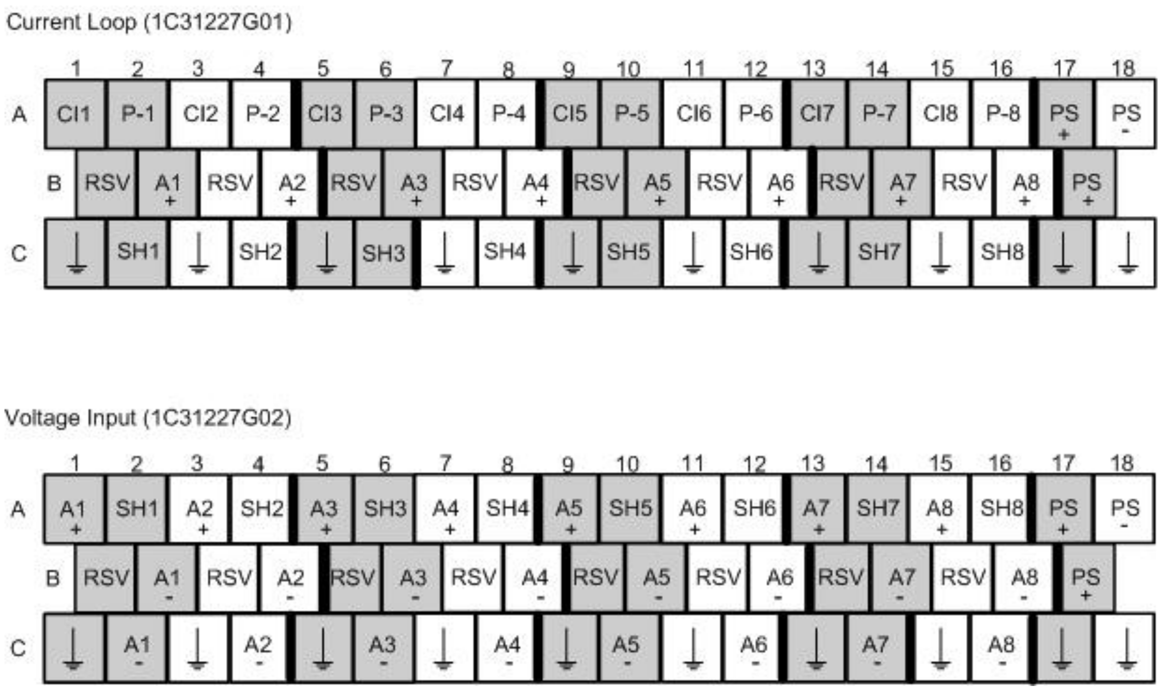


Figure 11: Terminal Block Connections for the Analog Input Personality Modules

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
⏚	Earth ground terminals.
A1 - A8 +	Analog Input positive terminal connection (connected to the positive terminal of the field device).
A1 - A8 -	Analog Input negative terminal connection (voltage input group only).
CI1 - CI8	Current input terminals.
P-1 - P-8	Loop power output terminals (for locally powered loops).
PS+, PS-	Auxiliary power supply terminals.

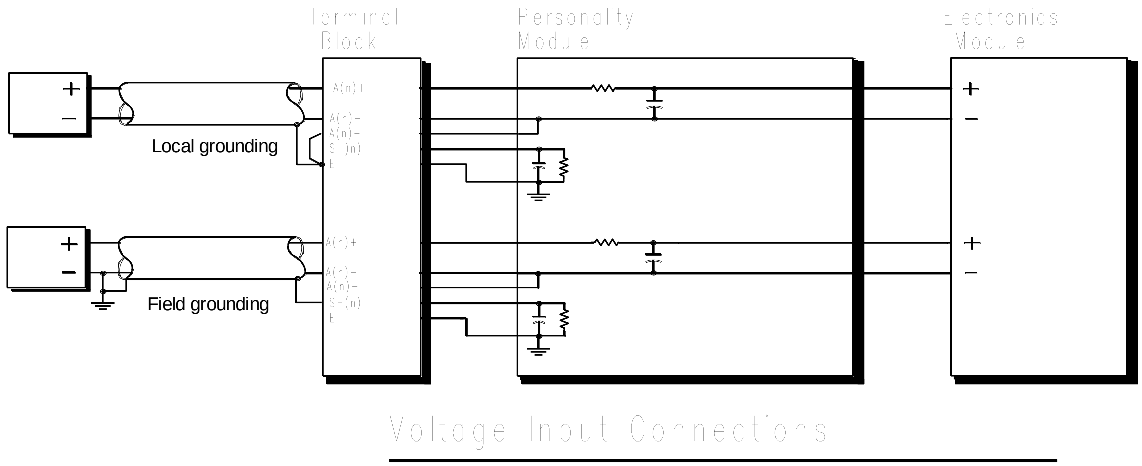
ABBREVIATION	DEFINITION
RSV	Reserved terminal. No connections allowed on these terminals.
SH1 - SH8	Shield terminal connection.

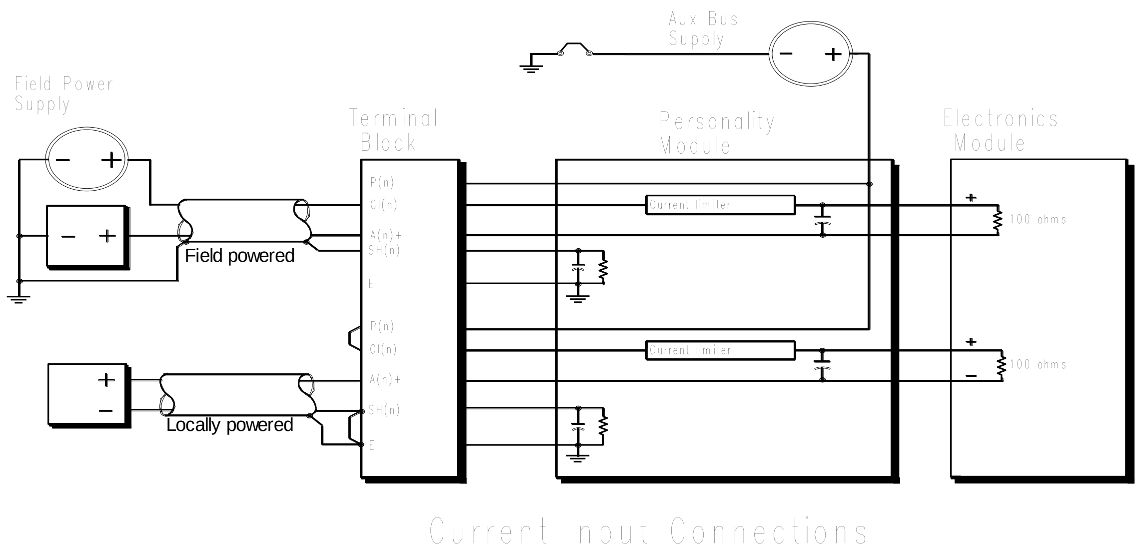
Use shielded twisted pair wire for the field wiring. Tie the Analog Input negative terminal and shield together and to earth ground, either locally at the cabinet or at the field device. Voltage inputs use the 1C31227G02 Personality modules. Grounding the shield and the analog input negative terminal at the cabinet or at the field device is arranged by the proper Terminal Block connections.

Similarly, current inputs using the 1C31227G01 Personality modules can accommodate field or locally powered devices by using the correct terminal block connections.

The Personality modules have a field connection diagram label on top of each module to facilitate field wiring. The figures in 14-Bit Analog Input Field Connection Wiring Diagrams (see page 57) show the implementations of the field connections for the various Personality module and field device combinations.

4.2.6 Field connection wiring diagrams - (AI-14)



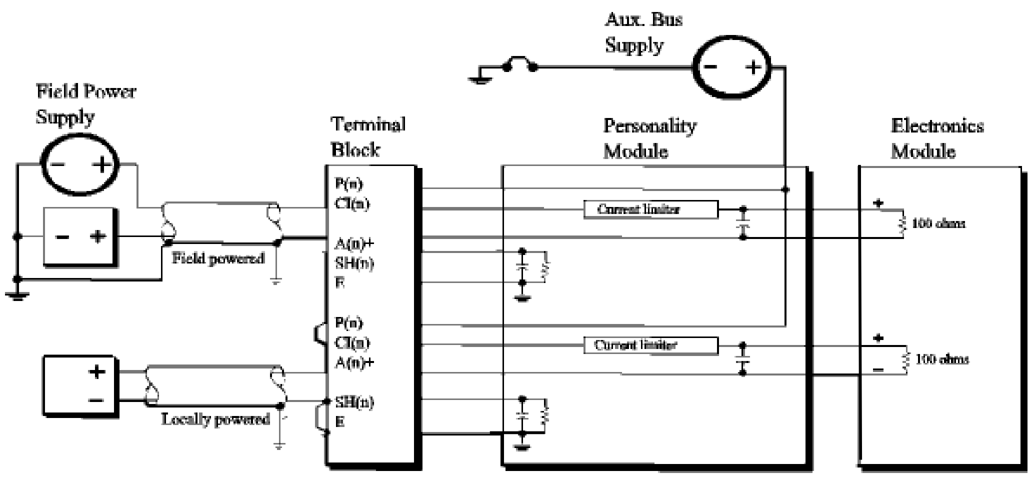


Caution

When using locally powered current inputs, the power distribution panel MUST be equipped with jumper module 5A26471G01 to ensure proper grounding of the aux Bus supply.

Figure 12: Field Connections for the Input Connectors

4.2.7 Field connection wiring diagrams (CE Mark) - (AI-14)



Caution

When using locally powered current inputs, the power distribution panel MUST be equipped with jumper module 5A26471G01 to ensure proper grounding of the aux Bus supply.

All field wiring must be braid shielded and grounded at the entry point of the cabinet using recommended hardware (refer to "Cable Guidelines" in the applicable Ovation installation manual for your system.

Figure 13: Field connections for Input Connectors (CE Mark)

4.2.8 Module block diagram - (AI-14)

The simplified block diagram for the voltage input configuration of the14-Bit Analog Input module is shown in the following figure. The channel 1 input is grounded locally at the cabinet, and grounding at the field device is shown for the channel 8 input.

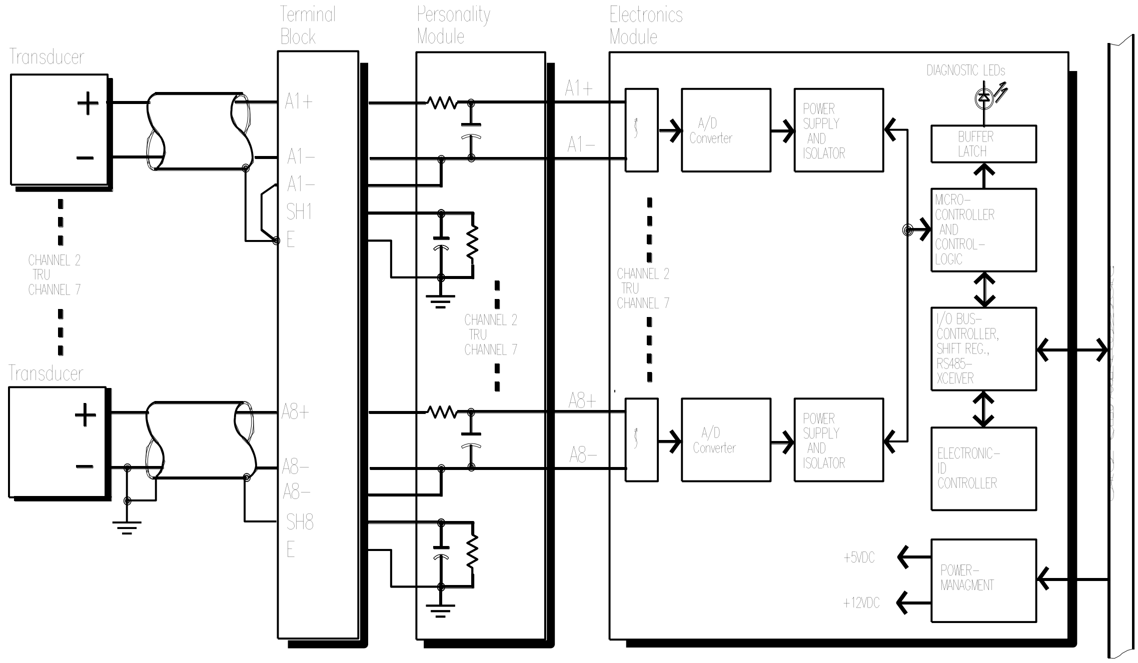


Figure 14: Voltage input connections

4.2.9 Register configuration/address information - (AI-14)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (See the *Ovation Operator Station User Guide*).

14-Bit Analog Input configuration/status (Address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module	Module Configured (1 = configured; 0 = unconfigured)
1	Force Error	Internal or forced error (1 = forced error; 0 = no forced error)
2	0, (ADD4 bit during diagnostics)	Not Used (0)
3	0, (ADD5 bit during diagnostics)	Not Used (0)
4	0, (ADD6 bit during diagnostics)	Warming
5	0, (ADD7 bit during diagnostics)	Not Used (0)
6	0, (ADD8 bit during diagnostics)	Not Used (0)
7	0, (DIAG_SET, initiates diagnostics)	Module is not calibrated

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
8	50/60 Hz Selection (0 = 60Hz, 1 = 50Hz)	50 Hz/60 Hz System (0 = 60Hz; 1 = 50Hz)
9	A/D conversion rate selection bit (0 = Normal, 1 = High speed)	A/D conversion rate bit (0 = Normal, 1 = High speed)
10	0, (SYS_CAL, initiates system calibration during diagnostics)	SYS_CAL in progress (during diagnostics)
11	SELF_CAL (initiates self calibration)	SYS_CAL completed (during diagnostics)
12	Not defined	SYS_CAL failed (during diagnostics)
13	Not defined	Internal Memory Error (FLASH Checksum, Register, or Static RAM Error)
14	Not defined	Module in diagnostic mode (during diagnostics)
15	Not defined	Point Fault [1]

[1] Refer to the Point Quality Register for descriptions of the Point Faults.

Bits defined for diagnostics are used only during factory testing.

Bit 0: This bit configures the module (write) or indicates the configuration state of the module (read). A “1” indicates that the module is configured. Note that until the module is configured, reading from addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write “1”) forces the module into its error state, resulting in the error LED being lit. The read of bit 1 indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the module's Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when addresses 0 through 11 (B in Hex) are read.

Bits 2-3: These bits are not used and are read as “0” under normal operation.

Bit 4: This bit (read) indicates that the module is in the “Warming” state. This state exists after power up and terminates after 8.16 seconds. The module is in the error condition during the warm up period.

Bits 5-6: These bits are not used and are read as “0” under normal operation.

Bit 7: This bit is the result of a checksum test of the EEPROM. A failure of this test can indicate a bad EEPROM, but typically indicates that the module has not been calibrated. A “0” indicates that there is no error condition. If an error is present, the error is indicated by the module error LED being lit. The point fault bit is set as all the point data is not calibrated. The “1” state of this bit indicates an unrecoverable error condition in the field.

Bits 8: A write to this bit configures the conversion rate of the A/C converters as follows:

Conversion Rate (1/sec)	Bit 8
20 (for 60Hz systems)	0
25 (for 50Hz systems)	1

The status of these bits (read) indicate the conversion rate to which the module is set.

Bit 9: Reserved

Bit 10: This bit is not used and is read as “0” under normal operation.

Bit 11: This bit (write) is used to initiate self-calibration. The sampling rate during self-calibration is 2 per second. The status (read) bit is not used and is read as “0” under normal operation.

Bit 12: This bit is not used and is read as “0” under normal operation.

Bit 13: This bit (read) indicates that the module has internal memory error (FLASH, checksum, Register, or Static RAM error). If this error is present, the module error LED is lit, the point fault bit is also set since the condition of the module is undetermined.

Bit 14: This bit is not used and is read as “0” under normal operation.

Bit 15: This bit indicates the point fault status of the module. It is the logical “OR” of the eight individual point quality statuses plus bits 1, 7, 12, and 13 of this register. A “0” indicates that all eight points have good quality and no module errors exist.

When bits 1, 4, 7 or 13 of the Status Register are not set, this bit (when set to “1”) indicates that at least one of the points has bad quality.

A subsequent read of the Point Quality Register at Address 12 (C in Hex) reveals the point(s) that have bad quality (see the following table). The Address 12 (C in Hex) Point Quality Register contains data only when the module fault is due to a bad point quality.

Word address 12 (C in Hex) serves the purpose of reporting the point quality of the eight channel inputs. The bit definitions for this register are encoded as shown in the following table.

Point quality register (Address 12 or C in Hex)

POINT	BIT	DESCRIPTION
1 - 8	0, 2, 4, 6, 8, 10, 12, 14	Communication to the Channel Failed
1 - 8	1, 3, 5, 7, 9, 11, 13, 15	Overrange Input/Blown Fuse/Open Loop

Communication to the Channel Failed - This bit is set when the communication to the corresponding channel has failed.

Overrange Input/Blown Fuse/Open Loop – This bit is set as follows:

- Current Input (Group 1) – When an input current less than 2.5mA (a blown fuse or open loop condition) is detected, or an overrange (greater than 24.6mA) of full scale is present.
- Voltage Input (Group 2) – When an overrange input of ±121% of the full scale value is read.

4.2.10 Diagnostic Logic card LEDs - (AI-13, AI-14 & HSAI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.

LED	Description
I (Red)	Internal Error LED. Lit whenever there is any type of error with the module **except** for a loss of power. Possible causes are: ▪ Module initialization is in progress. ▪ I/O Bus timeout has occurred. ▪ Internal hardware error. ▪ Module reset ▪ Module is uncalibrated. ▪ Forced error has been received from the Controller. ▪ Communication between the Field and Logic boards failed.
1 - 8 (Red)	Channel error. Lit whenever there is an error associated with a channel or channels. Possible causes are: ▪ Positive overrange: Input voltage greater than +121% of full scale value (for modules configured as voltage input). ▪ Negative overrange: Input voltage less than -121% of full scale value (for modules configured as voltage input). ▪ Current loop out of range ▪ Calibration readings out of range.
9 - 16	No LED.

4.2.11 Specifications - (AI-14)

- **Electronics module (1C31224)**
- **Personality module (1C31227)**

Description	Value
Number of channels	8
Input range	4 - 20 mA [1] ±1V [2]
Resolution	Group 1:14-Bits, Group 2:13-Bits & Sign
Guaranteed accuracy (@25×C)	±0.10% of full scale value ±1/2LSB @99.7% confidence.
Temperature coefficient	±0.24% of the full scale value over 0 to 60 degrees C.
Input impedance: [3]	10 M ohms
Sampling rate	20 times per second minimum when configured for 60 Hz rejection 25 times per second minimum when configured for 50Hz rejection
Self-calibration	On demand by the Ovation Controller.
Diagnostics	Internal module operating faults. Out of range detection. Open loop detection for current inputs.
Dielectric isolation: Channel to channel Channel to logic	 1000 V AC/DC 1000 V AC/DC
Normal mode rejection	60 dB @50 Hz ± 1/2% or @60 Hz ± 1/2% (when properly configured) 30 dB (typical) @50 Hz ± 5% or @60 Hz ± 5% (when properly configured)

DESCRIPTION	VALUE
Common mode rejection	120 dB @ DC or @ nominal (50/60 Hz) line frequency ± 1/2% and harmonics. 100 dB (typical) for nominal line frequency ± 5% and harmonics.
Module power	Main: 2.4 W typical; 3.125 W Maximum Aux: When used (1C31227G01) Aux power supply voltage = 24 V DC 3.84 W typical (8 inputs @ 20mA each)
Operating temperature range	0 to 60 degrees C (32 degrees F to 140 degrees F)
Storage temperature range	-40 degrees C to 85 degrees C (-40 degrees F to 185 degrees F)
Humidity (non-condensing)	0 to 95%
[1] Current inputs when using Personality module 1C31224G01 with 1C31227G01 Electronics module. [2] Voltage inputs when using Personality module 1C31224G02 with 1C31227G02 Electronics module. [3] Only for the voltage input module (Personality module 1C31224G02 with 1C31227G02 Electronics module).	

4.3 High Speed Analog Input Module (14-Bit) - (HSAI)

The combined Personality and Electronics modules form the High Speed Analog Input module. Eight sets of galvanically isolated input channels provide 14-bit resolution with 50 or 60 samples per second conversion rates. The input signals are conditioned and routed through the appropriate Personality module to the Electronics module. The Personality module also provides surge protection to protect the input circuits of the Electronics module. The Electronics module performs the analog to digital conversions and provides interfacing to the Ovation Serial I/O Bus.

The 14-Bit High Speed Analog Input is applicable for CE Mark certified systems.

Note: *I/O Module General Information (see page 25) contains information on for environmental, installation, wiring, and fuse information for I/O modules.*

4.3.1 Electronics modules (Emod) - (HSAI)

- **5X00070G01** interfaces to current signals with an input range of 4 to 20 mA.
- **5X00070G02** interfaces to voltage signals with an input range of ±1V, ±250mV, ±100mV.
- **5X00070G03** interfaces to voltage signals with an input range of ±5V, ±10V.
- **5X00070G04** interfaces to thermocouple inputs ± 20mV, ± 50Vm, ± 100mV.
- **5X00070G05** interfaces to thermocouple inputs ± 20mV, ± 50Vm, ± 100mV, (Non-EMC Cabinet).

4.3.2 Personality modules (Pmod) - (HSAI)

- **1C31227G01** interfaces to current input with an input range of 4 - 20 mA.
- **1C31227G02** voltage input.
- **1C31116G02** field powered current input ± 1mA.
- **1C31116G03** local powered ± 1mA current only.
- **1C31116G04** voltage inputs to temperature sensor.

4.3.3 Subsystems - (HSAI)

High Speed Analog Input subsystems (14-bit)

Range	Channels	Electronics Module	Personality Module
4 - 20mA, Field or Locally powered	8	5X00070G01[1,2]	1C31227G01
± 100mV, ± 250mV, ± 1V	8	5X00070G02[1,2]	1C31227G02
± 5V, ± 10V	8	5X00070G03[1,2]	1C31227G02
± 1mA 2 wire local powered	8	5X00070G02[1,2]	1C31116G03
± 1mA 4wire field powered	8	5X00070G02[1,2]	1C31116G02
± 20mV, ± 50mV, ± 100 (Thermocouple)	8	5X00070G04[1]	1C31116G04
± 20mV, ± 50mV, ± 100 (Thermocouple)	8	5X00070G05[2]	1C31116G04
[1] This module configuration is CE Mark Certified. [2] This module configuration is CE Mark Certified (Non-EMC Cabinet).			

4.3.4 External power supply information - (HSAI)

Note: *Module power specifications (main and auxiliary) refer to the actual power drawn by the module from the 24VDC main power supply and from the auxiliary power supply (if required) and **NOT** from the AC or DC Mains.*

If the High Speed Analog Input module uses the current input 1C31227G01 or 1C31116G03 Personality modules, the required voltage source may be obtained from the internal auxiliary power supply (backplane).

If the High Speed Analog Input module uses Pmod 1C31227G01 or 1C1116G02, field powered current loops can be used. Note that 1C31227G01 supplies both field and local power.

4.3.5 Thermocouple Personality module functionality & coefficients - (AI-13) & (HSAI)

When two dissimilar metals (a thermocouple) are joined together, a voltage (the Seebeck Voltage) is generated between them. This voltage is directly related to the temperature at the junction of the two metals. The relationship between the voltage and the temperature can be best described by a fifth order polynomial, determined by the two types of metals that are joined.

To measure the voltage (Vt) between the two metals, a voltmeter (in this case, an analog input card) must be connected to each wire. Unfortunately, this produces two new junctions and voltages (V1 and V2) between the terminals and the thermocouples. The following formula is used to find Vt: Vt = Vm -V1 -V2.

It is not possible to measure V1 and V2 without inducing more junctions and voltages; therefore, the analog input subsystem has a temperature sensor on the Personality module (1C31116G04) to measure the temperature (Tj) at the terminal block of the base unit.

A conversion formula, determined from the junction metal and thermocouple metals, is used to calculate the combined voltage of V1 and V2. This is called **Cold Junction Compensation**.

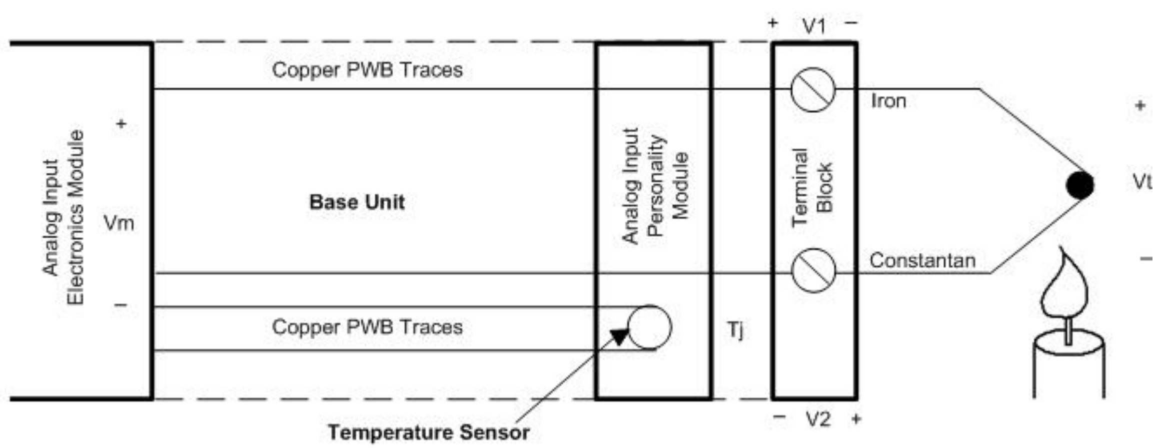


Figure 15: Thermocouple illustration

Use the Instrumentation tab of the Point Builder to select the Field Instrumentation Type (B or TB, E or TE, J or TJ, K or TK, R or TR, S or TS, T or TT). The Ovation system then assigns the default thermocouple coefficients based on the Type selected. Refer to the following table for these coefficient definitions.

If you override the default coefficients by entering new values, the new values remain **until** you select another thermocouple type. The values then return to the values for the type just selected.

Thermocouple coefficient definitions

THERMOCOUPLE TYPE	STANDARD TEMPERATURE RANGE	ACTUAL RANGE IN MV / TEMP	BEST FIT
B or TB	400 to 1100 Degrees C 800 to 2000 Degrees F	0.000 to 13.814 (0 to 1820) 0.006 to 13.814 (0 to 3308)	20 mv card 20 mv card

Thermocouple Type	Standard Temperature Range	Actual range in MV / TEMP	Best Fit
Fahrenheit COEF_1 = 3.5164700E+02 COEF_2 = 6.1388490E+05 COEF_3 = – 1.5397740E+08 COEF_4 = 3.3593730E+10 COEF_5 = – 4.0518260E+12 COEF_6 = 2.0039330E+14 COEF_7 = – 2.0E-06 COEF_8 = 0.0		**Centigrade** COEF_1 = 1.7758167E+02 COEF_2 = 3.4104717E+05 COEF_3 = – 8.5543000E+07 COEF_4 = – 8.5543000E+07 COEF_5 = – 8.5543000E+07 COEF_6 = 1.1132961E+14 COEF_7 = – 2.0E-06 COEF_8 = 0.0	
E or TE	– 18 to 286 Degrees C 0 to 550 Degrees F – 18 to 661 Degrees C 0 to 1200 Degrees F – 18 to 1000 Degrees C 0 to 1832 Degrees F	– 9.835 to 19.945 (– 270 to 286) – 9.835 to 19.945 (– 450 to 548) – 9.835 to 49.992 (– 270 to 661) – 9.835 to 49.956 (– 450 to 1221) – 9.835 to 76.358 (– 270 to 1000) – 9.835 to 76.358 (– 450 to 1832)	20 mv card 20 mv card 50 mv card 50 mv card 100 mv card 100 mv card
Fahrenheit COEF_1 = 3.1672830E+01 COEF_2 = 3.0306280E+04 COEF_3 = – 3.3449490E+05 COEF_4 = 6.8495880E+06 COEF_5 = – 6.9753490E+07 COEF_6 = 2.9236530E+08 COEF_7 = – 1.0939E-03 COEF_8 = 3.365E-05		**Centigrade** COEF_1 = – 1.8176111E-01 COEF_2 = 1.6836822E+04 COEF_3 = – 1.8583050E+05 COEF_4 = 3.8053267E+06 COEF_5 = – 3.8751939E+07 COEF_6 = 1.6242517E+08 COEF_7 = – 1.71E-05 COEF_8 = 6.057E-05	
J or TJ	– 18 to 365 Degrees C – 140 to 700 Degrees F – 18 to 760 Degrees C – 140 to 1400 Degrees F	– 8.096 to 19.971 (– 210 to 366) – 8.137 to 19.977 – 350 to 691) – 8.096 to 42.922 (– 210 to 760) – 8.137 to 42.922 – 350 to 1400)	20 mv card 20 mv card 50 mv card 50 mv card
Fahrenheit COEF_1 = 3.112531E+01 COEF_2 = 3.6070270E+04 COEF_3 = – 4.2886170E+05 COEF_4 = 2.2613820E+07 COEF_5 = – 5.1743790E+08 COEF_6 = 3.9727830E+09 COEF_7 = – 9.256E-04 COEF_8 = 2.862E-05		**Centigrade** COEF_1 = – 4.8593889E-01 COEF_2 = 2.0039039E+04 COEF_3 = – 2.3825650E+05 COEF_4 = 1.2563233E+07 COEF_5 = – 2.8746550E+08 COEF_6 = 2.2071017E+09 COEF_7 = – 9.76E-06 COEF_8 = 5.1516E-05	
K or TK	– 18 to 480 Degrees C 0 to 900 Degrees F – 18 to 1230 Degrees C 0 to 2250 Degrees F – 18 to 1370 Degrees C 0 to 2500 Degrees F	– 6.458 to 19.959 (– 270 to 484) – 6.456 to 19.978 (– 450 to 904) – 6.458 to 49.988 (– 270 to 1232) – 6.456 to 49.996 (– 450 to 2250) – 6.458 to 54.875 (– 270 to 1372) – 6.456 to 54.845 (– 450 to 2500)	20 mv card 20 mv card 50 mv card 50 mv card 100 mv card 100 mv card

THERMOCOUPLE TYPE	STANDARD TEMPERATURE RANGE	ACTUAL RANGE IN MV / TEMP	BEST FIT
Fahrenheit COEF_1 = 3.0344730E+01 COEF_2 = 4.4031910E+04 COEF_3 = 1.615839E+05 COEF_4 = – 1.616257E+07 COEF_5 = 4.4011090E+08 COEF_6 = – 3.599650E+09 COEF_7 = – 7.259E-04 COEF_8 = 2.243E-05		**Centigrade** COEF_1 = – 9.1959444E-01 COEF_2 = 2.4462172E+04 COEF_3 = 8.9768833E+04 COEF_4 = – 8.9792056E+06 COEF_5 = 2.4450606E+08 COEF_6 = – 1.9998056E+09 COEF_7 = – 8.14E-06 COEF_8 = 4.0374E-05	
R or TR	260 to 1100 Degrees C 500 to 2000 Degrees F	0.000 to 19.998 (0 to 1684) 0.089 to 19.997 (0 to 3063)	20 mv card 20 mv card
Fahrenheit COEF_1 = 8.3628480E+01 COEF_2 = 2.2737160E+05 COEF_3 = – 1.2482860E+07 COEF_4 = 1.2062540E+09 COEF_5 = – 7.4221280E+10 COEF_6 = 1.89930000E+12 COEF_7 = – 1.084E-04 COEF_8 = 3.24E-06		**Centigrade** COEF_1 = 2.8682489E+01 COEF_2 = 1.2631756E+05 COEF_3 = – 6.9349222E+06 COEF_4 = 6.7014111E+08 COEF_5 = – 4.1234044E+10 COEF_6 = 1.0551667E+12 COEF_7 = – 4.72E-06 COEF_8 = 5.832E-06	
S or TS	400 to 1100 Degrees C 750 to 2000 Degrees F	0.000 to 18.698 (0 to 1768) -0.092 to 18.696 (0 to 3214)	20 mv card 20 mv card
Fahrenheit COEF_1 = 1.1803440E+02 COEF_2 = 1.9859180E+05 COEF_3 = – 1.9730960E+04 COEF_4 = – 5.0093290E+08 COEF_5 = 4.1104880E+10 COEF_6 = – 1.1557940E+12 COEF_7 = – 1.0847E-04 COEF_8 = 3.26E-06		**Centigrade** COEF_1 = 4.7796889E+01 COEF_2 = 1.1032878E+05 COEF_3 = – 1.0961644E+04 COEF_4 = – 2.7829606E+08 COEF_5 = 2.2836044E+10 COEF_6 = – 6.4210778E+11 COEF_7 = – 4.15E-06 COEF_8 = 5.868E-06	
T or TT	-46 to 400 Degrees C -50 to 750 Degrees F	-6.258 to 19.945 (-270 to 385) -6.254 to 19.979 (-450 to 726)	20 mv card 20 mv card
Fahrenheit COEF_1 = 3.1892240E+01 COEF_2 = 4.6693280E+04 COEF_3 = – 1.3257390E+06 COEF_4 = 6.9620670E+07 COEF_5 = – 2.3278080E+09 COEF_6 = 3.3306460E+10 COEF_7 = – 7.3333E-04 COEF_8 = 2.243E-05		**Centigrade** COEF_1 = – 5.9866667E-02 COEF_2 = 2.5940711E+04 COEF_3 = – 7.3652167E+05 COEF_4 = 3.8678150E+07 COEF_5 = – 1.2932267E+09 COEF_6 = 1.8503589E+10 COEF_7 = – 1.55700E-05 COEF_8 = 4.0374E-05	

4.3.6 Temperature sensor Personality module (1C31116G04) - (HSAI)

Personality module 1C1116G04 of the analog input subsystem includes a temperature sensor IC. This is used for measuring the temperature of the terminal block to provide cold junction compensation for thermocouple inputs.

This module is used in conjunction with a terminal block cover (1C31207H01) to maintain a uniform temperature of the terminal block and sensor area. The cover fits over an entire base; however, the sensor only accurately measures the temperature under the half of the cover where the temperature sensor Personality module is installed. Therefore, if both modules under the cover require cold junction compensation, they each require the temperature sensor Personality module.

Note: *Installation instructions for the terminal block cover are provided in the Temperature Compensation Cover Mounting Kit (1B30047G01).*

The Group 4 Personality module provides a terminal block temperature measurement feature with the following specifications:

- Sampling Rate = 600 msec, Maximum, 300 msec, typical
- Resolution = +/- 0.5 degrees C (+/- 0.9 degrees F)
- Accuracy = +/- 0.5 degrees C over a 0 degrees C to 70 degrees C range

  (+/- 0.9 degrees F over a 32 degrees F to 158 degrees F range)

(See *Ovation Record Types Reference Manual*, *Ovation Init and AdMin User Guide*, and *Ovation Developer Studio User Guide*.)

4.3.7 Module block diagram - (HSAI)

The simplified block diagram for the voltage input configuration of the High Speed Analog Input module is shown in the following figure. The channel 1 input is grounded locally at the cabinet, and grounding at the field device is shown for the channel 8 input.

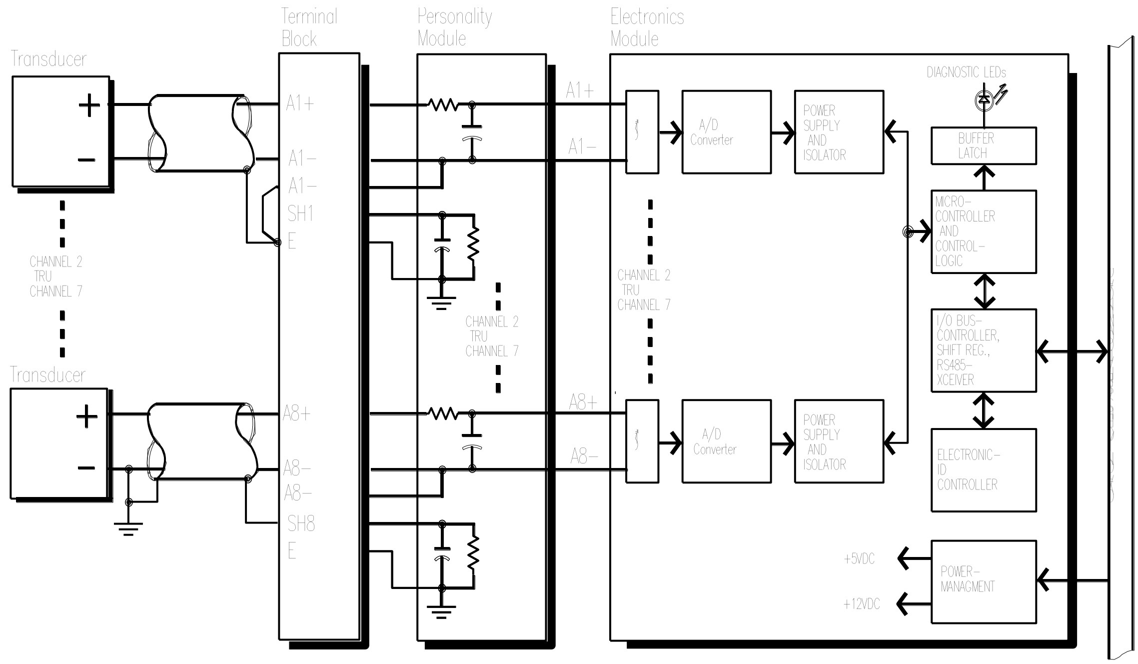


Figure 16: Voltage input configuration using Pmod 1C31227G02

4.3.8 Terminal block wiring information - (HSAI)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

The diagrams for the analog input Personality modules are illustrated in the field connections diagrams (see page 72). The following table lists and defines the abbreviations used in those diagrams.

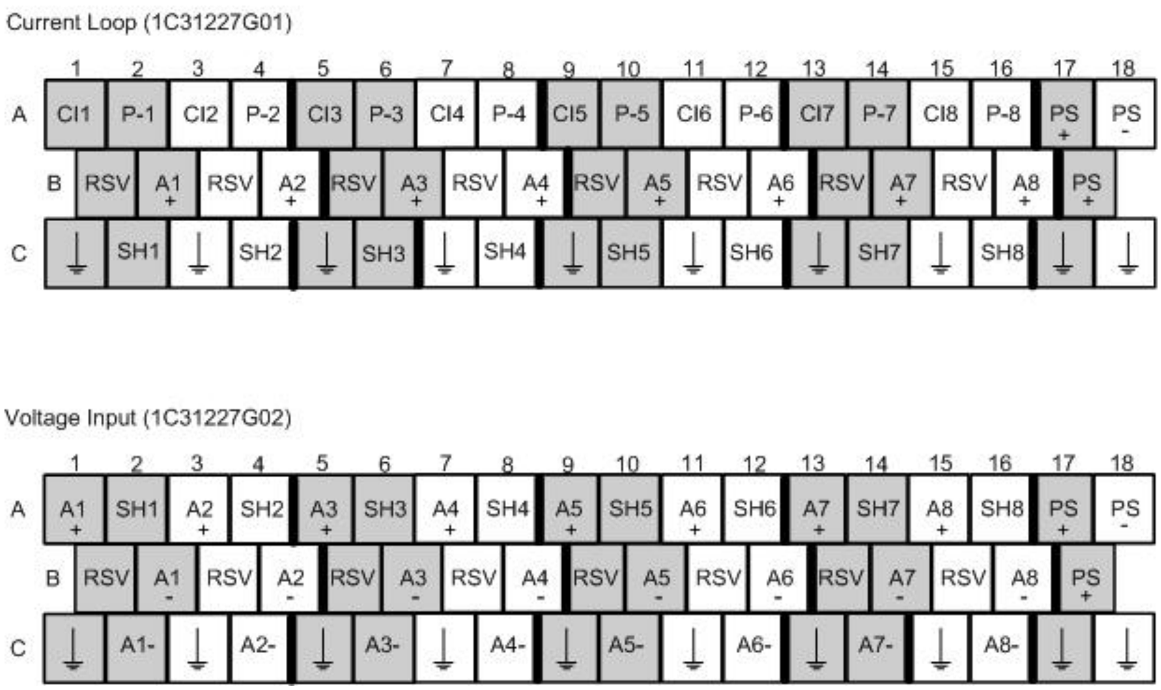


Figure 17: Terminal Block Connections for the Analog Input 1C31227 Pmods

Abbreviations used in diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals.
A1 - A8 +	Analog Input positive terminal connection (connected to the positive terminal of the field device).
A1 - A8 -	Analog Input negative terminal connection (voltage input group only).
CI1 - CI8	Current input terminals.
P-1 - P-8	Loop power output terminals (for locally powered loops).

ABBREVIATION	DEFINITION
PS+, PS-	Auxiliary power supply terminals.
RSV	Reserved terminal. No connections allowed on these terminals.
SH1 - SH8	Shield terminal connection.

Use shielded twisted pair wire for the field wiring. Tie the Analog Input negative terminal and shield together and to earth ground, either locally at the cabinet or at the field device. Voltage inputs use the 1C31227G02 Personality modules. Grounding the shield and the analog input negative terminal at the cabinet or at the field device is arranged by the proper Terminal Block connections.

Similarly, current inputs using the 1C31227G01 Personality modules can accommodate field or locally powered devices by using the correct terminal block connections.

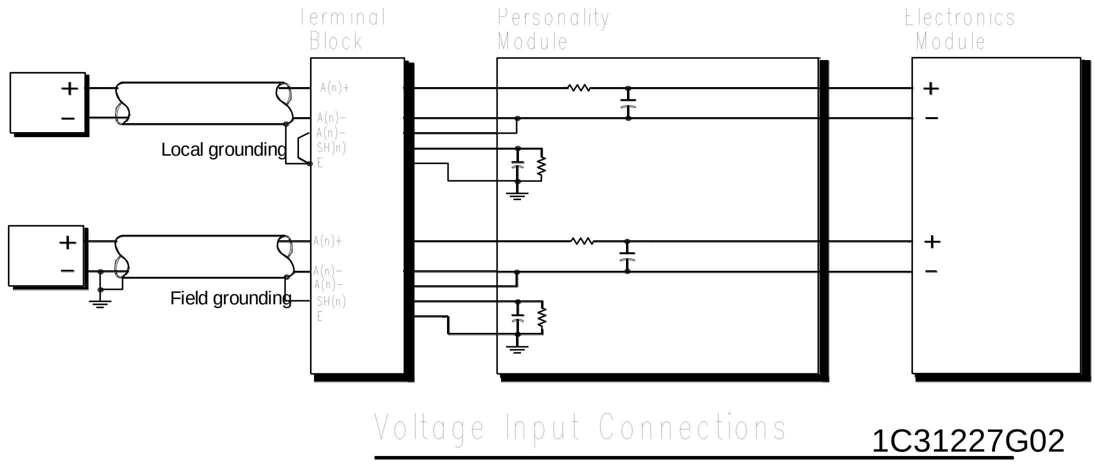
The Personality modules have a field connection diagram label on top of each module to facilitate field wiring. The following figures show the implementations of the field connections for the various Personality module and field device combinations.

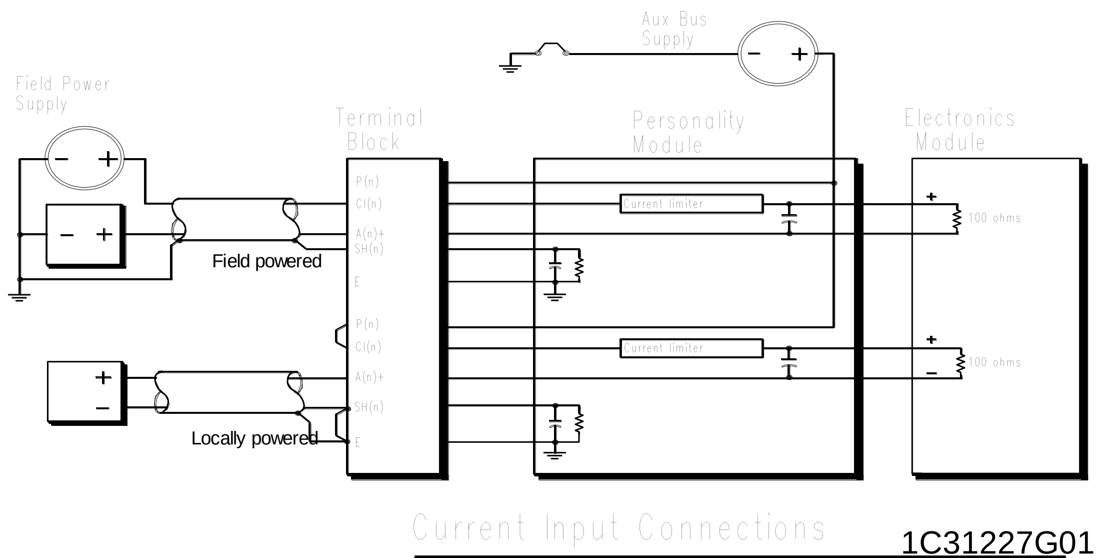
4.3.9 Field connection diagrams - (HSAI)

As is standard for analog signals, shielded twisted-pair wire should be used for the field interface. For the analog input, the negative (-) and shield should be tied together and to earth ground, either locally at the cabinet or at the field device.

The following four figures show how the various Personality modules require these connections or how the options are implemented. The fifth drawing illustrates the jumper settings for the Personality module.

4.3.10 Field connection wiring diagrams (Pmod 1C31227) - (HSAI)



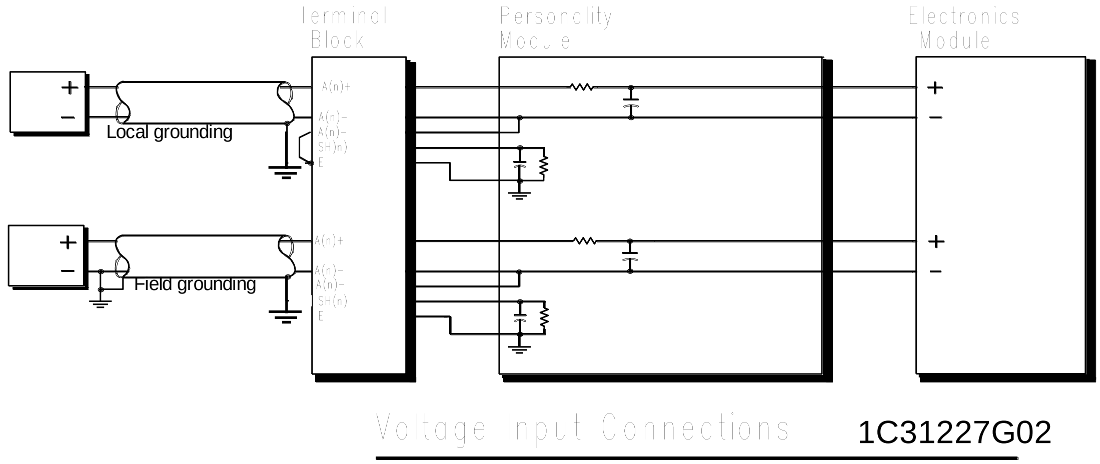


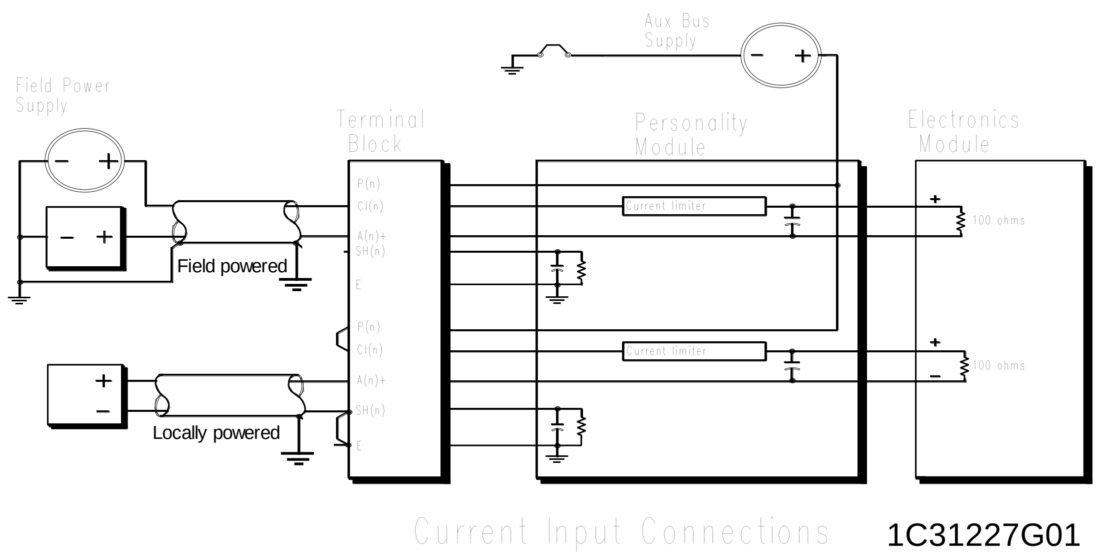
Caution

When using locally powered current inputs, the power distribution panel MUST be equipped with jumper module 5A26471G01 to ensure proper grounding of the aux Bus supply.

Figure 18: Field connections for the input connectors

4.3.11 Field connection wiring diagrams (Pmod 1C31227) (CE Mark) - (HSAI)





Caution

When using locally powered current inputs, the power distribution panel MUST be equipped with jumper module 5A26471G01 to ensure proper grounding of the aux Bus supply.

All field wiring must be braid shielded and grounded at the entry point of the cabinet using recommended hardware (refer to "Cable Guidelines" in the applicable Ovation installation manual for your system).

Figure 19: Field connections for the input connectors (CE Mark)

4.3.12 Field connection wiring diagrams (Pmod 1C31116) - (HSAI)

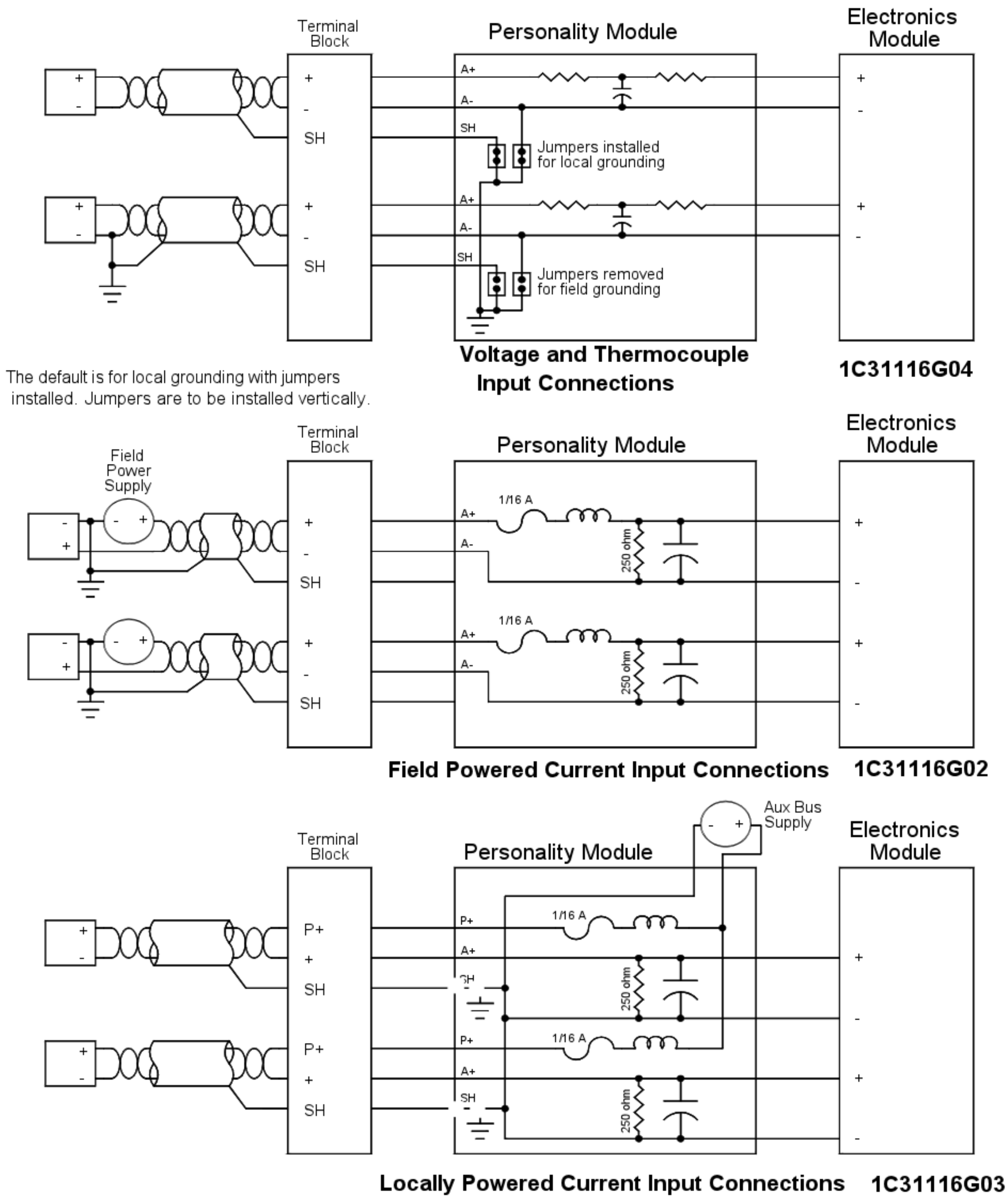
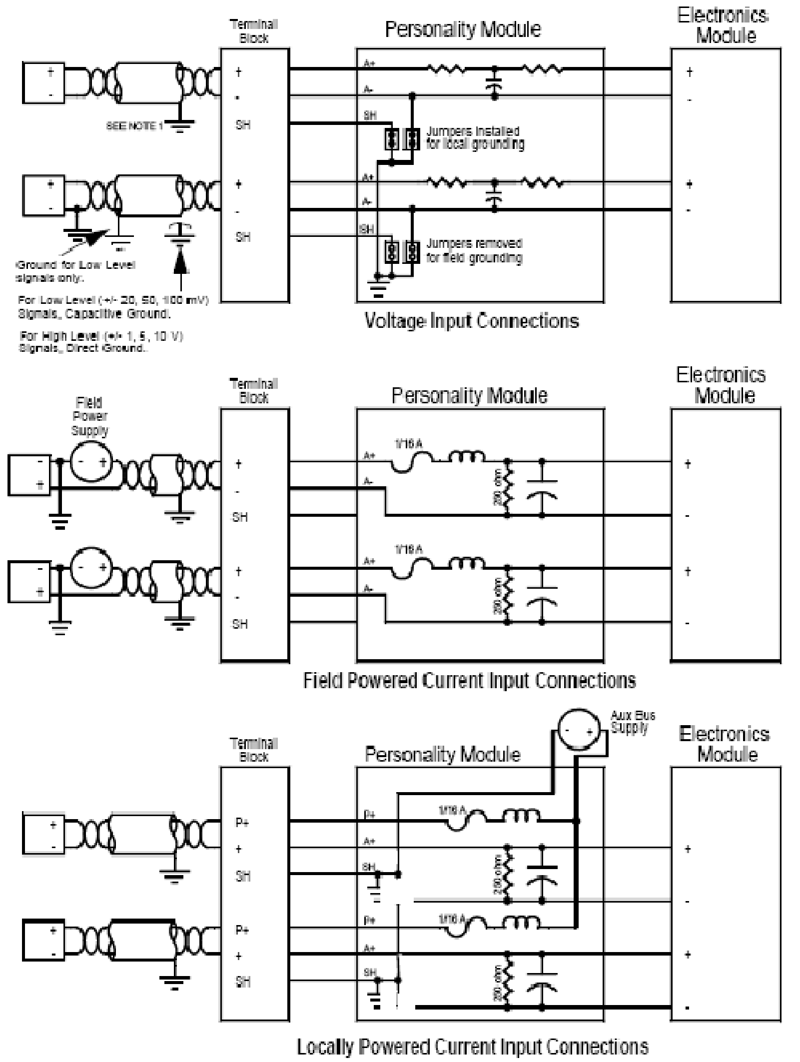


Figure 20: Field connections for the Analog Input Pmod

4.3.13 Field connection wiring diagrams, Pmod (Pmod 1C31116) (CE Mark) - (HSAI)



Caution

All field wiring must be braid shielded and grounded at the entry point of the cabinet using recommended hardware (refer to "Cable Guidelines" in the applicable Ovation installation manual for your system).

Figure 21: Field connections for the Analog Input Personality module (CE Mark)

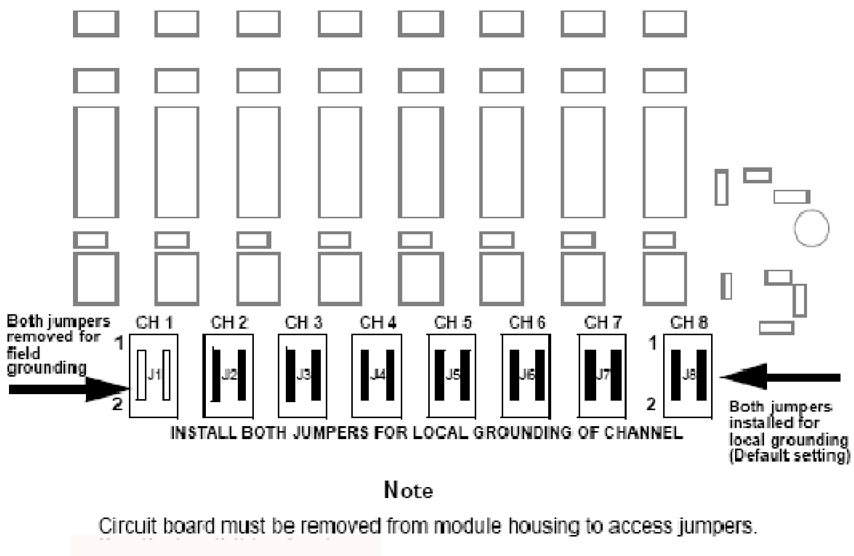


Figure 22: Jumper settings for Analog Input Personality module (1C31116G04)

4.3.14 Input address locations (Group 1) - (HSAI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. It varies slightly with the different groups (1-4), primarily in module calibration and range selection. The bit information contained within these words is shown in the following table.

These status words are only updated once per input channel sampling period; therefore, any Controller action based on changing the configuration (writing to address 13) must take this delay into account.

Data format for the configuration/module status register for group 1 definitions for the configuration/module status register lists

Bit	Description - Configuration Register (Write)	Description - Module Status Register (Read)
0	Configure module	Module Configured (1 = configured)
1	Force Error	Internal or forced error (1 = forced error)
2	0, (ADD4 bit During Diagnostics)	(Not Used)
3	0, (ADD5 bit During Diagnostics)	(Not Used)
4	0, (ADD6 bit During Diagnostics)	Warming
5	0, (ADD7 bit During Diagnostics)	(Not Used)
6	0, (ADD8 bit During Diagnostics)	(Not Used)
7	0, (DIAG_SET, Initiates Diagnostics)	Module is Not Calibrated
8	50/60 Hz Selection (1 = 50Hz)	50 Hz/60 Hz System (1 = 50Hz)
9	Not Defined	(Not Used)
10	0, (Initiates system calibration during Diagnostics)	SYS_CAL In Progress (During Diagnostics)
11	SELF_CAL (Initiates Self Calibration)	SYS_CAL Completed (During Diagnostics)

Bit	Description - Configuration Register (Write)	Description - Module Status Register (Read)
12	Not Defined	SYS_CAL Failed (During Diagnostics)
13	Not Defined	Internal Memory Error
14	Not Defined	Module In Diagnostic Mode (During Diagnostics)
15	Not Defined	Point Fault [1]
[1] Refer to the Point Quality Register for the descriptions of the Point Faults.		

Bits defined for Diagnostics are only used during factory testing.

The bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: This bit configures the module (write) or indicates the configuration state of the module (read). A “1” indicates that the module is configured. Note that until the module is configured, reading from addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write “1”) forces the module into the error state, resulting in the error LED being lit. The read of bit “1” indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the module’s Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when addresses 0 through 11 (B in Hex) are read.

Bits 2-3: These bits are not used and are read as “0” under normal operation.

Bit 4: This bit (read) indicates that the module is in the Warming state. This state exists after power up and terminates after 8.16 seconds. The module is in the error condition during the warm up period.

Bits 5-6: These bits are not used and read as “0” under normal operation.

Bit 7: This bit (read) is the result of a checksum test of the EEPROM. A failure of this test can indicate a bad EEPROM, but it typically indicates that the module has not been calibrated. A “0” indicates that there is no error condition. If an error is present, the module error LED is lit. The point fault bit is also set since all the point data is not calibrated. The “1” state of this bit indicates an unrecoverable error condition in the field.

Bit 8: The status of this bit (read) indicates the conversion rate of the module; write to this bit configures the conversion rate of A/D converters as shown in the following table.

Conversion Rate (1/sec.)	Bit 8
60 (for 60Hz systems)	0
50 (for 50Hz systems)	1

Bit 9: This bit is not used and is read as “0” under normal operation.

Bit 10: This bit is not used and is read as “0” under normal operation.

Bit 11: This bit (write) is used to initiate self-calibration. The sampling rate during self-calibration is two per second. The status (read) bit is not used and is read as “0” under normal operation

Bit 12: This bit is not used and is read as “0” under normal operation.

Bit 13: This bit (read) indicates that the module has internal memory error (FLASH checksum, Register or Static RAM error). If this error is present, the module error LED is lit, the point fault bit is also set since the condition of the module is undetermined.

Bit 14: This bit is not used and is read as “0” under normal operation.

Bit 15: This bit indicates the point fault status of the module. It is the logical “OR” of the eight individual point-quality status bits, plus the bits 1, 4, 7, and 13 of this register. A “0” indicates that all eight points have good quality and no module error exists. When bits 1, 4, 7 or 13 of the Status Register are not set, this bit (when set to “1”) indicates that at least one of the points has bad quality. A subsequent read of the Point Quality Register (Address 12, C in Hex) reveals the point(s) that have bad quality. The Address 12 (C in Hex) Point Quality Register contains data only when the module fault is due to a bad point quality.

4.3.15 Input address locations (Group 2) - (HSAI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. It varies slightly with the different groups (1-4), primarily in module calibration and range selection. The bit information contained within these words is shown in the following table.

These status words are only updated once per input channel sampling period; therefore, any Controller action based on changing the configuration (writing to address 13) must take this delay into account.

Data format for the configuration/module status register for group 2 definitions for the configuration/module status register bits

Bit	Description - Configuration Register (Write)	Description - Module Status Register (Read)
0	Configure module	Module Configured (1 = configured)
1	Force Error	Internal or forced error (1 = forced error)
2	0, (ADD4 bit During Diagnostics)	SYS_CAL In Progress (During Diagnostics)
3	0, (ADD5 bit During Diagnostics)	Module In Diagnostic Mode (During Diagnostics)
4	0, (ADD6 bit During Diagnostics)	Warming
5	0, (ADD7 bit During Diagnostics)	(Not Used)
6	0, (ADD8 bit During Diagnostics)	(Not Used)
7	0, (DIAG_SET, Initiates Diagnostics)	Module is Not Calibrated
8	50/60 Hz Selection (1 = 50Hz)	50 Hz/60 Hz System (1 = 50Hz)
9	250mv select (14-Bit)/Not Defined (13-Bit)	250mv select (14-Bit)/ 0 (13-Bit)
10	100mv select (14-Bit)/Not Defined(13-Bit)	100mv select(14-Bit)/0 (13-Bit)
11	SELF_CAL (Initiates Self Calibration)	SYS_CAL Completed (During Diagnostics)
12	0, (Initiates system calibration during Diagnostics)	SYS_CAL Failed (During Diagnostics)
13	0, Lock Calibration Gain (concurrent with the initiation of calibration during diagnostics)	Internal Memory Error
14	0, Clear Calibration (concurrent with the initiation of calibration during diagnostics)	(Not Used)[1]
15	Not Defined	Point Fault [1]
[1] Refer to the Point Quality Register for the descriptions of the Point Faults		

Bits defined for Diagnostics are only used during factory testing.

The bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: This bit configures the module (write) or indicates the configuration state of the module (read). A “1” indicates that the module is configured. Note that until the module is configured, reading from addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write “1”) forces the module into the error state, resulting in the error LED being lit. The read of bit “1” indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the module’s Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when addresses 0 through 11 (B in Hex) are read.

Bits 2-3: These bits are not used and are read as “0” under normal operation.

Bit 4: This bit (read) indicates that the module is in the Warming state. This state exists after power up and terminates after 8.16 seconds. The module is in the error condition during the warm up period.

Bits 5-6: These bits are not used and are read as “0” under normal operation.

Bit 7: This bit (read) is the result of a checksum test of the EEPROM. A failure of this test can indicate a bad EEPROM, but it typically indicates that the module has not been calibrated. A “0” indicates that there is no error condition. If an error is present, the module error LED is lit. The point fault bit is also set since all the point data is not calibrated. The “1” state of this bit indicates an unrecoverable error condition in the field.

Bit 8: The status of this bit (read) indicates the conversion rate of the module, write to this bit configures the conversion rate of A/D converters as shown in the following table.

Conversion Rate (1/sec.)	Bit 8
60 (for 60Hz systems)	0
50 (for 50Hz systems)	1

Bits 9-10: These bits are used to configure the ranges.

Full Scale	Bit 9	Bit 10
1V	0	0
250 mv	1	0
100 mv	0	1
invalid	1	1

Bit 11: This bit (write) is used to initiate self-calibration. The sampling rate during self-calibration is two per second. The status (read) bit is not used and is read as “0” under normal operation.

Bit 12: This bit is not used and is read as “0” under normal operation.

Bit 13: This bit (read) indicates that the module has internal memory error (FLASH checksum, Register or Static RAM error). If this error is present, the module error LED is lit, the point fault bit is also set since the condition of the module is undetermined.

Bit 14: This bit is not used and is read as “0” under normal operation.

Bit 15: This bit indicates the point fault status of the module. It is the logical "OR" of the eight individual point-quality status bits, plus the bits 1, 4, 7, and 13 of this register. A "0" indicates that all eight points have good quality and no module error exists. When bits 1, 4, 7 or 13 of the Status Register are not set, this bit (when set to "1") indicates that at least one of the points has bad quality. A subsequent read of the Point Quality Register (Address 12, C in Hex) reveals the point(s) that have bad quality. The Address 12 (C in Hex) Point Quality Register contains data only when the module fault is due to a bad point quality.

4.3.16 Input address locations (Group 3) - (HSAI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. It varies slightly with the different groups (1-4), primarily in module calibration and range selection. The bit information contained within these words is shown in the following table.

These status words are only updated once per input channel sampling period; therefore, any Controller action based on changing the configuration (writing to address 13) must take this delay into account.

Data format for the configuration/module status register for group 3 definitions for the configuration/module status register bits

Bit	Description - Configuration Register (Write)	Description - Module Status Register (Read)
0	Configure module	Module Configured (1 = configured)
1	Force Error	Internal or forced error (1 = forced error)
2	0, (ADD4 bit During Diagnostics)	SYS_CAL In Progress (During Diagnostics)
3	0, (ADD5 bit During Diagnostics)	Module In Diagnostic Mode (During Diagnostics)
4	0, (ADD6 bit During Diagnostics)	Warming
5	0, (ADD7 bit During Diagnostics)	(Not Used)
6	0, (ADD8 bit During Diagnostics)	(Not Used)
7	0, (DIAG_SET, Initiates Diagnostics)	Module is Not Calibrated
8	50/60 Hz Selection (1 = 50Hz)	50 Hz/60 Hz System (1 = 50Hz)
9	5V select (14-Bit)/Don't care (13-Bit)	250mv select (14-Bit)/ 0 (13-Bit)
10	0 (14-Bit)/Don't care(13-Bit)	100mv select(14-Bit)/0 (13-Bit)
11	SELF_CAL (Initiates Self Calibration)	SYS_CAL Completed (During Diagnostics
12	0, (Initiates system calibration during Diagnostics)	SYS_CAL Failed (During Diagnostics)
13	0, Lock Calibration Gain (concurrent with the initiation of calibration during diagnostics)	Internal Memory Error
14	0, Clear Calibration (concurrent with the initiation of calibration during diagnostics)	(Not Used)
15	Not Defined	Point Fault [1]
[1] Refer to the Point Quality Register for the descriptions of the Point Faults.		

Bits defined for Diagnostics are only used during factory testing.

The bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: This bit configures the module (write) or indicates the configuration state of the module (read). A "1" indicates that the module is configured. Note that until the module is configured, reading from addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write "1") forces the module into the error state, resulting in the error LED being lit. The read of bit "1" indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the module's Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when addresses 0 through 11 (B in Hex) are read.

Bits 2-3: These bits are not used and are read as "0" under normal operation.

Bit 4: This bit (read) indicates that the module is in the Warming state. This state exists after power up and terminates after 8.16 seconds. The module is in the error condition during the warm up period.

Bits 5-6: These bits are not used and are read as "0" under normal operation.

Bit 7: This bit (read) is the result of a checksum test of the EEPROM. A failure of this test can indicate a bad EEPROM, but it typically indicates that the module has not been calibrated. A "0" indicates that there is no error condition. If an error is present, the module error LED is lit. The point fault bit is also set since all the point data is not calibrated. The "1" state of this bit indicates an unrecoverable error condition in the field.

Bit 8: The status of this bit (read) indicates the conversion rate of the module, write to this bit configures the conversion rate of A/D converters as shown in the following table.

CONVERSION RATE (1/SEC.)	BIT 8
60 (for 60Hz systems)	0
50 (for 50Hz systems)	1

Bits 9-10: These bits are used to configure the ranges as follows for 14-Bit operation. For 13-Bit operation, these bits have no meaning.

Full Scale	Bit 9	Bit 10
10V	0	0
5V	1	0
2.5V(not supported)	0	1
invalid	1	1

Bit 11: This bit (write) is used to initiate self-calibration. The sampling rate during self-calibration is two per second. The status (read) bit is not used and read as "0" under normal operation.

Bit 12: This bit is not used and is read as "0" under normal operation.

Bit 13: This bit (read) indicates that the module has internal memory error (FLASH checksum, Register or Static RAM error). If this error is present, the module error LED is lit, the point fault bit is also set as the condition of the module is undetermined.

Bit 14: This bit is not used and is read as "0" under normal operation.

Bit 15: This bit indicates the point fault status of the module. It is the logical "OR" of the eight individual point-quality status bits, plus the bits 1, 4, 7, and 13 of this register. A "0" indicates that all eight points have good quality and no module error exists. When bits 1, 4, 7 or 13 of the Status Register are not set, this bit (when set to "1") indicates that at least one of the points has bad quality. A subsequent read of the Point Quality Register (Address 12, C in Hex) reveals the point(s) that have bad quality. The Address 12 (C in Hex) Point Quality Register contains data only when the module fault is due to a bad point quality.

4.3.17 Input address locations (Group 4) - (HSAI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. It varies slightly with the different groups (1-4), primarily in module calibration and range selection. The bit information contained within these words is shown in the following tables.

These status words are only updated once per input channel sampling period; therefore, any Controller action based on changing the configuration (writing to address 13) must take this delay into account.

Data Format for the configuration/module status register for group 4 definitions for the configuration/module status register bits

Bit	Description - Configuration Register (Write)	Description - Module Status Register (Read)
0	Configure Module	Module Configured (1 = configured)
1	Force Error	Internal or forced error (1 = forced error)
2	0, (ADD4 bit During Diagnostics)	SYS_CAL In Progress (During Diagnostics)
3	0, (ADD5 bit During Diagnostics)	Module In Diagnostic Mode (During Diagnostics)
4	0, (ADD6 bit During Diagnostics)	Warming
5	0, (ADD7 bit During Diagnostics)	(Not Used)
6	0, (ADD8 bit During Diagnostics)	(Not Used)
7	0, (DIAG_SET, Initiates Diagnostics)	Module is Not Calibrated
8	50/60 Hz Selection (1 = 50Hz)	50 Hz/60 Hz System (1 = 50Hz)
9	50mv select (14 bit)/Don't care (13-Bit)	50mv select (14 bit)/ 0 (13-Bit)
10	100mv select (14 bit)/Don't care(13-Bit)	100mv select (14 bit)/0 (13-Bit)
11	SELF_CAL (Initiates Self Calibration)	SYS_CAL Completed (During Diagnostics)
12	0, (Initiates system calibration during Diagnostics)	SYS_CAL Failed (During Diagnostics)
13	0, Lock Calibration Gain (concurrent with the initiation of calibration during diagnostics)	Internal Memory Error
14	0, Clear Calibration (concurrent with the initiation of calibration during diagnostics)	Temperature Sensor Failure
15	Not Defined	Point Fault [1]
[1] Refer to the Point Quality Register for the descriptions of the Point Faults		

Bits defined for Diagnostics are only used during factory testing.

The bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: This bit configures the module (write) or indicates the configuration state of the module (read). A "1" indicates that the module is configured. Note that until the module is configured, reading from addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write "1") forces the module into the error state, resulting in the error LED being lit. The read of bit "1" indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the module's Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when addresses 0 through 11 (B in Hex) are read.

Bits 2-3: These bits are not used and are read as "0" under normal operation.

Bit 4: This bit (read) indicates that the module is in the "Warming" state. This state exists after power up and terminates after 8.16 seconds. The module is in the error condition during the warm up period.

Bits 5-6: These bits are not used and are read as "0" under normal operation.

Bit 7: This bit (read) is the result of a checksum test of the EEPROM. A failure of this test can indicate a bad EEPROM, but it typically indicates that the module has not been calibrated. A "0" indicates that there is no error condition. If an error is present, the module error LED is lit. The point fault bit is also set as all the point data is not calibrated. The "1" state of this bit indicates an unrecoverable error condition in the field.

Bit 8: The status of this bit (read) indicates the conversion rate of the input module, write to this bit configures the conversion rate of A/D converters as shown in the following table.

CONVERSION RATE (1/SEC.)	BIT 8
60 (for 60Hz systems)	0
50 (for 50Hz systems)	1

Bits 9-10: These bits are used to configure the ranges as follows

FULL SCALE	Bit 9	Bit 10
20 mv	0	0
50 mv	1	0
100 mv	0	1
invalid	1	1

Bit 11: This bit (write) is used to initiate self-calibration. The sampling rate during self-calibration is 2 per second. The status (read) bit is not used and is read as "0" under normal operation

Bit 12: This bit is not used and is read as "0" under normal operation.

Bit 13: This bit (read) indicates that the module has internal memory error (FLASH checksum, Register or Static RAM error). If this error is present, the module error LED is lit, the point fault bit is also set as the condition of the module is undetermined.

Bit 14: This bit, if set, indicates that the temperature sensor has failed.

Bit 15: This bit indicates the point fault status of the module. It is the logical "OR" of the eight individual point-quality status bits, plus the bits 1, 4, 7, and 13 of this register. A "0" indicates that all eight points have good quality and no module error exists. When bits 1, 4, 7 or 13 of the Status Register are not set, this bit (when set to "1") indicates that at least one of the points has bad quality. A subsequent read of the Point Quality Register (Address 12, C in Hex) reveals the point(s) that have bad quality. The Address 12 (C in Hex) Point Quality Register contains data only when the module fault is due to a bad point quality.

4.3.18 Module register information - (HSAI)

Word address 14 (E in Hex) is not used and is read as "0" under normal operation.
Word address 12 (C in Hex) serves the purpose of reporting the point quality of the eight channel inputs.

High Speed Analog Input point quality register (address 12 or C in Hex)

Point	Bit	Description
1 - 8	0, 2, 4, 6, 8, 10, 12, 14	Communication to the Channel Failed.
1 - 8	1, 3, 5, 7, 9, 11, 13, 15	Overrange Input/Blown Fuse/Open Loop.

Communication to the Channel Failed - This bit is set when the communication to the corresponding channel has failed.

Over-range Input/Blown Fuse/Open Loop – This bit is set as follows:

- **Current Input Emods** – When an input current less than 2.5mA (a blown fuse or open loop condition) is detected, or an overrange (greater than 24.6mA) of full scale is present.
- **Voltage Input Emods** – When an overrange input of ±121% of the full scale value is read.

4.3.19 Diagnostic Logic card LEDs - (AI-13, AI-14 & HSAI)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (Red)	Internal Error LED. Lit whenever there is any type of error with the module **except** for a loss of power. Possible causes are: ▪ Module initialization is in progress. ▪ I/O Bus timeout has occurred. ▪ Internal hardware error. ▪ Module reset ▪ Module is uncalibrated. ▪ Forced error has been received from the Controller. ▪ Communication between the Field and Logic boards failed.

LED	DESCRIPTION
1 - 8 (Red)	Channel error. Lit whenever there is an error associated with a channel or channels. Possible causes are: ▪ Positive overrange: Input voltage greater than +121% of full scale value (for modules configured as voltage input). ▪ Negative overrange: Input voltage less than -121% of full scale value (for modules configured as voltage input). ▪ Current loop out of range ▪ Calibration readings out of range.
9 - 16	No LED.

4.3.20 Specifications - (HSAI)

- **Electronics module (5X00070)**
- **Personality modules (1C31227, 1C31116)**

DESCRIPTION	VALUE
Number of channels	8
Input range	G01: 4-20 ma G02: ±100mv, ±250mv, ±1V G03: ±5V, ±10V G04-05: ±20mv, ±50mv, ±100mv
Resolution	G01: 14 bits unipolar, G02 - G05: 14 bits including polarity.
Data format	G01: 14 bit binary, G02 - G05: 14 bit two's compliment.
Conversion type	Sigma Delta.
Operating Mode	self-scan.
Monotonicity	yes
Nonlinearity	0.003% of full scale.
Repeatability	Within guaranteed accuracy
Guaranteed accuracy (@25°C)	±0.10% of full scale value ±1/2LSB @99.7% confidence.
Temperature coefficient	±0.24% of the full scale value over 0 to 60°C.
Input impedance:	3.3 M ohms (G02, G04, G05) field configured; 200 M ohms (G03) field configured; 300 M ohms @20 mA for G01 field configured.
Maximum Overload	G01: ±48VDC or Vrms, G02 - G04: ±120VDC or Vrms.
Sample Duration time (msec)	50Hz configuration: G01 - G03: 20; G04, G05: 60. 60 Hz configuration: G01 - G03: 16.67; G04, G05: 50.
Self-calibration	On demand by the Ovation Controller.
Sample Repetition (msec)	50 Hz configuration: G01 - G03: 20; G04, G05: 64. 60 Hz configuration: G01 - G03: 16.67; G04, G05: 54.
Diagnostics	Internal module operating faults. Out of range detection. Open loop detection for current inputs.

DESCRIPTION	VALUE
Dielectric isolation: Channel to channel Channel to logic	 1000 V AC/DC 1000 V AC/DC
Normal mode rejection	60 dB @50 Hz ± 1/2% or @60 Hz ± 1/2% (when properly configured). 30 dB (typical) @50 Hz ± 5% or @60 Hz ± 5% (when properly configured).
Common mode rejection and channel-channel crosstalk	120 dB @ DC or @ the nominal (50/60 Hz) line frequency ± 1/2% and harmonics. 100 dB (typical) for nominal line frequency ± 5% and harmonics.
Module power	Main: 2.4 W typical; 3.125 W Maximum Aux: When used (1C31227G01) Aux power supply voltage = 24 V DC 3.84 W typical (8 inputs @ 20mA each)
Operating temperature range	0 to 60°C (32°F to 140°F).
Storage temperature range	-40°C to 85°C (-40°F to 185°F).
Humidity (non-condensing)	0 to 95%
Filtering	Digital, Sinc, 3dB cutoff: 13.1 Hz for 50Hz; 15.7 Hz for 60 Hz.

4.4 HART Analog Input module - (HAI)

HART (Highway Addressable Remote Transducer) is a digital communication protocol designed for industrial process measurement applications. Field measurement devices (transmitters) interface a process control system via an analog 4-to-20 mA current loop. HART uses a low-level frequency shift-keyed sine wave signal that is superimposed on the standard 4-to-20 mA process measurement current loop. Since the HART sine wave signal is small and its average value is zero, the current loop analog 4-to-20 mA signal is not significantly affected by the presence of the HART signal. Using HART allows a field device to provide more than one measurement, which is a feature not available when using only the 4-to-20 A analog current signal.

“Smart” field devices may be described as field devices in which the analog 4-to-20 mA signal, digital communication, and sometimes power, co-exist on the same pair of wires. The Ovation HART Analog Input (HAI) module is a standard form factor Ovation I/O module, which permits Ovation to communicate with HART devices.

The HART Analog Input Module is a CE Mark certified module.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

4.4.1 Electronics modules (Emod) - (HAI)

- **5X00058G01** interfaces to eight current loop signals with an input range of 4-20 mA.

4.4.2 Personality modules (Pmod) - (HAI)

- **5X00059G01** contains a single printed circuit board assembly with eight fused two-wire loop-powered or non-fused active-source (four-wire isolated current output) transmitter inputs. Eight user serviceable fuses (one fuse for each analog input channel) are located on the Pmod. Each fuse protects the auxiliary power supply only if the associated analog input channel is connected to a two-wire loop powered current transmitter.

***Note:** Revision 02 and later Personality modules contain a ninth user serviceable fuse (1/2 A) for the Electronics module +24 VDC auxiliary power input.*

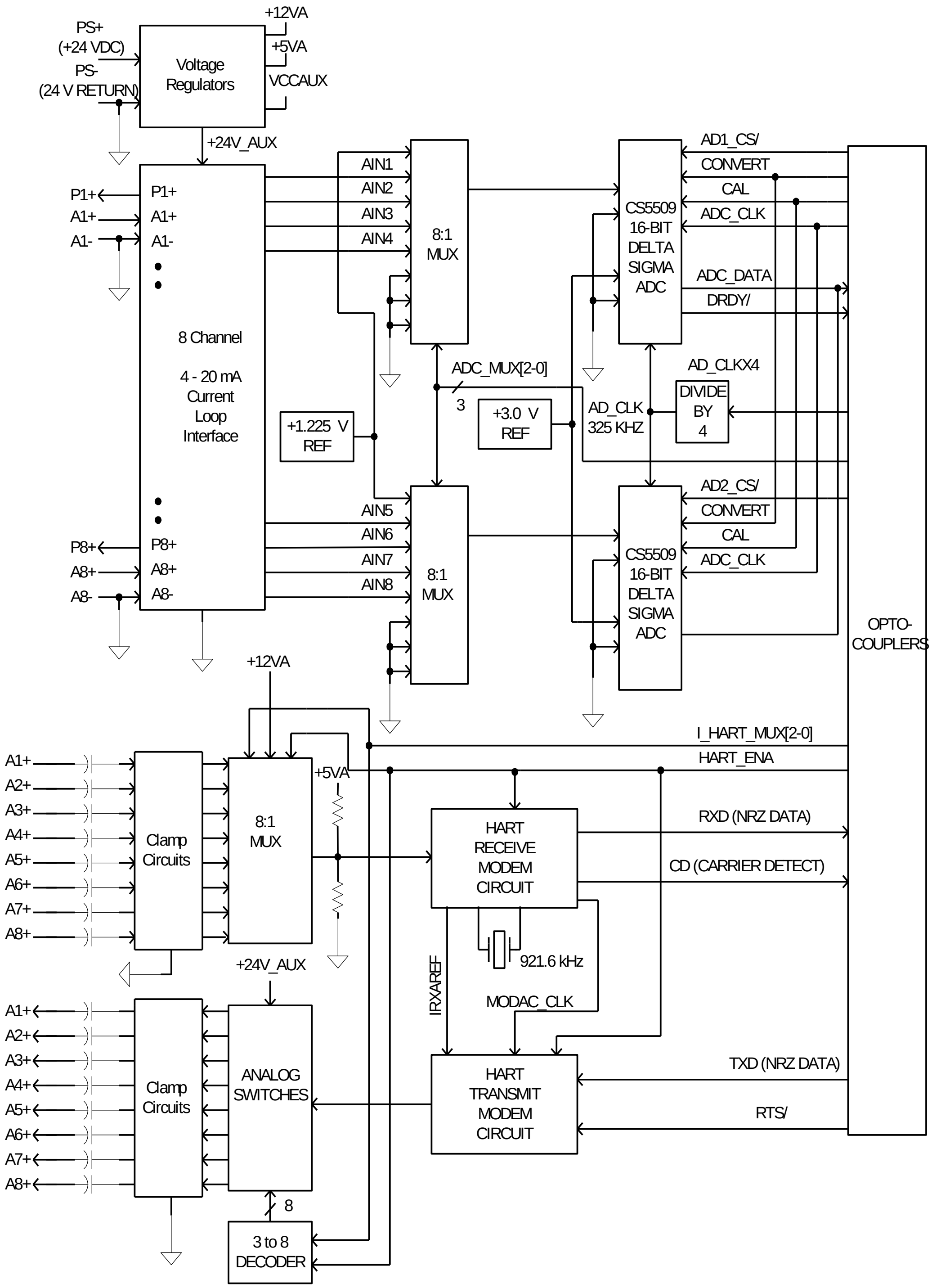
4.4.3 Subsystems - (HAI)

HART Analog Input subsystems (16-bit) [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4-20 mA loop powered (2 wire) or active source (4 wire)	8	5X00058G01[1]	5X00059G01
[1] This module configuration is CE Mark Certified.			

4.4.4 Module block diagram information - (HAI)

The Ovation HART Analog Input Module assembly consists of two modules: an Electronics module containing a logic printed circuit board (LHA) and a field printed circuit board (FHI). The simplified block diagram for the FHI field board is shown below. The Electronics module is used in conjunction with a Personality module, which contains a single printed circuit board (PHAI).



4.4.5 External power supply information - (HAI)

Note: *Module power specifications (main and auxiliary) refer to the actual power drawn by the module from the 24 VDC main power supply and from the +24 VDC auxiliary power supply and **NOT** from the AC or DC mains.*

The HART Analog Input Module utilizes the standard +24V Ovation main power supply to provide the power required for the logic circuitry.

The HART Analog Input Module utilizes a +24 auxiliary power supply to provide the power required for the field circuitry. This includes all 4-20 mA loop power, A/D conversion, and the remaining output channel components.

It is recommended that the HART Analog Input module utilize the Ovation cabinet's Auxiliary +24V DC power that is obtained from the standard Ovation DIN Rail power supply auxiliary output.

However, if an external auxiliary power supply is utilized by the HART Analog Input module, the power supply output noise cannot exceed 2.2 mVRMS Maximum for all rated loads across the frequency range of 500 HZ to 10 KHz, see the following figure.

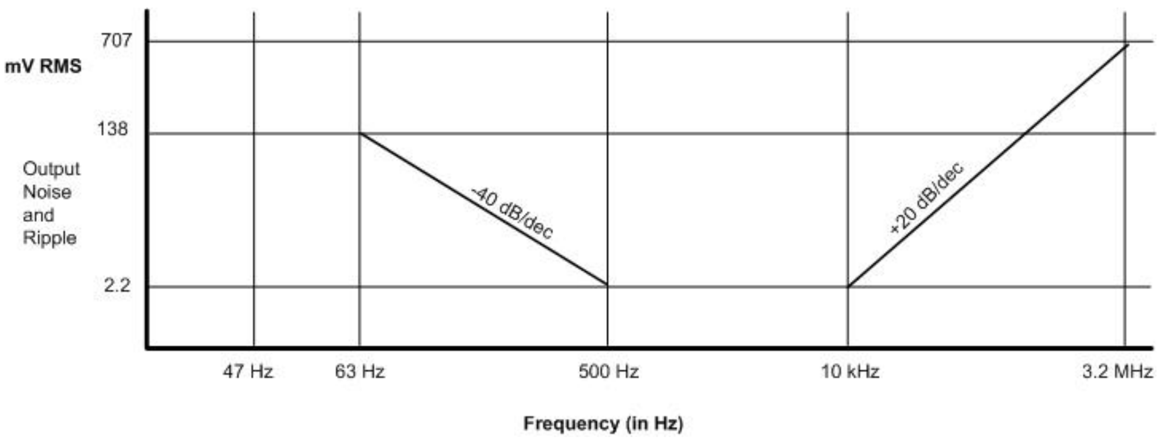


Figure 23: Power supply output noise requirements

If an external power supply is used, Using an External Power Supply (see page 799) contains steps to be undertaken before connecting the external power supply to the Ovation I/O base unit terminal block.

In addition, all modules utilizing the auxiliary power supplies, including the HART modules, **MUST** utilize shielded I/O cables in order to suppress coupled noise and transients into the HART modules. This includes modules on the same branch utilizing the auxiliary power, or modules on other branches utilizing the same auxiliary power. This recommendation applies regardless of the type of power supply chosen by the user.

4.4.6 Terminal block wiring information - (HAI)

Each Personality module has a simplified wiring diagram label on its side which appears above the terminal block. This diagram indicates how the wiring from the field is to be connected to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

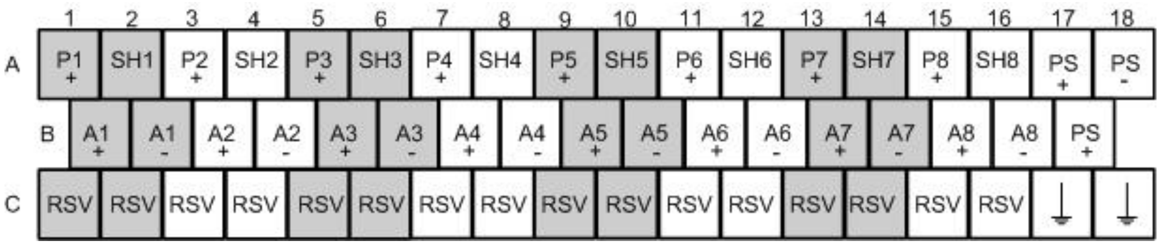
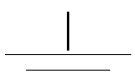


Figure 24: HART Analog Input terminal block pin assignments

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals.
A1 - A8 +	Analog Input terminal connection (connected to the negative terminal of a loop powered two-wire current transmitter or the positive terminal of an active-source current transmitter).
A1 - A8 -	Analog Input negative terminal connection (active-source only).
P1 - P8 +	Loop power output terminals (for loop powered two-wire current transmitters - connect to their positive terminal).
PS+, PS-	External Auxiliary power supply terminals.
RSV	Reserved terminal. No connections are allowed on these terminals.
SH1 - SH8	Shield terminal connection.

4.4.7 Field connection wiring diagrams - (HAI)

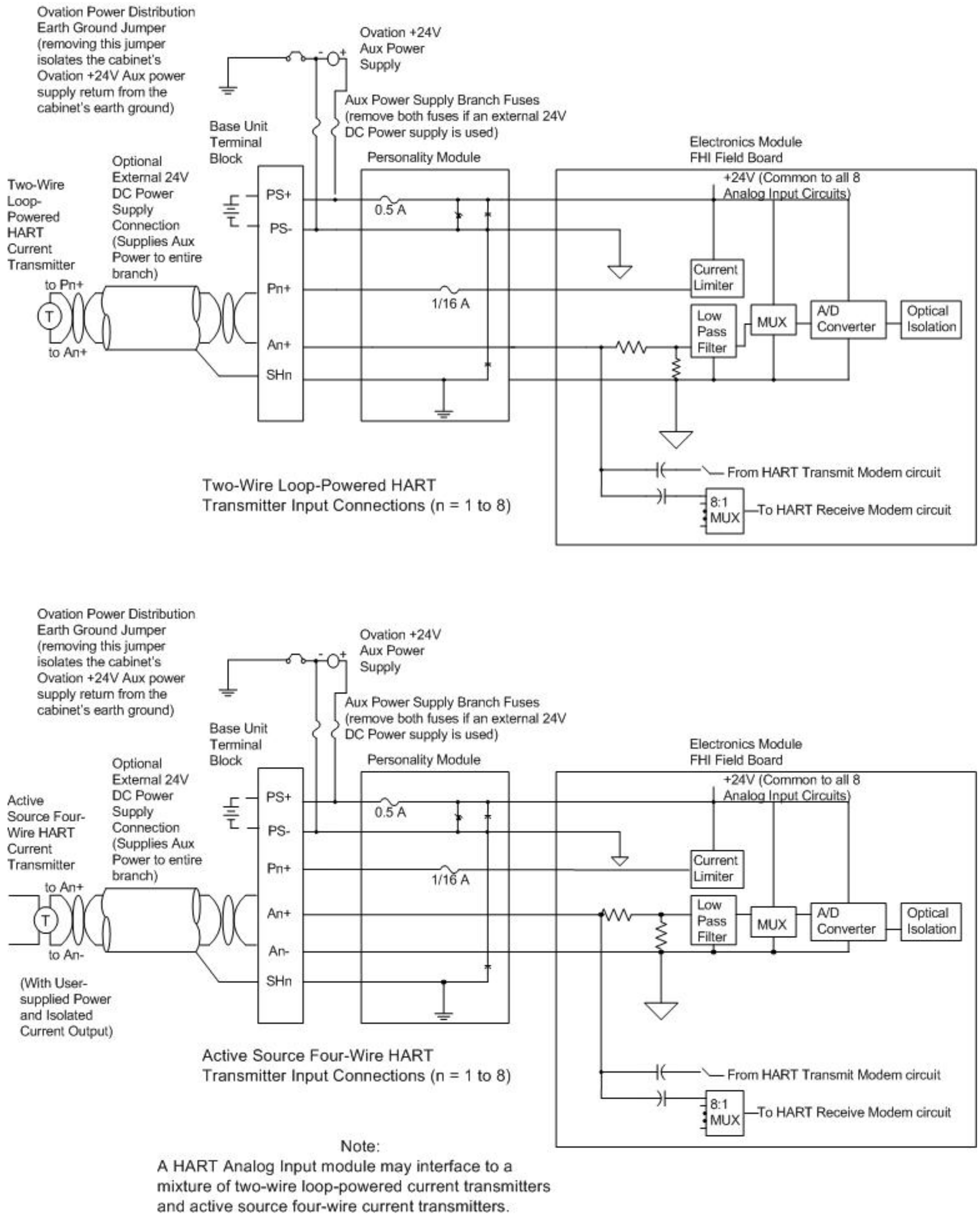


Figure 25: HART Analog Input connections

4.4.8 Field connection wiring diagrams (CE Mark) - (HAI)

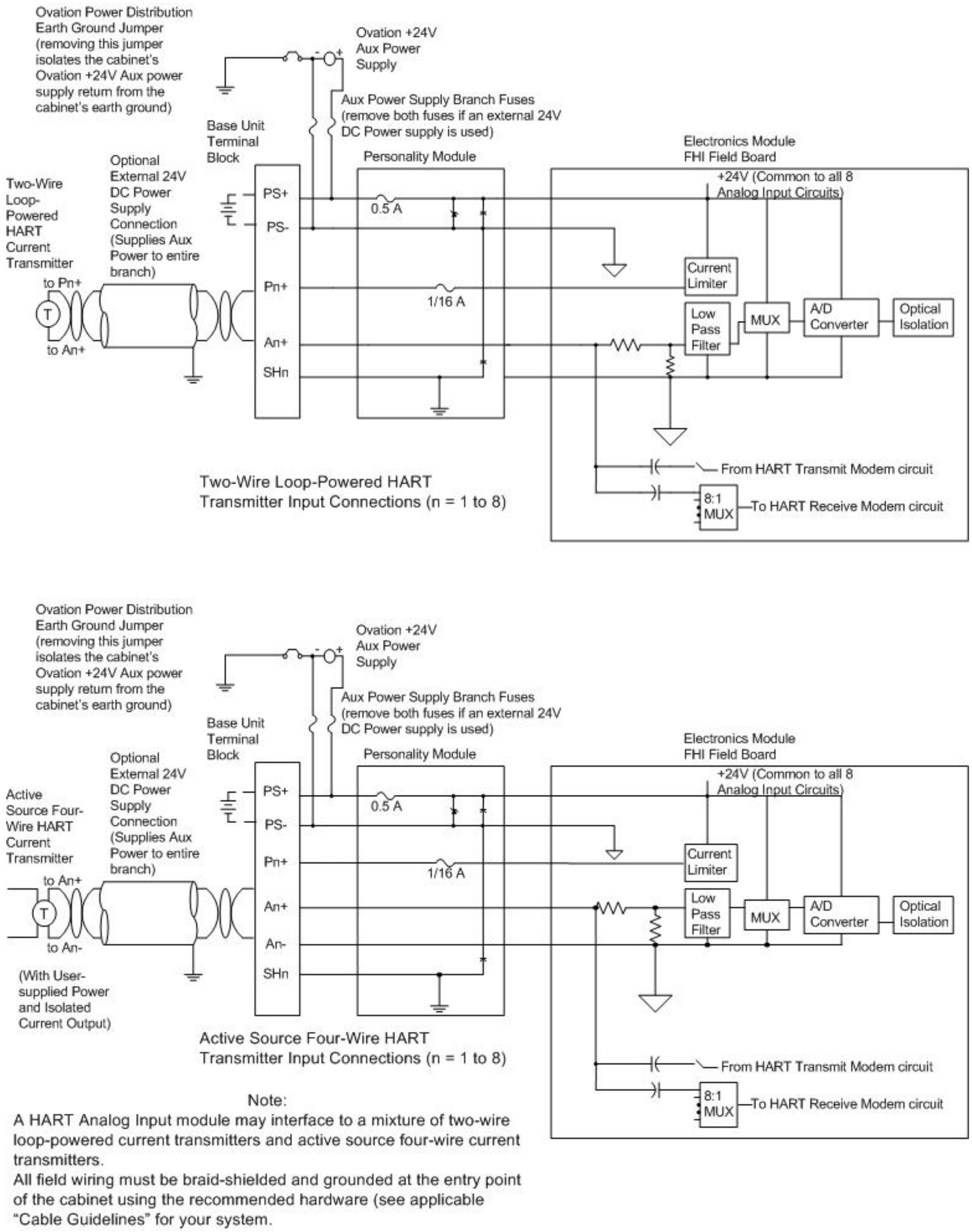


Figure 26: HART Analog Input Field Connections (CE Mark)

4.4.9 Field wiring cable requirements - (HAI)

Field I/O cable must be one or more single-twisted pair shielded or multiple-twisted pair with overall shield. Single and multiple pair may be combined provided that all of the shields share a common connection to earth ground in the Ovation cabinet.

Recommended minimum conductor size

Cable Length	Min. Conductor Size	Cable Type
Below 5,000 feet (1524 m)	24 AWG (0.51 mm dia.)	Single-twisted pair shielded or multiple-twisted pair with over-all shield.
Above 5,000 (1524 m)	20 AWG (0.81 mm dia.)	Single-twisted pair shielded.

The Maximum length of cable per HART network is dependent on the characteristics of the devices connected to the network and the characteristics of the cable to be used.

In a HART network, long cable lengths are possible when the dominant low impedance device (the HART Analog Input module) has an input impedance of approximately 250 ohms. Low capacitance good-quality cable is used, and the Smart transmitter (high impedance device) has a low input capacitance (less than 5000 pF) and a high input resistance (greater than 100 K ohm).

Example: Cable Length Calculation

Single Smart Transmitter, parallel network resistance = 250 ohm (HART Analog Input module input impedance)
Smart Transmitter Capacitance: 5000 pF
Cable Capacitance (Cx): 50 pF/ft.
Cable Resistance (Rx): 0.016 ohm/ft. (22 AWG)

Cx = Cable capacitance per unit length (feet or meters): The capacitance from one conductor to all other conductors (including the shield if shielded). This value is usually available from the cable manufacturer.

Rx = Cable resistance per unit length (feet or meters): This value should be available from the cable manufacturer. The table below contains the resistance values of some common copper wire sizes. The resistance per unit length is for a single wire but the length calculations and charts take into account the resistance of both wires.

Copper wire resistance table

Wire Size (AWG)	Resistance per ft. (Ohms)	Resistance per meter (Ohms)	Wire Size (sqmm)	Resistance per meter (Ohms)
16	0.0040	0.013	0.5	0.0368
17	0.0050	0.016	0.75	0.0265
18	0.0064	0.021	1.0	0.0184
19	0.0080	0.026	1.5	0.0123
20	0.010	0.032	_	_
21	0.013	0.042	_	_
22	0.016	0.052	_	_
23	0.020	0.066	_	_

Wire Size (AWG)	Resistance per ft. (Ohms)	Resistance per meter (Ohms)	Wire Size (sqmm)	Resistance per meter (Ohms)
24	0.026	0.085	_	_
25	0.032	0.10	_	_
26	0.041	0.13	_	_
27	0.051	0.17	_	_
28	0.065	0.21	_	_
29	0.082	0.27	_	_
30	0.100	0.33	_	_

From the following figure, using cable capacitance (Cx) of 50 pF/unit length and resistance (Rx) of 0.016 ohm/unit length, a direct reading of the corresponding length on the y-axis is approximately 3600 feet (unit length of feet from above parameters).

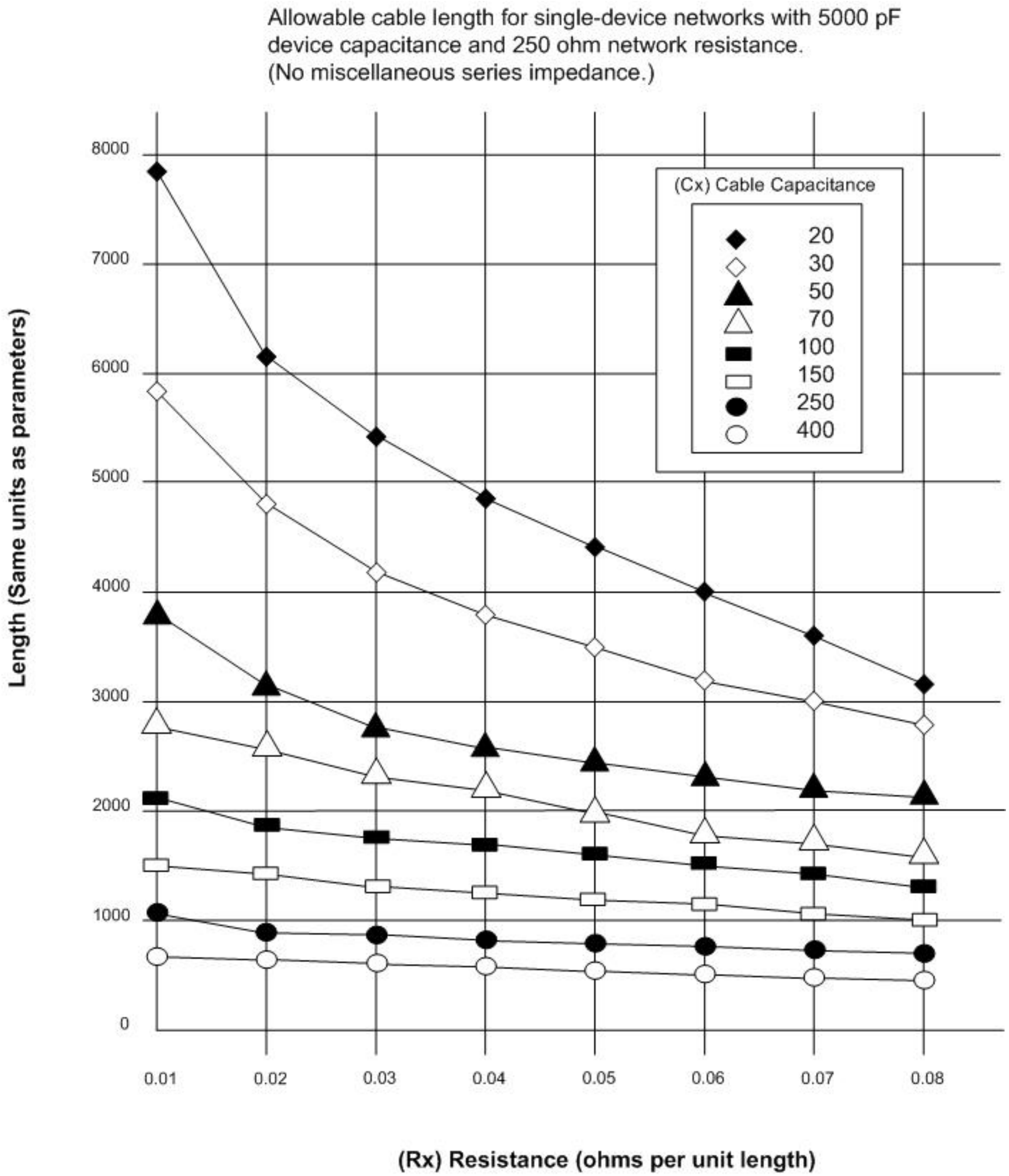


Figure 27: Length graph - single device network

4.4.10 Register configuration/address information - (HAI)

Each of the 16 direct registers on the HART (AI) module is summarized here and shown in more detail in the following tables. The status register can be read by using the Point Information window at an Operator's Station.

HART Analog Input register map

REG	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Indirect Memory Index	NA
1	Indirect Memory Data	Indirect Memory Data.
2 - 9	NA	Analog Input - Channel 1 - 8.
10	NA	Firmware Status Flags.
11	NA	HAI Firmware Revision.
12	NA	Channel Error Bits.
13	Module Configuration Register	Module Status Register (See table below.)
14	HART Enable	NA
15	NA	Module Electronic ID Data.

HART Analog Input configuration/status register (address 13 or D in Hex)

BIT	DATA DESCRIPTION (WRITE)	DATA DESCRIPTION (READ)
0	Configure Module	Module Configured (1 = configured; 0 = unconfigured.)
1	Force Error	Internal or forced error (1 = forced error; 0 = no forced error)
2 - 5	Reserved	NA
6	Reserved for Factory Test (must always be set to 0)	NA
7	Reserved for Factory Test (must always be set to 0)	NA
8	NA	Hardware Error.
9	NA	Bank 1 reference error.
10	NA	Bank 2 reference error.
11 - 13	Not Used	Not Used.
14	NA	Field power failed.
15	Reserved	Reserved.

Bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: This bit configures the module (write) or indicates the configuration state of module (read). A "1" indicates that the module is configured.

Bit 1: Forces the module into error state, illuminating the module's Error LED.

Bits 2 - 5: Reserved

Bits 6 - 7: Reserved for factory test, must always be set to 0.

Bit 8: Hardware error. Indicates one or more of the following is true:

- The FPGA did not program correctly on startup.
- The EE memory checksum is incorrect.
- The PROM checksum test has failed.
- Internal memory diagnostic has failed.

Bit 9: Reference error on first mux/AD combination.

Bits 11 - 13: Not used by the module.

Bit 10: Reference error on second mux/AD combination.

Bit 14: Field power failed.

Bit 15: Reserved.

HART Analog Input enable register (address 14 or E in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0 - 7	Multivariable Channel 1 - 8	Not Used.
8 - 15	HART Enabled - Channel 1 - 8	Not Used.

Bit definitions for this register are encoded as shown in the above table and described below:

Bits 0-7: These bits are set to enable multivariable messaging. Refer to the IO configuration guide for additional information.

The HAI, HAO, and IAH modules have the ability to retrieve additional variables from a field device. These variables are referred to as ‘multivariable’ and are named PV (primary variable), SV (secondary variable), TV (tertiary variable), and QV (quarterly variable).

If the bit is set, the module periodically retrieves whatever variables exist for the device.

The definitions of PV, SV, TV, and QV are found in the user’s manual for the field device supplied by the device manufacturer. The standard format of these four variables is IEEE 754, a floating-point format.

You must configure IO point records to cause the Controller to scan the module and retrieve the variables. (See the *Init and AdMin User Guide* or *Developer Studio User Guide*.)

Bits 8-15: In the IO configuration tool, you can set these flags on a per-channel basis to allow HART messaging, including multivariable messaging, to flow on that channel.

You should ensure that these bits are cleared for non-HART field devices. To avoid a HART communication error message, set each bit at “0” when connecting a non-HART output device.

4.4.11 Diagnostic Logic card LEDs - (HAI)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.

LED	Description
E (Red)	External Error LED. Illuminated upon loss of external auxiliary (field) power, as indicated by the loss of normal transitions of the EOC (end-of-convert) signal.
I (Red)	Internal Error LED. Lit whenever there is any type of error with the module **except** for a loss of power. Possible causes are: ▪ Module initialization is in progress. ▪ I/O Bus timeout has occurred. ▪ Register, static RAM, or FLASH checksum error. ▪ Module reset. ▪ Module is uncalibrated. ▪ Forced error has been received from the Controller. ▪ Communication between the Field and Logic boards failed.
1 -8 (Red)	LEDs 1 through 8 are used to indicate HART communication activity. When a HART message is sent, the LED for that particular channel is illuminated. When the HART response is received correctly, the LED is extinguished. When all is normal, that is, messages and responses are properly exchanged, a single LED blink is observed on the module's front cap. ▪ If a HART message is sent and no response is received, the HART Analog Input module exclusive-OR's the channel LED display with hex code 0xFF, resulting in all channel LEDs being illuminated except for the selected channel. For example, if the HART Analog Input module sent a HART message to device on channel 2, but the device was not connected to channel 2, the module would first illuminate LED 2 (all seven other channel LEDs extinguished). The module would then extinguish LED 2 and flash the other seven channel LEDs. This status indicates that the module sent a HART message on channel 2 and did not receive a valid response message after the initial message attempt or after any of the subsequent message retries.
9 - 16	No LED.

4.4.12 Specifications - (HAI)

- **Electronics module (5X00058)**
- **Personality module (5X00059)**

Description	Value
Number of channels	8
Input range	4 to 20 mA normal operation. 0 to 23 mA with under-range and over-range levels user selected and Controller monitored.
A/D Resolution	16 bits
Reference accuracy (@ 25 degrees C)	+/-0.05% of span @ 99.7% confidence.
Accuracy over temperature	+/-0.1% of span over the full operating temperature range.
Sampling rate (per ms)	Each channel is sampled every 24 ms.
Dielectric isolation: Channel to channel Channel to logic	 No channel to channel isolation. 1000 VAC/VDC for one minute.

DESCRIPTION	VALUE
Operating temperature range	0 degrees to 60 degrees C. (32 degrees F to 140 degrees F).
Humidity (non-condensing)	0% to 95%
Module power	Main: 1.2W typical. 2.5W Maximum. Aux. power supply voltage = 24 VDC -5%, +6.25% Aux: 4.1W typical. 7.2W Maximum.
Two-wire transmitter power	13.5V minimum (Pn+ to An+) @ 20 mA. where n = 1 to 8 (current limited to 32 mA Maximum)

4.5 HART High Performance Analog Input module - (HHPAI)

The HART (Highway Addressable Remote Transducer) High Performance Analog Input module is a standard Ovation I/O Module that provides eight galvanically isolated 4-20 mA analog inputs with HART transceivers. Each transceivers provides optically isolated communication to a dedicated UART (Universal Addressable Remote Transducer), thereby Maximizing HART communication throughout. Each channel may be individually configured for field powered or local powered transmitters via user accessible jumpers on the Personality module.

HART is a digital communication protocol designed for industrial process measurement applications. Field measurement devices (transmitters) interface for a process control system via an analog 4-to-20 mA current loop. HART uses a low-level frequency-shift-keyed sine wave signal that is superimposed on the standard 4-to-20 mA process measurement current loop. Since the HART sine wave signal is small and its average value is zero, the current loop analog 4-to-20 mA signal is not significantly affected by the presence of the HART signal. Using HART allows a field device to provide more than one measurement, which is a feature not available when using only the 4-to-20mA analog current signal.

“Smart” field devices may be described as field devices in which the analog 4-to-20 mA signal, digital communication, and sometimes power, co-exist on the same pair of wires. The Ovation HART Fast Analog Input (IAH) module is a standard form factor Ovation I/O module, which permits Ovation to communicate with HART devices.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

4.5.1 Electronics modules (Emod) - (HHPAI)

- **5X00106G01** interfaces to eight current loop signals with an input range of 4-20 mA.
- **5X00106G02** interfaces to eight current loop signals with an input range of 4-20 mA, (Reduced radiated emissions).

4.5.2 Personality modules (Pmod) - (HHPAI)

- **5X00109G01** contains eight fused input and user accessible jumpers that configure the channels for field powered or local powered transmitters on an individual basis.
- **5X00109G02** contains eight fused input and user accessible jumpers that configure the channels for field powered or local powered transmitters on an individual basis. Has the addition of active current limiting in the two-wire mode. Note that this module is available only in the following releases:
  - ☐ Ovation 3.4.0 and later.
  - ☐ Ovation 3.3.1 with patch OVA331063 installed.

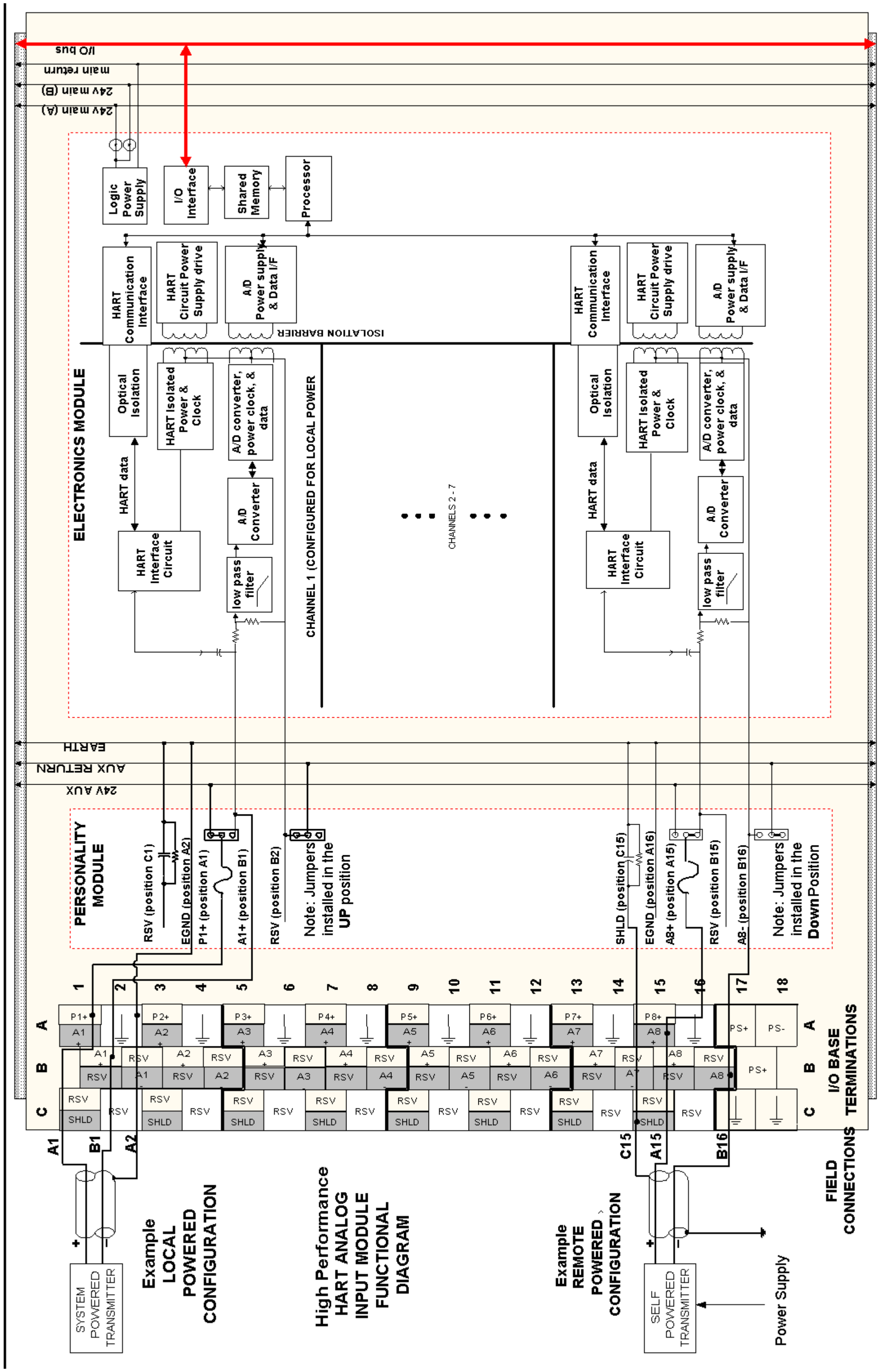
4.5.3 Subsystems - (HHPAI)

HART High Performance Analog Input subsystems (16-bit)

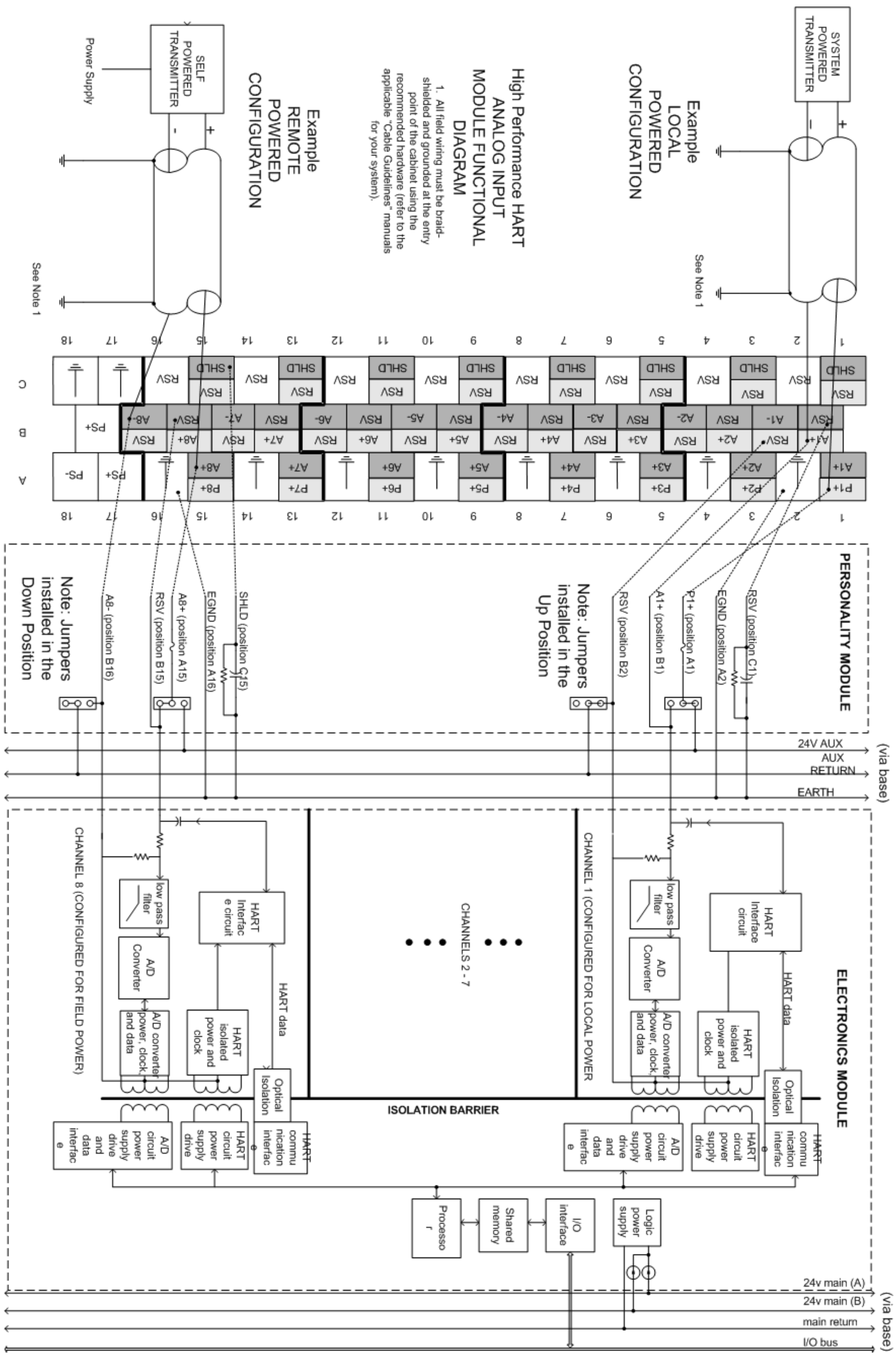
Range	Chnls	Electronics module	Personality module
4-20 mA [1]	8	5X00106G01	5X00109G01 or 5X00109G02 (Note that this module is available only in the following releases: ▪ Ovation 3.4.0 and later. ▪ Ovation 3.3.1 with patch OVA331063 installed.
4-20 mA[2] (Reduced radiated emissions).	8	5X00106G02	5X00109G01 or 5X00109G02 (Note that this module is available only in the following releases: ▪ Ovation 3.4.0 and later. ▪ Ovation 3.3.1 with patch OVA331063 installed.
4-20 mA [1] Analot Output pin-compatible.	8	5X00106G01	5X00170G01

[1] This module configuration is CE Mark Certified.
[2] This module configuration is CE Mark Certified (Non-EMC Cabinet).

4.5.4 Field wiring diagram - (HHPAI)


High Performance HART ANALOG INPUT MODULE FUNCTIONAL DIAGRAM
ELECTRONICS MODULE
PERSONALITY MODULE
I/O BASE TERMINATIONS
FIELD CONNECTIONS
Example LOCAL POWERED CONFIGURATION
Example REMOTE POWERED CONFIGURATION
SYSTEM POWERED TRANSMITTER
SELF POWERED TRANSMITTER
Power Supply
I/O bus
main return
24v main (B)
24v main (A)
EARTH
AUX RETURN
24V AUX
Logic Power Supply
I/O Interface
Shared Memory
Processor
HART Communication Interface
HART Circuit Power Supply drive
A/D Power supply & Data I/F
ISOLATION BARRIER
Optical Isolation
HART Isolated Power & Clock
A/D converter, power clock, & data
HART data
HART Interface Circuit
A/D Converter
low pass filter
CHANNEL 1 (CONFIGURED FOR LOCAL POWER
CHANNELS 2 - 7
RSV (position C1)
EGND (position A2)
P1+ (position A1)
A1+ (position B1)
RSV (position B2)
Note: Jumpers installed in the UP position
SHLD (position C15)
EGND (position A16)
A8+ (position A15)
RSV (position B15)
A8- (position B16)
Note: Jumpers installed in the Down Position

4.5.5 Field wiring diagram (CE Mark) - (HHPAI)



4.5.6 Power supply information - (HHPAI)

Note: *Module power specifications (main and auxiliary) refer to the actual power drawn by the module from the 24 VDC main power supply and from the +24 VDC auxiliary power supply and **NOT** from the AC or DC mains.*

The HART High Performance Analog Input module utilizes the standard +24V Ovation main power supply to provide the power required for the logic circuitry.

When one or more loop powered two-wire current transmitters are interfaced to the HART High Performance Analog Input module, the module utilizes a +24 auxiliary power supply to provide the power required by the current transmitters and their current loops.

It is recommended that the High Performance Analog Input module utilize the Ovation cabinet's Auxiliary +24V DC power that is obtained from the module's branch from the standard Ovation DIN Rail power supply auxiliary output.

However, if an external auxiliary power supply is utilized by the HART High Performance Analog Input module, the power supply output noise cannot exceed 2.2 mVRMS Maximum for all rated loads across the frequency range of 500 HZ to 10 KHz.

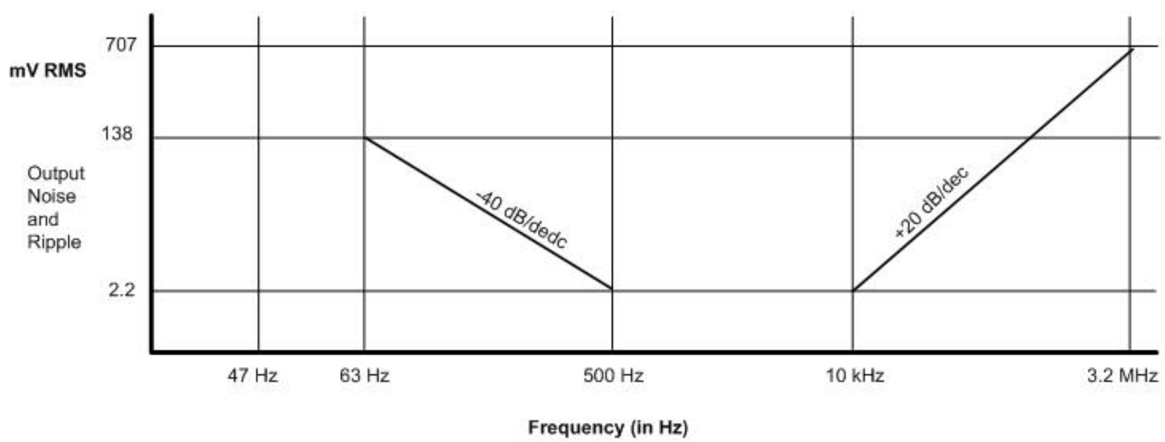


Figure 28: Power supply output noise requirements

All modules utilizing the auxiliary power supplies, including the HART High Performance Analog Input modules, **MUST** utilize shielded I/O cables in order to suppress coupled noise and transients into the HART High Performance Analog Input module. This requirement includes modules on the same branch utilizing the auxiliary power, or modules on other branches utilizing the same auxiliary power. This recommendation applies regardless of the user selected power supply style.

4.5.7 Terminal block wiring information - (HHPAI)

Each Personality module has a simplified wiring diagram label on its side which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. Note that there are two wiring configurations for each channel dependent upon whether the channel is configured for Local or Field powered transmitters.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

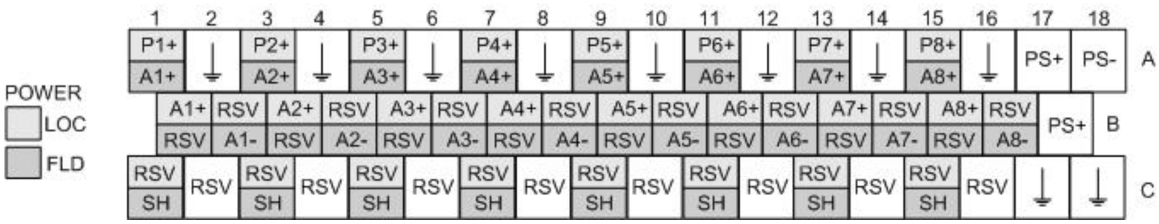
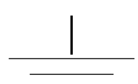


Figure 29: Wiring diagram label

The diagrams for the HART High Performance Analog Input Personality modules are illustrated in the figure above. The following table lists and defines the abbreviations used in those diagrams.

Wiring diagram label definitions

ABBREVIATION	ABBREVIATION
A1 - A8 +	Analog Input terminal connection (connected to the negative terminal of a local powered transmitter or the positive terminal of field powered transmitter).
A1 - A8 -	Analog Input negative terminal connection (field powered configuration only).
P1 - P8 +	Loop power output terminals (for local powered configuration only. Connected to the positive).
SH1 - SH8	Shield terminal connection. (For landing shields where the shield is to be grounded at the transmitter).
	Earth ground terminals. (For landing shields where the shield is to be grounded at the module).
PS+, PS-	External Auxiliary power supply terminals.
RSV	Reserved terminal. No connections are allowed on these terminals.

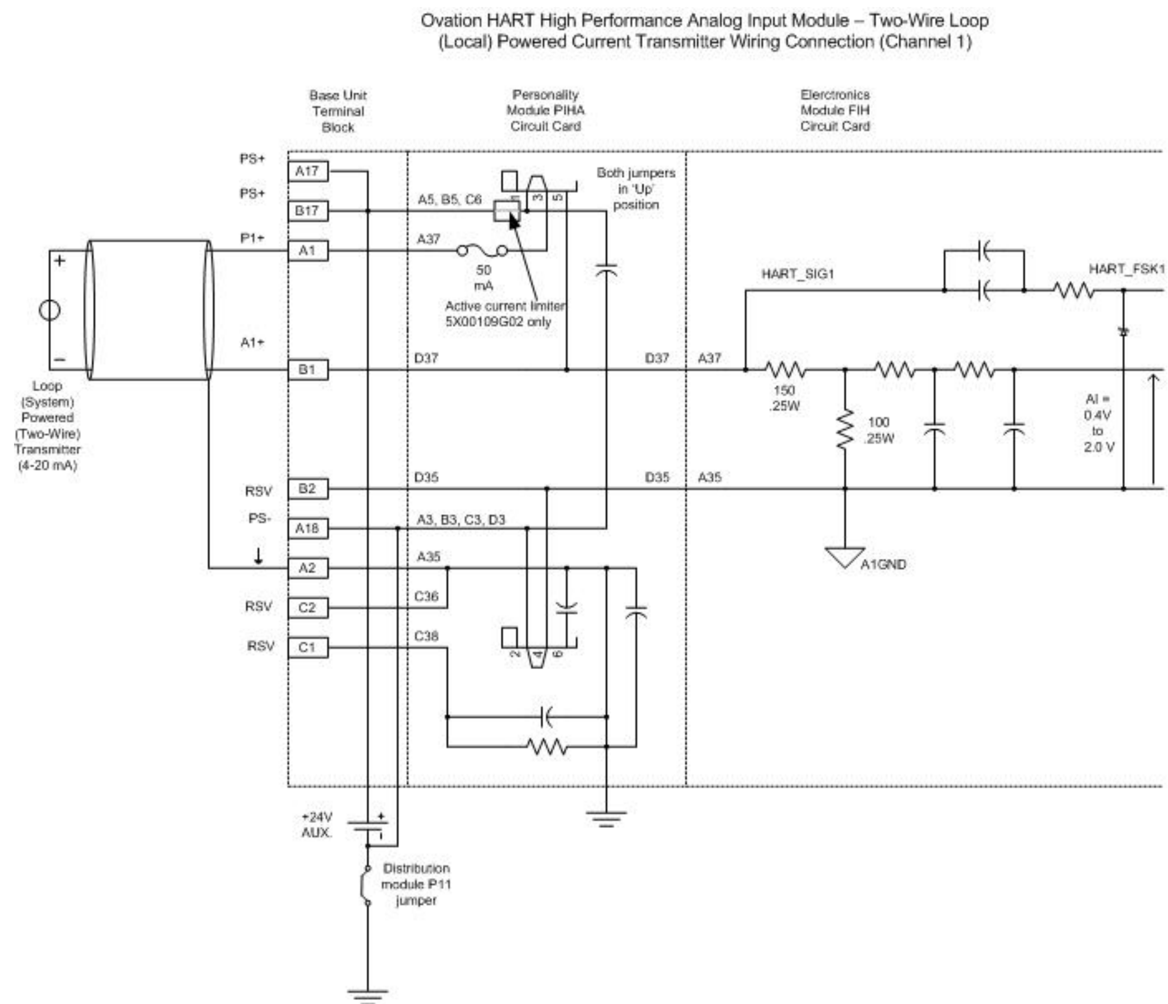
4.5.8 Field wiring cable requirements - (HHPAI)

Recommended minimum conductor size

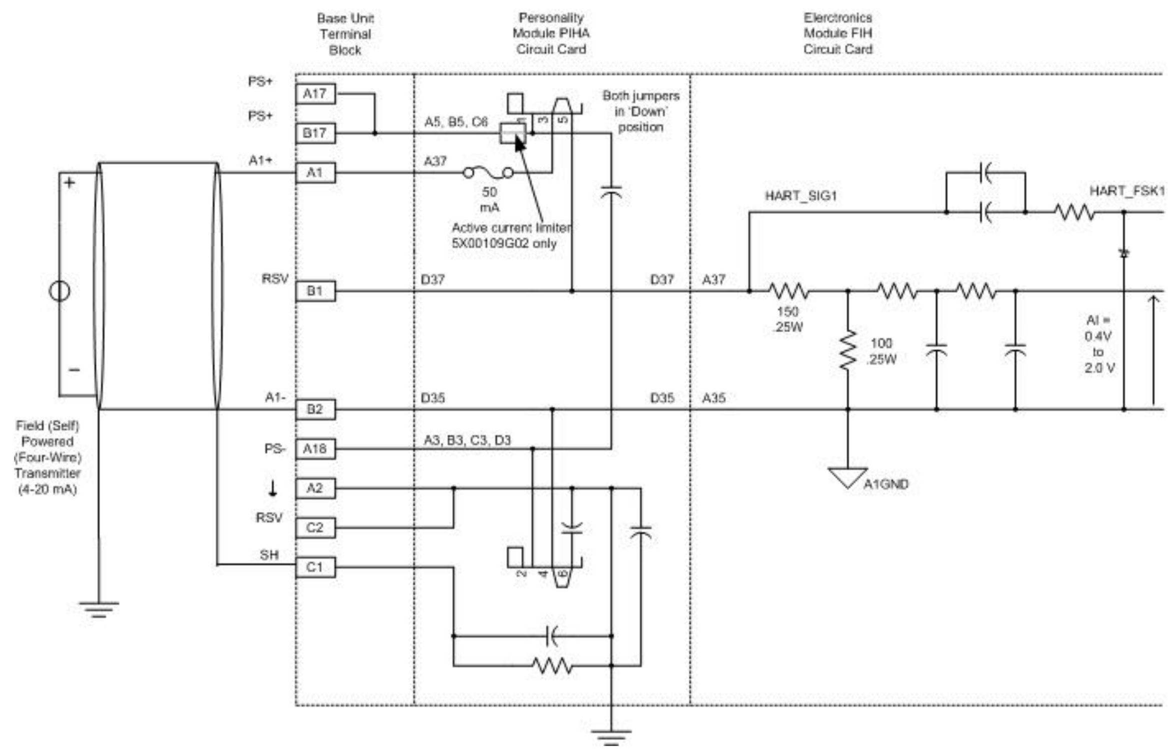
CABLE LENGTH	MIN. CONDUCTOR SIZE	CABLE TYPE
Less than 5,000 feet (1524 m)	24 AWG (0.51 mm dia.)	Single-twisted pair with over-all shield.
Greater than 5,000 feet, but less than 10,000 feet (3048 meters)	20 AWG (0.81 mm dia.)	Single-twisted pair with over-all shield.

Refer to the HART FSK Physical Layer Specification (HFC_SPEC-54) for additional cabling information.

4.5.9 Field connection wiring diagrams - (HHPAI)

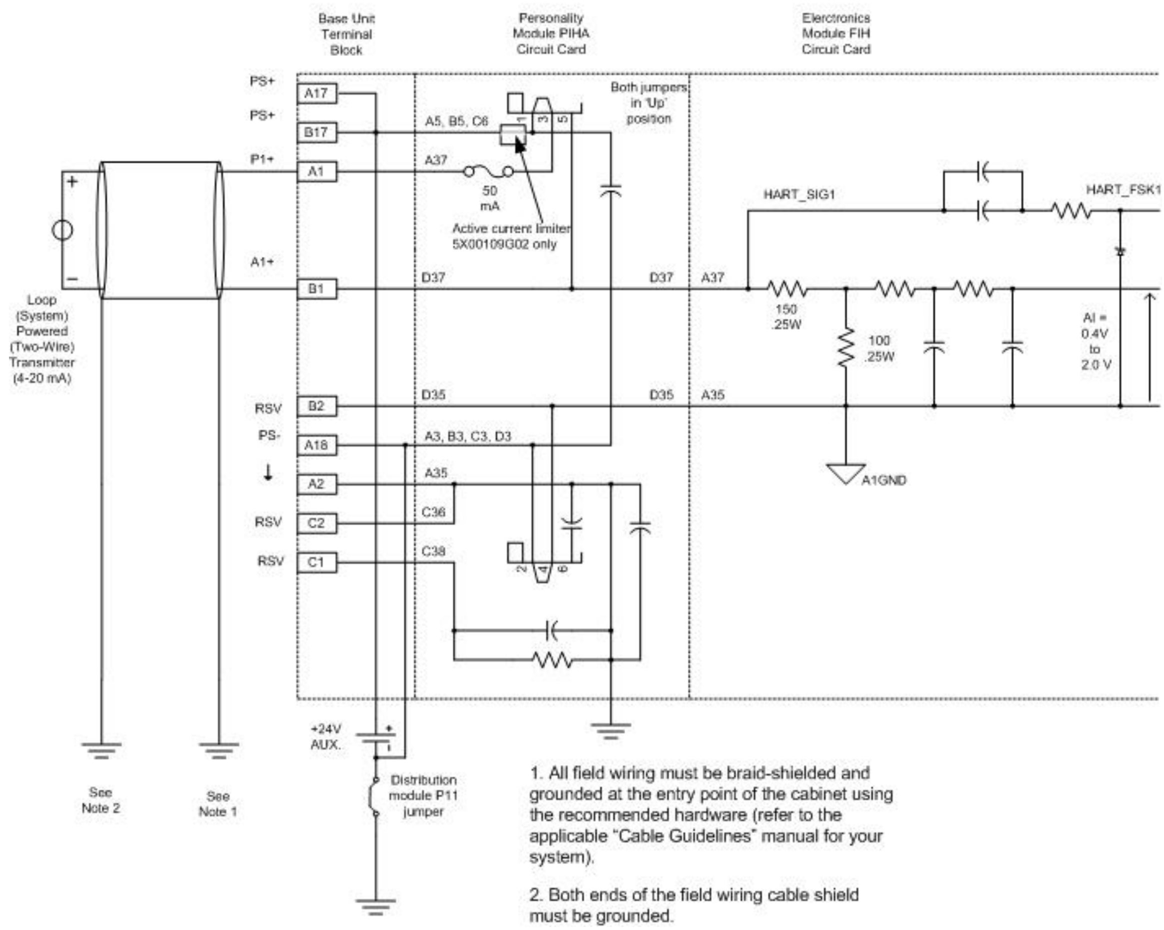


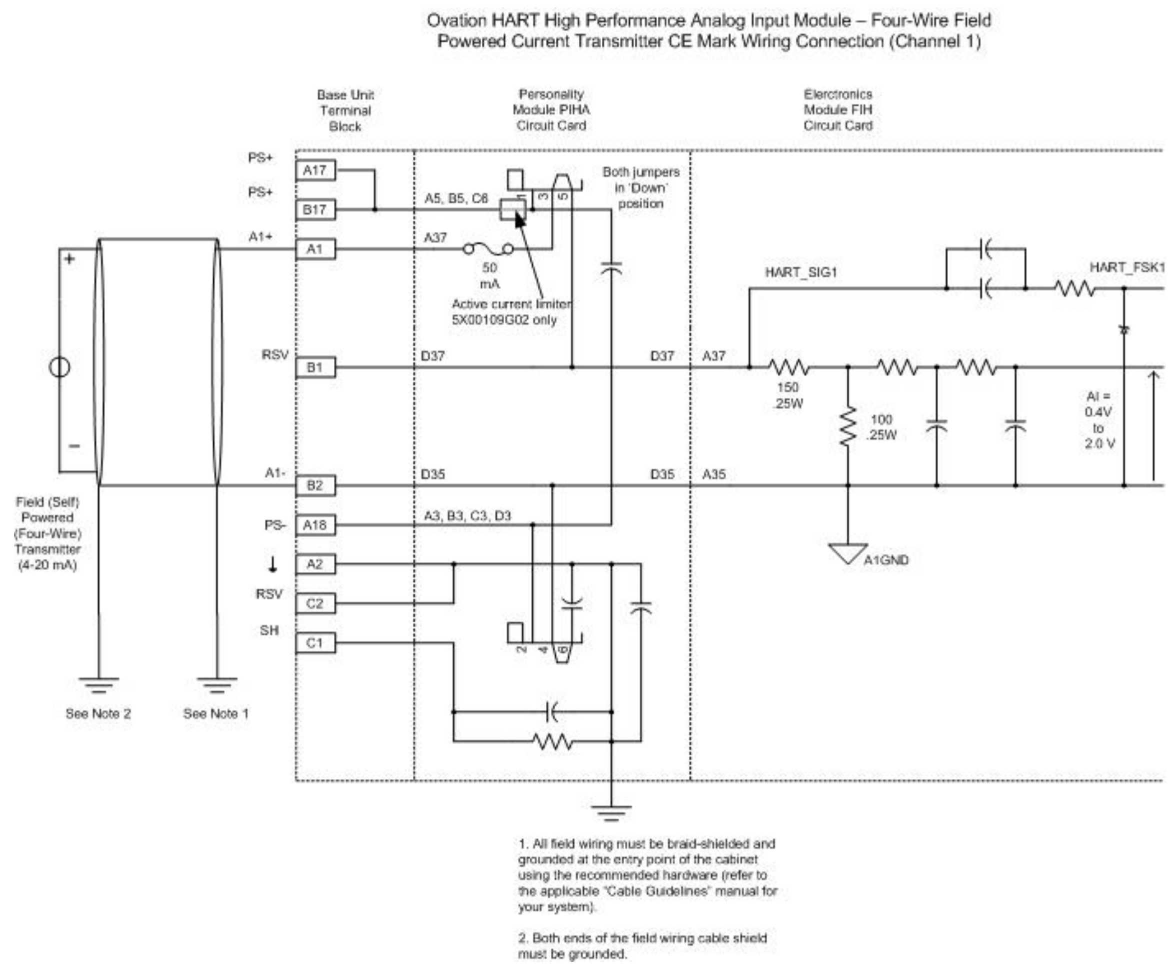
Ovation HART High Performance Analog Input Module – Four-Wire Field Powered Current Transmitter Wiring Connection (Channel 1)



4.5.10 Field connection wiring diagrams (CE Mark) - (HHPAI)

Ovation HART High Performance Analog Input Module – Two-Wire Loop
(Local) Powered Current Transmitter CE Mark Wiring Connection (Channel 1)





4.5.11 Personality Jumper Information - (HHPAI)

Each Personality module provides a 1/20 A fuse on each channel for loop protection. Additionally, each channel provides a pair of user accessible jumpers for configuring each channel for local powered transmitters or field powered transmitters. This configuration is on a per channel basis. The fuses and jumpers are accessible through the top of the module. The label, shown in the following figure, on the top of the module indicates how to position the jumpers. Note that there are two jumpers per channel and they must be positioned together.

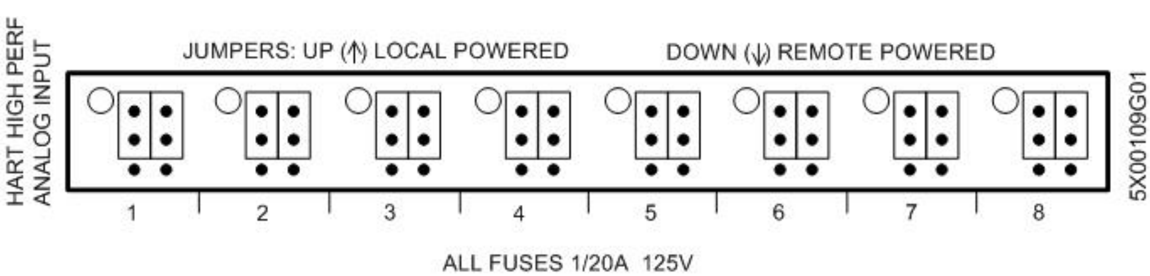


Figure 30: HART High Performance Analog Input Personality module

Note: *Jumpers are shown in the local powered configuration for all channels.*

4.5.12 Register configuration/address information - (HHPAI)

The module configuration/status register is module I/O register 13 (0xD). The register bit assignments are defined as follows:

Module configuration/status register

Bit	Data Description (Write)	Data Description (Read)
0	Configure Module	Module Configured (1 = configured)
1	Force Error	Internal or forced error (1 = forced error)
2	50/60 Hz selection (1=50 hz)	50/60 Hz System (1=50 Hz)
3	SELF_CAL (Initiates Self Calibration)	SELF_CAL (Initiates Self Calibration)
4	Toggle Bit (80C32 to 90S8515)	0, (Not Used)
5	0, (Not Used)	0, (Not Used)
6	0, (Not Used)	0, (Not Used)
7	80C32 diagnostics	80C32 diagnostics
8	0, (Not Used)	80C32 Memory Error
9	0, (Not Used)	9058515 Internal Error
10	0, (Not Used)	9058515 Memory Error
11	0, (Not Used)	Module not calibrated
12	0, (Not Used)	0, (Not Used)
13	Toggle Bit (90S8515 to 80C32)	Toggle Bit (90S8515 to 80C32)
14	0, (Not Used)	0, (Not Used)
15	0, (Not Used)	Point Fault[1]
[1]Refer to the Channel Error Register for the descriptions of the Point Faults.		

Bit 0: The Ovation Controller must set bit 0 of the Module Configuration register in order to access module I/O registers 0 through 11 (0xB). If bit 0 is not set, reading module I/O registers 0 through 11 (0xB) yields an Attention Status.

Bit 1: This bit (write "1") forces the module into error state, illuminating the module's internal Error LED. The read of bit "1" indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the modules Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when addresses 0 through 11 (B in Hex) are read.

Bits 2: The status of this bit (read) indicates the conversion rate of the module, write to this bit configures the conversion rate of the A/D converters as shown in the following table.

Conversion Rate (1/sec)	Bit #2
60 (for 60Hz systems)	0
50 (for 50Hz systems)	1

Bit 3: This bit (write) is used to initiate self-calibration. The sample rate during self-calibration is two per second. The status (read) bit is one as long as the configuration bit is set. If this is set, the module imitates one self calibration cycle. For subsequent self-calibration to occur, the bit must be cleared and reset or different configuration written to the card with this bit set.

Bit 4: Reserved for inter-module handshaking.

Bit 7: Reserved for Factory diagnosis.

Bit 8: This bit (read) indicates that the module has internal memory error. If this error is present, the internal error LED is lit.

Bit 9: This bit is set if bit 10 or 11 is set. If this bit is set, the internal error LED is lit. The Point Fault bit is set as the condition of the module is undetermined. Also, I/O channel registers 2-9 will be in attention.

Bit 10: This bit (read) indicates that the module has internal memory error (FLASH checksum, Register or Static RAM error). Bit 9 is set as well.

Bit 11: This bit indicates that the module is not calibrated. Bit 9 is set as well.

Bit 13: Reserved for inter-module handshaking.

Bit 15: Bit indicates point fault status of the module. It is the logical “OR” of any individual channel error status bits in register C, plus bit 9 of this register. A “0” indicates that all eight points have good quality and no module error exists. When bit 9 of the Status Register is not set, this bit (when set to “1”) indicates that at least one of the points has bad quality. A subsequent read of the Channel Error Register (address C) reveals the point(s) that have bad quality. The Channel Error Register contains data only when the module fault is due to a bad point quality.

HART High Performance Analog Input Enable Register (Address 14 or E in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0 - 7	Multivariable Channel 1 - 8	Not Used
8 - 15	HART Enabled - Channel 1 - 8	Not Used

Bit 0-7: A “1” in any of these bits causes Multivariable messaging on the corresponding channel.

Bit 8-15 A “1” in any of these bits indicate that a HART compliant device exists on the corresponding channel.

To avoid a HART communication error message, set each bit to “0” when connecting a non-HART output device.

The HART High Performance AI, HART High Performance AO, and IAH modules have the ability to retrieve additional variables from a field device. These variables are referred to as ‘multivariable’ and are named PV (primary variable), SV (secondary variable), TV (tertiary variable), and QV (quarterly variable).

The point data registers occupy locations 2-9 for analog input points 1-8 respectively. The data format is as follows:

Bit 15	Bit 14	Bit 13 - 0
		14 bit value
	Over-range Bit	

Bit 15	Bit 14	Bit 13 - 0
Point quality: (for good point quality (and proper card operation))		
Example Values		
Output Data in Hex		**Data Description**
8CCC		4 ma input
C000		20 ma input
CZZZ		+ Over Range
*0000-7FFF		*Card Trouble/Not Warmed Up/Bad Quality

Each of the 16 direct registers on the HART High Performance Analog Input module is summarized in the following tables and shown in more detail in the following tables. The module status register 13 (D in Hex) can be read by using the Point Information window at an Operator's Station. (See the *Ovation Operator Station User Guide*.)

HART Analog Input register map

Reg	Data Description - Config. Register (Write)	Data Description - Status Register (Read)
0	Indirect Memory Index	NA
1	Indirect Memory Data	Indirect Memory Data
2 - 9	NA	Analog Input - Channel 1 - 8
10	Calibration Register (Factory use only)	Calibration Register (Factory use only)
11	Flash down Handshaking	The exchange of signals between the transmitter and receiver to ensure synchronization before downloading a firmware revision to the flash memory.
12	NA	Channel Error Bits
13	Module Configuration Register)	Module Status Register
14	HART Enable	HART Enable
15	NA	Module Electronic ID Data

Word address 12 (C in Hex) is used to report the channel errors on the eight input channels. The following table is for reference only, Individual bits are not user accessible.

Channel error register output data format (read)

Point	Bit	Description
1 - 8	0, 2, 4, 6, 8, 10, 12, 14	Communication to the Channel has failed
1 - 8	1, 3, 5, 7, 9, 11, 13, 15	Over/under-range, Input/blown fuse/Open Loop

Communication to the Channel has failed - this bit is set when the communication to the corresponding channel has failed.

Over/under-range, Input/blown fuse/Open Loop - this bit is set when the corresponding Points input is less than 2.5mA (open loop condition), or greater than 25mA (over-range).

4.5.13 Diagnostic Logic card LEDs - (HHPAI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (Red)	Internal Error LED. Illuminated whenever there is any type of error within the module except for a loss of external auxiliary power. Possible causes are: ▪ The Controller sets the module's Force Error bit. ▪ Communications with the Controller is lost. ▪ The module is not calibrated. ▪ Flash memory, EE memory or RAM diagnostic failure.
1 - 8 (Red)	The eight channel LEDs serve two functions. LEDs 1-8 are used to indicate the firmware state during module startup and are then used to indicate HART communications activity and analog input health during normal module operation. After module configuration, the bank of eight channel LEDs (LEDs 1-8) is used to indicate HART communications activity and the health of the analog input. If the Analog Input for the associated analog input channel is healthy (bit 15 set in the point data word), then the LED is on. If the analog input channel is bad, then the LED is off. When a HART message is sent and received correctly, the LED blinks off for 100 msec if the analog input is healthy. When a HART message is sent and received incorrectly, the LED blinks off for 400 msec if the analog input is unhealthy.
9 - 16	No LED.

4.5.14 Specifications - (HHPAI)

- **Electronics module (5X00106)**
- **Personality module (5X00109)**

DESCRIPTION	VALUE
Number of channels	8
Input range	2.5 to 25 mA with under-range and over-range checking.
A/D Resolution	14 bits
Data format	14 bit binary
Bit weight	0.00122 ma
Conversion type	Sigma Delta
Operating Mode	self-scan
Monotonicity	yes
Nonlinearity	0.003% of full scale.

DESCRIPTION	VALUE
Repeatability	Within guaranteed accuracy.
Reference accuracy (@ 25oC)	+/-0.1% of full scale value (20mA) @ 99.7% confidence.
Accuracy over temperature	+/-0.24% of full scale value (20mA) over the full operating temperature range.
Sample duration time (msec)	50 when configured for 60 Hz rejection. 40 when configured for 50 Hz rejection.
Sample Repetition (msec)	60 Hz 50, 50 Hz 40
Dielectric isolation: Channel to channel Channel to logic	 1000 VAC/VDC for one minute. 1000 VAC/VDC for one minute.
Operating temperature range	0^{o} to 60^{o}C (32^{o}F to 140^{o}F).
Humidity (non-condensing)	0% to 95%
Module power	Drawn from Main: 4.1W typical. 4.5W Maximum. Drawn from Aux.: 3.84W typical (20mA X 8 loops X 24V). Dissipation in module: 5.06W typ. (Emod + Pmod).
Input Impedance	300 ohms
Maximum Overload	Fused at 50 ma
Normal Mode Rejection	60 dB @50 Hz ± 1/2% or @60 Hz ± 1/2% (when properly configured) 30 dB (typical) @50 Hz ± 5% or @60 Hz ± 5% (when properly configured).
Common mode rejection and channel-channel crosstalk	120 dB @ DC or @ the nominal (50/60 Hz) line frequency ± 1/2% and harmonics. 100 dB (typical) for nominal line frequency ± 5% and harmonics.
Filtering	Digital, $Sinc^{3}$3dB cutoff: 13.1 Hz for 50 Hz; 15.7 Hz for 60 Hz.

***Note:** Each channel reports current from about 2.5 to 25 ma. Above and below these values, the channel reports an error in the channel error register (4.5.10).*

4.6 RTD module (4 Channel) - (RTD-4)

The RTD module is used to convert inputs from Resistance Temperature Detectors (RTDs) to digital data. The digitized data is transmitted to the Controller.

The RTD Module is applicable for CE Mark Certified Systems.

***Note:** I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

4.6.1 Electronics modules (Emod) - (RTD-4)

- **1C31161G01** converts inputs for all ranges and is compatible only with Personality module 1C31164G01 (not applicable for CE Mark certified systems).
- **1C31161G02** converts inputs for all ranges and is compatible with Personality module 1C31164G02 (applicable for CE Mark certified systems).

4.6.2 Personality modules (Pmod) - (RTD-4)

- **1C31164G01** converts inputs for all ranges and is compatible only with Electronics module 1C31161G01 (not for new systems and is not applicable for CE Mark certified systems).
- **1C31164G02** (50/60 Hz filtered) converts inputs for all ranges and is only compatible with Electronics module 1C31161G02 (applicable for CE Mark certified systems).

4.6.3 Subsystems - (RTD-4)

RTD module subsystems

Range	Channels	Electronics Module	Personality Module
All	4	1C31161G01	1C31164G01
All (for 50/60 Hz filtered inputs and CE Mark certified systems)	4	1C31161G02 [1]	1C31164G02 [1]
[1] Configuration 1C3116G02 / 1C31164G02 is CE Mark Certified.			

4.6.4 Terminal block wiring information (Pmod 1C31164G01) - (RTD-4)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. The following diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

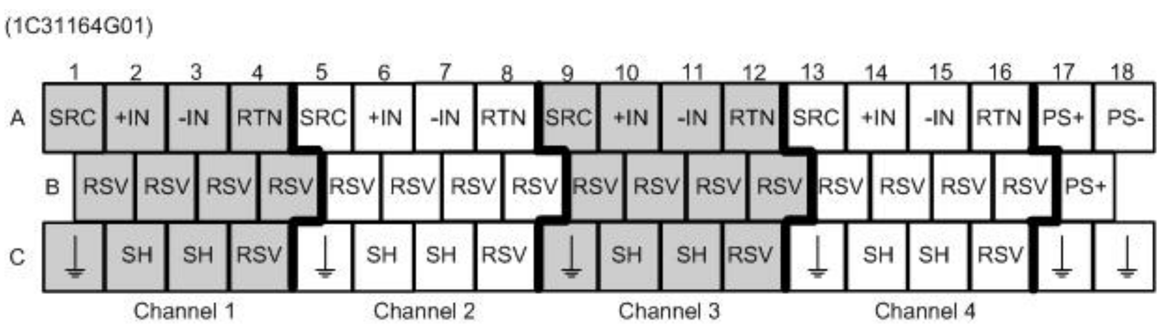
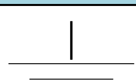


Figure 31: Terminal block connections for the RTD Pmod (1C31164G01)

The following table lists and defines the abbreviations used in this diagram.

Abbreviation	Definition
	Earth ground terminal
+IN, -IN	Positive and negative sense input connection.

ABBREVIATION	DEFINITION
PS+, PS-	Auxiliary power supply terminals.
RSV	Reserved terminal. No connections allowed on these terminals.
RTN	Return for current source connection.
SH	Shield connector.
SRC	Current source connection.

Note: *Do **not** use unmarked terminal block locations.*
PS+ and PS- are not used by this module.

4.6.5 Terminal block wiring information (Pmod 1C31164G02) - (RTD-4)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. The following diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

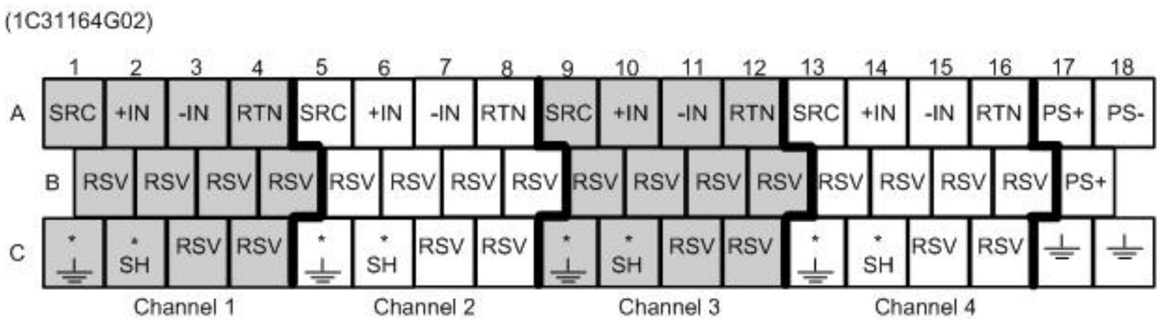


Figure 32: Terminal block connections for the RTD Pmod (1C31164G02)

The following table lists and defines the abbreviations used in this diagram.

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
⏚	Earth ground terminal.
+IN, -IN	Positive and negative sense input connection.
PS+, PS-	Auxiliary power supply terminals.
RTN	Return for current source connection.
RSV	Reserved terminal. No connections allowed on these terminals.
SH	Shield connector.

Abbreviation	Definition
SRC	Current source connection.

Note: *Do* ***not*** *use unmarked terminal block locations.*
PS+ and PS- are not used by this module.

4.6.6 Systems using (Pmod 1C31164G01) - (RTD-4)

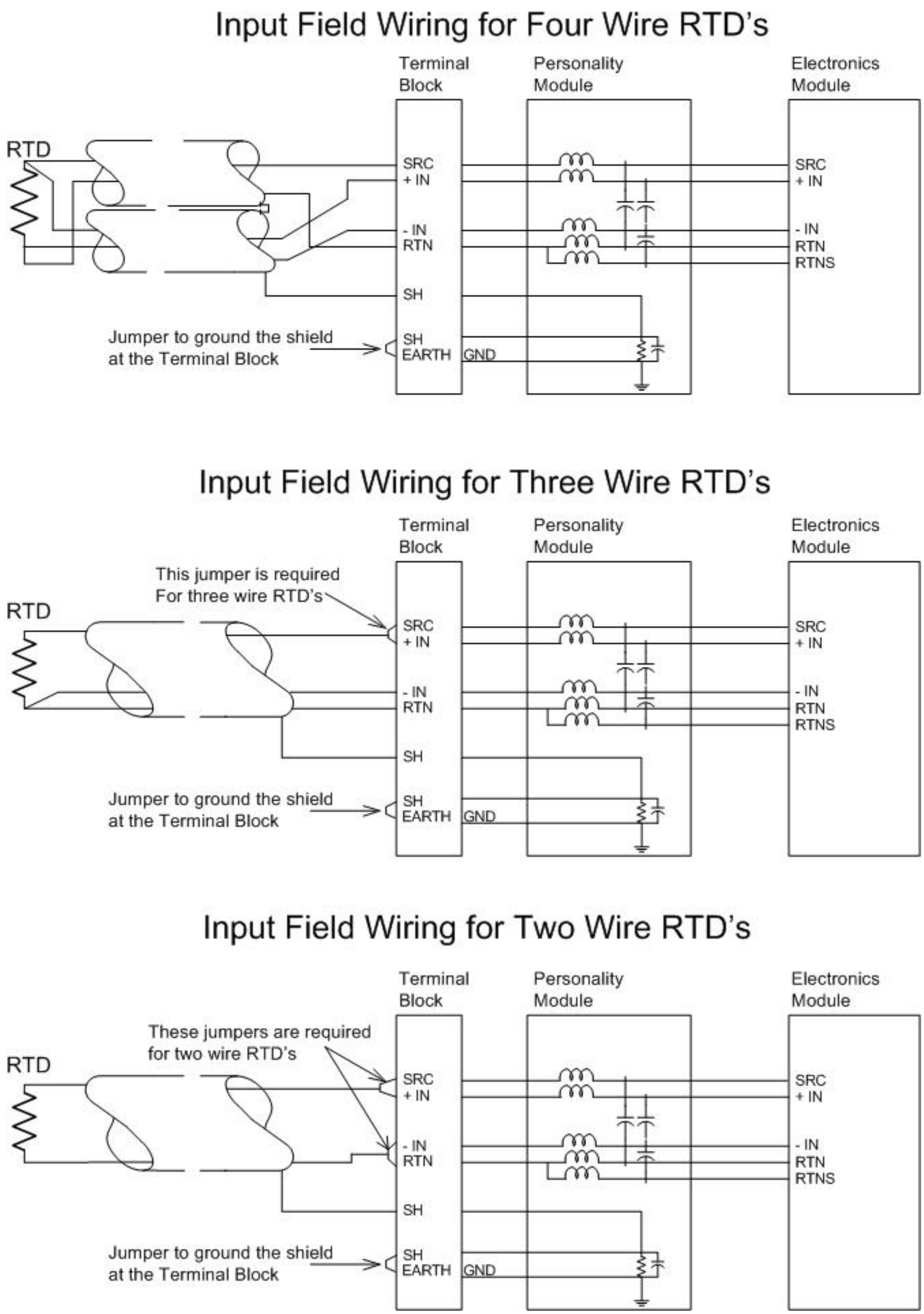


Figure 33: Field Connection for the RTD Pmod 1C31164G01

4.6.7 Field Wiring (Pmod 1C31164G02) - (RTD-4)

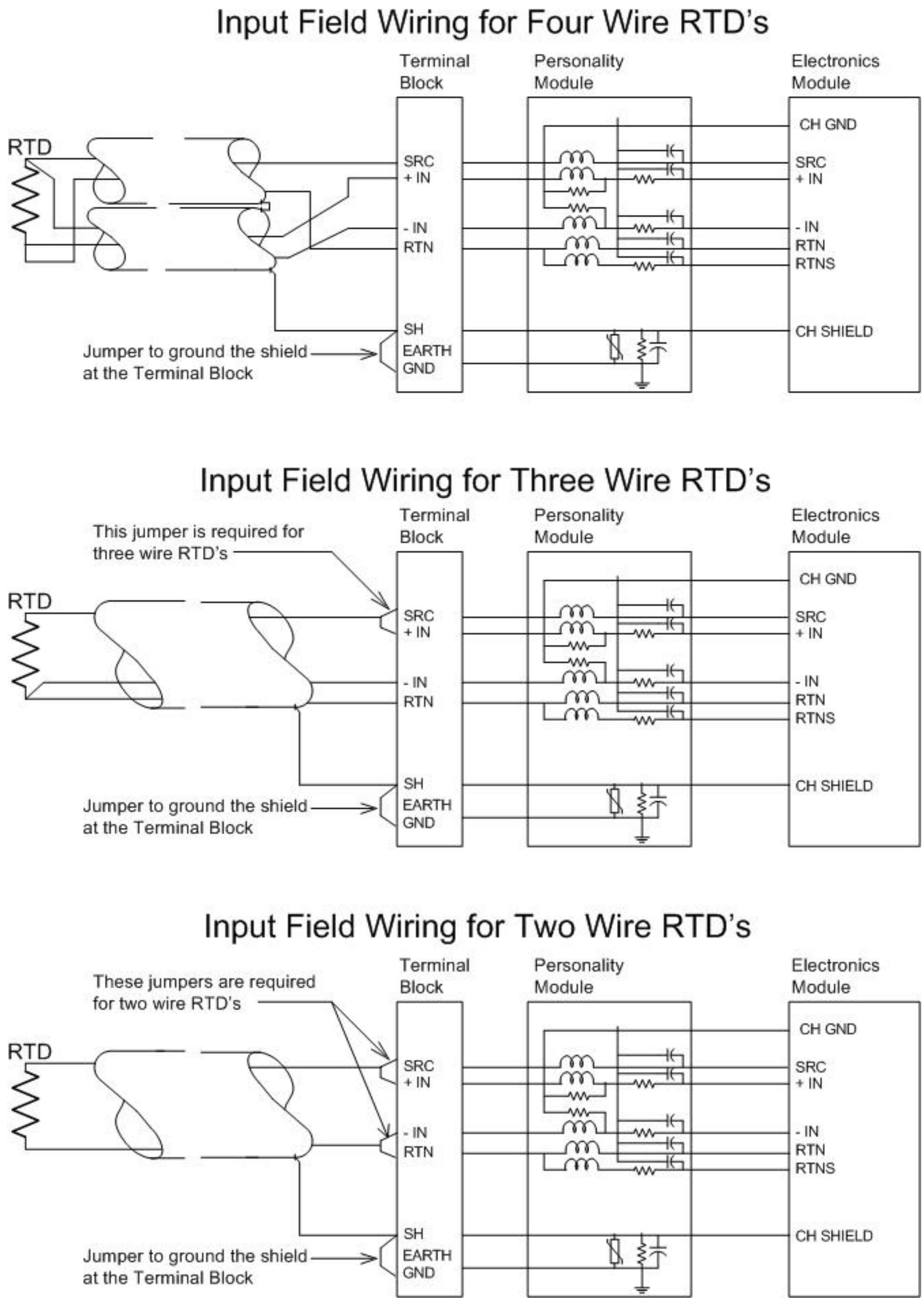
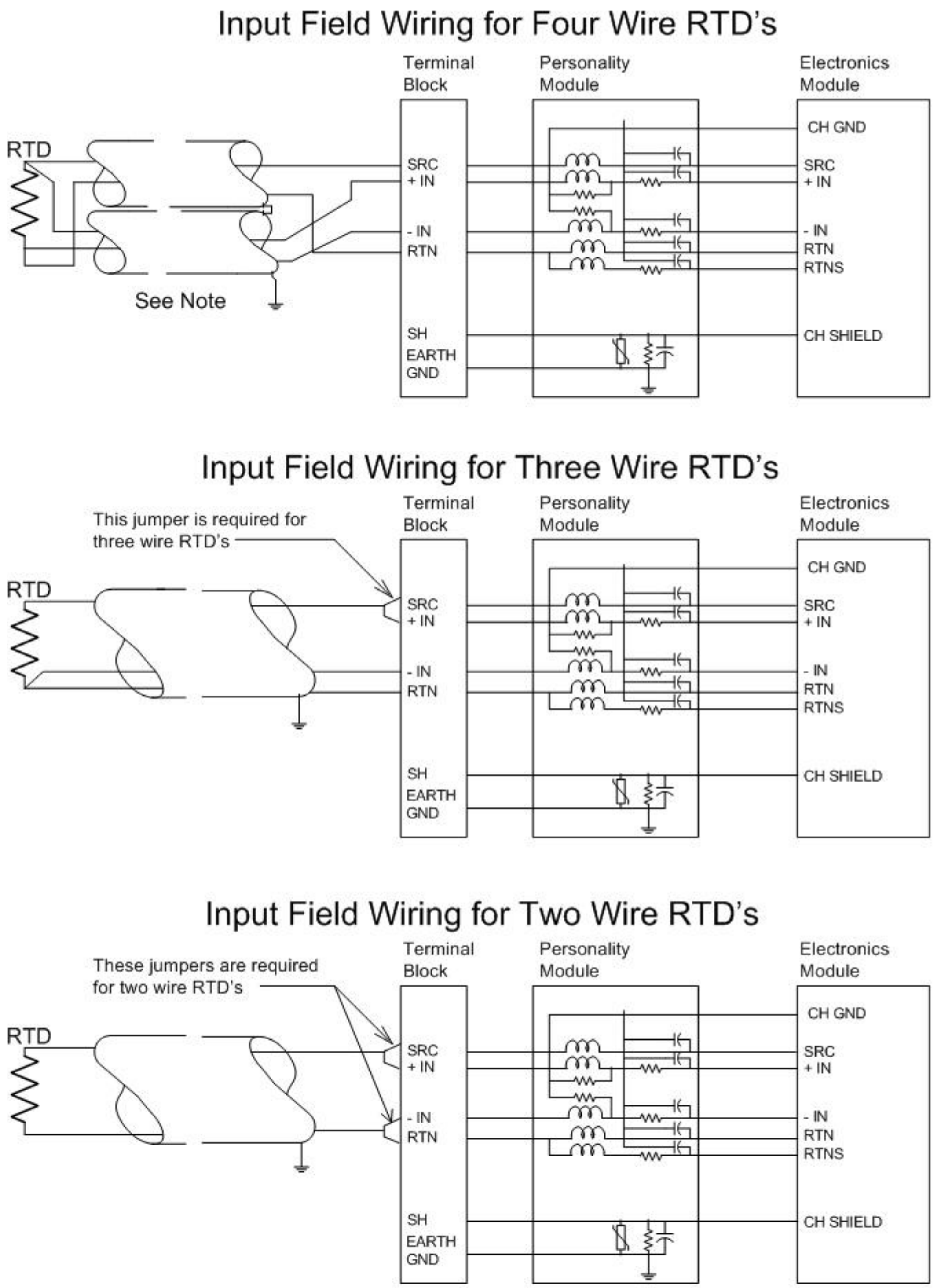


Figure 34: Field Connection for the RTD Personality Module

4.6.8 Field wiring diagrams (Pmod 1C31164G02) (CE Mark) - (RTD-4)



Note: All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to "Cable Guidelines" in the appropriate *Planning Your Ovation System* manual.

Figure 35: Field Connection for the RTD Personality Module (CE Mark)

4.6.9 RTD ranges - (RTD-4)

RTD ranges

Scale # (HEX)	Wires	Type	Temp °F	Temp °C	Rcold (ohm)	Rhot (ohm)	Excitation current (mA)	Accu-racy ± CTS	Accu-racy ±% of span
1	3	10 Ohm PL	0 to 1200	–18 to 649	6	106.3	0.1556	9	0.22
2	3	10 Ohm CU	0 to 302	–18 to 150	8.5	16.5	1.51	13	0.32
D	3	10 Ohm CU	32 to 284	0 to 140	50	80	1.0756	11	0.27
11	3	10 Ohm CU	32 to 230	0 to 110	53	78	1.1291	12	0.30
19	3	100 Ohm PL	–4 to 334	–20 to 168	92	163.67	0.5121	11	0.27
22	3	100 Ohm PL	32 to 520	0 to 271	100	200	0.4087	10	0.25
23	3	100 Ohm PL	32 to 1040	0 to 560	100	301	0.2554	10	0.25
25	3	120 Ohm NI	–12 to 464	–11 to 240	109	360	0.2104	10	0.25
26	3	120 Ohm NI	32 to 150	0 to 66	120	170	0.5240	13	0.32
28	3	120 Ohm NI	32 to 252	0 to 122	120	225	0.3682	11	0.27
80	4	100 Ohm PL	32 to 544	0 to 290	100	208	0.3921	10	0.25
81	4	100 Ohm PL	356 to 446	180 to 230	168	186	0.5240	30	0.74
82	4	200 Ohm PL	32 to 698	0 to 370	200	473	0.1675	12	0.30
83	4	200 Ohm PL	514 to 648	268 to 342	402	452	0.2142	29	0.71
84	4	100 Ohm PL	32 to 124	0 to 51	100	120	0.7860	19	0.47
85	4	100 Ohm PL	32 to 217	0 to 103	100	140	0.6386	13	0.32
86	4	100 Ohm PL	32 to 412	0 to 211	100	180	0.4644	11	0.27
87	4	100 Ohm PL	32 to 714	0 to 379	100	240	0.3296	10	0.25
88	4	200 Ohm PL	511 to 662	266 to 350	200	230	0.4170	24	0.59

4.6.10 Register configuration/address information - (RTD-4)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller.
Word address 13 (D in Hex) low byte is used for module configuration.
Word address 13 (D in Hex) high byte is used to define the scale for Channel 2.
The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See *Ovation Operator Station User Guide*.)

RTD configuration/status register (address 13 or D in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configure Module	Module Configured (1 = configured; 0 = un-considered.)
1	Force error	Internal or forced error (1 = forced error; 0 = no forced error.)
2	Not used	Point Fault bit (set when any point specific fault exists.)
3	Not used	Card trouble bit (set during card failure.)
4	Not used	Warming bit (set during power up or configuration.)
5	50/60 Hz select (0 = 60Hz, 1 = 50Hz)	50/60 Hz select readback (0 = 60Hz, 1 = 50Hz.)
6	Enable line frequency tracking.	Status of the line frequency tracking enable signal.
7	Diagnostic bit (do not use). When set in the “Diagnostics” mode, Bits 0 to 6 of the configuration register represent a word address of the Micro Controller’s internal memory.	Sync Fault (set if SYNC is missing or the reasonability test failed while the line frequency tracking is enabled.)
8 - 15	Channel #2 scale configuration	Channel #2 scale configuration read back

Note: *Line frequency tracking is presently NOT supported by the Ovation I/O system.*

Word address 14 (E in Hex) is used to define the scales for Channels 3 and 4.

Expansion configuration and status register (address 14 or E in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION (WRITE)	DATA DESCRIPTION - STATUS (READ)
0 - 7	Channel 3 scale configuration	Channel 3 scale configuration read back.
8 - 15	Channel 4 scale configuration	Channel 4 scale configuration read back.

Point status register (address 12 or C in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION (WRITE)	DATA DESCRIPTION - STATUS (READ)
0, 2, 4	Reserved for Point Status	Channel 1 - 4 reasonability test failed (Zero or Common mode.)
1, 3	Reserved for Point Status	Channel 1 - 4 current loop reasonability test failed.

Bit	Data Description - Configuration (Write)	Data Description - Status (Read)
8 - 15	Configure Channel 1 scales	Channel 1, scale configuration read back.
Note: *Status bits when set (1) indicate the fault condition.*		

Word address 12 (C in Hex) low byte is used for point status.
Word address 12 (C in Hex) high byte is used during write to define the scales for Channels 3 and 4.
The bit definitions for this register during read are encoded.

4.6.11 Diagnostic Logic card LEDs - (RTD-4)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set, or when a timeout of the watchdog timer occurs when the Controller stops communicating with the module. Also lit when the IMOK signal is false (0) indicating failures of part or all of the logic common to the input channels.
1 - 4 (Red)	Channel #1 - 4 error. Lit whenever there is an error associated with Channel 1 - 4.
5 - 16	No LED.

4.6.12 Specifications - (RTD-4)

- **Electronics module (1C31161)**
- **Personality module (1C31164)**

Description	Value
Number of channels	4
Sampling rate	Four per second (two per second during auto calibration.)
RTD ranges	Refer to the following RTD Ranges table.
Resolution	12 bits
Guaranteed accuracy (@25°C)	0.10% ± [0.045 (Rcold/Rspan)]% ± [((Rcold + Rspan)/4096 OHM)]% ± [0.5 OHM/Rspan]% ±10 µV ± 1/2LSB, where: Rcold and Rspan are in Ohms.
Temperature coefficient	10ppm/°C
Dielectric isolation: Channel to channel Channel to logic	 1000 V AC/DC 1000 V AC/DC
Input impedance	100 M OHM, 1 M OHM in power down (for input voltages 0 to 0.1 V.)
Module power	3.6 W typical; 4.2 W Maximum.

Description	Value
Operating temperature range	0 to 60°C (32°F to 140°F.)
Storage temperature range	-40°C to 85°C (-40°F to 185°F.)
Humidity (non-condensing)	0 to 95%

4.7 RTD module (8-Channel) - (RTD-8)

The 8-channel RTD module is used to convert inputs from Resistance Temperature Detectors (RTDs) to digital data. The digitized data is transmitted to the Controller.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

CAUTION! The following applies to channels that are subsequently wired to an RTD after power is applied to the module.

If an RTD is wired into a live eight channel RTD module, one of the following two conditions must be met to ensure reading of the RTD:

1. Cycle module power *after* the RTD is installed.

2. Configure or re-configure the particular point to which the RTD is installed.

Note that there are no considerations necessary if the RTD is installed prior to power being applied to the module. Further, once the conditions for proper operations are met, the RTD can be removed and subsequently re-installed at which time it is read correctly without any further considerations.

4.7.1 Electronics modules (Emod) - (RTD-8)

- **5X00119G01** converts inputs for all ranges and is compatible only with Personality module 5X00121G01
- **5X00119G02** converts inputs for all ranges and is compatible only with Personality module 5X00121G01 (Non-EMC cabinet).

4.7.2 Personality modules (Pmod) - (RTD-8)

- **5X00121G01** converts inputs for all ranges and is compatible only with Electronics module 5X00119G01.

4.7.3 Subsystems - (RTD-8)

RTD module (8-Channel) subsystems[1]

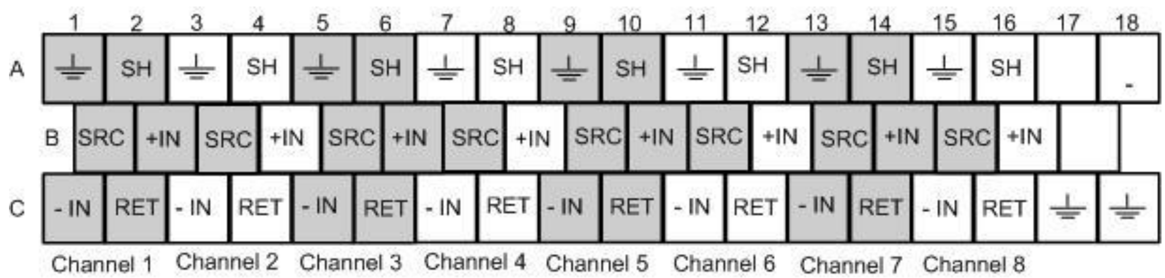
Channels	Electronics module	Personality module
8	5X00119G01[1]	5X00121G01

CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
8	5X00119G02[2]	5X00121G01
[1] This module configuration is CE Mark Certified. [2] This module configuration is CE Mark Certified (Non-EMC cabinet).		

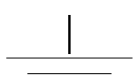
4.7.4 Terminal block wiring information (Pmod 5X00121G01) - (RTD-8)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The following table lists and defines the abbreviations used in this diagram.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*



Abbreviations used in wiring diagrams

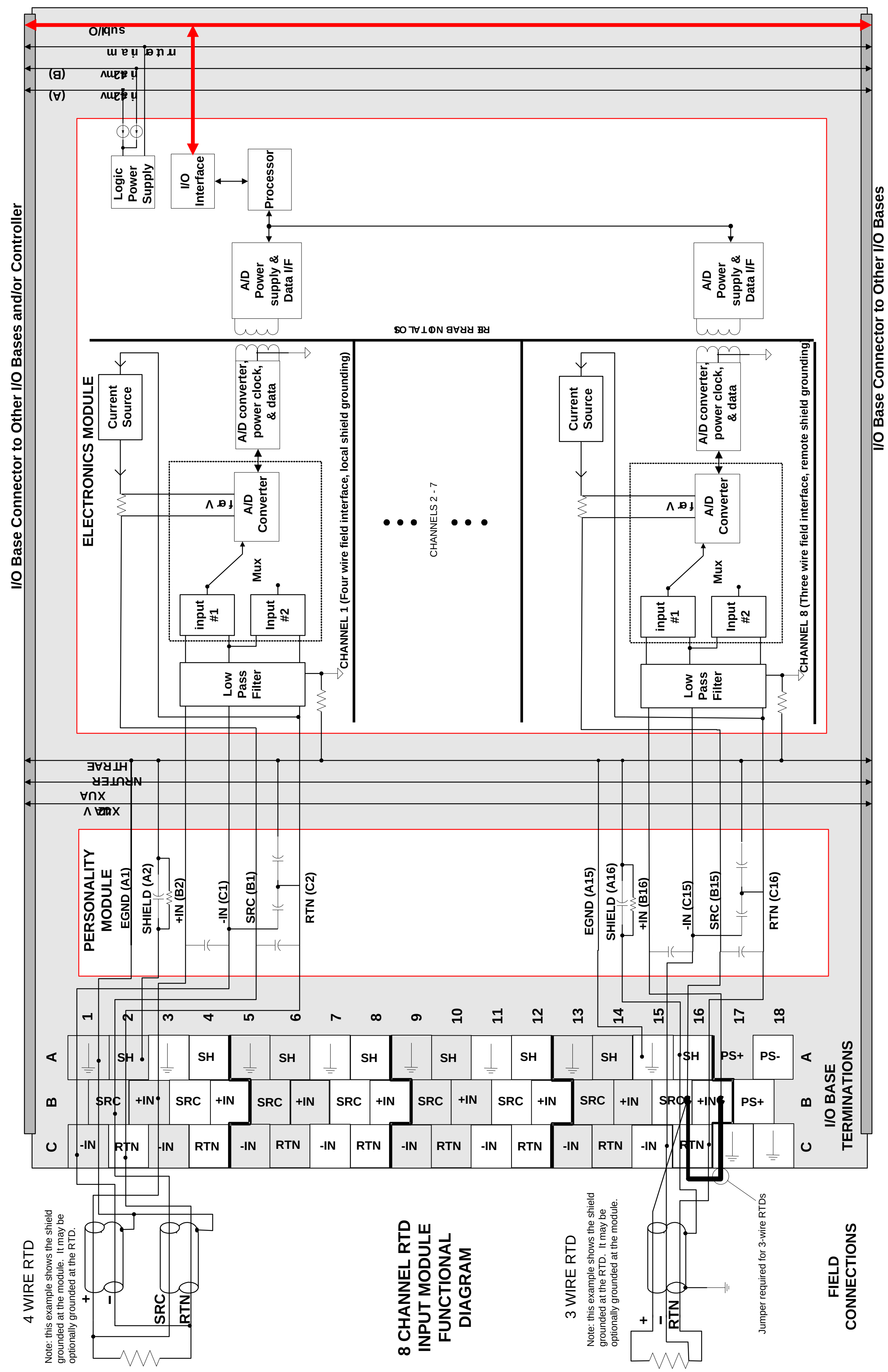
Abbreviation	Definition
	Earth ground terminal. Used for landing shields when the shield is to be grounded at the module.
+IN, -IN	Positive and negative sense input connection.
PS+, PS-	Auxiliary power supply terminals.
RTN	Return for current source connection.
SH	Shield connector. Used for landing shields when the shield is to be grounded at the RTD.
SRC	Current source connection.

Note: *PS+ and PS- are not used by this module.*

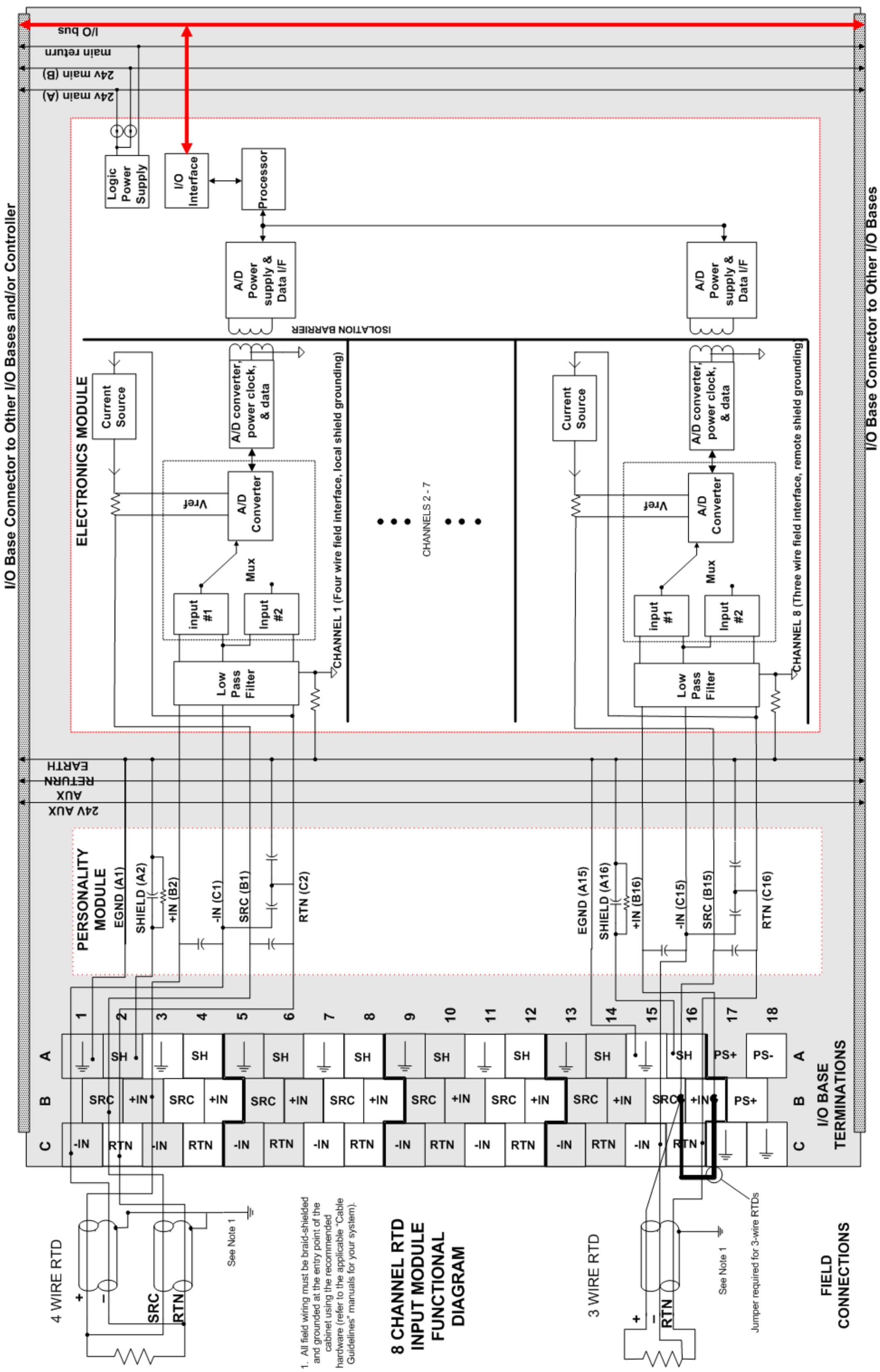
4.7.5 Module and field connection wiring - (RTD-8)

The Ovation 8-Channel RTD module consists of two modules, an Electronics module containing a logic printed circuit board (LIA) and a printed circuit board (FTD). The Electronics module is used in conjunction with a Personality module, which contains a single printed circuit board (PTD). The block diagram for the 8-channel RTD module is shown below.

Note: *Shielded twisted pair wiring should be used for Maximum noise immunity. The shield may be grounded at the module or in the field as outlined in the following diagrams*


I/O Base Connector to Other I/O Bases and/or Controller
I/O Base Connector to Other I/O Bases
ELECTRONICS MODULE
Logic Power Supply
I/O Interface
Processor
A/D Power supply & Data I/F
Current Source
A/D converter, power clock, & data
A/D Converter
Mux
input #1
input #2
Low Pass Filter
CHANNEL 1 (Four wire field interface, local shield grounding)
CHANNELS 2 - 7
CHANNEL 8 (Three wire field interface, remote shield grounding)
PERSONALITY MODULE
EGND (A1)
SHIELD (A2)
+IN (B2)
-IN (C1)
SRC (B1)
RTN (C2)
EGND (A15)
SHIELD (A16)
+IN (B16)
-IN (C15)
SRC (B15)
RTN (C16)
I/O BASE TERMINATIONS
SH
SRC
+IN
-IN
RTN
PS+
PS-
4 WIRE RTD
Note: this example shows the shield grounded at the module. It may be optionally grounded at the RTD.
8 CHANNEL RTD INPUT MODULE FUNCTIONAL DIAGRAM
3 WIRE RTD
Note: this example shows the shield grounded at the RTD. It may be optionally grounded at the module.
Jumper required for 3-wire RTDs
FIELD CONNECTIONS

4.7.6 Module and field connection wiring (CE Mark) - (RTD-8)



4.7.7 Ranges - (RTD-8)

Scale # (Hex) [1]	Scale # Hex) [2]	Wires	Type	Temp °F	Temp °C	Rcold (ohm)	Rhot (ohm)	Excitation current (mA)	Accuracy counts	Accuracy % of SPAN
0	0	3	10 Ohm PL	0 to 1200	–18 to 649	6	106.3	1.0	9	0.22
1	1	3	10 Ohm CU	0 to 302	–18 to 150	8.5	16.5	1.0	13	0.32
2	2	3	10 Ohm CU	32 to 284	0 to 140	50	80	1.0	11	0.27
3	3	3	10 Ohm CU	32 to 230	0 to 110	53	78	1.0	12	0.30
4	4	3	100 Ohm PL	–4 to 334	–20 to 168	92	163.67	1.0	11	0.27
5	5	3	100 Ohm PL	32 to 520	0 to 271	100	200	1.0	10	0.25
6	6	3	100 Ohm PL	32 to 1040	0 to 560	100	301	1.0	10	0.25
7	7	3	120 Ohm NI	–12 to 464	–11 to 240	109	360	1.0	10	0.25
8	8	3	120 Ohm NI	32 to 150	0 to 66	120	170	1.0	13	0.32
9	9	3	120 Ohm NI	32 to 252	0 to 122	120	225	1.0	11	0.27
0	10	4	100 Ohm PL	32 to 544	0 to 290	100	208	1.0	10	0.25
1	11	4	100 Ohm PL	356 to 446	180 to 230	168	186	1.0	30	0.74
2	12	4	200 Ohm PL	32 to 698	0 to 370	200	473	1.0	12	0.30
3	13	4	200 Ohm PL	514 to 648	268 to 342	402	452	1.0	29	0.71
4	14	4	100 Ohm PL	32 to 124	0 to 51	100	120	1.0	19	0.47
5	15	4	100 Ohm PL	32 to 217	0 to 103	100	140	1.0	13	0.32
6	16	4	100 Ohm PL	32 to 412	0 to 211	100	180	1.0	11	0.27
7	17	4	100 Ohm PL	32 to 714	0 to 379	100	240	1.0	10	0.25
8	18	4	200 Ohm PL	511 to 662	266 to 350	200	230	1.0	24	0.59

[1] For Hardware configuration.
[2] For Software Purposes. This value is used in Import/Export files.

4.7.8 Register configuration/address information - (RTD-8)

Word addresses 12 and 14 (described in the following two tables) are used to configure the appropriate scales for Channels 1 - 8 (refer to Column 1 in the table in Specifications (see page 132)).

Data format for the channel scale configuration register (address 12 or C in Hex)

Bit	Data Description - Configuration (Write)	Data Description - Status (Read)
0 - 3	Configure Channel #1 scale - Bit 0 - 3.	Channel #1 scale configuration (read back) - Bit 0 - 3.
4 - 7	Configure Channel #2 scale - Bit 0 - 3.	Channel #2 scale configuration (read back) - Bit 0 - 3.
8 - 11	Configure Channel #3 scale - Bit 0 - 3.	Channel #3 scale configuration (read back) - Bit 0 - 3.
12 - 15	Configure Channel #4 scale - Bit 0 - 3.	Channel #4 scale configuration (read back) - Bit 0 - 3.

CAUTION: Configuring any or all channel scales while the system is running causes all channels to return attention status for up to two seconds following the reconfiguration.

Data format for the channel scale configuration register (address 14 or E in Hex)

Bit	Data Description - Configuration (Write)	Data Description - Status (Read)
0 - 3	Configure Channel #5 scale - Bit 0 - 3.	Channel #5 scale configuration (read back) - Bit 0 - 3.
4 - 7	Configure Channel #6 scale - Bit 0 - 3.	Channel #6 scale configuration (read back) - Bit 0 - 3.
8 - 11	Configure Channel #7 scale - Bit 0 - 3.	Channel #7 scale configuration (read back) - Bit 0 - 3.
12 - 15	Configure Channel #8 scale - Bit 0 - 3.	Channel #8 scale configuration (read back) - Bit 0 - 3.

CAUTION: Configuring any or all channel scales while the system is running causes all channels to return attention status for up to two seconds following the reconfiguration.

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (Bit Pattern Field on the Hardware Tab). (See the *Ovation Operator Station User Guide.*)

8-Channel RTD configuration/status register (address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure Module.	Module Configured (1 = configured; 0 = unconfigured.)
1	Force error.	Internal/forced error (1 = forced error; 0 = no forced error.)
2	50/60 Hz select (0 = 60Hz, 1 = 50Hz.)	50/60 Hz System (1 = 50Hz) (read back.)
3	SELF_CAL (Initiates Self Calibration.)	Warming bit (set during power up or configuration.)
4	0	0
5	0	0

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
6	0	Module Not Calibrated.
7	0	0
8 - 15	Channel 1 - 8 _ 3/4 Wire.	Channel 1 - 8 _ 3/4 Wire - Configuration (read back.)

Bit 0: This bit configures the module (write) or indicates the configuration state of the module (read). A “1” indicates that the module is configured. Note that until the module is configured, reading from addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write “1”) forces the module into the error state, resulting in the error LED being lit. The read of bit “1” indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the module’s Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when address 0 through 11 (B in Hex) are read.

Bit 2: The status of this bit (read) indicates the conversion rate of the module, write to this bit configures the conversion rate of A/D converters as shown below.

Conversion Rate (1/sec.)	Bit 2
60 (for 60Hz systems)	0
50 (for 50Hz systems)	1

Bit3: Write: This bit is used to initiate self-calibration. Read: This bit indicates that the module is in the “Warming” state. This state exists after power up and terminates after 8.16 seconds. The module is in the error condition during the warm up period.

Bits 4 - 5: These bits are not used and read as “0” under normal operation.

Bit 6: This bit (read) is the result of a checksum test of the EEPROM. A failure of this test can indicate a bad EEPROM, but it typically indicates that the module has not been calibrated. A “0” indicates that there is no error condition. If an error is present, the internal error LED is lit and attention status is returned for all address offsets 0-11 (0x0 - 0xB). The “1” state of this bit indicates an unrecoverable error condition in the field.

Bit 7: This bit is not used and read as “0” under normal operation.

Bits 8 - 15: These bits are used to configure channels 1 - 8 respectively for 3 or 4 wire operation. A “0” indicates 3 wire and a “1” indicates 4 wire operation, see the tables below).

4.7.9 Diagnostic Logic card LEDs - (RTD-8)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.

LED	DESCRIPTION
I (Red)	Internal Fault LED. Lit whenever there is any type of error with the module **except** to a loss of power. Possible causes are: ▪ Module initialization is in progress. ▪ I/O Bus time-out has occurred. ▪ Register, static RAM, or FLASH checksum error. ▪ Module reset. ▪ Module is uncalibrated. ▪ Forced error has been received from the Controller. ▪ Communication between the Field and Logic boards failed.
1 - 8 (Red)	Channel #1 - 8 error. Lit whenever there is an error associated with a channel or channels. Possible causes are: ▪ Positive overrange. ▪ Negative overrange. ▪ Communication with the channel has failed.
9 - 16	No LED.

4.7.10 Specifications - (RTD-8)

- **Electronics module (5X00119)**
- **Personality module (5X00121)**

DESCRIPTION	VALUE
Number of channels.	8
Sample repetition time and sample duration time (msec.)	50 HZ mode: 40/sec. normally. In 3 wire mode, lead resistance measurement occurs once every 6.45 sec. during which the time rises to 333. 60 HZ mode: 20/sec. normally. In 3 wire mode, lead resistance measurement occurs once every 6.45 sec. during which the time rises to 500. Self Calibration Mode: Occurs on demand only. The rate drops to 1/sec. once during each self calibration cycle.
RTD ranges.	Refer to the following RTD Ranges table.
Resolution.	12 bits + polarity.
Data format.	Two's compliment.
Conversion type.	Sigma Delta.
Operating Mode.	Self-scan.
Monotonicity.	Yes
Nonlinearity.	0.003% of full scale.
Repeatability.	With guaranteed accuracy.
Guaranteed accuracy (@25×C.)	0.10% ± [0.045 (Rcold/Rspan)]% ± [((Rcold + Rspan)/4096 OHM)]% ± [0.5 OHM/Rspan]% ±10 µV ± 1/2LSB where: Rcold and Rspan are in Ohms.
Temperature coefficient.	10ppm/ oC.

DESCRIPTION	VALUE
Dielectric isolation: Channel to channel. Channel to logic.	 200V AC/DC. 1500 V AC/DC.
Input impedance.	100 M OHM. 50 K OHM in power down.
Maximum Overload.	Fused at 50 ma.
Module power.	3.6 W typical; 4.2 W Maximum.
Operating temperature range.	0 to 60^{0}C (32^{0}F to 140^{0}F.)
Storage temperature range.	-40^{0}C to 85^{0}C (-40^{0}F to 185^{0}F.)
Humidity (non-condensing).	0 to 95%.
Self Calibration.	On Demand by Ovation Controller.
Common Mode Rejection and Channel Crosstalk.	120 dB @ DC and nominal power line frequency (+/- 1/2%.)
Normal Mode Rejection.	100 dB @ DC and nominal power line frequency (+/- 1/2%.)
Filtering.	Digital, Sinc - 3dB cutoff: 13.1 Hz for 50 Hz; 15.7 Hz for 60 Hz.

4.8 16 Channel 4-20mA Analog Input module (Windows Ovation 3.4 and above)

The Ovation 16 Channel 4-20mA Analog Input module provides an interface between the Ovation Controller and 16 field devices that use a 4-20mA current loop. Up to 16 4-20mA (2-wire or 4-wire) transmitters can be connected per module.

Note: *The Ovation 16 Channel 4-20mA Analog Input module (2-wire and 4-wire configurations) requires the following to function properly: Ovation software release 3.4.0 or later and OCR400 Controller with G03 IOIC (5X00226G03 I/O interface controller). Also, this module is only for local I/O branch applications.*

In a 2-wire 4-20mA configuration, user input signals are routed directly to the Analog Input Emod without the use of a Personality module (Pmod). A Pmod cavity insert is used to cover the unused connector and provide terminal wiring information..

In a 4-wire 4-20mA configuration, a Personality Module (5X00501G01) is required to interface the user signals to the Analog Input Emod.

Note: *A 16 Channel 4-20mA Analog Input module must be inserted into an Ovation 4-slot I/O base (5X00497G01) for proper operation. The Ovation 16 Channel Analog Input module will not function in a standard 2-slot Ovation I/O base. Refer to I/O Module General Information (see page 25) for environmental, installation, wiring, and fuse information for I/O modules.*

4.8.1 Electronics modules (Emod) - 16 Channel 4-20mA Analog Input

- **5X00501G01** - 16 Channel 4-20mA Analog Input Electronics module.

4.8.2 Personality modules (Pmod) - 16 Channel 4-20mA Analog Input

- **5X00502G01** - 16 Channel 4-20mA Analog Input Personality module for both 4-wire and 2-wire configurations.
- **1X00692H01** - 16 Channel 4-20mA Analog Input Personality cavity insert for 2-wire configurations only.

4.8.3 Subsystems - 16 Channel 4-20mA Analog Input

16 Channel 4-20mA Analog Input subsystems

DESCRIPTION	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
16 Channel 4-20mA Analog Input, 2-wire and 4-wire	16	5X00501G01	5X00502G01
16 Channel 4-20mA Analog Input, 2-wire only	16	5X00501G01	1X00692H01

Note: *The 16 Channel 4-20mA Analog Input requires the use of an Ovation 4-slot I/O Base (5X00497G01) to provide additional wire terminations to support the 16 channels. The Ovation 16 Channel 4-20mA Analog Input CANNOT be used in the standard I/O bases (1B30035H01, 1X00014H01, or 5X00334G01).*

4.8.4 Terminal block wiring information 16 Channel 4-20mA Analog Input (2-Wire)

The following figure and table are for the terminal block arrangement for the 2-wire 4-20mA 16 Channel Analog Input module. Row A is not used; no external connections are to be made to Row A. Row B is Analog Input (n+). Row C is utilized to provide power to the "+" field terminals of 2-wire loop-powered transmitter. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The table lists and defines the abbreviations used in those diagrams.

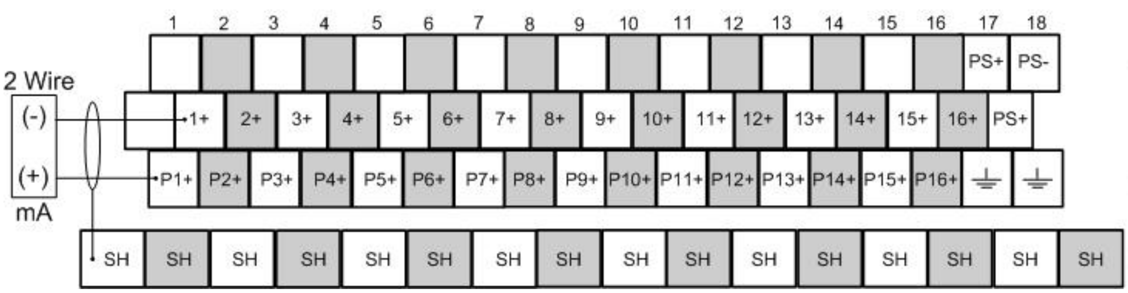


Figure 36: Terminal block connections for the 2-Wire 16 Channel 4-20mA Analog Input module

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals.

ABBREVIATION	DEFINITION
1+ through 16+	Analog Input positive terminal connection (connect to the negative terminal of the field device).
P1+ through P16+	Loop power output terminals (connect to the positive terminal of the field device).
PS+, PS-	Auxiliary power supply terminals. No external connections required when using Ovation +24V DC Auxiliary Power Supply. Ovation Aux Supply provided to module through branch.
	Reserved terminals. Connections should not be made on these unmarked terminals.
SH	Shield terminal connections. All shield connections are tied together internally on a 4-slot I/O base and connected to Earth ground on the module.
+24VDC Auxiliary Power enters the module through the internal branch connection or terminal block (PS+/PS-). Power is fused on the module then individually current limited and delivered to the channel loop power output terminal (P1+ through P16+) for connection to the field device (+) terminal. Each field device (-) terminal then connects to the Analog Input channel positive terminal (1+ through 16+) where it is read by the module. The negative reference for all 16 channels is PS-. All shields are tied together on the base terminal strip and connected to Earth ground on the module.	

Note: *For CE Mark Certified Systems: All field wiring must be Braid Shielded and Grounded at the entry point of the cabinet using recommended hardware. Refer to the Cable Guidelines section of the applicable Ovation Installation manual.*

When using locally powered (2-wire) Analog Input 4-20mA Inputs, the Power Distribution Module (5X00489G01) must have the Main GND and AUX GND referenced together. Therefore, ensure that the Main grounding bar (J10) and AUX grounding bar (J11) are installed and referenced to earth on the Power Distribution Module.

4.8.5 Terminal block wiring information - 16 Channel Analog Input 4-20mA (4-Wire)

The following figure and table are for the terminal block arrangement of the 4-wire 4-20mA 16 Channel Analog Input module. Row A is Analog Input (n-). Row B is Analog Input (n+). Row C is not used in 4-wire applications; however, in 2-wire applications, Row C can be used to supply loop power (Pn+) to circuit. This diagram indicates how to connect a single 4-wire field device to the terminal block in the base unit. The table lists and defines the abbreviations used in those diagrams.

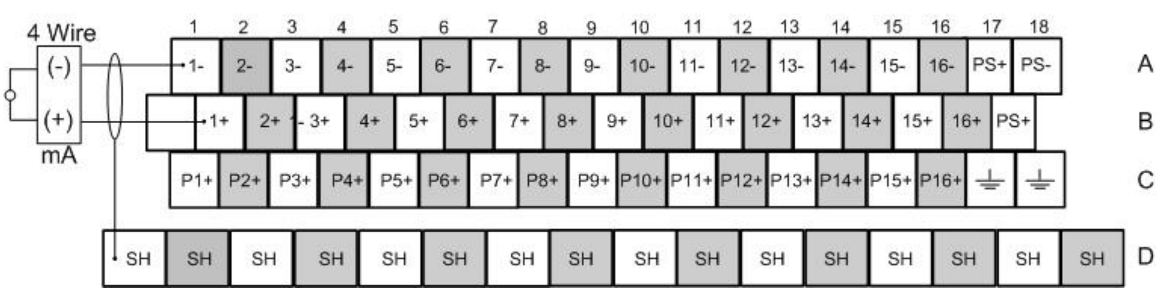


Figure 37: Terminal block connections for the 4-Wire 16 Channel 4-20mA Analog Input module

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
⏚	Earth ground terminals.
1+ through 16+	Analog Input Positive Terminal (connect to positive terminal of 4-wire field device; connect to negative terminal of 2-wire field device)
1- through 16-	Analog Input Negative Terminal (connect to negative terminal of 4-wire field device; leave unconnected for 2-wire field device)
PS+, PS-	Auxiliary power supply input terminals. No external connections required when using Ovation +24V DC Auxiliary Power Supply. Ovation Aux Supply provided to module through branch.
P1+ through P16+	Loop Power Output Terminals (leave unconnected for 4-wire device; connect to positive terminal of 2-wire device)
SH	Shield terminal connection.
For 4-wire Devices: Loop Power enters from the field device. The field device output (+) terminal connects to the Analog Input channel positive terminal (1+ through 16+) where it is read by the module. Each field device output (-) terminal connects to the Analog Input channel negative terminal (1- through 16-). The negative reference (1- through 16-) of all 16 analog inputs are tied together on the Pmod and tied through the Emod to Earth ground and all shields (SH) on the terminal strip.	
For 2-wire Devices: +24VDC Auxiliary Power enters through the internal branch connection or the terminal block connections (PS+/PS-). Power is fused on the module then individually current limited and delivered to channel Loop Output Terminals (P1+ through P16+) for connection to the 2-wire field device (+) terminal. Each 2-wire field device (-) terminal then connects to the Analog Input channel positive terminal (1+ through 16+) where it is read by the module. The negative reference for all 16 channels is tied together with all shields (SH) of terminal strip and Earth ground on module.	

Note: *For CE Mark Certified Systems: All field wiring must be Braid Shielded and Grounded at the entry point of the cabinet using the recommended hardware. Refer to the Cable Guidelines section of the applicable Ovation Installation manual.*

When using locally powered (2-wire) Analog Input 4-20mA Inputs, the Power Distribution Module (5X00489G01) must have the Main GND and AUX GND referenced together. Therefore, ensure that the Main grounding bar (J10) and AUX grounding bar (J11) are installed and referenced to earth on the Power Distribution Module.

4.8.6 Field connection wiring diagrams - 16 Channel 4-20mA Analog Input (2-Wire)

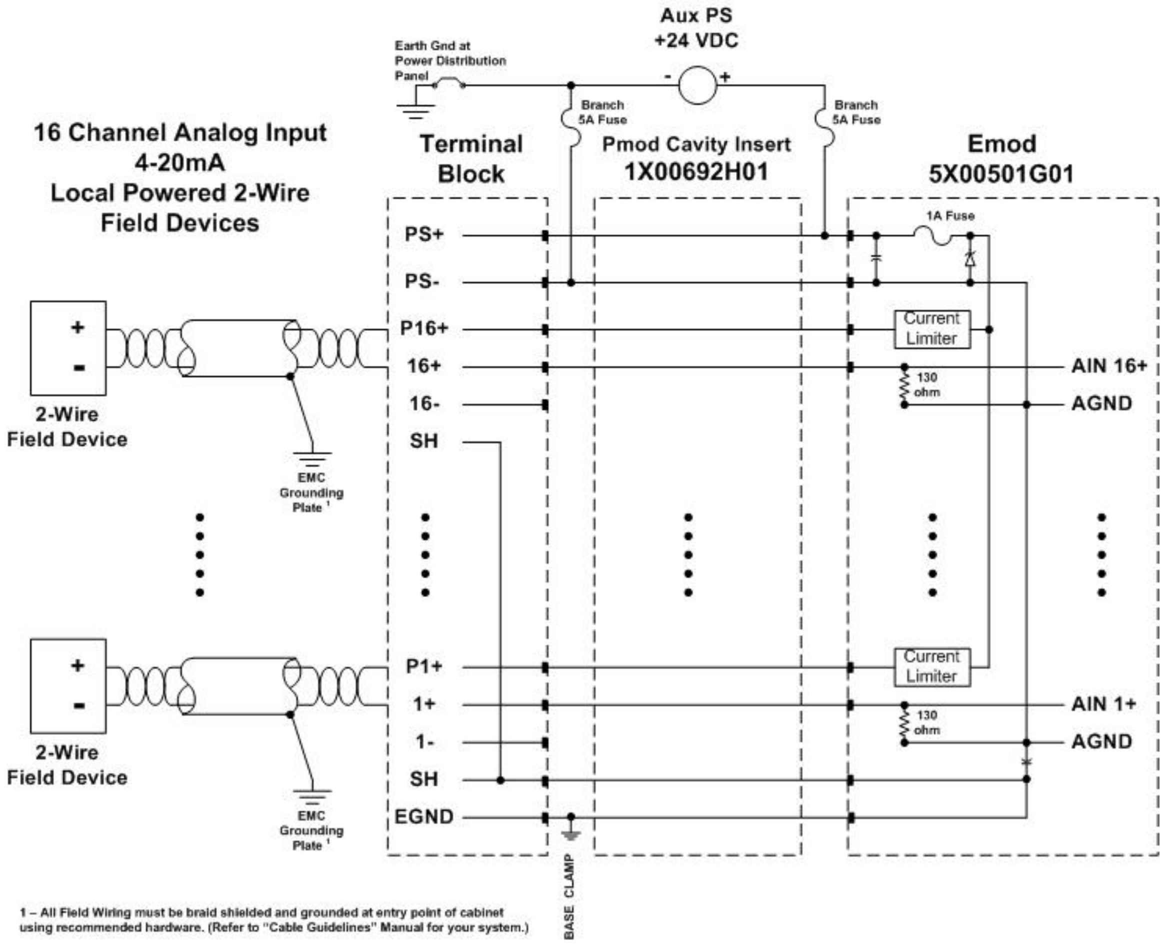


Figure 38: Wiring diagram - 16 Channel 4-20mA Analog Input module (2-wire configuration)

4.8.7 Field connection wiring diagrams - 16 Channel 4-20mA Analog Input (4-Wire)

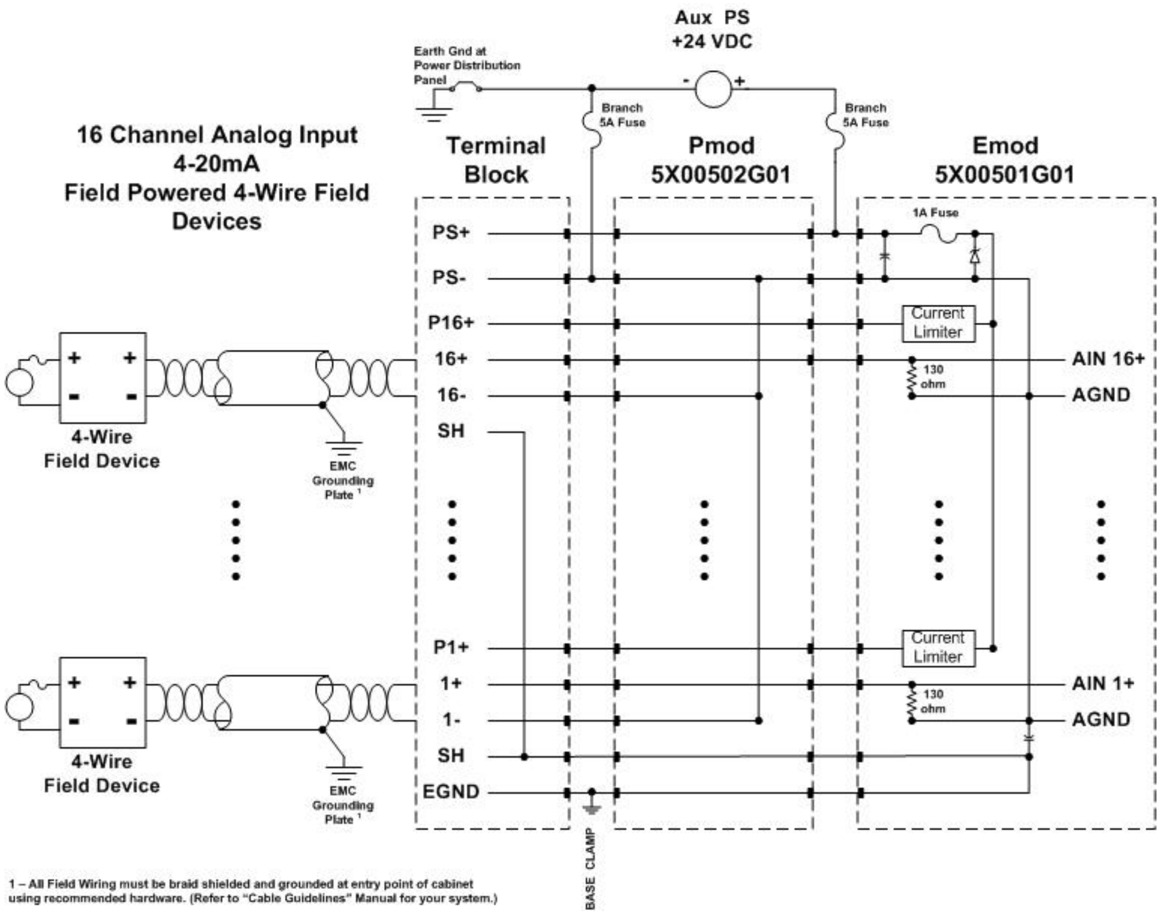


Figure 39: Wiring diagram - 16 Channel 4-20mA Analog Input module (4-wire configuration)

4.8.8 Register configuration/status information - 16 Channel 4-20mA Analog Input

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (See the *Ovation Operator Station User Guide*).

16 Channel 4-20mA Analog Input - Module Configuration/Status Register (Address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module	1 = configured 0 = not configured *
1	Internal or forced error	1 = forced error set by controller 0 = no forced error *

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
2	Not defined	1 = Calibration in Progress 0 = Default *
3	Not defined	1 = Gain Calibration Complete 0 = Default *
4	Not defined	1 = Calibration Fault 0 = Default *
5	Not defined	Not defined, 0 = Permanent Value
6	Not defined	1 = Not Calibrated 0 = Calibrated *
7	Not defined	1= Blown Fuse Detected 0= Fuse OK *
8	Not defined	0 = Permanent Value
9	Select 50/60 Hz System	1= 50 Hz * 0= 60 Hz
10	Start Gain Calibration **	1 = Gain calibration in progress 0 = Default *
11	Start Offset Calibration **	1= Offset Calibration in Progress 0= Default *
12	Not defined	1= Offset Calibration Complete 0 = Default *
13	Not defined	1= Un-Calibration Started 0 = Default *
14	Start Un-calibration **	1= Un-Calibration Complete 0 = Default *
15	Not defined	1= Channel Fault detected 0 = No Channel Fault detected *
* Default value.		
** These commands are used during module factory test only and are not used or performed during normal system operation.		

Bits defined for diagnostics are used only during factory testing.

Bit 0: This bit configures the module (write) and indicates the configuration state of the module (read). A “1” indicates that the module is configured. Note that until the module is configured, reading from addresses 0 through 11 (B in Hex) produces an attention status.

Bit 1: This bit (write “1”) forces the module into its error state. The read of bit 1 indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is reflected in the module's Internal Error LED (I) LED (see *Diagnostic LEDs - 16 Channel 4-20mA Analog Input* (see page 142)). Whenever this bit is set, an attention status is returned to the Controller when addresses 0 through 11 (B in Hex) are read.

Bits 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14: These bits are used only for diagnostics and calibration during factory testing and should not be modified. The default read values during normal system operation are listed.

Bit 7: Blown fuse detection bit.

Bit 9: Indicates if the module is set up for a 50 or 60 Hz system.

Bit 15: Indicates a fault in at least one enabled channel was detected. Channel Status Register (0xC) can be read to determine which channel(s) are in fault.

Channel Enable/Mask Register - 16 Channel 4-20mA Analog Input

Word address 14 (E in Hex) is used to enable or disable individual analog input channels on the module. Masking an unused channel can prevent open-loop errors from being reported to the system if the channel is not wired.

Channel Enable/Mask Register (Address 14 or E in Hex)

Bit	Description (Write)	Description (Read)
0	1 = Enable Channel 1 0 = Mask Channel 1 Faults	1 = Channel 1 Enabled 0 = Channel 1 Faults Masked
1	1 = Enable Channel 2 0 = Mask Channel 2 Faults	1 = Channel 2 Enabled 0 = Channel 2 Faults Masked
2	1 = Enable Channel 3 0 = Mask Channel 3 Faults	1 = Channel 3 Enabled 0 = Channel 3 Faults Masked
3	1 = Enable Channel 4 0 = Mask Channel 4 Faults	1 = Channel 4 Enabled 0 = Channel 4 Faults Masked
4	1 = Enable Channel 5 0 = Mask Channel 5 Faults	1 = Channel 5 Enabled 0 = Channel 5 Faults Masked
5	1 = Enable Channel 6 0 = Mask Channel 6 Faults	1 = Channel 6 Enabled 0 = Channel 6 Faults Masked
6	1 = Enable Channel 7 0 = Mask Channel 7 Faults	1 = Channel 7 Enabled 0 = Channel 7 Faults Masked
7	1 = Enable Channel 8 0 = Mask Channel 8 Faults	1 = Channel 8 Enabled 0 = Channel 8 Faults Masked
8	1 = Enable Channel 9 0 = Mask Channel 9 Faults	1 = Channel 9 Enabled 0 = Channel 9 Faults Masked
9	1 = Enable Channel 10 0 = Mask Channel 10 Faults	1 = Channel 10 Enabled 0 = Channel 10 Faults Masked
10	1 = Enable Channel 11 0 = Mask Channel 11 Faults	1 = Channel 11 Enabled 0 = Channel 11 Faults Masked
11	1 = Enable Channel 12 0 = Mask Channel 12 Faults	1 = Channel 12 Enabled 0 = Channel 12 Faults Masked
12	1 = Enable Channel 13 0 = Mask Channel 13 Faults	1 = Channel 13 Enabled 0 = Channel 13 Faults Masked
13	1 = Enable Channel 14 0 = Mask Channel 14 Faults	1 = Channel 14 Enabled 0 = Channel 14 Faults Masked
14	1 = Enable Channel 15 0 = Mask Channel 15 Faults	1 = Channel 15 Enabled 0 = Channel 15 Faults Masked
15	1 = Enable Channel 16 0 = Mask Channel 16 Faults	1 = Channel 16 Enabled 0 = Channel 16 Faults Masked

Channel Status Register - 16 Channel 4-20mA Analog Input

Word address 12 (C in Hex) is used to report the status of the individually enabled analog input channels. A reported fault may indicate an open loop, over-range, under-range, or calibration fault on an enabled channel.

Channel Status Register (Address 12 or C in Hex)

BIT	DESCRIPTION (READ ONLY)
0	1 = Enabled Channel 1 Fault Exists 0 = No Fault Reported on Channel 1
1	1 = Enabled Channel 2 Fault Exists 0 = No Fault Reported on Channel 2
2	1 = Enabled Channel 3 Fault Exists 0 = No Fault Reported on Channel 3
3	1 = Enabled Channel 4 Fault Exists 0 = No Fault Reported on Channel 4
4	1 = Enabled Channel 5 Fault Exists 0 = No Fault Reported on Channel 5
5	1 = Enabled Channel 6 Fault Exists 0 = No Fault Reported on Channel 6
6	1 = Enabled Channel 7 Fault Exists 0 = No Fault Reported on Channel 7
7	1 = Enabled Channel 8 Fault Exists 0 = No Fault Reported on Channel 8
8	1 = Enabled Channel 9 Fault Exists 0 = No Fault Reported on Channel 9
9	1 = Enabled Channel 10 Fault Exists 0 = No Fault Reported on Channel 10
10	1 = Enabled Channel 11 Fault Exists 0 = No Fault Reported on Channel 11
11	1 = Enabled Channel 12 Fault Exists 0 = No Fault Reported on Channel 12
12	1 = Enabled Channel 13 Fault Exists 0 = No Fault Reported on Channel 13
13	1 = Enabled Channel 14 Fault Exists 0 = No Fault Reported on Channel 14
14	1 = Enabled Channel 15 Fault Exists 0 = No Fault Reported on Channel 15
15	1 = Enabled Channel 16 Fault Exists 0 = No Fault Reported on Channel 16

4.8.9 Diagnostic LEDs - 16 Channel 4-20mA Analog Input

Logic card LED indications

LED	DESCRIPTION
P (green)	Power OK LED. Lit when module main power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit to indicate Auxiliary 24VDC field power is not present, is below threshold, or the module's Auxiliary 24VDC fuse is blown.
I (Red)	Internal Fault LED. Lit whenever there is any type of internal module error. Possible causes include: ▪ Module initialization is in progress. ▪ I/O Bus timeout has occurred. ▪ Internal hardware error. ▪ Module reset. ▪ Module is uncalibrated. ▪ Forced error has been received from the Controller. ▪ Communication between the Field and Logic boards failed. **Note:** *Failure of Auxiliary 24VDC power is considered to be an external error.*
1-16 (Red)	A channel error LED is lit when a fault is detected on an enabled channel. Possible causes include: ▪ Over-range fault: Input current >22mA ▪ Under-range fault: Input current <2.5mA ▪ Open loop fault ▪ Blown fuse fault (2-wire)

Note: *24V Auxiliary Fuse Rating: 1 A, 250V Fast-acting fuse 5X20 mm.*

4.8.10 Specifications - 16 Channel 4-20mA Analog Input

16 Channel 4-20mA Analog Input module specifications

DESCRIPTION	VALUE
Number of channels	16
Input types and ranges	4 - 20 mA ±1V; 2-wire or 4-wire single-ended Valid Input Range: 2.5 to 22mA Under Current : <2.5mA Over Current: >22mA (Broken) Open Loop: 0 to 2.5mA
Resolution	14-Bits, no missing code
Accuracy	±0.10% of full scale value ±1/2LSB @99.7% confidence. Resolution conditions: 25 degrees C +/- 1 degree 50% +/- 1% RH 0V common mode

DESCRIPTION	VALUE
Input impedance	130 Ohms +/- 0.1%
Sampling rate	Data rate of 50 samples per second when configured for 50Hz rejection. Data rate of 60 samples per second when configured for 60Hz rejection. Refresh rate: 200 ms for 16 channels
Self-calibration	Self calibration is performed only during factory test on demand over the I/O bus. Calibration is not performed during normal module operation.
Diagnostics	Internal module operating faults, Out of range detection, Open loop detection, and Module (Auxiliary 24VDC power supply) blown fuse
Dielectric isolation: Channel to logic	 1000 V AC/DC Channel to Channel is common
Normal mode rejection	NMRR 50dB at 50SPS / 60 SPS
Common mode rejection	CMRR 120 dB
Module power	▪ Drawn from Main: 1.20W typical; 1.38W max. ▪ Drawn from Auxiliary: 0.48W typical; 0.56W max. (4-wire) 8.16W typical; 9.38W max. (2-wire)\ ▪ Power Dissipated in Emod/Pmod: 1.69W typical; 1.94W max.
2-Wire Transmitter Power	19.18V available for current loops @ 20mA (4.82V drop on module) 16 channel @ 20mA Each channel current limited to 26.5mA
Operating temperature range	0 to 60 degrees C (32 degrees F to 140 degrees F)
Storage temperature range	-40 degrees C to 85 degrees C (-40 degrees F to 185 degrees F)
Humidity (non-condensing)	0 to 95%

SECTION 5

Analog Output modules

IN THIS SECTION

5.1 Analog Output module - (AO)

The Analog Output Electronics module uses low-power-drain 12-bit serial digital-to-analog converters (DACs) to provide four galvanically isolated output channels. The serial clock and data allow the four channels to be updated every 1.5 ms. The serial interface uses opto-isolators for high-voltage isolation.

The Analog Output module is a CE Mark Certified module.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

5.1.1 Electronics modules (Emod) - (AO)

- **1C31129G01** provides voltage output range of 0 to 5 V DC.
- **1C31129G02** provides voltage output range of 0 to 10 V.
- **1C31129G03** provides current output range of 0 to 20 mA with diagnostics.
- **1C31129G04** provides current output range of 0 to 20 mA without diagnostics.
- **1C31129G05** provides current output range of 4 to 20 mA for redundant applications (with diagnostics).

5.1.2 Personality modules (Pmod) - (AO)

- **1C31132G01** routes field signals from the Electronics module to the terminal block.
- **1C31132G02** For Redundant analog output module.
- **5X00170G01** Analot Output pin-compatible.

5.1.3 Subsystems - (AO)

Analog Output subsystems

Range	Channels	Electronics module	Personality module
0-5 Volts DC	4	1C31129G01[1]	1C31132G01
0-10 Volts DC	4	1C31129G02[1]	1C31132G01
0-20 mA with Diagnostics (4-20 mA with Diagnostics can also be selected in the I/O Builder for Solaris applications; card will be configured appropriately).	4	1C31129G03[1]	1C31132G01
0-20 mA without Diagnostics (4-20 mA without Diagnostics can also be selected in the I/O Builder for Solaris applications; card will be configured appropriately).	4	1C31129G04[1]	1C31132G01
4-20 mA with Diagnostics (For Redundant applications).	4	1C31129G05[2]	1C31132G02
[1] This module configurations is CE Mark Certified. [2] For Redundant applications using Windows Ovation 3.2 and above.			

5.1.4 Terminal block wiring information - (AO)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The diagram for the analog output Personality module is illustrated in the following figure. The following table lists and defines the abbreviations used in this diagram.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Shielded twisted pair wiring should be used for Maximum noise immunity.

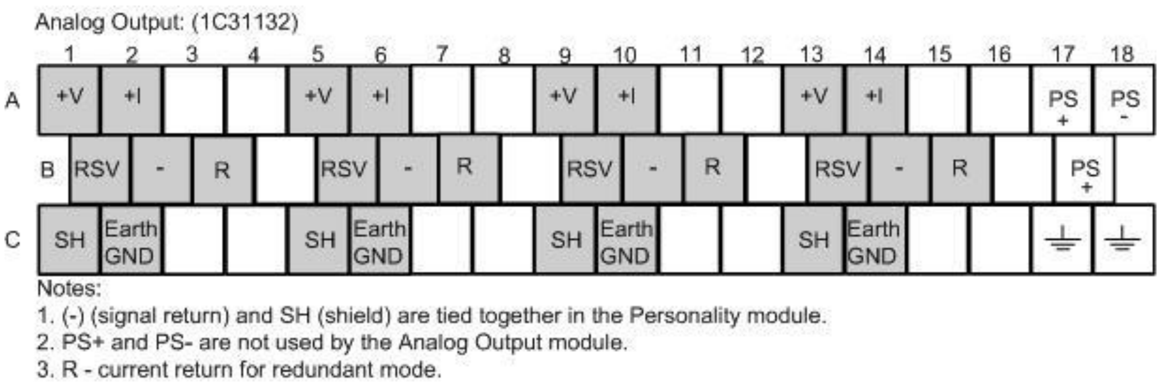


Figure 40: Terminal block connections for the Analog Output Personality module

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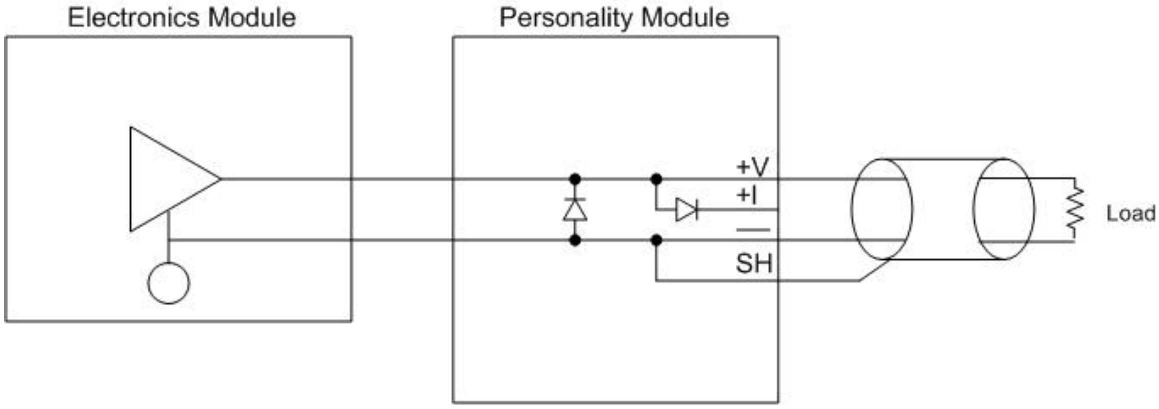
Note: *1. R is only used with the combination of 1C31129G05 and 1C31132G02.*
2. Do ***not*** *use unmarked terminal block locations.*
3. Shield terminals (SH) are ***not*** *connected in CE Mark systems.*

Abbreviations used in wiring diagrams

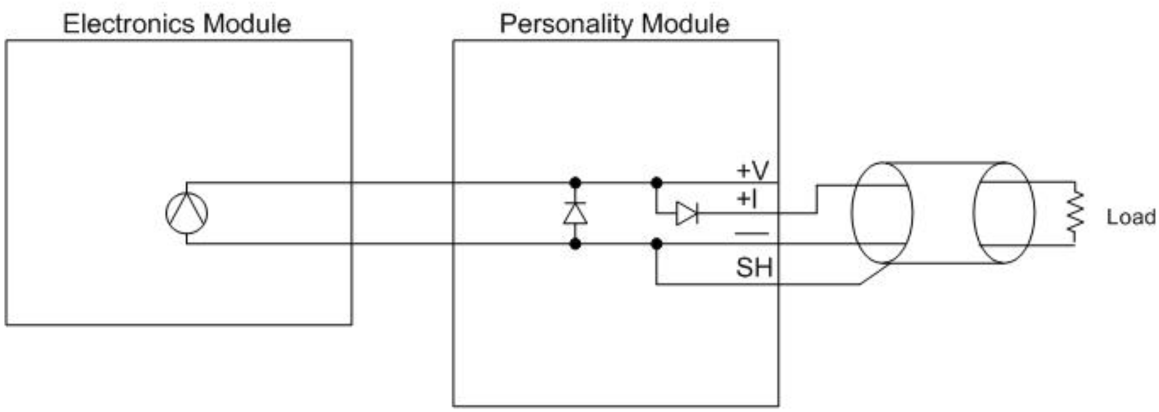
ABBREVIATION	DEFINITION
⏚	Earth ground terminals.
+I	Current output source terminal.
RSV	Reserved terminal. No connections allowed on these terminals.
SH	Shield terminal connection.
+V	Voltage output source terminal connection.
PS+, PS-	Auxiliary power supply terminals.
-	Reference for voltage and current output.
R	Current return for redundant mode.

The loads can be floating or grounded. For Maximum noise immunity, it is best to reference a floating load to local earth by placing a jumper between the SH terminal and the adjacent earth GND terminal.

5.1.5 Field connection wiring diagrams (1C31129G01/G02) (simplex) - (AO)



Voltage Output

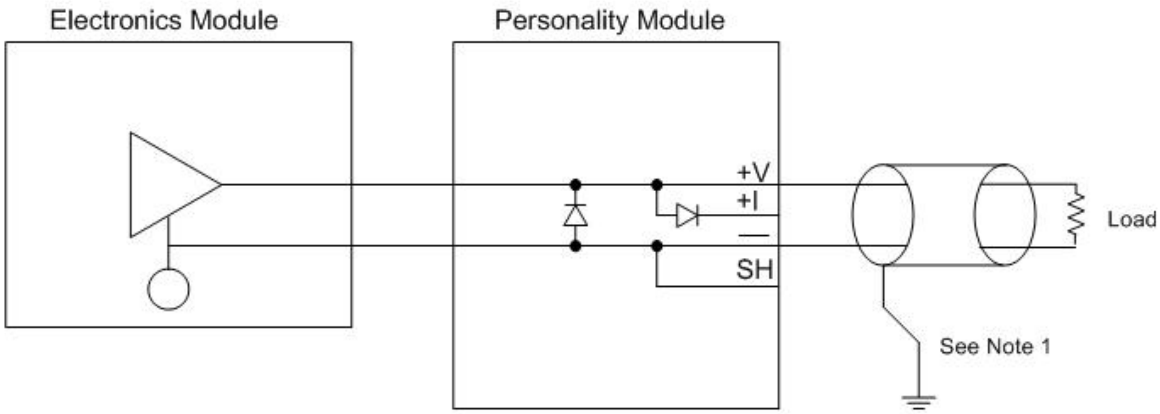


Current Output (with Current Measurement Test Points *)

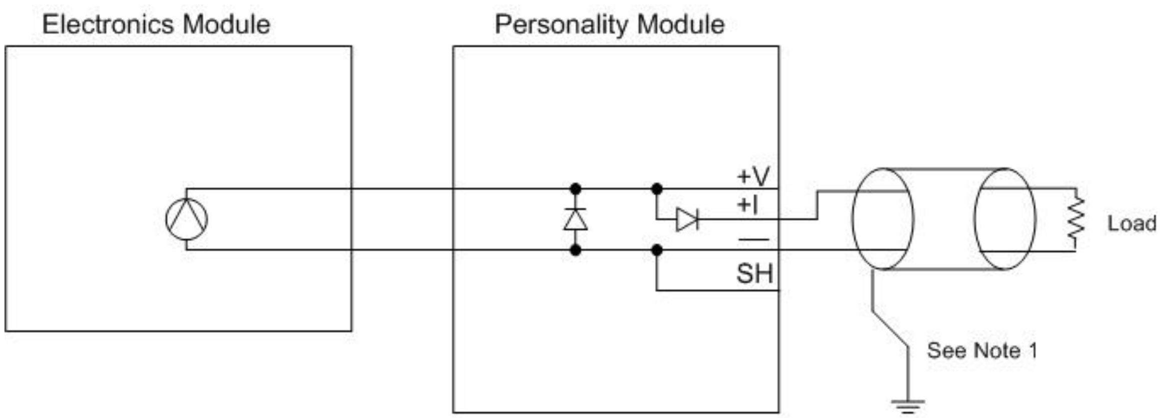
* Connect meter between +V and +I to measure current without disconnecting loop.

Figure 41: Field connection for the Analog Output Pmod

5.1.6 Field connection wiring diagrams (CE Mark) - (AO)



Voltage Output



Current Output (with Current Measurement Test Points[2])

Notes

1. All field wiring MUST be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to the applicable "Cable Guidelines" information for your system).

2. Connect meter between +V and +I to measure current without disconnecting loop.

Figure 42: Field connection for the Analog Output Personality module (CE Mark)

5.1.7 Field connection wiring diagrams (1C31129G02) (Redundant) - (AO)

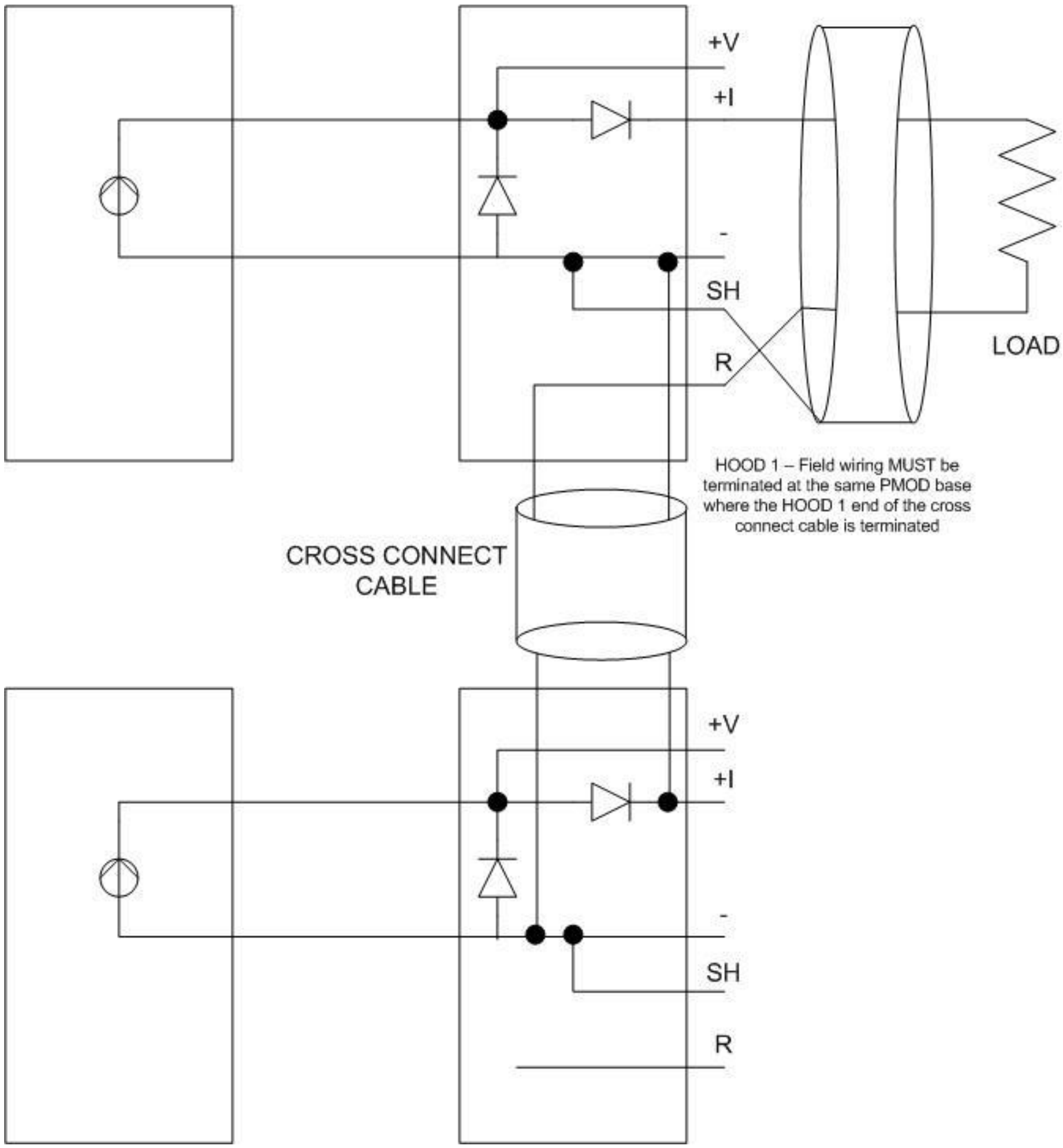
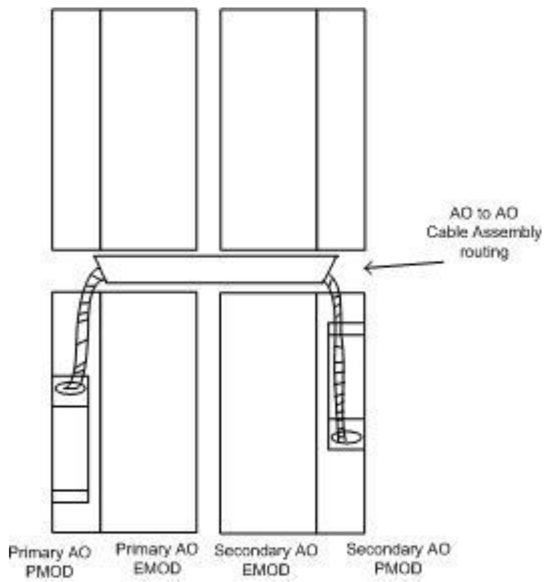


Figure 43: Field connection for the Redundant Analog Output Personality module

5.1.8 Cable assembly routing configuration (Redundant) - (AO)



Note: *The cable assembly end labeled* ***Hood 1*** *must be installed next to the module wired to the field.*

5.1.9 Register configuration/address information - (AO)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern Field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Analog Output configuration/status register (address 13 or D in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configure	Configured (1 = configured; 0 = unconfigured)
1	Force Error	Forced Error (1 = forced error; 0 = no forced error)
2 - 4	Communications Timeout Setting [1]	Communications Timeout Setting [1]
	Bit 4 / Bit 3 / Bit 2 / Timeout	Bit 4 / Bit 3 / Bit 2 / Timeout
	0 0 0 16 seconds	0 0 0 16 seconds
	0 0 1 4 seconds	0 0 1 4 seconds
	0 1 0 2 seconds	0 1 0 2 seconds
	0 1 1 1 seconds	0 1 1 1 seconds
	1 0 0 500 milliseconds	1 0 0 500 milliseconds
	1 0 1 250 milliseconds	1 0 1 250 milliseconds
	1 1 0 125 milliseconds	1 1 0 125 milliseconds
	1 1 1 62.5 milliseconds	1 1 1 62.5 milliseconds

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
3	Communication Timeout Bit [1]	Communication Timeout Bit 1 [1]
4	Communication Timeout Bit [1]	Communication Timeout Bit 2 [1]
5	Hold Output	Hold Output.
6	Not used	Channel error (G05 only).
7	Disable power	Disable power.
15	Redundant Operation (G05 only)	Redundant Operation (G05 only).
[1] The tolerance on the timeout period is +/- 35%.		

The bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: When Bit 0 is set, the module is configured. The module cannot be read and does not operate until the configure bit is set with a write. Subsequent writes to address 13 should also have Bit 0 set.

Bit 1: Bit 1 is the Force-Error bit. When Bit 1 is set, the Internal Error LED is turned on, and data registers can be written, but not read.

Bits 2-4: These bits are used to select the communication timeout period.

Bit 5: This bit is Hold Output on communication timeout. If Bit 5 is set and no communication to the module occurs for the defined time period, only the communication LED goes off, and the Internal Error LED goes on, but the outputs hold their last value.
If Bit 5 is not set and no communication to the module occurs for the defined time period, the outputs reset to zero and the Internal Error LED goes on.

Bit 6: Group 5 only - Set on any channel error (over-current, under-current, Power Supply failure).

Bit 7: This bit is the disable power bit.

Bit 15: Group 5 only - Set to indicate redundant operation.

All the bits are cleared to zero on power up.

CAUTION! This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

The register at address 12 (C in Hex) is for diagnostics and is a read-only register. The overcurrent and undercurrent status bits may be read from this register. The following table shows the overcurrent and undercurrent bits for each channel. The overcurrent bits are used for both the voltage groups and current groups. The undercurrent bits only have meaning for the current group. The voltage output groups do not implement the undercurrent bit.

The simultaneous setting of a channel's overcurrent and undercurrent bits indicates a loss of Field Card power supply for that channel. Overcurrent and undercurrent bits indicate the output current status of this module and not the loop current.

Note: *Group 4 current output Field Cards do not have these diagnostic capabilities and the overcurrent and undercurrent bits are strapped in the logical zero state. Since the Group 4 modules do not have diagnostics, the information is not available to the Ovation Controller to support redundancy logic calculations. Groups 1 and 2 do not have undercurrent indication.*

Output Current Status register address location information (address 12 or C in Hex)

BIT	DESCRIPTION
0, 2, 4, 6	Channel 1 - 4 Overcurrent
1, 3, 5, 7	Channel 1 - 4 Undercurrent

5.1.10 Diagnostic Logic card LEDs - (AO)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set. Also lit when a timeout of the watchdog timer occurs when Controller stops communicating with module.

LED	DESCRIPTION
1 - 4 (Red)	Channel 1 - 4 error. Over-current or undercurrent indication. ▪ On groups 1, 2, 3, and 5, the LEDs are ON after power up until the module is configured. ▪ On groups 1 and 2, the LED is ON for over-current output or loss of output D/A power. ▪ On group 3, and 5, the LED is ON for over-current/undercurrent output or loss of output D/A power. ▪ Group 4 does not have diagnostic LEDs.
5 - 16	No LED.

5.1.11 Specifications - (AO)

- **Electronics module (1C31129)**
- **Personality module (1C31132)**

DESCRIPTION	VALUE
Number of channels	4
Maximum update time	2 msec
Output range	0 – 5 V [1], 0 -10 V [1], 0 - 20 mA [2]
Resolution	12 bits
Data Format	Binary
Bit Weight	Current Output: 0.005 ma - Voltage output: 2.5 mv.
Setting time (full scale change) to 1% of range	Current Output: 660 usec
Overshoot	None
Inductive Loads (current outputs)	10 mH
Power up/down	The outputs power up at 0 mA (G03, G04), 4mA (G05) or 0 V (G01, G02).
Monotonicity	Yes
Crosstalk between channels	>60dB
Nonlinearity	1/2 LSB
Repeatability	<1 LSB
Output noise	5 mv Max
Guaranteed accuracy (@25°C)	0.1% of full scale.
Temperature coefficient	30 ppm/°C.
User loop voltage	Power for current loop output is supplied by module.
Dielectric isolation: Channel to channel - Channel to logic	1000 V AC/DC - 1000 V AC/DC.
Output loading: Current Voltage	0 Ohms minimum; 750 Ohms Maximum. 10 mA Maximum.

DESCRIPTION	VALUE
Module power Current output Voltage output	 4 W typical; 6 W Maximum. 2 W typical; 3 W Maximum.
Operating temperature range	0 to 60°C (32°F to 140°F).
Storage temperature range	-40°C to 85°C (-40°F to 185°F).
Humidity (non-condensing)	0 to 95%

[1] Overcurrent load indications.
[2] Module supplied loop voltage, overcurrent and undercurrent diagnostic indication. Provides the ability to measure current without disconnecting loop.

5.2 HART Analog Output module - (HAO)

The Ovation HART (Highway Addressable Remote Transducer) Analog Output Module consists of an Electronics module and a personality mode. The Ovation HART Analog Output Module is designed to interface with eight HART compliant output devices utilizing a 4-20 mA control loop signal. A HART compliant output device exchanges digital information with the Ovation control system in addition to the standard 4-20 mA control loop signal. The digital information is imposed on the 4-20 mA signal according to the guidelines of the HART Protocol Specification. HART uses a low-level frequency shift-keyed sine-wave signal that is superimposed on the 4-20 mA signal. The average value of the HART signal is zero. Therefore, the HART signal does not interfere with the 4-20 mA control signal.

The HART Analog Output module is a CE Mark certified module.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

5.2.1 Electronics modules (Emod) - (HAO)

- **5X00062G01** contains eight multiplexed, 4-20 mA output channels that interface with eight HART output devices.

5.2.2 Personality modules (Pmod) - (HAO)

- **5X00063G01** contains passive circuitry for each of the eight channels. There is a user-serviceable fuse located on the Personality module. This fuses the auxiliary power supplying the field side circuitry of the eight output channels.

5.2.3 Subsystems - (HAO)

HART Analog Output subsystems (14 bit)[1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4-20 mA	8	5X00062G01[1]	5X00063G01
[1] This module configuration is CE Mark certified.			

5.2.4 Module block diagrams - (HAO)

The Ovation HART analog output module assembly consists of two modules inserted into an Ovation base unit. The Electronics module contains a logic printed circuit board (LHA) and a field printed circuit board (FHO). The simplified block diagram for the HART analog output Electronics modules FHO board is shown in the following figure. The Electronics module is used in conjunction with a Personality module, which contains a single printed circuit board (PHAO).

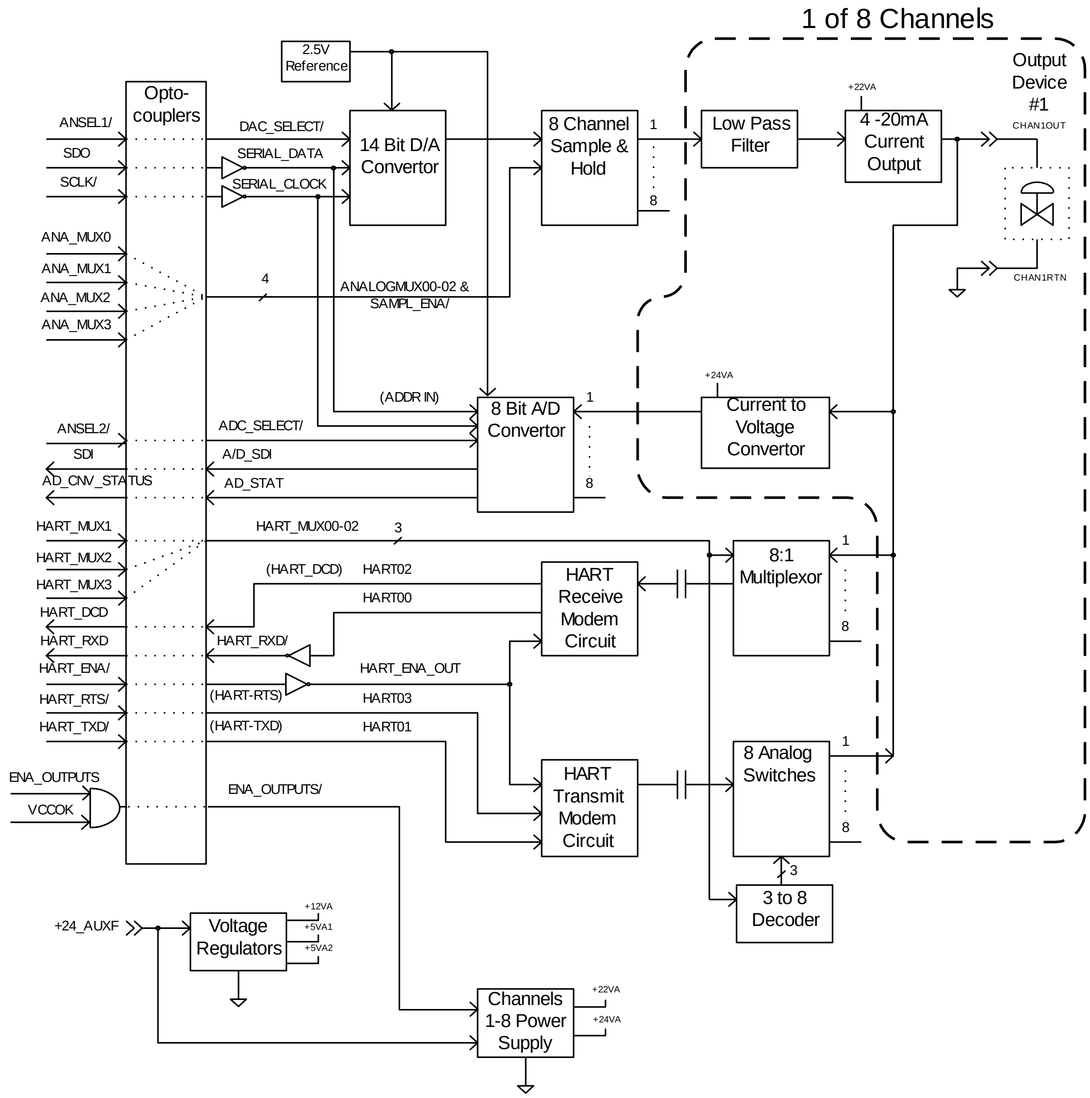


Figure 44: HART Analog Output field board block diagram

5.2.5 External power supply information - (HAO)

Note: *Module power specifications (main and auxiliary) refer to the actual power drawn by the module from the 24 VDC main power supply and from the +24 VDC auxiliary power supply and* ***NOT*** *from the AC or DC mains.*

The HART Analog Output Module utilizes the standard +24V Ovation main power supply to provide the power required for the logic circuitry.

The HART Analog Output Module utilizes a +24 auxiliary power supply to provide the power required for the field circuitry. This includes all 4-20 mA loop power, D/A conversion, and the remaining output channel components.

It is recommended that the HART Analog Output module utilize the Ovation cabinet's Auxiliary +24V DC power that is obtained from the standard Ovation DIN Rail power supply auxiliary output.

However, if an external auxiliary power supply is utilized by the HART Analog Input module, the power supply output noise cannot exceed 2.2 mVRMS Maximum for all rated loads across the frequency range of 500 HZ to 10 KHz .

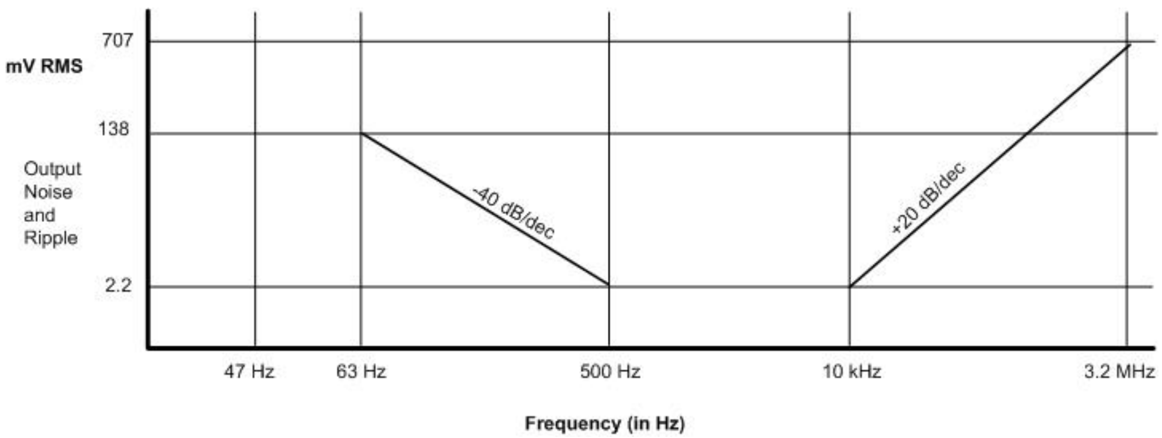


Figure 45: Power supply output noise requirements

If an external power supply is used, Using an External Power Supply (see page 799) contains steps to be undertaken before connecting the external power supply to the Ovation I/O base unit terminal block.

In addition, all modules utilizing the auxiliary power supplies, including the HART modules, **MUST** utilize shielded I/O cables in order to suppress coupled noise and transients into the HART modules. This includes modules on the same branch utilizing the auxiliary power, or modules on other branches utilizing the same auxiliary power. This recommendation applies regardless of the type of power supply chosen by the user.

5.2.6 Terminal block wiring information - (HAO)

Each Personality module has a simplified wiring diagram label on its side which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The diagrams for the HART Analog Output Personality modules are illustrated in the following figure. The following table lists and defines the abbreviations used in those diagrams.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

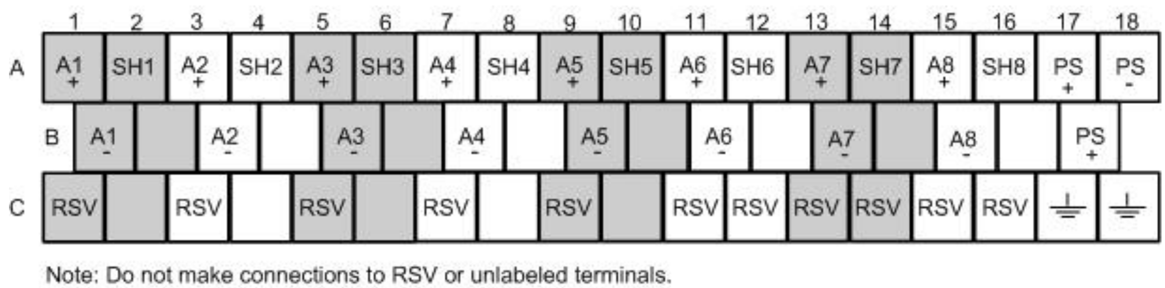
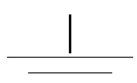


Figure 46: HART Analog Output terminal block pin assignments

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals.
A1 - A8 +	Analog Output positive terminal connection (connected to the positive terminal of a HART analog output device).
A1 - A8 -	Analog Output negative terminal connection (connected to the negative terminal of a HART analog output device.)
PS+, PS-	External Auxiliary power supply terminals.
SH1 - SH8	Shield terminal connection.

5.2.7 Field connection wiring diagrams - (HAO)

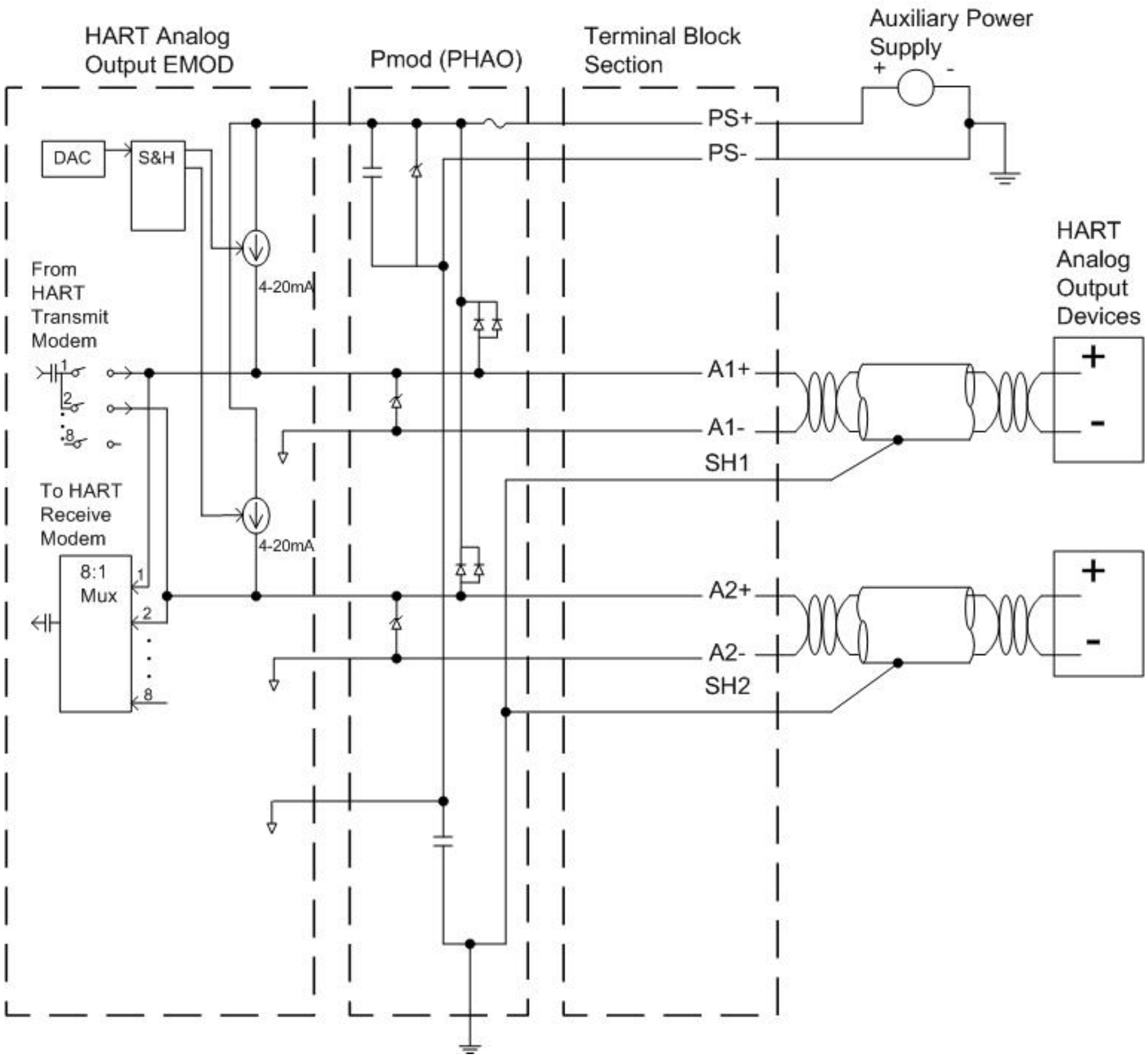
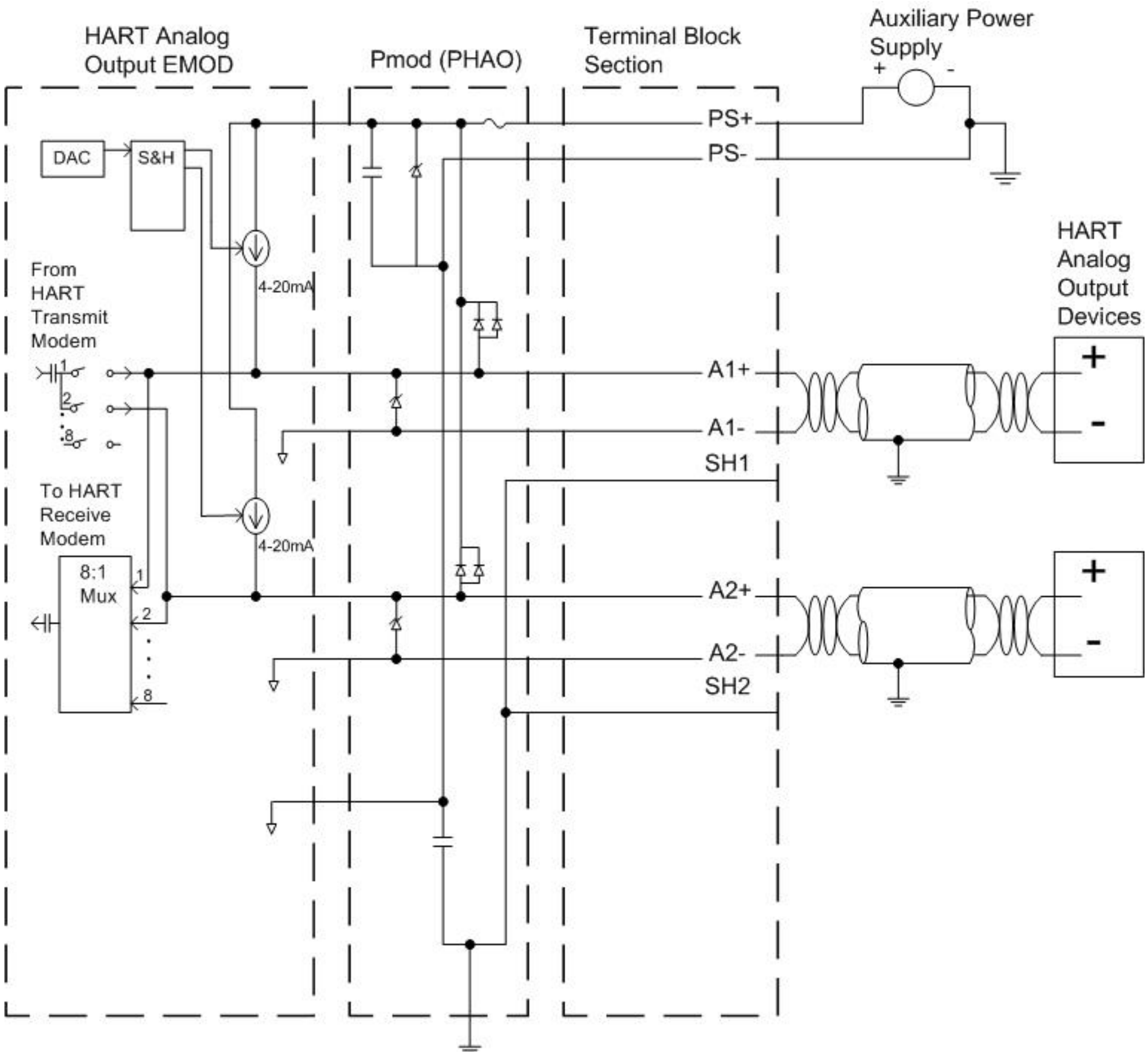


Figure 47: Field wiring (non-CE Mark) (2 of 8 channels depicted)

5.2.8 Field connection wiring diagrams (CE Mark) - (HAO)



Note:
All field wiring must be braid-shielded and grounded at the point of entry of the cabinet using the recommended hardware (refer to the applicable "Cable Guidelines" information for your system).

Figure 48: Field wiring (CE Mark) (2 of 8 channels depicted)

5.2.9 Field wiring cable requirements - (HAO)

Field I/O cable must be one or more single-twisted pair shielded or multiple-twisted pair with overall shield. Single and multiple-pair may be combined provided that all of the shields share a common connection to earth ground in the Ovation cabinet.

Recommended minimum conductor size

Cable Length	Min. Conductor Size	Cable Type
Below 5,000 feet (1524 m)	24 AWG (0.51 mm dia.)	Single-twisted pair shielded or multiple-twisted pair with over-all shield.
Above 5,000 (1524 m)	20 AWG (0.81 mm dia.)	Single-twisted pair shielded.

The Maximum length of cable per HART network is dependent on the characteristics of the devices connected to the network and the characteristics of the cable to be used.

In a HART network, long cable lengths are possible when the dominant low impedance device (the HART field device) has an input impedance of approximately 250 ohms and the signal cable is good quality having low capacitance (Cx) and resistance (Rx) per unit length.

Cx = Cable capacitance per unit length (feet or meters): The capacitance from one conductor to all other conductors (including the shield if shielded). This value is usually available from the cable manufacturer.

Rx = Cable resistance per unit length (feet or meters): This value should be available from the cable manufacturer. Filed Wiring Requirements (see page 93) for the HART Analog Input Module contains the resistance values of some common copper wire sizes. The resistance per unit length is for a single wire but the length calculations and charts take into account the resistance of both wires.

Refer to field device manufacturer's literature for more information on cabling lengths since device impedances may vary among field devices. In addition, refer to the HART FSK Physical Layer Specification (HCF_SPEC - 54) for additional information.

5.2.10 Open loop detect register - (HAO)

If one of these bits is set, the channel readback diagnostic indicates the difference between the desired value and the actual value that exceeds the accepted deadband. This bit signifies an open loop condition.

Pass/Fail per channel register (address 12 or C in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0 - 7	NA	Channel 1 - 8 bad
8 - 16	Not Used	Not Used

5.2.11 Register configuration/address information - (HAO)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

HART Analog Output register map

Reg	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Indirect Memory Index.	NA
1	Indirect Memory Data.	Indirect Memory Data.
2 - 9	Analog Output - Channel 1 - 8	NA
10	Calibration Register (Factory use only).	Calibration Register (Factory use only.)
11	NA	HAI Firmware Revision.
12	NA	Channel Error Bits.
13	Module Configuration Register.	Module Status Register.
14	NA	HART Enable (See the table below.)
15	Module Electronic ID Data.	NA

HART HAO Configuration/Status Register (address 13 or D in Hex)

<table>
<tr><th>Bit</th><th>Data Description - (Write)</th><th>Data Description - (Read)</th></tr>
<tr><td>0</td><td>Configure module</td><td>Module Configured.
(1 = configured; 0 = unconfigured.)</td></tr>
<tr><td>1</td><td>Force Error</td><td>Internal or forced error
(1 = forced error; 0 = no forced error.)</td></tr>
<tr><td>2 - 4</td><td>Communications Timeout Setting [1]

Bit 4 | Bit 3 | Bit 2 | Timeout
0 | 0 | 0 | 16 seconds
0 | 0 | 1 | 4 seconds
0 | 1 | 0 | 2 seconds
0 | 1 | 1 | 1 seconds
1 | 0 | 0 | 500 milliseconds
1 | 0 | 1 | 250 milliseconds
1 | 1 | 0 | 125 milliseconds
1 | 1 | 1 | 62.5 milliseconds</td><td>Communications Timeout Setting [1]

Bit 4 | Bit 3 | Bit 2 | Timeout
0 | 0 | 0 | 16 seconds
0 | 0 | 1 | 4 seconds
0 | 1 | 0 | 2 seconds
0 | 1 | 1 | 1 seconds
1 | 0 | 0 | 500 milliseconds
1 | 0 | 1 | 250 milliseconds
1 | 1 | 0 | 125 milliseconds
1 | 1 | 1 | 62.5 milliseconds</td></tr>
<tr><td>5</td><td>Timeout Action</td><td>NA</td></tr>
<tr><td>6</td><td>Reserved for Factory Test (must be set to 0.)</td><td>NA</td></tr>
<tr><td>7</td><td>Reserved for Factory Test (must be set to 0.)</td><td>NA</td></tr>
</table>

Bit	Data Description - (Write)	Data Description - (Read)
8	NA	Hardware Error.
9 - 13	Not Used.	Not Used.
14	NA	Field Power Failed.
15	Reserved	Reserved.
[1] The tolerance on the timeout period is +/- 35%.		

Bit definitions for this register are encoded as shown above and described below:

Bit 0: Configures the module (write) or indicates the configuration state of the module (read). A “1” indicates that the module is configured. Until the module is configured, addresses 0 through 11 produce an attention status.

Bit 1: This bit (write “1”) forces the module into its error state causing the Internal Error LED to light.

Bits 2-4: These bits are used to select the Controller communications timeout period.

Bit 5: If this bit is set and the Controller times out, the module continues to output the last value received. If the bit is cleared and the Controller times out, the module outputs zero to the DAC for each channel, yielding 0 mA on the outputs after the time out period defined by bits 2-4.

Bits 6-7: Reserved for use by the Factory Test. These bits must always be set to 0.

Bit 8: When set, this indicates one or more of the following conditions are true:

- The FPGA did not program correctly upon startup.
- The EE memory checksum is incorrect.
- The PROM checksum test has failed.
- Internal memory diagnostic has failed.

Bits 9-13: Not Used.

Bit 14: Field power failed.

Bit 15: Reserved.

CAUTION! This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

HART Analog Output Enable Register (Address 14 or E in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0 - 7	Multi-variable Enabled.	NA
8 - 15	HART Enabled - Channel 1 - 8.	NA

Bits 0-7: These bits are set to enable multivariable messaging.

The HAI, HAO, HART High Performance AI and HART High Performance AO modules have the ability to retrieve additional variables from a field device. These variables are referred to as 'multivariables' and are named PV (primary variable), SV (secondary variable), TV (tertiary variable), and QV (quarterly variable).

If the bit is set, the module periodically retrieves whatever variables exist for the device.

The definitions of PV, SV, TV, and QV are found in the user manual for the field device supplied by the device manufacturer. The standard format of these four variables is IEEE 754, a floating-point format.

You must configure IO point records to cause the Controller to scan the module and retrieve the variables. (See *Ovation Init and AdMin* for Solaris systems or the *Ovation Developer Studio User Guide* for Windows-based systems).

Bits 8-15: In the IO configuration tool, you can set these flags on a per-channel basis to allow HART messaging, including Multivariable messaging, to flow on that channel.

If one of these bits is set, the channel readback diagnostic indicates the difference between the desired value and the actual value that exceeds the accepted deadband. This bit signifies an open loop condition.

5.2.12 Diagnostic Logic card LEDs - (HAO)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Error LED. Illuminated upon loss of external auxiliary (field) power, as indicated by the loss of normal transitions of the EOC (end-of-convert) signal.

LED	DESCRIPTION
I (Red)	Internal Error LED. Illuminated whenever there is any type of error within the module except for a loss of external auxiliary power. Possible causes are: ▪ The Controller sets the module's Force Error bit. ▪ Communications with the Controller is lost. ▪ EPROM, EE memory or RAM diagnostic failure.
1 - 8 (Green)	After module configuration, the bank of eight channel LEDs (LEDs 1 through 8) is used to indicate HART communication activity. When a HART message is sent, the LED for that particular channel is illuminated. When the HART response is received correctly, the LED is extinguished. Therefore, when all is normal, that is, messages and responses are properly exchanged, a single LED blink is observed on the module's front cap. If a HART message is sent and no response is received, the HART Analog Output module exclusive-OR's the channel LED display with hex code 0xFF. This results in all channel LEDs being illuminated except for the selected channel. For example, if the HART Analog Output module sent a HART message to a device on channel 2, but the device was not connected to channel 2, the module would first illuminate LED 2 (all seven other channel LEDs extinguished). The module would then extinguish LED 2 and flash the other seven channel LEDs. This status indicates that the module sent a HART message on channel 2 and did not receive a valid response message after the initial message attempt or after any of the subsequent message retries.
9 - 16	No LED.

5.2.13 Specifications - (HAO)

- **Electronics module (5X00062)**
- **Personality module (5X00063)**

DESCRIPTION	VALUE
Number of channels	8
Channel Update Rate	24 mS (Each channel is updated once every 24 mS by the on-board microcontroller, 14 Bit resolution typ.)
Output Range	4 to 20 mA
D/A Resolution	14 Bits
Accuracy over Temperature Range	0.25% of Span
User Loop Voltage	Power for loop current is supplied through the module by an auxiliary power supply.
Diagnostics	Open loop feedback detection. 8 Pass/Fail bits are stored in data register 0xC in Hex.
Dielectric isolation: Channel to Channel Channel to logic	 None 1000 VAC/VDC for 1 minute.
Output Loading	4-20 mA into 700 ohm load Maximum (230 ohm minimum to 600 ohm Maximum).[1]
Output Compliance	20 mA@21.6 VDC Supply into 700 ohm load.
Operating Temperature Range	0^{o} to 60^{o} C
Humidity (non-condensing)	0% to 95%

DESCRIPTION	VALUE
Module Power	Main: 24 VDC, 1.2 W typical, 2.5W Maximum Aux: 24 VDC (-5%,+6.25%), 6W typical, 7.2W Maximum
[1] Per the HART Physical Layer Specification (HCF_SPEC - 54).	

5.3 HART High Performance Analog Output module - (HHPAO)

The Ovation HART High Performance Analog Output module consists of an Electronics module and a personality mode cavity insert. The Ovation HART High Performance Analog Output module is designed to interface with four HART compliant output devices utilizing a 4-20 mA control loop signal. A HART compliant output device exchanges digital information with the Ovation control system in addition to the standard 4-20 mA control loop signal. The digital information is imposed on the 4-20 mA signal according to the guidelines of the HART Protocol Specification. HART uses a low-level frequency shift-keyed sine-wave signal that is superimposed on the 4-20 mA signal. The average value of the HART signal is zero. Therefore, the HART signal does not interfere with the 4-20 mA control signal.

Note: *I/O Module General Information* *(see page 25)* *contains environmental, installation, wiring, and fuse information for I/O modules.*

5.3.1 Electronics modules (Emod) - (HHPAO)

- **5X00167G01** contains four independent self-powered, 4-20 mA output channels that interface with 4 HART output devices.
- **5X00167G31** contains four independent self-powered, 4-20 mA output channels that interface with 4 HART output devices (Q-line migration).

5.3.2 Personality modules (Pmod) - (HHPAO)

- **1X00188H01** (molded plastic cavity insert)
- **5X00211G03** (Q-line migration)

5.3.3 Subsystems - (HHPAO)

HART High Performance Analog Output subsystems (16-bit)[1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
4-20 mA	4	5X00167G01[1]	1X00188H01 (molded plastic cavity insert)
4-20 mA	4	5X00167G31	5X00211G03 (Q-line migration)
[1] This module configuration is CE Mark Certified.			

A Personality module is not required in order to use the HART High Performance Analog Output module. However, there may be requirements to use the Ovation Analog Output module base unit terminal assignments for the actuator interface field wiring. In those cases, you must use the 5X00170G01 HART High Performance Analog Output Personality module.

5.3.4 Module Block Diagrams - (HHPAO)

The Ovation HART High Performance Analog Output module assembly consists of one module inserted into an Ovation base unit. The Electronics module contains a logic printed circuit board (LOH) and a field printed circuit board (FOH). The simplified block diagram for the HART High Performance Analog Output Electronics modules FOH board is shown in the following two figures. The Electronics module is used in conjunction with a Personality module cavity insert which plugs into the base unit cavity normally occupied by a Personality module.

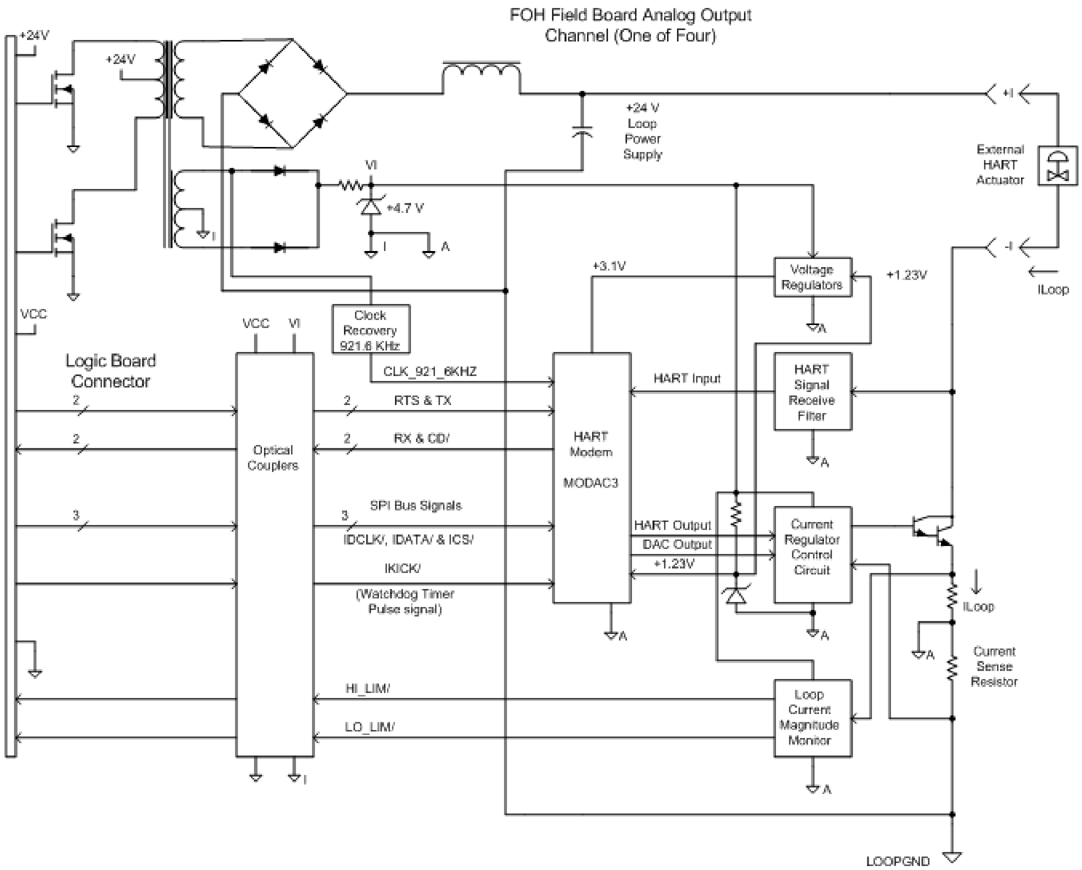


Figure 49: HART High Performance Analog Output Field Board Block Diagram (with 1X00188H01 Personality Module Cavity Insert Present)

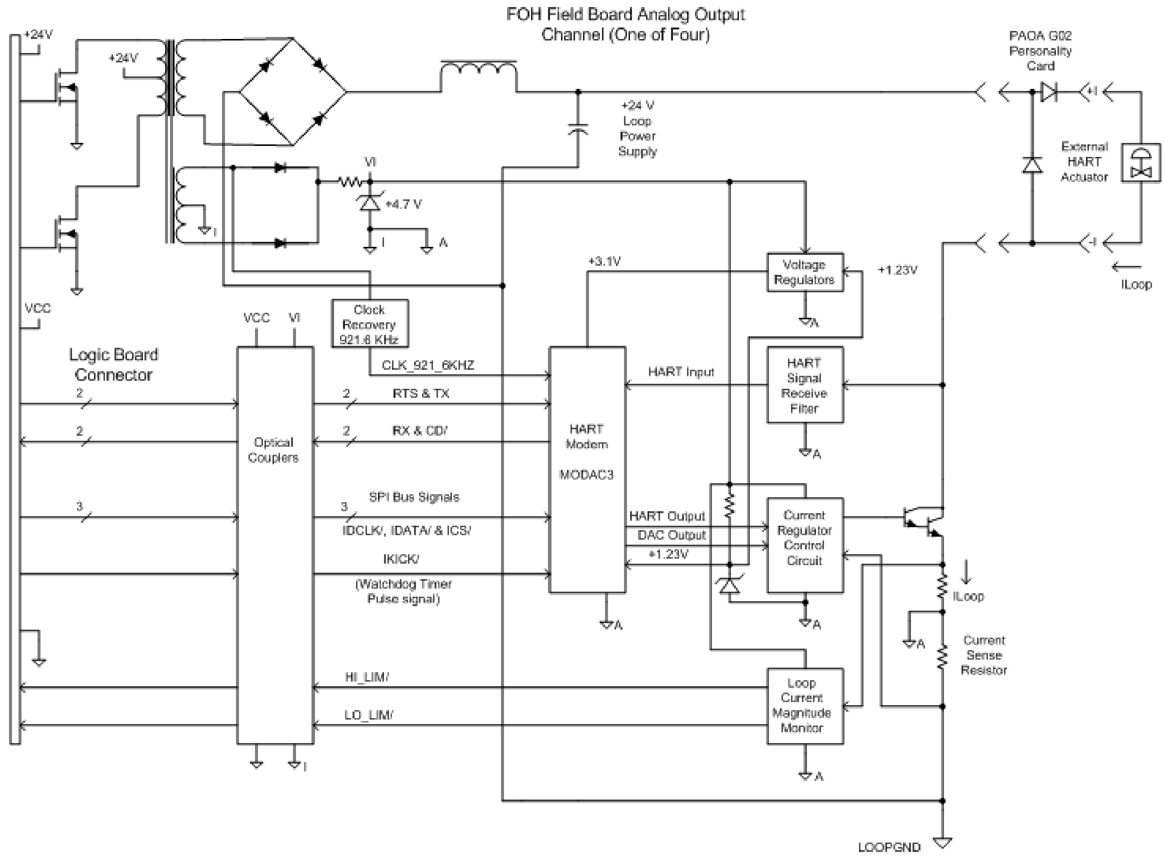
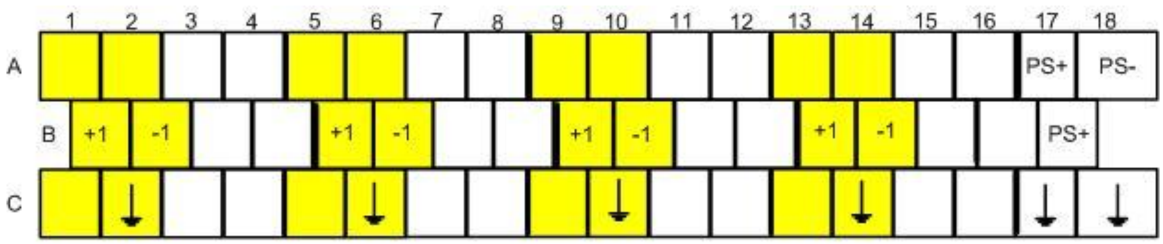


Figure 50: HART High Performance Analog Output Field Board Block Diagram (5X00170G01 Personality Module Present)

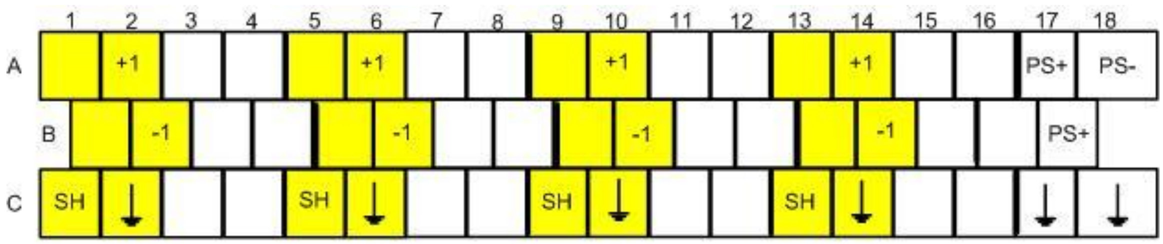
5.3.5 Terminal block wiring information - (HHPAO)

Each Personality module cavity insert has a simplified wiring diagram label on its top which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The wiring diagrams for the HART High Performance Analog Output Personality modules are illustrated in HART Analog Output Field Connection Wiring Diagrams.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

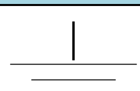


HART High Performance Analog Output (with 1X00188H01 Personality Module)



HART High Performance Analog Output (with 5X00170G01 Personality Module)

Abbreviations used in wiring diagrams

Abbreviation	Definition
	Earth ground terminals
+I	Analog Output positive terminal connection (connected to the positive terminal of a HART analog output device).
-I	Analog Output negative terminal connection (connected to the negative terminal of a HART analog output device)
PS+, PS-	External Auxiliary power supply terminals (Not Used)

Note: *All unused channels must have a wired jumper installed across the channel output terminals in order to prevent channel Under current alarms. Starting with Ovation 3.4 systems, a resistor or wired jumper is not necessary because the Ovation Developer Studio will mask off module alarms for an unused channel and eliminate the nuisance alarm.*

5.3.6 Field Connection wiring diagrams (Emod) - (HHPAO)

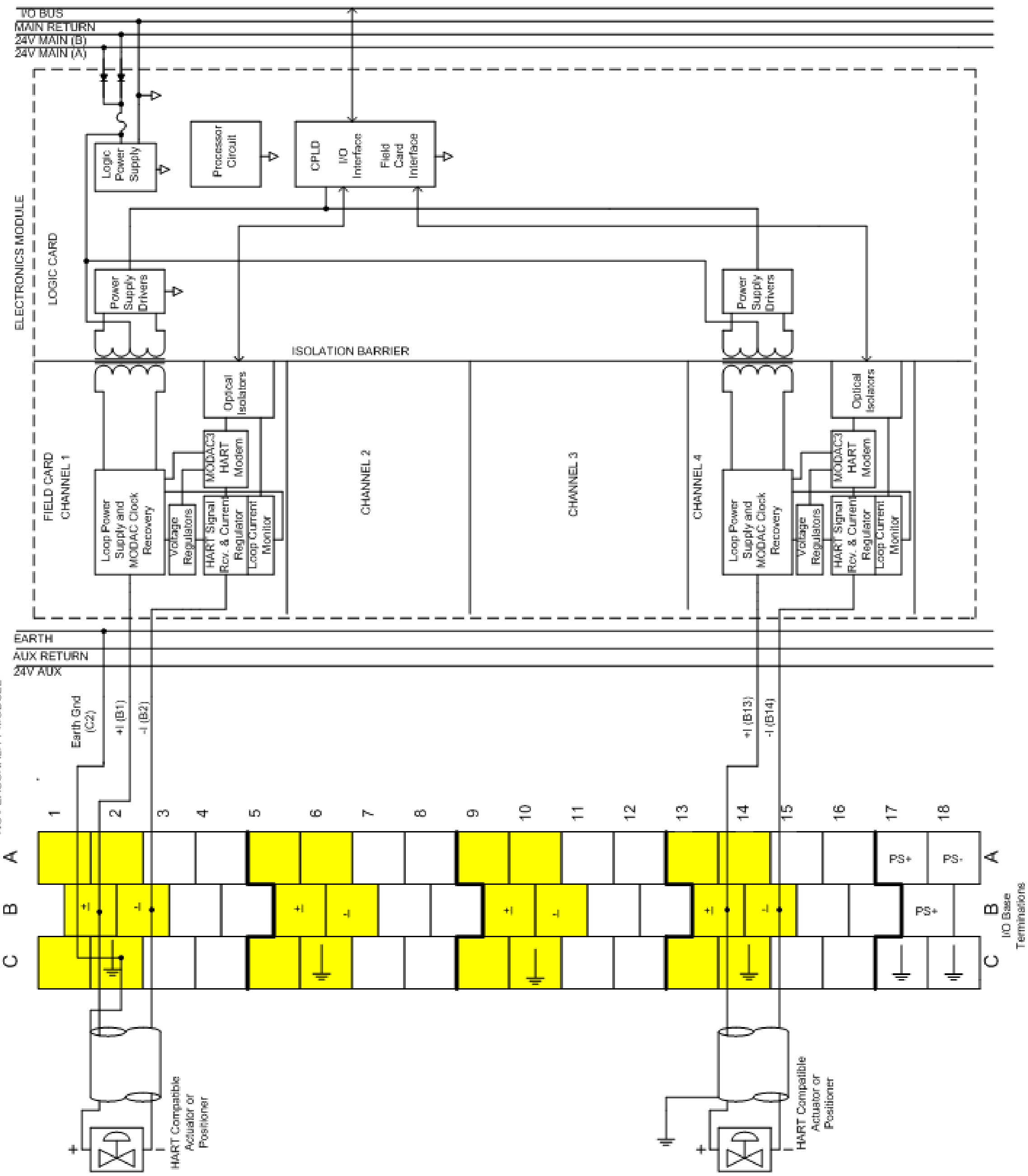


Figure 51: Field wiring with cavity insert

5.3.7 Field Connection wiring diagrams (CE Mark) - (HHPAO)

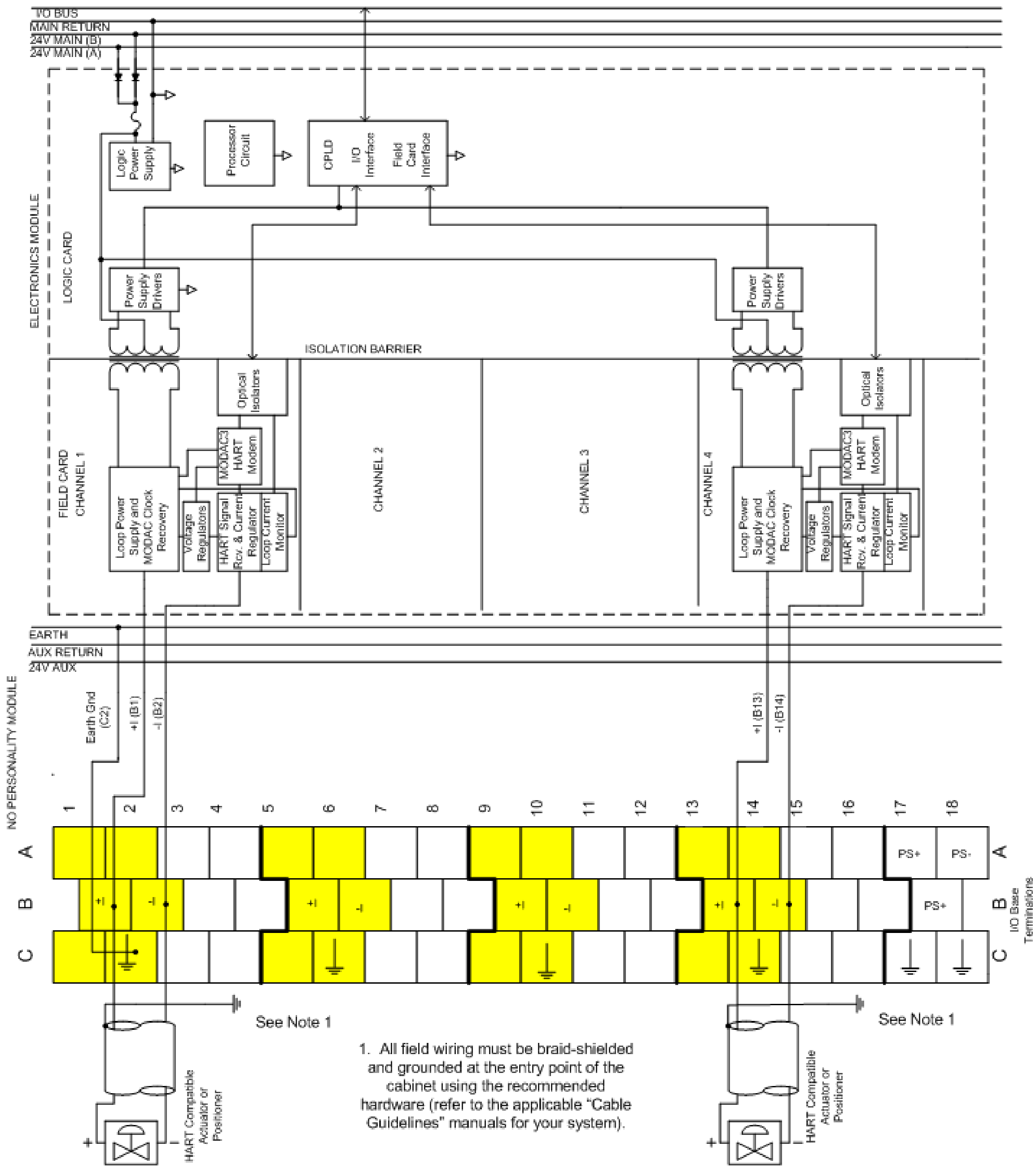


Figure 52: Field wiring with cavity insert (CE Mark)

5.3.8 Field Connection wiring diagrams (Pmod 5X00211G03) - (HHPAO)

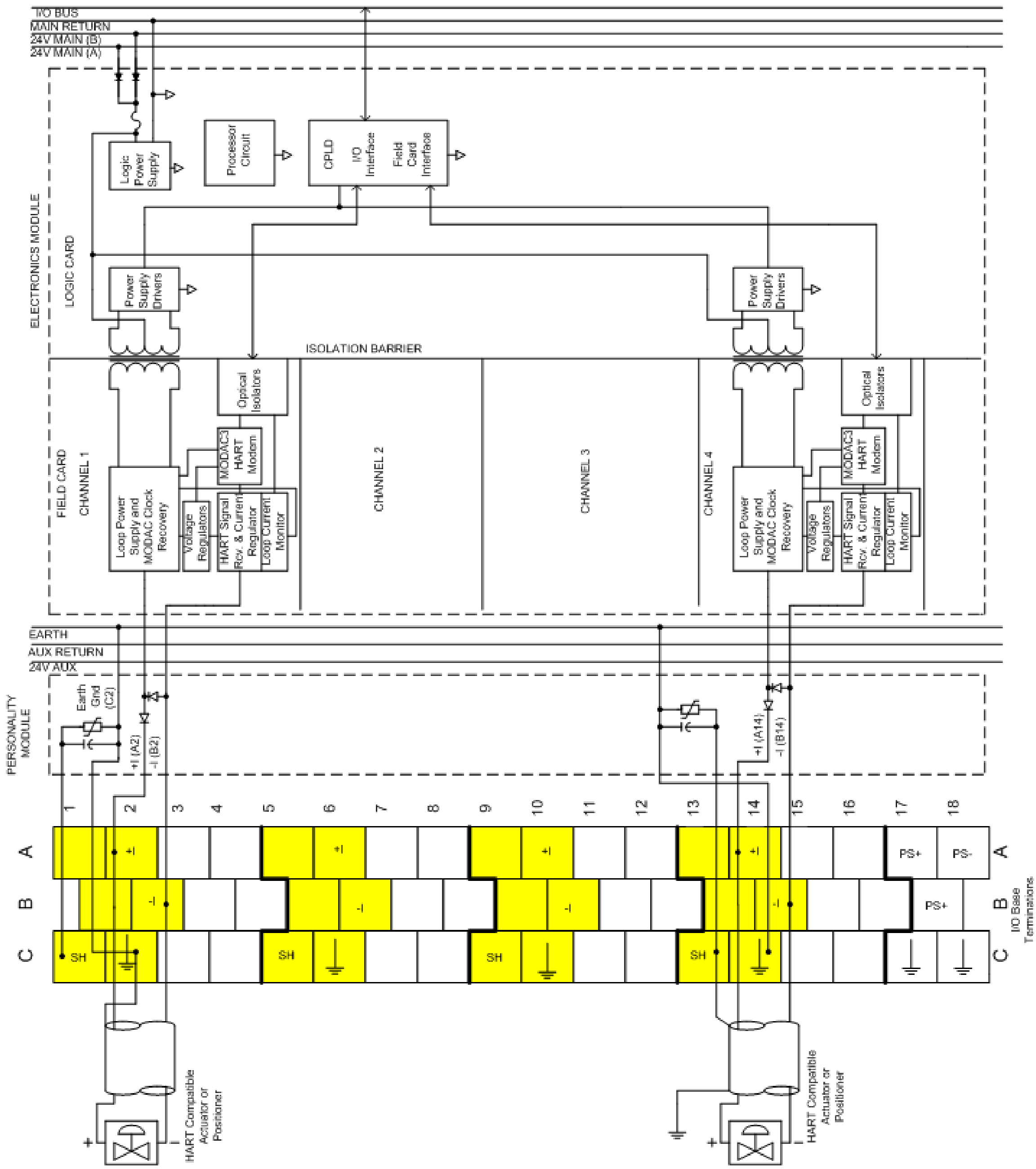


Figure 53: Field wiring with cavity insert

5.3.9 Field Connection wiring diagrams (Pmod 5X00211G03) (CE Mark) - (HHPAO)

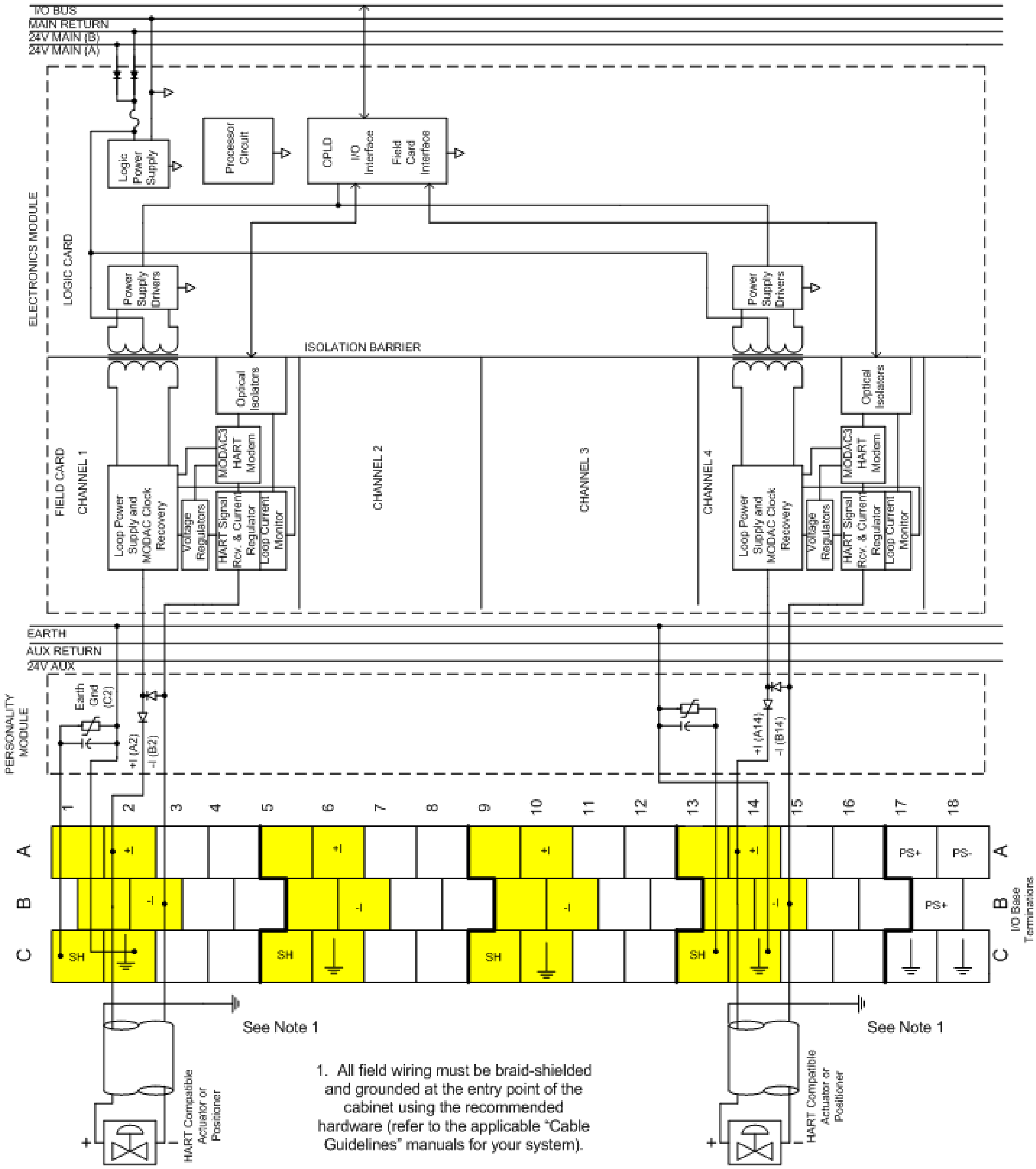


Figure 54: Field wiring with Pmod (CE Mark)

5.3.10 Field wiring cable requirements - (HHPAO)

Field I/O cable must be one or more single-twisted pair shielded or multiple-twisted pair with overall shield. Single and multiple-pair may be combined provided that all of the shields share a common connection to earth ground in the Ovation cabinet.

Recommended minimum conductor size

Cable Length	Min. Conductor Size	Cable Type
Below 5,000 feet (1524 m)	24 AWG (0.51 mm dia.)	Single-twisted pair shielded or multiple-twisted pair with over-all shield.
Above 5,000 (1524 m)	20 AWG (0.81 mm dia.)	Single-twisted pair shielded.

The Maximum length of cable per HART network is dependent on the characteristics of the devices connected to the network and the characteristics of the cable to be used.

5.3.11 Register configuration/address information - (HHPAO)

Word address 13 (D in Hex) is used to write to the Module Configuration Register and to read the Module Status Register.

The status register information is copied to the A2 field of the module's RM record. The A2 field can be viewed by using the Point Information window at an Operator Station to display the RM record and then clicking the Value tab. (See *Ovation Operator Station User Guide* for more information on the Point Information window.)

Prior to the Ovation 3.4 release, a module alarm would be generated when any of the module's channels were unused. Starting with Ovation 3.4, unused channels will not cause an alarm to be reported.

Configuration/status register (address 13 or D in Hex)

Bit	Data Description - (Write)	Data Description - (Read)
0	Configure module	Module Configured (1 = configured; 0 = unconfigured)
1	Force Error	Internal or forced error (1 = forced error; 0 = no forced error)

BIT	DATA DESCRIPTION - (WRITE)				DATA DESCRIPTION - (READ)			
2 - 4	Communications Timeout Setting [1]				Communications Timeout Setting [1]			
	BIT 4	BIT 3	BIT 2	TIMEOUT	BIT 4	BIT 3	BIT 2	TIMEOUT
	0	0	0	16 seconds	0	0	0	16 seconds
	0	0	1	4 seconds	0	0	1	4 seconds
	0	1	0	2 seconds	0	1	0	2 seconds
	0	1	1	1 seconds	0	1	1	1 seconds
	1	0	0	500 milliseconds	1	0	0	500 milliseconds
	1	0	1	250 milliseconds	1	0	1	250 milliseconds
	1	1	0	125 milliseconds	1	1	0	125 milliseconds
	1	1	1	62.5 milliseconds	1	1	1	62.5 milliseconds
5	Timeout Action				NA			
6	Factory Test				Not Used			
7	Reserved				Reserved			
8 - 11	NA				Channel 1 - 4, over-under			
12 - 15	Not Used				Not Used			

[1] The tolerance on the timeout period is +/- 35%.

Bit 0: Configures the module (write) or indicates the configuration state of the module (read). “1” indicates that the module is configured. Until module is configured, addresses 0 through 11 produces an attention status.

Bit 1: This bit (write “1”) forces the module into its error state causing the Internal Error LED to light.

Bits 2-4: These bits are used to select the Controller communications timeout period.

Bit 5: If this bit is set and the Controller times out, the module continues to output the last value received. If the bit is cleared and the Controller times out, the module outputs data to the DAC for each channel, that yields 4mA on the outputs after the time-out period defined by bits 2-4.

Bit 6: This bit is only used in the manufacturing test. When the bit is set and PE is active, the module enters a factory test mode.

Bits 7: Reserved.

Bit 8: 1=Channel 1 output current is overrange or underrange.

Bit 9: 1=Channel 2 output current is overrange or underrange.

Bit 10: 1=Channel 3 output current is overrange or underrange.

Bit 11: 1=Channel 4 output current is overrange or underrange.

Bits 12-15: Not Used.

Output Communication Timeout Settings

Timeout Bit 2	Timeout Bit 1	Timeout Bit 0	Timeout Period
0	0	0	16 seconds
0	0	1	4 seconds
0	1	0	2 seconds
0	1	1	1 second
1	0	0	500 milliseconds
1	0	1	250 milliseconds
1	1	0	125 milliseconds
1	1	1	62 milliseconds
Time-outs have a tolerance of +/- 35%. The default after a power-up is 16 seconds.			

CAUTION! This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

The following table is for reference only, Individual bits are not user accessible.

Over/Under current limit register (address 12 or C in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0 - 3	NA	Channel 1 - 4 Under Current
4 - 7	NA	Channel 1 - 4 Over Current
8 - 15	Not Used	Not Used

Enable Register (Address 14 or E in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0 - 3	Multi-variable Enabled - Channel 1 - 4	NA
4 - 7	Not Used	Not Used
8 - 11	HART Enabled - Channel 1 - 4	NA

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
12 - 15	Not Used	Not Used

Bits 0-3: These bits are set to enable multivariable messaging. Refer to the IO configuration guide for additional information.

The HAI, HAO, HART High Performance AI, HART High Performance AO modules have the ability to retrieve additional variables from a field device. These variables are referred to as ‘multivariables’ and are named PV (primary variable), SV (secondary variable), TV (tertiary variable), and QV (quarterly variable).

If the bit is set, the module periodically retrieves whatever variables exist for the device.

The definitions of PV, SV, TV, and QV are found in the user’s manual for the field device supplied by the device manufacturer. The standard format of these four variables is IEEE 754, a floating-point format.

You must configure IO point records to cause the Controller to scan the module and retrieve the variables. (See *Ovation Init and AdMin* for Solaris systems or the *Ovation Developer Studio User Guide* for Windows-based systems).

Bits 8-11: In the IO configuration tool, you can set these flags on a per-channel basis to allow HART messaging, including Multivariable messaging, to flow on that channel.

You should ensure that these bits are cleared for non-HART field devices. To avoid a HART communication error message, set each bit at “0” when connecting a non-HART output device.

5.3.12 Diagnostic Logic card LEDs - (HHPAO)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (Red)	Internal Error LED. Illuminated whenever there is any type of error within the module except for a loss of external auxiliary power. Possible causes are: ▪ The Controller sets the module’s Force Error bit. ▪ Communications with the Controller is lost. ▪ EPROM, EE memory or RAM diagnostic failure.
1 - 4 (Green)	After module configuration, the bank of four channel LEDs (LEDs 1 through 4) is used to indicate HART communication activity and the health of the analog outputs. If the analog output for the associated analog output channel is healthy (no overcurrent or undercurrent condition), then the channel LED will be ON. If the analog output channel is bad (an overcurrent or undercurrent is present), then the channel LED will be off. When a HART message is sent and received correctly, the channel LED blinks off for 100 msec if the analog output is healthy. When a HART message is sent and received incorrectly, the channel LED blinks off for 400 msec if the analog output is healthy.
5 - 16	No LED.

5.3.13 Specifications - (HHPAO)

DESCRIPTION	VALUE
Number of channels	4
Sample duration time (msec)	33 mSec (Maximum)
Output range	4 to 20 mA nominal signal voltage (Span) 0 to 23.5 mA (full signal range)
D/A resolution	16 bits
Bit weight	0.000305 mA
Data format	16-bit binary output
Conversion type	Sigma Delta DAC
Operating mode	Self scan
Monotonicity	Yes
Non-linearity	DNL: <1 LSB full scale, INL: <0.1 LSB full scale
Repeatability	Within guaranteed accuracy
Power up/Power down	Power up and power down to 4mA
Type of loads	HART compatible devices
Maximum inductive load	Per the HART physical layer specification
Settling time	Per the HART physical layer specification
Overshoot	Per the HART physical layer specification
Crosstalk	Per the HART physical layer specification
Output ripple	Per the HART physical layer specification
Sample repetition (msec)	33 msec Maximum
Filtering	2-pole low pass filter at 10 Hz
Reference Accuracy Temperature Range	0.10% of full scale (20mA) @25º C
Temperature Coefficient	25ppm of full scale / º C
Current Loop Power	For each channel, power for loop current is supplied by the module
Diagnostics	Loop Current Overrange/Underrange detection. Eight Error bits are stored in data register 0xC in Hex (Address 12)
Dielectric isolation: Channel to Channel/logic	1000 VAC/VDC for 1 minute/1000 VAC/VDC for 1 minute
Output Loading	4-20 mA (0 ohm minimum to 600 ohm Maximum)
Operating Temperature Range	0º to 60º C (32º to 140º F)
Storage Temperature Range	-40º to 85º C (-40º to 185º F)
Humidity (non-condensing)	0% to 95%
Module Power	Main: 24 VDC, 4.56W nominal, 6.75W Max, Aux: 24 VDC, Not Used.

SECTION 6

Digital Input modules

IN THIS SECTION

6.1 Digital Input module - (DI)

The Digital Input module contains 16 channels where each channel has voltage level sensing circuitry used to detect whether an input is on or off. The module is available with 16 galvanically isolated differential inputs, or 16 single-ended (common return) digital inputs with on-card blown fuse detection for the auxiliary power supply. The selection of the Personality module determines if the inputs are differential or single-ended. The input voltage level monitored by the module is determined by the particular card group in the module.

The field side circuitry for the single ended configuration (see page 184), and for the differential configuration (see page 185) are described in their respective sections. An input resistor provides the normal mode surge protection and limits the current during normal operation. An opto-isolator provides high dielectric isolation between the field side and the logic or I/O bus side.

The Single-Ended Digital Input configuration has a circuit used to monitor the presence of the auxiliary supply. Two cases cause this monitor circuitry to report a blown fuse status and issue an attention status to the Ovation Controller:

- Fuse is blown on the Personality module.
- Auxiliary supply level is lower than minimum On Input Voltage.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

6.1.1 Electronics modules (Emod) - (DI)

- **1C31107G01** provides for 24/48 VAC/VDC single-ended or differential inputs.
- **1C31107G02** provides for 125 VAC/VDC single-ended or differential inputs.

6.1.2 Personality modules (Pmod) - (DI)

- **1C31110G01** provides for single-ended inputs.
- **1C31110G02** provides for differential inputs.

6.1.3 Subsystems - (DI)

Digital Input subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24/48 VAC/VDC Single-ended Differential	16 16	1C31107G01 1C31107G01	1C31110G01 1C31110G02
125 VAC/VDC Single-ended Differential	16 16	1C31107G02 1C31107G02	1C31110G01 1C31110G02
[1] All module configurations listed in the table are CE Mark Certified.			

When the 125VAC/VDC Digital Input Emod (1C31107G02) is used in applications with the un-fused Differential Pmod (1C31110G02), external fusing or other current limiting devices are recommended on the hazardous inputs to provide protection to the external wiring and power source.

CAUTION! For CE Mark certified systems, any base unit that contains a 125VAC/DC Digital Input Electronics module (1C31107G02) with a Differential Digital Input Personality module (1C31110G02) and interfaces to hazardous voltage (>30 V RMS, 42.4 V peak, or 60 VDC) must include a hazardous voltage warning label (1B30025H01) on that base unit.

Any base unit that contains a 125VAC/DC Digital Input Electronics module (1C31107G02) with a Single-ended Digital Input Personality module (1C31110G01) and interfaces to hazardous voltage (>30 V RMS, 42.4 V peak, or 60 VDC) must include a hazardous voltage warning label (1B30025H01) on ALL base units on the branch.

Place this label in a visible location on the base unit, preferably above the spare fuse location. The project drawings must indicate this.

6.1.4 External power supply information single-ended (front end) - (DI)

If the Digital Input subsystem uses the 1C31110G01 Personality module (configured for 16 single-ended inputs), the required voltage source may be obtained from the internal auxiliary power supply (backplane) or it may be obtained from an external power supply.

If an external power supply is used, refer to Using an External Power Supply (see page 799) this section contains steps to follow before connecting the external power supply to the Digital Input module base unit terminal block.

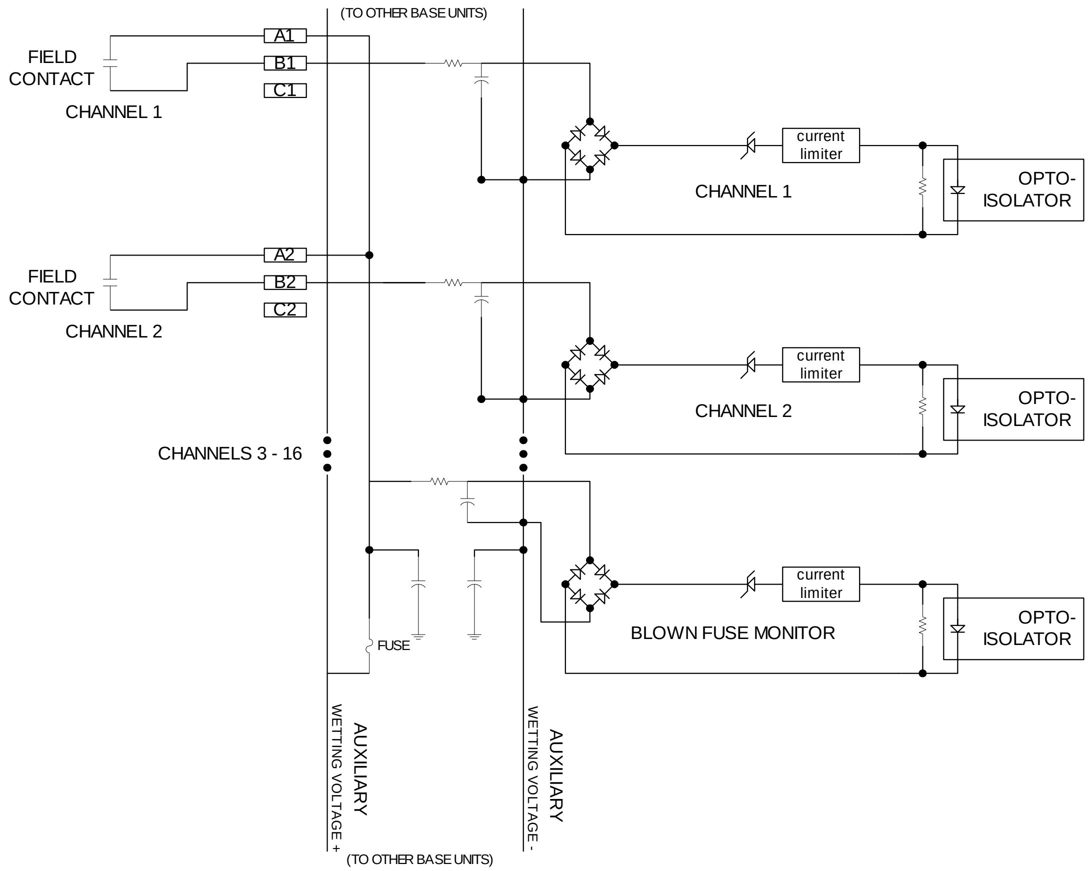


Figure 55: Single-Ended Digital Input front end

6.1.5 External power supply information differential (front end) - (DI)

If the Digital Input subsystem uses the 1C31110G01 Personality module (configured for 16 single-ended inputs), the required voltage source may be obtained from the internal auxiliary power supply (backplane) or it may be obtained from an external power supply.

If an external power supply is used, Using an External Power Supply (see page 799) contains steps to be undertaken before connecting the external power supply to the Digital Input module base unit terminal block.

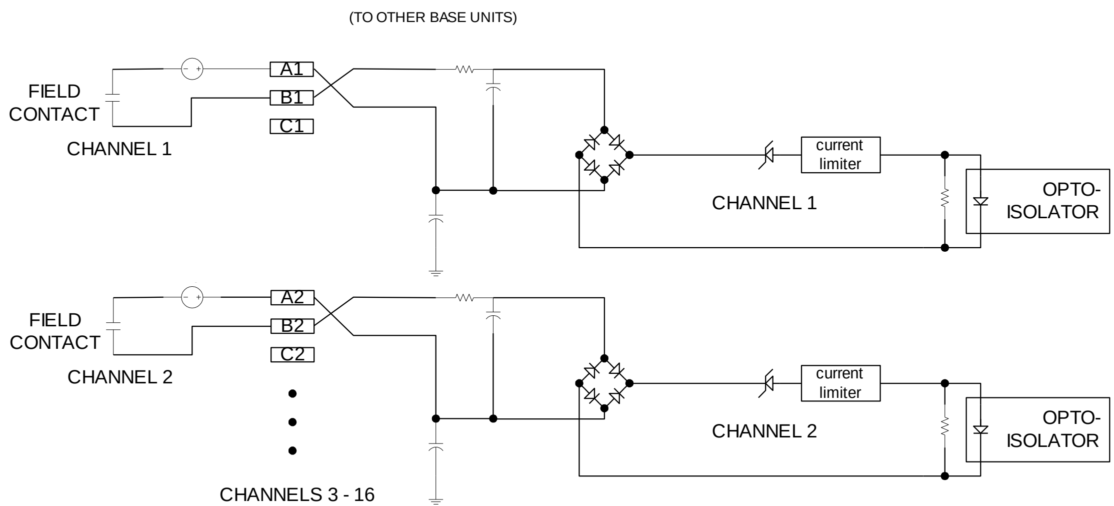


Figure 56: Differential Digital Input front end

6.1.6 Terminal block wiring information - (DI)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

The diagrams for the digital input Personality modules are illustrated in the following figure. The following table lists and defines the abbreviations used in those diagrams.

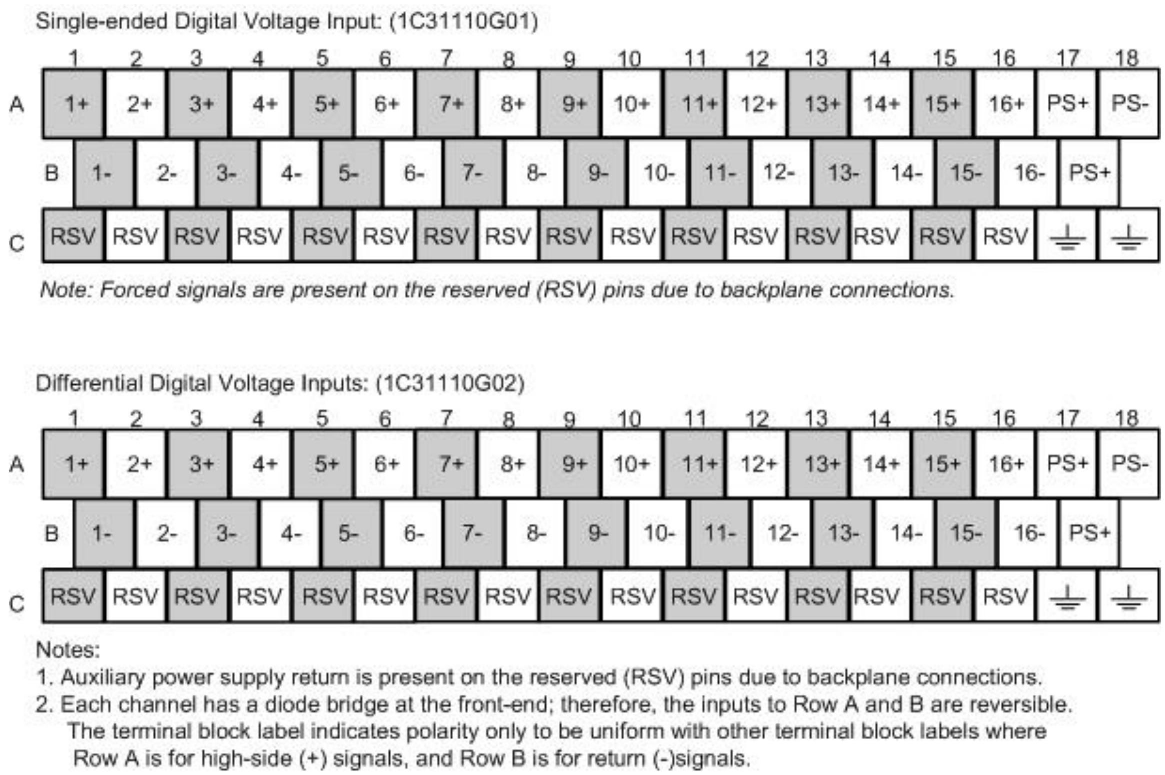


Figure 57: Terminal block connections for Digital Voltage Input Pmods

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals
1+ through 16+	Digital input positive terminal connection
1- through 16-	Digital input negative terminal connection
PS+, PS-	Auxiliary Power Supply terminals
RSV	Reserved terminal. No connection allowed on these terminals

*Do **not** use terminal block locations marked RSV.*

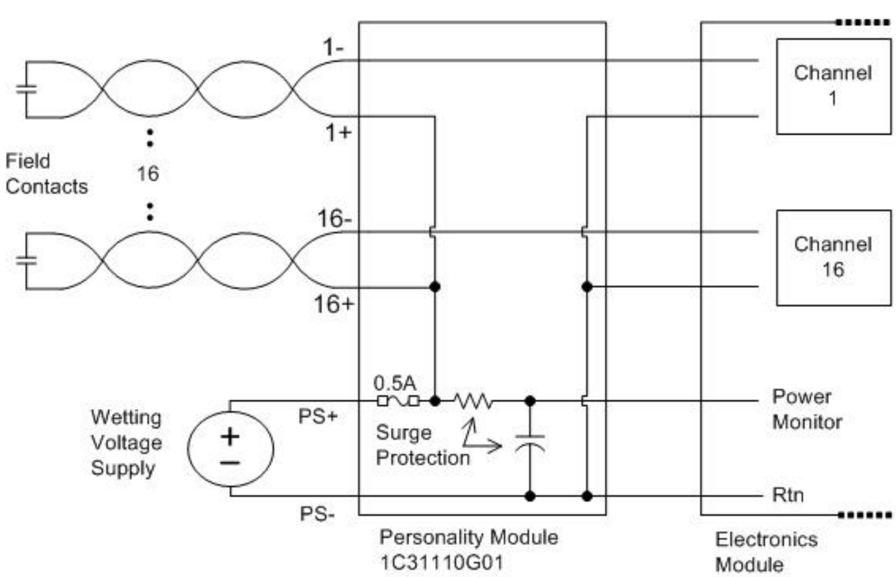
6.1.7 Field wiring configuration considerations - (DI)

The following minimum leakage resistances of the cable and the interface devices apply:

- 24/48VDC - 175 K ohms
- 24 VAC - 50 K ohms
- 125 VDC - 250 K ohms
- 125 VAC - 50 K ohms

6.1.8 Field connection wiring diagrams - (DI)

Single-Ended Digital Voltage Inputs



Differential Digital Voltage Inputs

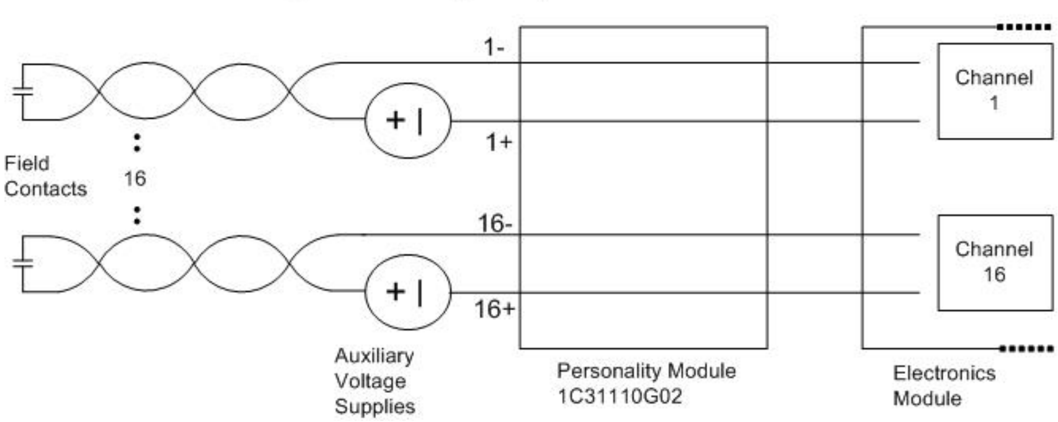
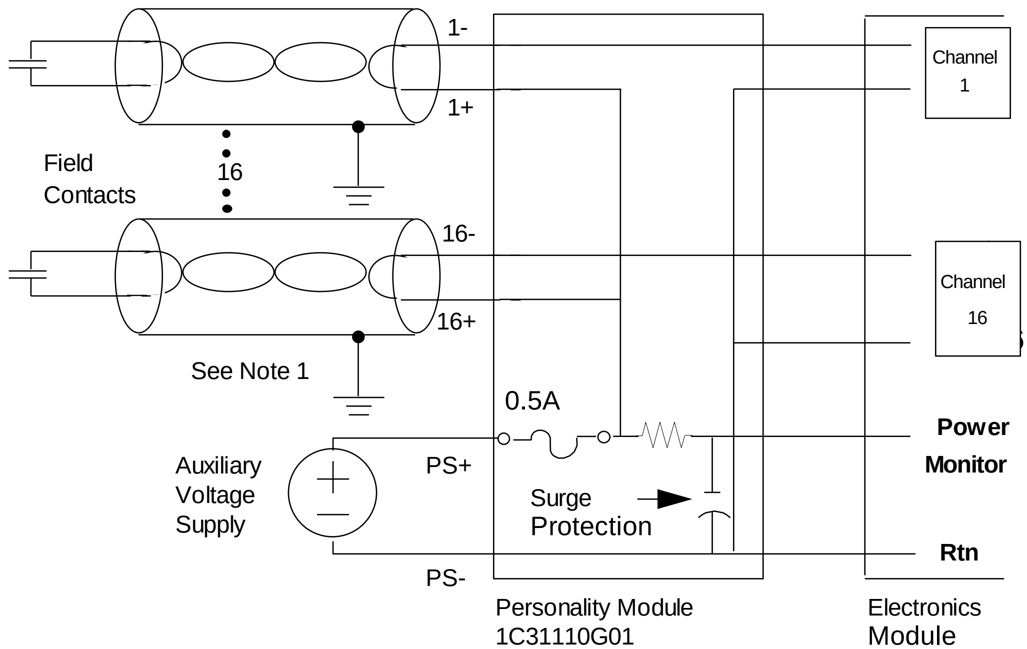


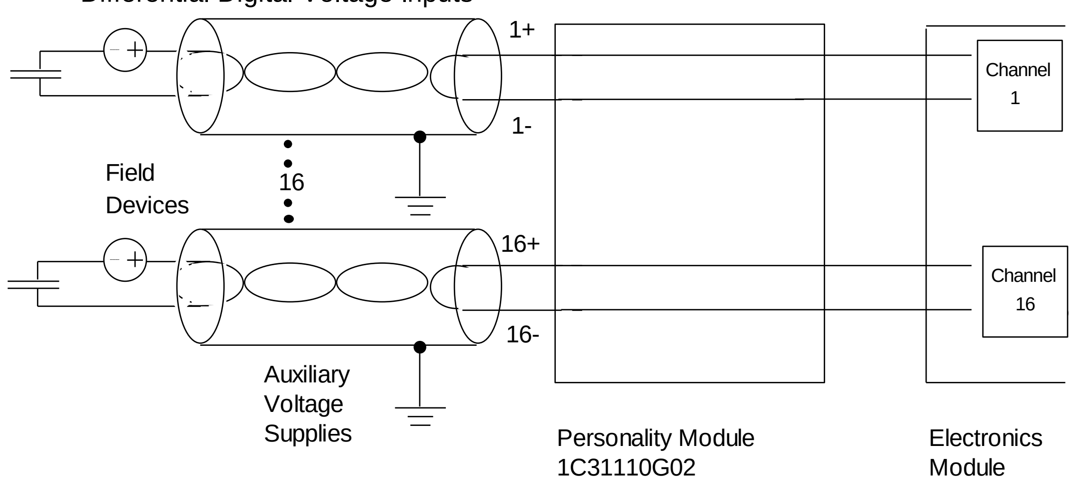
Figure 58: Field connections for the Digital Input Personality module (non-CE Mark)

6.1.9 Field connection wiring diagrams (CE Mark) - (DI)

Single-Ended Digital Voltage Inputs



Differential Digital Voltage Inputs



Note

All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to the applicable "Cable Guidelines" information for your system).

Figure 59: Field connection for the Digital Input Personality module (CE Mark)

6.1.10 Register configuration/address information - (DI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configure module (1 = configure; 0 = unconfigure, causing an attention status)	Module Configured (1 = configured; 0 = unconfigured)
1	Force Error (1 = force an attention status to be read by Controller; 0 = no forced error)	Forced error (1 = forced error set by Controller; 0 = no forced error)
2 - 5	Not defined	Not defined
6	Blown fuse enable [1] (1 = enable blown fuse detection; 0 = disable blown fuse detection)	Blown fuse enable (1 = blown fuse detection is enabled; 0 = blown fuse detection is disabled)
7	Not defined	Blown fuse (1 = fuse blown or auxiliary voltage not present; 0 = fuse OK and auxiliary voltage present)
8	Not defined	Reserved
9	Reserved	Reserved
10	Not defined	Reserved
11 - 15	Not defined	Not defined
[1] Blown Fuse Enable should always be set to “0” on the differential modules (1C31232G02 and 1C31232G03).		

Bit definitions for this register are encoded as shown in the table above and described below:

Bit 0: After the Compact Digital Input module power is cycled, this bit is “0.” A “1” must be written to this bit. If the module is not configured in this manner, an attention status is sent to the Controller upon an attempt to read the point data.

Bit 1: This bit is “0” after the Compact Digital Input module power is cycled. If the Controller sets this bit, an attention status is issued.

Bits 2-5 Not Defined

Bit 6: The Blown Fuse Enable bit is “0” after the Digital Input module power is cycled. This bit must be set by the Controller for Compact Digital Input modules, using the single-ended personality module, to detect a blown auxiliary power supply fuse when it reads the Status Register. Blown Fuse Enable should always be set to “0”on the differential modules (1C31232G02 and 1C31232G03). The bit may be read back through the Module Status Register.

Bit 7: This bit is set in the Status Register only if the Blown Fuse Enable bit (6) is set and the single-ended on-board auxiliary supply fuse has blown or the auxiliary voltage is not present. This bit is not defined in the Configuration Register.

Bit 8: These bits are reserved in the Status Register. These bits are not defined in the Configuration Register.

Bit 9: This bit is reserved.

Bit 10: Reserved

Bits 11-15: These bits are not defined in the Configuration register and are read as high in the Status register.

6.1.11 Diagnostic Logic card LEDs - (DI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (Red)	External Fault LED. Lit when the Blown Fuse bit (Bit 7) of the Status Register is set. This indicates the field supply fuse is blown or the auxiliary power supply is not present. This LED should never light if the Digital Input module is installed since the Blown Fuse Enable bit (Bit 6) of the Status Register should be set to the inactive state by the Controller.
1 - 16 (Green)	Point Status LED. Lit when the input voltage of the LED's corresponding channel is greater than the channel's minimum On Input Voltage.

6.1.12 Specifications - (DI)

- **Electronics module (1C31107)**
- **Personality module (1C31110)**

DESCRIPTION	VALUE
Number of channels	16
Input range (single-ended or differential)	Refer to the following table.
Debounce Filter Propagation delay Field card output to Point Data Register: Digital Debounce Circuit Delay Time:	 3.75 msec. Min. 4.0 msec. typ. 4.25 msec. Max. 4.0 msec. typ.
Cable length (quality is 50pF/ft or better)	1000 feet Maximum @ 50pF/ft or better
Diagnostics	Internal module operating faults. Blown fuse detection. [3]
Dielectric isolation: Channel to channel Channel to logic	 No Isolation 1000V AC/DC
Module power (drawn from logic supply)	Main: 1.1 W typical, 1.5 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)

Description	Value
Humidity (non-condensing)	0 to 95%
[1] Blown fuse detection applies to single-ended channel configuration only, where an on-board fuse is provided for the auxiliary power supply.	

Digital Input ranges

Input Level	On Input Voltage (VDC or VAC RMS)		Off Input Voltage (VDC or VAC RMS)	On Input Current (mA)		Off Input Current (mA	Power in Front End (Watts)
	Min	Max	Max	Min	Max	Max	Typical
24 VDC	18	60	9	0.6	2.6	0.33	0.75
24 VAC	22	30	7	2.8	5.5	0.6	0.80
48 VDC	18	60	9	0.6	2.6	0.33	1.50
125 VDC	75	132	55	0.65	2.0	0.37	2.80
125 VAC	85	132	40	8.2	13.5	1.9	3.30

6.2 Redundant Digital Input module (Windows Ovation 3.2 and above) - (RDI)

The Ovation Redundant Digital Input module provides sixteen digital channels to monitor the states (“0” or “1”) of sixteen field digital inputs. The module contains two voltage sensing circuits for each of the 16 I/O channels located on the module. These channels are compared for agreement on each of the respective channels located on the module. This comparison provides a channel mismatch indication to the Controller via a comparison register when one of the channels on the module is faulty. Additionally, this mismatch presents a module attention status to the Controller. If all 16 channels are in agreement, the module comparison register indicates the module is functional. Therefore, each module within the redundant pair is checked for functionality and the Controller determines which module is giving a correct indication for control usage.

Redundant power for all sixteen digital input channels is either supplied by the Ovation auxiliary power supply or by an external 24V auxiliary power source. In either situation, the redundant pair module shares a common 24VDC auxiliary power source. The module provides an isolation diode on the contact power feed in order to prevent a single point of failure from the surge components located on the module. Additionally, the personality modules in the redundant pair accept individual power feeds from their respective branches; thereby eliminating a single point of failure due to auxiliary power branch fusing.

The Redundant Ovation Digital Input module operates in redundant mode when a cable assembly is placed between the personality module of two Redundant Digital Input modules. With the redundant cable installed, the field signal wiring needs to be connected to one base unit terminal block. Alternatively, without the redundancy cable installed, the Redundant Digital Input module will function as a standalone input module. The customer field wiring must connect to each respective base in that situation.

Note: *If an external power is used, individual wires must be routed from the supply to each I/O base forming the redundant pair.*

The Redundant Digital Input Module assembly consists of two modules inserted into an Ovation base unit. The electronics module contains a logic printed circuit card (LSW) and a field printed circuit card (FDR). The electronics module is used in conjunction with a personality module. The logic card uses its electronics module logic side connector located at one end of the logic card, to interface to the Ovation base unit backplane. Through the backplane, the LSW logic card accesses the Ovation I/O bus, the module base address setting, and the redundant +24VDC I/O module main power supplies. The LSW logic card connects to the FDR field card via an inter-card connector that is located at the opposite end of the logic card. The FDR field card interfaces the base unit backplane via the FDR card’s electronics module field side connector. The base unit backplane allows the FDR field card to interface the personality module's PDR personality printed circuit card and the base unit backplane's termination block.

Features

- 1000V dielectric withstand isolation between field ground and logic ground.
- 16 single-ended digital inputs.
- 24VDC input level support.
- Optical isolation provided for the field inputs to logic.
- Standard Ovation I/O bus interface circuitry.
- On-board wetting voltage fusing and a blown fuse detection monitor for the external wetting voltage power supply for single-ended digital inputs field circuitry.
- Individual channel fusing to eliminate a single point of failure at each input sensing circuit.

- Isolation diode at contact power feed to eliminate a single point of failure within the personality module circuitry.
- Electronic ID, identifying module type, group, serial number, and revision.
- Hot-swapping capability.
- Modules operate in pairs (redundant mode). Pairs of modules used in redundant mode must be located in two independent branches at the same height offset.
- Field termination at one set of I/O terminal blocks per redundant pair.
- LEDs indicate the status of each input contact state.
- Electronic ID information stored in logic card EEPROM.
- The I/O base unit provides the electronics module with redundant +24 VDC power supply feeds.

6.2.1 Electronics modules (Emod) - (RDI)

- **5X00411G01** Provides 16 redundant 24VDC IEC 61131-2 Compliant, Type 1 differential current sinking inputs with individual channel fusing (non-user serviceable).

6.2.2 Personality modules (Pmod) - (RDI)

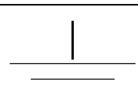
- **5X00414G01** Front end connections, auxiliary power surge protection, and module fuse protection for the 24V common power.

6.2.3 Subsystems - (RDI)

Redundant Digital Input subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24 V (Single Ended) Digital Input current sinking, IEC 61131-2 Compliant Type 1 digital Inputs.	16	5X00411G01	5X00414G01

6.2.4 Terminal block wiring information - (RDI)

ABBREVIATION	DEFINITION
1+ through 16+	Digital input positive terminal connection
1- through 16-	Digital input negative terminal connection
	Earth ground terminal
PS+, PS-	Auxiliary Power Supply terminals
RSV	Reserved terminal.

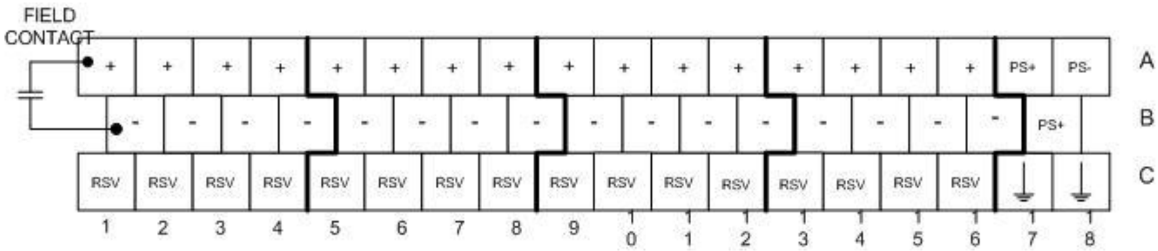


Figure 60: 5X00411 Terminal_Block

<notes> No external connections are to be made to any base unit terminal labeled RSV.
For DI module redundancy, field wiring is only connected to the base unit terminals of one DI module in the redundant pair.
Unlike the DI module field signal terminations, DI module auxiliary voltage connections must be made to both redundant DI modules' base unit terminal blocks either through the normal auxiliary branch traces or via external power supply connections through terminals A17 and A18.

For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See Marshaling Base Unit *(see page 35) for more information.*

6.2.5 Field connection wiring diagrams - (RDI)

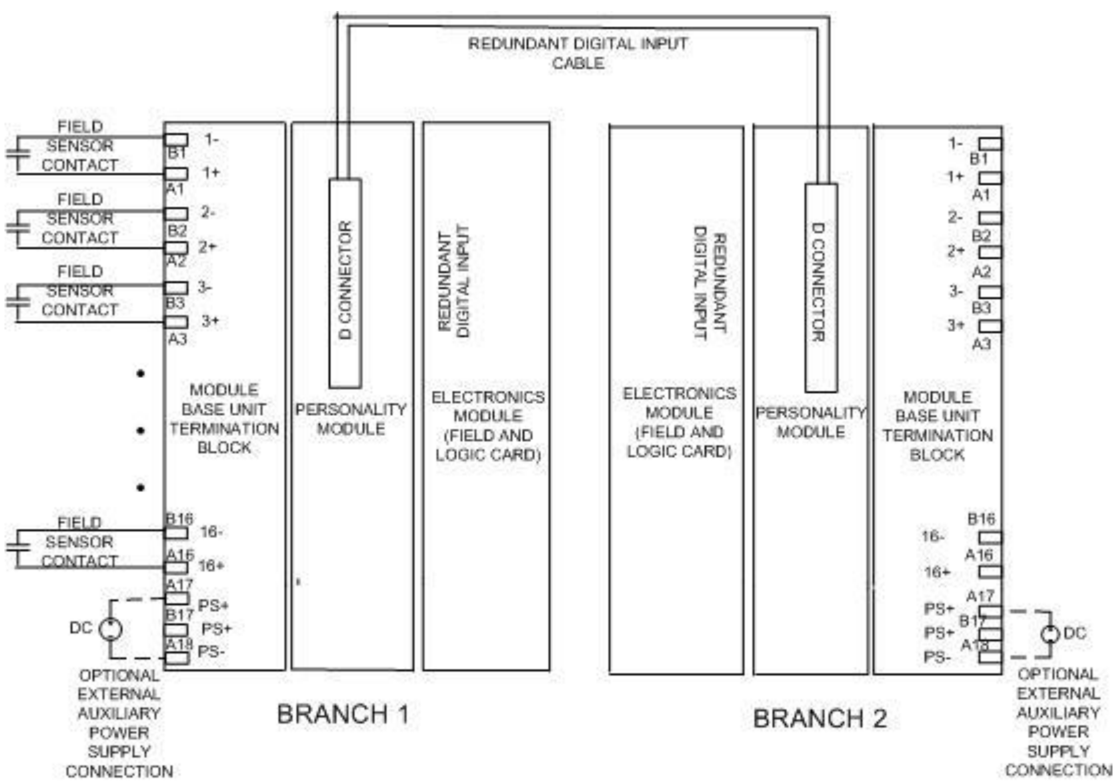


Figure 61: Redundant Current-Sinking Single-Ended Digital Inputs

The "+" inputs are actually the module field card's fused Auxiliary power supply positive rail. Channel 4 through 15 input terminals not shown for clarity purposes.

The auxiliary power supply voltage may be derived either from the base unit backplane's printed circuit card auxiliary voltage traces or from an optional external auxiliary power supply.

1. To use the base unit backplane's printed circuit backplane Auxiliary voltage, do not connect an external power supply to the base unit termination block PS+ and PS- terminals since the base unit backplane's Auxiliary voltage automatically appears at these terminals.

   The two plug-in branch Aux. fuses must be installed into their sockets located on the Controller backplane or on the transition panel to which the module's base unit branch interfaces.

2. To use an external 24 VDC auxiliary power supply, connect the power supply "+" and "-" terminals to the base unit PS+ and PS- terminals as shown. This connection will force all modules on this branch to use the external auxiliary power supply voltage.

   The two plug-in branch Aux. fuses must be removed from their sockets located on the Controller backplane or on the transition panel to which the module's base unit branch interfaces.

Note: *No other external power supplies may be connected to other base unit termination block PS+ or PS- terminals located in the same branch. A common external power supply must include discrete wiring from the power supply to each t/o base for the Redundant Digital Input pair.*

6.2.6 Cable assembly routing - (RDI)

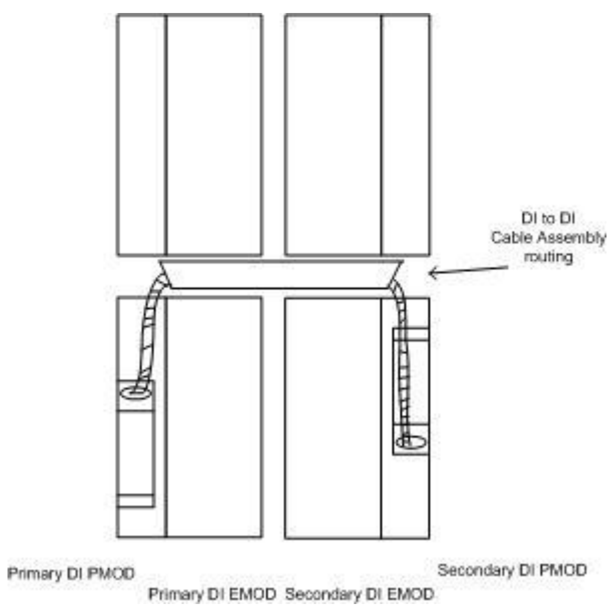


Figure 62: Redundant Interface Cable

The FDR also includes a cross cable in place circuit to detect the presence of the redundancy cable when utilized in a redundant configuration. This circuit accepts the cross cable power signal from the redundant module and sinks this to ground through the front end of an opto-coupler circuit. The circuit is a duplicate schematic of the blown fuse detection circuit described above with differing connection signals “Cross Cable Power In” and “Cross Cable In Place”. If the module is configured for redundancy and the cross cable is not in place, this will generate an attention status to the Controller from the module which does not have field wiring attached.

6.2.7 Module block diagrams - (RDI)

The Redundant Digital Input Electronics Module consists of a LSW logic card and a FDR field Card. The LSW logic card interfaces to the I/O bus through the Ovation base unit backplane from which it accesses the Ovation serial I/O data bus (serial data and clock signals), base address, and redundant +24 VDC power supplies. The LSW logic card connects to the field card through a pair of inter-card connectors.

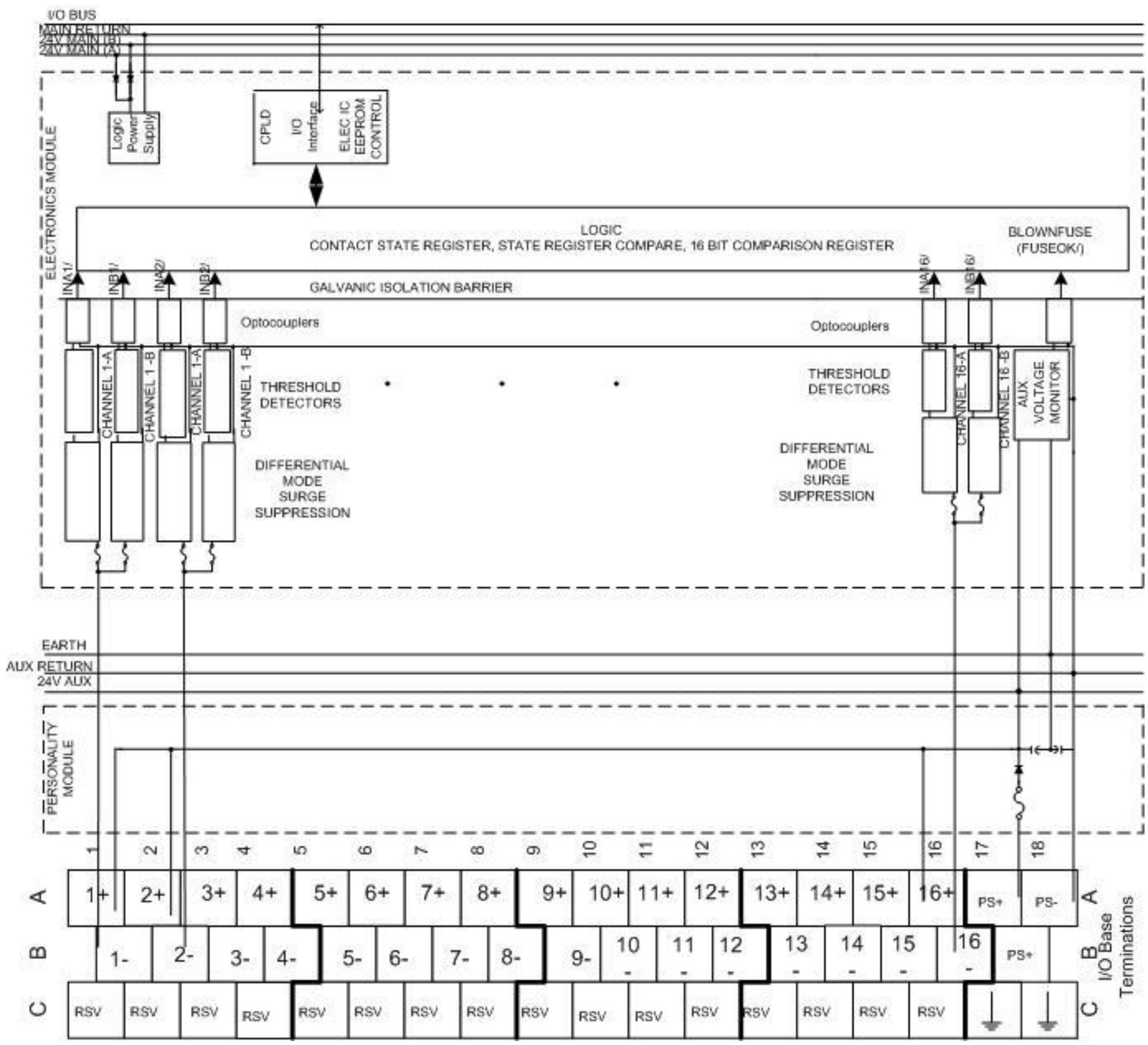
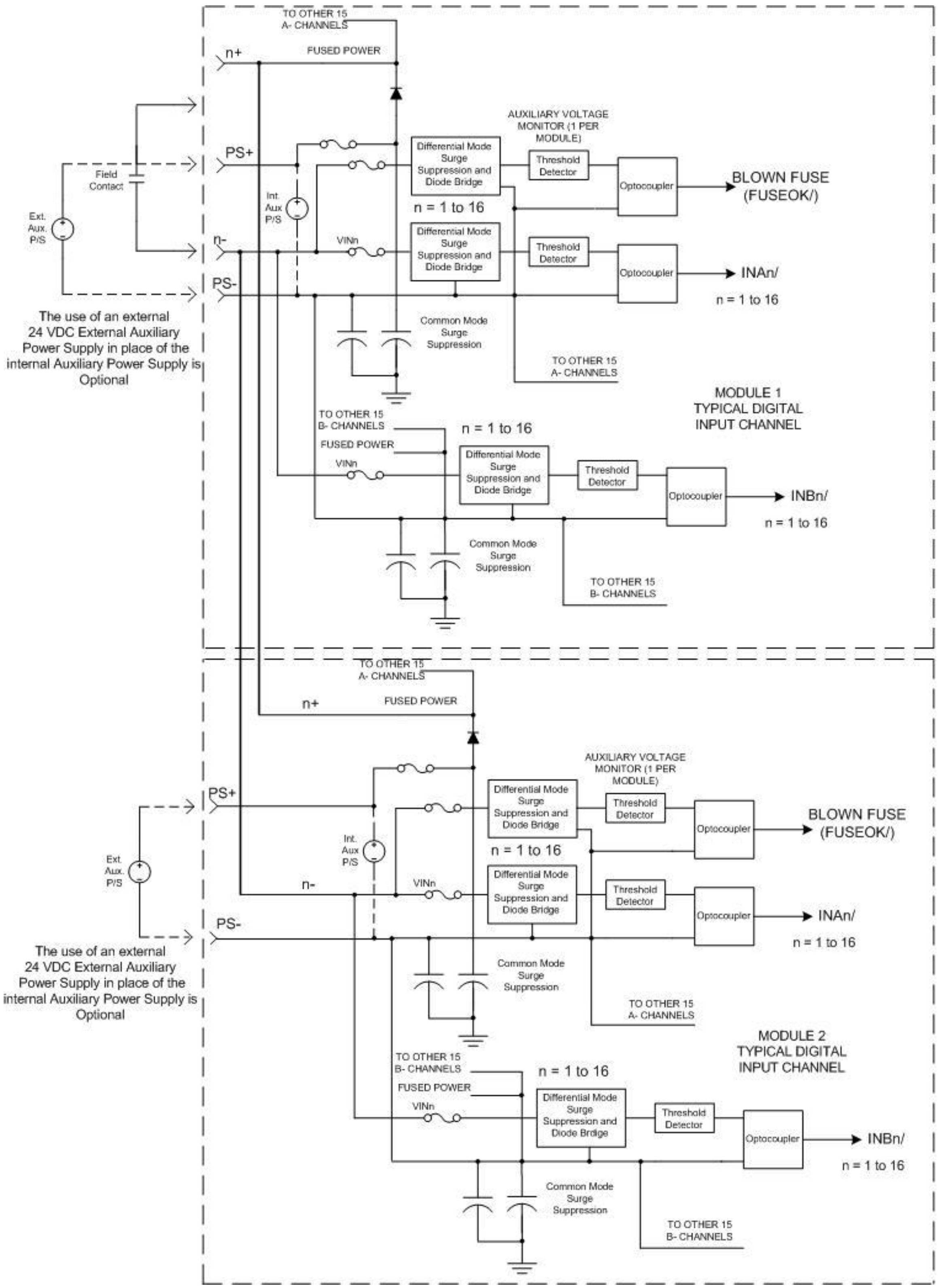


Figure 63: 5X00411 Block Diagram

6.2.8 Functional block diagram - (RDI)

The FDR contains 16 channels where each channel has duplicate voltage level sensing circuitry used to detect whether an input is on “1” or off “0”. Individual redundant module channels include surface mount fusing for fault isolation in the event of an individual channel failure. The LSW contains the communications circuitry needed to send the input status information back to the Controller and allow channel comparison for sensing a mismatch situation and issue a module attention status to the Controller.

The Redundant Digital Personality Module provides front-end signal connections along with module fuse protection for overall module powering. Additionally, this board provides auxiliary power surge protection. The PDR configures the FDR to handle 16 single-ended digital inputs. It also provides a 37 position D-shell connector for redundancy purposes. The D-shell connector is used to terminate a cable assembly in redundant module configurations linking two Redundant Digital Input modules personality cards together. Both modules access a common group of sixteen input channels via the cable assembly with one set of field terminations landed at one base assembly.


TO OTHER 15
A- CHANNELS
n+
FUSED POWER
AUXILIARY VOLTAGE
MONITOR (1 PER
MODULE)
PS+
Field
Contact
Differential Mode
Surge
Suppression and
Diode Bridge
Threshold
Detector
Optocoupler
BLOWN FUSE
(FUSEOK/)
Ext.
Aux.
P/S
Int.
Aux
P/S
n = 1 to 16
n-
VINn
INAn/
PS-
n = 1 to 16
The use of an external
24 VDC External Auxiliary
Power Supply in place of the
internal Auxiliary Power Supply is
Optional
Common Mode
Surge
Suppression
TO OTHER 15
A- CHANNELS
MODULE 1
TYPICAL DIGITAL
INPUT CHANNEL
TO OTHER 15
B- CHANNELS
FUSED POWER
INBn/
TO OTHER 15
B- CHANNELS
MODULE 2
TYPICAL DIGITAL
INPUT CHANNEL
Differential Mode
Surge
Suppression and
Diode Brdige

6.2.9 Signal propagation delay - (RDI)

FDR card signal propagation delay.

This is the typical time elapsed from the time that a field contact opens or closes until the time that associated channel's output signal (INn/ where n = 1 to 16) changes states. Assumes a 1 foot (0.305 m) long test cable.

INPUT	DELAY TIME FOR	DELAY TIME FOR
voltage level	contact opening	contact closing
24 VDC	0.03 msec. typ.	0.1 msec. typ.

There is an additional propagation delay due to field cable capacitance charging when the field contact opens. This delay is per 1,000 feet of field cable and assumes a 30 pF/foot cable capacitance.

Note: *There is no additional propagation delay to consider when the field contact closes.*

INPUT	ADDITIONAL DELAY TIME FOR
voltage level	contact opening
24 VDC	0.06 msec. typ.

The minimum allowed sum of the combined field cable resistance plus the field contact leakage resistance assumes that the Auxiliary power supply voltage is its Maximum allowable value (30 VDC for 24 VDC inputs).

INPUT	MINIMUM FIELD CABLE RESISTANCE PLUS THE FIELD CONTACT LEAKAGE RESISTANCE VOLTAGE LEVEL
24 VDC	100 Kohm

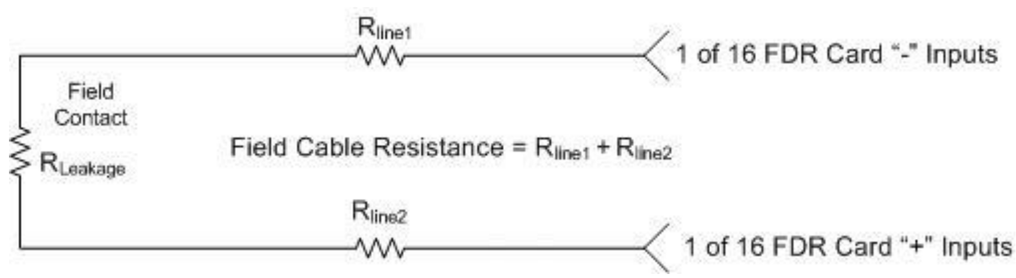


Figure 64: Redundant DI Field Cable Resistance

If a channel's field cable resistance plus the contact leakage resistance is less than the value specified above, the channel may report that its field contact state is closed even though the field contact is actually open.

6.2.10 Voltage-current curve - (RDI)

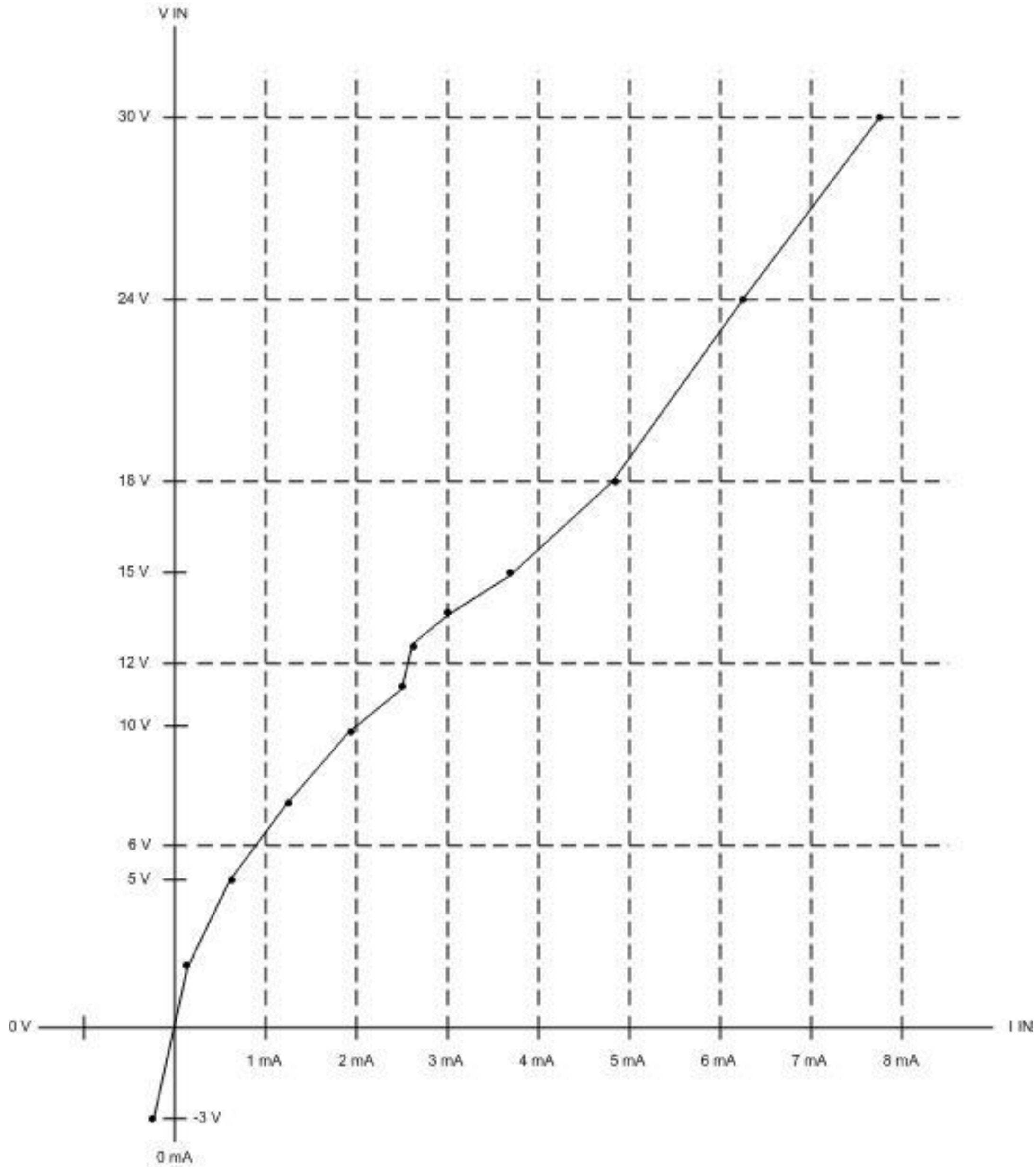


Figure 65: (FDR) Current-sinking Digital Input Voltage/Current Curve

6.2.11 Switching Input Voltage Current Curve - (RDI)

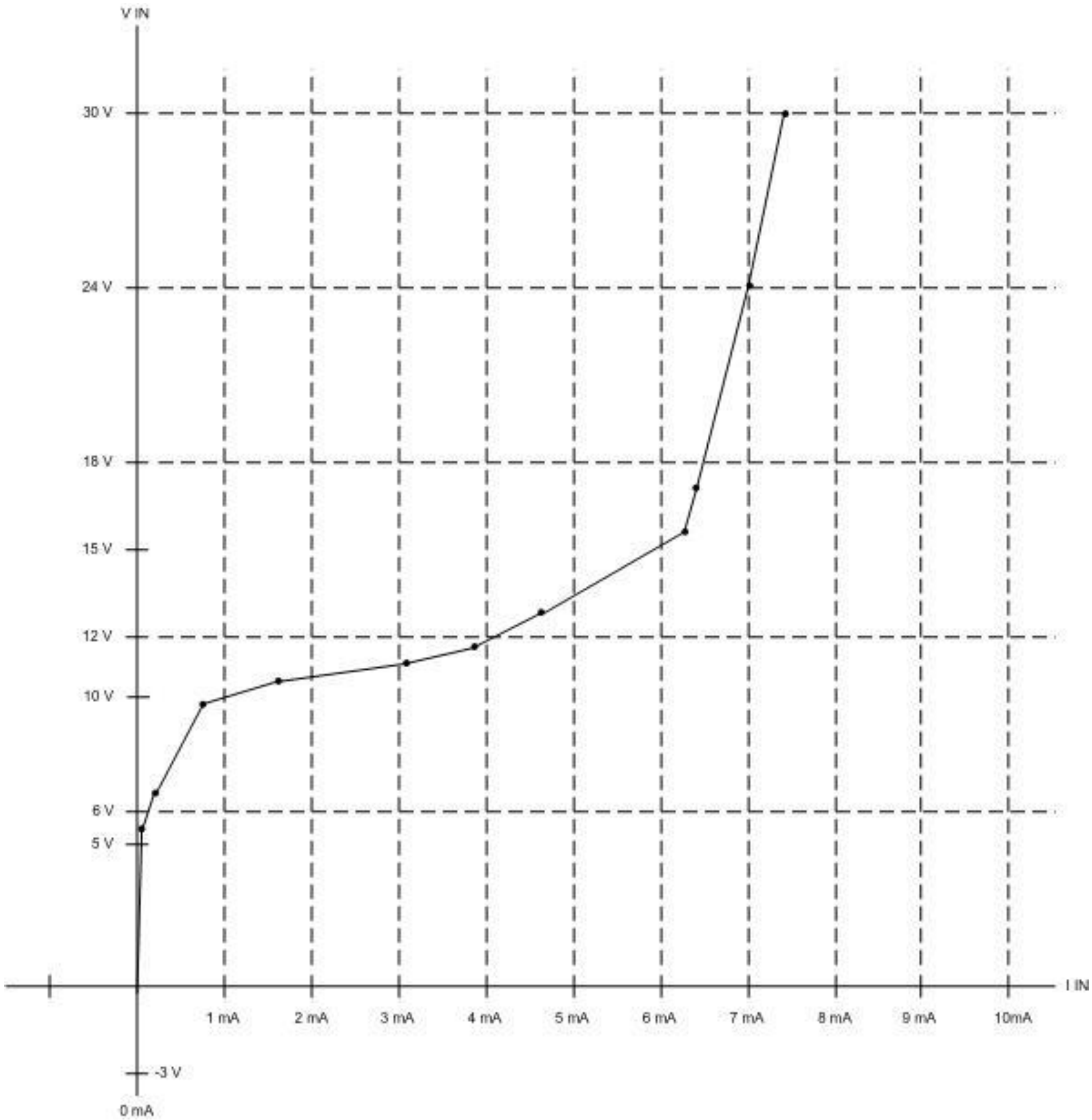


Figure 66: Switching Input Voltage Current Curve (Redundant Mode)

6.2.12 Logic Card Digital Debounce Filter Propagation Delay - (RDI)

LSW Card Propagation Delay – Field card output to Point Data Register:

3.75 msec. Min.
4.0 msec. typ.
4.25 msec. Max.

LSW Card Digital Debounce Circuit Delay Time:

4.0 msec. typ.

Any module digital input state change time that is less than the LSW card Digital Debounce time will be rejected by the module and will not appear in the Point Data Register.

Module Channel Mismatch Digital Debounce

Channel mismatch digital debounce between redundant I/O channels on the module (Channel A and Channel B) to comparison register C.

Total Module Response Time

The following chart lists the typical time that a digital input state change takes to propagate through the field card and the logic card to the module's Point Data Register. A 1 foot (0.305 M) long field cable is assumed.

Module Assembly Group	"1" – Closed to "0" – Opened Transition	"0" – Open to "1" – Closed Transition
Group 1 – 24 VDC Digital Inputs	4.1 msec. typ.	4.03 msec. typ.

6.2.13 Register configuration/address information - (RDI)

The Module Configuration Register is module I/O register 13 (0xD) and is a write register. The register bit assignments are defined in the Table below.

Bit	Function
0	1 = Configure. 0 = Unconfigure, causing an attention status.
1	1 = Force an attention status to be read by the controller. 0 = No Forced Error.
2 - 5	Not defined.
6	Allow asserted field card BLOWN FUSE signal to illuminate the module E LED and to force a module attention status. 1 = Enable Blown Fuse detection. 0 = Disable field detection circuitry.
7 - 12	Not defined.
13	1= Field Cabling Attached to this module.
14	Not defined.

BIT	FUNCTION
15	1 = Set as a Redundant Module. 0 = Set as a Non-Redundant Module.

The Redundant Digital Input module will not store point data until configured. The point data registers are valid and available as soon as the module is configured.

Electronics modules should have the Module Configuration register bits 6 & 15 set as appropriate and desired during module configuration:

The Module Status Register is module I/O register 13 (0xD) and is a read register. The register bit assignments are defined in the Table below

BIT	FUNCTION
0	1 = configured. 0 = not configured.
1	1 = Forced error set by controller. 0 = No forced error.
2 - 5	Not defined. 1 = permanent value.
6	1 = Blown fuse detection is enabled. 0 = Blown fuse detection is disabled.
7	1 = Fuse blown [1]. 0 = Fuse OK .
8	0 = permanent value.
9	Cross Cable Absent = 1, Set to 0 when Non-redundant Module [2]
10	0 = permanent value.
11 - 12	Not defined. 1 = permanent value.
13	1 = Field Cable Attached to this module selected. [4].
14	Channel Comparison Fault [3].
15	1= Redundant Module Selected 0 = Non-Redundant Module Selected [5].

[1] when configured for blown fuse detection and true this will cause an attention status to the Controller.
[2] When the module is not configured for redundancy this bit is set to a permanent value of 0. When the module is configured for redundancy and the cross cable is not in place, this will cause an attention status to the Controller.
[3] These bits indicate that one of the on-board redundant channels A & B do not match one another. Each bit corresponds to one of 16 board channels respectively. When configured for the redundant mode a channel comparison fault will produce an attention status. When configured for non-redundant mode a channel comparison fault will NOT produce an attention status.
4 This bit indicates a read back of the configuration setting at offset 13 reg D. It indicates that the field cabling will be attached to this module. When this bit is set , removal of the cross connect cable will not produce attention status and the module will allow controller access of the channel registers. If this bit is not set, indicating field cabling is not connected, then any module read will produce attention status when the cross connect cable is removed.
[5] If the bit is set and one of the on board redundant channels A & B do not match one another, then any module read will produce attention status.
Bits 9 and 13 are irrelevant when the module is configured for non-redundant applications.

The Comparison Register is module I/O register C and is a read register. The register bit assignments are defined in the Table below.

Note: *This is the resultant comparison when examining channel register A & B respectively on this module.*

BIT	FUNCTION
0 - 15	1 = Channel 1 - 15 of Group A and Group B are different. 0 = Channel 1 - 15 of Group A and Group B are the same.

The watchdog timer illuminates the internal fault LED if the I/O Controller fails to access the Redundant Digital Input Module within the timeout period listed below.

MINIMUM TIMEOUT PERIOD	NOMINAL TIMEOUT PERIOD	MAXIMUM TIMEOUT PERIOD
1.1 sec.	1.6 sec.	2.1 sec.

The Point Data for Channel Group A Register is module I/O register 0 and is a read register. The register bit assignments for a current-sinking digital input field card are defined in the table below.

Note: *This is the first of the pair of channels located on this module.*

BIT	FUNCTION
0 - 15	Channel 1 - 15 of Group A field contact is closed

The Point Data for Channel Group B Register is module I/O register 1 and is a read register. The register bit assignments for a current-sinking digital input field card are defined in the table below.

Note: *This is the second of the pair of channels located on this module.*

BIT	FUNCTION
0 - 15	Channel 1 - 15 of Group B field contact is closed

6.2.14 Blown Fuse Detection - (RDI)

The FDR has a 17th channel used to monitor the presence of the wetting supply for single ended digital inputs as shown in Module block diagrams for the Redundant Digital Input module (see page 196). It is identical to a typical digital input channel except that the normal mode surge suppression components are located on the personality module PDR and no output voltage comparator is employed and capacitor C3 is added to the circuit output. C3 acts as a noise filter because the auxiliary voltage monitor circuit output does not provide an input to a four millisecond digital filter as do the outputs of the sixteen digital input channels. Two cases cause this monitor circuitry to report a blown fuse status and issue an attention status to the Controller:

- Fuse is blown on PDR.
- Wetting supply level is lower than minimum On Input Voltage for the FDR.

6.2.15 Cross Cable in Place Circuit - (RDI)

The FDR also includes a cross cable in place circuit to detect the presence of the redundancy cable when utilized in a redundant configuration. This circuit accepts the cross cable power signal from the redundant module and sinks this to ground through the front end of an opto-coupler circuit. The circuit is a duplicate schematic of the blown fuse detection circuit described above with differing connection signals “Cross Cable Power In” and “Cross Cable In Place”. If the module is configured for redundancy and the cross cable is not in place, this will generate an attention status to the Controller from the module which does not have field wiring attached.

6.2.16 Diagnostic Logic card LEDs - (RDI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED is Lit when: ▪ The Blown Fuse bit (Bit-7) of the Module Status Register is set. This indicates that the external wetting supply fuse on the FDR has blown or the wetting supply is not present or below its acceptable threshold. ▪ The Cross cable is not in place when configured for redundant configurations (Status Register Bit 9).
I (Red)	The Internal Fault LED (LE17) is lit under the following conditions: ▪ The Force Error bit (Bit-1) of the Configuration Register is set. ▪ The Ovation Controller is not communicating with the Ovation Redundant Digital Input electronics module. ▪ One of the 16 channels in comparison register do not match one another. This is derived from the comparison register (CH).
1 - 16 (Green)	Each of the sixteen channel LEDS (LE16- LE1) is guaranteed to light when the input voltage of the LED's corresponding channel is greater than the channel's minimum On Input Voltage. Reference in Specifications -(RDI) (see page 205) for voltage levels.

6.2.17 Specifications -(RDI)

- **Electronics module (5X00411G01)**
- **Personality module (5X00414G01)**

DESCRIPTION	VALUE
Voltage Category:	24 VDC.
Reverse Polarity Protection	Yes, each channel incorporates a front-end diode bridge.
Operating Voltage:	15 to 30 VDC.
Input Voltage For “1” Signal For “0” Signal	 15 to 30 VDC. -3 to 5 VDC.
Input Current: For “1” Signal	4 mA typ. per Channel – (Includes Channel A & B per Channel). 5.2 mA Max per Channel – (Includes Channel A & B per Channel).

DESCRIPTION	VALUE
Input Current Fuse Monitor: Aux present	2 mA typ 2.6mA Max.
Input Current Cross Cable: Cable Present	2 mA typ. 2.6mA Max.
Input Characteristic:	IEC 61131-2, Type 1.
Number of Input Channels:	16
Channels per Common:	16
Galvanic isolation: Between channels and I/O Bus Between channels	 Yes. No, Single-ended PMOD.
Current drawn: From I/O Bus Base Unit 24 V Main Power	 45 mA typ. for all inputs off – Channels A & B. 75 mA typ. for all inputs on.
Power dissipation of module: (sum of 24 V Main Power and 24 V field channel power)	 1.08 W typ. for all inputs off. 3.43 W typ. for all inputs on.
Status Display	Green LED per channel. LEDs located in non-galvanically isolated logic card circuit.
Diagnostic Function	Blown fuse detection monitor circuit for auxiliary contact power status located on FDR board.

Environmental Specifications

TYPE	DESCRIPTION
Ambient Air Temperature	The operating ambient air temperature range is from 0° C to 60° C. The temperature is measured approximately 0.5 inches from any point on the module while it is mounted in its normal vertical or horizontal position, and while subject to the air movements which result from natural convection only (that is, no forced air movement).
Humidity (non-condensing)	The humidity range is from 0% to 95% relative humidity, non-condensing, through an ambient air temperature range of 0°C through 60°C, but with a Maximum wet bulb temperature not over 35°C (95°F).
Vibration	The module shall remain operational while subject to testing defined in IEC 68-2-6 over the following curve: 0.15mm displacement from 10 to 57 Hz and 2G's from 57 to 500 Hz, when attached to a properly mounted DIN rail.
Shock	The module will remain operational and reliable after being subjected to testing defined in IEC 68-2-27 over the following curve: 15 G's for 11 milliseconds and 1/2 sine wave.
Power Supply Voltage	Minimum Nominal Maximum Main Primary Voltage: 21.0 V 24.0 V 25.0 V Main Secondary Voltage: 21.0 V 24.0 V 25.0 V The two main supply voltages are the redundant power feeds to the electronics module and are diode auctioneered on the electronics module's logic card.

6.3 Compact Digital Input module - (CompactDI)

The Compact Digital Input module contains 16 channels where each channel has voltage level sensing circuitry used to detect whether an input is on or off. The input voltage level sensed by the module is determined by the particular card group of the module.

The module is available for three options:

- 16 galvanically isolated differential inputs (unfused) (24/48 VAC/VDC or 125 VAC/VDC).
- 16 single-ended (common return) digital inputs with a common fuse and on-card blown fuse detection for the auxiliary power supply (24/48 VDC).
- 16 individually fused digital inputs using a common power supply. Blown fuse detection is not available with this option (24/48 VDC or 24 VAC or 125 VAC/VDC).

Refer to the following cross references for information concerning:

- Field side circuitry for the single-ended configuration (see page 210).
- Circuitry information for the differential configuration.
- Field side circuitry for the 16 individually fused configuration.

An input resistor provides the normal mode surge protection and limits the current during normal operation. An opto-isolator provides high dielectric isolation between the field side and the logic or I/O bus side.

The Single-Ended Digital Input configuration has a circuit used to monitor the presence of the auxiliary supply (blown fuse detection). Two events cause this monitor circuitry to report a blown fuse status and issue an attention status to the Ovation Controller:

- Fuse is blown on the Electronics module.
- Auxiliary supply level is lower than minimum On Input Voltage.

In addition, a cavity insert that includes a wiring diagram is available for placement in the Personality module cavity in the Base Unit in all configurations except the 16 point individually fused option which requires a personality module (5X00034). The Compact Digital Input module is a CE Mark certified module.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

6.3.1 Electronics modules (Emod) - (CompactDI)

- **1C31232G01** provides for 24/48 VDC single-ended inputs.
- **1C31232G02** provides for 24/48 VDC or 24 VAC differential inputs and supports the 16 point individually fused option.
- **1C31232G03** provides for 125 VAC/VDC differential inputs and supports the 16 point individually fused option.

6.3.2 Personality modules (Pmod) - (CompactDI)

- **5X00034G01** provides for 16 point individual fusing with a common supply.

  This is an optional Personality module that is available for use with the differential input Electronics modules (1C31232G02, 1C31232G03) for applications requiring individual point fusing with a common supply.

Note: *This Personality module is not available for use with the Single-Ended Compact Digital Input electronics module 1C31232G01. In the event that individual fusing is not required, a cavity insert (1C31238H01) is available that fits into the Personality module cavity in the Base Unit and provides wiring information.*

6.3.3 Subsystems - (CompactDI)

Compact Digital Input subsystems

RANGE [1]	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE OR CAVITY INSERT [2]
24/48 VDC Single-ended	16	1C31232G01	1C31238H01 (molded plastic cavity insert)
24 VAC/VDC Differential 48 VDC Differential	16	1C31232G02	5X00034G01(Fused Pmod) 1C31238H01 (molded plastic cavity insert)
125 VAC/VDC Differential	16	1C31232G03	5X00034G01 (Fused Pmod) 1C31238H01(molded plastic cavity insert)

[1] All module configurations listed in the table are CE Mark Certified.
[2] This is an insert that fits into the Personality module position and provides a wiring schematic label for the module.

When the 125VAC/VDC Compact Digital Input Emod (1C31232G03) is used in applications without the Fused Pmod (5X00034G01), additional external fusing or other current limiting devices are recommended on the hazardous inputs to provide additional protection to the external wiring and power source.

6.3.4 External Power Supply Information - (CompactDI)

The required voltage source may be obtained from the internal auxiliary power supply (backplane) or it may be obtained from an external power supply when using the following modules:

- **1C31232G01** single-ended Electronics module (configured for 16 single-ended inputs).
- **1C31232G02** or **1C31232G03** 16 point individually fused configuration Electronics modules with 5X00034 Personality module.

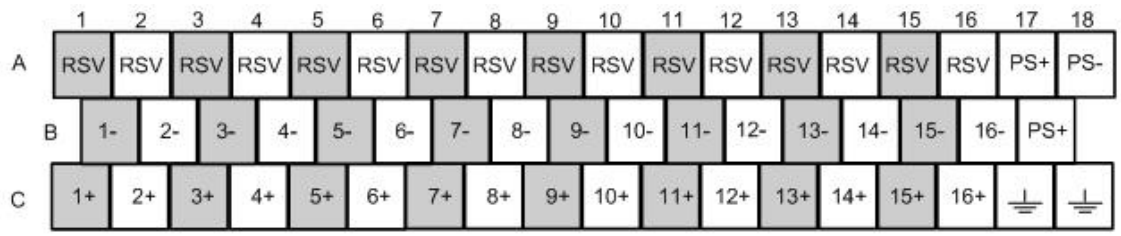
If an external power supply is used, refer to Using an External Power Supply (see page 799) which contains steps to be undertaken before connecting the external power supply to the Compact Digital Input module base unit terminal block.

6.3.5 Terminal block wiring information - (CompactDI)

The available cavity insert or Personality module has a simplified wiring diagram label on top, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

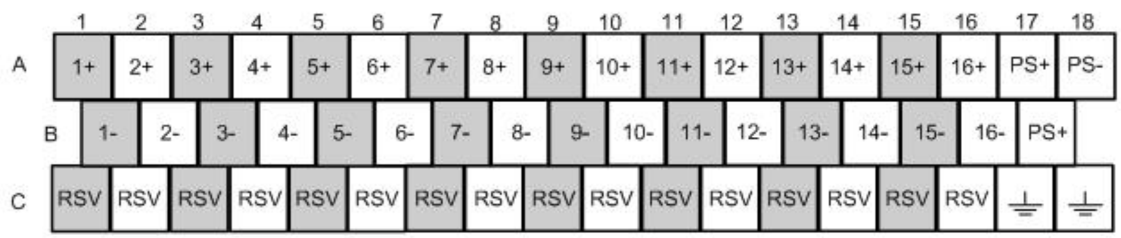
***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

The following table lists and defines the abbreviations used in the diagram.



Configuration Using the Foam Insert (16 point single-ended or differential)

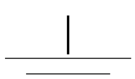
Note: On the differential modules (1C31232G02 and 1C31232G03 only), each channel has a diode bridge at the front-end. Therefore, the inputs to Row B and C are reversible.



Configuration Using the 16 Point Individually Fused Personality Module

Figure 67: Terminal Block Connections for the Compact Digital Input Module

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals
1+ through 16+	Digital input positive terminal connection
1- through 16-	Digital input negative terminal connection
PS+, PS-	Auxiliary Power Supply terminals
RSV	Reserved terminal. Do not use, except where indicated.

6.3.6 Field wiring considerations - (CompactDI)

The following minimum leakage resistances of the cable and the interface devices apply:

- 24/48VDC - 175 K ohms
- 24 VAC - 50 K ohms
- 125 VDC - 225 K ohms
- 125 VAC - 50 K ohms

CAUTION! For CE Mark certified systems: Any base unit that contains a 125VAC/DC Compact Digital Input Electronics module (1C31232G03) with cavity insert (1C31238H01) and interfaces to hazardous voltage (>30 V RMS, 42.4 V peak, or 60 VDC) must include a hazardous voltage warning label (1B30025H01) on that base unit.

Any base unit that contains a 125VAC/DC Compact Digital Input Electronics module (1C31232G03) with the individually fused Personality module (5X00034G01) and interfaces to hazardous voltage (>30 V RMS, 42.4 V peak, or 60 VDC) must include a hazardous voltage warning label (1B30025H01) on ALL base units on the branch.

Place this label in a visible location on the base unit, preferably above the spare fuse location. The project drawings must indicate this.

6.3.7 Field connection wiring diagrams - (CompactDI)

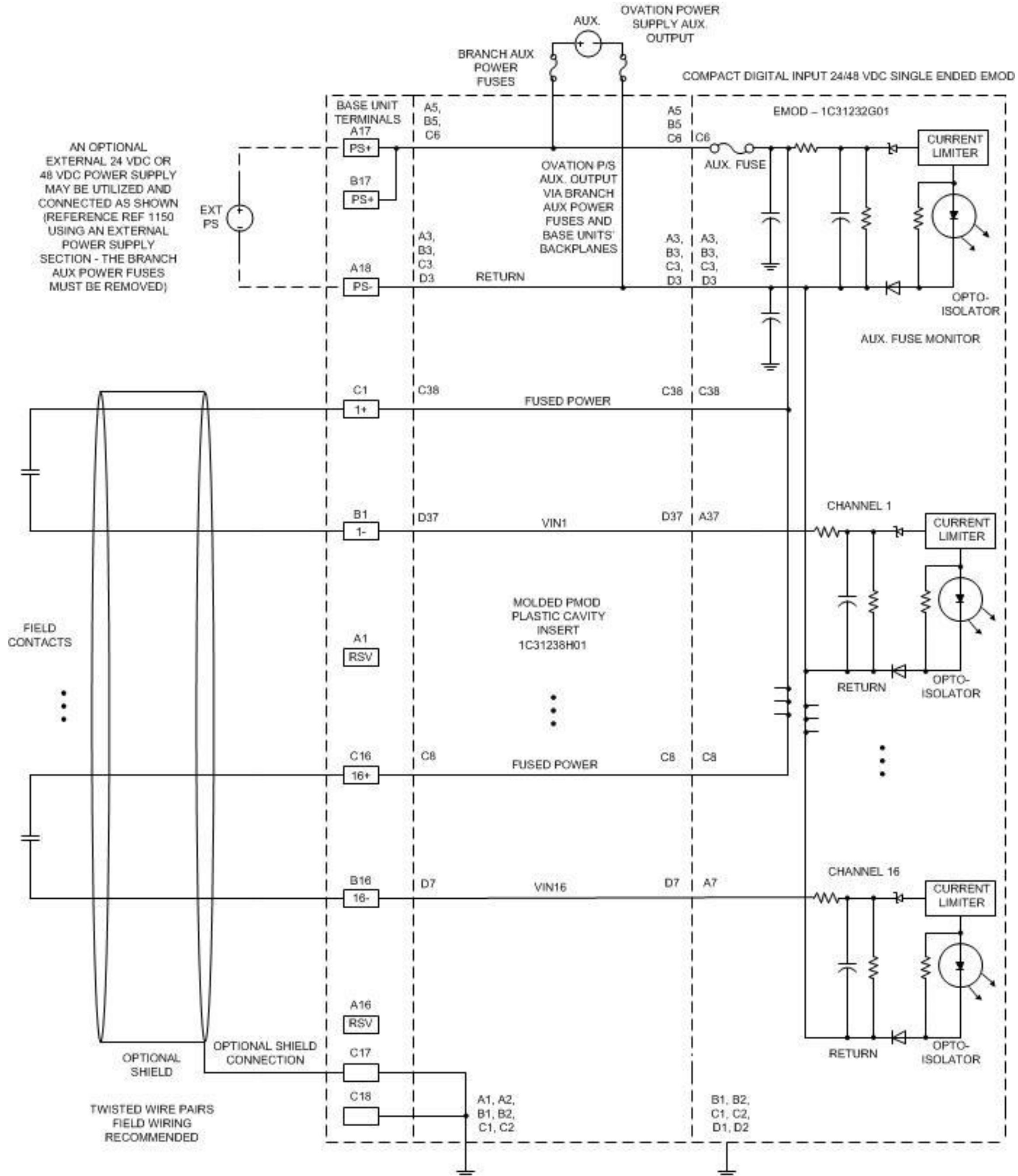
The following minimum leakage resistances of the cable and the interface devices apply:

- 24/48VDC - 175 K ohms
- 24 VAC - 50 K ohms
- 125 VDC - 225 K ohms
- 125 VAC - 50 K ohms

CAUTION! For CE Mark certified systems: Any base unit that contains a 125VAC/DC Compact Digital Input Electronics module (1C31232G03) with cavity insert (1C31238H01) and interfaces to hazardous voltage (>30 V RMS, 42.4 V peak, or 60 VDC) must include a hazardous voltage warning label (1B30025H01) on that base unit.

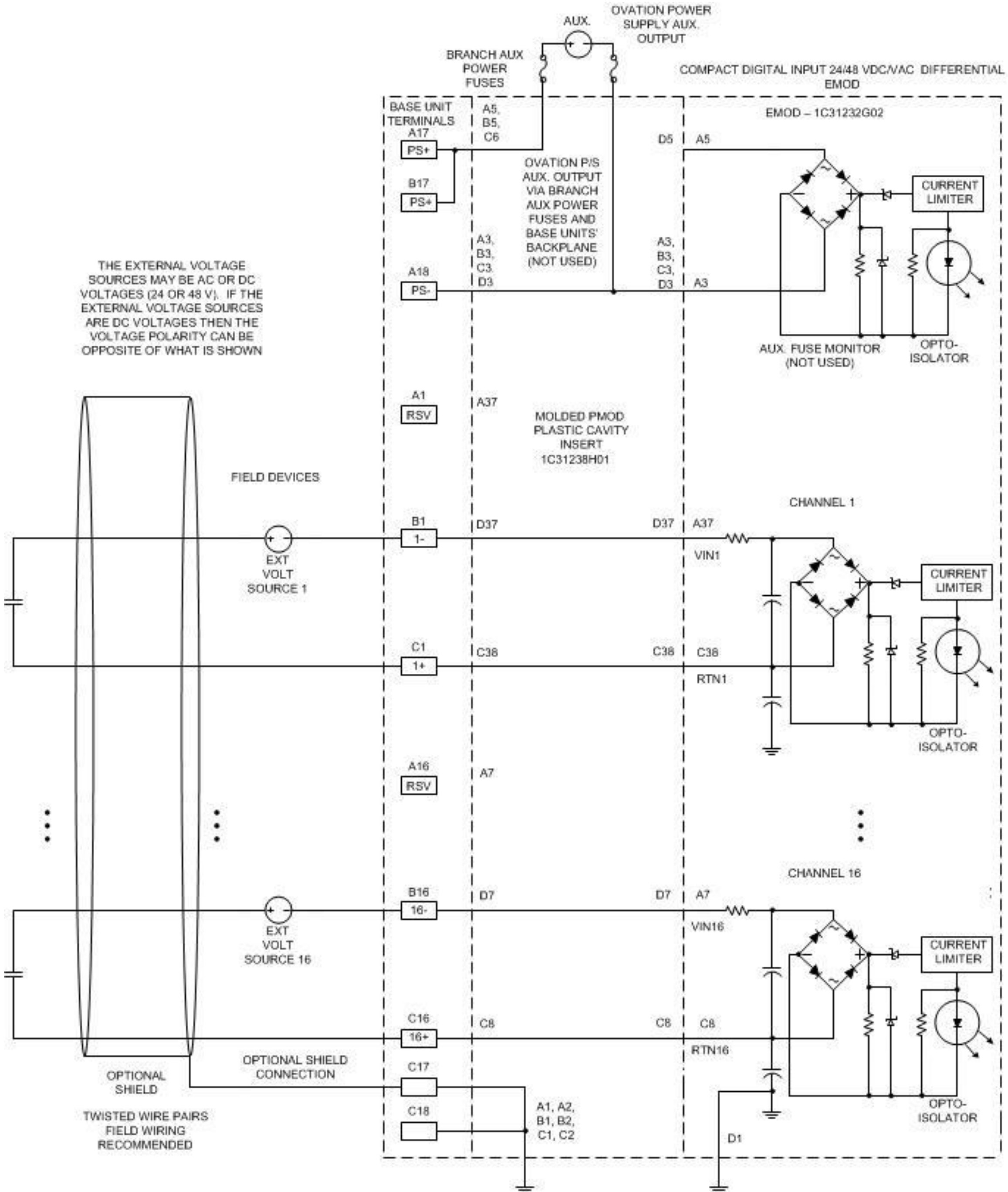
Any base unit that contains a 125VAC/DC Compact Digital Input Electronics module (1C31232G03) with the individually fused Personality module (5X00034G01) and interfaces to hazardous voltage (>30 V RMS, 42.4 V peak, or 60 VDC) must include a hazardous voltage warning label (1B30025H01) on ALL base units on the branch.

Place this label in a visible location on the base unit, preferably above the spare fuse location. The project drawings must indicate this.



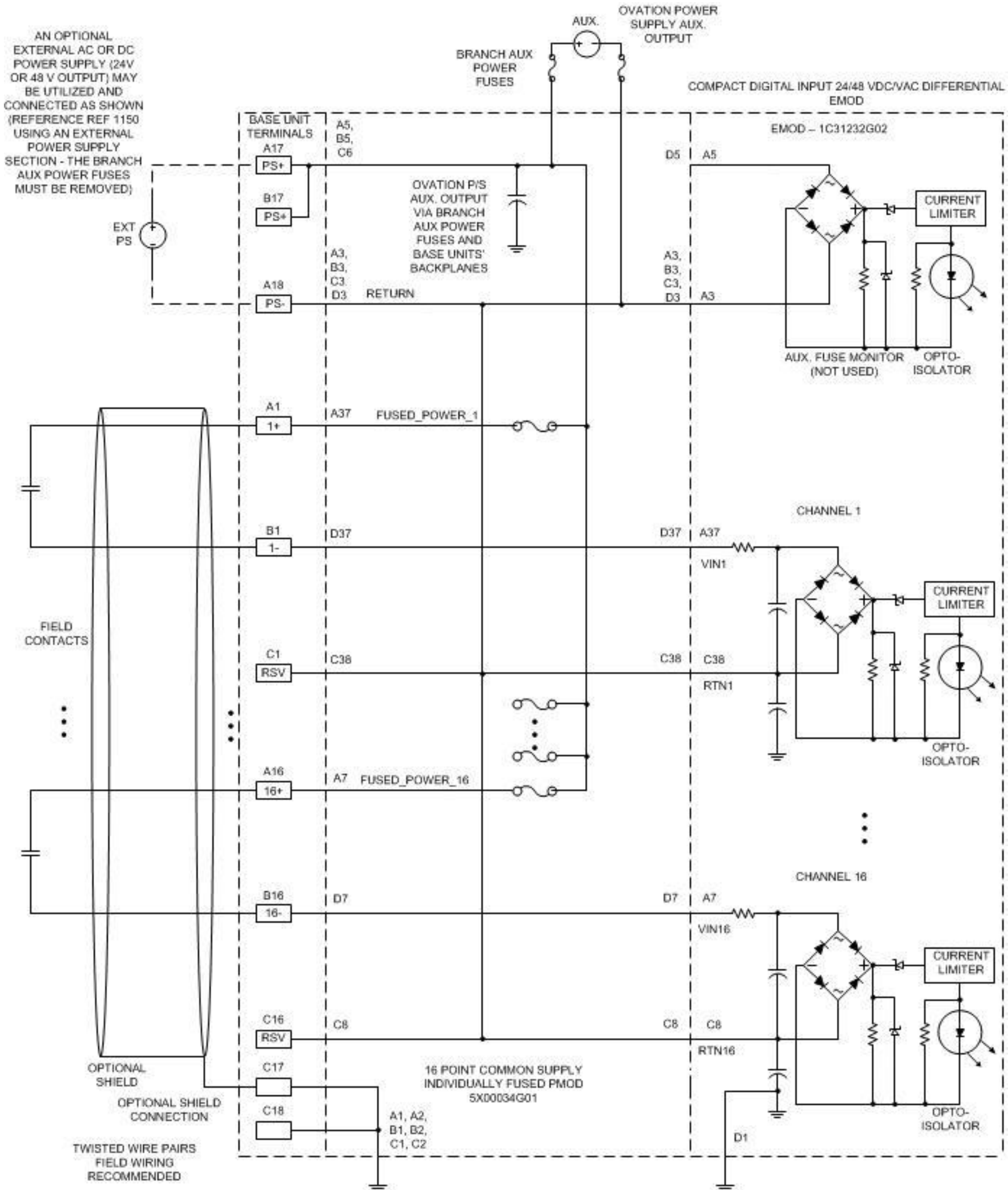
16 SINGLE ENDED (COMMON RETURN) 24/48 VDC CURRENT SINKING DIGITAL VOLTAGE INPUTS WITH COMMON FUSE AND ON-CARD AUX. POWER SUPPLY BLOWN FUSE DETECTION (DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP ONE) (NON-CE MARK)



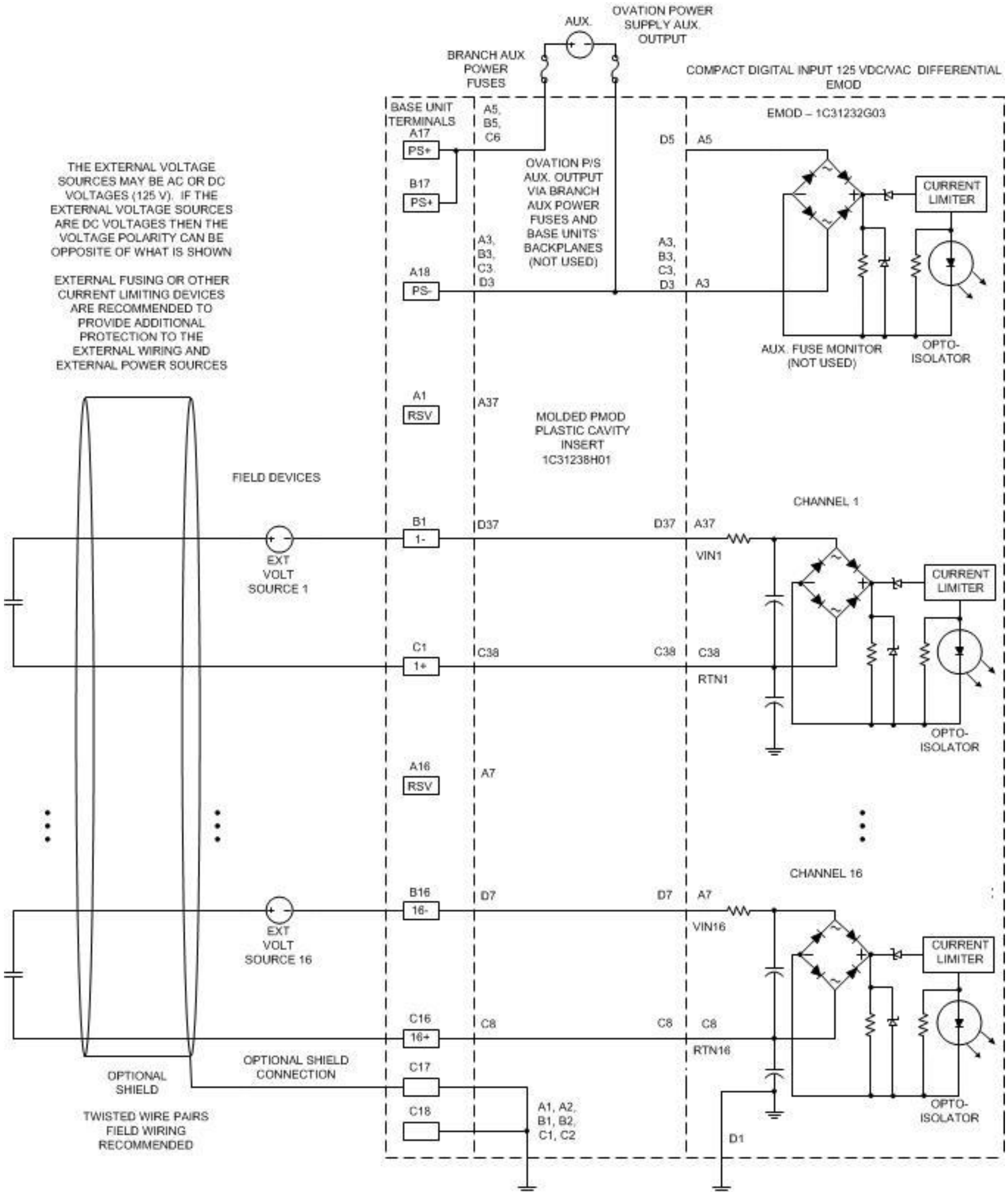
16 GALVANICALLY ISOLATED DIFFERENTIAL (UNFUSED) CURRENT SINKING 24/48 VDC/VAC DIGITAL VOLTAGE INPUTS
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP TWO) (NON-CE MARK)



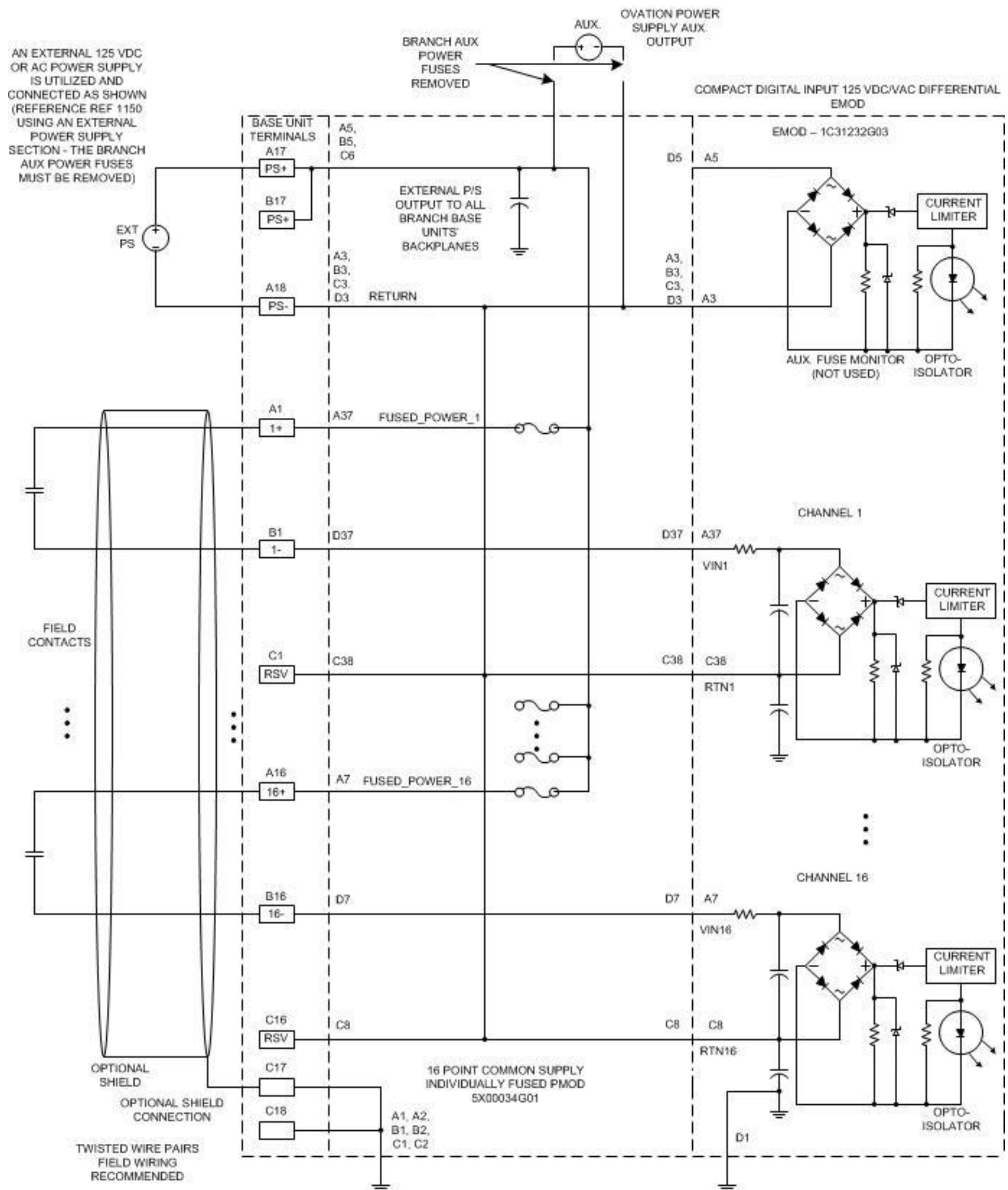
16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT SINKING 24/48 VDC/VAC DIGITAL VOLTAGE INPUTS
(NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP TWO) (NON-CE MARK)



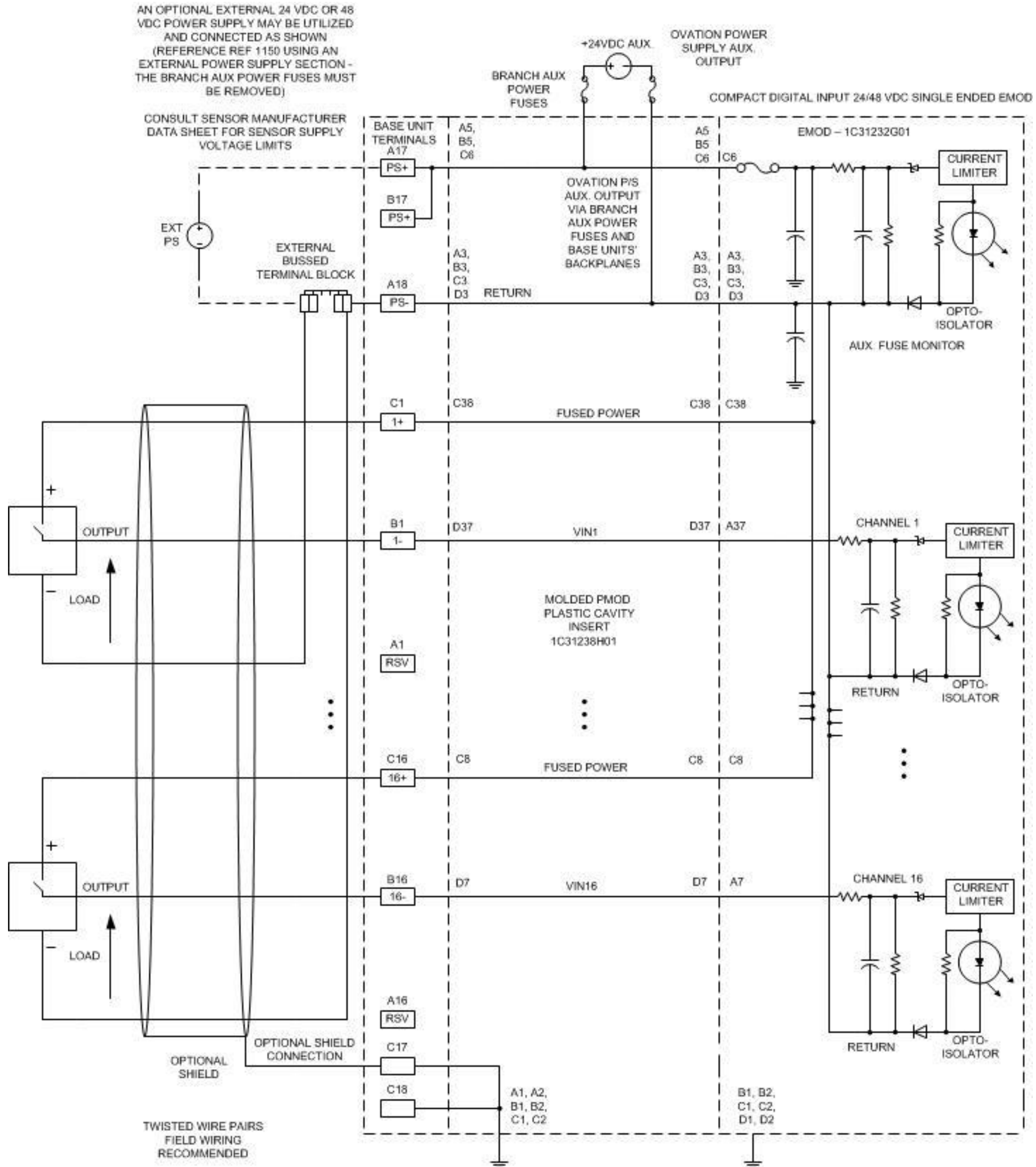
16 GALVANICALLY ISOLATED DIFFERENTIAL (UNFUSED) CURRENT SINKING 125 VDC/VAC DIGITAL VOLTAGE INPUTS
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP THREE) (NON-CE MARK)



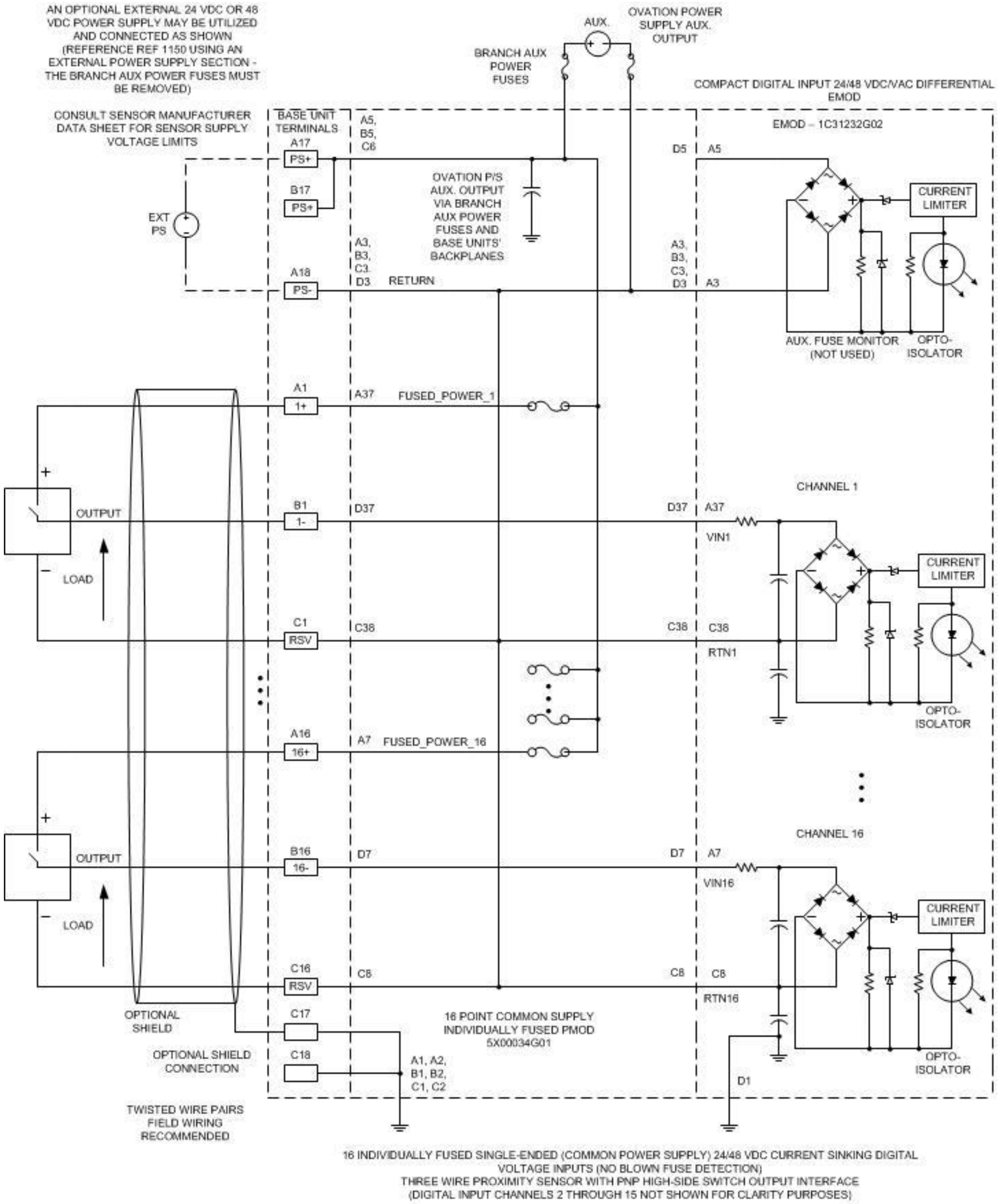
16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT SINKING 125 VDC/VAC DIGITAL VOLTAGE INPUTS
(NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP THREE) (NON-CE MARK)



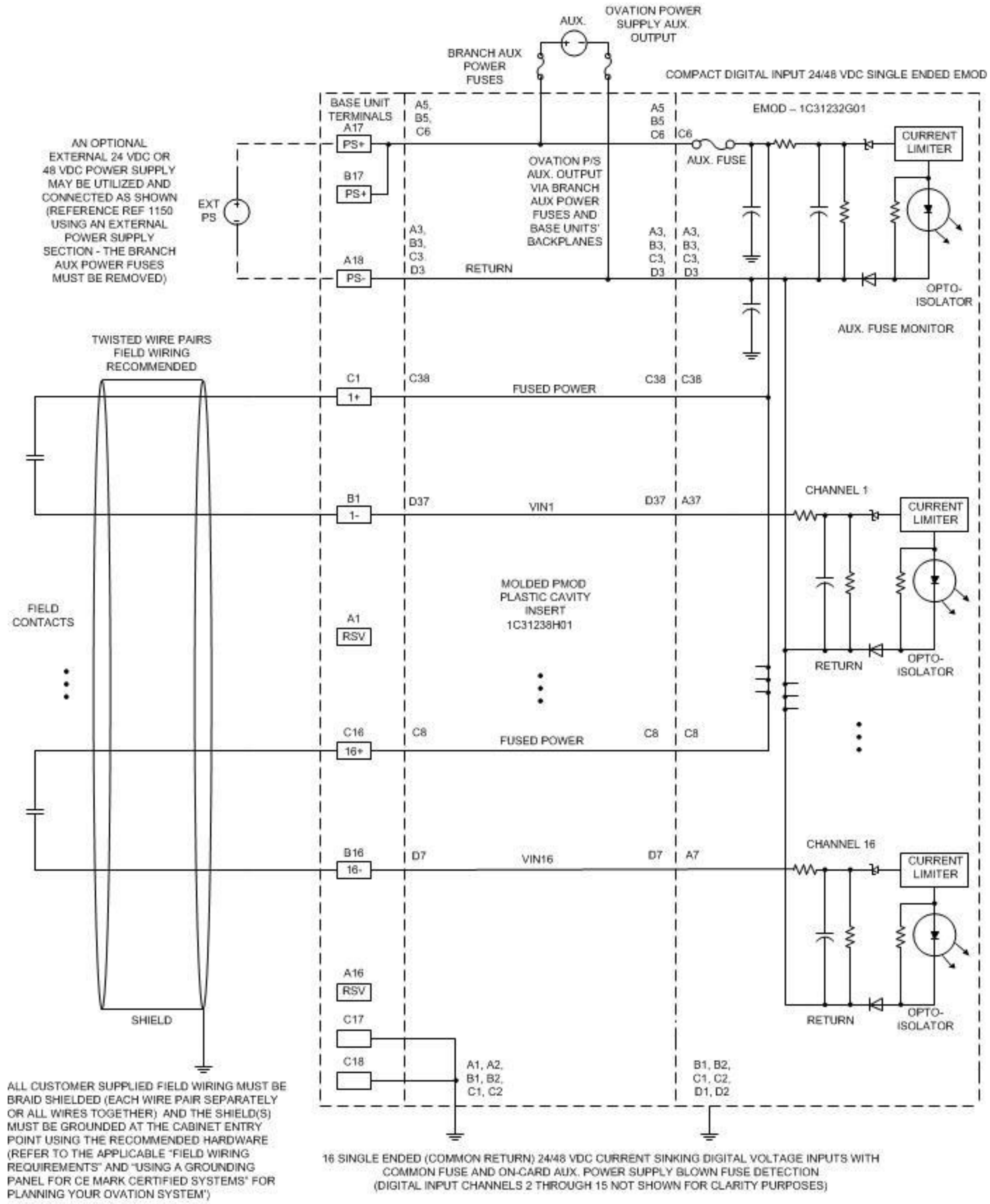
16 SINGLE ENDED (COMMON RETURN) 24/48 VDC CURRENT SINKING DIGITAL VOLTAGE INPUTS WITH COMMON FUSE AND ON-CARD AUX. POWER SUPPLY BLOWN FUSE DETECTION
THREE WIRE PROXIMITY SENSOR WITH PNP HIGH-SIDE SWITCH OUTPUT INTERFACE
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP ONE) (NON-CE MARK)

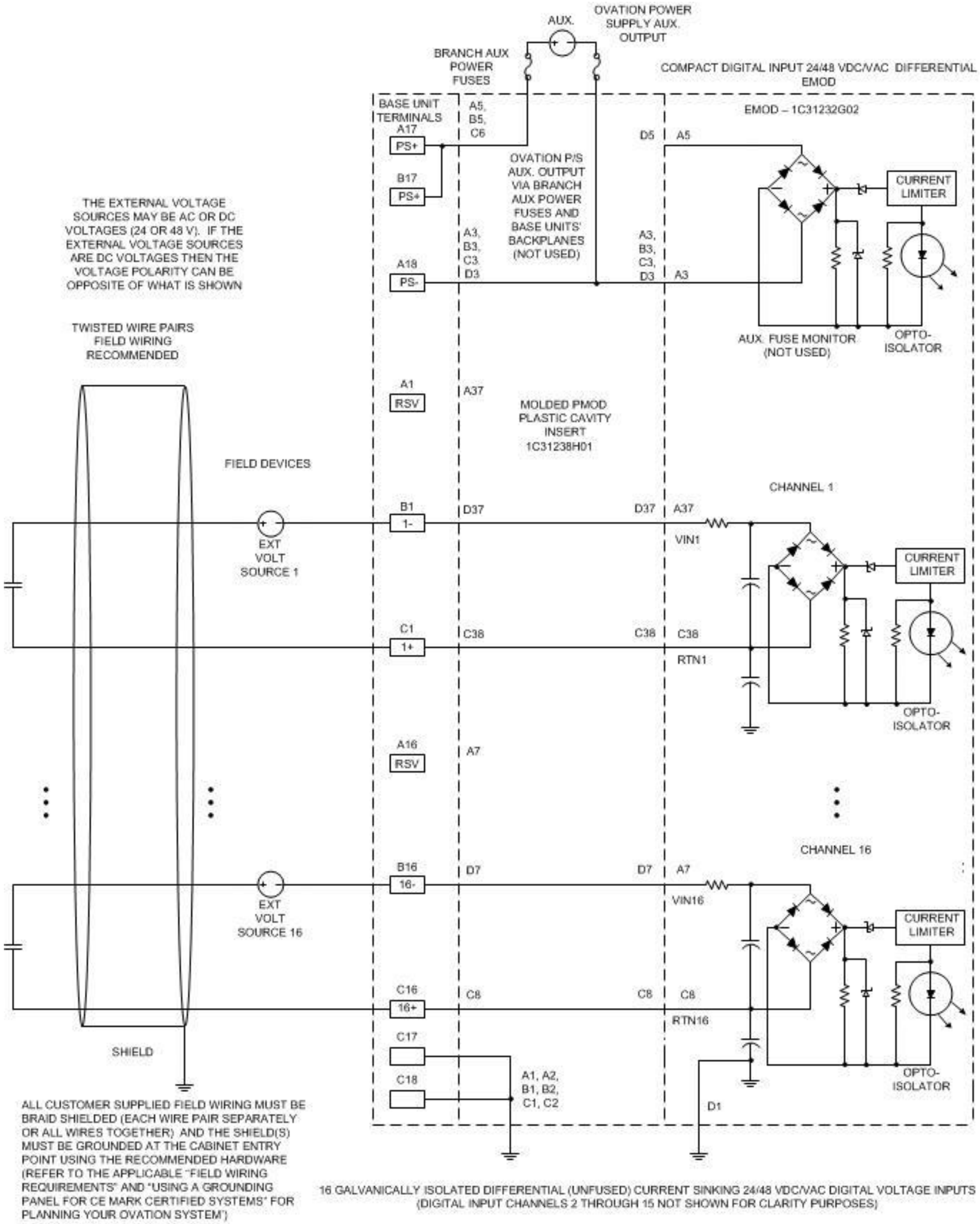


FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP TWO) (NON-CE MARK)

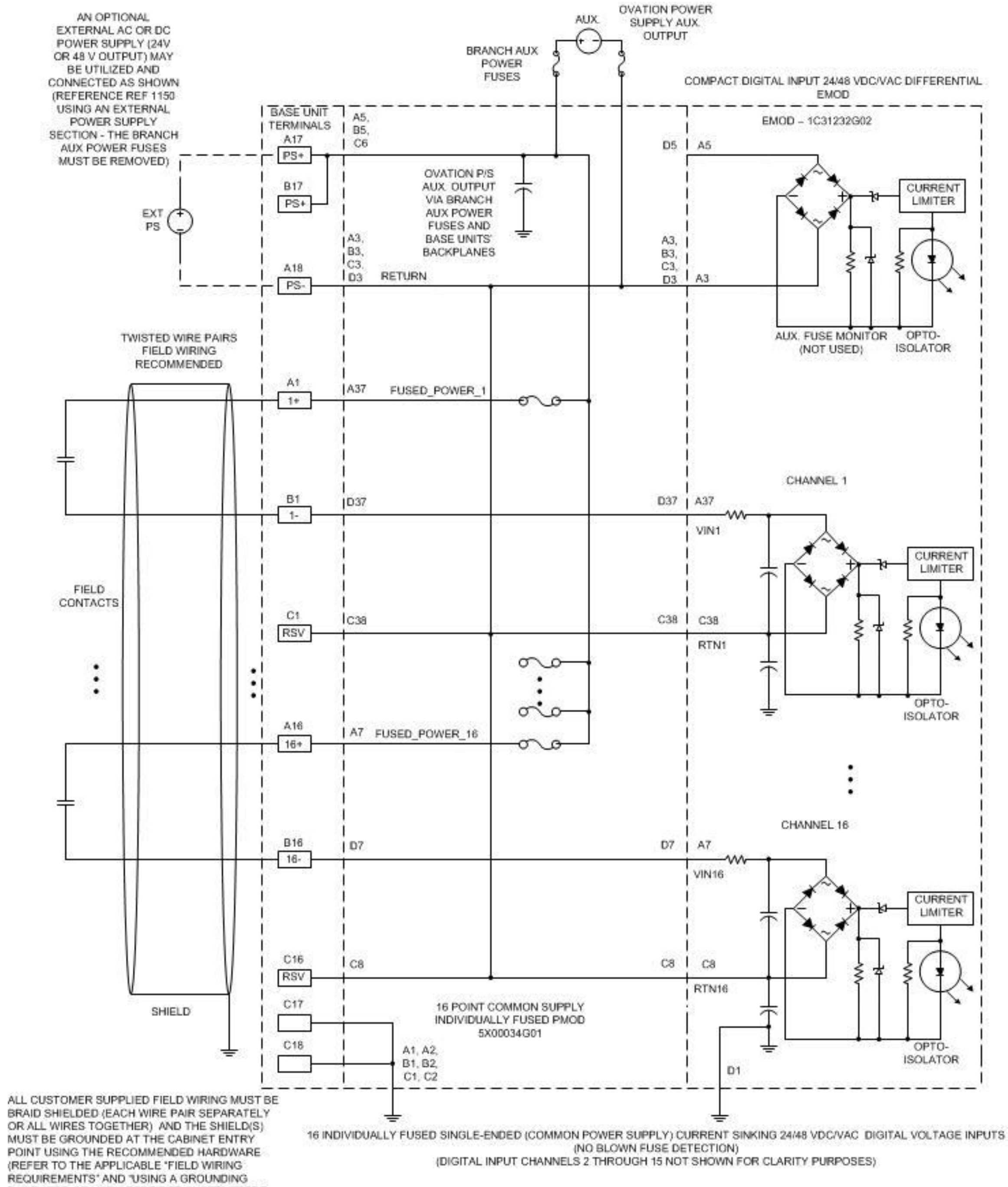
6.3.8 Field connection wiring diagrams (CE Mark) - (CompactDI)



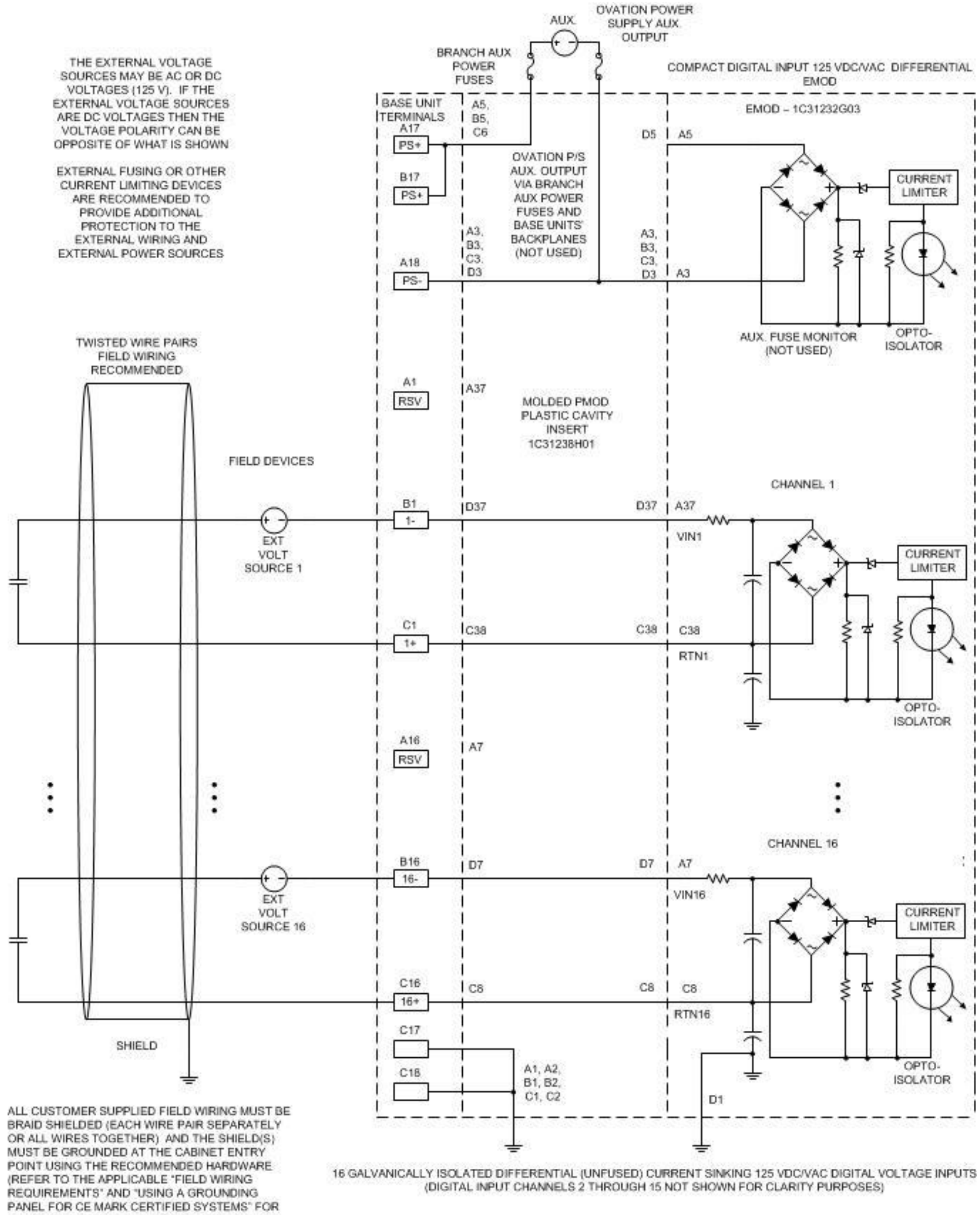
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP ONE) (CE MARK)



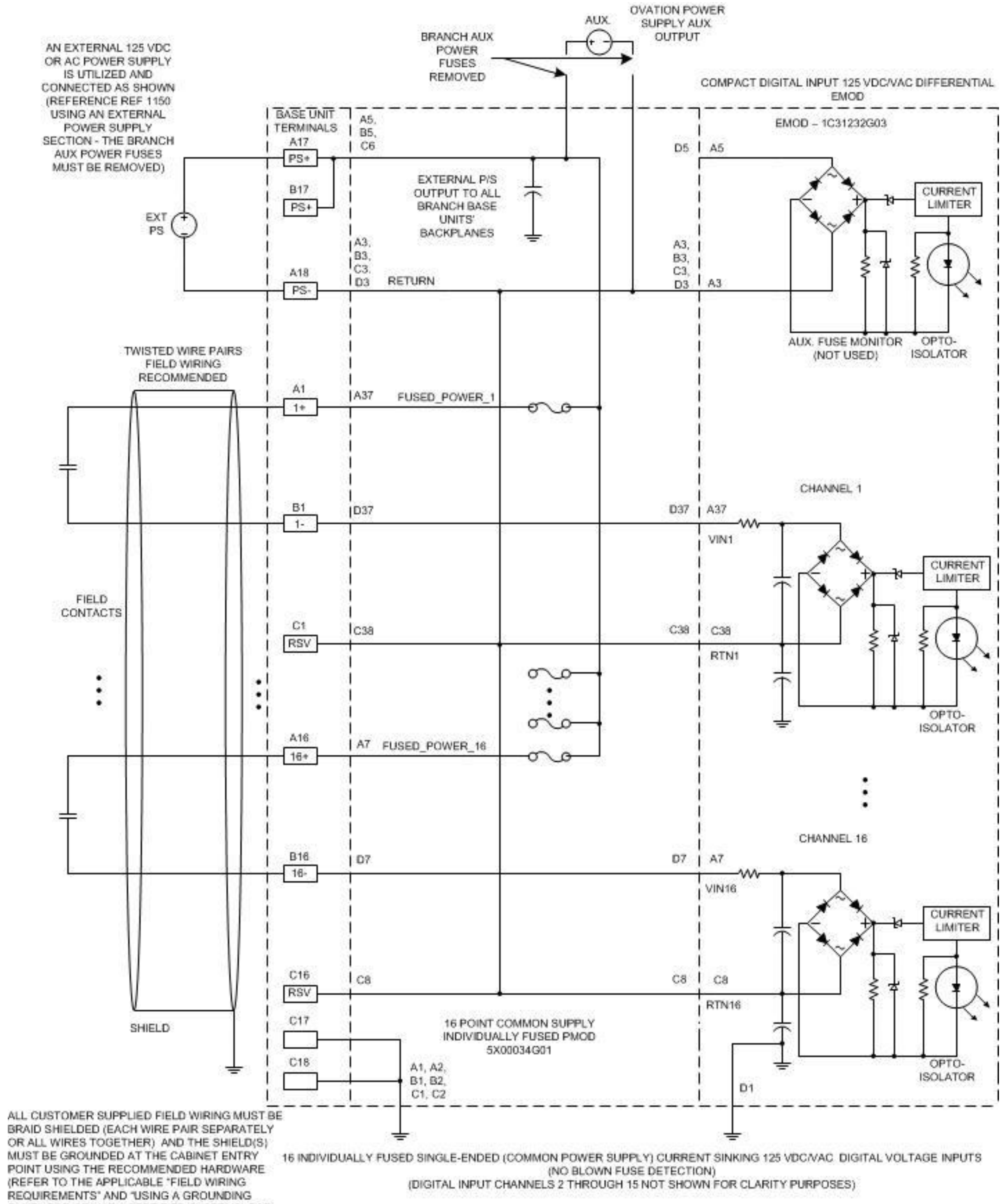
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP TWO) (CE MARK)



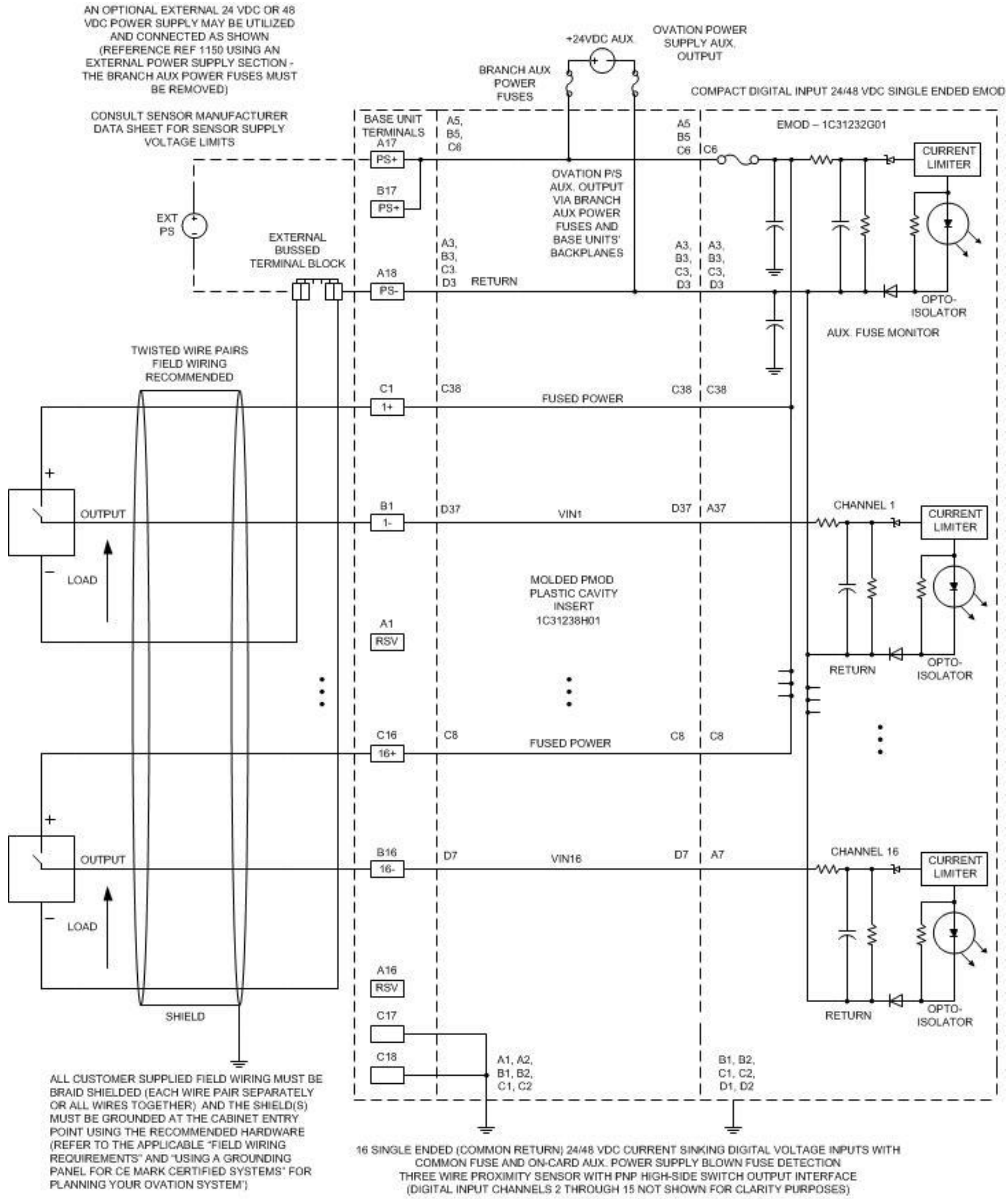
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP TWO) (CE MARK)



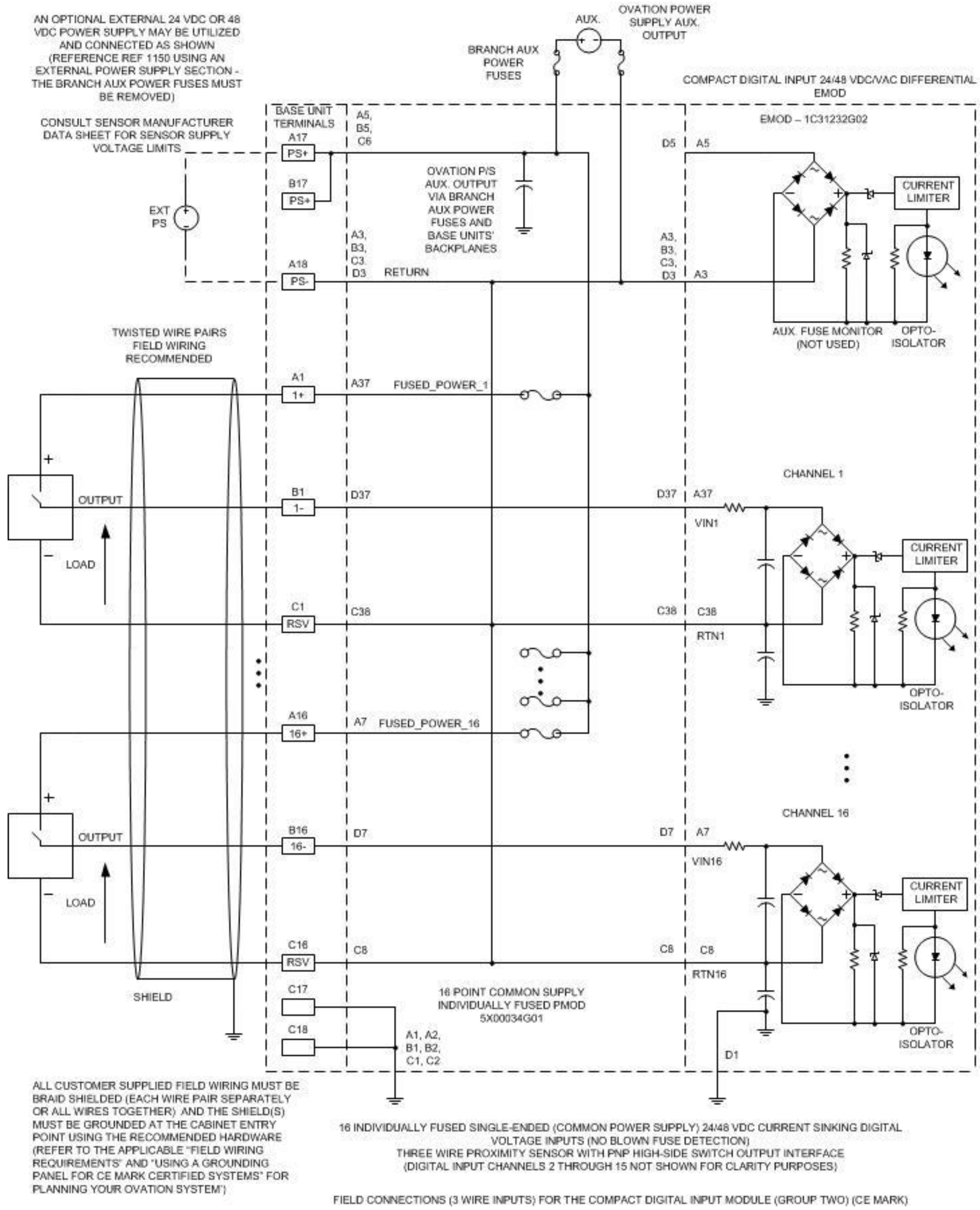
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP THREE) (CE MARK)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP THREE) (CE MARK)



FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP ONE) (CE MARK)



FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT DIGITAL INPUT MODULE (GROUP TWO) (CE MARK)

6.3.9 Register configuration/address information - (CompactDI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module (1 = configure; 0 = unconfigure, causing an attention status)	Module Configured (1 = configured; 0 = unconfigured)
1	Force Error (1 = force an attention status to be read by Controller; 0 = no forced error)	Forced error (1 = forced error set by Controller; 0 = no forced error)
2 - 5	Not defined	Not defined
6	Blown fuse enable [1] (1 = enable blown fuse detection; 0 = disable blown fuse detection)	Blown fuse enable (1 = blown fuse detection is enabled; 0 = blown fuse detection is disabled)
7	Not defined	Blown fuse (1 = fuse blown or auxiliary voltage not present; 0 = fuse OK and auxiliary voltage present)
8	Not defined	Reserved
9	Reserved	Reserved
10	Not defined	Reserved
11 - 15	Not defined	Not defined
[1] Blown Fuse Enable should always be set to “0” on the differential modules (1C31232G02 and 1C31232G03).		

Bit definitions for this register are encoded as shown in the table above and described below:

Bit 0: After the Compact Digital Input module power is cycled, this bit is “0.” A “1” must be written to this bit. If the module is not configured in this manner, an attention status is sent to the Controller upon an attempt to read the point data.

Bit 1: This bit is “0” after the Compact Digital Input module power is cycled. If the Controller sets this bit, an attention status is issued.

Bits 2-5 Not Defined

Bit 6: The Blown Fuse Enable bit is “0” after the Digital Input module power is cycled. This bit must be set by the Controller for Compact Digital Input modules, using the single-ended personality module, to detect a blown auxiliary power supply fuse when it reads the Status Register. Blown Fuse Enable should always be set to “0”on the differential modules (1C31232G02 and 1C31232G03). The bit may be read back through the Module Status Register.

Bit 7: This bit is set in the Status Register only if the Blown Fuse Enable bit (6) is set and the single-ended on-board auxiliary supply fuse has blown or the auxiliary voltage is not present. This bit is not defined in the Configuration Register.

Bit 8: These bits are reserved in the Status Register. These bits are not defined in the Configuration Register.

Bit 9: This bit is reserved.

Bit 10: Reserved

Bits 11-15: These bits are not defined in the Configuration register and are read as high in the Status register.

6.3.10 Diagnostic Logic card LEDs - (CompactDI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED is Lit when: ▪ The Blown Fuse bit (Bit-7) of the Module Status Register (see Register configuration/address information - (Compact DI) (see page 226)) is set. This indicates that the auxiliary supply fuse has blown or the auxiliary supply is not present or below its acceptable threshold.
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the (see Register configuration/address information - (Compact DI) (see page 226)) is active or when a timeout of the watchdog timer occurs when the Controller stops communicating with the module.
1 - 16 (Green)	Point Status LEDs 1-16. Lit when the input voltage of the LED's corresponding channel is greater than the channel's minimum On Input Voltage.

6.3.11 Specifications - (CompactDI)

- **Electronics module (1C31232G01, 1C31232G02, 1C31232G03)**
- **Personality module (5X00034G01)**

DESCRIPTION	VALUE
Number of channels	16
Input range (single-ended or differential)[1]	Refer to the table below.
Propagation delay time for contact closing 24V/48VDC 24VAC 125VDC 125VAC	 3.5 mSec maximum 3.5 mSec maximum 4.0 mSec maximum 4.0 mSec maximum
Propagation delay time for contact opening[2] 24V/48VDC 24VAC 125VDC 125VAC	 16.0 mSec maximum 14.0 mSec maximum 20.0 mSec maximum 25.0 mSec maximum

Description	Value
Additional delay time for contact opening due to cable capacitance (1,000 foot cable assumed) 25 pF/ft cable – 24V/48VDC 25 pF/ft cable – 24VAC 25 pF/ft cable – 125VDC 25 pF/ft cable – 125VAC 50 pF/ft cable – 24V/48VDC 50 pF/ft cable – 24VAC 50 pF/ft cable – 125VDC 50 pF/ft cable – 125VAC	1.0 mSec maximum 1.0 mSec maximum 1.0 mSec maximum 2.0 mSec maximum 2.0 mSec maximum 2.0 mSec maximum 2.0 mSec maximum 4.0 mSec maximum
Cable length	1,000 ft maximum (50 pF/ft quality or better)
Cable capacitance	50,000 pF maximum
Diagnostics	Internal module operating faults, Ground Fault Detection[3]
Dielectric isolation: Channel to Channel[4] Channel to logic	1000 VAC 2,000 VAC (differential inputs); 1,000 VAC (single-ended inputs)
Module Main +24V Power drawn	1.1 W typical, 1.5 W maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
[1] Input range level is dependent on module group. [2] Does not include the effects of field cable capacitance. [3] Blown fuse detection applies to single-ended channel configuration only (Group 1), where an on-board fuse is provided for the auxiliary power supply. [4] Channel to channel isolation applies to differential channel configuration only.	

Compact Digital Input Ranges

Group	Input Level	On Input Voltage (VDC or VAC RMS)		Off Input Voltage (VDC or VAC RMS)	On Input Current (mA)		Off Input Current (mA)	Input Power (Watts)
		Min	Max	Max	Miin	Max	Max	Typical
1	24 VDC	20	60	9	1.3	2.6	0.33	0.65
1	48 VDC	20	60	9	1.3	2.6	0.33	1.70
2	24 VDC	20	60	9	1.3	2.6	0.33	0.69
2	24 VAC	22	30	7	2.8	5.5	0.60	0.80
2	48 VDC	18	60	9	1.3	2.6	0.33	1.75
3	125 VDC	80	140	55	1.3	2.8	0.33	4.26
3	125 VAC	85	132	40	2.8	14.0	3.00	5.10

6.4 Contact Digital Input module - (ContactDI)

The Contact Input module, comprised of an Electronics module and Personality module, provides 16 contact input current detecting channels with common returns. The field side circuitry and terminal connections (see page 233) for three of these channels are shown (see page 231).

A +48V on-board power supply provides current limited contact wetting voltage if the contact is open. If the contact closes, current is drawn from the +10V supply which turns on the associated opto-isolator; thereby, relaying a closed contact state to the I/O bus. The opto-isolators and the isolation provided by the 10V and 48 Volt power supply provide high dielectric isolation between the field side and the logic or I/O bus side.

On-Board power supply checking

If the +10V on-board power supply were to fail, all points associated with module input channels would have a zero (false) value. One of the sixteen module input channels may be employed to verify the availability of the +10V on-board power supply output voltage. The selected module input channel has a wire jumper hard wired between the channel's positive (+) input terminal and the channel's negative (-) or common input terminal. This hard wired input channel should always be a one (true) if the +10V on-board power supply output voltage is present.

To implement this on-board power supply checking feature when building points for the module's input channels, select power check enable in the Config tab. Also specify the module channel used for the power check feature (1-16). When the module input channels are scanned, the hard wired module input channel is also scanned to verify that it has a value of one. If not, the module input channels will be tagged with "bad quality".

If desired, a point may be built for the hard wired module input channel and be set to alarm on a value of zero.

There are two methods of wiring field devices to the Contact Input module termination block (see page 233). Each field contact may have a separate input and return line as shown for channel 1. Alternatively, field contacts wired to the same Contact Input module may share a return line as shown for channels 2 and 3. For either wiring method, **do not** tie the contact return line to earth ground or a ground fault condition occurs as well as a degradation of the common mode surge protection.

Debouncing of a contact input signal is done by an RC filter and digital debouncer on the logic side. If a contact changes state for less than 3 msec, the change of state is always is rejected. If the Contact changes state for more than 7 msec, the change of state always accepted.

Ground fault detection circuitry on a Contact Input module activates when an input or return line for any channel finds a low impedance (<5 K ohms) path to earth ground. A single ground fault wire does not cause an error in the point data, but multiple ground faults (if they include input and return lines) could cause faulty data (that is, channels appearing as if contacts are closed when they are really open).

When a ground fault occurs, the external error LED lights, and the GND Fault bit in the Status Register (see page 237) is set. If the GND Fault (see page 233) Attention Enable bit is set in the Configuration Register (see page 237), a ground fault is seen as a catastrophic error causing an attention status to be sent back to the Controller. The Contact Input module is a CE Mark certified module.

Note: *I/O Module General Information* *(see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

6.4.1 Electronics modules (Emod) - (ContactDI)

- **1C31142G01** provides 48 VDC on-card auxiliary power for 16 contact inputs with common return.

6.4.2 Personality modules (Pmod) - (ContactDI)

- **1C31110G03** contains surge-protection components for 16 inputs.

6.4.3 Subsystems - (ContactDI)

Contact Digital Input subsystems[1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
48 VDC On-Card Auxiliary (Legacy)	16	1C31142G01	1C31110G03
[1] This module configuration is CE Mark certified.			

6.4.4 Terminal block wiring information - (ContactDI)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The diagram for the contact input Personality module (also known as digital input) is illustrated in the following figure.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

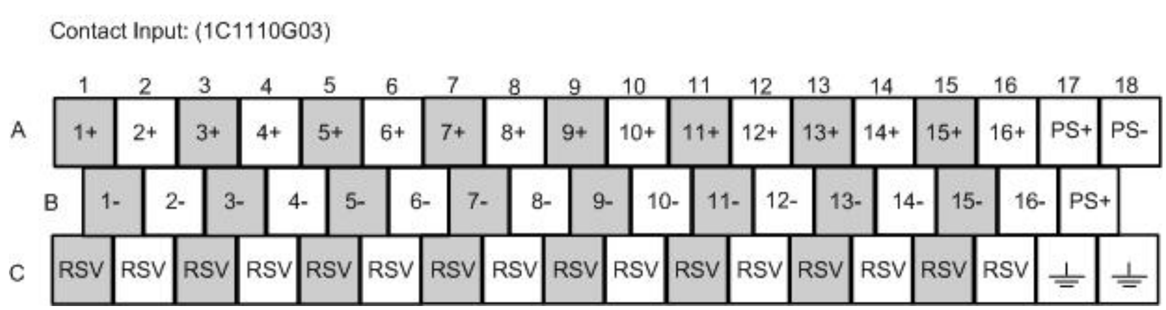
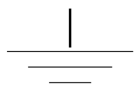


Figure 68: Terminal Block Connections for the Contact Input Personality Modules

The following table lists and defines the abbreviations used in this diagram.

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals
1+ through 16+	Contact input positive terminal connection
1- through 16-	Contact input negative terminal connection
PS+, PS-	Auxiliary Power Supply terminals
RSV	Reserved terminal. No connection allowed on these terminals

Note: *Do **not** use terminal block locations marked RSV.*

6.4.5 Field wiring restrictions - (ContactDI)

The following definitions apply to the restrictions listed below:

- Rshunt = contact shunt resistance
- Rcontact = resistance associated with a closed contact
- Rreturn = resistance of the common return line
- Rline = resistance of the non-common cable length to and from the contact
- Rwiring = Rcontact + Rline + 16Rreturn
- Rfault = resistance from either line to ground which causes a ground fault

Cable resistances (see page 234) that affect contact input performance. The following restrictions apply:

- Under no-ground-fault conditions or if the channel return (low) line has a ground fault:
  - ☐ Rshunt across contact must be ≥ 10k ohms to always recognize an open contact as open.
  - ☐ Rshunt across contact must be ≥ 50k ohms to maintain the high level contact-wetting voltage.
- If the input connection from a channel has a ground fault with the contact open:
  - ☐ Rshunt across contact must be ≥ 150k ohms to guarantee ground fault is detected.
- For a ground fault on the input or return connection to a channel:
  - ☐ Rfault from either line to ground must be ≤ 5K ohms to guarantee detection of the ground fault.
- With or without ground fault conditions:
  - ☐ Rwiring through field wiring to contact must be < 100 ohms to always recognize a closed contact as closed.

6.4.6 Field wiring cable lengths - (ContactDI)

The following two tables list the Maximum cable lengths for field wiring to the contacts. For both, assume Rcontact is 0 ohms.

The following table applies when there are individual common return lines brought to the card edge. This implies that Rreturn is 0 ohms.

Maximum cable length for 16 individual common returns

Wire Gauge	Ohms per Thousand Feet - (Solid Copper Wire)	Maximum Cable Length - (Thousands of Feet)
18	6.64	7.5
20	10.2	4.9
22	16.2	3.0

The following table applies when all 16 channels share a common return line. In both tables, the Maximum Cable Length is the length of the cables from the termination block to the contacts in the field.

Maximum cable length for a single common return for all 16 inputs

Wire Gauge	Ohms per Thousand Feet - (Solid Copper Wire)	Maximum Cable Length - (Thousands of Feet)
12	1.66	3.54
14	2.27	2.59
16	4.18	1.40
18	6.64	0.89

6.4.7 Field connection wiring diagrams (front end) - (ContactDI)

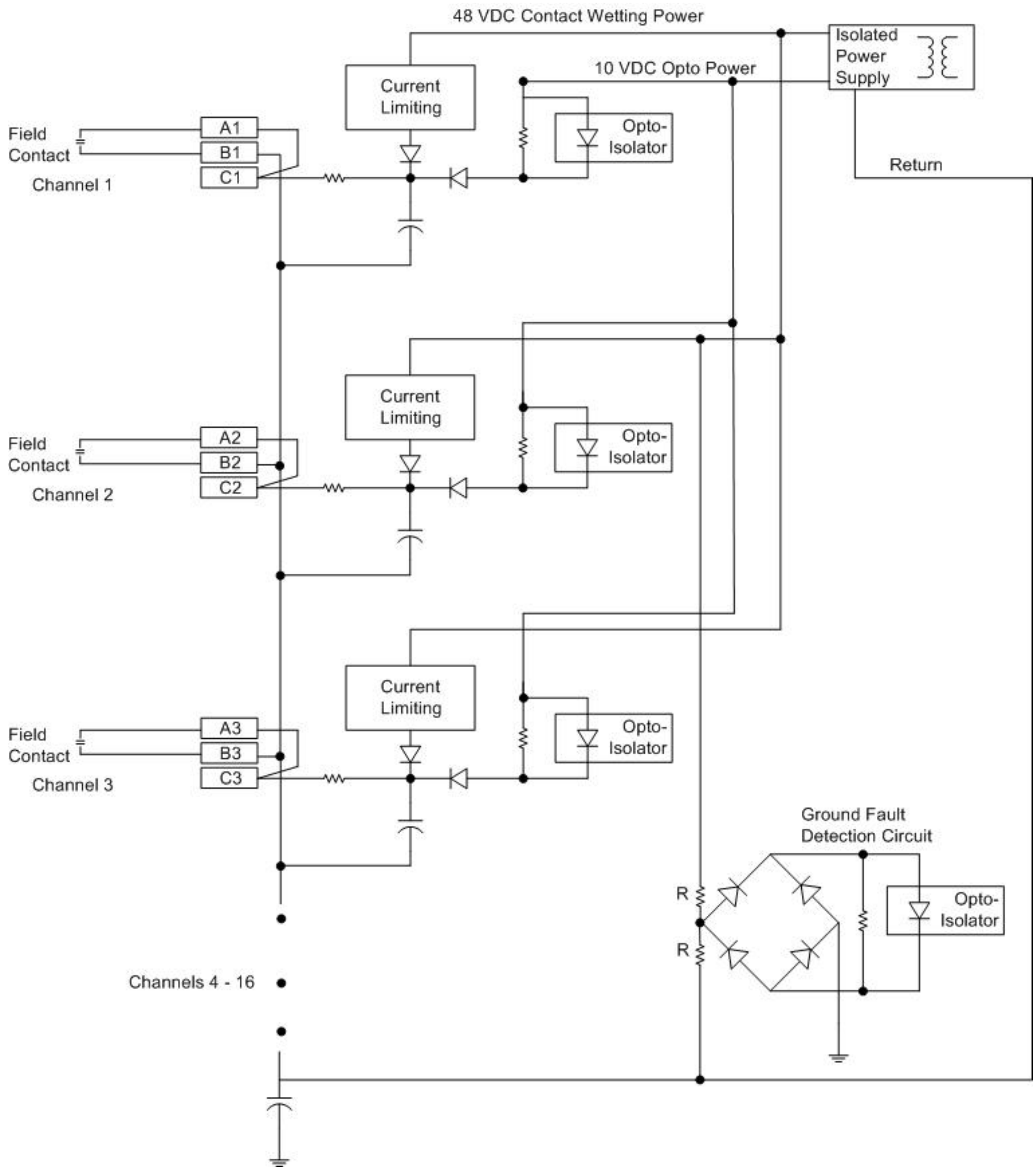


Figure 69: Contact Input module front end

6.4.8 Cable impedances in field wiring - (ContactDI)

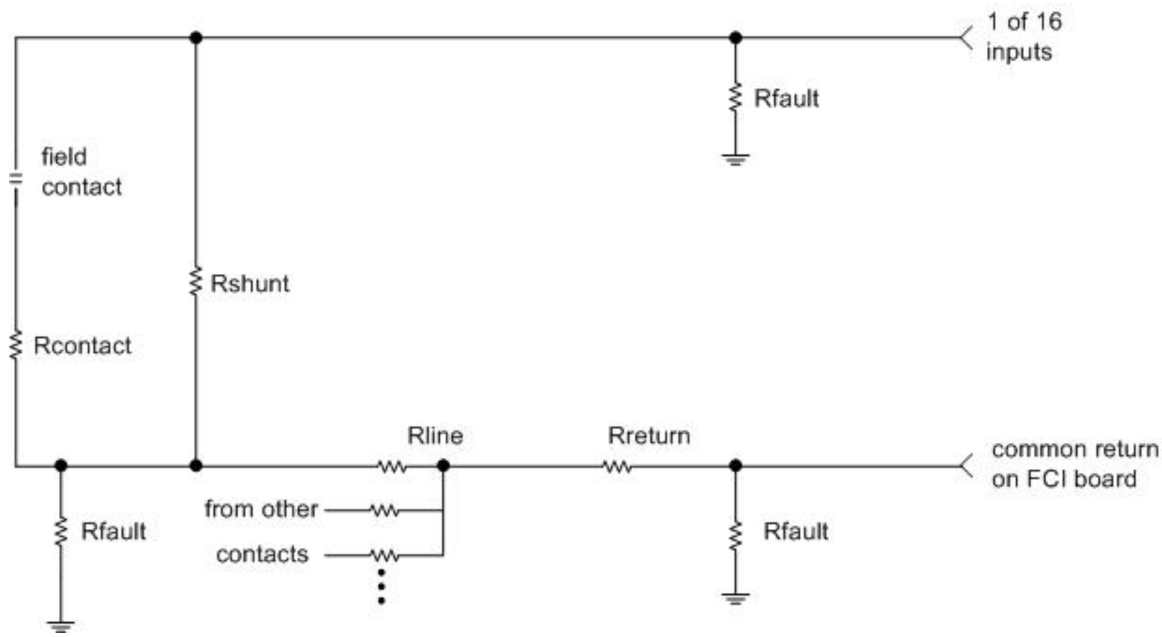
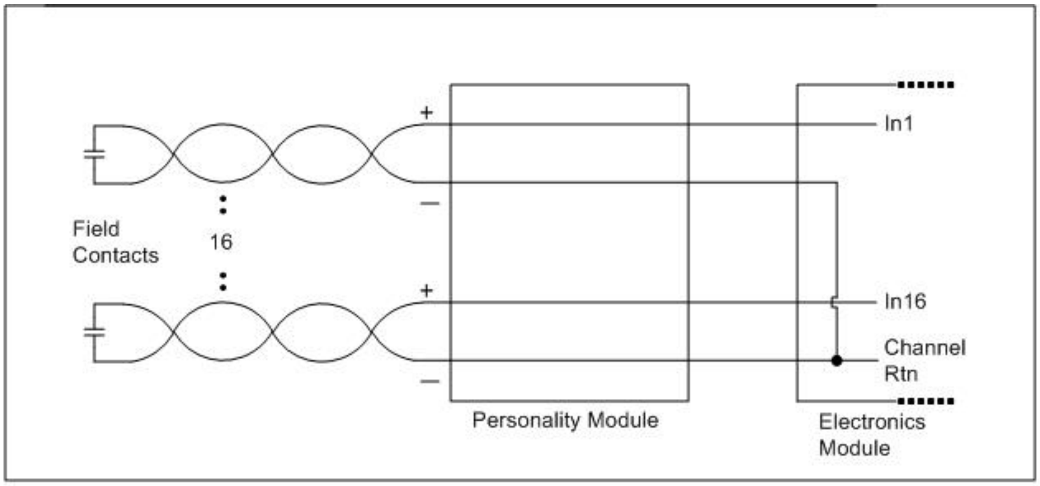


Figure 70: Cable impedances in field wiring

6.4.9 Field connection wiring diagrams - (ContactDI)



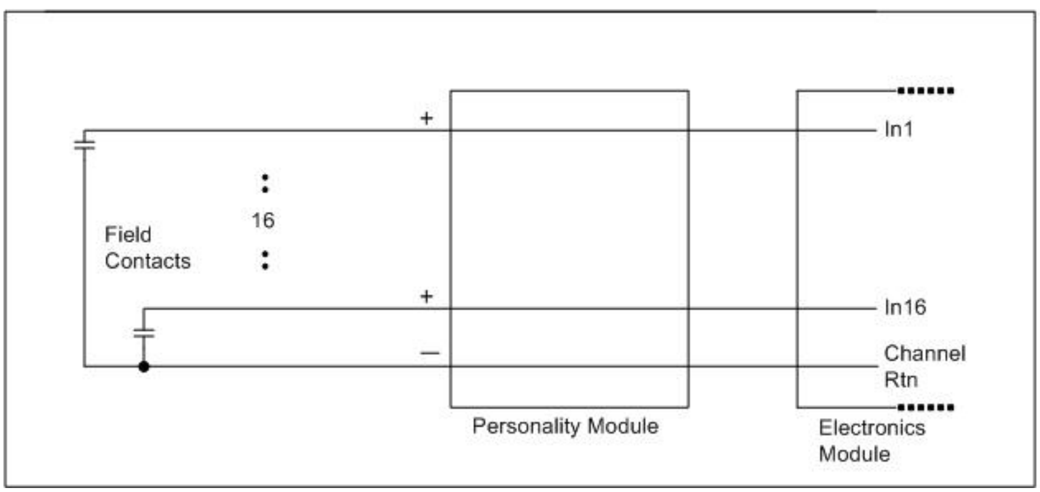


Figure 71: Field connection for the Contact Input Personality module

6.4.10 Field connection wiring diagrams (CE Mark) - (ContactDI)

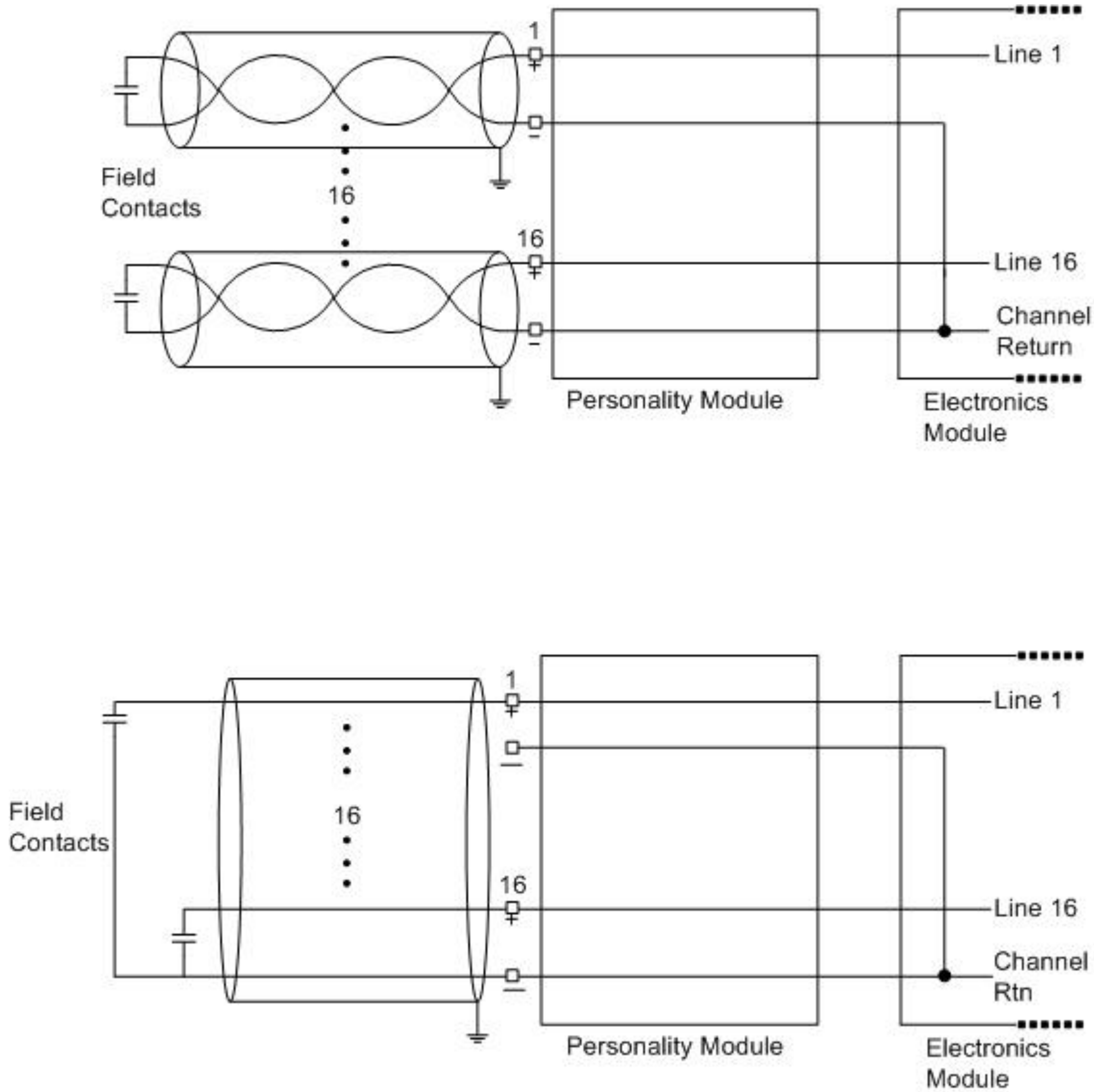


Figure 72: Field connection for the Contact Input Personality module (CE Mark)

Note: *All field wiring MUST be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware.*

6.4.11 Register configuration/address information - (ContactDI) & (CCDI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Contact (and Compact Contact) Input configuration/status register (address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module 1 = configure 0 = unconfigure, causing an attention status	Module Configured 1 = configured 0 = unconfigured
1	Force Error 1 = force an attention status to be read by Controller 0 = no forced error	Forced error 1 = forced error set by Controller 0 = no forced error
2-5	Not defined	Not defined
6-7	Reserved	Reserved
8	Not defined	Wetting Voltage Failure 1 = +48V wetting Voltage Failed 0 = +48V wetting Voltage OK.
9	Ground Fault Attention Enable 1 = configure GND fault to cause an attention status 0 = configure GND fault to not cause an attention status	Ground Fault Attention Enable 1 = GND fault causes attention status 0 = GND fault does not cause an attention status
10	Not defined	Ground Fault 1 = field wiring has a ground fault 0 = field wiring does not have a ground fault
11-15	Not defined	Not defined

The bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: After the Contact Input module power is cycled, this bit is “0.” A “1” must be written to the Configure module bit. If the module is not configured in this manner, an attention status is sent to the Controller upon an attempt to read the point data. The bit may be read back through the Status Register.

Bit 1: The Force Error bit is “0” after the Contact Input module power is cycled. If the Controller sets the Force Error bit, an attention status is issued. The bit may be read back through the Status Register.

Bits 2-5: These bits are not defined.

Bit 6 & 7: These bits are reserved in the Status Register.

Bit 8: This bit is set in the Status Register if the +48V supply on the FCI board fails.

Bit 9: The GND Fault Attention Enable bit is “0” after the Contact Input module power is cycled. This bit must be set by the Controller if a ground fault is to be treated as a catastrophic failure. If Bit 9 is set, a ground fault causes an attention status to be returned to the Controller upon accessing the module, and no point data can be read. If the bit is not set, a ground fault does not inhibit the Controller from reading point data. In the latter case, if more than one ground fault occurs on the field wiring to a Contact Input module, false point data may possibly be read on channels with open contacts.

Bit 10: This bit is set in the Status Register if a ground fault occurs in the field wiring. This bit is not defined in Configuration Register.
Bits 11-15: These bits are not defined in the Configuration register and are read as high in the Status register. These bits cannot be accessed by the Controller during a write to the module.

6.4.12 Power Checking (ContactDI - CCDI)

The module has an internal 48 transistor voltage supply and is capable of looking at 16 different contact inputs. Each input that is connected to a dry contact requires a digital point name or packed group point name with bit position. A closed contact will produce a one (true) value for the associated point whereas an open contact produces a zero (false) value. If the power supply were to fail, all points would have a zero (false) value.

Power on checking uses one of the sixteen inputs to verify that the 48 volt supply has not failed. The selected point is hard wired to simulate a closed contact, and should therefore always be a one (true) statement.

To implement the feature, when building the points for the field inputs, within the point config tab, the power on checking is enabled, and the channel is used (hardwired) is declared. When the field inputs are scanned, the hard wired channel is also scanned to verify that it has a value of one. If not, the field inputs will be tagged with “bad quality”.

If desired, a point may be built for the hard wired channel and be set to alarm on zero.

Note: *The terminal wiring for the Contact Digital Input and Compact Contact Digital Input modules is different.*

6.4.13 Diagnostic Logic card LEDs - (ContactDI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit when GND Fault bit (Bit 10) of the Status Register (see page 237) is set. This indicates that a ground fault has occurred in the field wiring. An attention status is generated when the External Fault LED is lit only if the GND Fault Attention Enable bit (Bit 9) is set.
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set or when the on-board +48V/+10/V wetting power supply fails. Also lit when a timeout of the watchdog timer occurs when Controller stops communicating with module. An attention status is always generated when the LED is lit.
1 (Green)	Point Status LEDs 1-16. Lit when the input contact of the LED’s corresponding channel is closed.

6.4.14 Specifications - (ContactDI)

- **Electronics module (1C31142)**
- **Personality module (1C31110)**

DESCRIPTION	VALUE
Number of channels	16
On board auxiliary power supply	42 V minimum 55 V Maximum
Propagation delay	7 mSec Maximum
Contact bounce rejection Always rejects contact change of state Always accepts contact change of state	 < 3 mSec > 7 mSec
Closed contact output current	4 mA minimum 8 mA Maximum
Diagnostics	Internal module operating faults. Ground Fault Detection
Dielectric isolation: Channel to logic	 1000 V AC/DC
Module power	4.56 W typical 4.75 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

6.5 Compact Contact Digital Input module - (CCDI)

The Compact Contact Input module, comprised of an Electronics module, provides 16 contact input current detecting channels with common returns.

Additionally, a cavity insert that includes a wiring diagram is available for placement in the Personality module cavity in the base unit.

A +48V on-board power supply provides current limited contact wetting voltage if the contact is open. If the contact closes, current is drawn from the +10V supply which turns on the associated opto-isolator; thereby, relaying a closed contact state to the I/O bus. The opto-isolators and the isolation provided by the 10V and 48 Volt power supply provide high dielectric isolation between the field side and the logic or I/O bus side.

On-Board power supply checking

If the +10V on-board power supply were to fail, all points associated with module input channels would have a zero (false) value. One of the sixteen module input channels may be employed to verify the availability of the +10V on-board power supply output voltage. The selected module input channel has a wire jumper hard wired between the channel's positive (+) input terminal and the channel's negative (-) or common input terminal. This hard wired input channel should always be a one (true) if the +10V on-board power supply output voltage is present.

To implement this on-board power supply checking feature when building points for the module's input channels, select power check enable in the Config tab. Also specify the module channel used for the power check feature (1-16). When the module input channels are scanned, the hard wired module input channel is also scanned to verify that it has a value of one. If not, the module input channels will be tagged with "bad quality".

If desired, a point may be built for the hard wired module input channel and be set to alarm on a value of zero.

There are two methods of wiring field devices to the Compact Contact Input module termination block. Each field contact may have a separate input and return line. Alternatively, field contacts wired to the same Contact Input module may share a return line. For either wiring method, **do not** tie the contact return line to earth ground or a ground fault condition occurs as well as a degradation of the common mode surge protection.

Debouncing of a contact input signal is done by an RC filter and digital debouncer on the logic side. If a contact changes state for less than three msec, the change of state always is rejected. If the Contact changes state for more than seven msec, the change of state always is accepted.

Ground fault detection circuitry on the Compact Contact Input module activates when the input or return line for any channel finds a low impedance (<5K ohms) path to earth ground. A single wire with a ground fault does not cause an error in the point data, but multiple ground faults, if they include input and return lines, could cause faulty data (that is, channels appearing as if their contacts are closed when they are really open).

When a ground fault occurs, the external error LED lights, and the GND Fault bit in the Status Register is set. If the GND Fault Attention Enable bit is set in the Configuration Register, a ground fault is seen as a catastrophic error causing an attention status to be sent back to the Controller.

The Compact Contact Input module is applicable for CE Mark certified systems.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

6.5.1 Electronics modules (Emod) - (CCDI)

- **1C31234G01** provides 48 VDC on-card auxiliary power for 16 contact inputs with common return.

6.5.2 Personality Module (Pmod) - (CCDI)

A cavity insert is available that fits into the Personality module cavity in the Base Unit and provides wiring information.

- **1C31238H01** Personality Module Cavity Plastic insert

6.5.3 Subsystems - (CCDI)

Compact Contact Digital Input subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	MOLDED PLASTIC CAVITY INSERT [2]
Compact Contact with 48 VDC On-Card Auxiliary	16	1C31234G01	1C31238H01
[1] This module configuration is CE Mark Certified. [2] This is an insert that fits into the Personality module position and provides a wiring schematic label for the module.			

6.5.4 Terminal block wiring information - (CCDI)

The available cavity insert has a simplified wiring diagram label on its top, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The diagram for the Compact Contact Input module is illustrated in the following figure. The following table lists and defines the abbreviations used in this diagram.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

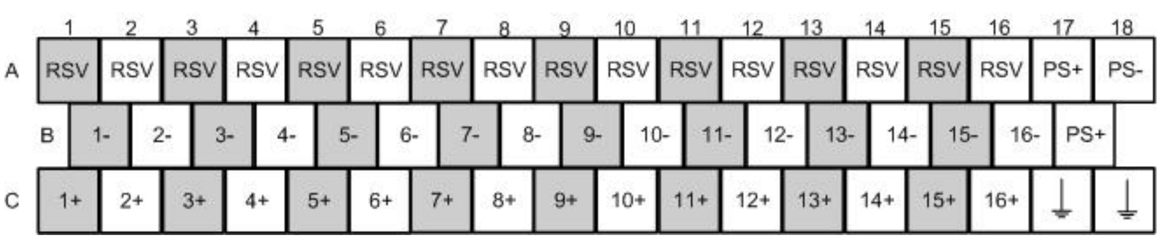
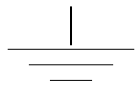


Figure 73: Terminal block connections for the Compact Contact Input modules

Abbreviations used in wiring diagrams

Abbreviation	Definition
	Earth ground terminals
1+ through 16+	Contact input positive terminal connection
1- through 16-	Contact input negative terminal connection
PS+, PS-	Auxiliary Power Supply terminals
RSV	Reserved terminal. No internal connection

6.5.5 Field wiring restrictions - (CCDI)

The following definitions apply to the restrictions listed below:

- Rshunt = contact shunt resistance
- Rcontact = resistance associated with a closed contact
- Rreturn = resistance of the common return line
- Rline = resistance of the non-common cable length to and from the contact
- Rwiring = Rcontact + Rline + 16Rreturn
- Rfault = resistance from either line to ground which causes a ground fault

Cable resistances (see page 244) that affect contact input performance. The following restrictions apply:

- Under no-ground-fault conditions or if the channel return (low) line has a ground fault:
  - ☐ Rshunt across contact must be ≥ 10k ohms to always recognize an open contact as open.
  - ☐ Rshunt across contact must be ≥ 50k ohms to maintain the high level contact-wetting voltage.
- If the input connection from a channel has a ground fault with the contact open:
  - ☐ Rshunt across contact must be ≥ 150k ohms to guarantee ground fault is detected.
- For a ground fault on the input or return connection to a channel:
  - ☐ Rfault from either line to ground must be ≤ 5K ohms to guarantee detection of the ground fault.
- With or without ground fault conditions:
  - ☐ Rwiring through field wiring to contact must be < 100 ohms to always recognize a closed contact as closed.

6.5.6 Field wiring cable lengths - (CCDI)

The following two tables list the Maximum cable lengths for field wiring to the contacts. For both tables, assume Rcontact is 0 ohms.

The following table applies when there are individual common return lines brought to the card edge. This implies that Rreturn is 0 ohms.

Maximum cable length for 16 individual common returns

Wire Gauge	Ohms per Thousand Feet - (Solid Copper Wire)	Maximum Cable Length - (Thousands of Feet)
18	6.64	7.5
20	10.2	4.9
22	16.2	3.0

The following table applies when all 16 channels share a common return line. In both tables, the Maximum Cable Length is the length of the cables from the termination block to the contacts in the field.

Maximum cable length for a single common return for all 16 inputs

Wire Gauge	Ohms per Thousand Feet - (Solid Copper Wire)	Maximum Cable Length - (Thousands of Feet)
12	1.66	3.54
14	2.27	2.59
16	4.18	1.40
18	6.64	0.89

6.5.7 Cable impedances in field wiring - (CCDI)

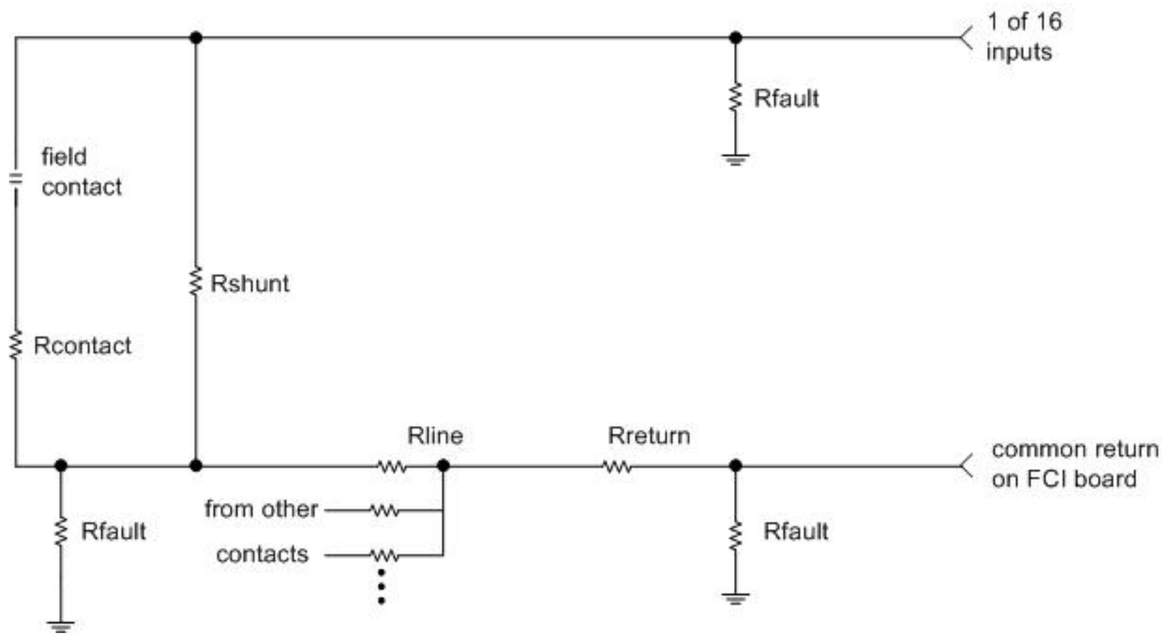
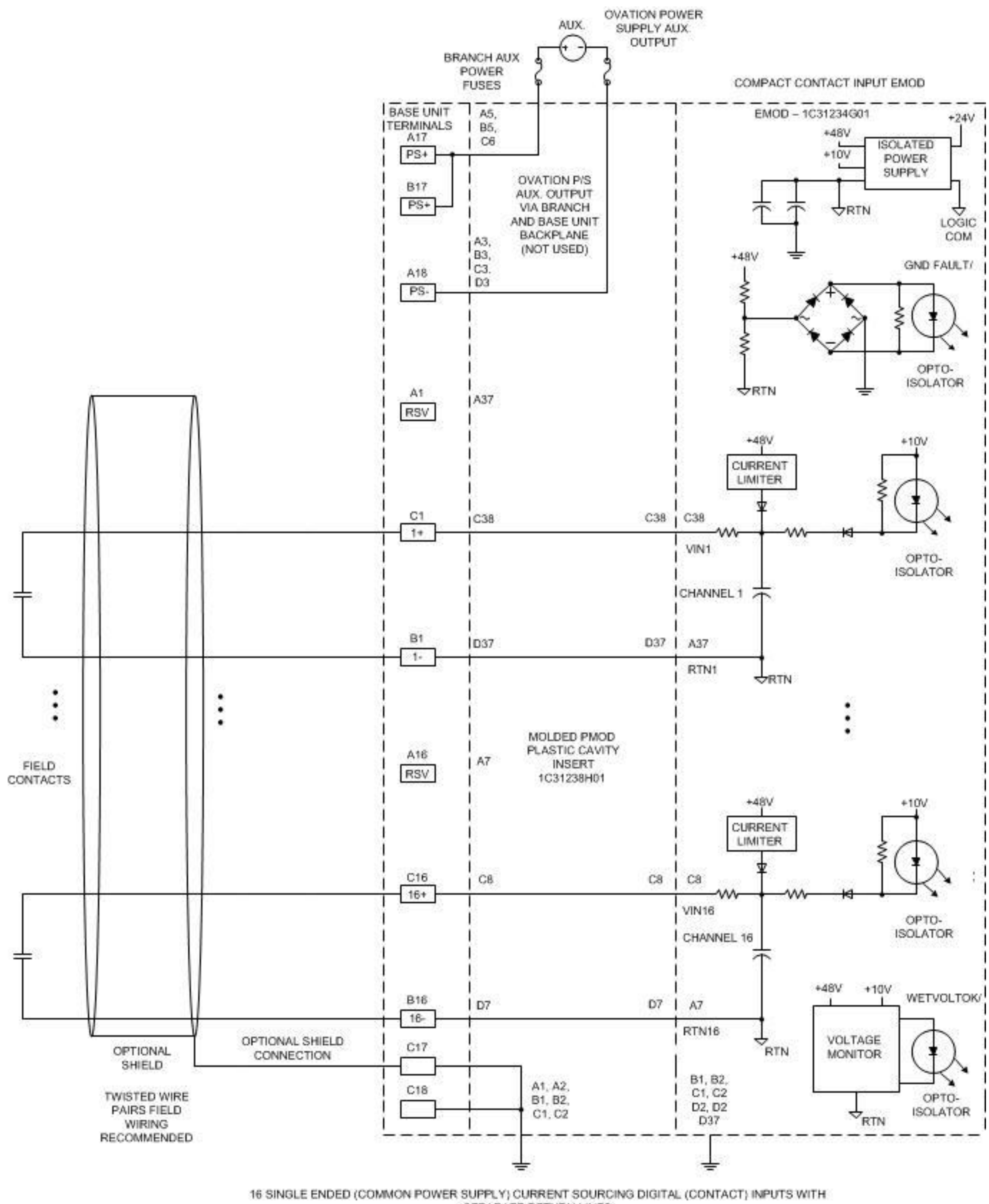


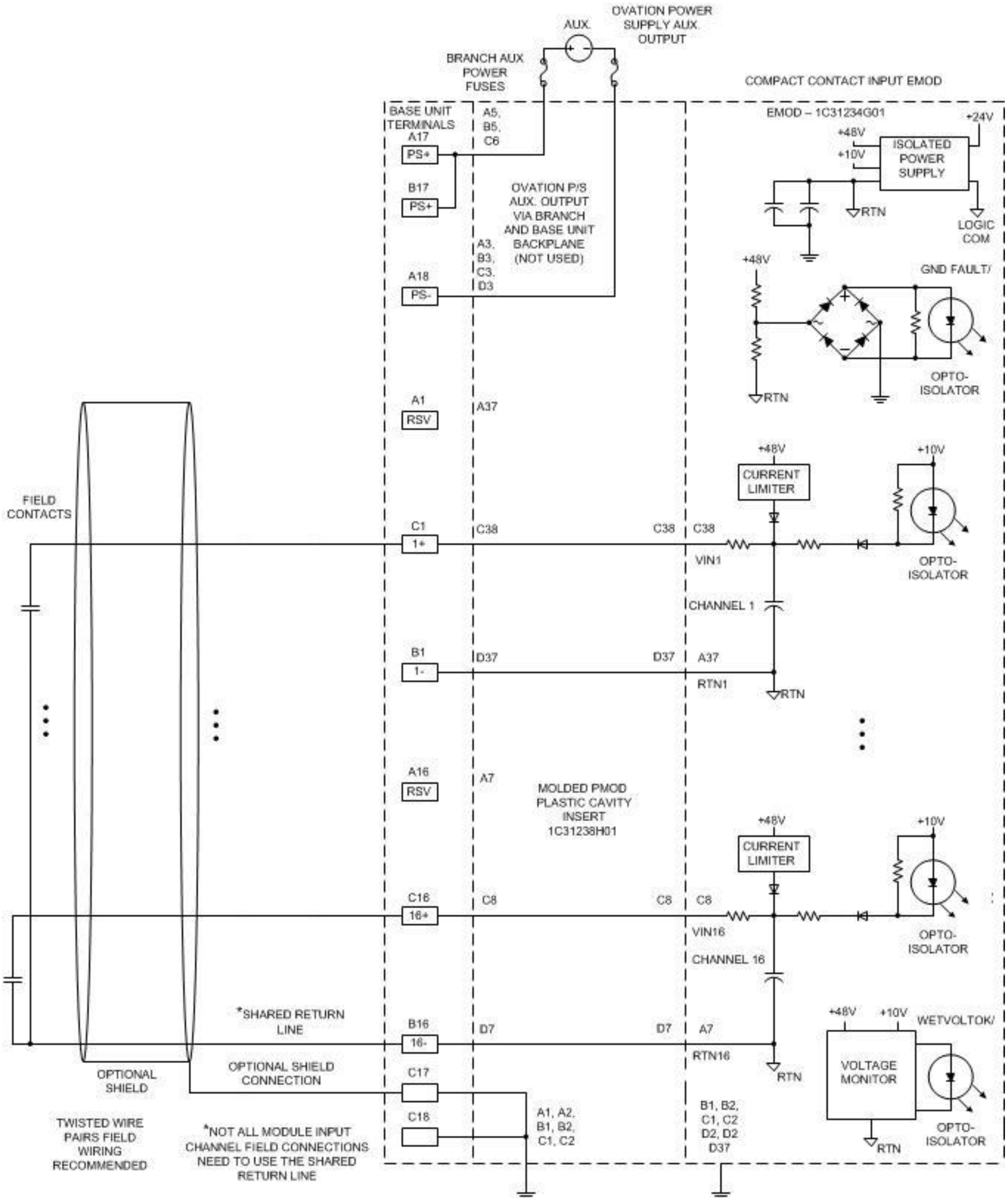
Figure 74: Cable impedances in field wiring

6.5.8 Field wiring diagrams - (CCDI)



16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SEPARATE RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

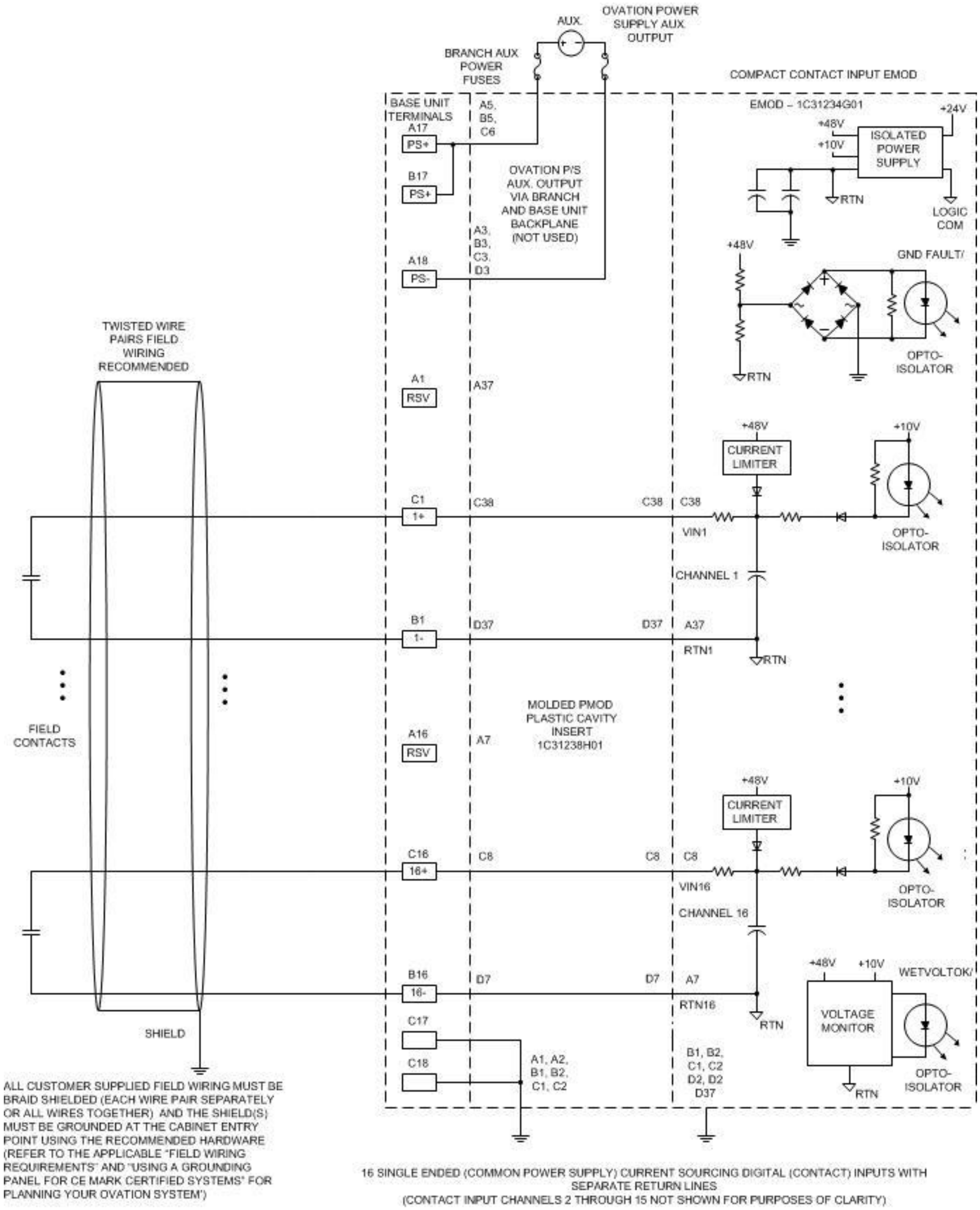
FIELD CONNECTIONS FOR THE COMPACT CONTACT INPUT MODULE (NON-CE MARK)



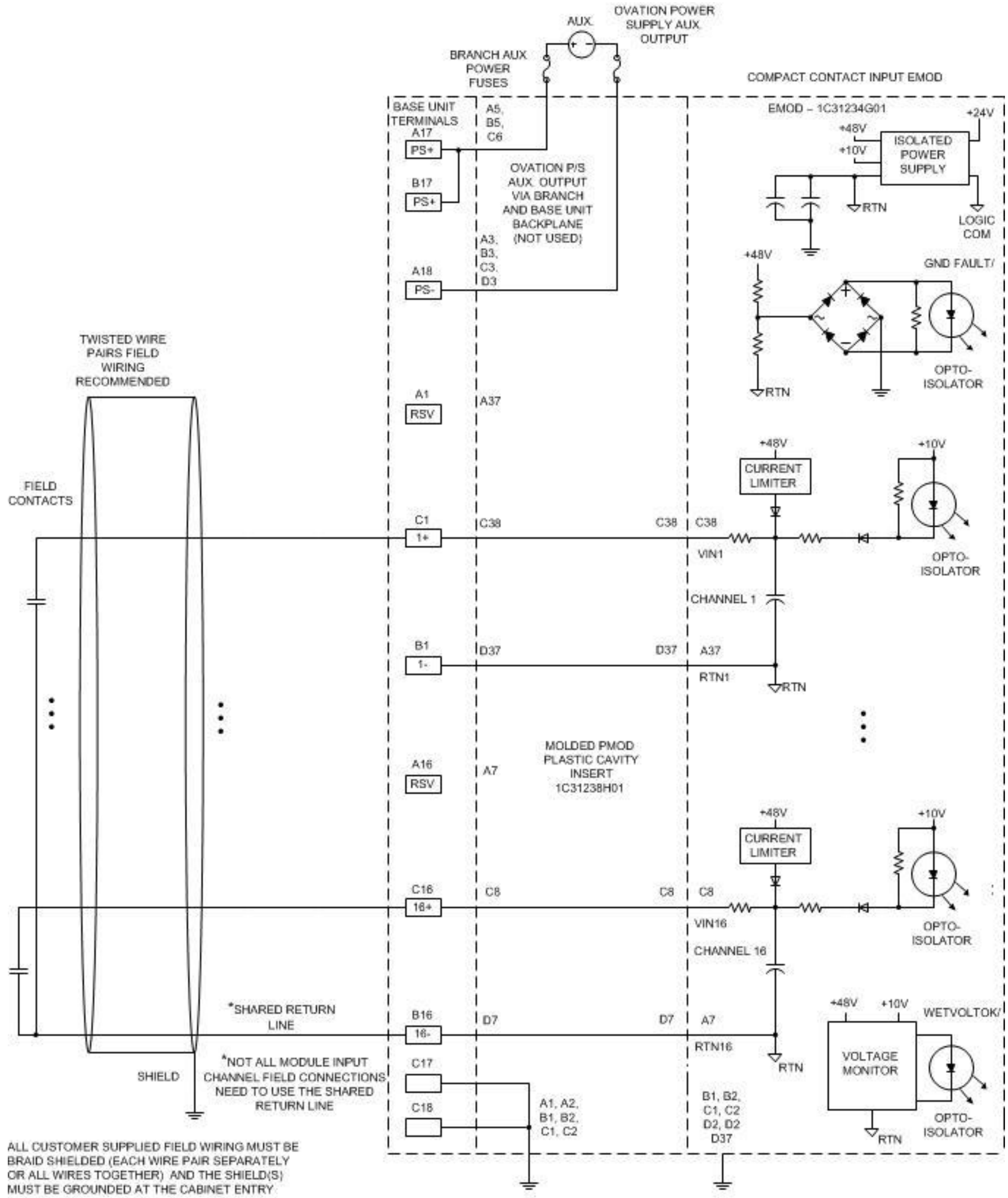
16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SHARED RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS FOR THE COMPACT CONTACT INPUT MODULE (NON-CE MARK)

6.5.9 Field connection wiring diagrams (CE Mark) - (CCDI)



FIELD CONNECTIONS FOR THE COMPACT CONTACT INPUT MODULE (CE MARK)



ALL CUSTOMER SUPPLIED FIELD WIRING MUST BE BRAID SHIELDED (EACH WIRE PAIR SEPARATELY OR ALL WIRES TOGETHER) AND THE SHIELD(S) MUST BE GROUNDED AT THE CABINET ENTRY POINT USING THE RECOMMENDED HARDWARE (REFER TO THE APPLICABLE "FIELD WIRING REQUIREMENTS" AND "USING A GROUNDING PANEL FOR CE MARK CERTIFIED SYSTEMS" FOR PLANNING YOUR OVATION SYSTEM")

16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SHARED RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS FOR THE COMPACT CONTACT INPUT MODULE (CE MARK)

6.5.10 Register configuration/address information - (ContactDI) & (CCDI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Contact (and Compact Contact) Input configuration/status register (address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module 1 = configure 0 = unconfigure, causing an attention status	Module Configured 1 = configured 0 = unconfigured
1	Force Error 1 = force an attention status to be read by Controller 0 = no forced error	Forced error 1 = forced error set by Controller 0 = no forced error
2-5	Not defined	Not defined
6-7	Reserved	Reserved
8	Not defined	Wetting Voltage Failure 1 = +48V wetting Voltage Failed 0 = +48V wetting Voltage OK.
9	Ground Fault Attention Enable 1 = configure GND fault to cause an attention status 0 = configure GND fault to not cause an attention status	Ground Fault Attention Enable 1 = GND fault causes attention status 0 = GND fault does not cause an attention status
10	Not defined	Ground Fault 1 = field wiring has a ground fault 0 = field wiring does not have a ground fault
11-15	Not defined	Not defined

The bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: After the Contact Input module power is cycled, this bit is “0.” A “1” must be written to the Configure module bit. If the module is not configured in this manner, an attention status is sent to the Controller upon an attempt to read the point data. The bit may be read back through the Status Register.

Bit 1: The Force Error bit is “0” after the Contact Input module power is cycled. If the Controller sets the Force Error bit, an attention status is issued. The bit may be read back through the Status Register.

Bits 2-5: These bits are not defined.

Bit 6 & 7: These bits are reserved in the Status Register.

Bit 8: This bit is set in the Status Register if the +48V supply on the FCI board fails.

Bit 9: The GND Fault Attention Enable bit is "0" after the Contact Input module power is cycled. This bit must be set by the Controller if a ground fault is to be treated as a catastrophic failure. If Bit 9 is set, a ground fault causes an attention status to be returned to the Controller upon accessing the module, and no point data can be read. If the bit is not set, a ground fault does not inhibit the Controller from reading point data. In the latter case, if more than one ground fault occurs on the field wiring to a Contact Input module, false point data may possibly be read on channels with open contacts.

Bit 10: This bit is set in the Status Register if a ground fault occurs in the field wiring. This bit is not defined in Configuration Register.
Bits 11-15: These bits are not defined in the Configuration register and are read as high in the Status register. These bits cannot be accessed by the Controller during a write to the module.

6.5.11 Power Checking (ContactDI - CCDI)

The module has an internal 48 transistor voltage supply and is capable of looking at 16 different contact inputs. Each input that is connected to a dry contact requires a digital point name or packed group point name with bit position. A closed contact will produce a one (true) value for the associated point whereas an open contact produces a zero (false) value. If the power supply were to fail, all points would have a zero (false) value.

Power on checking uses one of the sixteen inputs to verify that the 48 volt supply has not failed. The selected point is hard wired to simulate a closed contact, and should therefore always be a one (true) statement.

To implement the feature, when building the points for the field inputs, within the point config tab, the power on checking is enabled, and the channel is used (hardwired) is declared. When the field inputs are scanned, the hard wired channel is also scanned to verify that it has a value of one. If not, the field inputs will be tagged with "bad quality".

If desired, a point may be built for the hard wired channel and be set to alarm on zero.

Note: *The terminal wiring for the Contact Digital Input and Compact Contact Digital Input modules is different.*

6.5.12 Diagnostic Logic card LEDs - (CCDI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit when GND Fault bit (Bit 10) of the Status Register is set. This indicates that a ground fault has occurred in the field wiring. An attention status is generated when the External Fault LED is lit only if the GND Fault Attention Enable bit (Bit 9) is set.
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set or when the on-board +48V/+10/V wetting power supply fails. Also lit when a timeout of the watchdog timer occurs when Controller stops communicating with module. An attention status is always generated when the LED is lit.
1 - 16 (Green)	Point Status LEDs 1-16. Lit when the input contact of the LED's corresponding channel is closed.

6.5.13 Specifications - (CCDI)

Description	Value
Number of channels	16
On board auxiliary power supply	42 V minimum 55 V Maximum
Propagation delay	7 mSec Maximum
Contact bounce rejection Always rejects contact change of state Always accepts contact change of state	 < 3 mSec > 7 mSec
Closed contact output current	4 mA minimum 8 mA Maximum
Diagnostics	Internal module operating faults, Ground Fault Detection
Dielectric isolation: Channel to logic	 1000 V AC/DC
Module power	4.56 W typical 4.75 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

6.6 Sequence of Events Digital Input module - (SEDI)

The Sequence of Events (SOE) module provides 16 digital channels to monitor the open or closed state of digital inputs or contacts in the field. The module provides a filter to reject changes of state less than four milliseconds. The Sequence of Events module can also perform event tagging and chatter control for each input channel.

The Ovation Controller writes a channel event tagging mask to the Electronics module to enable event tagging for specific input channels. It has a chatter control flag for each channel to indicate that an input channel has changed state too many times in a period of time or is changing state at too fast a rate. It also has a channel ID to indicate which channel changed state.

Each channel is checked every 125 microseconds. If the channel event tagging mask bit is zero, that channel is not checked. Time synchronization is accomplished by the Ovation Controller writing a time reference simultaneously to all Sequence of Events modules with a one millisecond resolution.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules. All SOE modules in a Controller MUST be connected to the IOIC card that is configured as the Time Keeper.*

A control bit written by the Ovation Controller provides two options for handling input chatter:

- The first option sets the chatter control flag if the rate of change for an input is greater than 1 per 100 milliseconds.
- The second option sets the chatter control flag if four or more state changes occur on an input between reads of the event buffer.

There are two 32 event buffers. This allows the event tagging and chatter control function to be writing into one event buffer while the Ovation Controller is reading the other event buffer. The Ovation Controller only reads each module a small portion of the loop time. This allows both event buffers to be available the rest of the loop time.

Each event buffer contains 64 words with up to 32 Channel-IDs and 32 Event-Times. The event buffers are memories. The memory control circuit controls which event buffer to write into and which event buffer to read from. Before reading the event buffer, the buffer status register must be read to determine the number of words to read.

The Sequence of Events module is a CE Mark certified module.

CAUTION! (For CE Mark certified systems) Any base unit that contains a 125VDC Sequence of Events Electronics module (1C31157G02) with differential Digital Input Personality module (1C31110G02) and interfaces to hazardous voltage (>60 VDC) must include a hazardous voltage warning label (1B30025H01) on that base unit.

Any base unit that contains a 125VDC Sequence of Events Electronics module (1C31157G02) with single-ended Digital Input Personality module (1C31110G01) and interfaces to hazardous voltage (>60 VDC) must include a hazardous voltage warning label (1B30025H01) on ALL base units on the branch.

Place this label in a visible location on the base unit, preferably above the spare fuse location. The project drawings must indicate this.

6.6.1 Electronics modules (Emod) - (SEDI)

- **1C31157G01** provides for 24/48 VDC single-ended or differential inputs.
- **1C31157G02** provides for 125 VDC single-ended or differential inputs.

6.6.2 Personality modules (Pmod) - (SEDI)

- **1C31110G01** (single-ended inputs) and **1C31110G02** (differential input) are used for digital input (see page 254).

6.6.3 Subsystems - (SEDI)

Sequence of Events Digital Input subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24/48 VDC Single-ended (Legacy)	16	1C31157G01	1C31110G01
Differential (Legacy)	16	1C31157G01	1C31110G02
125 VDC Single-ended (Legacy)		1C31157G02	1C31110G01
Differential (Legacy)	16	1C31157G02	1C31110G02
All module configurations listed in the table are CE Mark certified unless they contain a 5FDI.			

When the 125VDC Sequence of Events Digital Input Emod (1C31157G02) is used in applications without the un-fused Differential Pmod (1C31110G02), external fusing or other current limiting devices are recommended on the hazardous inputs to provide protection to the external wiring and power source.

6.6.4 External power supply information - (SEDI)

If the Sequence of Events Digital Input module uses the 1C31110G01 Personality module (configured for 16 single-ended inputs), the required voltage source may be obtained from the internal auxiliary power supply (backplane) or it may be obtained from an external power supply.

If an external power supply is used, Using an External Power Supply (see page 799) contains steps to be undertaken before connecting the external power supply to the Sequence of Events Digital Input module base unit terminal block.

6.6.5 Wiring information - (SEDI)

The Sequence of Events modules can be divided into two types depending on their front end connections. The digital Input field Interface modules can be broken down further into Single-Ended and Differential as well as low and high voltage.

The following wiring section topics are divided to show the wiring of the Sequence of Events Digital Input Field Interface modules and then the Sequence of Events Contact Field Interface modules.

6.6.6 Field interface - (SEDI)

The Digital Input configuration contains 16 channels, where each channel has voltage level sensing circuitry used to detect whether an input is on or off. The Sequence of Events module has 16 galvanically isolated differential inputs to accommodate separate external auxiliary supplies, or 16 single-ended (common return) digital inputs with an on-card blown fuse detector to accommodate a common external auxiliary supply for all channels. The selection of the Personality module determines if the inputs are differential or single-ended. The input voltage level monitored by the module is determined by the particular card group in the module.

The field side circuitry for the single-ended configuration and the differential configuration is shown under Field Wiring Considerations for the Digital Input Configuration (see page 256). An input resistor provides the normal mode surge protection and limits the current during normal operation. An opto-isolator provides high dielectric isolation between the field side and the logic or I/O bus side. The Single-Ended Digital Input configuration has a circuit used to monitor the presence of the wetting supply. Two cases cause this monitor circuitry to report a blown fuse status and issue an attention status to the Ovation Controller:

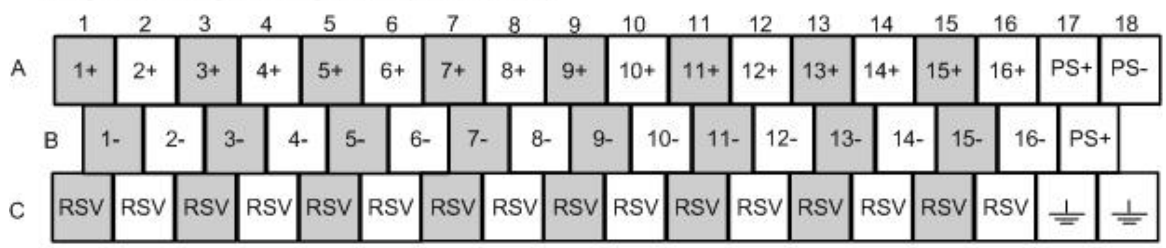
- Fuse is blown on the PDIA.
- Auxiliary supply level is lower than minimum On Input Voltage.

6.6.7 Terminal block wiring information - (SEDI)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The diagrams for the Sequence of Events digital input Personality modules are illustrated below.

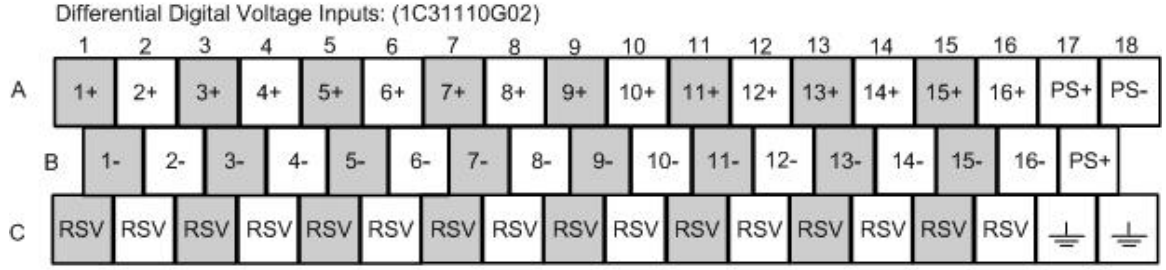
Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Single-Ended Digital Voltage Input: (1C31110G01)



Note: Forced signals are present on the reserved (RSV) pins due to backplane connections.

Differential Digital Voltage Inputs: (1C31110G02)

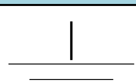


Notes:
1. Forced signals are present on the reserved (RSV) pins due to backplane connections.
2. Each channel has a diode bridge at the front-end; therefore, inputs to Row A and B are reversible.
3. The terminal block label indicates polarity only to be uniform with other terminal block labels where Row A is for high-side (+) signals, and Row B is for return (-) signals.

Figure 75: Terminal block connections for the Sequence of Events Digital Input Pmods

The following table lists the abbreviations used in the terminal block diagrams.

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals
1+ through 16+	Digital input positive terminal connection
1- through 16-	Digital input negative terminal connection
PS+, PS-	Auxiliary Power Supply terminals

ABBREVIATION	DEFINITION
RSV	Reserved terminal. No connection allowed on these terminals

Note: *Do **not** use unmarked terminal block locations.*

6.6.8 Field wiring configuration considerations - (SEDI)

The following minimum leakage resistances of the cable and the interface devices apply:

24 VDC - 100 K ohms
48 VDC - 150 K ohms
125 VDC - 250 K ohms

6.6.9 Field wiring diagrams configuration - (SEDI)

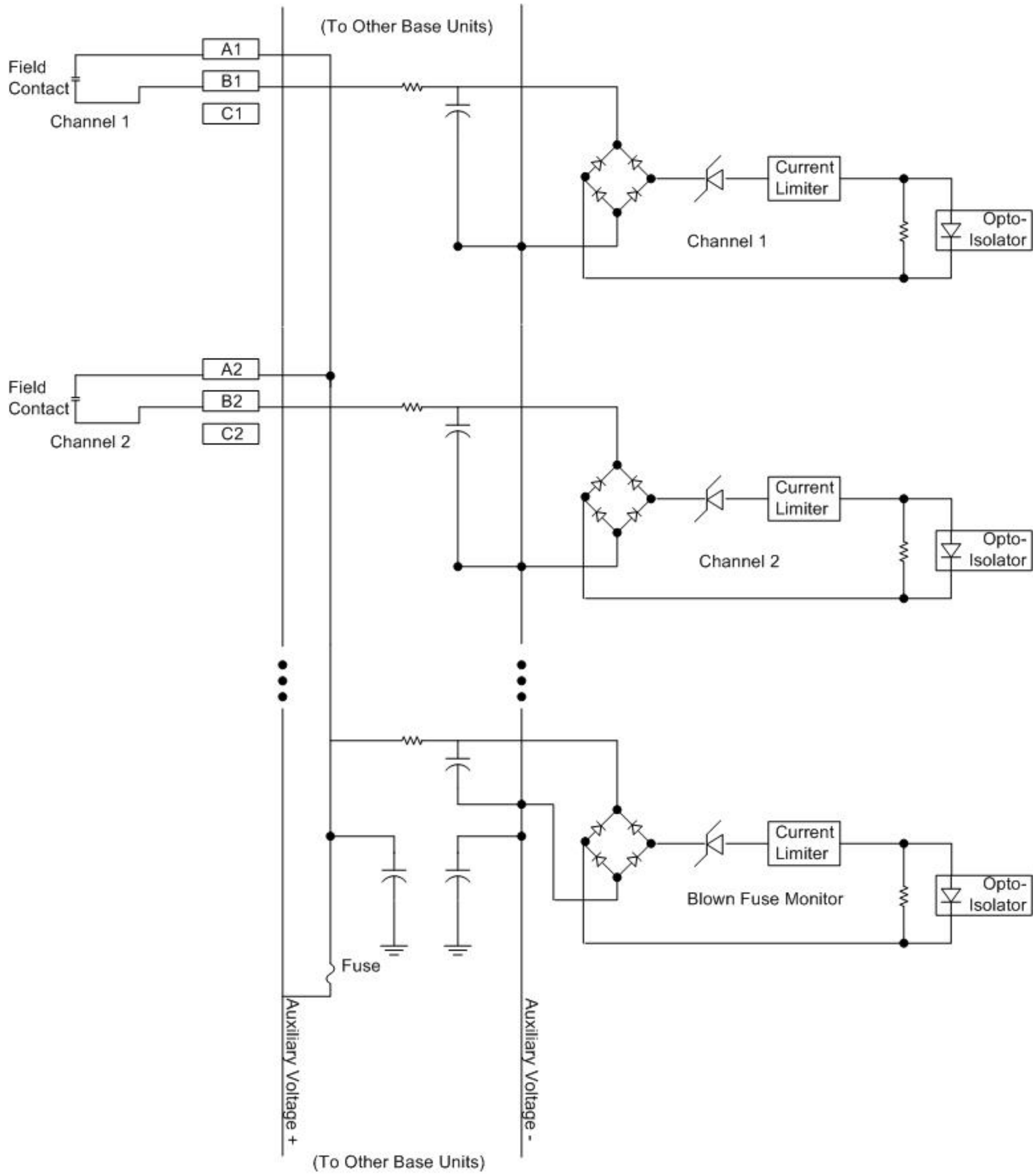


Figure 76: Sequence of Events module single-ended Digital Input front end

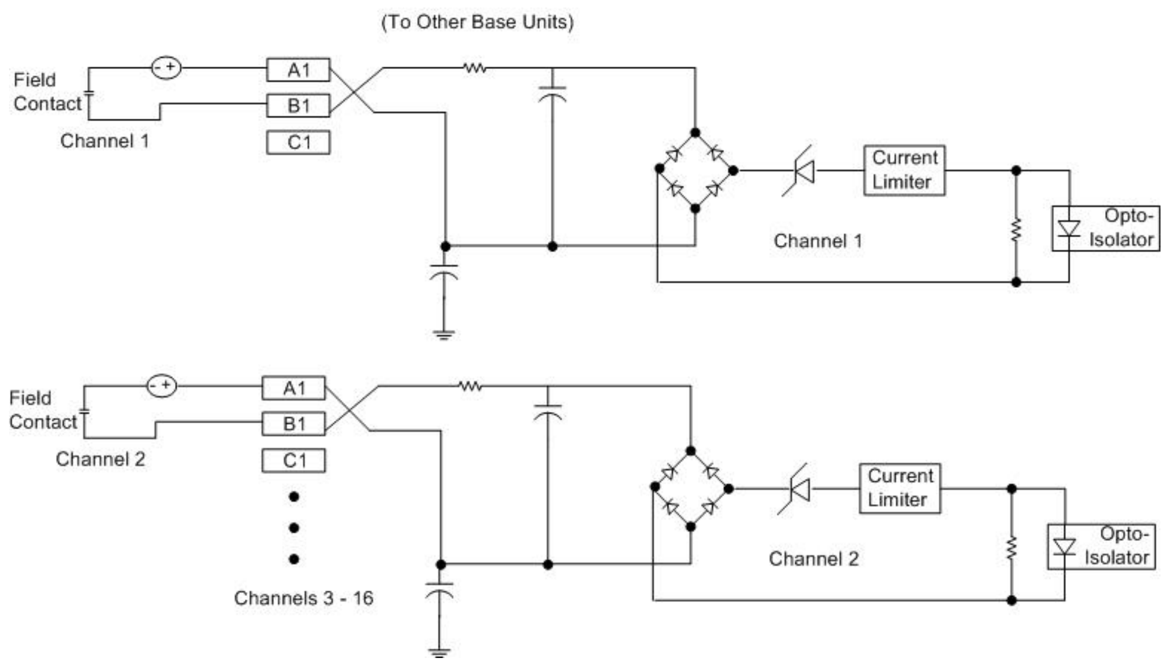
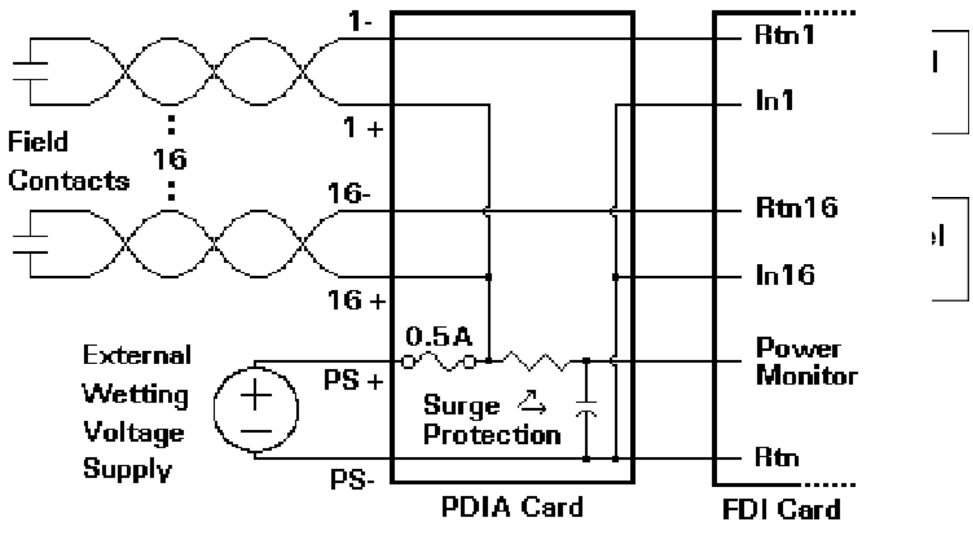


Figure 77: Sequence of Events module differential Digital Input front end

6.6.10 Field connection wiring diagrams - (SEDI)

Single-Ended Digital Voltage Inputs



Differential Digital Voltage Inputs

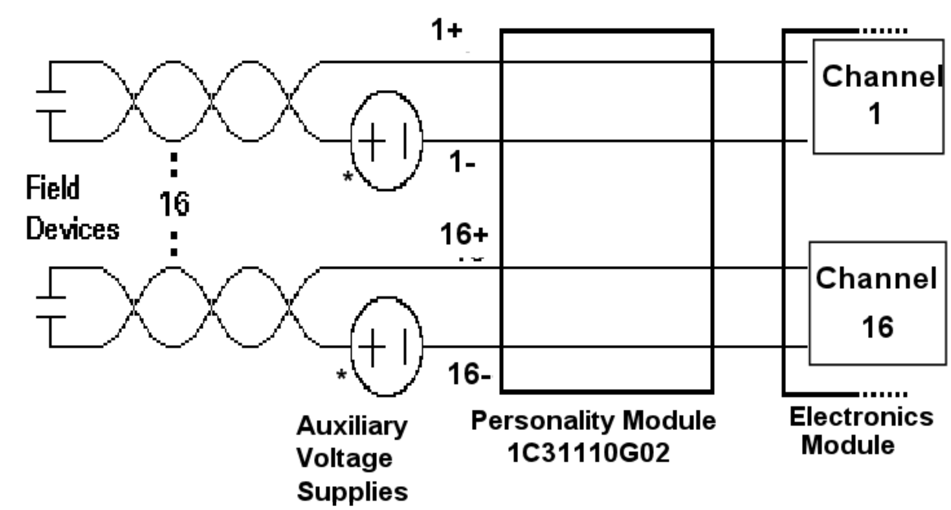


Figure 78: Field connections for the SOE Digital Input Pmod

6.6.11 Field connection wiring diagrams (CE Mark) - (SEDI)

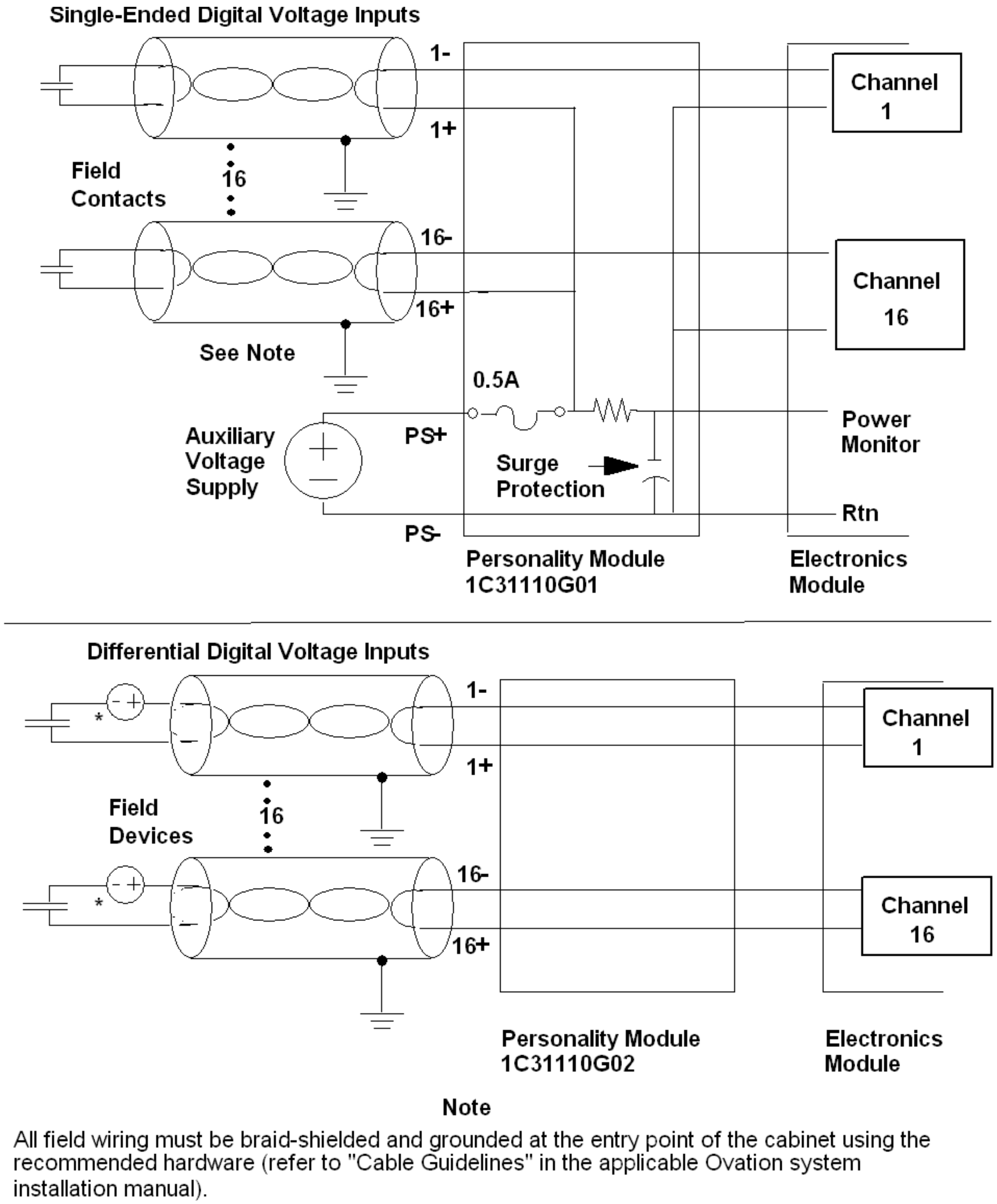


Figure 79: Field connections for the SOE Digital Input Pmod (CE Mark)

6.6.12 Register configuration/address information - (SEDI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Sequence of Events Digital Input configuration/Status Register (address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module	Module configured (1 = configured; 0=not configured)
1	Force internal error	Internal error (1 = forced error; 0=no forced error)
2 - 5	Not used. Should be set to zero (0).	Not used
6	Enable digital input blown fuse signal and module attention for blown fuse	Status of enable digital input blown fuse signal and module attention for blown fuse
7	Not used. Should be set to zero (0).	Blown fuse for digital input
8	Contact input field card (enable contact input auxiliary voltage failure signal and module attention for auxiliary voltage failure and ground fault detection)	Status of contact input field card (enable contact input auxiliary voltage failure signal and module attention for auxiliary voltage failure and ground fault detection circuitry)
9	Not used. Should be set to zero (0).	Auxiliary voltage failure for contact input
10	Enable module attention for a GND fault.	Status of Enable module attention for a GND fault.
11	Not used. Should be set to zero (0).	GND fault
12	Disable chatter control	Disable chatter control
13	Chatter control option.	Status of chatter control option.
14	Not used. Should be set to zero (0).	Clock synchronized.
15	Not used. Should be set to zero (0).	Not used.

Bit 0: Module does not operate until this bit is set with a write.

Bit 1: When this bit is set, the internal error LED is turned on, and only the status registers can be read.

Bit 6: This bit should be set for a single-ended input and cleared for a differential input.

Bits 8 - 10: These bits should be cleared to zero (0).

Bit 12: When this bit is set and an input channel is not masked off, that input can chatter and each event is recorded until the event buffer overflows. Default state is “0” and enables the chatter control function.

Bit 13: When this bit is set, chatter is flagged when an input changes state four or more times between event buffer reads. When cleared, chatter is flagged for state changes greater than 1 per 100 milliseconds.

Bits 14 - 15: Not used in the Configuration Register. Bit 14 is clock synchronized in the Status Register.

Word address 14 (E in Hex) is used to enable or disable the channel event tagging mask.

Secondary/expansion configuration/status register (address 14 or E in Hex)

Bit	Data Description - Configuration (Write)	Data Description - Status (Read)
0 - 15	Channel Event Tagging mask	Channel Event Tagging mask

6.6.13 Diagnostic Logic card LEDs - (SEDI) - (SECompactDI)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	For Single-ended Digital Input: Lit when fuse blows or there is a loss of the auxiliary power supply (only when Bit 6 of Configuration register is set; then Bit 7 of the Status register is set). For Differential Digital Input: Not lit since the configuration bit is not set, and the blown fuse signal from the field card is ignored.
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set, or when a timeout of the watchdog timer occurs when the Controller stops communicating with the module. Also lit when Controller stops communicating with the module.
1 - 16 (Green)	Lit when the input voltage of the LED's corresponding channel is greater than the channel's minimum "On Input Voltage."

6.6.14 Specifications - (SEDI)

- **Electronics module (1C31157G01 and 1C31157G02)**
- **Personality module (1C31110G01 and 1C31110G02)**

Description	Value
Number of channels	16
Input range (single-ended or differential) [1]	Refer to the table below
Propagation delay of contact change of state [2] 24V/48V DC 125VDC	 3.75 mSec minimum; 4.25 mSec Maximum 3.75 mSec minimum; 4.45 mSec Maximum
Signal rejection Always rejects change of state Always accepts change of state	 < 3.87 mSec > 4.13 mSec
Cable length (quality is 50pF/ft or better)	1000 feet Maximum
Diagnostics	Internal module operating faults and Blown fuse detection. [3]

DESCRIPTION	VALUE
Dielectric isolation: Channel to channel [4] Channel to logic	 1000 V DC 500 V AC 1000 V AC/DC
Module power from logic supply	Main: 1.44 W typical, 1.8 W Maximum
Operating temperature range	0 to 60×C (32×F to 140×F)
Storage temperature range	-40×C to 85×C (-40×F to 185×F)
Humidity (non-condensing)	0 to 95%
[1] Input range level is dependent on module group. [2] Does not include cable capacitance. [3] Blown fuse detection applies to single-ended channel configuration only, where an on-board fuse is provided for the auxiliary power supply. [4] Channel to channel isolation applies to differential channel configuration only.	

Sequence of Events Digital Input ranges

INPUT LEVEL	ON INPUT VOLTAGE (VDC)		OFF INPUT VOLTAGE (VDC)	ON INPUT CURRENT (MA)		OFF INPUT (WATTS)	INPUT POWER TYPICAL
	Min	**Max**	**Min**	**Min**	**Max**	**Max**	
24 VDC	18	60	9	0.9	2.6	0.3	1.1
48 VDC	18	60	9	0.9	2.6	0.3	2.2
125 VDC	80	140	55	0.6	1.5	0.3	3.3

6.7 Sequence of Events Contact Digital Input Field Interface module - (SEContactDI)

The Contact Input configuration provides 16 contact input current detecting channels with common returns. The field side circuitry and terminal connections for three of these channels are shown in Field Wiring Diagrams for the Contact Input Configuration (see page 266).

A +48V on-board power supply provides current limited contact wetting voltage if the contact is open. If the contact closes, current is drawn from the +10V supply which turns on the associated opto-isolator; thereby, relaying a closed contact state to the I/O bus. The opto-isolators and the isolation provided by the 10V and 48 V power supply provide high dielectric isolation between the field side and the logic or I/O bus side.

There are two methods of wiring field devices to the termination block. Each field contact may have a separate input and return line as shown for channel 1. Alternatively, field contacts wired to the same module may share a return line as shown for channels 2 and 3. For either wiring method, **do not** tie the contact return line to earth ground or a ground fault condition occurs as well as a degradation of the common mode surge protection.

Ground fault detection circuitry on the Sequence of Events module with Contact Inputs activates when the input or return line for any channel finds a low impedance (<10K ohms) path to earth ground. A single wire with a ground fault does not cause an error in the point data, but multiple ground faults (if they include input and return lines) could cause faulty data (that is, channels appearing as if their contacts are closed when they are really open).

When a ground fault occurs, the external error LED lights, and the GND Fault bit 11 in the Status Register is set. If the GND Fault Attention Enable bit 8 is set in the Configuration Register, a ground fault is seen as a catastrophic error causing an attention status to be sent back to the Controller. See Field Wiring Diagrams for the Contact Input Configuration (see page 266) for ground fault detection circuitry.

6.7.1 Electronics modules (Emod) - (SEContactDI)

1C31157G03 (Contact Input) provides for 48 VDC on-card auxiliary power.

6.7.2 Personality modules (Emod) - (SEContactDI)

1C31110G03 (Contact Input) provides for 48 VDC on-card auxiliary power.

6.7.3 Subsystems - (SEContactDI)

Sequence of Events Contact Digital Input Field interface subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Contact Input w/ 48 VDC On-Card auxiliary (Legacy)	16	1C31157G03	1C31110G03
All module configurations listed in the table are CE Mark certified unless they contain a 5FDI.			

6.7.4 Field wiring restrictions - (SEContactDI)

The following definitions apply to the restrictions listed below:

- Rshunt = contact shunt resistance
- Rcontact = resistance associated with a closed contact
- Rreturn = resistance of the common return line
- Rline = resistance of the non-common cable length to and from the contact
- Rwiring = Rcontact + Rline + 16Rreturn
- Rfault = resistance from either line to ground which causes a ground fault

Field Wiring Diagrams for the Contact Input Configuration (see page 266) shows possible cable resistances that affect contact input performance. The following restrictions apply:

- Under no-ground-fault conditions or if the channel return (low) line has a ground fault:
  - Rshunt across contact must be greater than or equal to 10k ohms to always recognize an open contact as open.
  - Rshunt across contact must be greater than or equal to 50k ohms to maintain the high level contact-wetting voltage.
- If the input connection from a channel has a ground fault with the contact open:
  - Rshunt across contact must be greater than or equal to 150k ohms to guarantee ground fault is detected.
- For a ground fault on the input or return connection to a channel:
  - Rfault from either line to ground must be less than or equal to 5K ohms to guarantee detection of the ground fault.
- With or without ground fault conditions:
  - Rwiring through field wiring to contact must be less than 100 ohms to always recognize a closed contact as closed.

6.7.5 Field Wiring Diagrams - (SEContactDI)

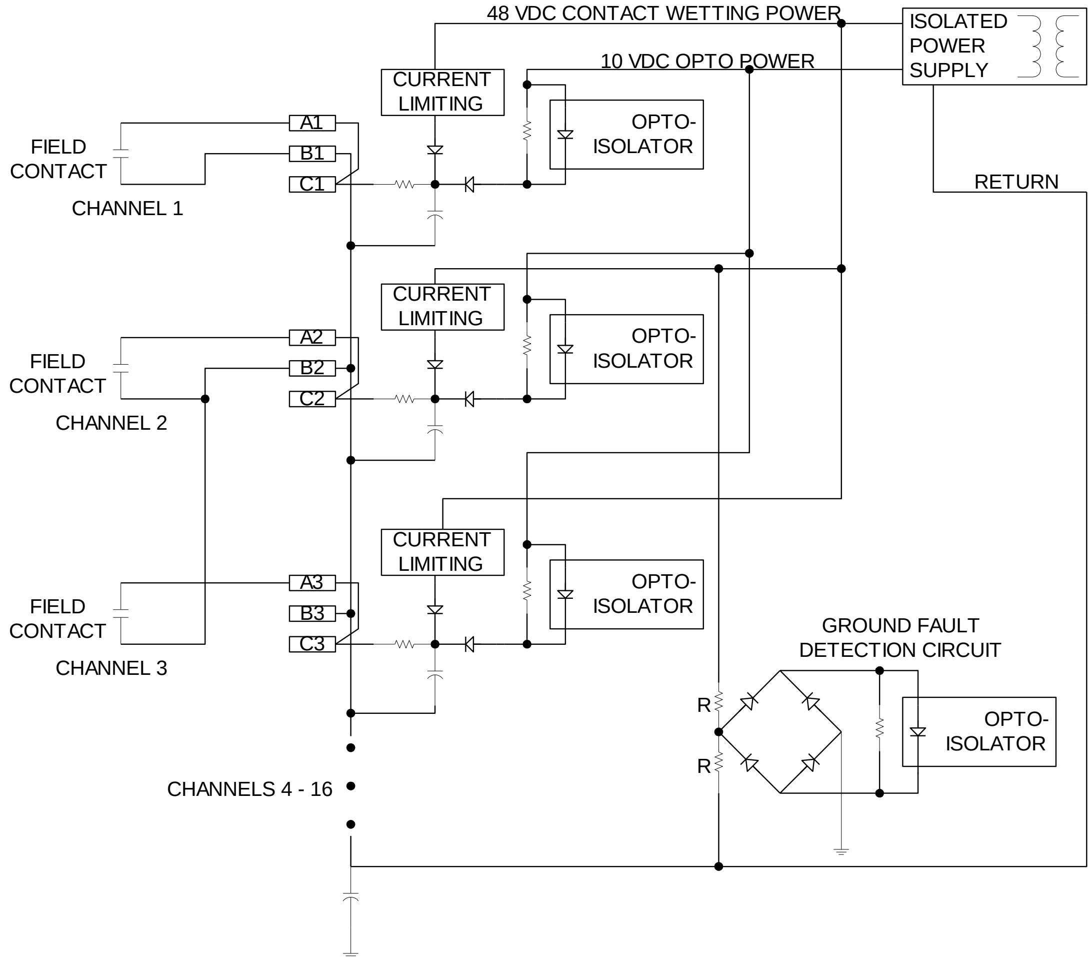


Figure 80: Sequence of Events Module Contact Input Front End

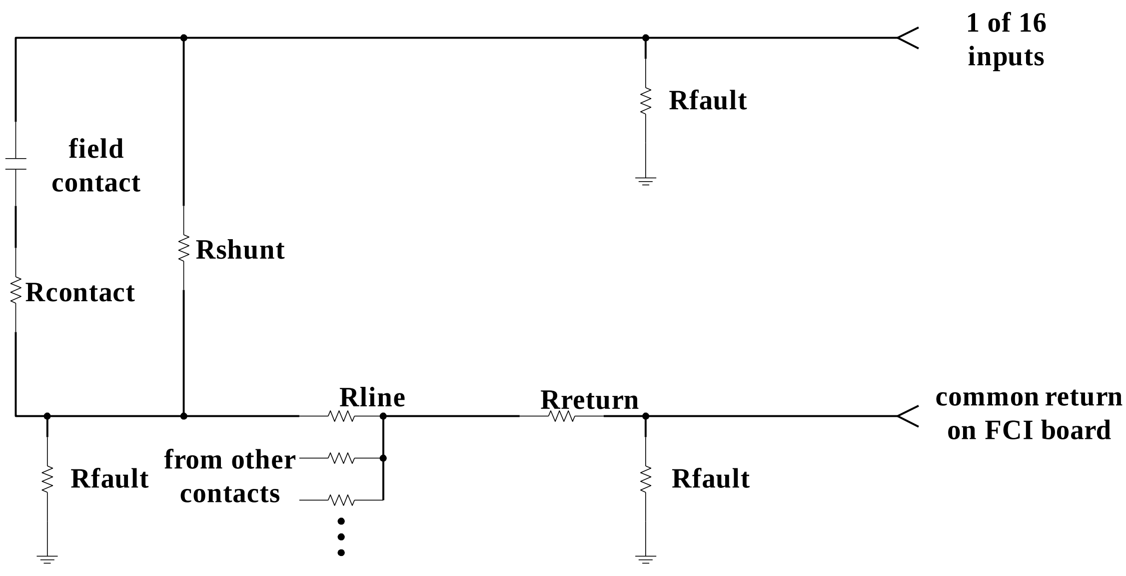


Figure 81: Cable Impedances in Field Wiring

6.7.6 Field wiring cable lengths - (SEContactDI)

The following two tables list the Maximum cable lengths for field wiring to the contacts. For both, assume Rcontact is 0 ohms.

The table below applies when there are individual common return lines brought to the card edge. This implies that Rreturn is 0 ohms.

Maximum cable length for 16 individual common returns

Wire Gauge	Ohms per Thousand Feet (Solid Copper Wire)	Maximum Cable Length (Thousands of Feet)
18	6.64	7.5
20	10.2	4.9
22	16.2	3.0

The table below applies when all 16 channels share a common return line. In both tables, the Maximum Cable Length is the length of the cables from the termination block to the contacts in the field.

Maximum cable length for a single common return for all 16 inputs

Wire Gauge	Ohms per Thousand Feet (Solid Copper Wire)	Maximum Cable Length (Thousands of Feet)
12	1.66	3.54
14	2.27	2.59
16	4.18	1.40
18	6.64	0.89

6.7.7 Terminal block wiring information - (SEContactDI)

The diagram for the Sequence of Events contact input Personality module is illustrated in the figure below.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

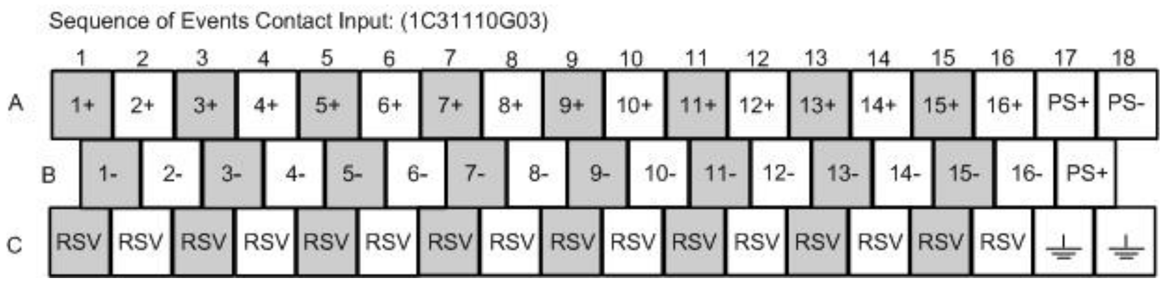
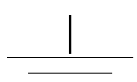


Figure 82: Terminal block connections for the Sequence of Events Contact Input Personality modules

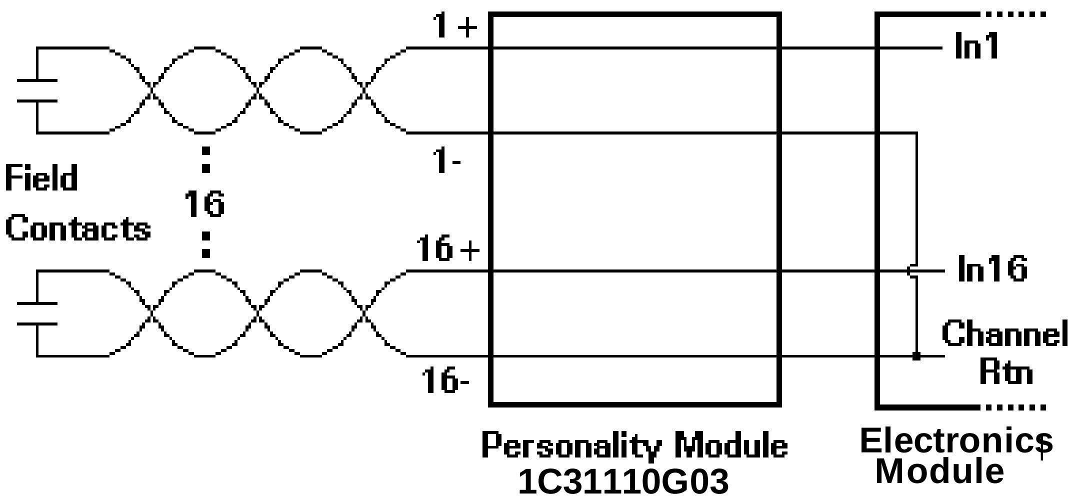
The following table lists and defines the abbreviations used in this diagram.

Abbreviations used in wiring diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals.
1+ through 16+	Contact input positive terminal connection.
1- through 16-	Contact input negative terminal connection.
PS+, PS-	Auxiliary Power Supply terminals.
RSV	Reserved terminal. No connection allowed on these terminals.

Note: *Do **not** use terminal block locations marked RSV.*

6.7.8 Field connection wiring diagrams - (SEContactDI)



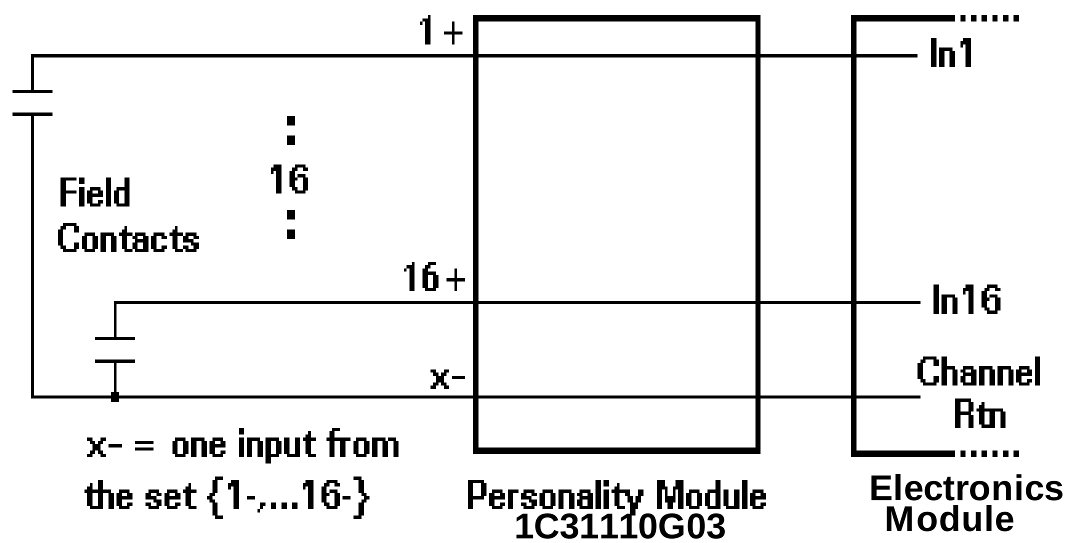
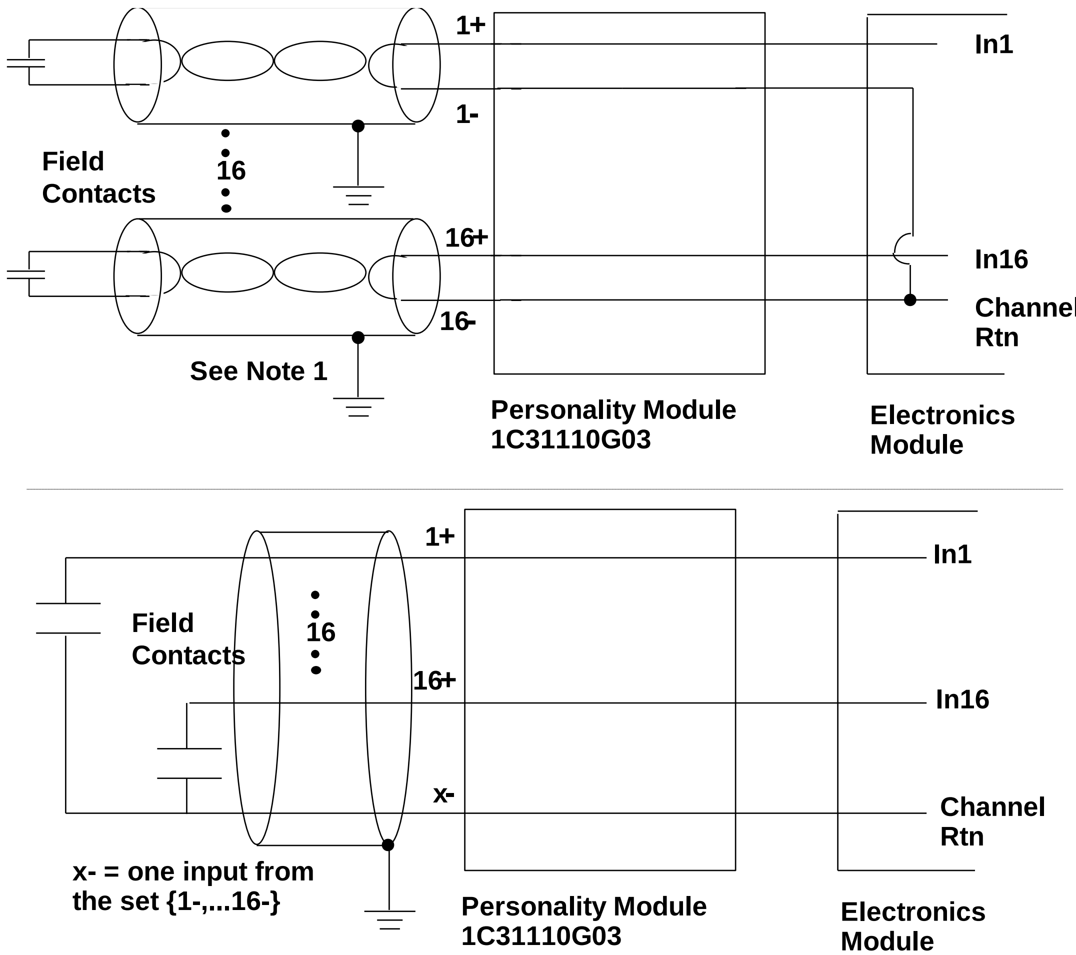


Figure 83: Field connections for the SOE Contact Input Pmod

6.7.9 Field connection wiring diagrams (CE Mark) - (SEContactDI)



Note

All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to "Cable Guidelines" in the applicable Ovation system installation manual).

Figure 84: Field connection for the SOE Contact Input Pmod (CE Mark)

6.7.10 Diagnostic Logic card LEDs - (SEDI) - (SECompactDI)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	For Single-ended Digital Input: Lit when fuse blows or there is a loss of the auxiliary power supply (only when Bit 6 of Configuration register is set; then Bit 7 of the Status register is set). For Differential Digital Input: Not lit since the configuration bit is not set, and the blown fuse signal from the field card is ignored.

LED	DESCRIPTION
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set, or when a timeout of the watchdog timer occurs when the Controller stops communicating with the module. Also lit when Controller stops communicating with the module.
1 - 16 (Green)	Lit when the input voltage of the LED's corresponding channel is greater than the channel's minimum "On Input Voltage."

6.7.11 Specifications - (SEContactDI)

DESCRIPTION	VALUE
Number of channels	16
On board auxiliary power supply	42 V minimum 55 V Maximum
Signal rejection Always rejects contact change of state. Always accepts contact change of state	 < 3.87 mSec > 4.13 mSec
Propagation delay of contact change of state [1]	3.75 mSec minimum; 4.4 mSec Maximum
Closed contact output current	4 mA minimum, 8 mA Maximum
Diagnostics	Internal module operating faults, Ground Fault Detection
Dielectric isolation: Channel to logic	 1000 V AC/DC
Module power from logic supply	4.56 W typical (all inputs on), 5.0 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
[1] Does not include cable capacitance.	

6.8 Sequence of Events Compact Digital Input Field Interface module - (SECompactDI)

The Compact Sequence of Events (SOE) module provides 16 digital channels to monitor the open or closed state of digital inputs or contacts in the field. The module provides a filter to reject changes of state less than four milliseconds. The Compact Sequence of Events module can also perform event tagging and chatter control for each input channel.

The Ovation Controller writes a channel event tagging mask to the Electronics module to enable event tagging for specific input channels. It has a chatter control flag for each channel to indicate that the input channel has changed state too many times in a period of time, or is changing state at too fast a rate. It also has a channel ID to indicate which channel changed state. Each channel is checked every 125 micro-seconds. If the channel event tagging mask bit is zero, that channel is not checked.

If there is an input channel state change, the change is recorded in the SOE module's Event Buffer and the input channel's Chatter counter is incremented. When the input channel's Chatter counter value reaches four, any additional state changes are not recorded for that input channel. The recording of additional state changes for that input channel is inhibited until the input channel Chatter counter is reset to a zero value.

A control bit written by the Ovation Controller provides two options for resetting an input channel's Chatter counter:

- Each input channel's Chatter counter is reset after the Ovation Controller reads the SOE module's Event Buffer. With this option selected, the SOE module identifies up to four state changes for each of its input channels between successive Ovation Controller Event Buffer read operations.
- Each input channel's Chatter counter is checked every 100 milliseconds and is decremented if its value is greater than zero. When the input channel's Chatter counter value reaches zero, future input channel state changes may be entered into the Event Buffer. With this option selected, an input state change rate greater than 1 per 100 milliseconds results in no new Event Buffer entries for that input channel while a lower input state change rate allows new Event Buffer entries for that input channel.

The Compact Sequence of Events module is a CE Mark certified module.

There are two 32 event buffers which allow the event tagging and chatter control function to be writing into one event buffer while the Ovation Controller is reading the other event buffer. The Ovation Controller only reads each module a small portion of the loop time. This allows both event buffers to be available the rest of the loop time.

Each event buffer contains 64 words with up to 32 Channel-IDs and 32 Event-Times. The event buffers are memories. The memory control circuit controls which event buffer to write into and which event buffer to read from. Before reading the event buffer, the buffer status register must be read to determine the number of words to read.

Time synchronization is accomplished by the Ovation Controller writing a time reference simultaneously to all Sequence of Events modules with a 1 millisecond resolution. The Compact Sequence of Event module is CE Mark applicable.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*
All SOE modules in a Controller MUST be connected to the IOIC card that is configured as the Time Keeper.

CAUTION! Do NOT mix the Compact Sequence of Events module (1C31233) with the Sequence of Events module (1C31157) in the same system.

CAUTION! CE Mark certified systems: Any base unit that contains a 125VDC Compact Sequence of Events Electronics module (1C31233G03) with cavity insert (1C31238H01) and interfaces to hazardous voltage (>60 VDC) must include a hazardous voltage warning label (1B30025H01) on that base unit.
Any base unit containing a 125VDC Compact Sequence of Events Electronics module (1C31233G03) with Fused Digital Input Personality module (5X00034G01) and interfaces to hazardous voltage (>60 VDC) must include a hazardous voltage warning label (1B30025H01) on ALL base units on the branch.
Place this label in a visible location on the base unit, preferably above the spare fuse location. The project drawings must indicate this.

The Compact Sequence of Events module comes in five combinations of Electronics and Personality modules:

- 24/48 VDC single-ended digital input.
- 24/48 VDC differential input.
- 125 VDC single-ended digital input.
- 125 VDC differential input.
- 48 VDC contact input with on card auxiliary supply.

6.8.1 Electronics modules (Emod) - (SECompactDI)

- **1C31233G01** provides for 24/48 VDC single-ended inputs.
- **1C31233G02** provides for 24/48 VDC differential inputs and supports the 16 point individually fused option.
- **1C31233G03** provides for 125 VDC differential inputs and supports the 16 point individually fused option.
- **1C31233G04** (Contact Input) provides for 48 VDC on-card auxiliary power.

6.8.2 Personality modules (Pmod) - (SECompactDI)

A cavity insert is available that fits into the Personality module cavity in the Base Unit and provides wiring information.

- **1C31238H01** Personality Module Cavity Plastic insert
- **5X00034G01** provides for 16 point individual fusing with a common supply.

This is an optional Personality module that is available for use with the differential input Electronics modules (**1C31233G02**, **1C31233G03**) for applications requiring individual point fusing with a common supply.

6.8.3 Subsystems - (SECompactDI)

Sequence of Events Compact Digital Input Field subsystems [1]

Range	Channels	Electronics module	Personality module or Cavity Insert [1]
Compact 24/48 VDC SOE Single-ended digital input	16	1C31233G01	1C31238H01[2] (molded plastic cavity insert)
Compact 24/48 VDC SOE Differential digital input	16	1C31233G02	1C31238H01[2] (molded plastic cavity insert)
Compact 24/48 VDC SOE Single Ended digital input	16	1C31233G02	5X00034G01 (Fused Pmod)
Compact 125 VDC SOE Differential digital input	16	1C31233G03	1C31238H01[2] (molded plastic cavity insert)
Compact 125 VDC SOE Single Ended digital input	16	1C31233G03	5X00034G01 (Fused Pmod)
Compact 48 VDC SOE On-card auxiliary Contact Input w/48V wetting	16	1C31233G04	1C31238H01[2] (molded plastic cavity insert)

[1] All module configurations listed in this table are CE Mark Certified.

[2] This is a cavity insert that fits into the Personality module position and provides a wiring schematic label for the module.

When the 125VDC Compact Digital Input Emod (1C31233G03) is used in applications without the Fused Pmod (5X00034G01), additional external fusing or other current limiting devices are recommended on the hazardous inputs to provide additional protection to the external wiring and power source.

6.8.4 External power supply information - (SECompactDI)

When using the **1C31233G01** single-ended module, or **1C31233G02/G03** with Personality module **5X00034G01**, the required voltage source may be obtained from the internal auxiliary power supply (Controller backplane) or it may be obtained from an external power supply.

If an external power supply is used, Using an External Power Supply (see page 799) contains steps to be undertaken before connecting the external power supply to the Compact Sequence of Events Digital Input module base unit terminal block.

6.8.5 Wiring information - (SECompactDI)

The Compact Sequence of Events modules can be divided into two types depending on their front end connections. The digital Input field Interface modules can be broken down further into Single-Ended and Differential as well as low and high voltage.

The following wiring section topics are divided to show the wiring of the Compact Sequence of Events Digital Input Field Interface modules and then the Compact Sequence of Events Contact Field Interface modules.

6.8.6 Field wiring diagrams configuration (Front end) (G04) - (SECompactDI)

The Contact Input configuration (**1C31233G04**) provides 16 contact input current detecting channels with common returns.

A +48V on-board power supply provides current limited contact wetting voltage if the contact is open. If the contact closes, current is drawn from the +10V supply which turns on the associated opto-isolator; thereby, relaying a closed contact state to the I/O bus. The opto-isolators and the isolation provided by the 10V and 48 Volt power supply provide high dielectric isolation between the field side and the logic or I/O bus side.

On-Board power supply checking

If the +10V on-board power supply were to fail, all points associated with module input channels would have a zero (false) value. One of the sixteen module input channels may be employed to verify the availability of the +10V on-board power supply output voltage. The selected module input channel has a wire jumper hard wired between the channel's positive (+) input terminal and the channel's negative (-) or common input terminal. This hard wired input channel should always be a one (true) if the +10V on-board power supply output voltage is present.

To implement this on-board power supply checking feature when building points for the module's input channels, select power check enable in the Config tab. Also specify the module channel used for the power check feature (1-16). When the module input channels are scanned, the hard wired module input channel is also scanned to verify that it has a value of one. If not, the module input channels will be tagged with "bad quality".

If desired, a point may be built for the hard wired module input channel and be set to alarm on a value of zero.

There are two methods of wiring field devices to the termination block. Each field contact may have a separate input and return line. Alternatively, field contacts wired to the same module may share a return line. For either wiring method, **do not** tie the contact return line to earth ground or a ground fault condition occurs, as well as a degradation of the common mode surge protection.

Ground fault detection circuitry on the Sequence of Events module with Contact Inputs activates when the input or return line for any channel finds a low impedance (<5 K ohms) path to earth ground. A single wire with a ground fault does not cause an error in the point data, but multiple ground faults, if they include input and return lines, could cause faulty data (that is, channels appearing as if their contacts are closed when they are really open).

When a ground fault occurs, the external error LED lights, and the GND Fault bit 11 in the Status Register is set. If the GND Fault Attention Enable bit 8 is set in the Configuration Register, a ground fault is seen as a catastrophic error causing an attention status to be sent back to the Controller. See the following figure below for ground fault detection circuitry.

6.8.7 Field interface - (SECompactDI)

The Digital Input configuration contains 16 channels, where each channel has voltage level sensing circuitry used to detect whether an input is on or off. Style 1C31233G02/G03 has 16 galvanically isolated differential inputs to accommodate separate external auxiliary supplies. Style **1C31233G01** has 16 single-ended (common return) digital inputs with an on-card blown fuse detect to accommodate a common external auxiliary supply for all channels. The input voltage level monitored by the module is determined by the particular card group in the module.

Also, Style **1C31233G02/G03** can be used with the individually fused Personality module **5X00034G01** for applications requiring individual point fusing with a common supply.

An input resistor provides the normal mode surge protection and limits the current during normal operation. An opto-isolator provides high dielectric isolation between the field side and the logic or I/O bus side. The Single-Ended Digital Input configuration has a circuit used to monitor the presence of the wetting supply. Two cases cause this monitor circuitry to report a blown fuse status and issue an attention status to the Ovation Controller:

- Fuse is blown on the module.
- Auxiliary supply level is lower than minimum On Input Voltage.

6.8.8 Field wiring field interface restrictions (G01-G03) - (SECompactDI)

The following minimum leakage resistances of the cable and the interface devices apply:

24 VDC - 100 K ohms; 48 VDC - 150 K ohms; 125 VDC 250 K ohms

6.8.9 Field wiring cable lengths (G04) - (SECompactDI)

The following two tables list the Maximum cable lengths for field wiring to the contacts. For both, assume Rcontact is 0 ohms.

The table below applies when there are individual common return lines brought to the card edge. This implies that Rreturn is 0 ohms.

Maximum cable length for 16 individual common returns

Wire Gauge	Ohms per Thousand Feet (Solid Copper Wire)	Maximum Cable Length(Thousands of Feet)
18	6.64	7.5
20	10.2	4.9
22	16.2	3.0

The table below applies when all 16 channels share a common return line. In both tables, the Maximum cable length is the length of the cables from the termination block to the contacts in the field.

Maximum cable length for a single common return for all 16 inputs

Wire Gauge	Ohms per Thousand Feet (Solid Copper Wire)	Maximum Cable Length (Thousands of Feet)
12	1.66	3.54
14	2.27	2.59
16	4.18	1.40
18	6.64	0.89

6.8.10 Field Wiring Restrictions (G04) - (SECompactDI)

The following definitions apply to the restrictions listed below:

- Rshunt = contact shunt resistance
- Rcontact = resistance associated with a closed contact
- Rreturn = resistance of the common return line
- Rline = resistance of the non-common cable length to and from the contact
- Rwiring = Rcontact + Rline + 16Rreturn
- Rfault = resistance from either line to ground which causes a ground fault

The figure below shows possible cable resistances that affect contact input performance. The following restrictions apply:

- Under no-ground-fault conditions or if the channel return (low) line has a ground fault:
  - ☐ Rshunt across contact must be greater than or equal to 10k ohms to always recognize an open contact as open.
  - ☐ Rshunt across contact must be greater than or equal to 50k ohms to maintain the high-level contact-wetting voltage.
- If the input connection from a channel has a ground fault with the contact open:
  - ☐ Rshunt across contact must be greater than or equal to 150k ohms to guarantee ground fault is detected.
- For a ground fault on the input or return connection to a channel:
  - ☐ Rfault from either line to ground must be less than or equal to 5K ohms to guarantee detection of the ground fault.

- With or without ground fault conditions:
  - Rwiring through field wiring to contact must be < 100 ohms to always recognize a closed contact as closed.

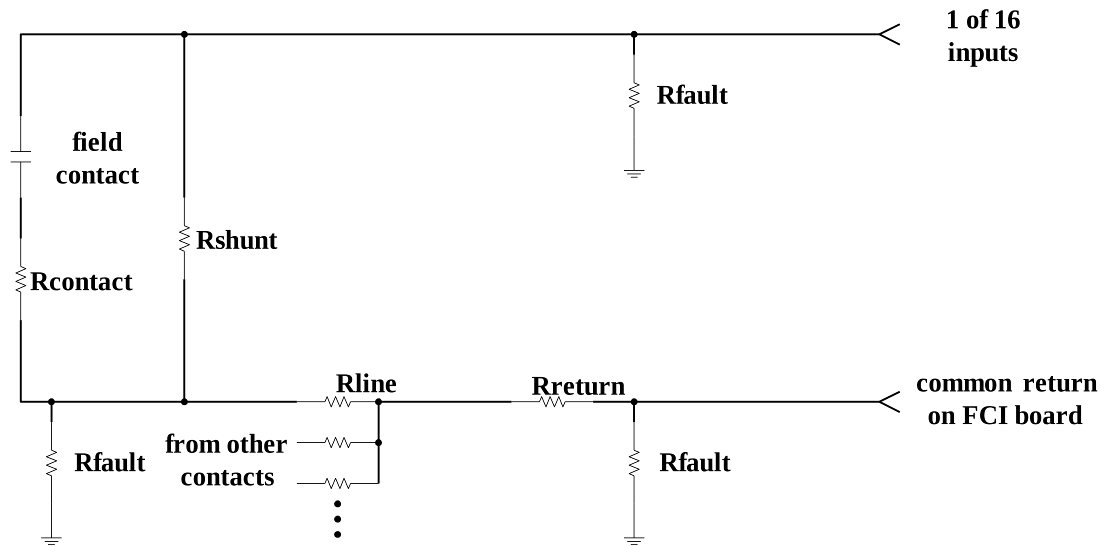


Figure 85: Cable impedances in field wiring

6.8.11 Terminal block wiring information - (SECompactDI)

The available cavity insert has a simplified wiring diagram label on top, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The diagrams for the Compact Sequence of Events Digital Input module are illustrated below.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

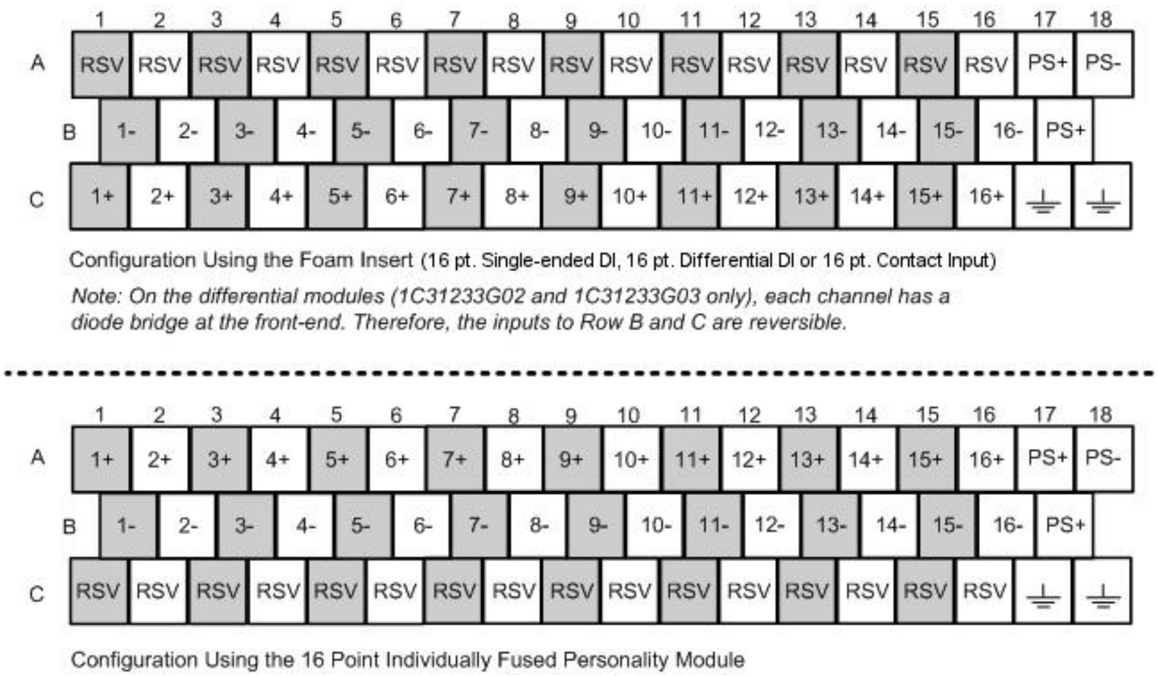
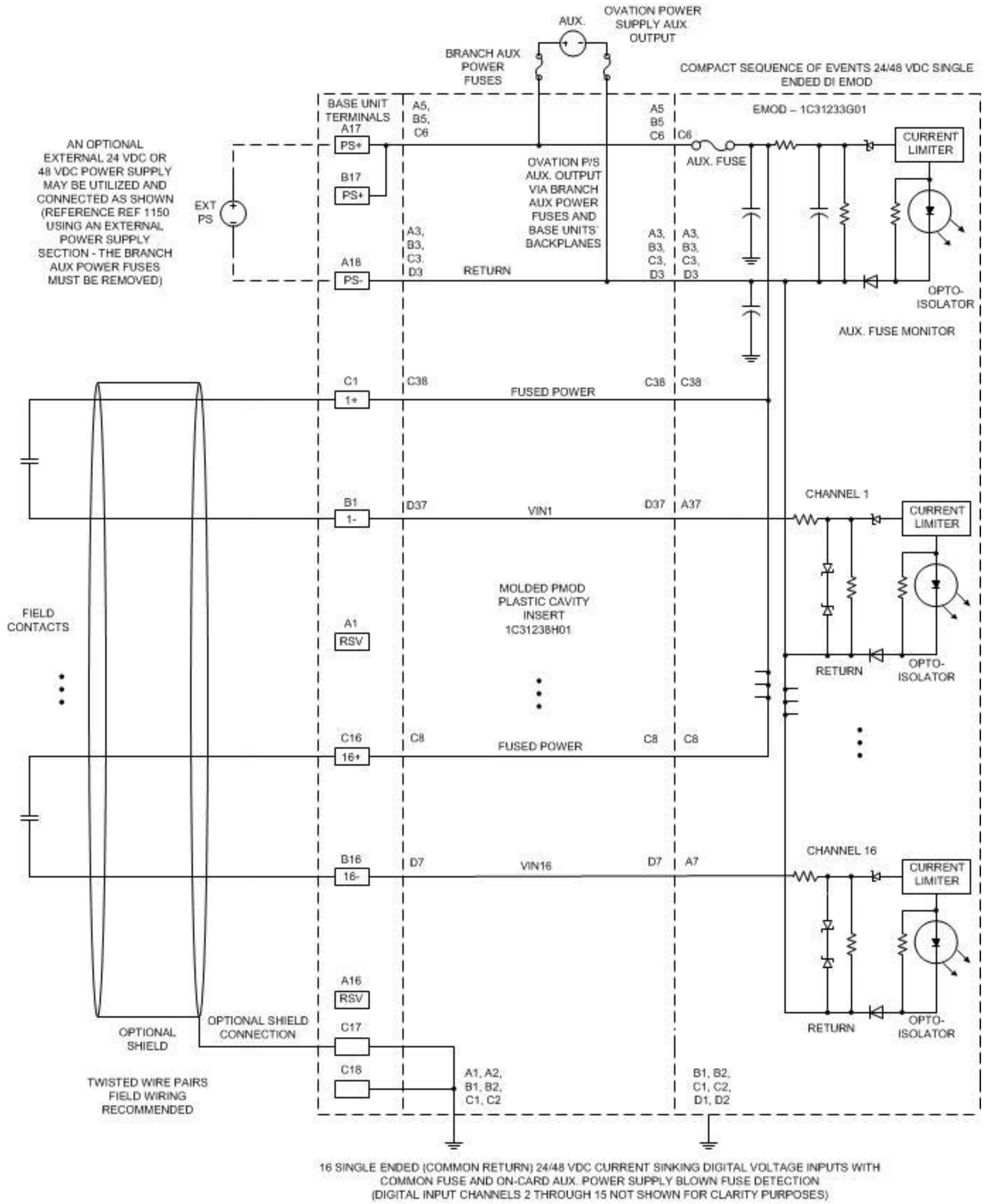


Figure 86: Terminal Block Connections for the Compact Sequence of Events Digital Input Module (1C31233G01-G04)

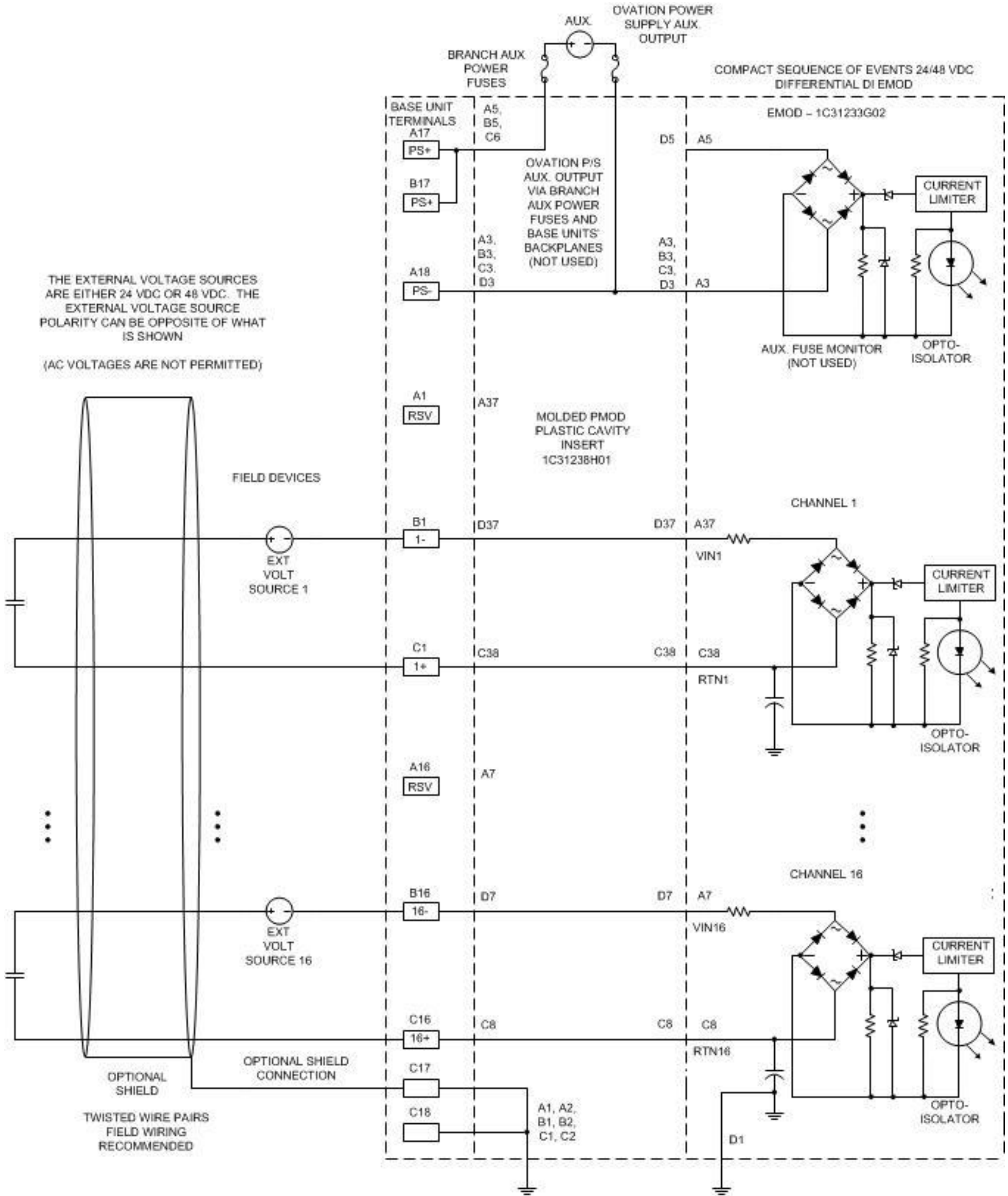
ABBREVIATION	DEFINITION
⏚	Earth ground terminals
1+ through 16+	Digital (Contact) input positive terminal connection.
1- through 16-	Digital (Contact) input negative terminal connection.
PS+, PS-	Auxiliary Power Supply terminals.
RSV	Reserved terminal. No internal connection, except where indicated.

6.8.12 Field connection wiring diagrams Field Interface module (G01-3) - (SECompactDI)



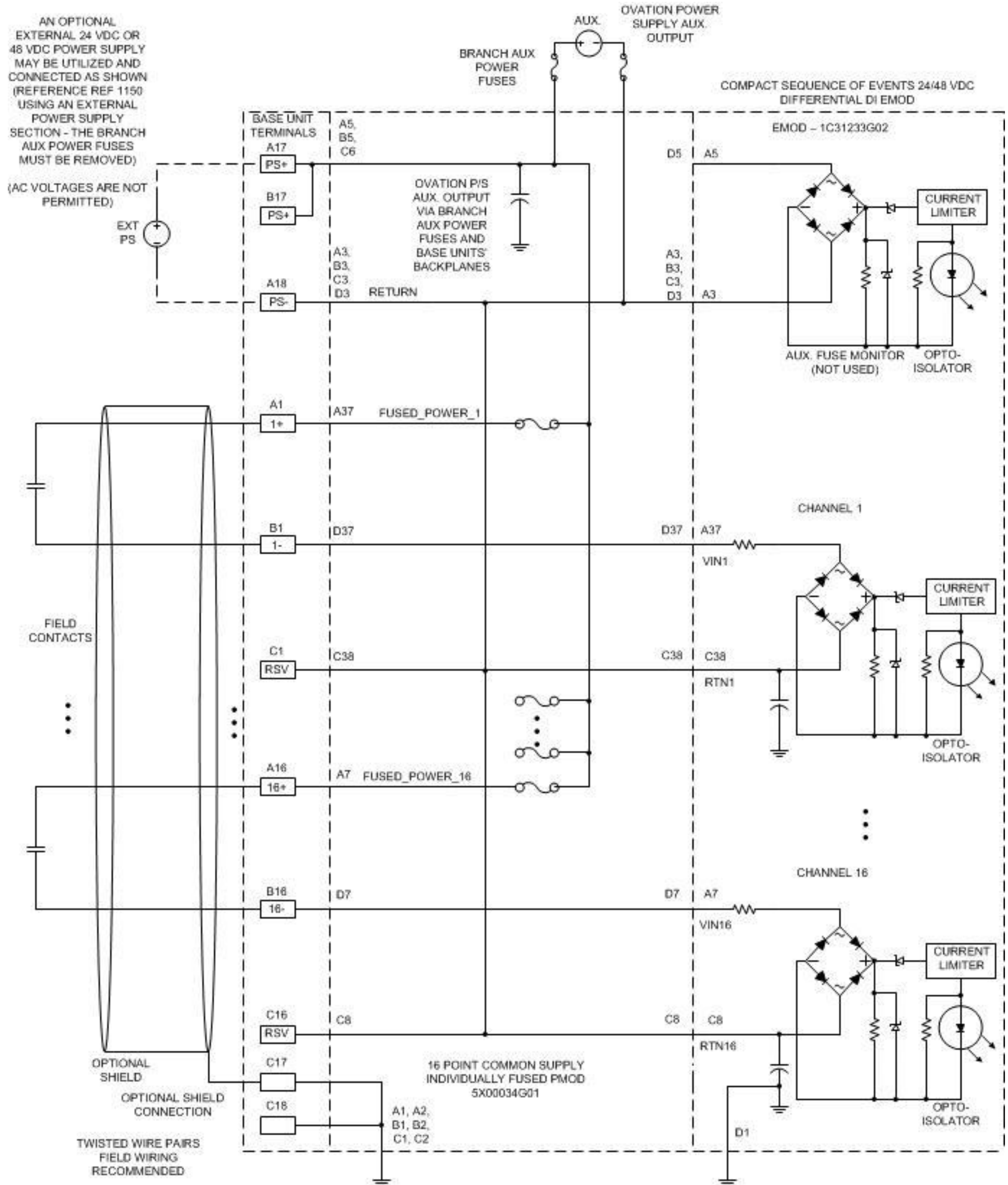
16 SINGLE ENDED (COMMON RETURN) 24/48 VDC CURRENT SINKING DIGITAL VOLTAGE INPUTS WITH COMMON FUSE AND ON-CARD AUX. POWER SUPPLY BLOWN FUSE DETECTION (DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (NON-CE MARK)



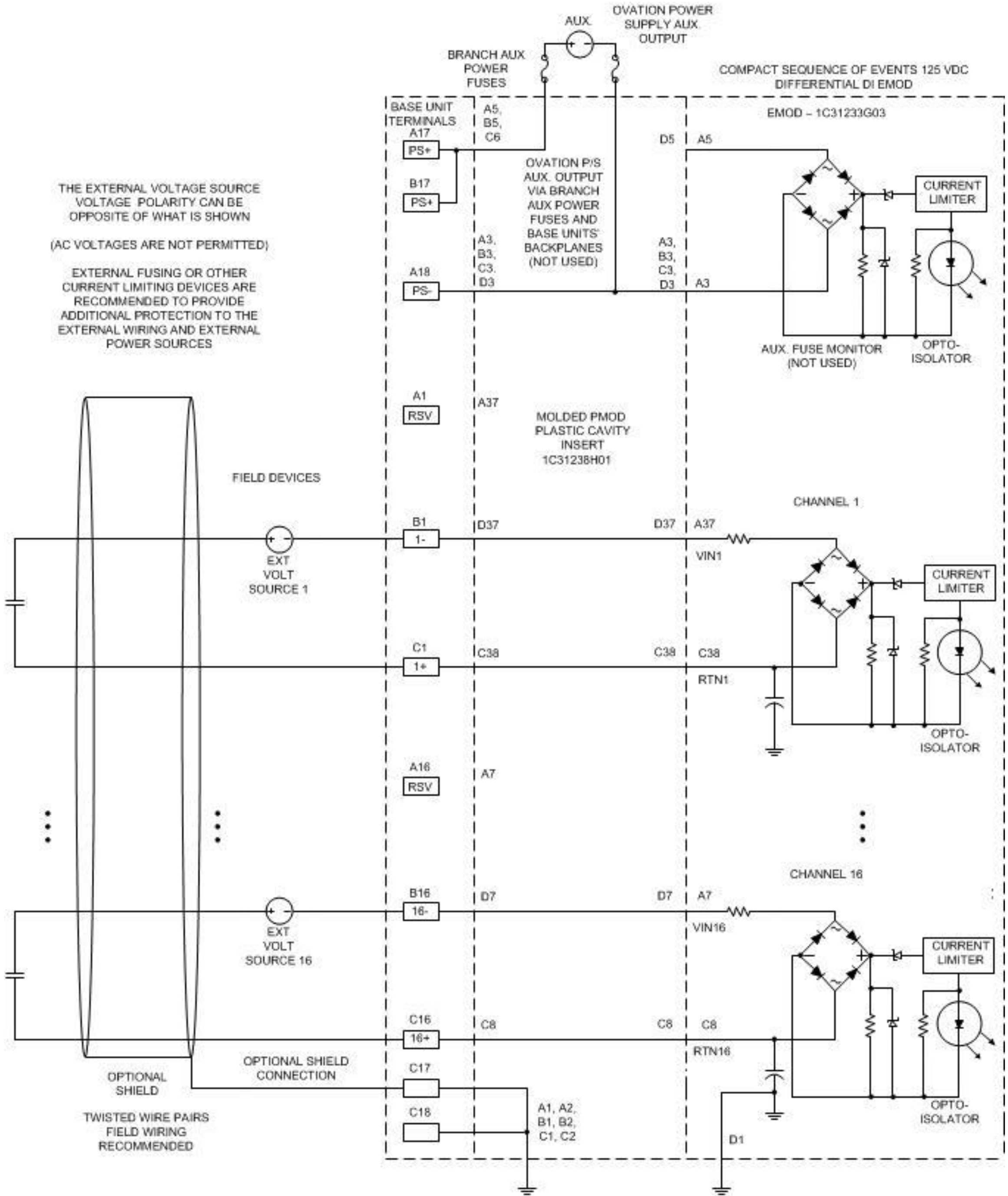
16 GALVANICALLY ISOLATED DIFFERENTIAL (UNFUSED) CURRENT SINKING 24/48 VDC DIGITAL VOLTAGE INPUTS
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (NON-CE MARK)



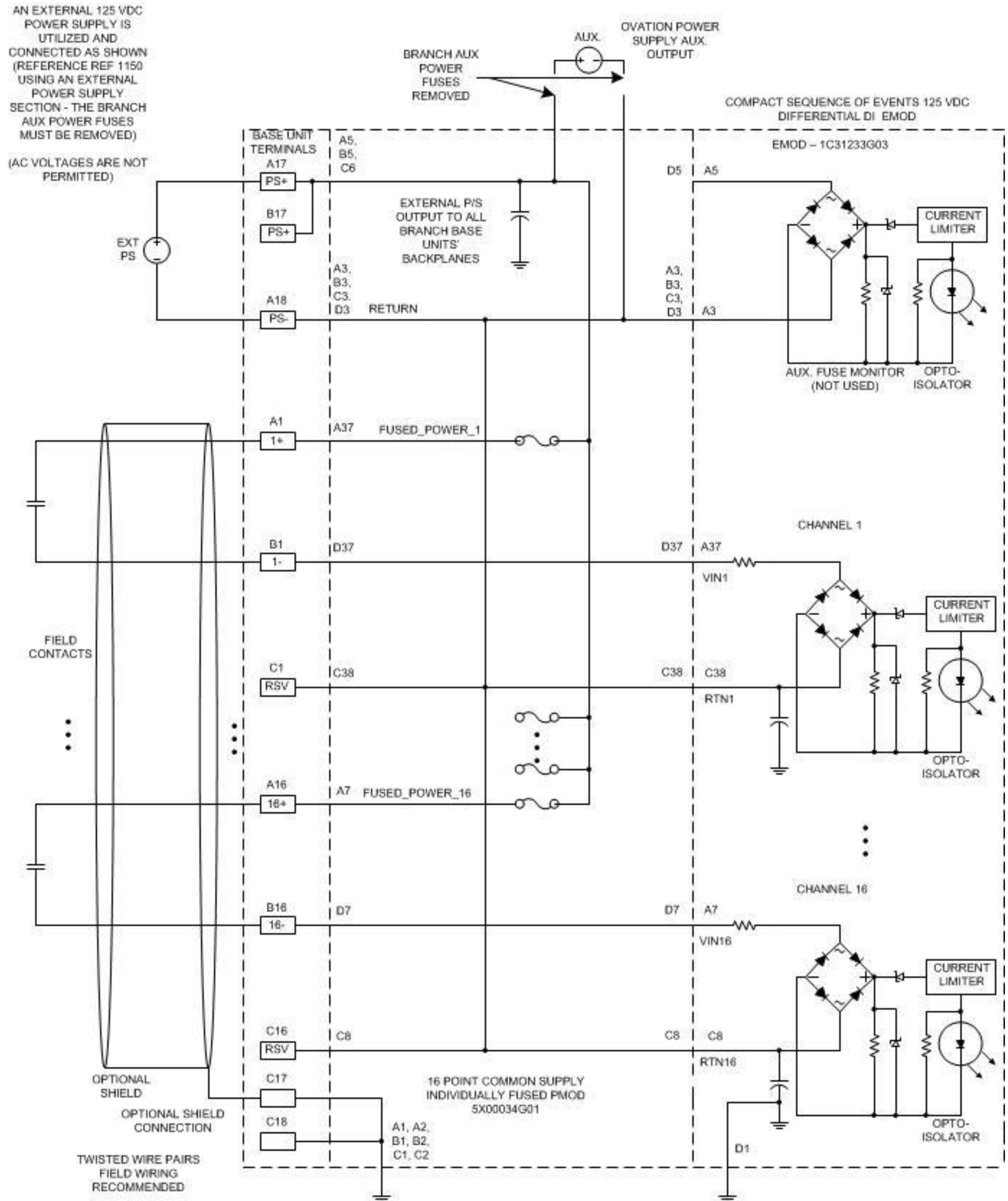
16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT SINKING 24/48 VDC DIGITAL VOLTAGE INPUTS
(NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (NON-CE MARK)



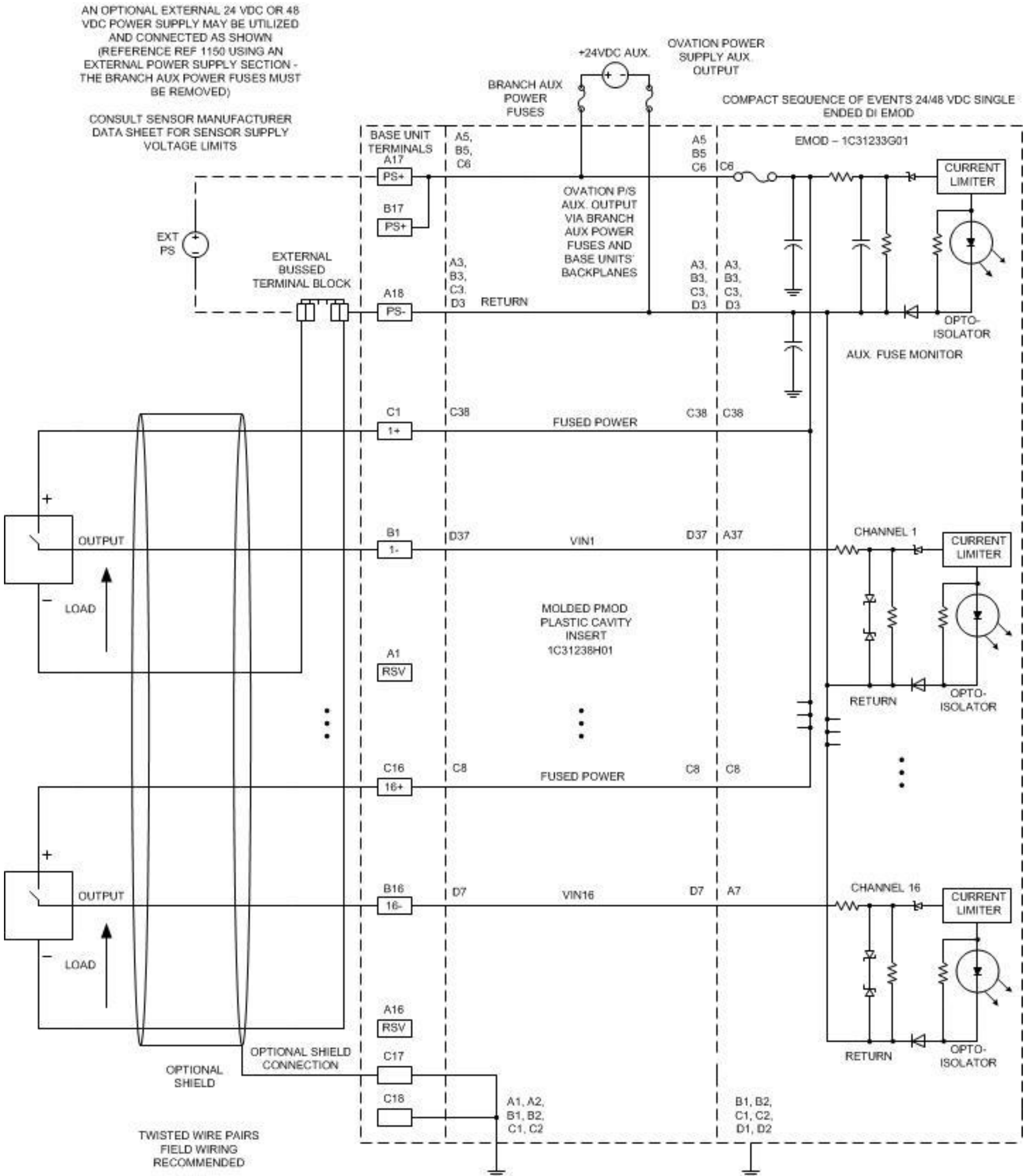
16 GALVANICALLY ISOLATED DIFFERENTIAL (UNFUSED) CURRENT SINKING 125 VDC DIGITAL VOLTAGE INPUTS
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (NON-CE MARK)



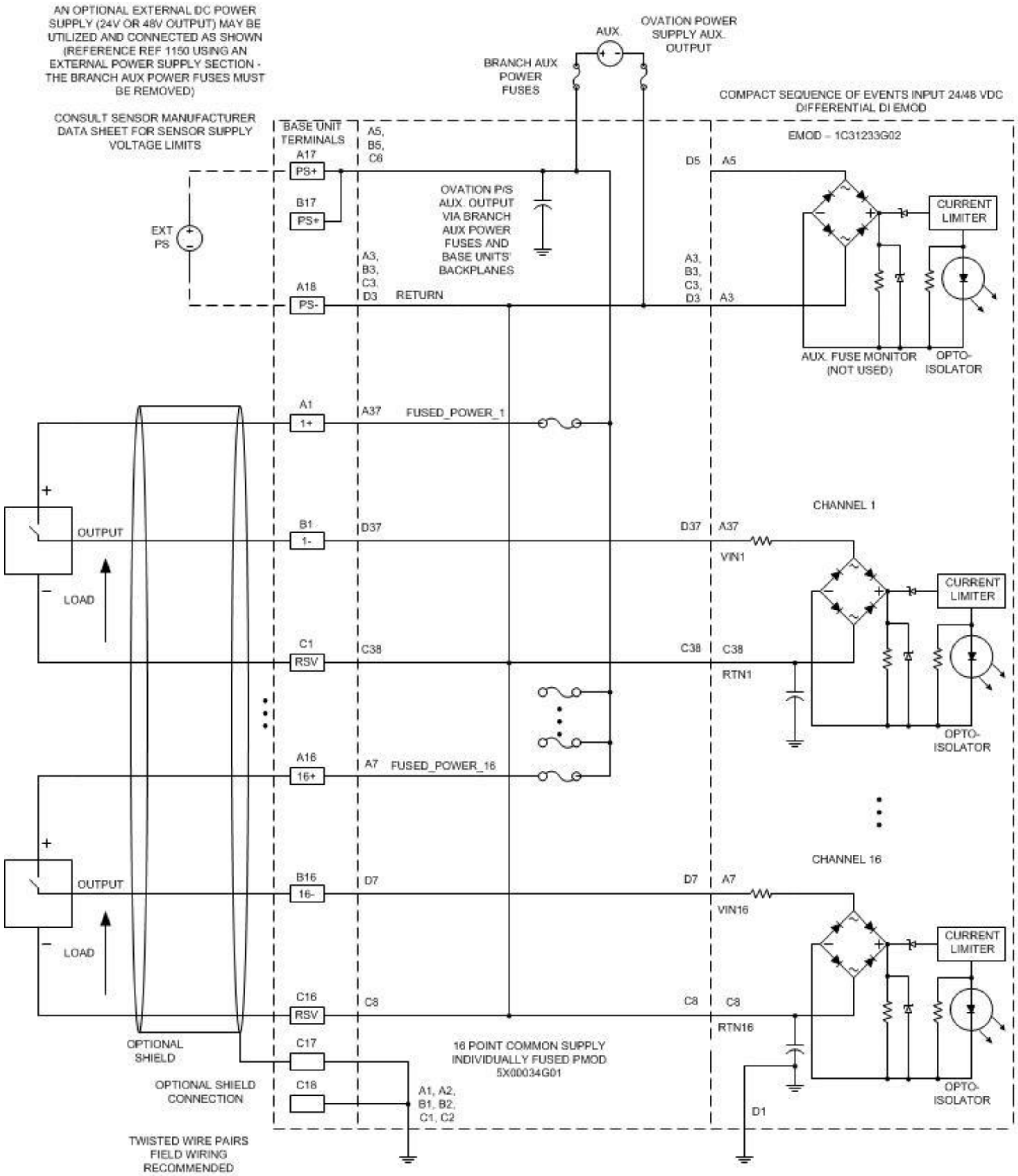
16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT 125 VDC SINKING DIGITAL VOLTAGE INPUTS
(NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (NON-CE MARK)



16 SINGLE ENDED (COMMON RETURN) 24/48 VDC CURRENT SINKING DIGITAL VOLTAGE INPUTS WITH COMMON FUSE AND ON-CARD AUX. POWER SUPPLY BLOWN FUSE DETECTION
THREE WIRE PROXIMITY SENSOR WITH PNP HIGH-SIDE SWITCH OUTPUT INTERFACE
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

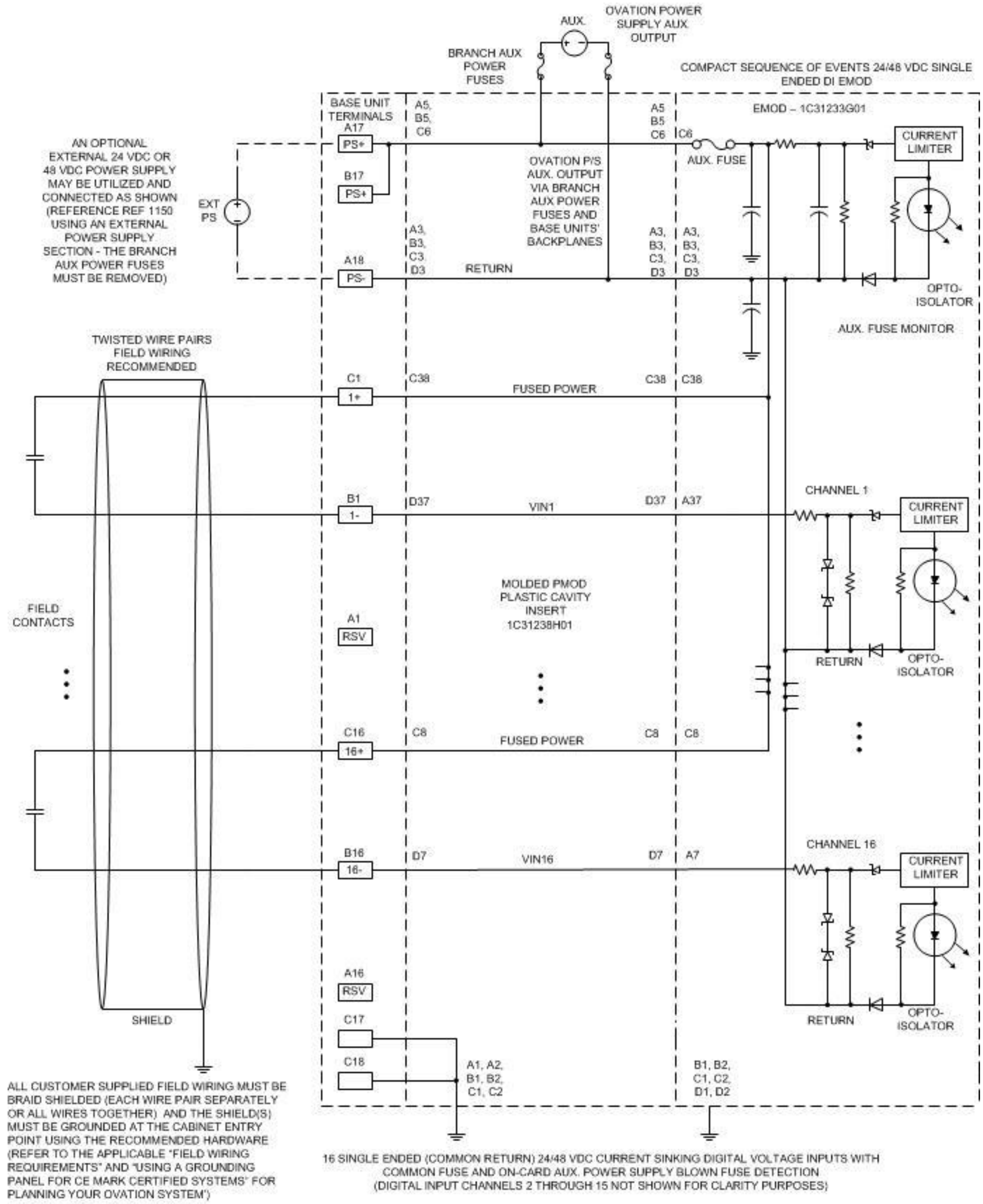
FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (NON-CE MARK)



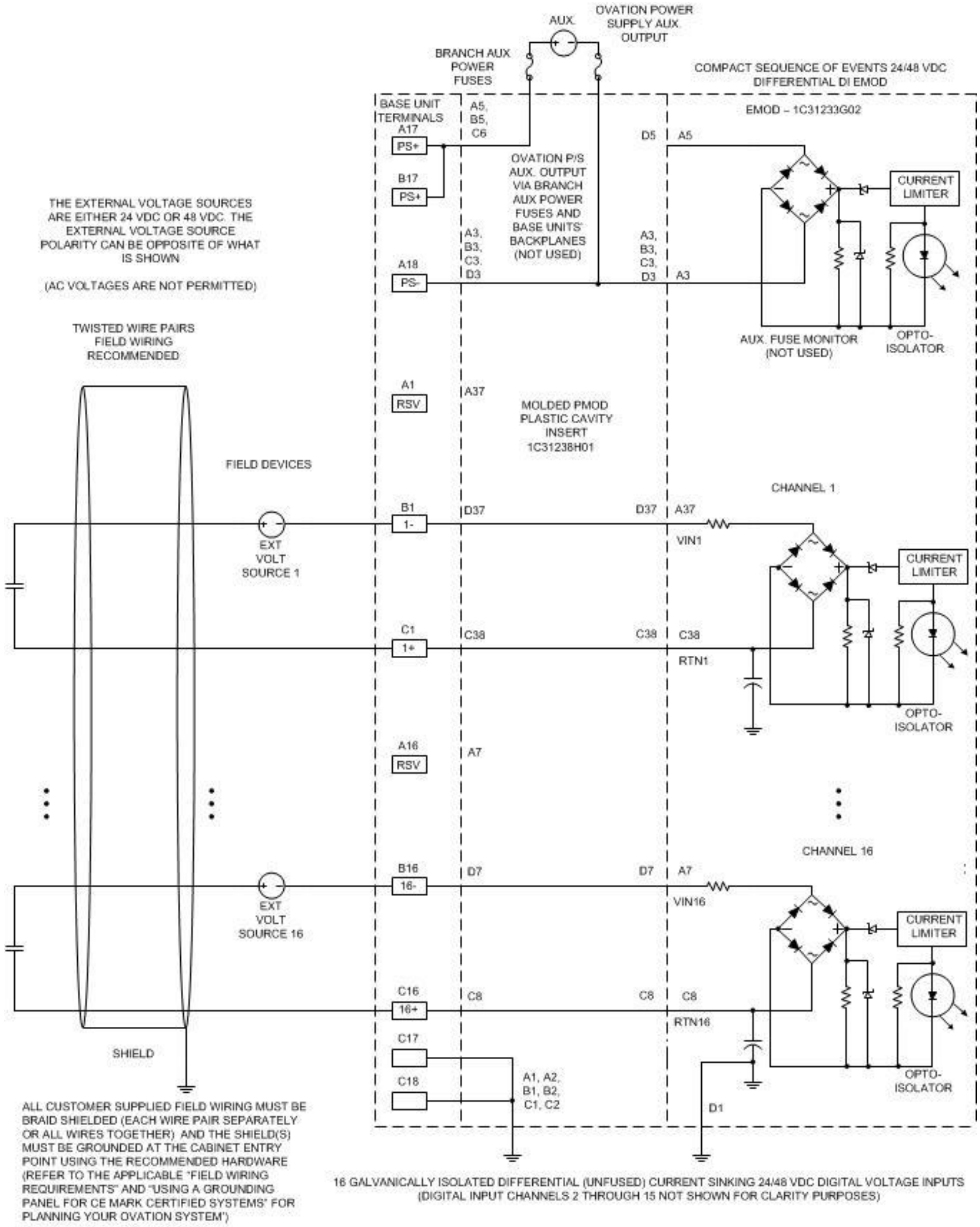
16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) 24/48 VDC CURRENT SINKING DIGITAL VOLTAGE INPUTS (NO BLOWN FUSE DETECTION)
THREE WIRE PROXIMITY SENSOR WITH PNP HIGH-SIDE SWITCH OUTPUT INTERFACE
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (NON-CE MARK)

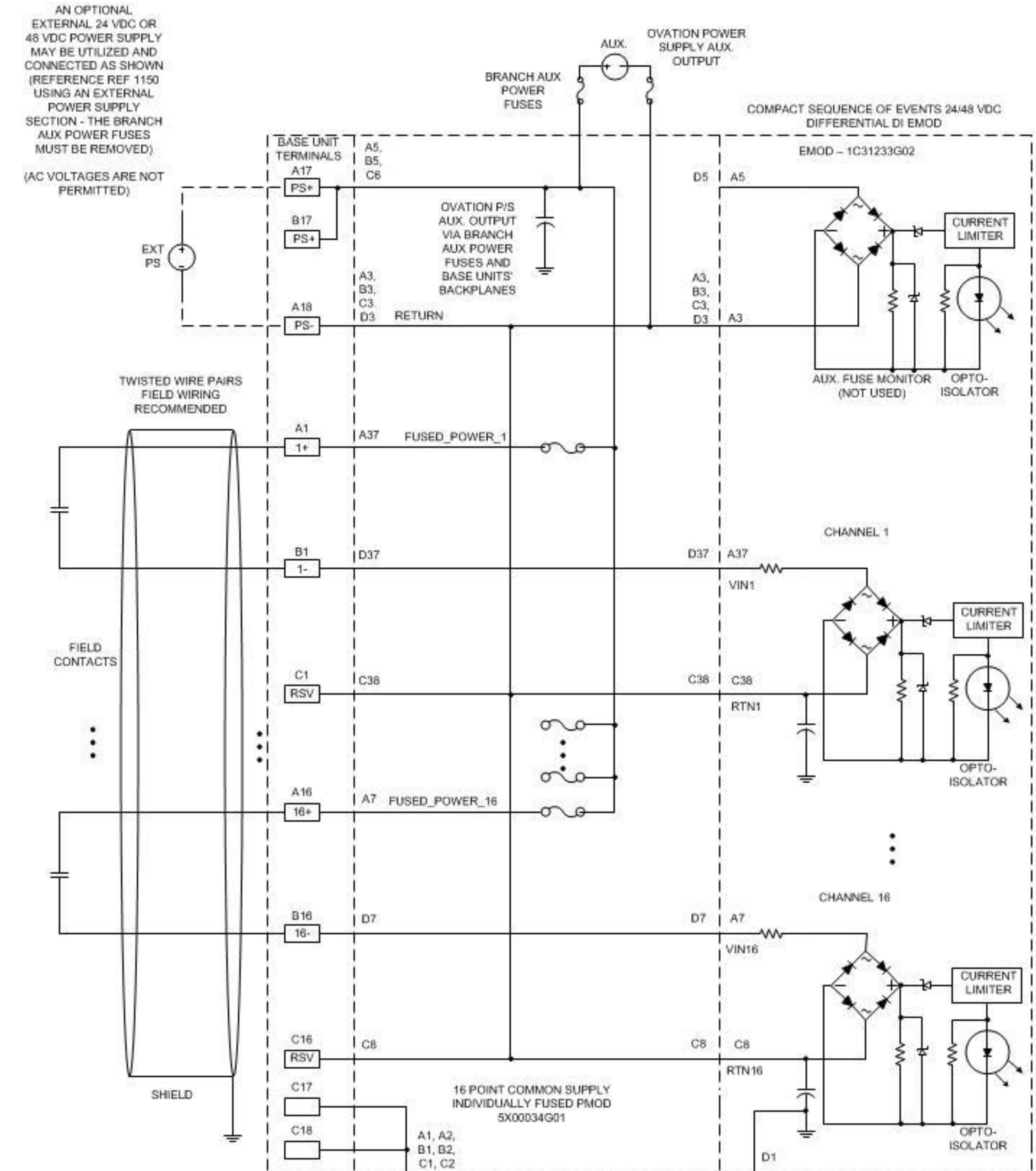
6.8.13 Field connection wiring diagrams (CE Mark) (G01-3) - (SECompactDI)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (CE MARK)



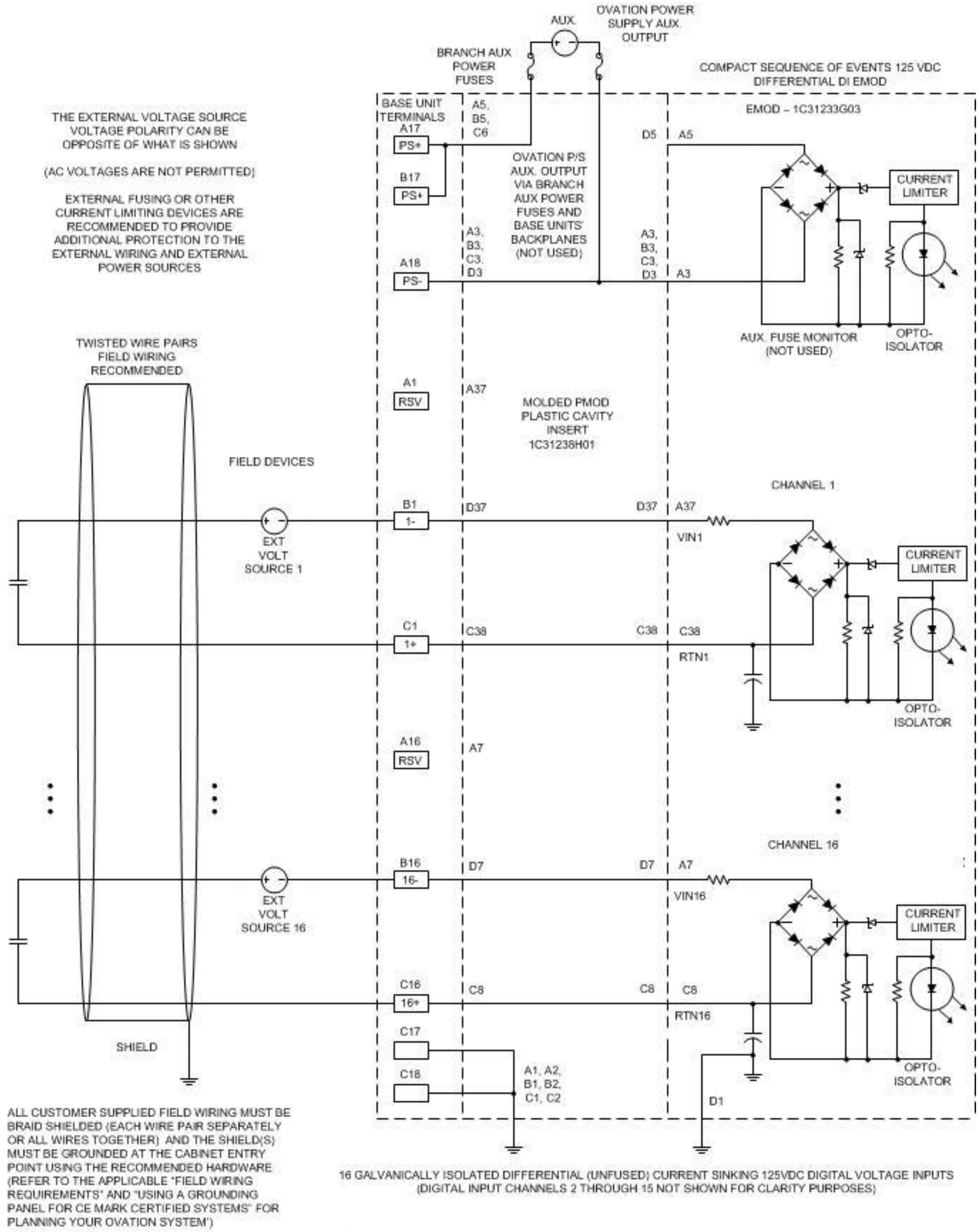
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (CE MARK)



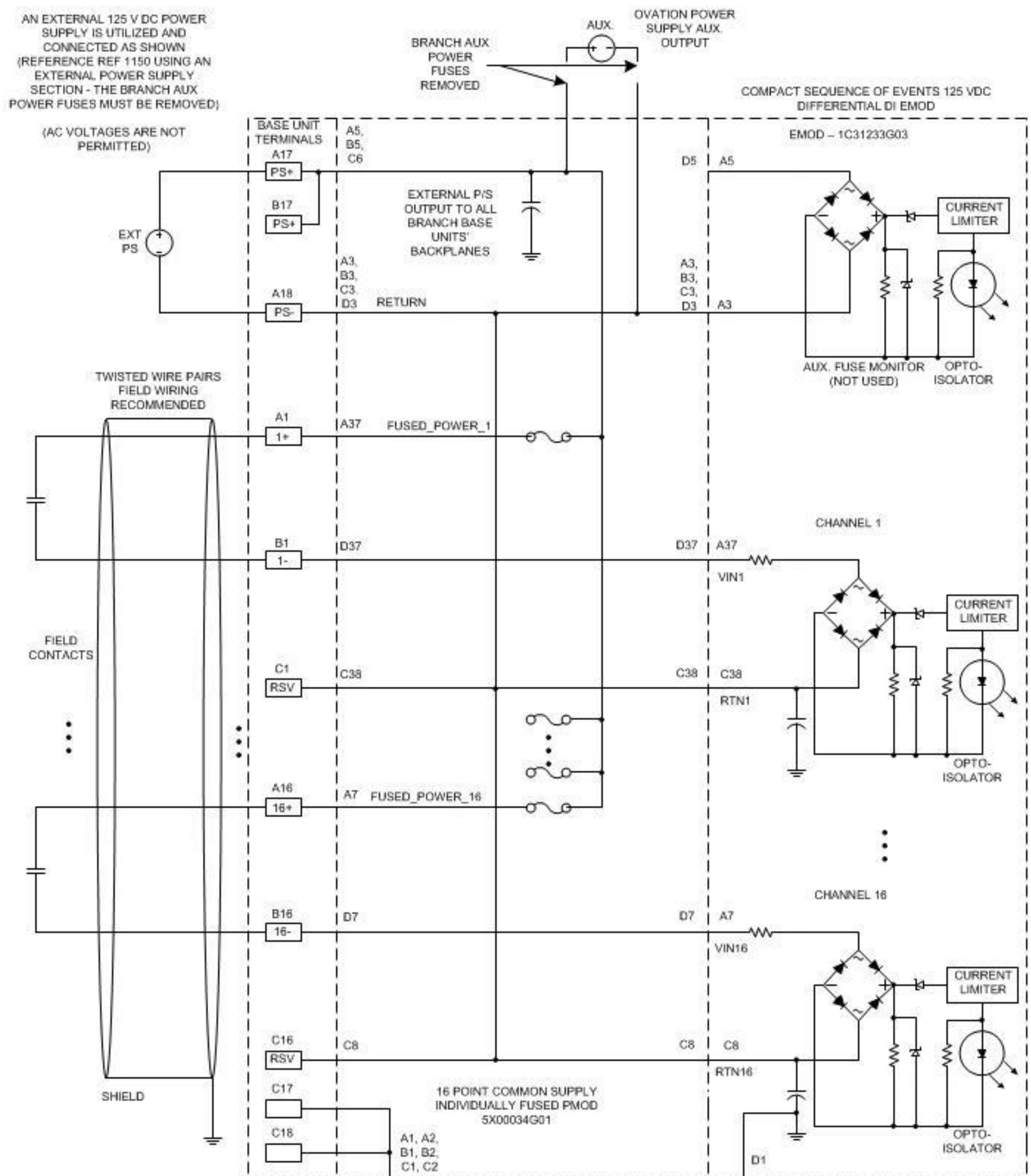
ALL CUSTOMER SUPPLIED FIELD WIRING MUST BE BRAID SHIELDED (EACH WIRE PAIR SEPARATELY OR ALL WIRES TOGETHER) AND THE SHIELD(S) MUST BE GROUNDED AT THE CABINET ENTRY POINT USING THE RECOMMENDED HARDWARE (REFER TO THE APPLICABLE "FIELD WIRING REQUIREMENTS" AND "USING A GROUNDING PANEL FOR CE MARK CERTIFIED SYSTEMS" FOR PLANNING YOUR OVATION SYSTEM")

16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT SINKING 24/48 VDC DIGITAL VOLTAGE INPUTS
(NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (CE MARK)



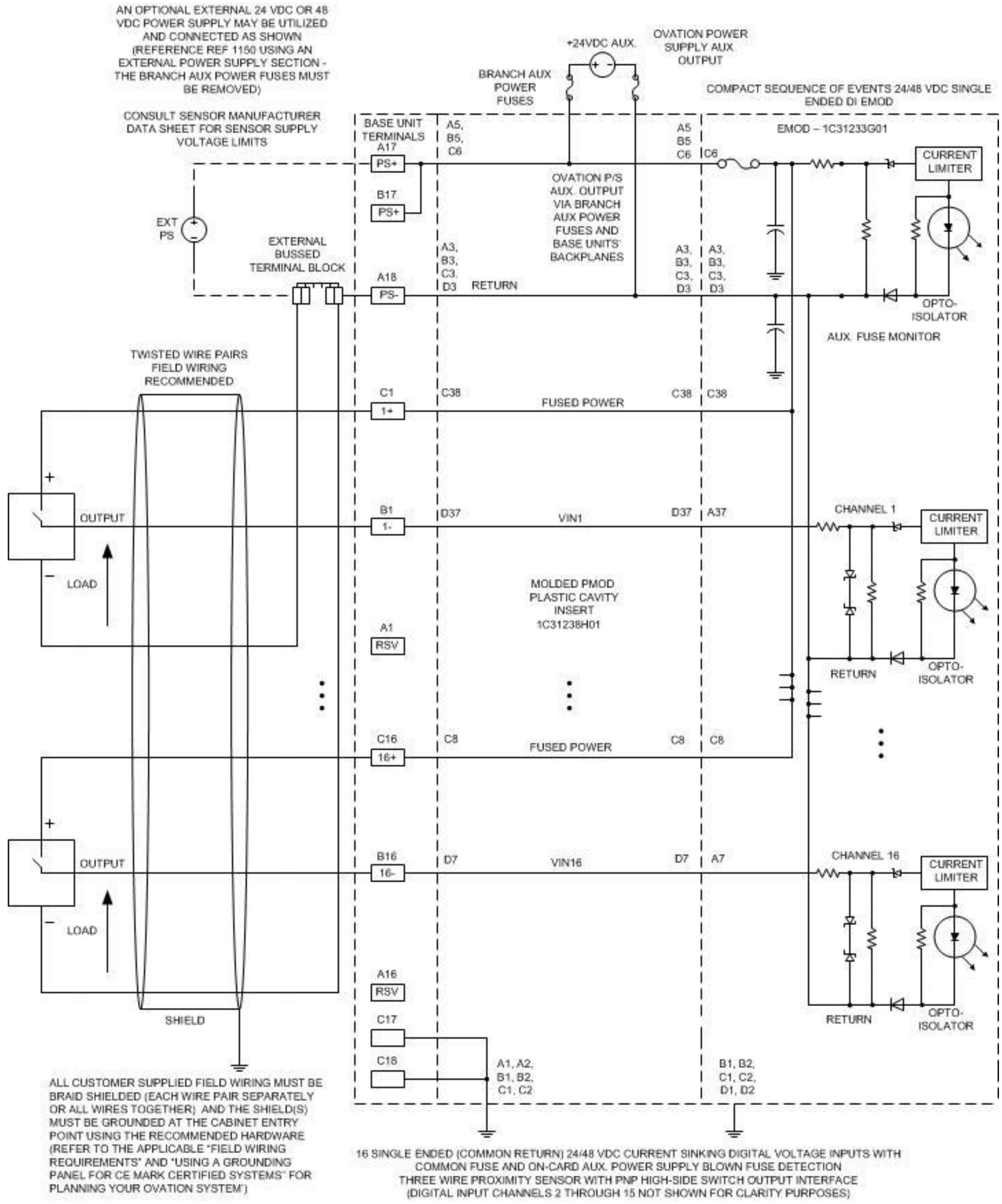
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (CE MARK)



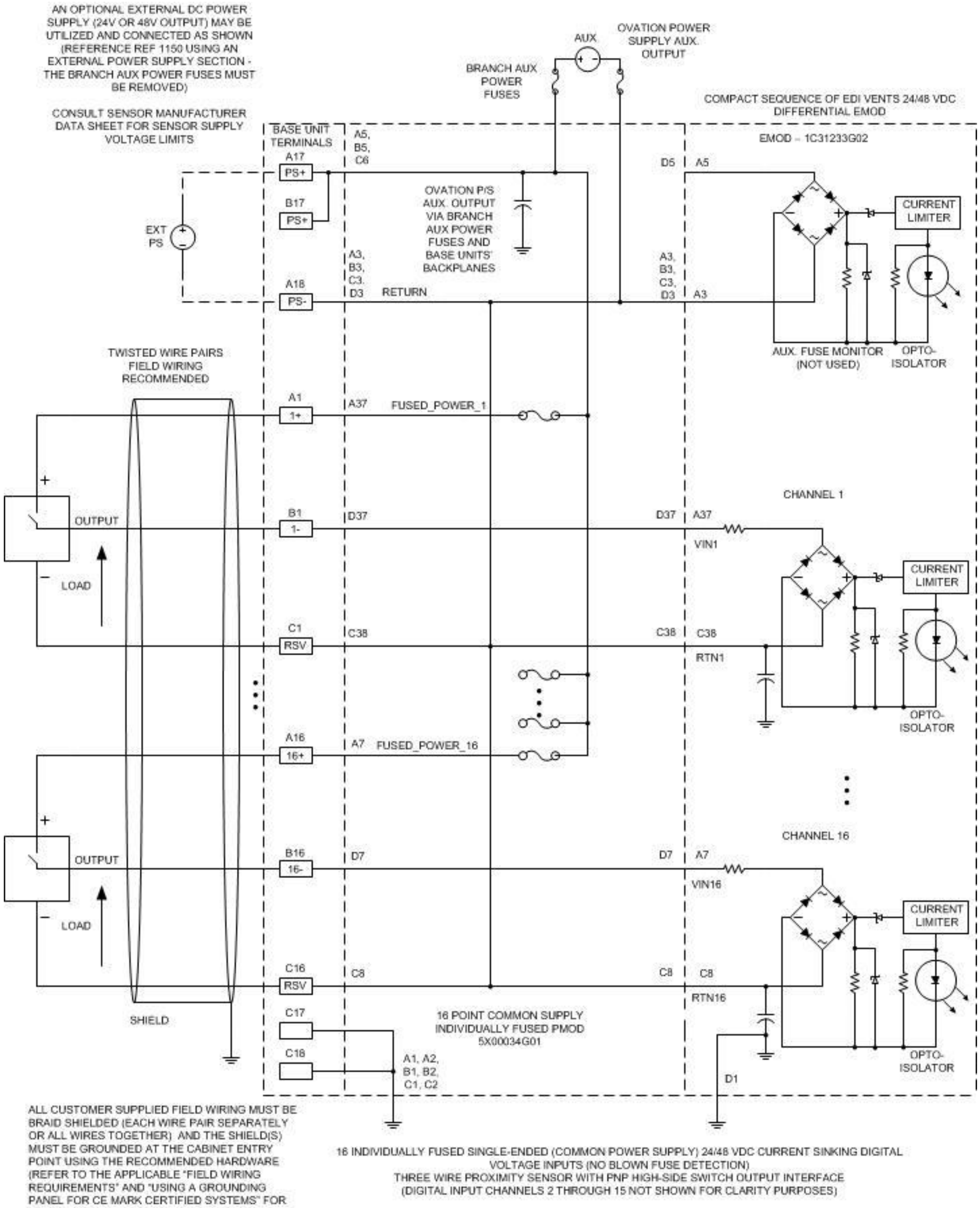
ALL CUSTOMER SUPPLIED FIELD WIRING MUST BE BRAID SHIELDED (EACH WIRE PAIR SEPARATELY OR ALL WIRES TOGETHER) AND THE SHIELD(S) MUST BE GROUNDED AT THE CABINET ENTRY POINT USING THE RECOMMENDED HARDWARE (REFER TO THE APPLICABLE "FIELD WIRING REQUIREMENTS" AND "USING A GROUNDING PANEL FOR CE MARK CERTIFIED SYSTEMS" FOR PLANNING YOUR OVATION SYSTEM")

16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT SINKING 125 VDC DIGITAL VOLTAGE INPUTS
(NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (CE MARK)

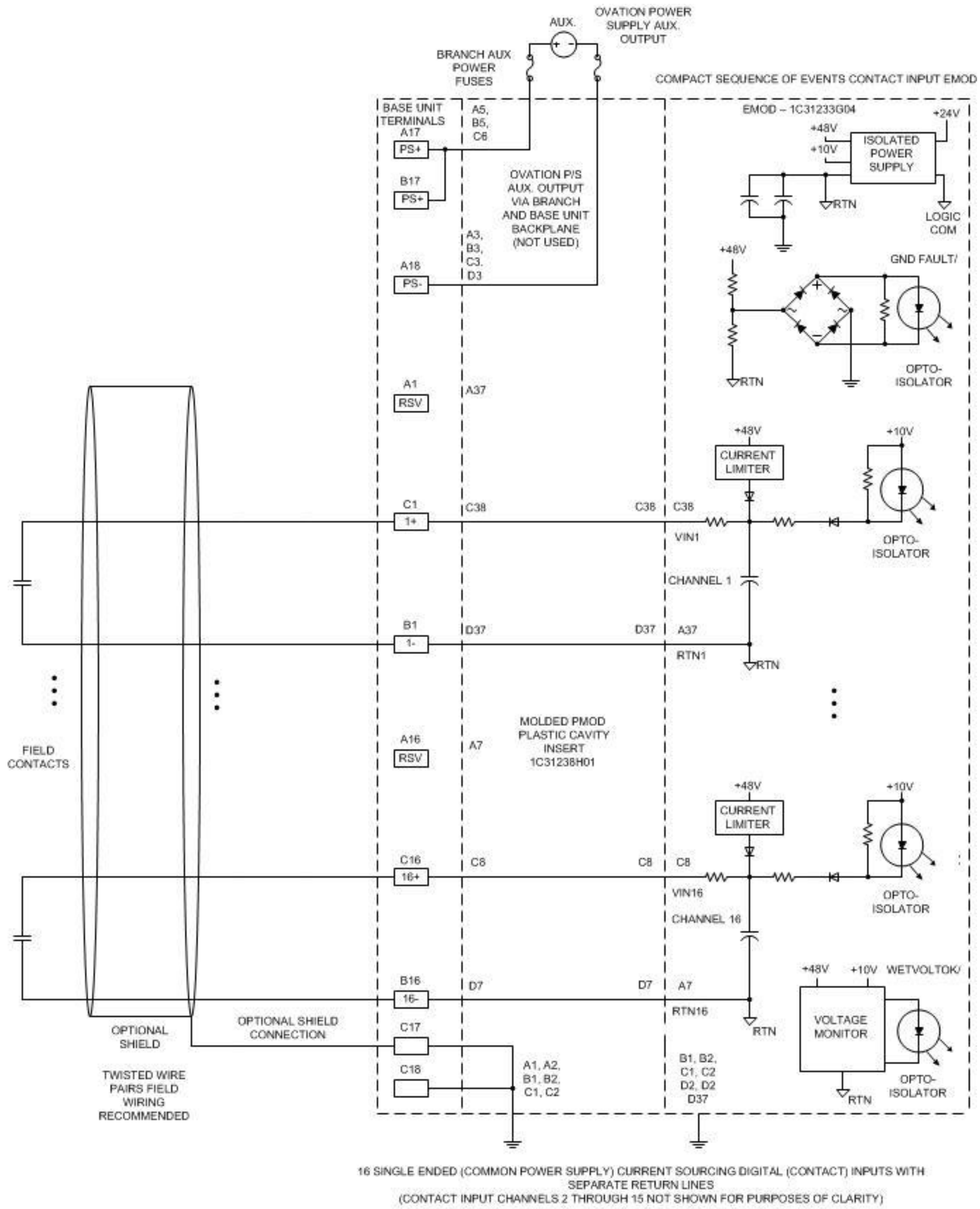


FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (CE MARK)



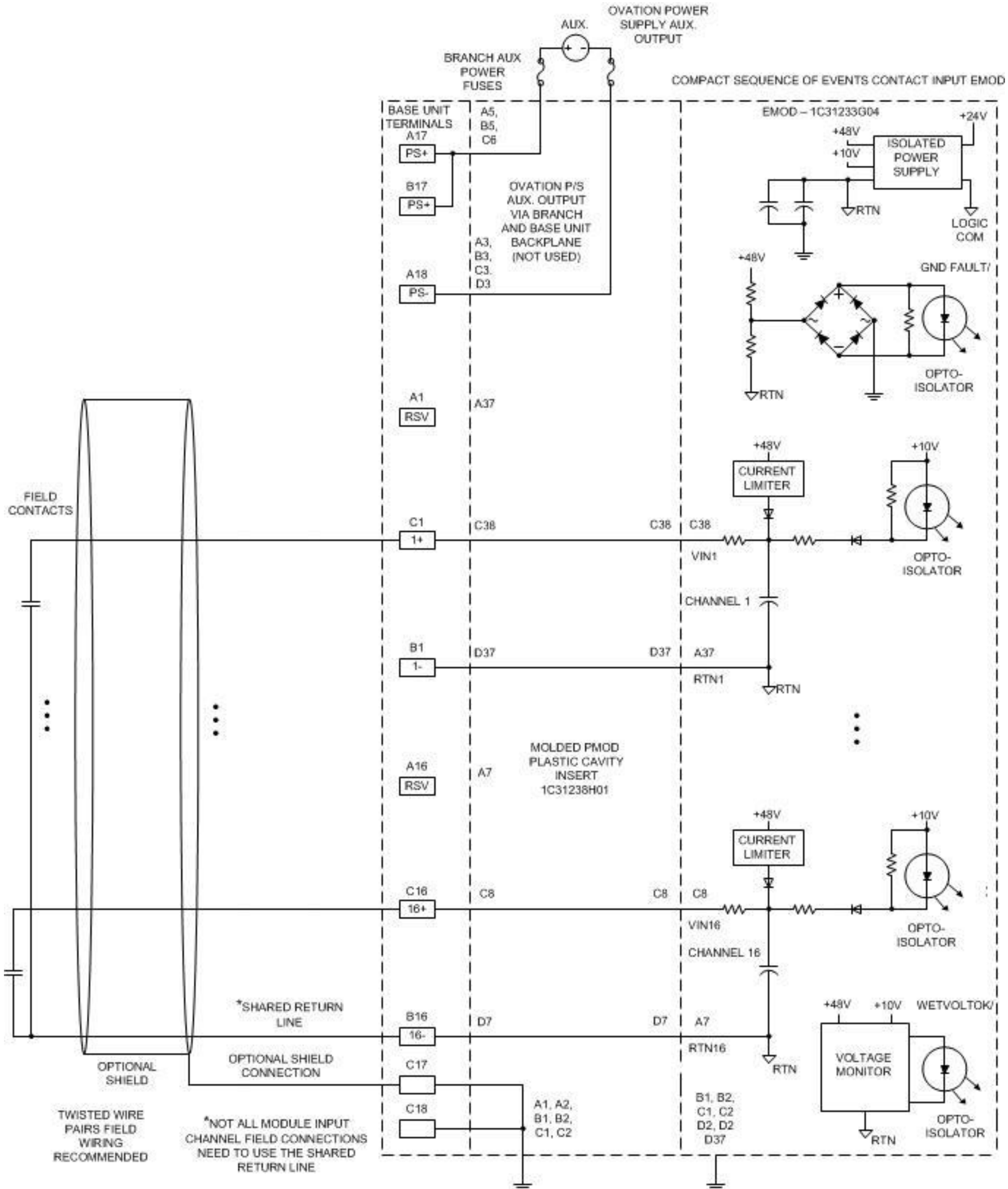
FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (CE MARK)

6.8.14 Field connection wiring diagram (G04) - (SECompactDI)



16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SEPARATE RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

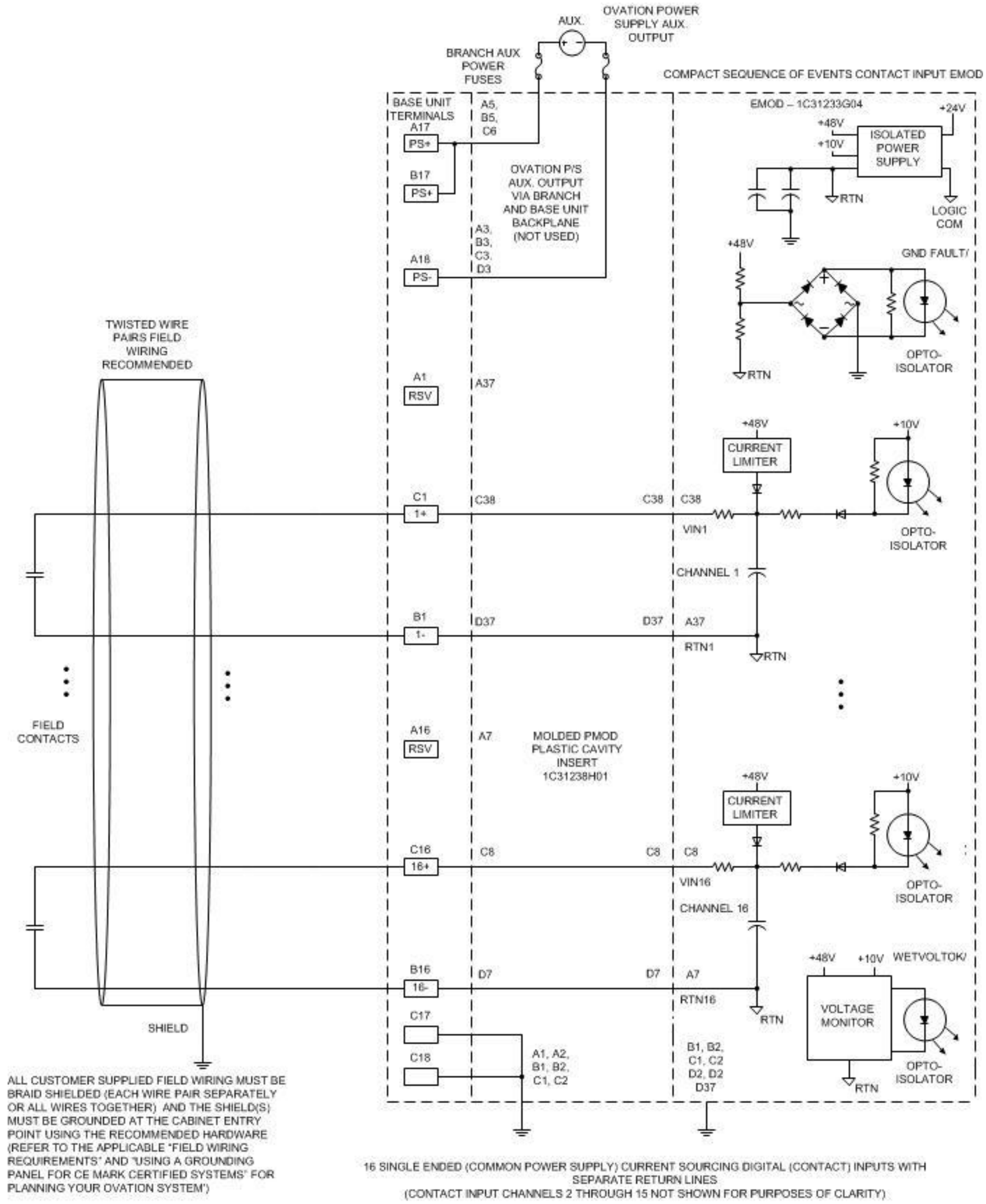
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (NON-CE MARK)



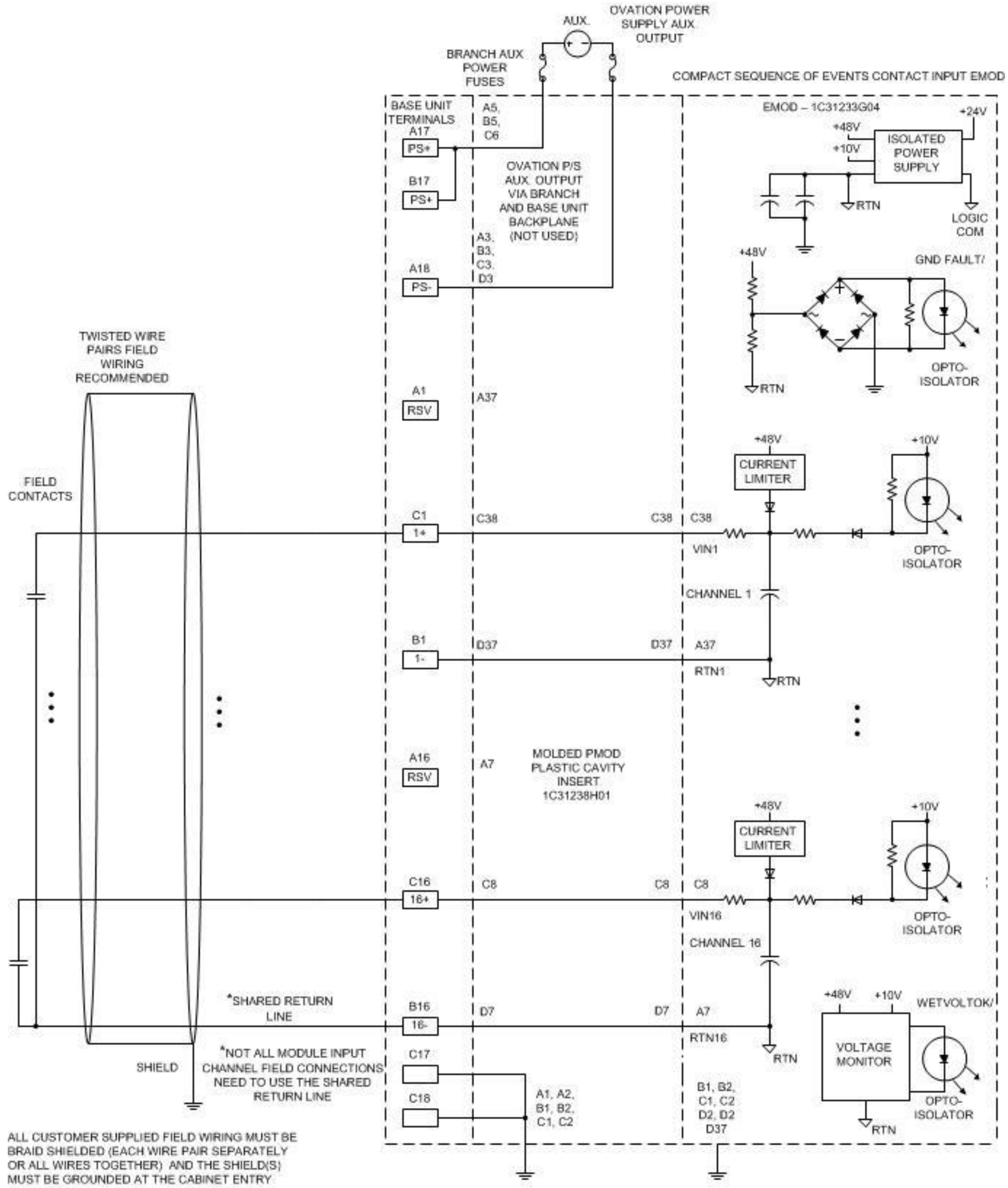
16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SHARED RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS (TWO WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (NON-CE MARK)

6.8.15 Field connection wiring diagram (CE Mark) (G04) - (SECompactDI)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (CE MARK)



ALL CUSTOMER SUPPLIED FIELD WIRING MUST BE BRAID SHIELDED (EACH WIRE PAIR SEPARATELY OR ALL WIRES TOGETHER) AND THE SHIELD(S) MUST BE GROUNDED AT THE CABINET ENTRY POINT USING THE RECOMMENDED HARDWARE (REFER TO THE APPLICABLE "FIELD WIRING REQUIREMENTS" AND "USING A GROUNDING PANEL FOR CE MARK CERTIFIED SYSTEMS" FOR PLANNING YOUR OVATION SYSTEM")

16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SHARED RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (CE MARK)

6.8.16 Register configuration/address information - (SECompactDI)

Register configuration/address information (1C31233G01 - G03)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern Field on the Hardware Tab). Refer to the applicable *Ovation Operator Station User Guide* for information about the Point Information window.

Compact Sequence of Events Digital Input Configuration/Status Register (Address 13 or D in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configure module.	Module configured (1 = configured; 0 = not configured)
1	Force internal error.	Internal error (1 = forced error; 0 = no forced error)
2 - 5	Not used. Should be set to zero (0).	Not used.
6	Enable digital input blown fuse signal and module attention for blown fuse.	Status of enable digital input blown fuse signal and module attention for blown fuse.
7	Not used. Should be set to zero (0).	Blown fuse for digital input.
8	Contact input field card (enable contact input auxiliary voltage failure signal and module attention for auxiliary voltage failure and ground fault detection circuitry).	Status of contact input field card (enable contact input auxiliary voltage failure signal and module attention for auxiliary voltage failure and ground fault detection circuitry).
9	Not used. Should be set to zero (0).	Auxiliary voltage failure for contact input
10	Enable module attention for a GND fault.	Status of Enable module attention for a GND fault.
11	Not used. Should be set to zero (0).	Not used.
12	Disable chatter control.	Disable chatter control.
13	Chatter control option.	Status of chatter control option.
14	Not used. Should be set to zero (0).	Not used.
15	Not used. Should be set to zero (0).	Not used.
Applicable for configuration of the Digital Input module (1C31233G01 - G03).		

Bit 0: Module does not operate until this bit is set with a write.

Bit 1: When this bit is set, the internal error LED is turned on, and only the status registers can be read.

Bits 2 - 5 Not used.

Bit 6: This bit should be set for a single-ended digital input (1C31233G01) and cleared for the others.

Bit 7: Not used.

Bit 8: This bit is set to enable contact input auxiliary voltage failure signal and module attention for auxiliary voltage failure and ground fault detection circuitry.

Bit 9: Not used.

Bit 10: This bit is set to enable module GND fault attention status.

Bit 11: Not used.

Bit 12: When this bit is set and an input channel is not masked off, that input can chatter and each event is recorded until the event buffer overflows. Default state is “0” and enables the chatter control function.

Bit 13: When this bit is set, chatter will be flagged when an input changes state four or more times between event buffer reads. When cleared, chatter is flagged for state changes greater than 1 per 100 milliseconds.

Bits 14 - 15: Not used

Register configuration/address information (1C31233G04)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern Field on the Hardware Tab). (See the *Ovation Operator Station User Guide*.)

Compact Sequence of Events Contact Input Configuration/Status Register [1] (address 13 or D in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configure module.	Module configured (1=configured; 0=unconfigured)
1	Force internal error.	Internal error (1=forced error; 0=no forced error)
2 - 5	Not used. Should be set to zero (0).	Not used.
6	Enable digital input blown fuse signal and module attention for blown fuse.	Status of enable digital input blown fuse signal and module attention for blown fuse.
7	Not used. Should be set to zero (0).	Blown fuse for digital input.
8	Contact input field card (enable contact input auxiliary voltage failure signal and module attention for auxiliary voltage failure and ground fault detection circuitry).	Status of contact input field card (enable contact input auxiliary voltage failure signal and module attention for auxiliary voltage failure and ground fault detection circuitry).
9	Not used. Should be set to zero (0).	Auxiliary voltage failure for contact input.
10	Enable module attention for a GND fault.	Status of Enable module attention for a GND fault.
11	Not used. Should be set to zero (0).	GND fault.
12	Disable chatter control.	Disable chatter control.
13	Reset chatter control counters on buffer unfreeze (instead of decrementing every 100 milliseconds).	Status of reset chatter control counters on buffer unfreeze (instead of decrementing every 100 milliseconds).
14	Not used. Should be set to zero (0).	Clock synchronized.
15	Not used. Should be set to zero (0).	Not used.
[1] Applicable for configuration of the Contact Input module (1C31233G04).		

Bit 0: Module does not operate until this bit is set with a write.

Bit 1: When this bit is set, the internal error LED is turned on, and only the status registers can be read.

Bits 2 - 5: Not used.

Bit 6: This bit should be cleared to zero (0).

Bit 7: Not used.

Bit 8: This bit should be set.

Bit 9: Not used.

Bit 10: This bit should be set according to application need.

Bit 11: Not used.

Bit 12: When this bit is set and an input channel is not masked off, that input can chatter and each event is recorded until the event buffer overflows. Default state is “0” and enables the chatter control function.

Bit 13: When this bit is set, the chatter control counter for each channel is reset each time an event buffer is unfrozen instead of being decremented each 100 milliseconds. Default state is “0” and has the chatter control counter being decremented every 100 milliseconds.

Bits 14 - 15: Not used.

Secondary/Expansion configuration/Status Register

Word address 14 (E in Hex) is used to enable or disable the channel event tagging mask.

Secondary/Expansion configuration/Status Register (address 14 or E in Hex)

BIT	DATA DESCRIPTION CONFIGURATION (WRITE)	DATA DESCRIPTION STATUS (READ)
0 - 15	Channel Event Tagging mask	Channel Event Tagging mask

6.8.17 Diagnostic Logic card LEDs - (SECompactDI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	For Single-ended Digital Input: Lit when fuse blows or there is a loss of the auxiliary power supply (Only when Bit 6 of Configuration register is set. Then Bit 7 of the Status register is set.) For Differential Digital Input: Not lit since the configuration bit is not set, and the blown fuse signal from the field card is ignored.
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set, or when a timeout of the watchdog timer occurs when the Controller stops communicating with the module. Also lit when Controller stops communicating with the module.

LED	DESCRIPTION
1 - 16 (Green)	Lit when the input voltage of the LED's corresponding channel is greater than the channel's minimum "On Input Voltage."

6.8.18 Specifications and ranges (G01-3) - (SECompactDI)

DESCRIPTION	VALUE
Number of channels	16
Input range (single-ended or differential) [1]	Refer to the table below.
Propagation delay of contact change of state [2] 24V/48V DC 125VDC	 3.75 mSec minimum; 4.25 mSec Maximum 3.75 mSec minimum; 4.45 mSec Maximum
Signal rejection Always rejects change of state Always accepts change of state	 < 3.87 mSec > 4.13 mSec
Cable length (quality is 50pF/ft or better)	1000 feet Maximum
Diagnostics	Internal module operating faults and Blown fuse detection. [3]
Dielectric isolation: Channel to channel [4] Channel to logic	 1000 VAC 2000 VAC differential; 1000 VAC others
Module power from logic supply	Main: 1.44 W typical, 1.8 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

[1] Input range level is dependent on module group.

[2] Does not include cable capacitance.

[3] Blown fuse detection applies to single-ended channel configuration only, when an on-board fuse is provided for the auxiliary power supply.

[4] Channel to channel isolation applies to differential channel configuration only.

Compact Sequence of Events Digital Input Ranges

INPUT LEVEL	ON INPUT VOLTAGE (VDC)		OFF INPUT VOLTAGE (VDC)	ON INPUT CURRENT (MA)		OFF INPUT (WATTS)	INPUT POWER TYPICAL
	Min	Max	Max	Min	Max	Max	
24 VDC	20	60	9	1.3	2.6	0.33	0.65

Input Level	On Input Voltage (VDC)		Off Input Voltage (VDC)	On Input Current (mA)		Off Input (Watts)	Input Power Typical
48 VDC	20	60	9	1.3	2.6	0.33	1.7
125 VDC	80	140	55	1.3	2.8	0.33	4.26

6.8.19 Specifications and ranges (G04) - (SECompactDI)

Description	Value
Number of channels	16
Channels per common	16
Voltage Category	48 VDC - nominal open contact wetting voltage.
Open contact voltage	For "0" signal = 42 V min. 55 V max.
Closed contact Input current	For "1" signal = 4 mA min. 8 mA max.
Galvanic isolation	Between channels and I/O bus = Yes, 1,000 VAC. Between channels = No.
Current draw, from I/O base unit, 24 V main power	62 mA typical for all inputs off. 190 mA typical for all inputs on.
Power dissipation of module, 24 V main power	1.5 watts typical for all inputs off. 4.5 watts typical for all inputs on.
Total module response time, (1 foot (0.305 M) long test cable)	"0" Open to "1" Close = 4.125 msec typ. "1" Close to "0" Open = 4.125 msec typ.
Resolution	1/8 msec resolution for time tagging an event.
Accuracy (time tagged)	1 msec relative to clock from the I/O bus. 1/8 msec relative to other module channels.
Propagation delay through logic card to Present State register (field card output to Present State register)	3.75 msec Min. 4.25 msec Max.
Logic card digital debounce time	3.75 msec Min. 4.00 typical. 4.25 msec Max.
Field card signal propagation delay. (1 foot (0.305 M) long test cable)	0.13 msec typ delay time for contact opening. 0.09 msec typ delay time for contact closing.
Additional propagation delay due to field cable capacitance - field contact opening.	0.04 msec typ per 1,000 foot of cable (30 pF/ft.)
Status display	Green LED per channel. LEDs located in logic card circuit.
Cable limitations: Contact shunt resistance Wiring resistance	Must be greater than 50 Kohms to maintain high level open contact wetting voltage. Must be greater than 10 Kohms to allow open contact to be recognized as an open contact. Must be less than 100 ohms to allow closed cotact to be recognized as a closed circuit.
Diagnostics	Internal module operating faults.

DESCRIPTION	VALUE
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

6.9 Enhanced Compact Sequence of Events Digital Input module - (ECSOEDI)

The Ovation Enhanced Compact Sequence of Events module provides field wire break detection (Group 5 only) and field digital input state change detection (SOE One Shot).

The SOE one shot feature describes a feature that will enable SOE event detections that happen asynchronously to Controller tasks that read the present input state and event buffers. There are two types of events that are defined.

- A high to low transition of the input.
- A low to high transition of the input.

The two types of events are mutually exclusive of each other. Events registered on various points are also mutually exclusive of each other. SOE on shot events are only recorded if the input state transition is followed by a 4 millisecond minimum steady state time. Otherwise the one shot event is ignored.

The Module performs a sequence of events function for the Ovation distributed control system. It provides sixteen digital channels to monitor the states ("0" or "1") of sixteen field digital inputs. No personality module is required if the sixteen digital channels are used as differential inputs. The Ovation Enhanced Compact Sequence of Events Electronics Module plugs into a standard Ovation Base Unit's electronics module cavity.

The Enhanced Compact Sequence of Events electronics Module consists of an LSW logic card and a field Card (FDJ, FDI, FCI or FDW). The LSW logic card Interfaces to the I/O bus through the Ovation base unit backplane from which it accesses the Ovation serial I/O data bus (serial data and clock signals), base address, and redundant +24 VDC power supplies. The LSW logic card connects to the field card through a pair of inter-card connectors.

If the 5X00034G01 16-Point Individually Fused Channel Personality module is not employed, the Enhanced Compact Sequence of Events electronics module's the field card directly interfaces to the base unit termination block via the base unit backplane.

For the Enhanced Compact Sequence of Events module's 16-point individually fused channel option, the 5X00034G01 personality module is used. The Enhanced Compact Sequence of Events Electronics module FDI or FDW field card interfaces to the base unit terminal block via the 5X00034G01 Personality module's PDIC personality card.

Features

The Enhanced Compact Sequence of Events Electronics Module has 16 field inputs of the levels defined in Electronics module (Emod) for the Enhanced Compact Sequence of Events module (see page 305). The module performs a digital de-bounce on these 16 field input signals in order to obtain the present input state data. The present input state data will be placed in the module's I/O bus Present Input State register. Using the present input state data, the module calculates the event change of state information and status information for the I/O bus.

- 1,000 V dielectric isolation between the field circuits and the Ovation I/O bus common.
- I/O Bus Watchdog Timer
- Module Electronic ID information stored in the logic card EEPROM.
- The I/O module base address is established by the base unit location.
- The base unit provides the electronics module with redundant +24 VDC power supply feeds.
- Module hot swap capability

- Sixteen digital inputs whose present states can be read directly
- Positive Transition Latched register and Negative Transition Latched registers are provided to permit the Controller to directly detect captured low to high and high to low event transitions.
- Field contact wire break detection (Group 5 only)
- 4 millisecond contact de-bounce time.
- 1/8 millisecond resolution event (input change of state) recording.
- 1 millisecond event recording with reference to the time tag clock time sent to the module by the Controller.
- Module can time tag events for 65 seconds before the internal module clock rolls over.
- Internal module time tag clock can be resynchronized by the Controller
- Contains two 32-event buffers
- The module can be configured to mask off specific input channels that will not be checked by the module's event tagging and chatter control logic.
- The module can be configured to enable or disable chatter control for all sixteen input channels. The chatter control counter, if enabled, may be configured to decrement at a defined rate or to be reset when the module event buffers are switched.

6.9.1 Personality modules (Pmod) - (ECSOEDI)

5X00034G01 provides for individual fusing for each of the sixteen digital input channels using a common power supply. This is an optional personality module that available for use for applications requiring individual point fusing with a common power supply.

Note: *The use of the 5X00034G01 personality module converts differential current sinking digital inputs into single-ended current sinking digital inputs. The 5X00034G01 personality module taps the base unit's internal auxiliary voltage and distributes this voltage to all sixteen module digital input channels.*

6.9.2 Electronics modules (Emod) - (ECSOEDI)

- **5X00357G01** Sixteen 24/48 VDC single-ended current-sinking digital inputs (FDJ field card)
- **5X00357G02** Sixteen 24/48 VDC differential current-sinking digital inputs (FDI field card) - supports 16-point individually fused channel option
- **5X00357G03** Sixteen 125 VDC differential current-sinking digital inputs (FDI field card) - supports 16-point individually fused channel option
- **5X00357G04** Sixteen 48 VDC single-ended current-sourcing digital inputs (contact inputs) using on-card power supply (FCI field card)
- **5X00357G05** Sixteen 24 VDC IEC 61131-2 compliant Type 1 differential current-sinking digital inputs with wire break detection capability (FDW field card) – supports 16-point individually fused channel option

6.9.3 One shot function - (ECSOEDI)

The Enhanced Sequence of Events module contains a one-shot function which is accessible through two 16 bits registers that capture two types of events. The digital de-bounce circuit samples each field input channel once every 125 microseconds. If a field input channel's state change remains present for 32 consecutive samples, the event is stored on the corresponding set of latches depending on which type of event occurred. The first type of event is a 16 bit register for low to high transition of each digital input. This is known as Positive Transition Latched Register. The second is a 16 bit register for high to low transition of each digital input. This is known as Negative Transition Latched Register. These are mutually exclusive of each other. Events registered on every channel are also mutually exclusive of each other. Each event will set and latch the corresponding bit in the appropriate event register and it will remain in logic '1' value, even if several valid transitions occur. The reset of the entire latched register will only follow if a read of the event register is performed.

A watchdog timer for one-shot registers would clear the one-shot registers if no reads occur to Positive Transition Latched Register or Negative Transition Latched Register within a period of 5 seconds. After a timeout, the collection of one shot information is prevented until the Controller resumes reading either Positive Transition Latched Register or Negative Transition Latched Register. The first read would be a throw away which would re-activate the watchdog timer. The second read would yield valid register data.

6.9.4 Wire break detect function - (ECSOEDI)

The 5X00358 LSW printed circuit card assembly groups available for enhanced compact sequence of events application are Group Two - with one shot function, and Group Three - with one shot function and wire break detection capability. Group Two LSW logic cards will interface to electronic module assembly groups one to four (G01-G04). Group Three LSW logic cards will interface to electronic module assembly group five (G05).

The wire break detect function has a 16 bit mask register stored in latches. If the wire break mask bit is set for a particular input channel, the condition of field wiring will be detected for that channel.

The digital de-bounce circuit samples each field wiring channel once every 125 microseconds. If a field wiring channel's state change remains present for 32 consecutive samples, the module's Channel Wire Break Detect Register is updated with the new status of field wiring channel. Sampling the field wiring channel states for 32 consecutive times yields a nominal 4 millisecond digital de-bounce time period. Any field wiring change that is less than the digital de-bounce time will be rejected by the module.

6.9.5 Subsystems - (ECSOEDI)

Enhanced Compact Sequence of Events Digital Input subsystems

RANGE	CHANNELS	ELECTRONIC MODULE	PERSONALITY MODULE OR CAVITY INSERT
24/48 VDC Single-ended Digital Input - Current Sinking	16	5X00357G01	1C31238H01[1]
24/48 VDC Differential Digital Input - Current Sinking	16	5X00357G02	1C31238H01[1]

RANGE	CHANNELS	ELECTRONIC MODULE	PERSONALITY MODULE OR CAVITY INSERT
24/48 VDC (Individually Fused Channels with Common power supply) Single-Ended Digital Input - Current Sinking	16	5X00357G02	5X00034G01
125 VDC Differential Digital Input - Current Sinking	16	5X00357G03	1C31238H01[1]
125 VDC (Individually Fused Channels with Common power supply) Single-Ended Digital Input - Current Sinking	16	5X00357G03	5X00034G01
48 VDC Single-ended Digital Input - Current Sourcing (Contact input) with On-Card 48 VDC power supply	16	5X00357G04	1C31238H01[1]
24 VDC (Differential) Digital Input - Current Sinking, IEC61131-2 Compliant Type 1 Digital Inputs	16	5X00357G05	1C31238H01[1]
24 VDC (Individually Fused Channels with Common power supply) Single-Ended Digital Input - Current Sinking, IEC61131-2 Compliant Type 1 Digital Inputs	16	5X00357G05	5X00034G01
[1] This is a plastic insert that fits into the base unit's Personality module cavity and provides a base unit terminal block wiring label for the module.			

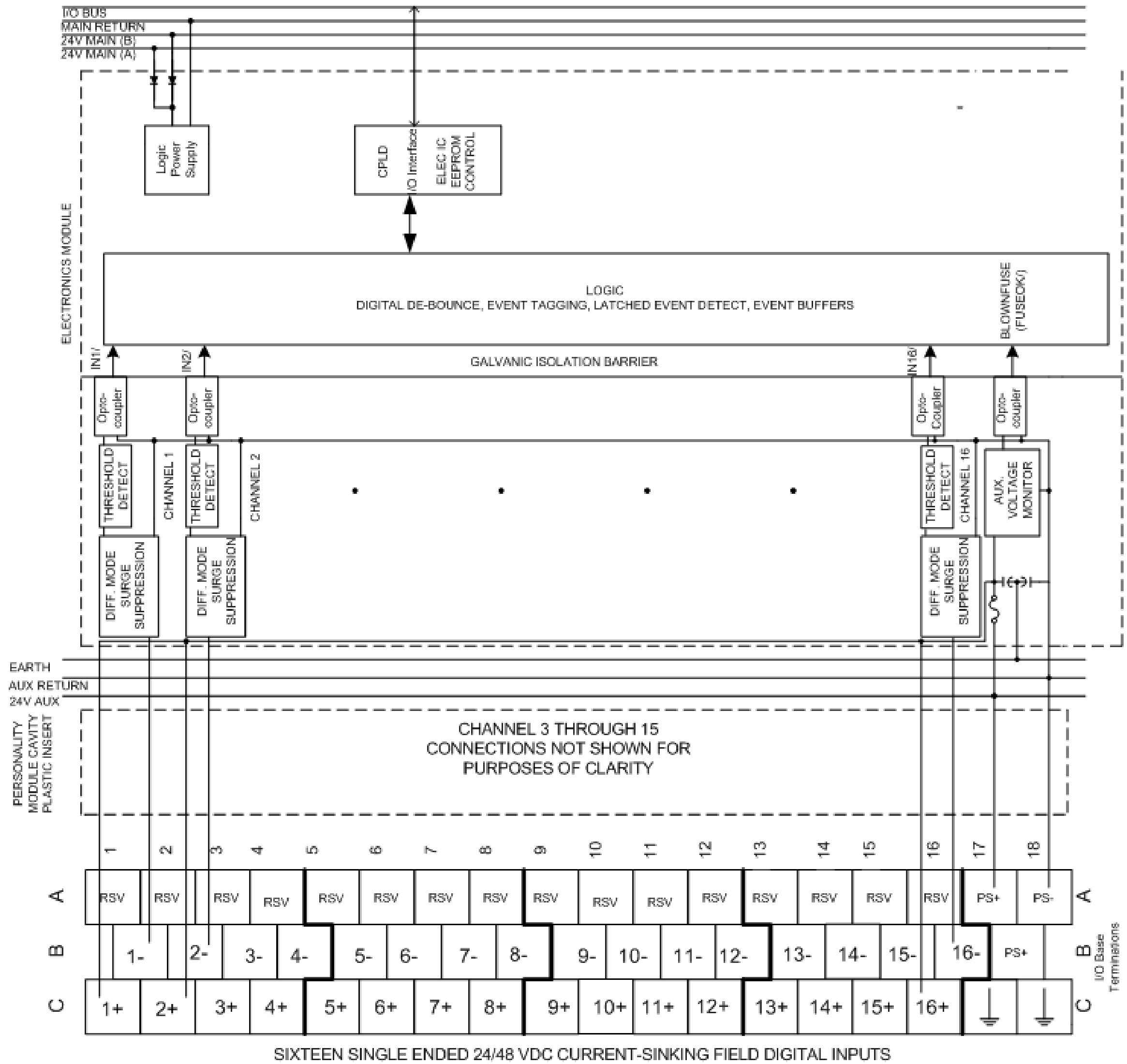
6.9.6 Enhanced Compact Sequence of Events Digital Input module (5X00357G01) (FDJ) - (ECSOEDI)

Style 5X00357G01 has 16 single-ended (common return) current sinking digital inputs with a field card auxiliary power supply fuse and accommodates a common auxiliary 24 VDC or 48 VDC power supply used by all channels. The required auxiliary power supply voltage source may be obtained from the cabinet's internal auxiliary power supply or it may be obtained from an external power supply. The module's field card contains circuit used to monitor the presence of the auxiliary power supply voltage. Two cases cause this field card monitor circuitry to report a blown fuse status:

- Module field card auxiliary power supply fuse is open circuited
- Auxiliary power supply voltage level is below the monitor circuit's On input voltage threshold

Each channel contains an input resistor to provide normal mode surge protection and a current regulator circuit to limit input current during normal operation. Each channel contains an optocoupler to provide galvanic isolation between the field digital input circuit and module's logic or I/O bus side.

Module-base unit interconnection diagram (5X00357G01) - (ECSOEDI)

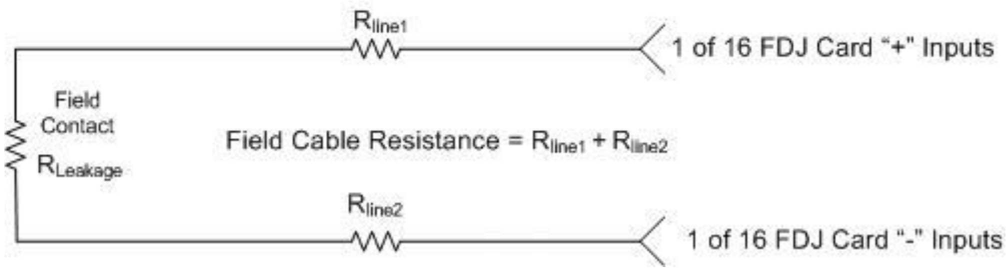


Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

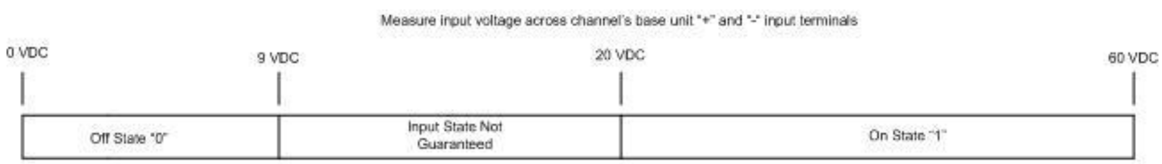
Field wiring (5X00357G01) - (ECSOEDI)

The minimum combined field cable resistance plus field contact leakage resistance value assumes that the Auxiliary power supply voltage is its Maximum allowable value (30 VDC for 24 VDC inputs and 60 VDC for 48 VDC inputs).

Input voltage level	Minimum field cable resistance plus field contact leakage resistance
24 VDC	100 Kohm
48 VDC	150 Kohm

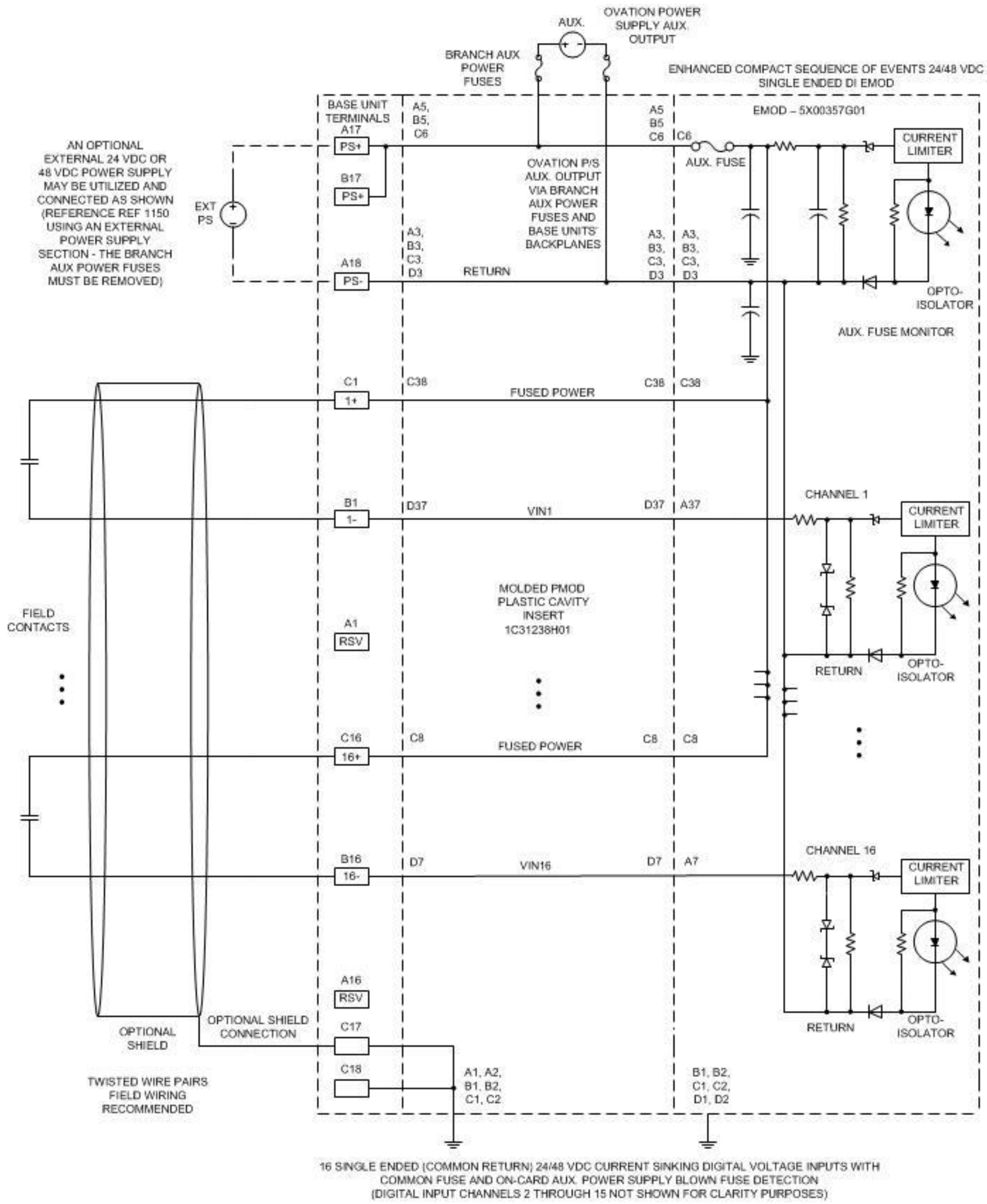


If a channel's combined field cable resistance and contact leakage resistance is less than the values specified above, the channel may report that its field contact state is closed even though the field contact is actually open.

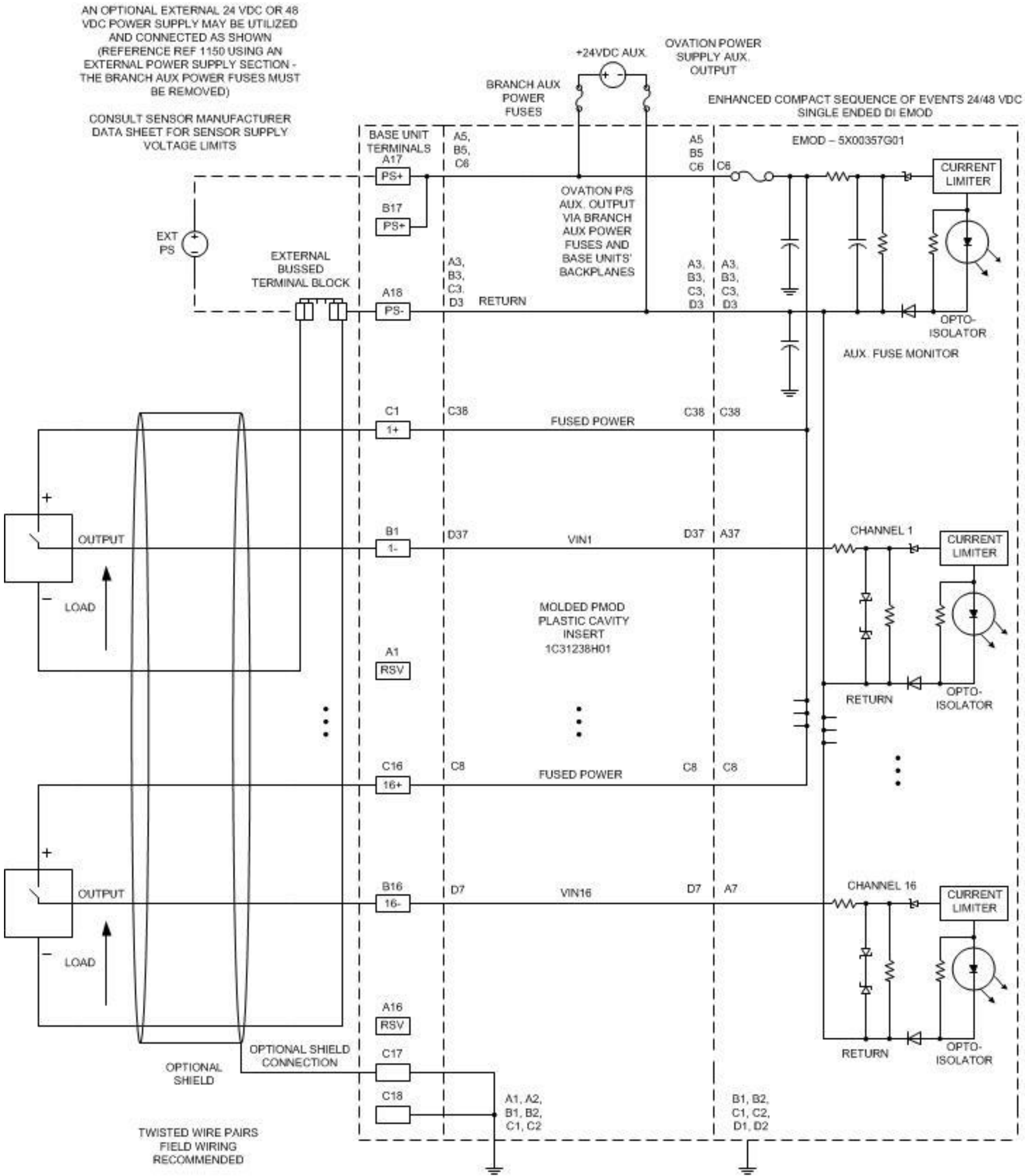


On/Off-State Input Voltage Range

Field connection wiring - 5X00357G01

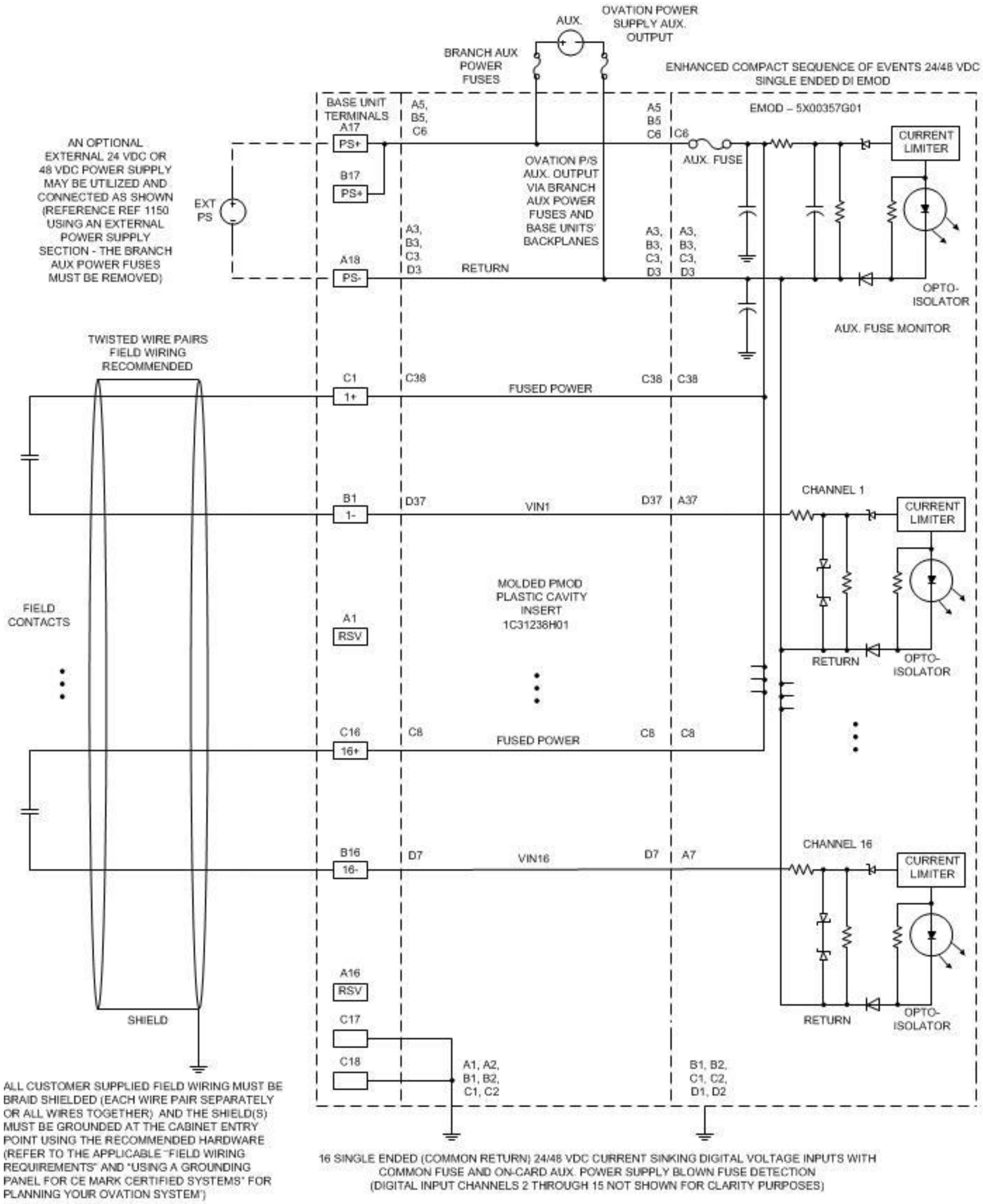


FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (NON-CE MARK)

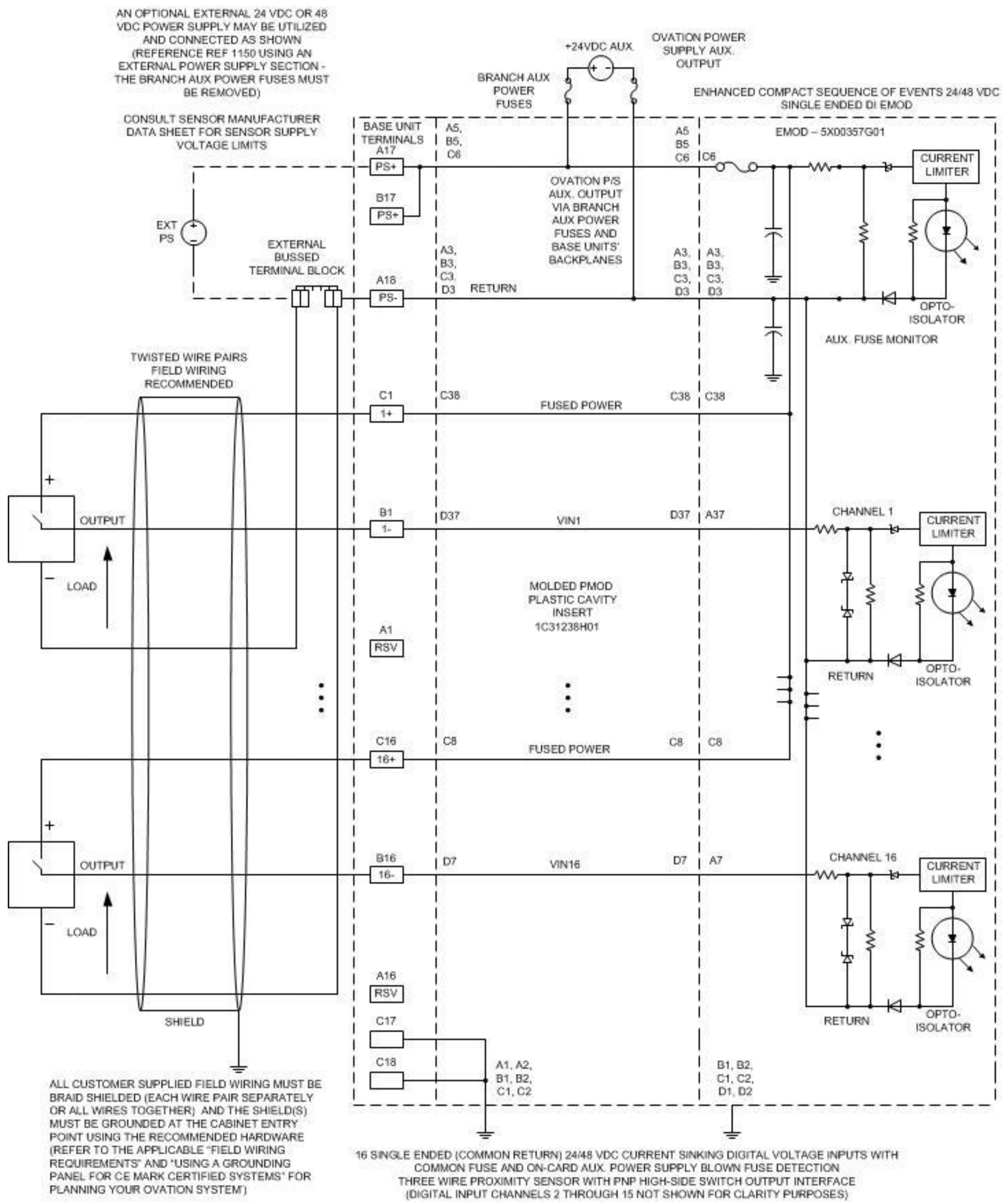


16 SINGLE ENDED (COMMON RETURN) 24/48 VDC CURRENT SINKING DIGITAL VOLTAGE INPUTS WITH COMMON FUSE AND ON-CARD AUX. POWER SUPPLY BLOWN FUSE DETECTION
THREE WIRE PROXIMITY SENSOR WITH PNP HIGH-SIDE SWITCH OUTPUT INTERFACE
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

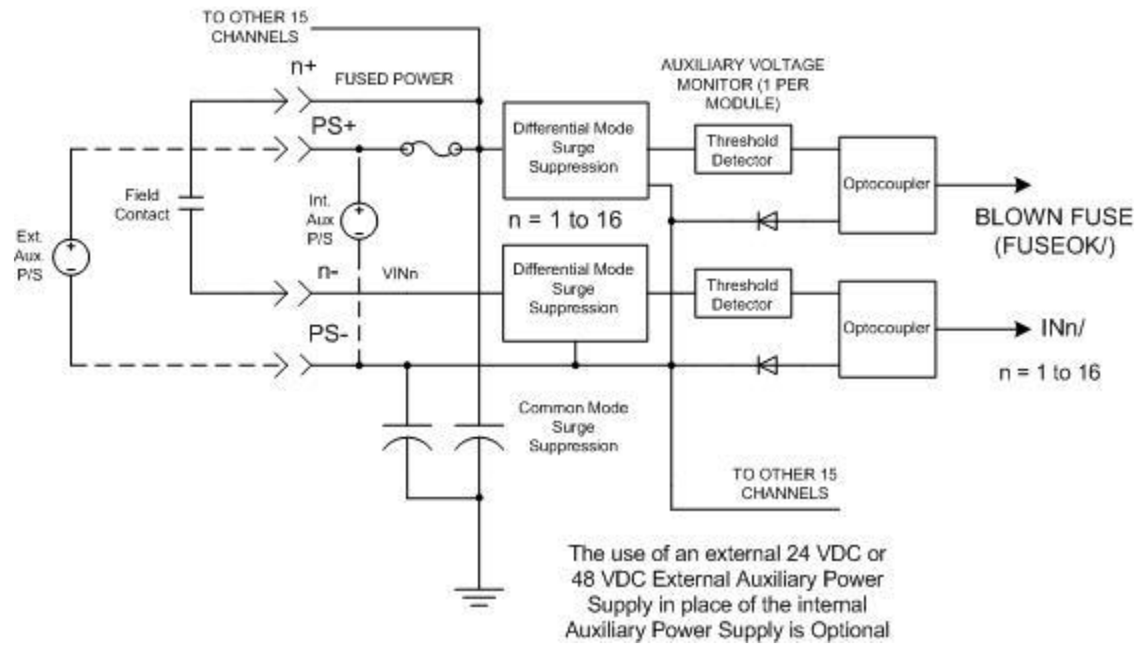
FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (NON-CE MARK)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (CE MARK)



FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP ONE) (CE MARK)



The "+" inputs are actually the module field card's fused Auxiliary power supply positive rail.

The auxiliary power supply voltage may be derived either from the base unit backplane's printed circuit card auxiliary voltage traces or from an optional external auxiliary power supply

1. To use the base unit backplane's printed circuit backplane Auxiliary voltage, do not connect an external power supply to the base unit termination block PS+ and PS- terminals since the base unit backplane's Auxiliary voltage automatically appears at these terminals

   The two plug-in branch Aux. fuses must be installed into their sockets located on the Controller backplane or on the transition panel to which the module's base unit branch interfaces.

2. To use an external 24 VDC or 48 VDC auxiliary power supply, connect the power supply "+" and "-" terminals to the base unit PS+ and PS- terminals as shown. This connection will force all modules on this branch to use the external auxiliary power supply voltage.

   The two plug-in branch Aux. fuses must be removed from their sockets located on the Controller backplane or on the transition panel to which the module's base unit branch interfaces.

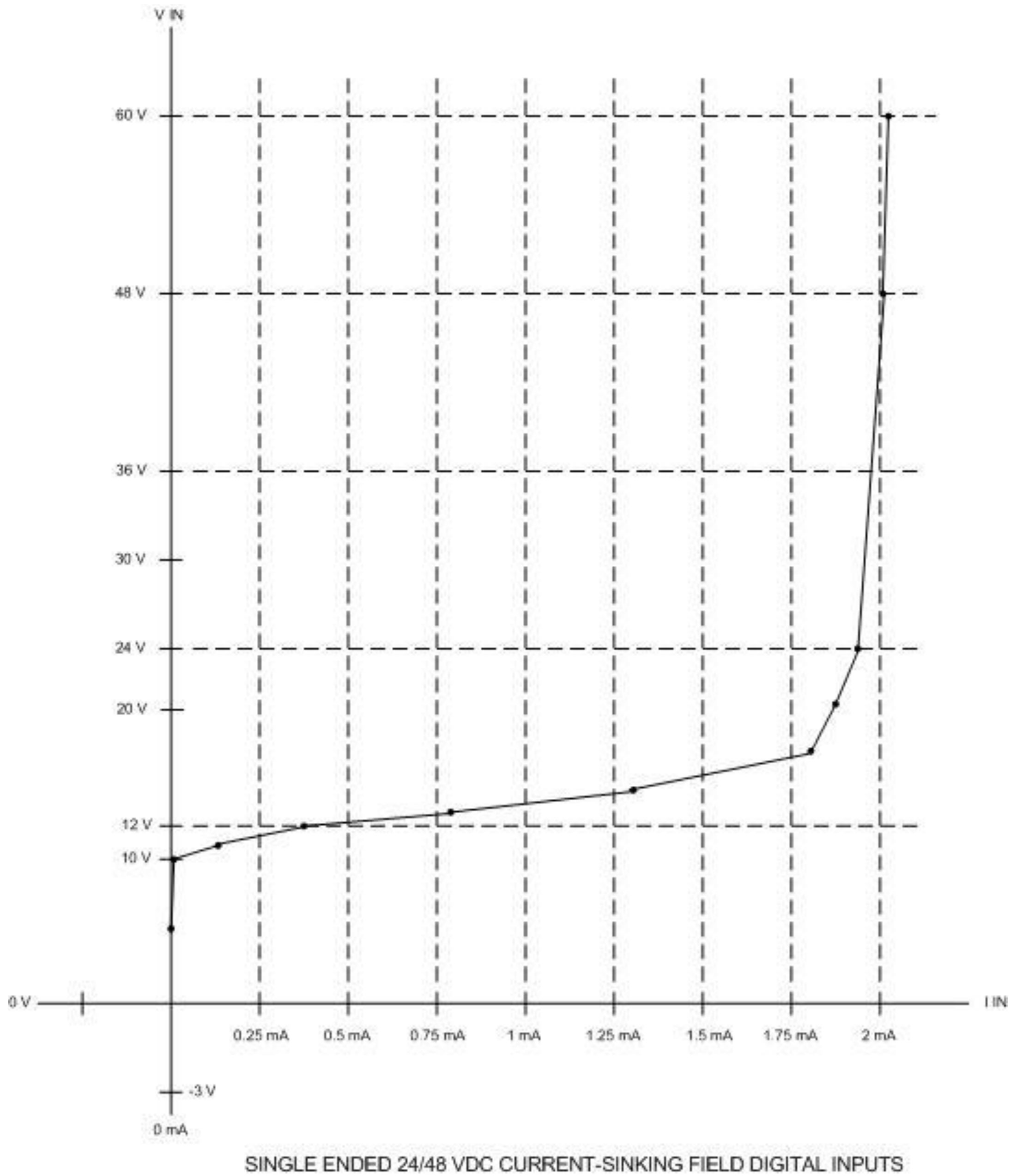
No other external power supplies may be connected to other base unit termination block PS+ or PS- terminals located in the same branch.

External power supply information (5X00357G01 - G05) - (ECSOEDIG01, G02, G03, G05)

When using the Enhanced Compact Sequence of Events module, the required voltage source may be obtained from the internal auxiliary power supply (Controller backplane) or it may be obtained from an external power supply.

If an external power supply is used, there are steps to be undertaken before connecting the external power supply to the Enhanced Compact Sequence of Events Digital Input module base unit terminal block, Refer to *Using an External Power Supply* (see page 799).

Voltage-current curve (5X00357G01) - (ECSOEDI)



Specifications (5X00357G01) - (ECSOEDI)

DESCRIPTION	VALUE
Voltage category	24 VDC or 48 VDC
Reverse polarity protection	Yes, each channel incorporates a diode in series with the optocoupler.
Operating voltage	20-60 VDC.

DESCRIPTION	VALUE
Input voltage	For "1" signal = 20-60 VDC. For "0" signal = 0-9 VDC.
Input current	For "1" signal = 1.3 mA Min - 2.6 mA Max.
Number of channels Channels per common	16 16
Galvanic isolation	Between channels and I/O bus = Yes. Between channels = No.
Current draw, from I/O bus base unit, 24 V main power	44 mA typical for all inputs off. 77 mA typical for all inputs on.
Power dissipation of module Sum of 24V main power and 24V field channel power Sum of 24V main power and 48V field channel power	 1.1 W typical for all inputs off. 2.54 W typical for all inputs on. 1.1 W typical for all inputs off. 3.24 W typical for all inputs on.
Total module response time (1 foot (0.305 M) long field cable is assumed)	"0" Open to "1" Close = 4.02 msec typ "1" Close to "0" Open = 4.13 msec typ
Resolution	1/8 msec for time tagging an event.
Accuracy (time tagged)	1 msec relative to clock from I/O bus. 1/8 msec relative to other module channels.
LSW card Propagation delay - field card output to present input state register	3.75 mesc. Min. 4.0 msec. typ. 4.25 msec. Max.
LSW card digital debounce circuit delay time	4.0 msec. typ.
Status Display	Green LED per channel. LEDs located in logic card circuit.

Note: *Any module digital input state change time that is less than the LSW card digital debounce time will be rejected by the module and will not appear in the present input state register.*

FDJ card signal propagation delay. This is the typical time elapsed from the time that a field contact opens or closes until the time that associated channel's output signal (INn/ where n = 1 to 16) changes states. Assumes a 1 foot (0.305 m) long test cable.

Input voltage level	Delay time for contact opening	Delay time for contact closing
24 VDC	0.13 msec. typ.	0.02 msec. typ.
48 VDC	0.13 msec. typ.	0.02 msec. typ.

There is an additional propagation delay due to field cable capacitance charging when the field contact opens. This delay is per 1,000 feet of field cable and assumes a 30 pF/foot cable capacitance.

Note: *There is no additional propagation delay to consider when the field contact closes.*

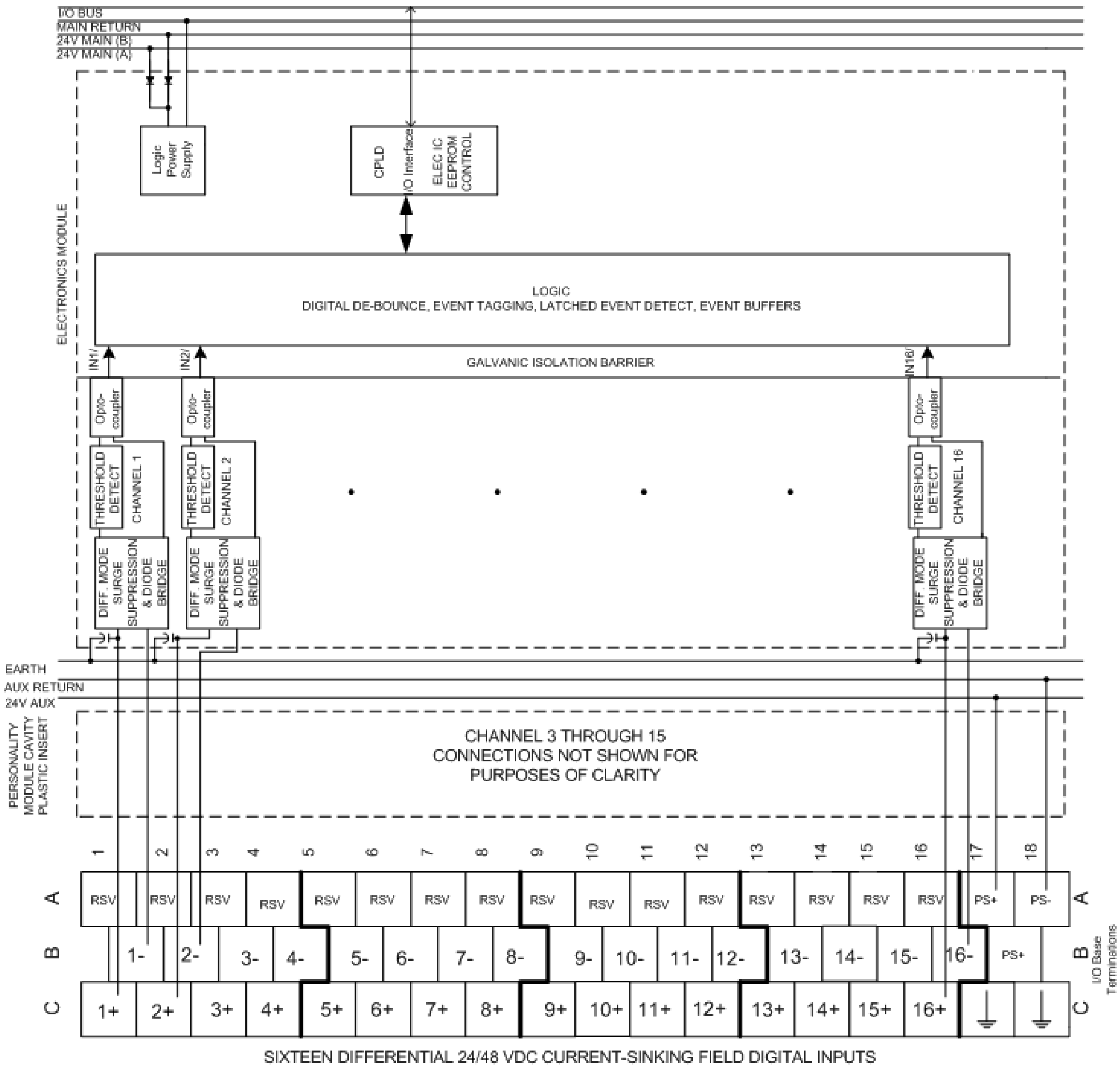
Input voltage level	Additional delay time for contact opening
24 VDC	0.2 msec. typ.
48 VDC	0.6 msec. typ.

6.9.7 Enhanced Compact Sequence of Events Digital Input module (5X00357G02) (FDI) - (ECSOEDI)

Style 5X00357G02 has 16 differential (galvanically isolated) current sinking digital inputs that can accommodate a separate 24 VDC or 48 VDC auxiliary power supply for each channel. Style 5X00357G02 can be used with the 5X00034G01 Individually Fused 16 Point personality module for applications requiring individual channel fusing of a common 24 VDC or 48 VDC auxiliary power supply. The required auxiliary power supply voltage source may be obtained from the cabinet's internal auxiliary power supply or it may be obtained from an external power supply or multiple external power supplies. Each channel contains an input resistor to provide normal mode surge protection and a current regulator circuit to limit input current during normal operation. A diode bridge allows input voltages of either polarity to be applied. Each channel contains an optocoupler to provide galvanic isolation between the field digital input circuit and module's logic or I/O bus side.

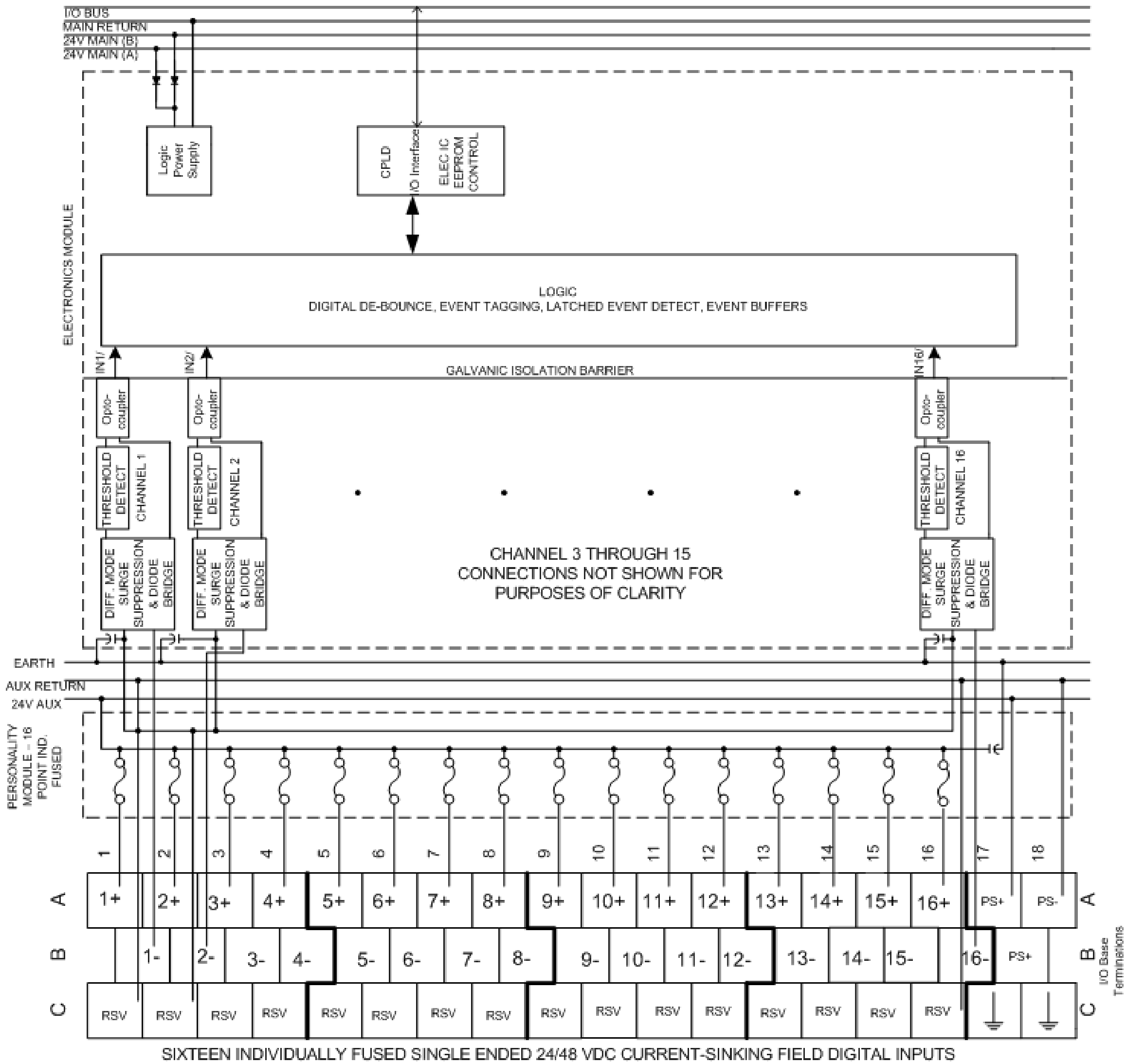
Note: *The use of the 5X00034G01 personality module converts differential current sinking digital inputs into single-ended current sinking digital inputs. The 5X00034G01 personality module taps the base unit's internal auxiliary voltage and distributes this voltage to all 16 module digital input channels.*

Module-base unit interconnection (5X00357G02) - (ECSOEDI)



***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Module-base unit interconnection (Individually Fused) (5X00357G02) - (ECSOEDI)

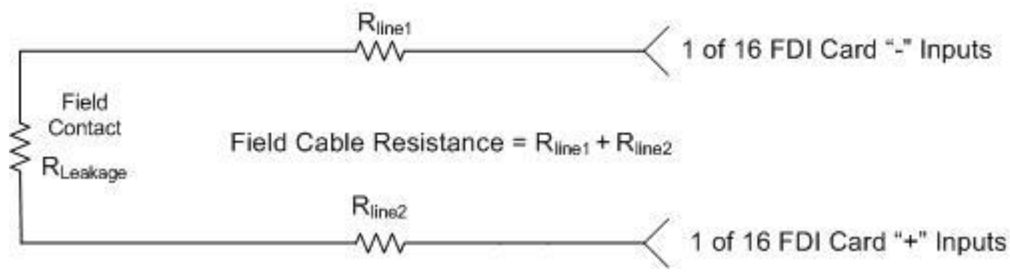


***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

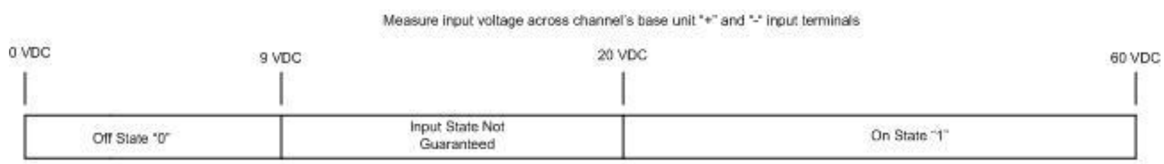
Field wiring (5X00357G02) - (ECSOEDI)

The minimum combined field cable resistance plus field contact leakage resistance value assumes that the Auxiliary power supply voltage is its Maximum allowable value (30 VDC for 24 VDC inputs and 60 VDC for 48 VDC inputs).

Input voltage level	Minimum field cable resistance plus field contact leakage resistance
24 VDC	100 Kohm
48 VDC	150 Kohm

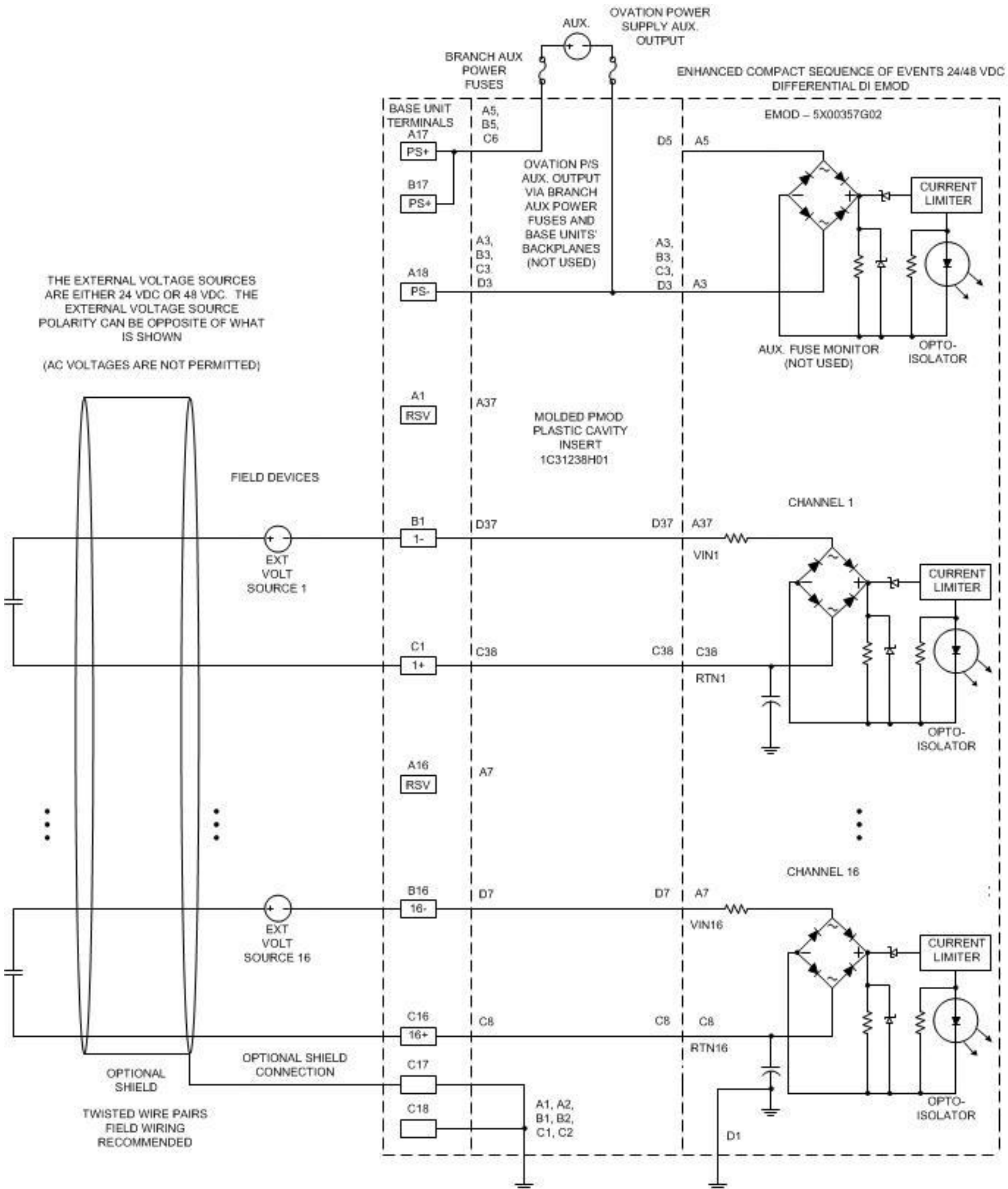


If a channel's combined field cable resistance and contact leakage resistance is less than the values specified above, the channel may report that its field contact state is closed even though the field contact is actually open.



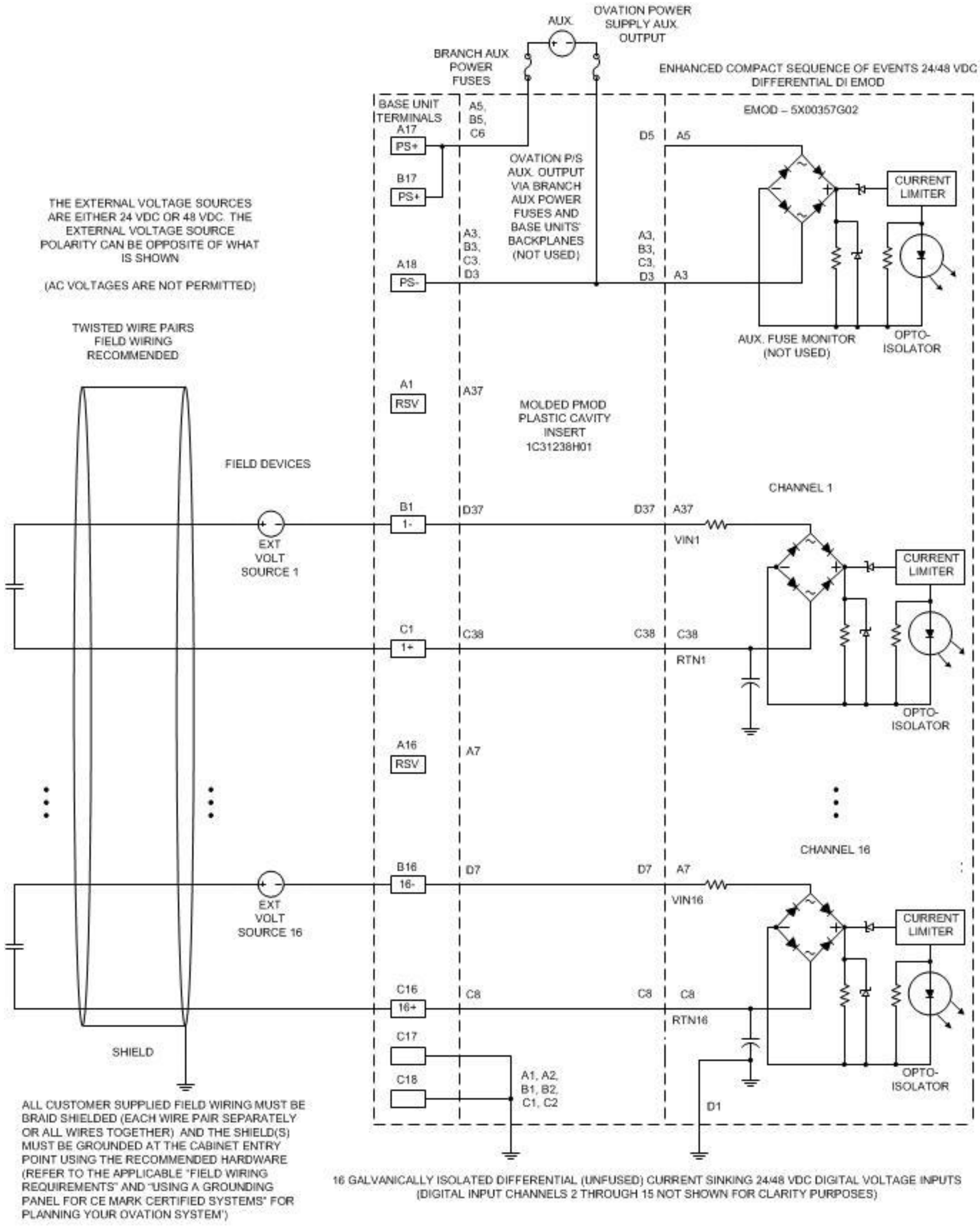
On/Off-State Input Voltage Range

Field connection wiring (5X00357G02) - (ECSOEDI)



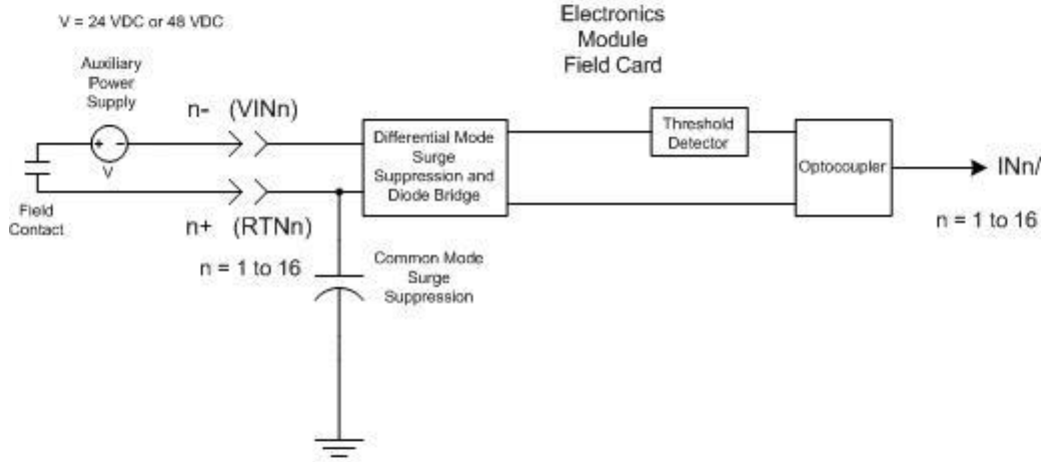
16 GALVANICALLY ISOLATED DIFFERENTIAL (UNFUSED) CURRENT SINKING 24/48 VDC DIGITAL VOLTAGE INPUTS
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (NON-CE MARK)



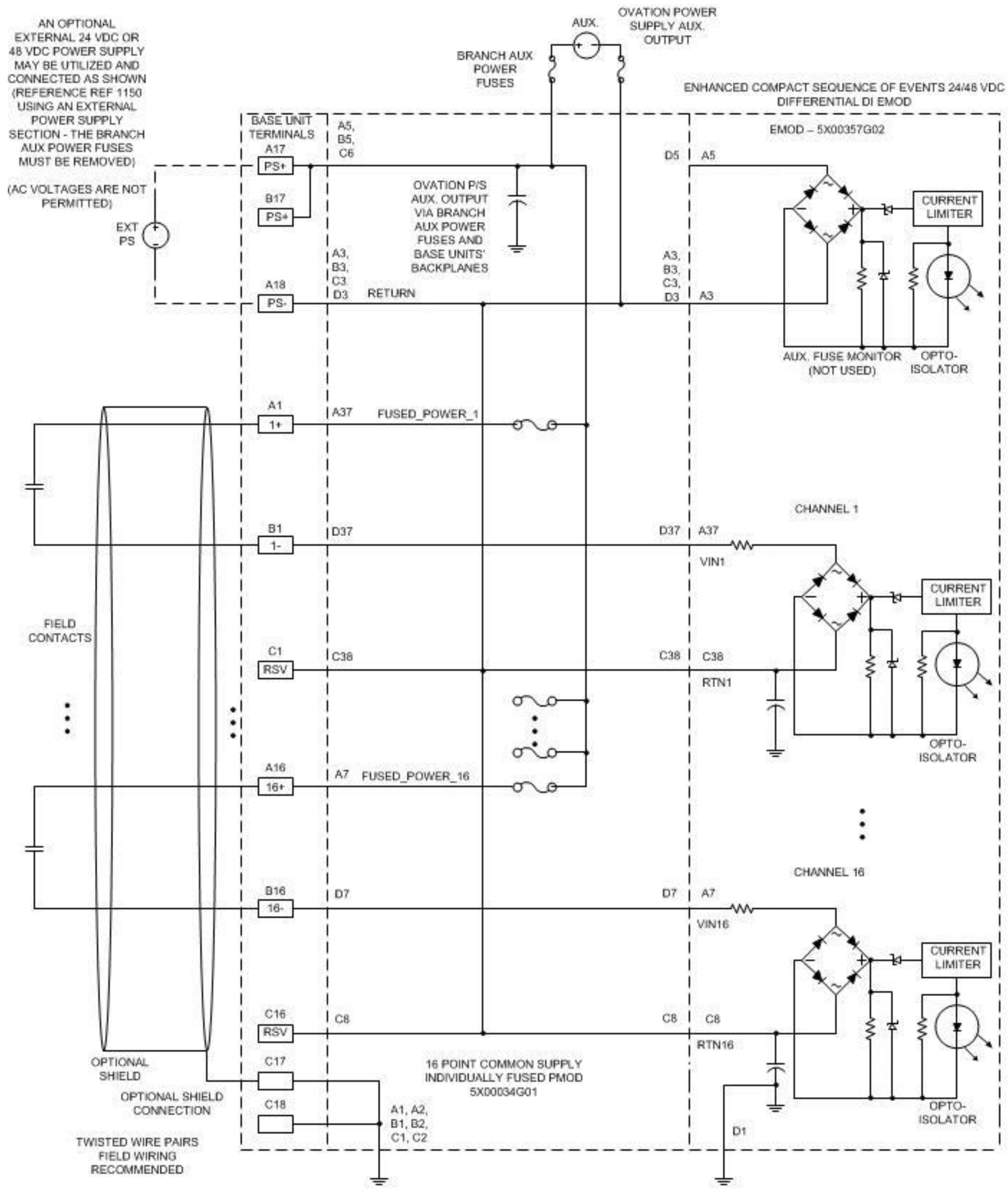
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (CE MARK)

Note: *Channel 4 through 15 input terminals not shown for clarity purposes.*



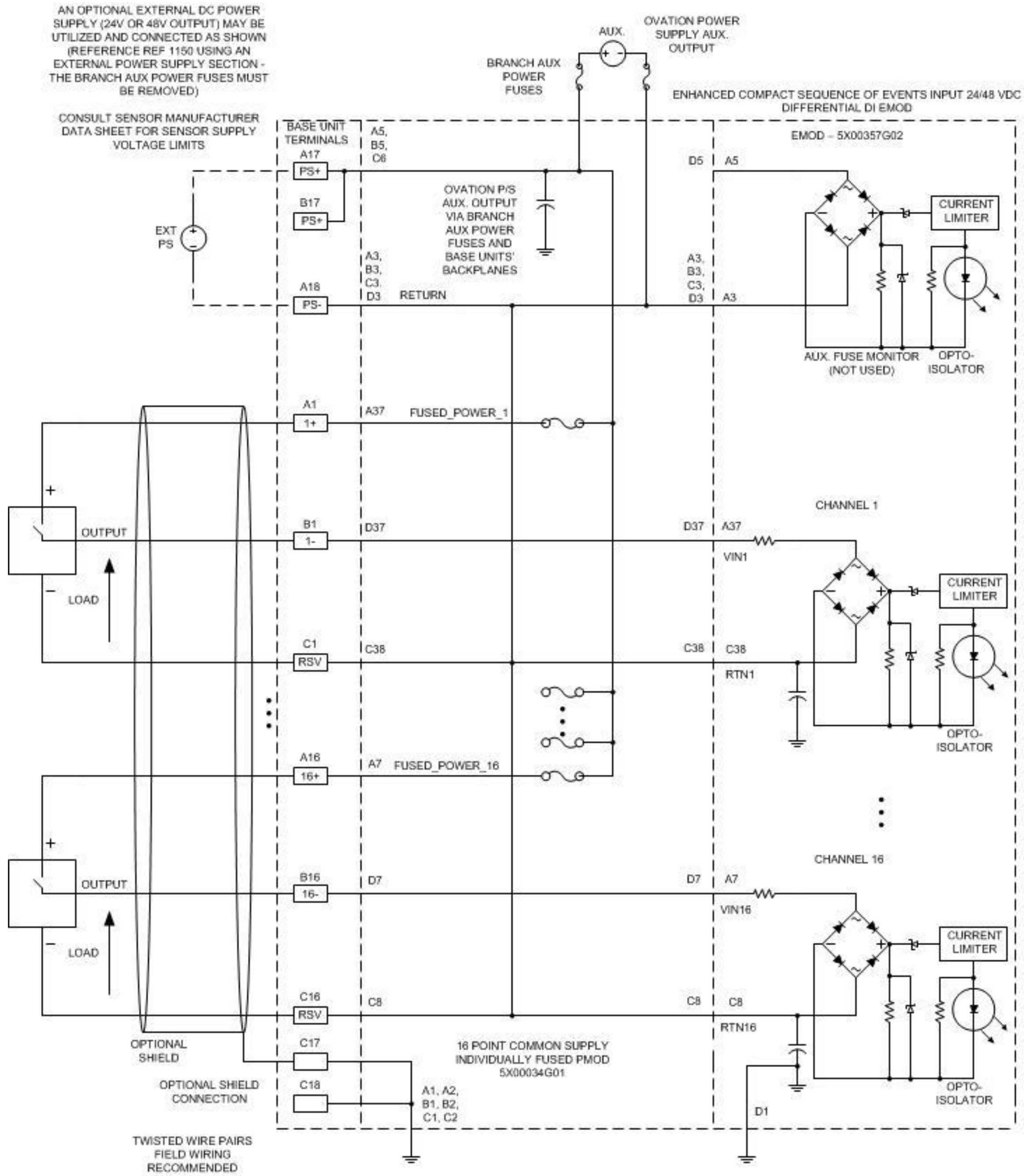
24/48 VDC DIFFERENTIAL CURRENT-SINKING FIELD DIGITAL INPUT CHANNEL

Field connection wiring Individually Fused (5X00357G02) - (ECSOEDI)



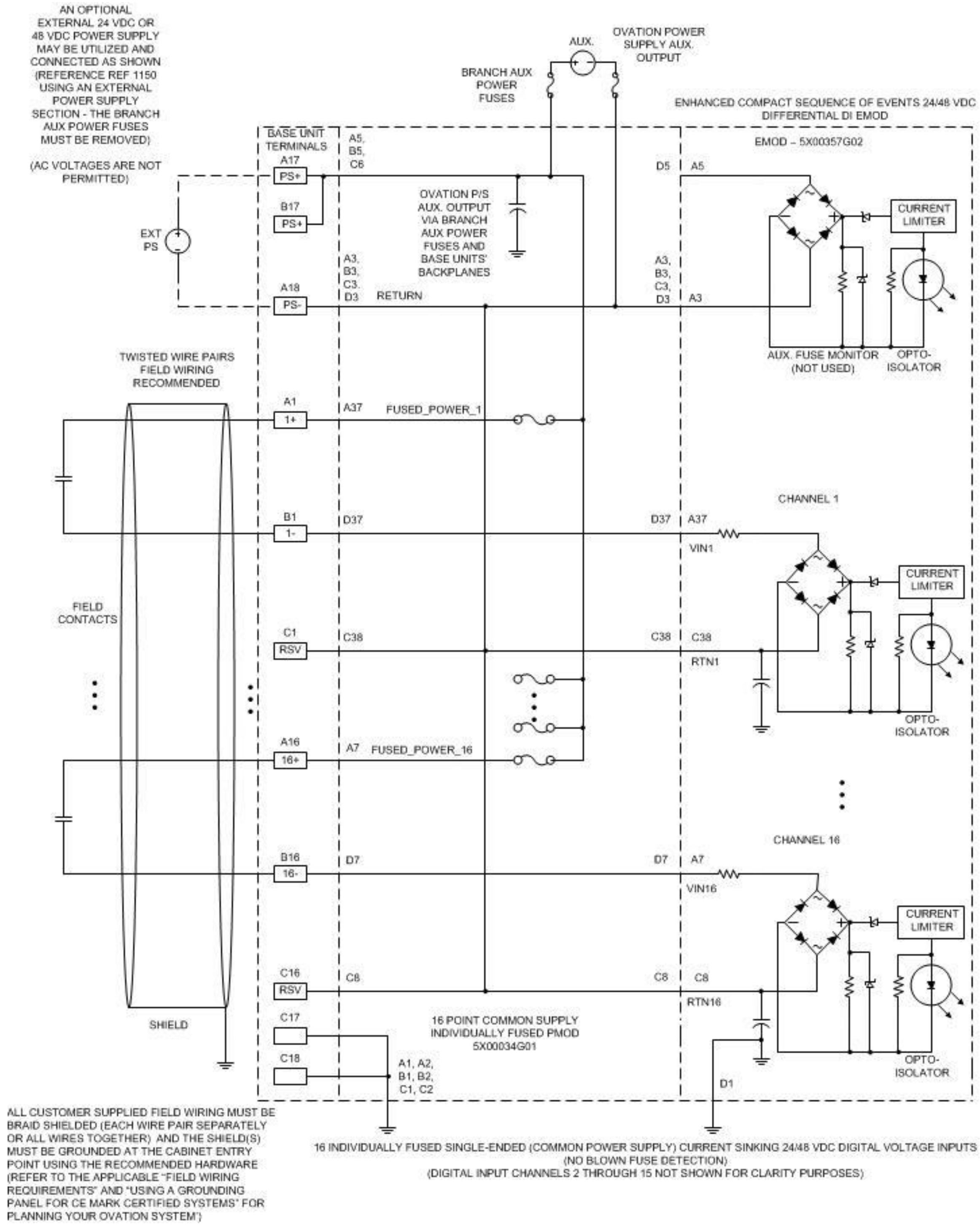
16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT SINKING 24/48 VDC DIGITAL VOLTAGE INPUTS (NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (NON-CE MARK)

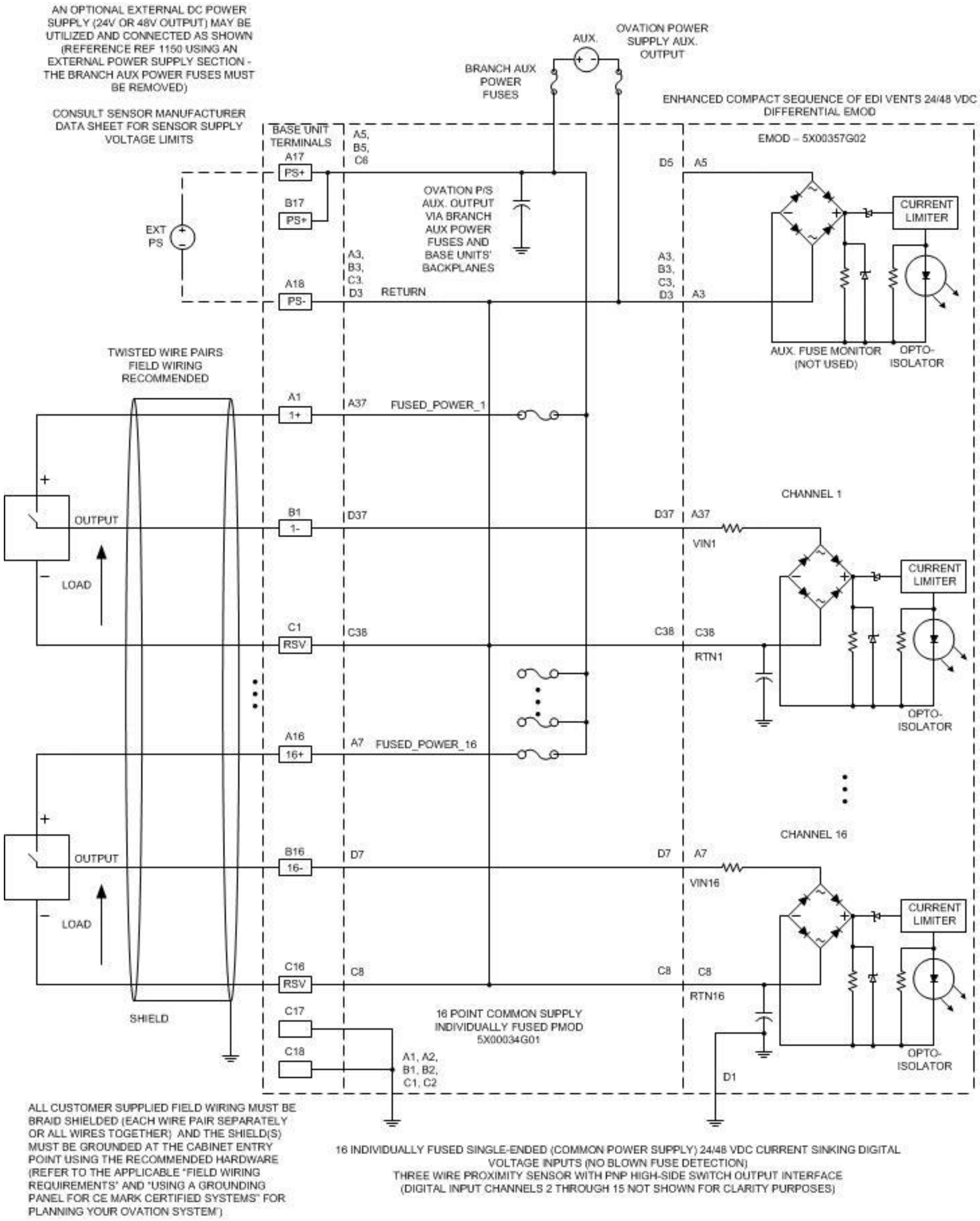


16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) 24/48 VDC CURRENT SINKING DIGITAL VOLTAGE INPUTS (NO BLOWN FUSE DETECTION)
THREE WIRE PROXIMITY SENSOR WITH PNP HIGH-SIDE SWITCH OUTPUT INTERFACE
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

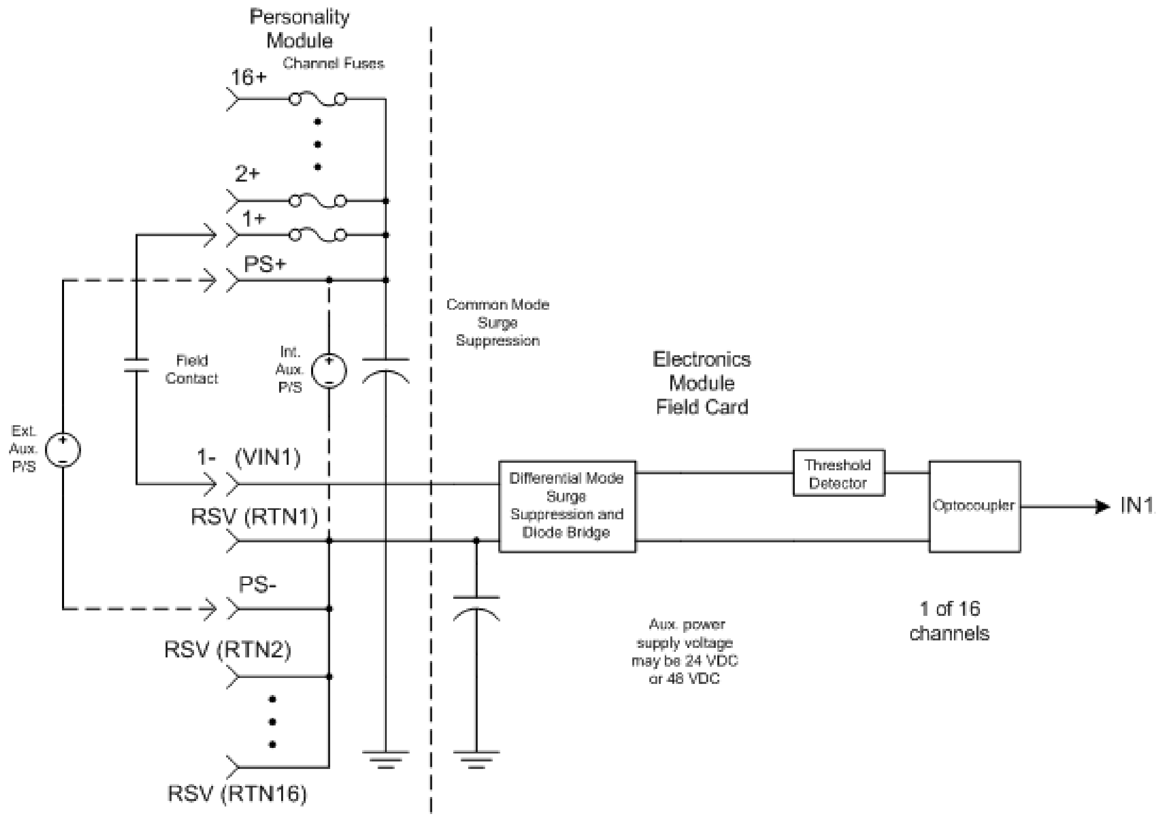
FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (NON-CE MARK)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (CE MARK)



FIELD CONNECTIONS (3 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP TWO) (CE MARK)



24/48 VDC INDIVIDUALLY FUSED CURRENT-SINKING FIELD DIGITAL INPUT CHANNEL

The “+” inputs are actually the 5X00034G01 personality module PDIC personality card’s fused Auxiliary power supply positive rail. The “-” inputs are the field card’s channel VIN inputs. The PDIC personality card connects the sixteen field card channel RTN inputs to the auxiliary power supply return.

For 5X00357G02/5X00034G01 module combinations, the auxiliary power supply voltage may be derived either from the base unit backplane’s printed circuit card auxiliary voltage traces or from an optional external auxiliary power supply.

1. To use the base unit backplane’s printed circuit backplane Auxiliary voltage, do not connect an external power supply to the base unit termination block PS+ and PS- terminals since the base unit backplane’s Auxiliary voltage automatically appears at these terminals.

   The two plug-in branch Aux. fuses must be installed into their sockets located on the Controller backplane or on the transition panel to which the module’s base unit branch interfaces.

2. To use an external 24 VDC (5X00357G02) or 48 VDC (5X00357G02) auxiliary power supply, connect the power supply “+” and “-” terminals to the base unit PS+ and PS- terminals as shown. This connection will force all modules on this branch to use the external auxiliary power supply voltage.

   The two plug-in branch Aux. fuses must be removed from their sockets located on the Controller backplane or on the transition panel to which the module’s base unit branch interfaces.

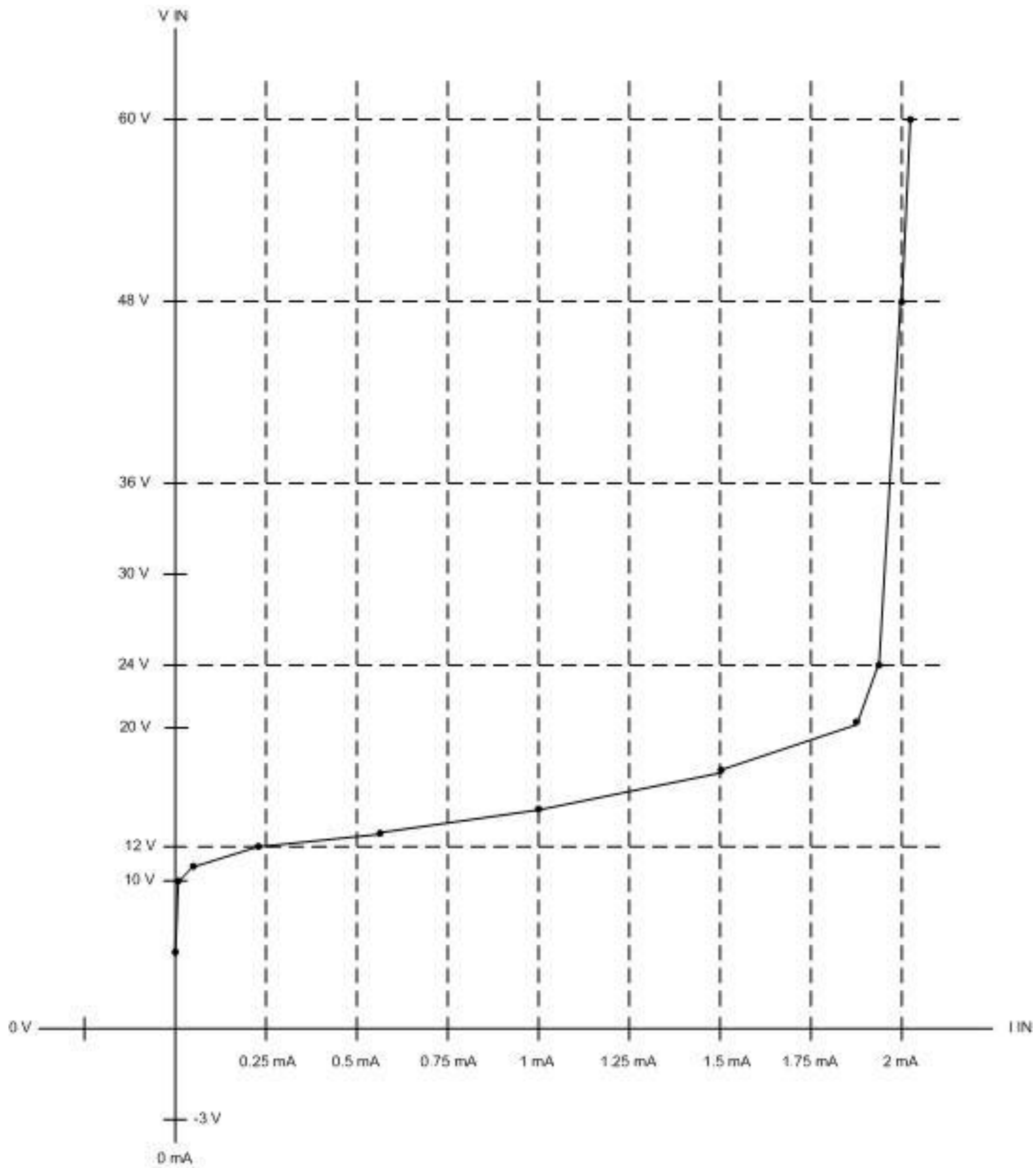
No other external power supplies may be connected to other base unit termination block PS+ or PS- terminals located in the same branch.

External power supply information (5X00357G01 - G05) - (ECSOEDIG01, G02, G03, G05)

When using the Enhanced Compact Sequence of Events module, the required voltage source may be obtained from the internal auxiliary power supply (Controller backplane) or it may be obtained from an external power supply.

If an external power supply is used, there are steps to be undertaken before connecting the external power supply to the Enhanced Compact Sequence of Events Digital Input module base unit terminal block, Refer to *Using an External Power Supply* (see page 799).

Voltage-current curve (5X00357G02) - (ECSOEDI)



24/48 VDC CURRENT-SINKING FIELD DIGITAL INPUTS

Specifications (5X00357G02) - (ECSOEDI)

DESCRIPTION	VALUE
Voltage category	24 VDC or 48 VDC
Reverse polarity protection	Yes, each channel incorporates a front-end diode bridge
Operating voltage	20-60 VDC
Input voltage	For "1" signal = 20-60 VDC For "0" signal = 0-9 VDC
Input current	For "1" signal = 1.3 mA Min - 2.6 mA Max
Number of channels Channels per common	16 1,5X00357G02/1C31238H01 16, 5X00357G02/5X00034G01
Galvanic isolation	Between channels and I/O bus = Yes Between channels = Yes, 5X00357G02/1C31238H01 No, 5X00357G02/5X00034G01
Current draw, from I/O bus base unit, 24 V main power	44 mA typical for all inputs off 63 mA typical for all inputs on
Power dissipation of module Sum of 24V main power and 24V field channel power. Sum of 24V main power and 48V field channel power	 1.06 W typical for all inputs off 2.16 W typical for all inputs on 1.06 W typical for all inputs off 2.82 W typical for all inputs on
Total module response time (1 foot (0.305 M) long field cable is assumed)	"0" Open to "1" Close = 4.02 msec typ "1" Close to "0" Open = 4.13 msec typ
Resolution	1/8 msec for time tagging an event
Accuracy (time tagged)	1 msec relative to clock from I/O bus 1/8 msec relative to other module channels
LSW card Propagation delay - field card output to present input state register	3.75 mesc. Min. 4.0 msec. typ. 4.25 msec. Max.
LSW card digital debounce circuit delay time	4.0 msec. typ.
Status Display	Green LED per channel. LEDs located in isolated logic card circuit

Note: *Any module digital input state change time that is less than the LSW card digital debounce time is rejected by the module and does not appear in the present input state register.*

FDI card signal propagation delay, is the typical time elapsed from the time that a field contact opens or closes until the time that associated channel's output signal (INn/ where n = 1 to 16) changes states. Assumes a 1 foot (0.305 m) long test cable.

Input voltage level	Delay time for contact opening	Delay time for contact closing
24 VDC	0.13 msec. typ.	0.02 msec. typ.
48 VDC	0.13 msec. typ.	0.02 msec. typ.

There is an additional propagation delay due to field cable capacitance charging when the field contact opens. This delay is per 1,000 feet of field cable and assumes a 30 pF/foot cable capacitance.

Note: *There is no additional propagation delay to consider when the field contact closes.*

Input voltage level	Additional delay time for contact opening
24 VDC	0.2 msec. typ.
48 VDC	0.6 msec. typ.

6.9.8 Enhanced Compact Sequence of Events Digital Input module (5X00357G03) (FDI) - (ECSOEDI)

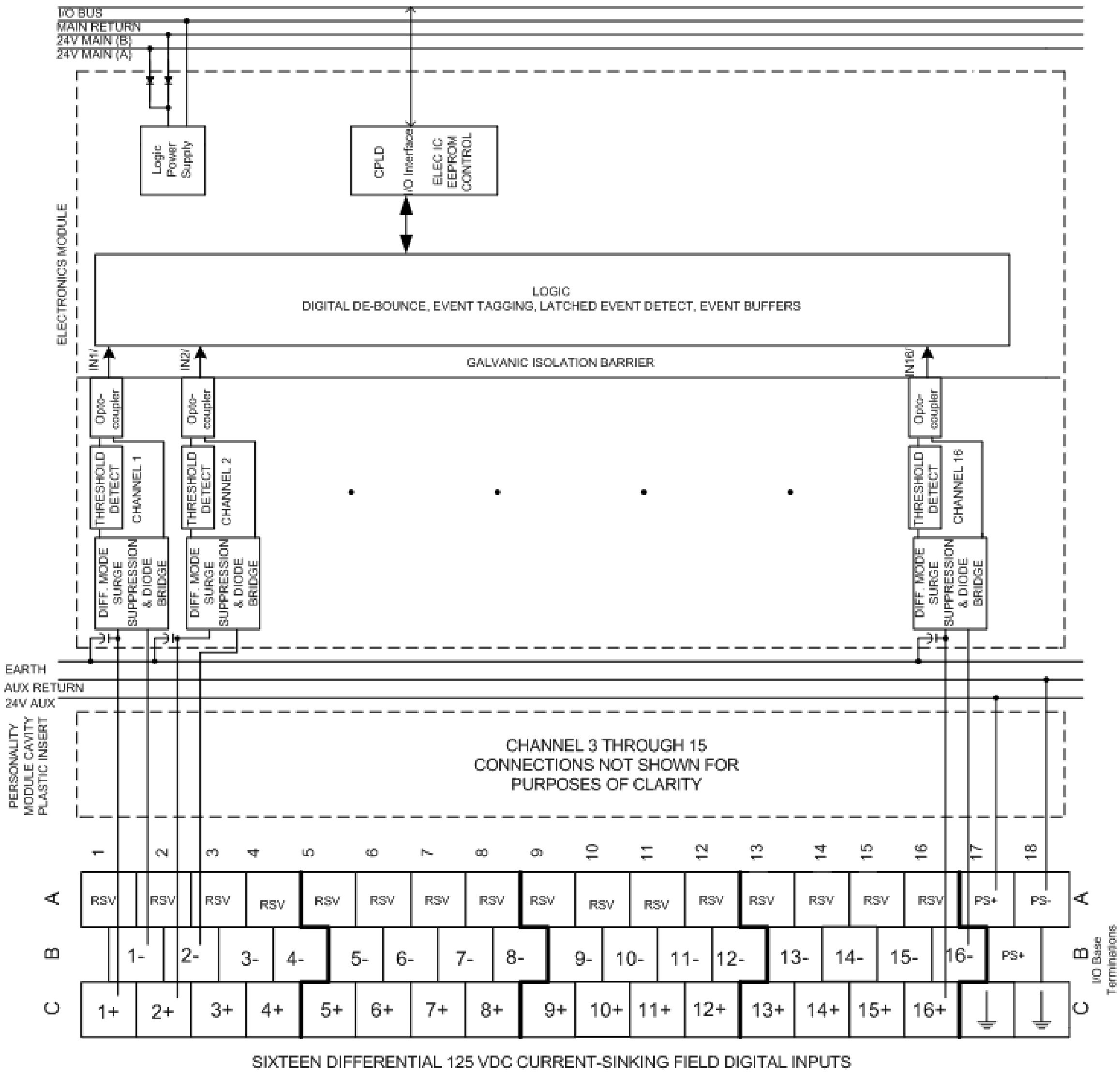
Style 5X00357G03 has 16 differential (galvanically isolated) current sinking digital inputs that can accommodate a separate 125 VDC auxiliary power supply for each channel. Style 5X00357G03 can be used with the 5X00034G01 Individually Fused 16 Point personality module for applications requiring individual channel fusing of a common 125 VDC auxiliary power supply. The required 125 VDC auxiliary power supply voltage source may be obtained from the module base unit backplane (both module I/O branch plug-in fuses removed and external 125 VDC power supply connected to module base unit PS+ and PS- terminals) or it may be obtained from an external power supply or multiple external power supplies.

When the 5X00357G03 Enhanced Compact Sequence of Events electronics module is used without the 5X00034G01 Individually Fused 16 Point personality module, additional external fusing or other current limiting devices are recommended on the hazardous inputs to provide additional protection to the external wiring and 125 VDC power supply.

Each channel contains an input resistor to provide normal mode surge protection and a current regulator circuit to limit input current during normal operation. A diode bridge allows input voltages of either polarity to be applied. Each channel contains an optocoupler to provide galvanic isolation between the field digital input circuit and module's logic or I/O bus side.

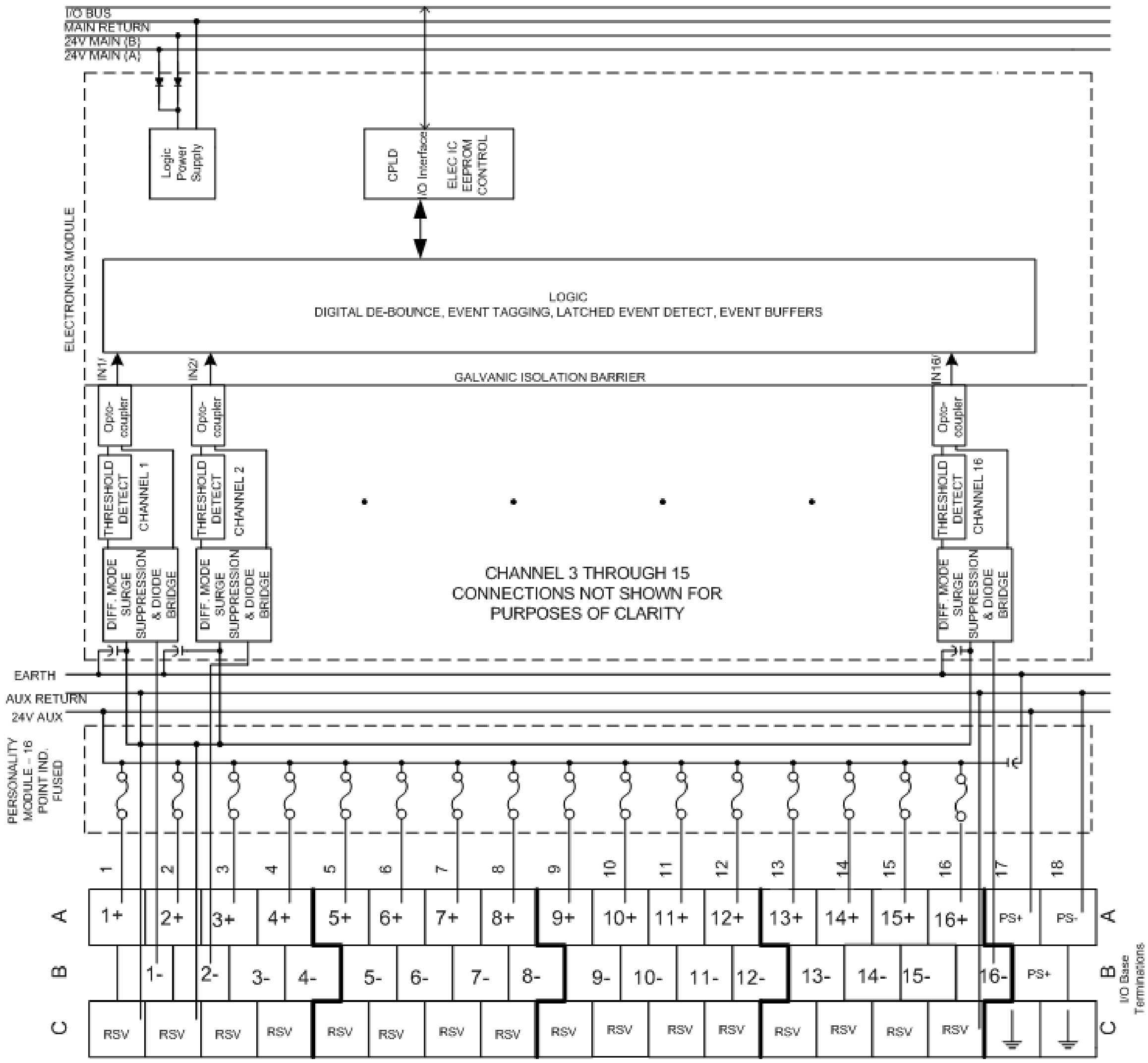
Note: *The use of the 5X00034G01 personality module converts differential current sinking digital inputs into single-ended current sinking digital inputs. The 5X00034G01 personality module taps the base unit's internal auxiliary voltage and distributes this voltage to all sixteen module digital input channels.*

Module-base unit interconnection (5X00357G03) - (ECSOEDI)



***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Module-base unit interconnection individually Fused (5X00357G03) - (ECSOEDI)



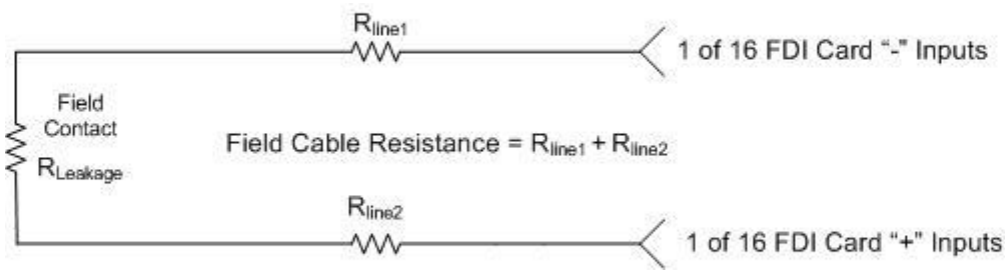
SIXTEEN INDIVIDUALLY FUSED SINGLE ENDED 125 VDC CURRENT-SINKING FIELD DIGITAL INPUTS

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

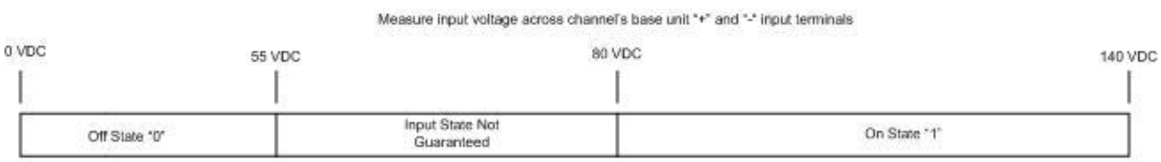
Field wiring (5X00357G03) - (ECSOEDI)

The minimum combined field cable resistance plus field contact leakage resistance value assumes that the Auxiliary power supply voltage is its Maximum allowable value (140 VDC for 125 VDC inputs).

Input voltage level	Minimum field cable resistance plus field contact leakage resistance
125 VDC	250 Kohm

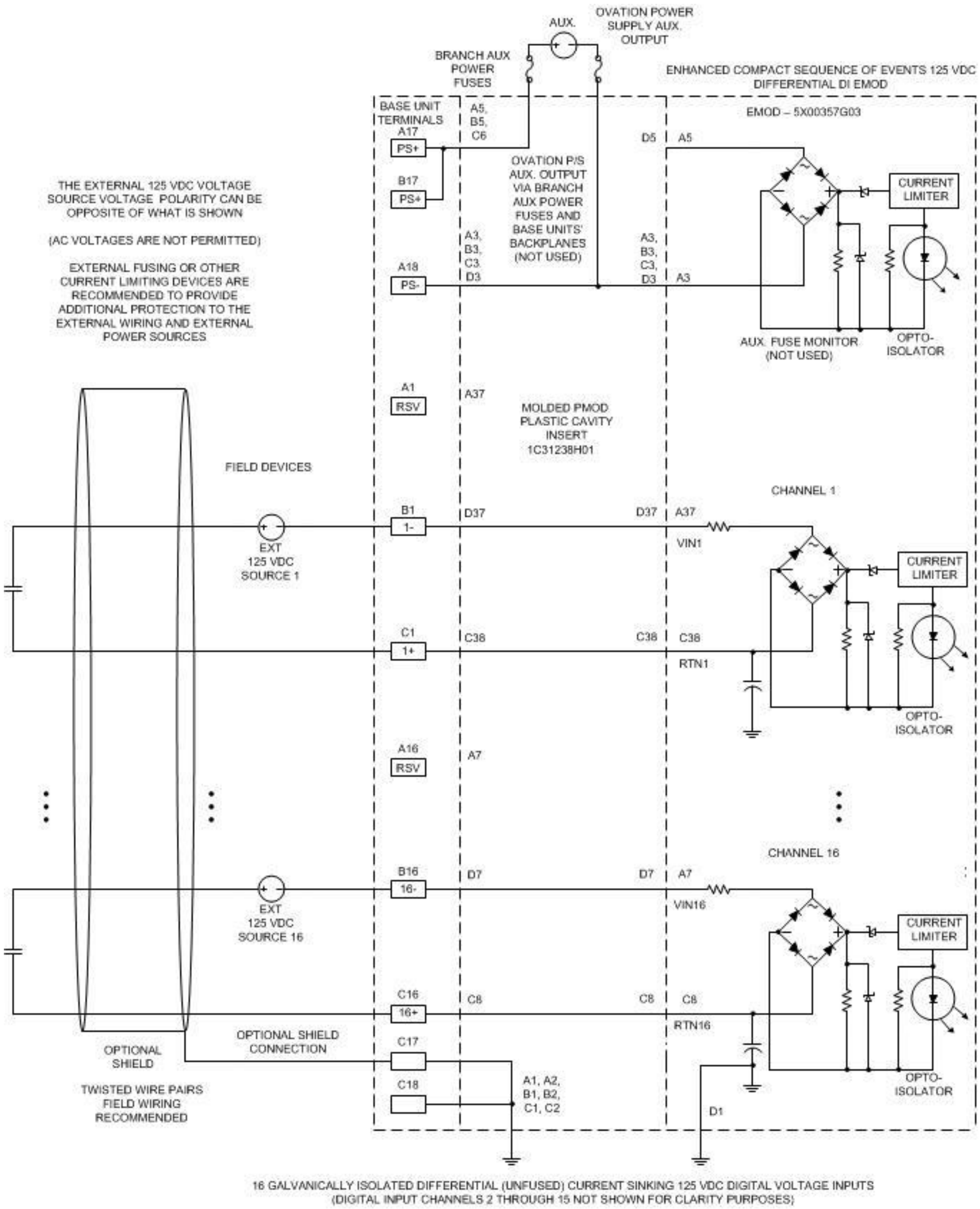


If a channel's combined field cable resistance and contact leakage resistance is less than the values specified above, the channel may report that its field contact state is closed even though the field contact is actually open.

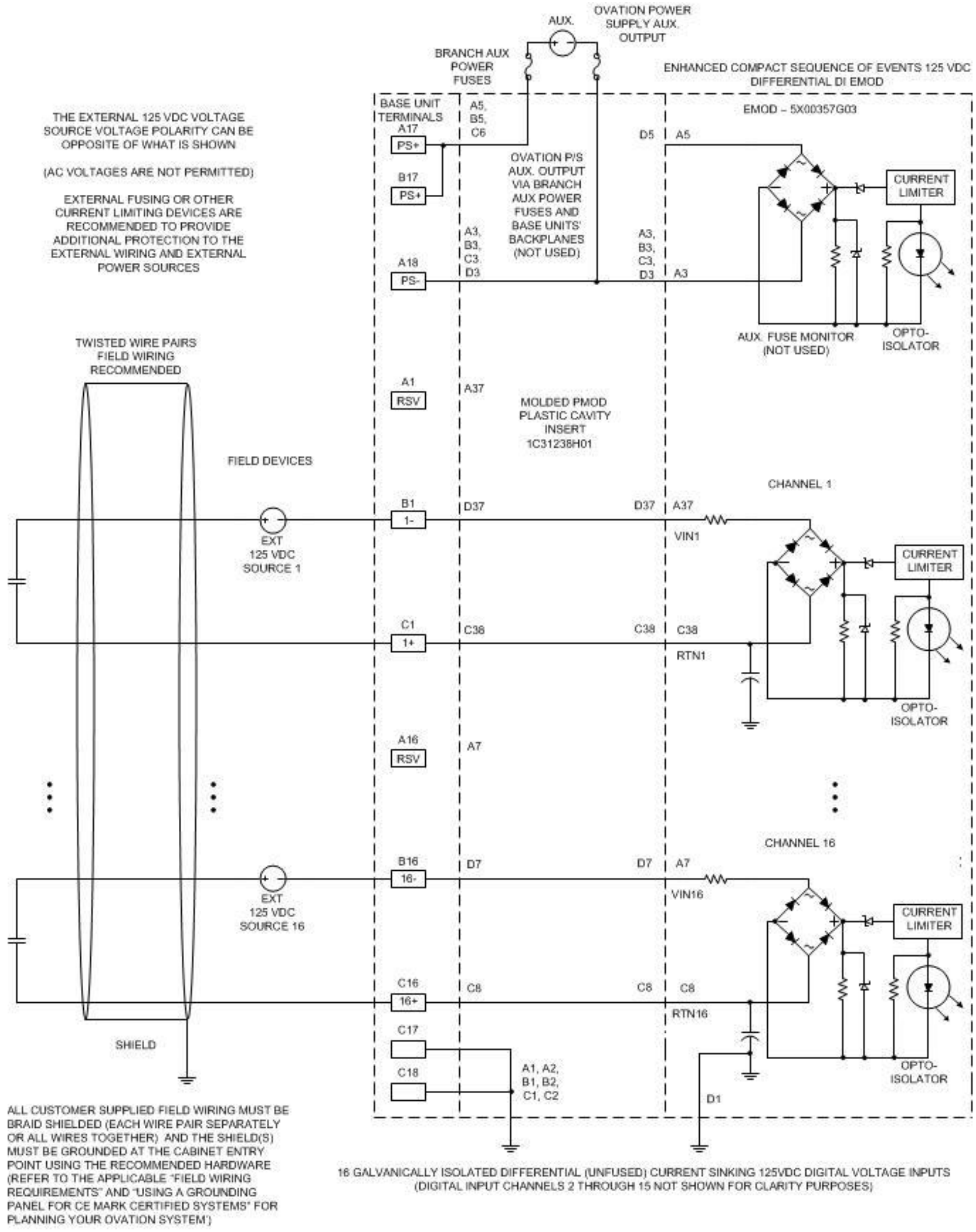


On/Off-State Input Voltage Range

Field connection wiring (5X00357G03) - (ECSOEDI)

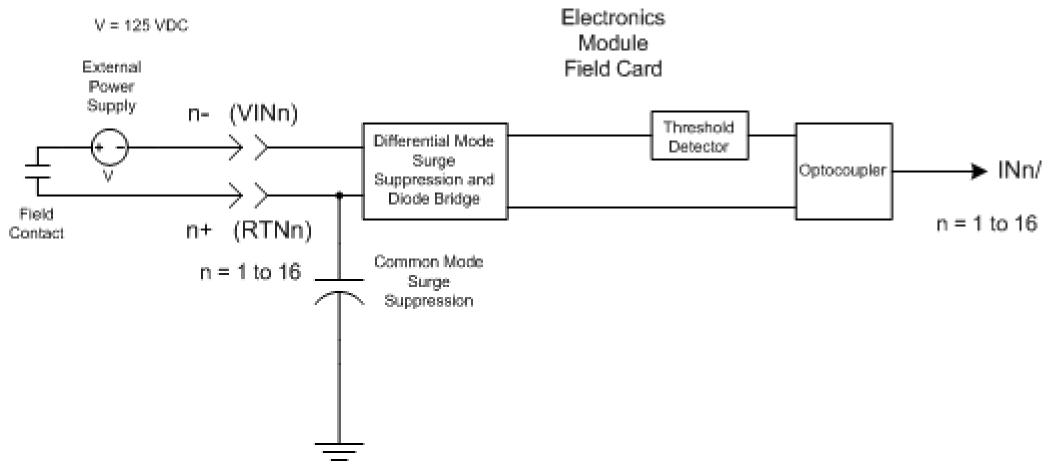


FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (NON-CE MARK)



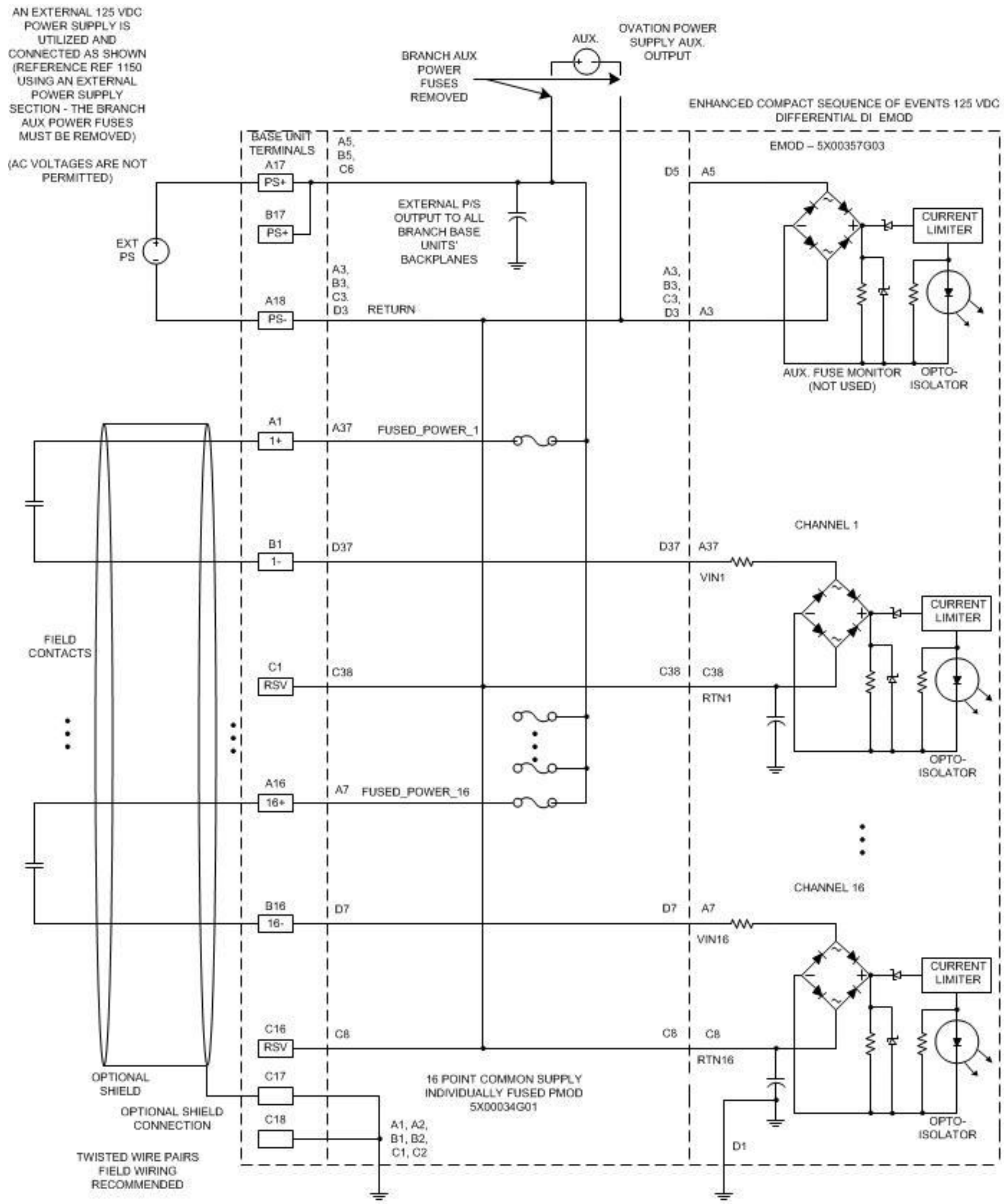
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (CE MARK)

Channel 4 through 15 input terminals not shown for clarity purposes.



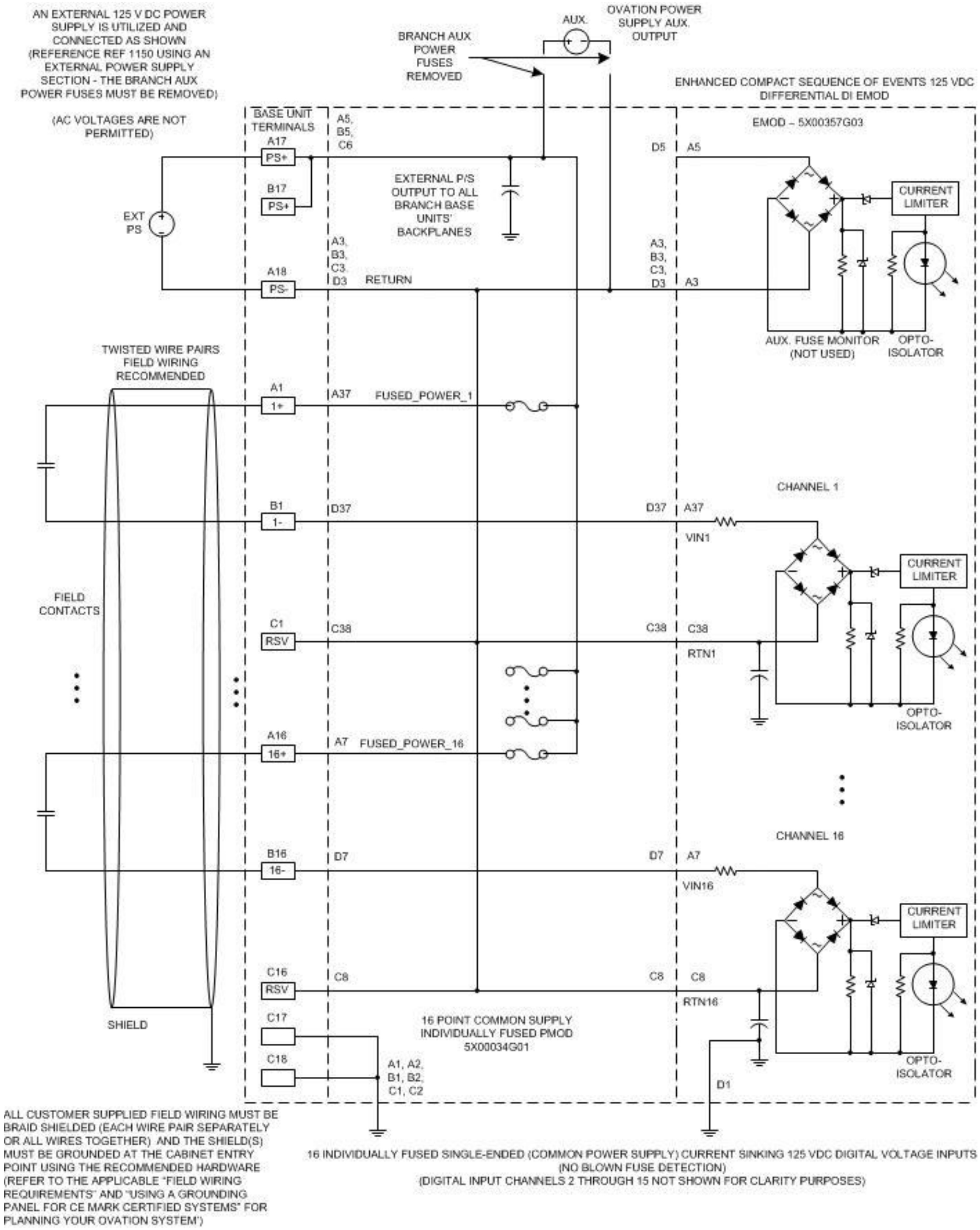
125 VDC DIFFERENTIAL CURRENT-SINKING FIELD DIGITAL INPUT CHANNEL

Field connection wiring Individually Fused (5X00357G03) - (ECSOEDI)

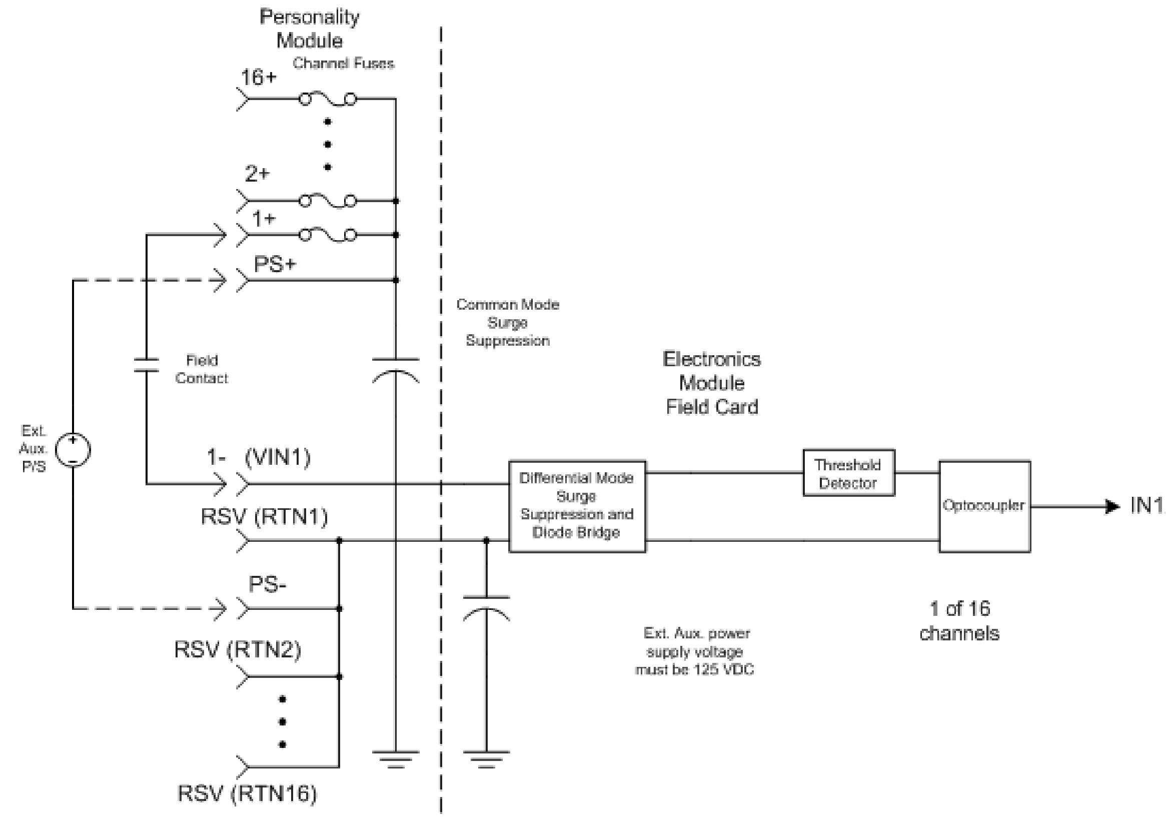


16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT 125 VDC SINKING DIGITAL VOLTAGE INPUTS
(NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR CLARITY PURPOSES)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (NON-CE MARK)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS INPUT MODULE (GROUP THREE) (CE MARK)



125 VDC INDIVIDUALLY FUSED CURRENT-SINKING FIELD DIGITAL INPUT CHANNEL

The “+” inputs are actually the 5X00034G03 personality module PDIC personality card’s fused Auxiliary power supply positive rail. The “-” inputs are the field card’s channel VIN inputs. The PDIC personality card connects the sixteen field card channel RTN inputs to the auxiliary power supply return.

For 5X00357G03 module combinations, the +125 VDC auxiliary power supply voltage must be obtained from an external auxiliary power supply.

To use an external 125 VDC (5X00357G03) auxiliary power supply, connect the power supply “+” and “-” terminals to the base unit PS+ and PS- terminals as shown. This connection will force all modules on this branch to use the external auxiliary power supply voltage.

The two plug-in branch Aux. fuses must be removed from their sockets located on the Controller backplane or on the transition panel to which the module’s base unit branch interfaces.

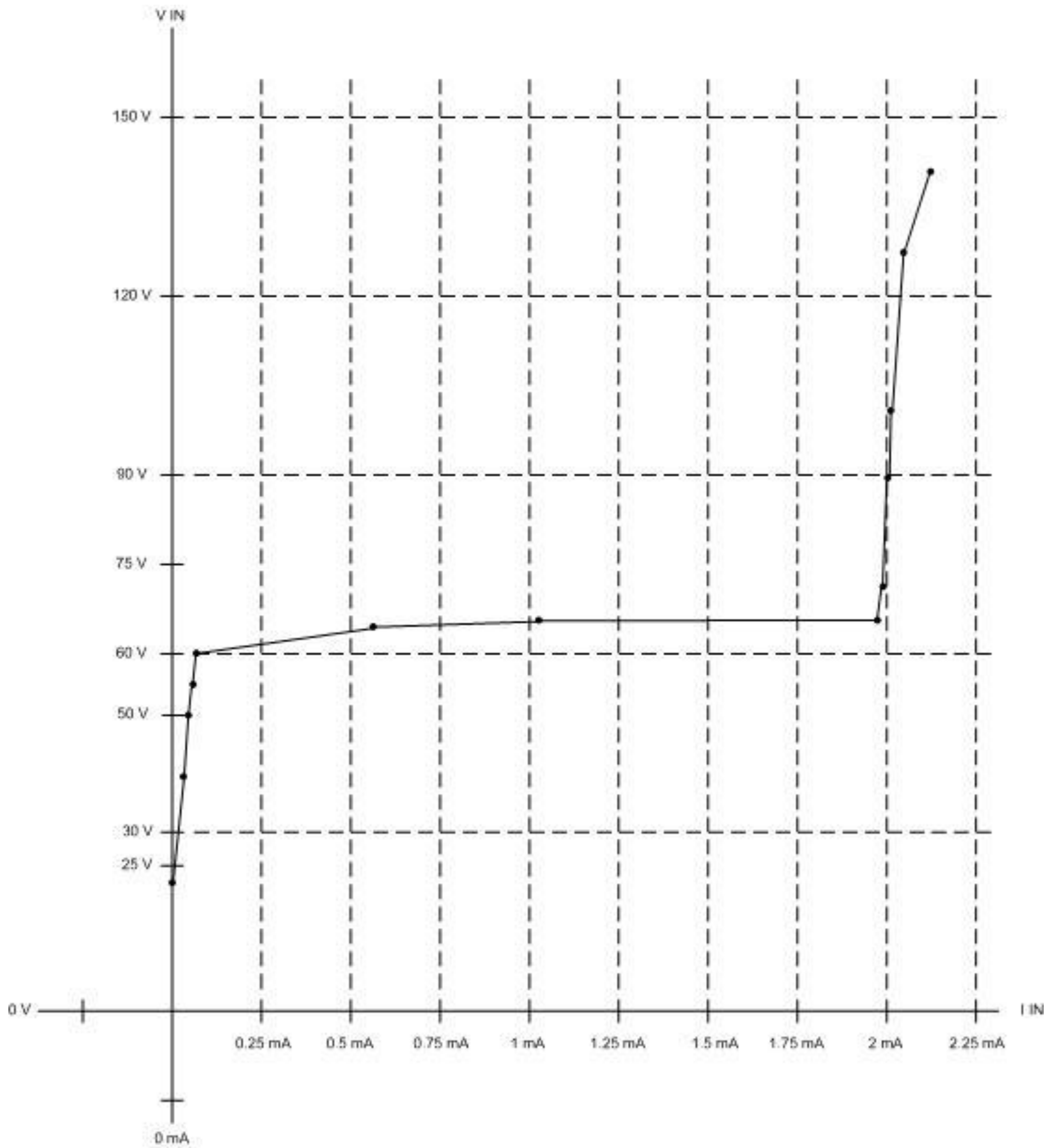
No other external power supplies may be connected to other base unit termination block PS+ or PS- terminals located in the same branch.

External power supply information (5X00357G01 - G05) - (ECSOEDIG01, G02, G03, G05)

When using the Enhanced Compact Sequence of Events module, the required voltage source may be obtained from the internal auxiliary power supply (Controller backplane) or it may be obtained from an external power supply.

If an external power supply is used, there are steps to be undertaken before connecting the external power supply to the Enhanced Compact Sequence of Events Digital Input module base unit terminal block, Refer to *Using an External Power Supply* (see page 799).

Voltage-current curve (5X00357G03) - (ECSOEDI)



125 VDC DIFFERENTIAL CURRENT-SINKING FIELD DIGITAL INPUTS

Specifications (5X00357G03) - (ECSOEDI)

DESCRIPTION	VALUE
Voltage category	125 VDC
Reverse polarity protection	Yes, each channel incorporates a front-end diode bridge
Operating voltage	80-140 VDC
Input voltage	For "1" signal = 80-140 VDC For "0" signal = 0-55 VDC
Input current	For "1" signal = 0.8 mA Min - 2.8 mA Max
Number of channels Channels per common	16 1,5X00357G03/1C31238H01 16, 5X00357G03/5X00034G01
Galvanic isolation	Between channels and I/O bus = Yes Between channels = Yes, 5X00357G03/1C31238H01 No, 5X00357G03/5X00034G01
Current draw, from I/O bus base unit, 24 V main power	44 mA typical for all inputs off 62 mA typical for all inputs on
Power dissipation of module Sum of 24V main power and 125V field channel power	1.06 W typical for all inputs off 3.36 W typical for all inputs on
Total module response time (1 foot (0.305 M) long field cable is assumed)	"0" Open to "1" Close = 4.02 msec typ "1" Close to "0" Open = 4.2 msec typ
Resolution	1/8 msec for time tagging an event
Accuracy (time tagged)	1 msec relative to clock from I/O bus 1/8 msec relative to other module channels
LSW card Propagation delay - field card output to present input state register	3.75 msec. Min. 4.0 msec. typ. 4.25 msec. Max.
LSW card digital debounce circuit delay time	4.0 msec. typ.
Status Display	Green LED per channel. LEDs located in logic card circuit

Note: *Any module digital input state change time that is less than the LSW card digital debounce time is rejected by the module and does not appear in the present input state register.*

FDI card signal propagation delay is the typical time elapsed from the time that a field contact opens or closes until the time that associated channel's output signal (INn/ where n = 1 to 16) changes states. Assumes a 1 foot (0.305 m) long test cable.

Input voltage level	Delay time for contact opening	Delay time for contact closing
125 VDC	0.2 msec. typ.	0.02 msec. typ.

There is an additional propagation delay due to field cable capacitance charging when the field contact opens. This delay is per 1,000 feet of field cable and assumes a 30 pF/foot cable capacitance.

Note: *There is no additional propagation delay to consider when the field contact closes.*

Input voltage level	Additional delay time for contact opening
125 VDC	1.1 msec. typ.

6.9.9 Enhanced Compact Sequence of Events Digital Input module (5X00357G04) (FCI) - (ECSOEDI)

Style 5X00357G04 has 16 single-ended current sourcing digital inputs (contact inputs) that share a common return and that all use the module's internal 48 VDC power supply voltage. No power supply is required. The internal +48 V on-card power supply provides a current limited contact wetting voltage if a channel's field contact is open. When the contact closes, current is drawn from the +10 V on-card power supply and turns on the channel's associated optocoupler, which relays a closed contact state "1" to the I/O bus. The sixteen channel optocouplers and the on-card power supply transformer provide galvanic isolation between the field digital inputs (contact inputs) circuit and the module's logic or I/O bus side.

On-Board power supply checking

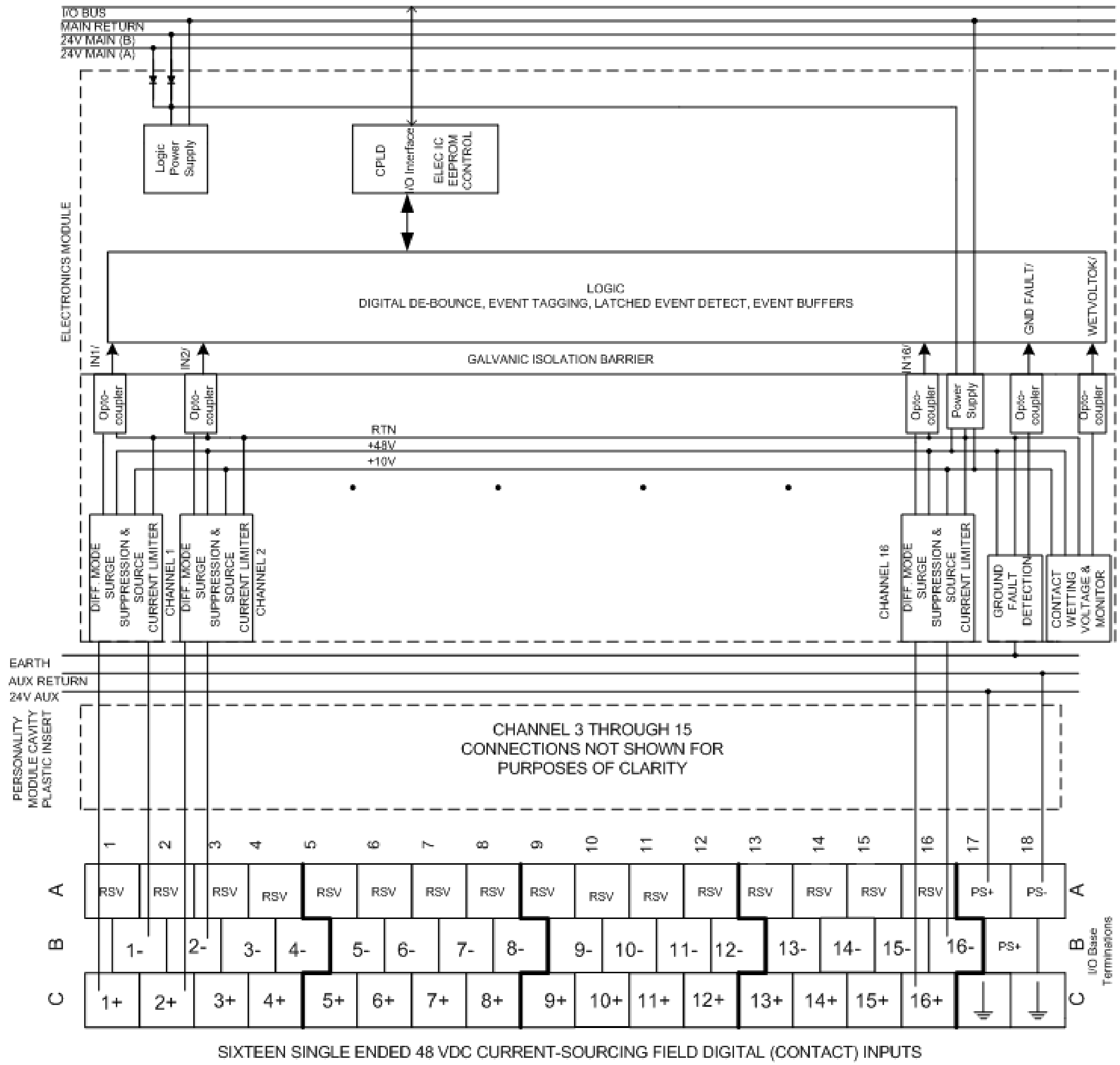
If the +10V on-board power supply were to fail, all points associated with module input channels would have a zero (false) value. One of the sixteen module input channels may be employed to verify the availability of the +10V on-board power supply output voltage. The selected module input channel has a wire jumper hard wired between the channel's positive (+) input terminal and the channel's negative (-) or common input terminal. This hard wired input channel should always be a one (true) if the +10V on-board power supply output voltage is present.

To implement this on-board power supply checking feature when building points for the module's input channels, select power check enable in the Config tab. Also specify the module channel used for the power check feature (1-16). When the module input channels are scanned, the hard wired module input channel is also scanned to verify that it has a value of one. If not, the module input channels will be tagged with "bad quality".

If desired, a point may be built for the hard wired module input channel and be set to alarm on a value of zero.

Each field contact may have a separate input and return wire conductor to the module's base unit terminals. Alternatively, field contacts wired to the same module may share a common return wire conductor. A Ground fault detection circuit is provided to determine if an input or return wire for any channel find a low impedance path to earth ground. A single wire with a ground fault will not cause an error in point data. However, multiple wire ground faults that include input and return wires, could cause faulty point data (that is, channels appearing as if their field contacts are closed when the contacts are really open).

Module-base unit interconnection (5X00357G04) - (ECSOEDI)



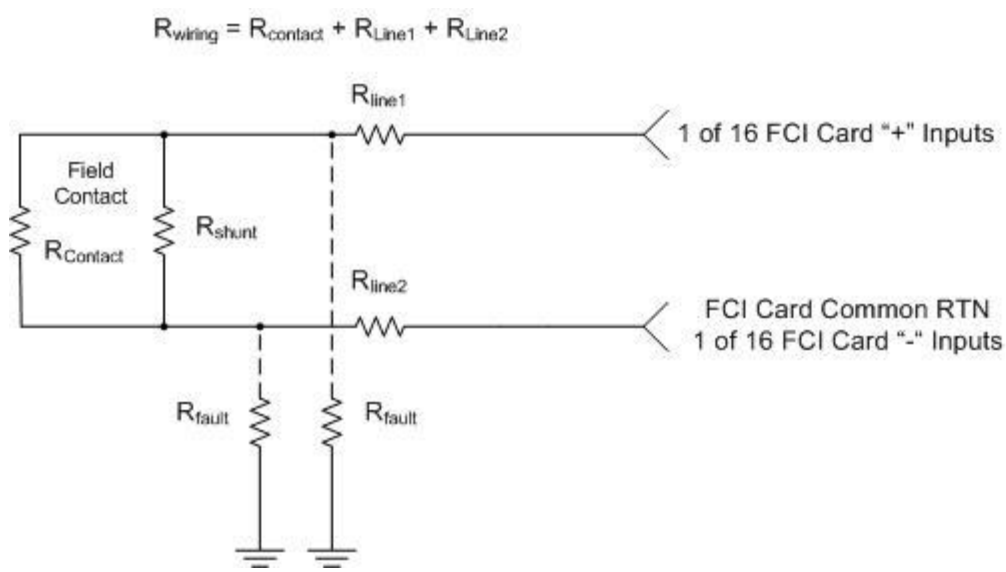
Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Field wiring (5X00357G04) - (ECSOEDI)

Time required for channel wetting voltage level to exceed 40 V following field contact opening: 6 msec. Max.

Cabling Limitations

RWiring for closed contact recognition	100 ohms Max.
Rshunt for open contact recognition	10,000 ohms Min.
Rshunt for high-level voltage (> 40V) open contact recognition	50,000 ohms Min.
Rshunt for ground fault detection with open contact and "+" input line ground fault	150,000 ohms Min.
Rfault from either "+" or "-"input line to ground for ground fault detection	5,000 ohms Max.



Field wiring (5X00357G04) (contact) - (ECSOEDI)

The figure below shows possible field cable resistances that affect input channel performance. The following definitions apply:

RContact = resistance associated with a closed contact

Rshunt = open contact shunt resistance

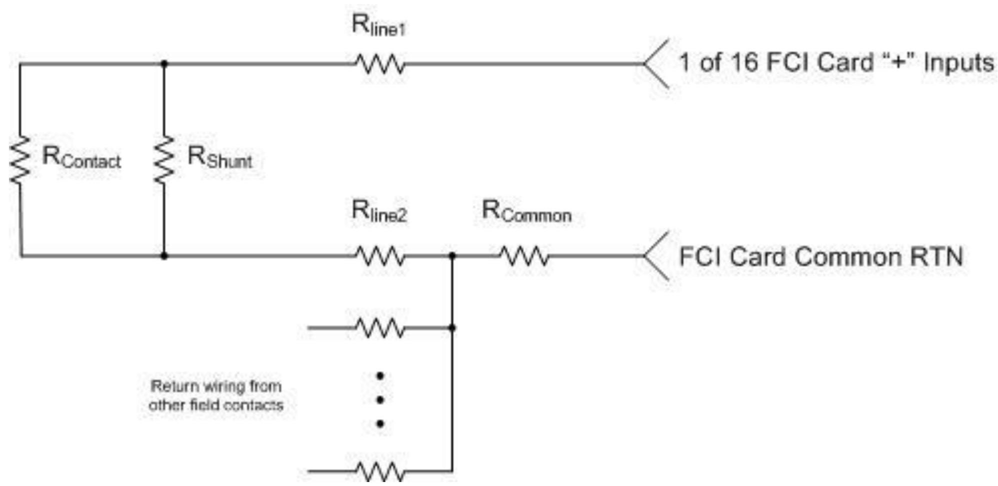
RLine1 = resistance of the wire routed from the contact to the FCI "+" input.

RLine2 = resistance of the non-common wire routed from the contact to the FCI "-" or RTN input

RCommon = resistance of the common wire routed from multiple contacts to the FCI "+" input

RCommon = 0 if each field contact has its own pair of "+" and "-" field wires

RWiring = RContact + RLine1 + RLine2 + 16 RCommon



The following constraints are generated from the above figure:

1. No field wire ground faults or a "-"or RTN field wire ground fault:

   Rshunt must be > 10Kohms for the input channel to recognize the field contact state as open.

   Rshunt must be > 50Kohms for the input channel to maintain a high level open contact wetting voltage.

2. "+" field wire ground fault:

   Rshunt must be > 20Kohms for the input channel to recognize the field contact state as open.

   Rshunt must be > 100Kohms for the input channel to maintain at least a 20 V open contact wetting voltage.

3. With or without a field wire ground fault condition:

   RWiring through the field wiring to the field contact must be < 100 ohms for the input channel to recognize a closed contact.

The table below lists the Maximum field wiring cable lengths between field contacts and the module base unit termination block when each field contact has its own wire routed between it and the module base unit termination block (RCommon = 0 ohms). It is assumed that RContact = 0 ohms.

RWiring = RLine1 + RLine2

RWiring = 100 ohms Max.

Assume that RLine1 = RLine2 since both the field contact "+" and "-" wires should be the same length.

2 RLine1 = 100 ohms Max.

RLine1 = 50 ohms Max.

Wire Gauge	Ohms per 1000 Feet @ 20 degrees C (68 degrees F) for Solid Copper Wire	Maximum Cable Length (Thousand Feet)
18 AWG	6.385	7.5
20 AWG	10.15	4.9
22 AWG	16.14	3.0
24 AWG	25.67	1.9
26 AWG	40.81	1.2

The table below lists the Maximum field wiring cable lengths between field contacts and the module base unit termination block when all module field contacts share a common return wire routed between the field contacts and one of the module base unit termination block "-" terminals. It is assumed that RContact = 0 ohms. To simplify calculations, it is assumed that RLine2 = 0 ohms and that that RLine1 = RCommon

RWiring = RLine1 + 16 RCommon

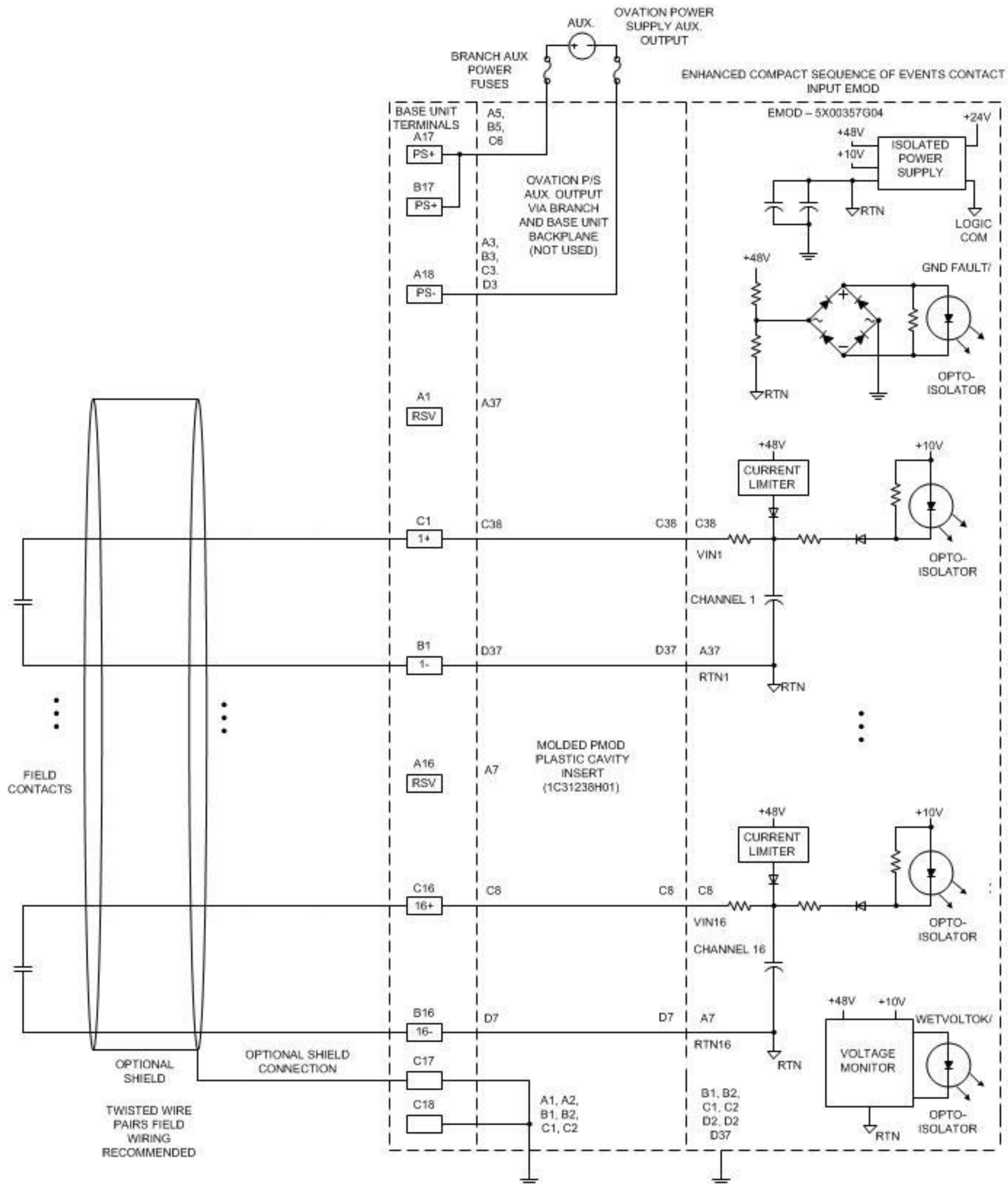
RWiring = 17 RLine1

RWiring = 100 ohms Max.

RLine1 = 5.88 ohms Max.

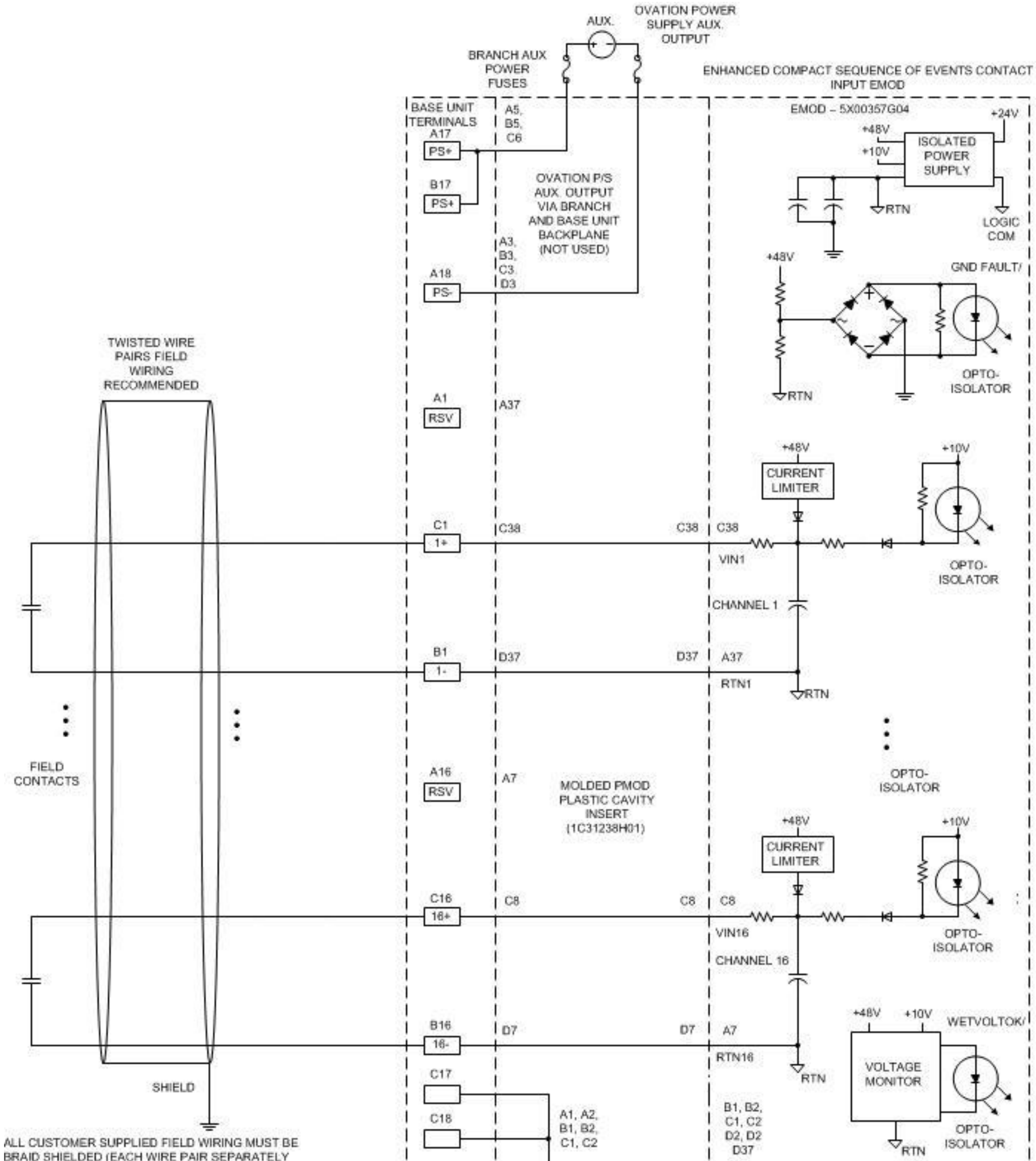
Wire Gauge	Ohms per 1000 Feet @ 20 degrees C (68 degrees F) for Solid Copper Wire	Maximum Cable Length (Thousand Feet)
12 AWG	1.588	3.54
14 AWG	2.525	2.3
16 AWG	4.016	1.4
18 AWG	6.385	0.89
20 AWG	10.15	0.57

Field connection wiring (5X00357G04) - (ECSOEDI)



16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SEPARATE RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (NON-CE MARK)



ALL CUSTOMER SUPPLIED FIELD WIRING MUST BE BRAID SHIELDED (EACH WIRE PAIR SEPARATELY OR ALL WIRES TOGETHER) AND THE SHIELD(S) MUST BE GROUNDED AT THE CABINET ENTRY POINT USING THE RECOMMENDED HARDWARE (REFER TO THE APPLICABLE "FIELD WIRING REQUIREMENTS" AND "USING A GROUNDING PANEL FOR CE MARK CERTIFIED SYSTEMS" FOR PLANNING YOUR OVATION SYSTEM")

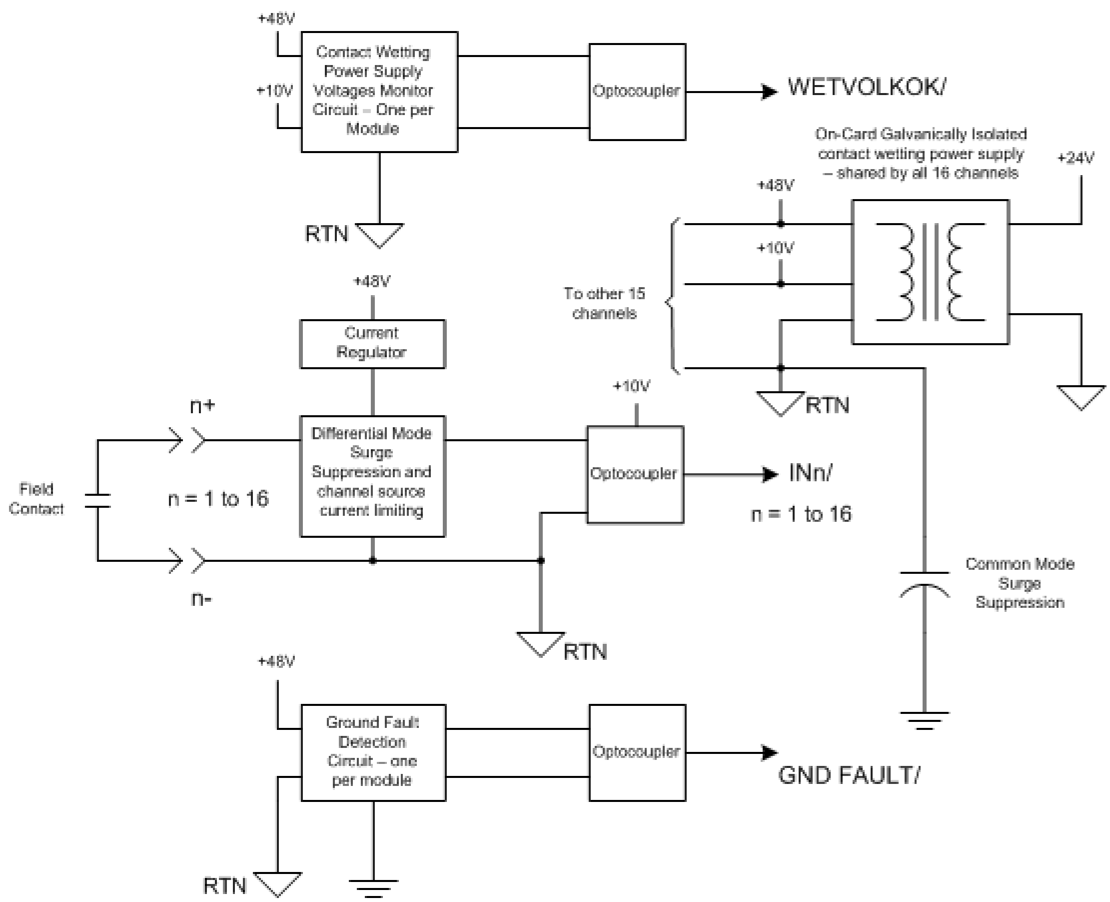
16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SEPARATE RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (CE MARK)

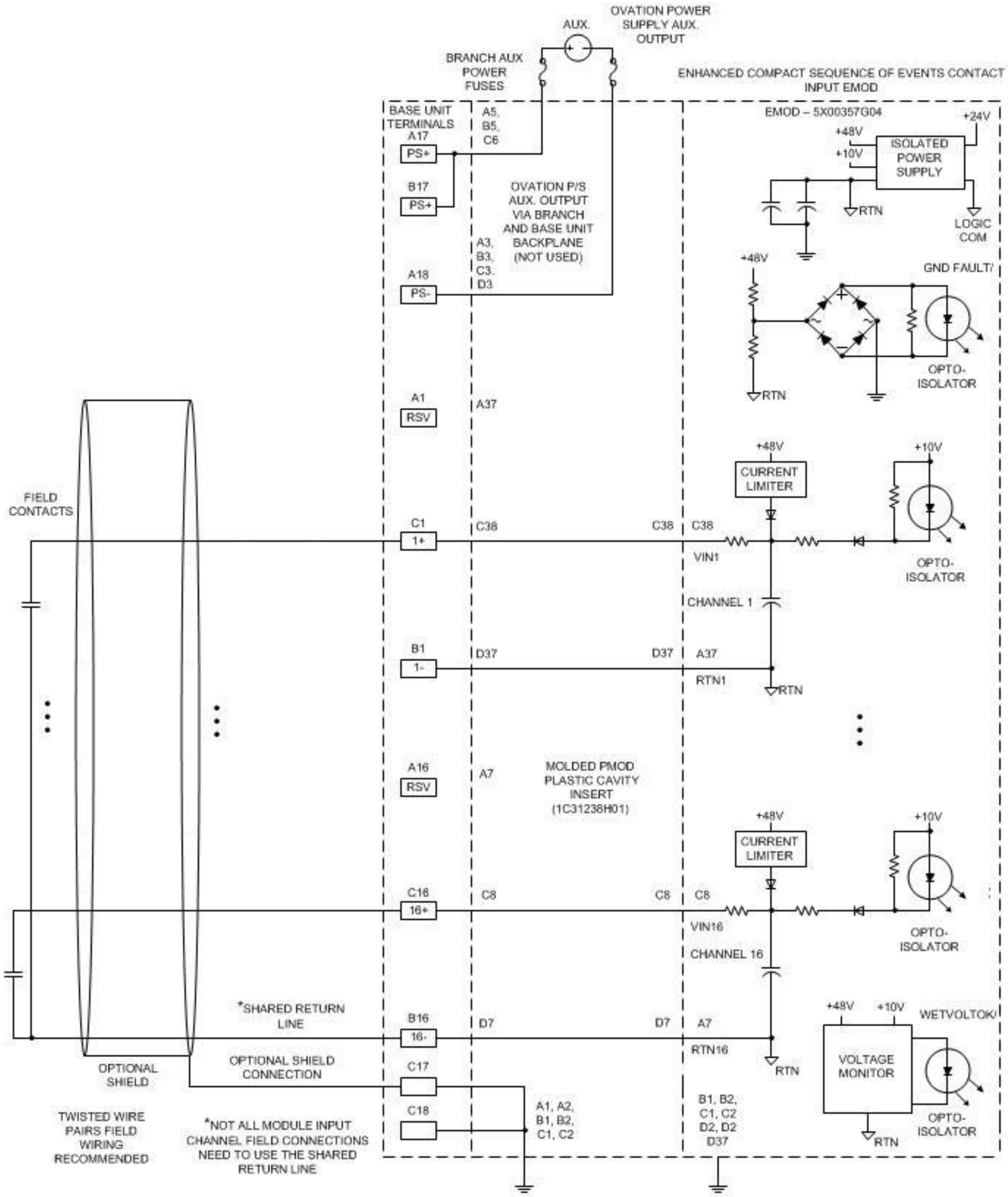
Each field contact has a separate input "+" and return "-" line.

The sixteen "-" inputs are tied together on the FCI field card and are connected to the galvanically isolated wetting power supply common return for all sixteen channels.

Note: *Do not tie any of the "+" or "-" inputs to earth ground. A ground fault condition will occur as well as degradation of the field card's common mode surge protection.*

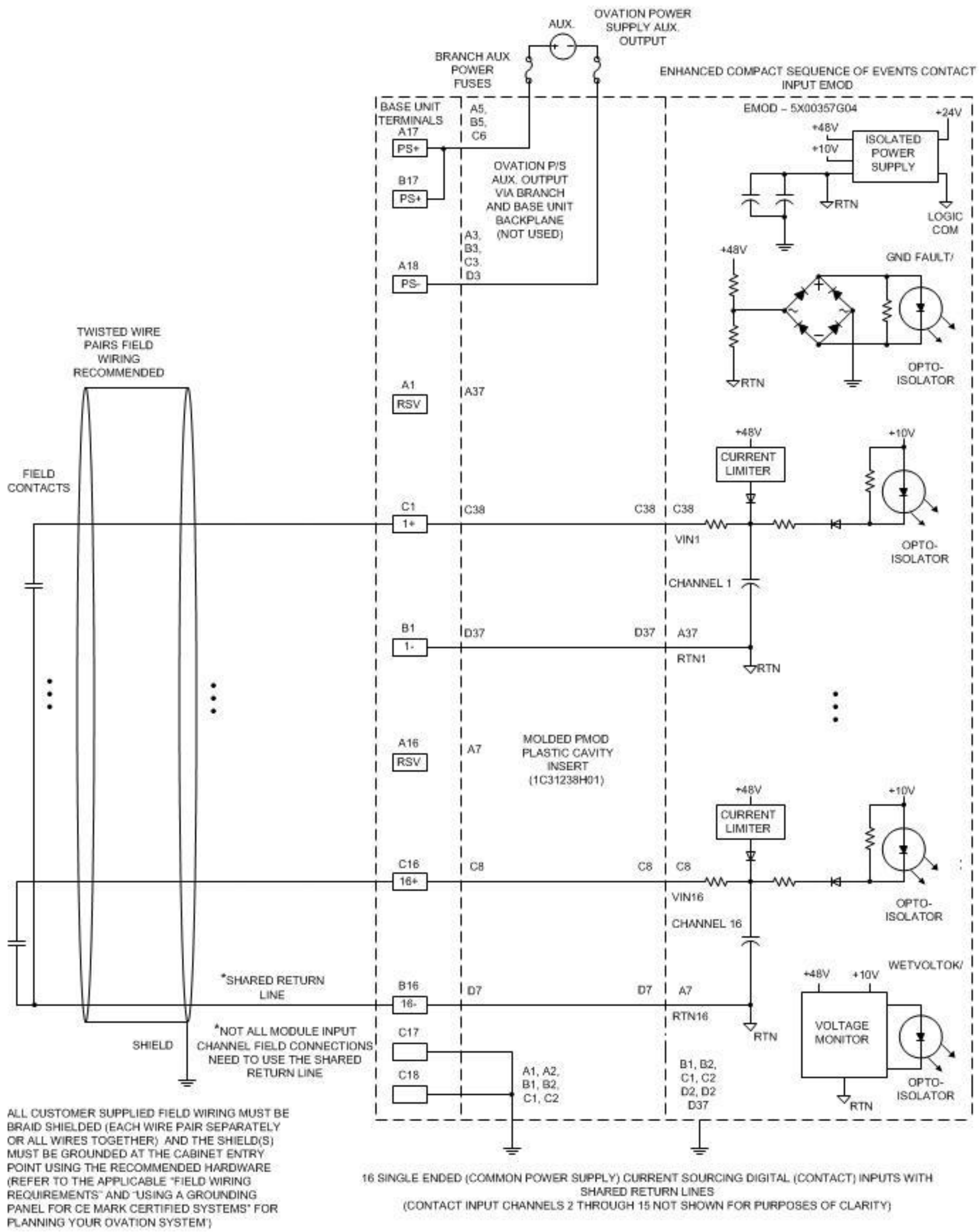


48 VDC SINGLE ENDED CURRENT-SOURCING FIELD DIGITAL (CONTACT) INPUT CHANNEL



16 SINGLE ENDED (COMMON POWER SUPPLY) CURRENT SOURCING DIGITAL (CONTACT) INPUTS WITH SHARED RETURN LINES
(CONTACT INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS (TWO WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (NON-CE MARK)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FOUR) (CE MARK)

Each field contact has a separate input "+", but shares a common return line connection to a single channel's Return "-" input terminal.

The sixteen "-" inputs are tied together on the FCI field card and are connected to the galvanically isolated wetting power supply common return for all sixteen channels.

Note: *Do not tie any of the "+" or "-" inputs to earth ground. A ground fault condition will occur as well as degradation of the field card's common mode surge protection.*

Specifications (5X00357G04) - (ECSOEDI)

DESCRIPTION	VALUE
Voltage category	48 VDC – nominal open contact wetting voltage.
Reverse polarity protection	Not applicable, field inputs are dry contacts with power supplied by field card circuit.
Open contact voltage	For "0" signal = 42 V Min. - 55 V Max.
Closed contact Input current	For "1" signal = 4 mA Min. - 8 mA Max.
Number of channels Channels per common	16 16
Galvanic isolation	Between channels and I/O bus = Yes. Between channels = No.
Current draw, from I/O bus base unit, 24 V main power	62 mA typical for all inputs off. 172 mA typical for all inputs on.
Power dissipation of module 24V main power	1.49 W typical for all inputs off. 4.13 W typical for all inputs on.
Total module response time (1 foot (0.305 M) long field cable is assumed)	"0" Open to "1" Close = 4.09 msec typ "1" Close to "0" Open = 4.13 msec typ
Resolution	1/8 msec for time tagging an event
Accuracy (time tagged)	1 msec relative to clock from I/O bus. 1/8 msec relative to other module channels.
LSW card Propagation delay - field card output to present input state register	3.75 mesc. Min. 4.0 msec. typ. 4.25 msec. Max.
LSW card digital debounce circuit delay time	4.0 msec. typ.
Status Display	Green LED per channel. LEDs located in logic card circuit.

Note: *Any module digital input state change time that is less than the LSW card digital debounce time is rejected by the module and does not appear in the present input state register.*

FCI card signal propagation delay is the typical time elapsed from the time that a field contact opens or closes until the time that associated channel's output signal (INn/ where n = 1 to 16) changes states. Assumes a 1 foot (0.305 m) long test cable.

Input voltage level	Delay time for contact opening	Delay time for contact closing
48 VDC	0.13 msec. typ.	0.09 msec. typ.

There is an additional propagation delay due to field cable capacitance charging when the field contact opens. This delay is per 1,000 feet of field cable and assumes a 30 pF/foot cable capacitance.

Note: *There is no additional propagation delay to consider when the field contact closes.*

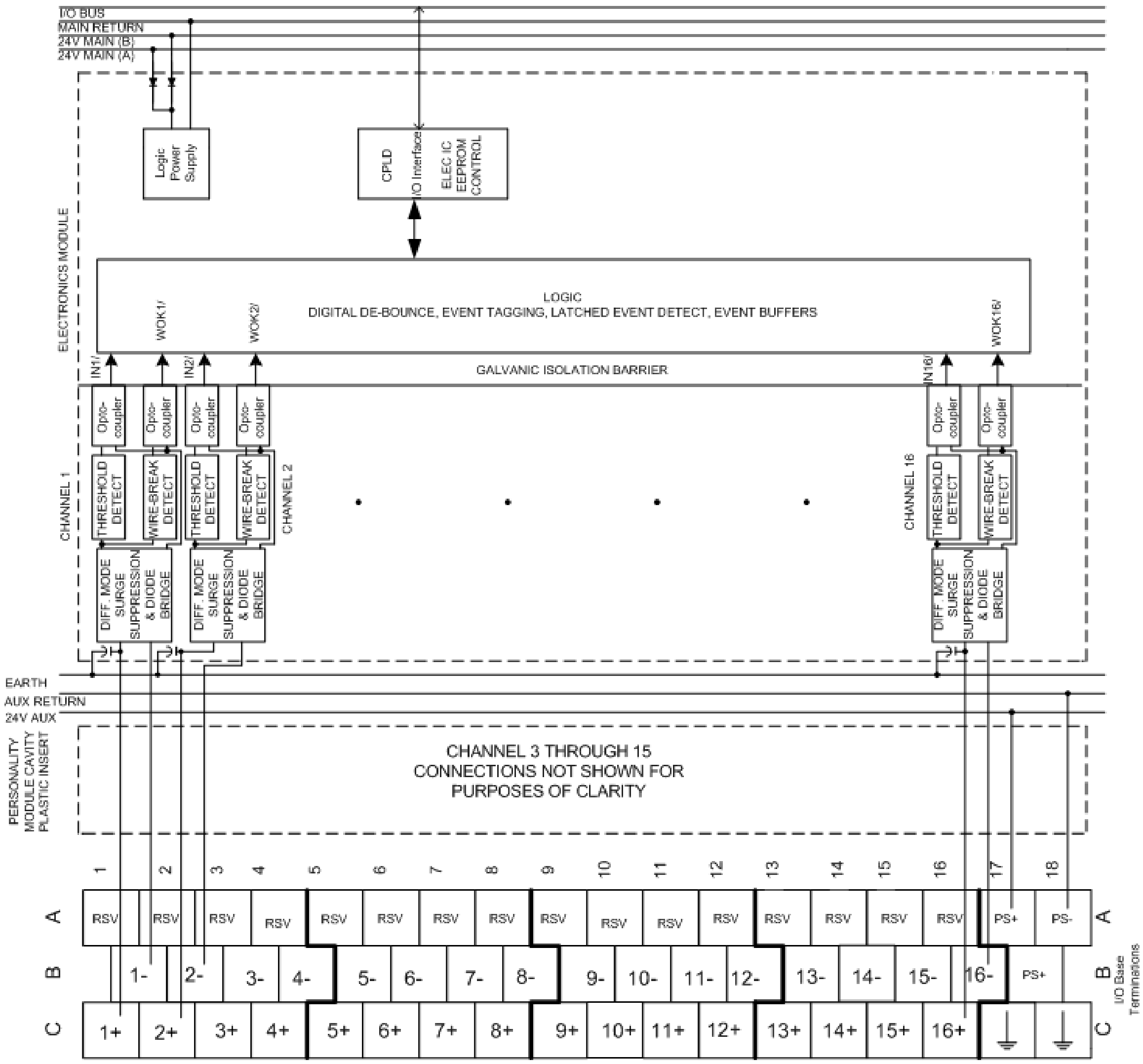
Input voltage level	Additional delay time for contact opening
48 VDC	0.04 msec. typ.

6.9.10 Enhanced Compact Sequence of Events Digital Input module (5X00357G05) (FDW) - (ECSOEDI)

Style 5X00357G05 has 16 differential (galvanically isolated) IEC 61131-2 compliant Type 1 24 VDC current sinking digital inputs that can accommodate a separate 24 VDC auxiliary power supply for each channel. Style 5X00357G05 can be used with the 5X00034G01 Individually Fused 16 Point personality module for applications requiring individual channel fusing of a common 24 VDC auxiliary power supply. The required auxiliary power supply voltage source may be obtained from the cabinet's internal auxiliary power supply or it may be obtained from an external power supply or multiple external power supplies. Each channel contains an input resistor to provide normal mode surge protection and a current regulator circuit to limit input current during normal operation. A diode bridge allows input voltages of either polarity to be applied. Each channel contains two optocouplers to provide galvanic isolation between the field digital input circuit and module's logic or I/O bus side. One optocoupler provides the input state status. The second optocoupler provides the field contact wire break status. This wire break status is only valid if a 10 Kohm resistor is installed directly across the field contact.

Note: *The use of the 5X00034G01 personality module converts differential current sinking digital inputs into single-ended current sinking digital inputs. The 5X00034G01 personality module taps the base unit's internal auxiliary voltage and distributes this voltage to all sixteen module digital input channels.*

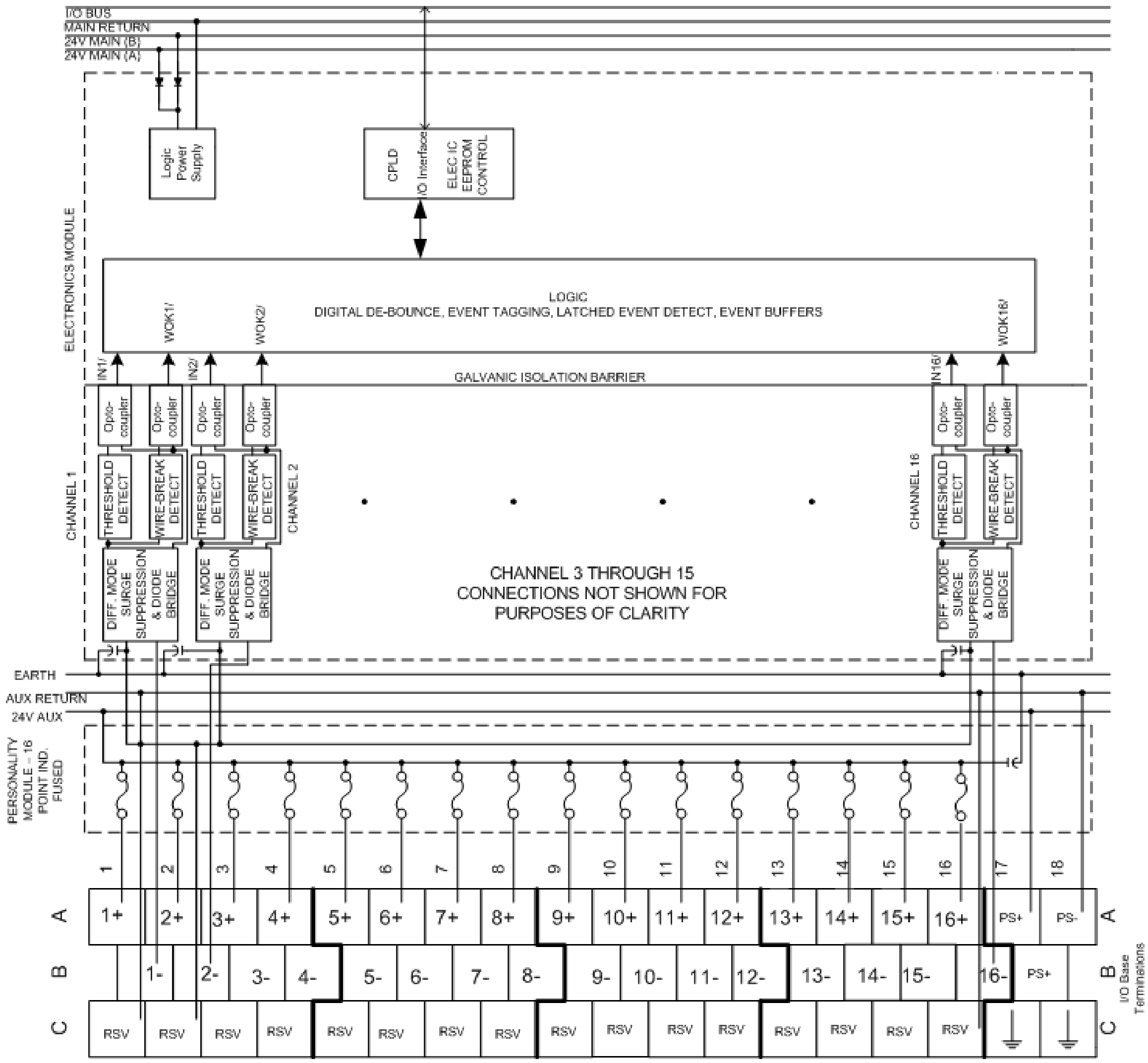
Module-base unit interconnection (5X00357G05) - (ECSOEDI)



SIXTEEN DIFFERENTIAL 24 VDC CURRENT-SINKING FIELD DIGITAL INPUTS (WITH FIELD WIRE-BREAK DETECTION)

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Module-base unit interconnection (5X00357G05) (individually fused) - (ECSOEDI)



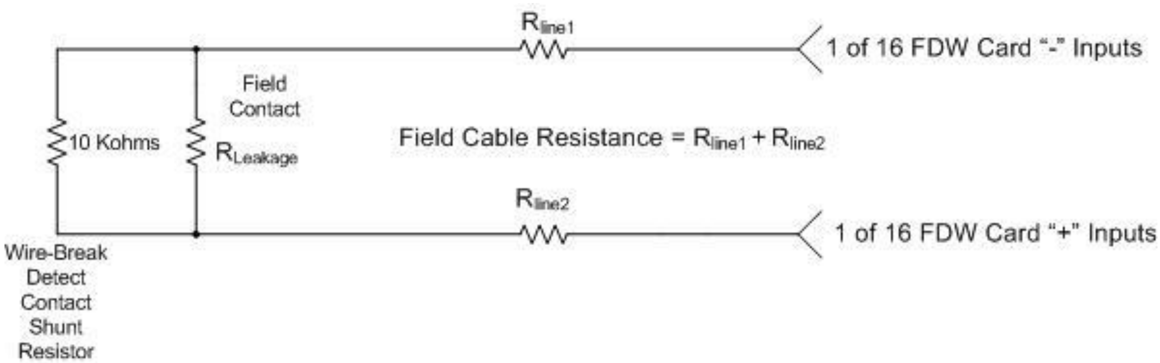
SIXTEEN INDIVIDUALLY FUSED SINGLE ENDED 24 VDC CURRENT-SINKING FIELD DIGITAL INPUTS (WITH FIELD WIRE-BREAK DETECTION)

***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

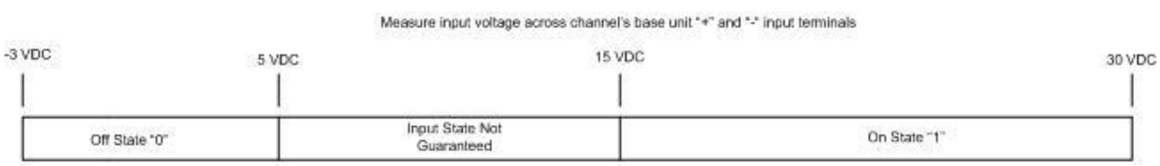
Field wiring (5X00357G05) - (ECSOEDI)

The minimum combined field cable resistance plus field contact leakage resistance value assumes that the Auxiliary power supply voltage is its Maximum allowable value (30 VDC for 24 VDC inputs and 60 VDC for 48 VDC inputs).

Input voltage level	Minimum field cable resistance plus field contact leakage resistance
24 VDC	10 Kohm

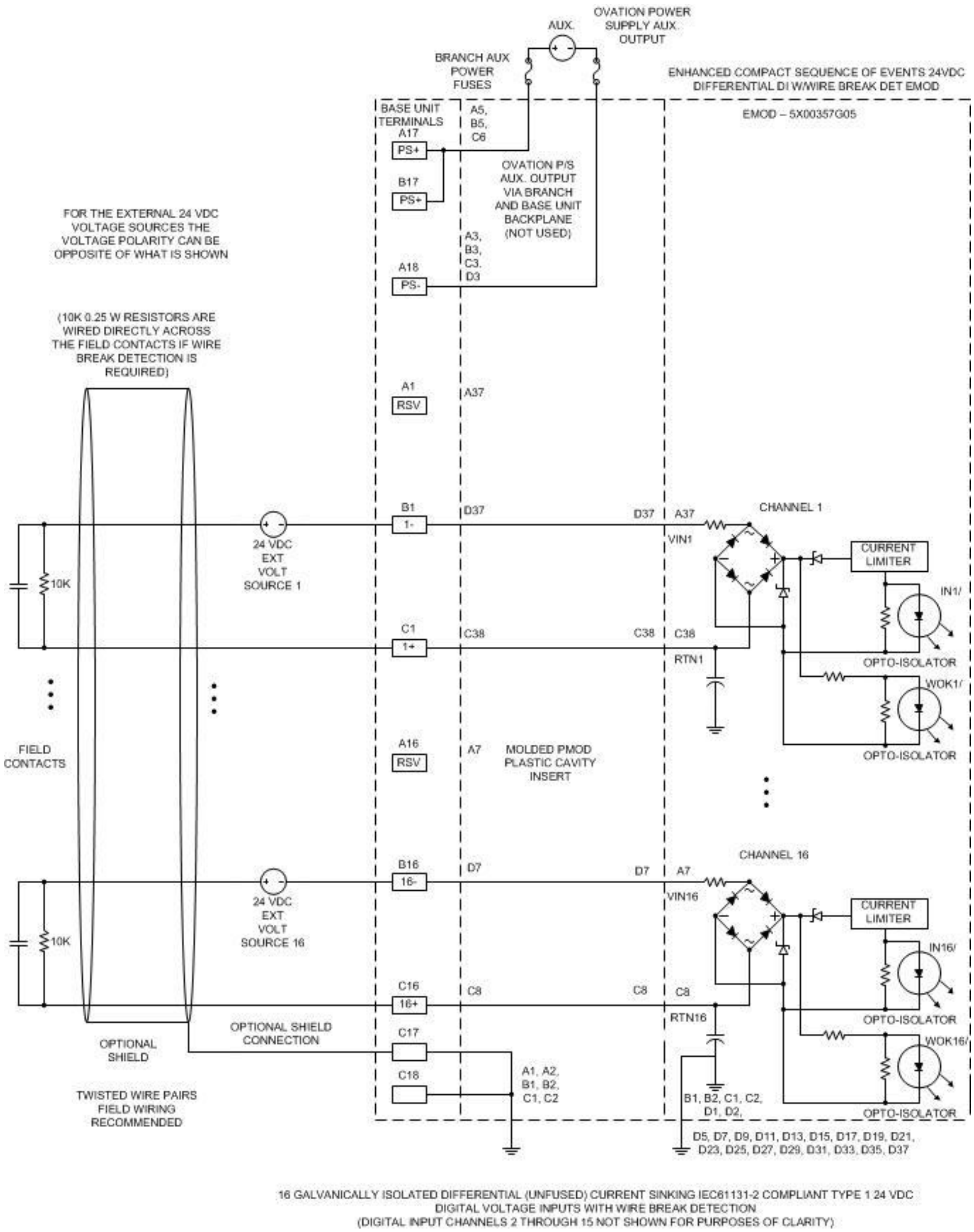


If a channel's combined field cable resistance and contact leakage resistance is less than the values specified above, the channel may report that its field contact state is closed even though the field contact is actually open.

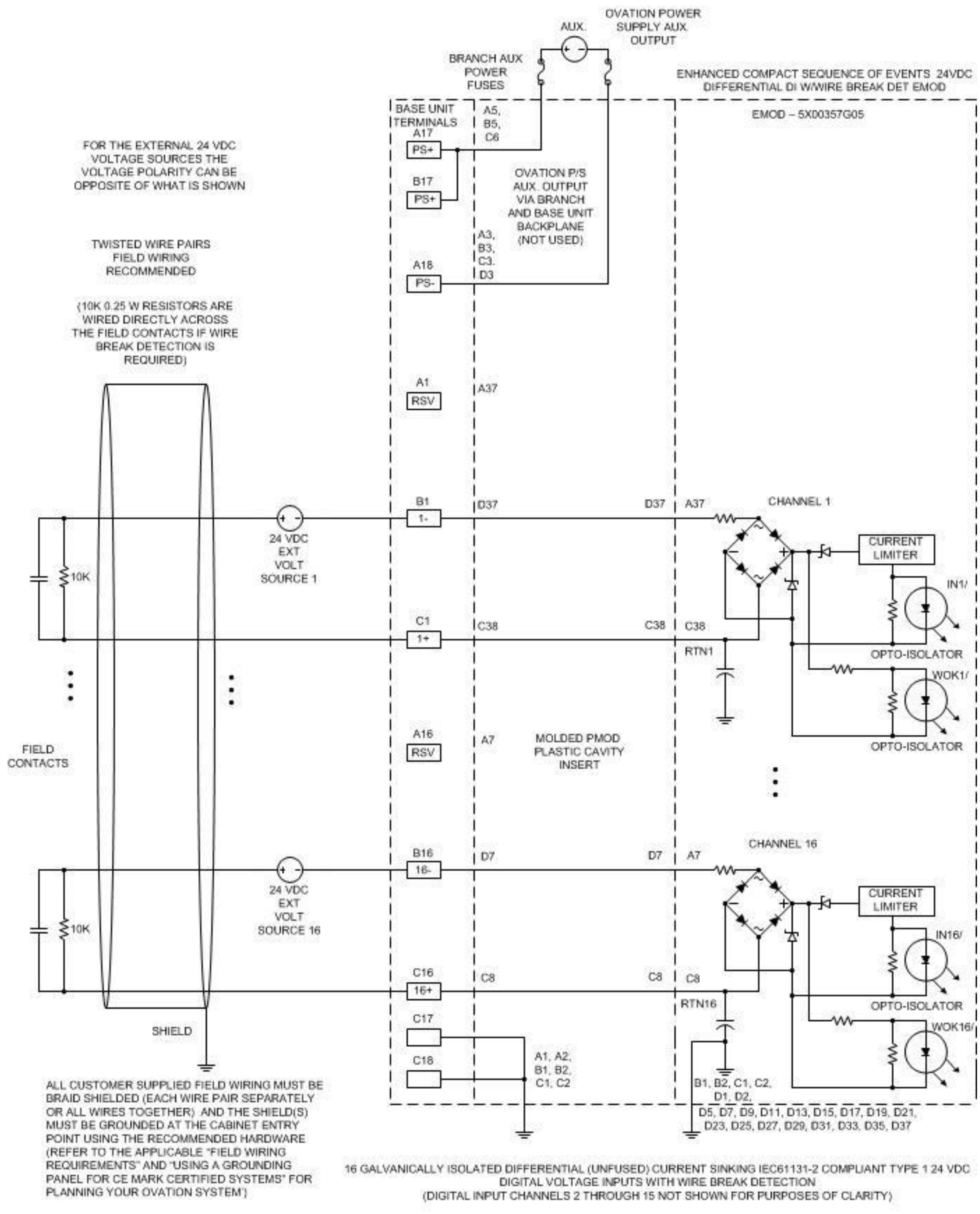


On/Off-State Input Voltage Range

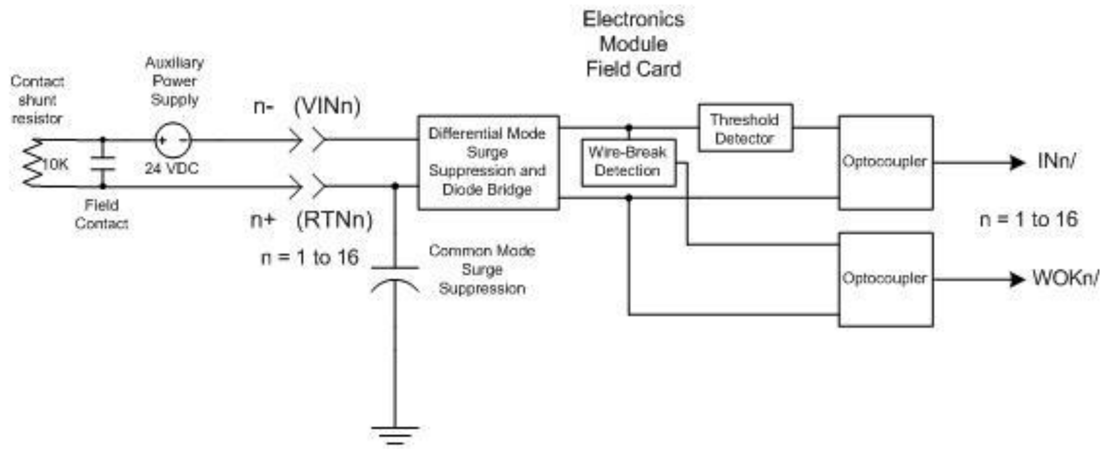
Field connection wiring (5X00357G05) - (ECSOEDI)



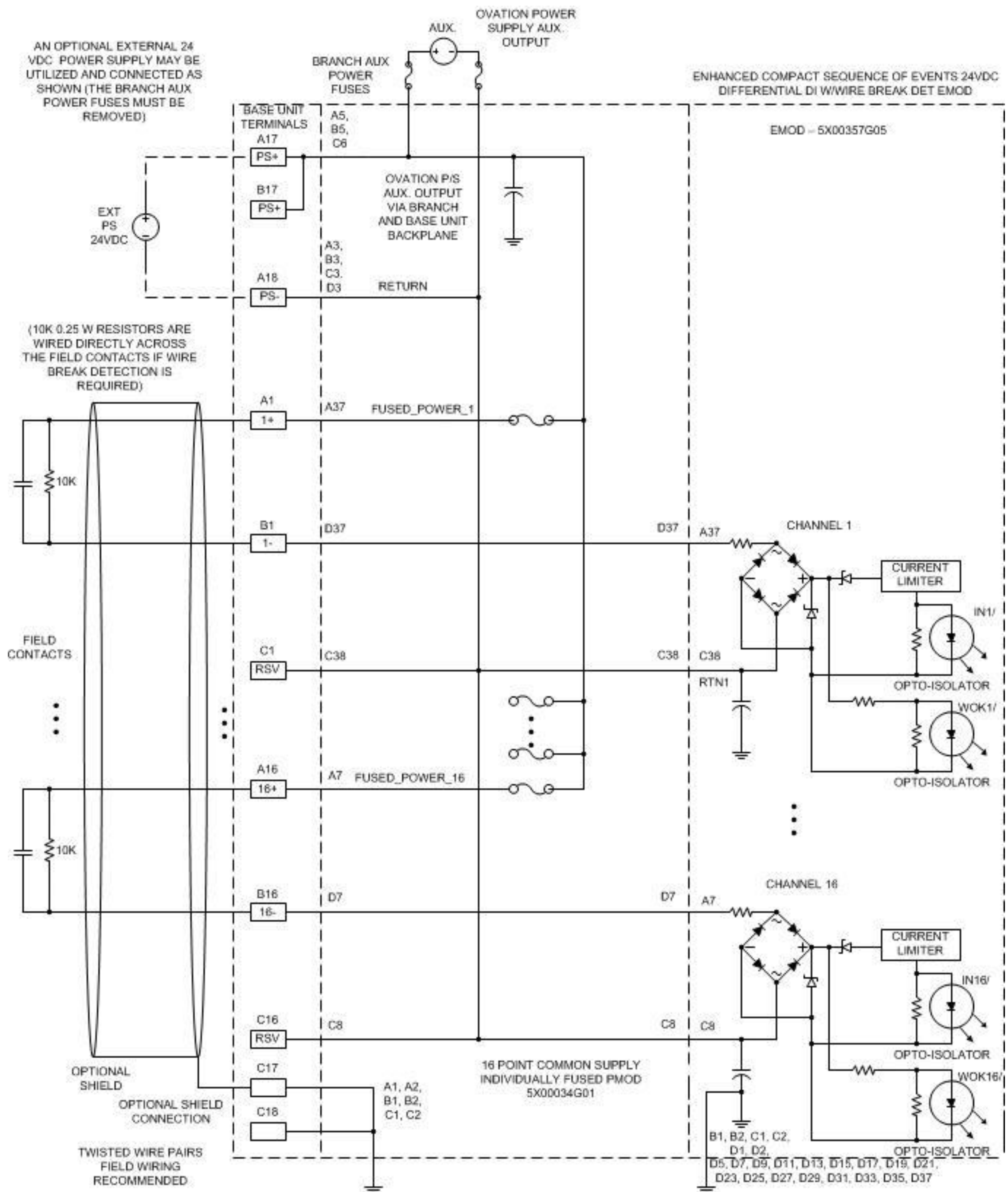
FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FIVE) (NON-CE MARK)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FIVE) (CE MARK)

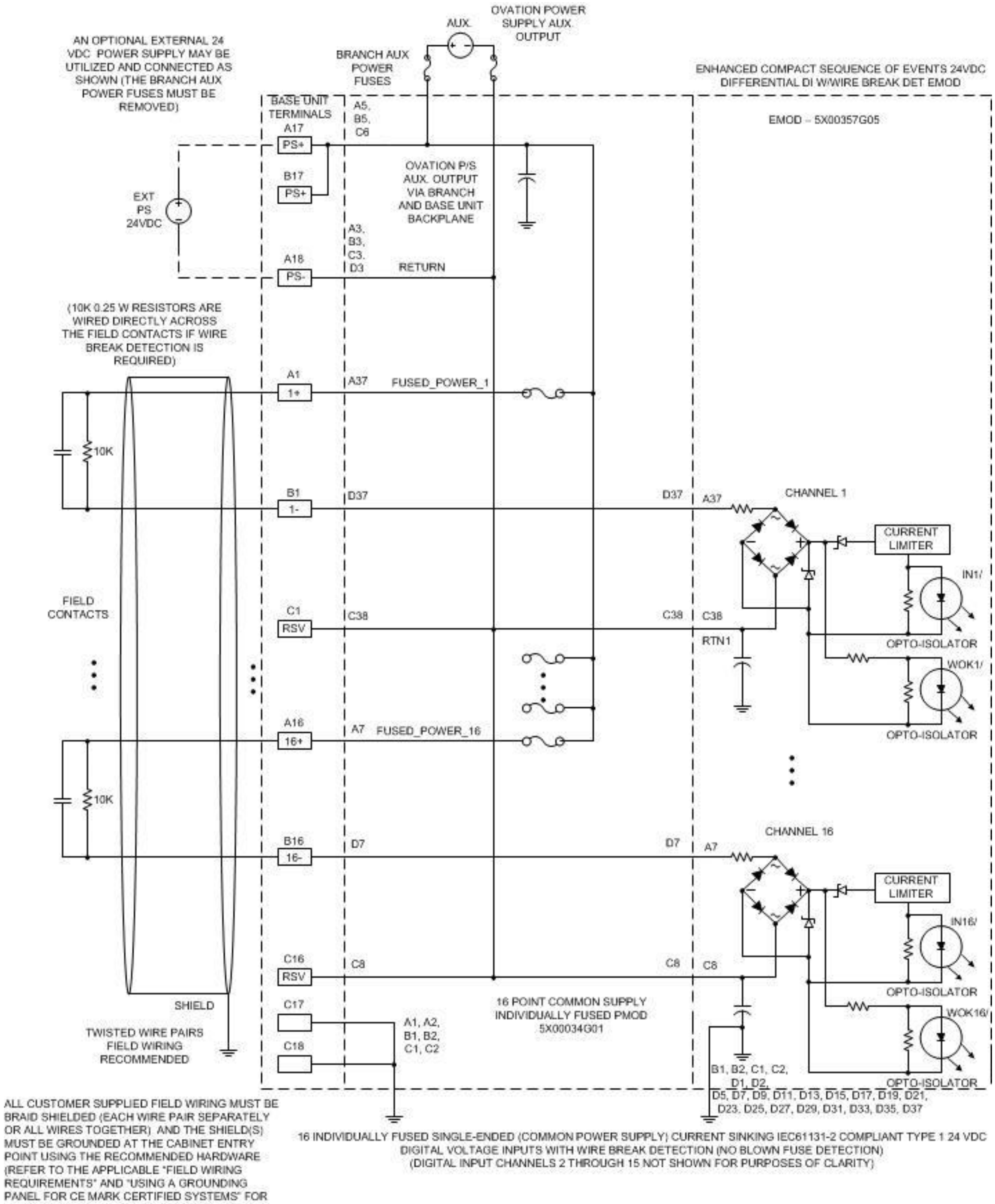


24 VDC DIFFERENTIAL CURRENT-SINKING FIELD DIGITAL INPUT CHANNEL (WITH FIELD WIRE-BREAK DETECTION)



16 INDIVIDUALLY FUSED SINGLE-ENDED (COMMON POWER SUPPLY) CURRENT SINKING IEC61131-2 COMPLIANT TYPE 1 24 VDC DIGITAL VOLTAGE INPUTS WITH WIRE BREAK DETECTION (NO BLOWN FUSE DETECTION)
(DIGITAL INPUT CHANNELS 2 THROUGH 15 NOT SHOWN FOR PURPOSES OF CLARITY)

FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FIVE) (NON-CE MARK)



FIELD CONNECTIONS (2 WIRE INPUTS) FOR THE ENHANCED COMPACT SEQUENCE OF EVENTS MODULE (GROUP FIVE) (CE MARK)

The “+” inputs are actually the 5X00034G05 personality module PDIC personality card’s fused Auxiliary power supply positive rail. The “-” inputs are the field card’s channel VIN inputs. The PDIC personality card connects the sixteen field card channel RTN inputs to the auxiliary power supply return.

For 5X00357G05 module combinations, the 24 VDC auxiliary power supply voltage may be derived either from the base unit backplane’s printed circuit card auxiliary voltage traces or from an optional external auxiliary power supply.

1. To use the base unit backplane’s printed circuit backplane 24 VDC auxiliary voltage, do not connect an external power supply to the base unit termination block PS+ and PS- terminals since the base unit backplane’s Auxiliary voltage automatically appears at these terminals.

   The two plug-in branch Aux. fuses must be installed into their sockets located on the Controller backplane or on the transition panel to which the module’s base unit branch interfaces.

2. To use an external 24 VDC auxiliary power supply, connect the power supply “+” and “-” terminals to the base unit PS+ and PS- terminals as shown. This connection will force all modules on this branch to use the external auxiliary power supply voltage.

   The two plug-in branch Aux. fuses must be removed from their sockets located on the Controller backplane or on the transition panel to which the module’s base unit branch interfaces.

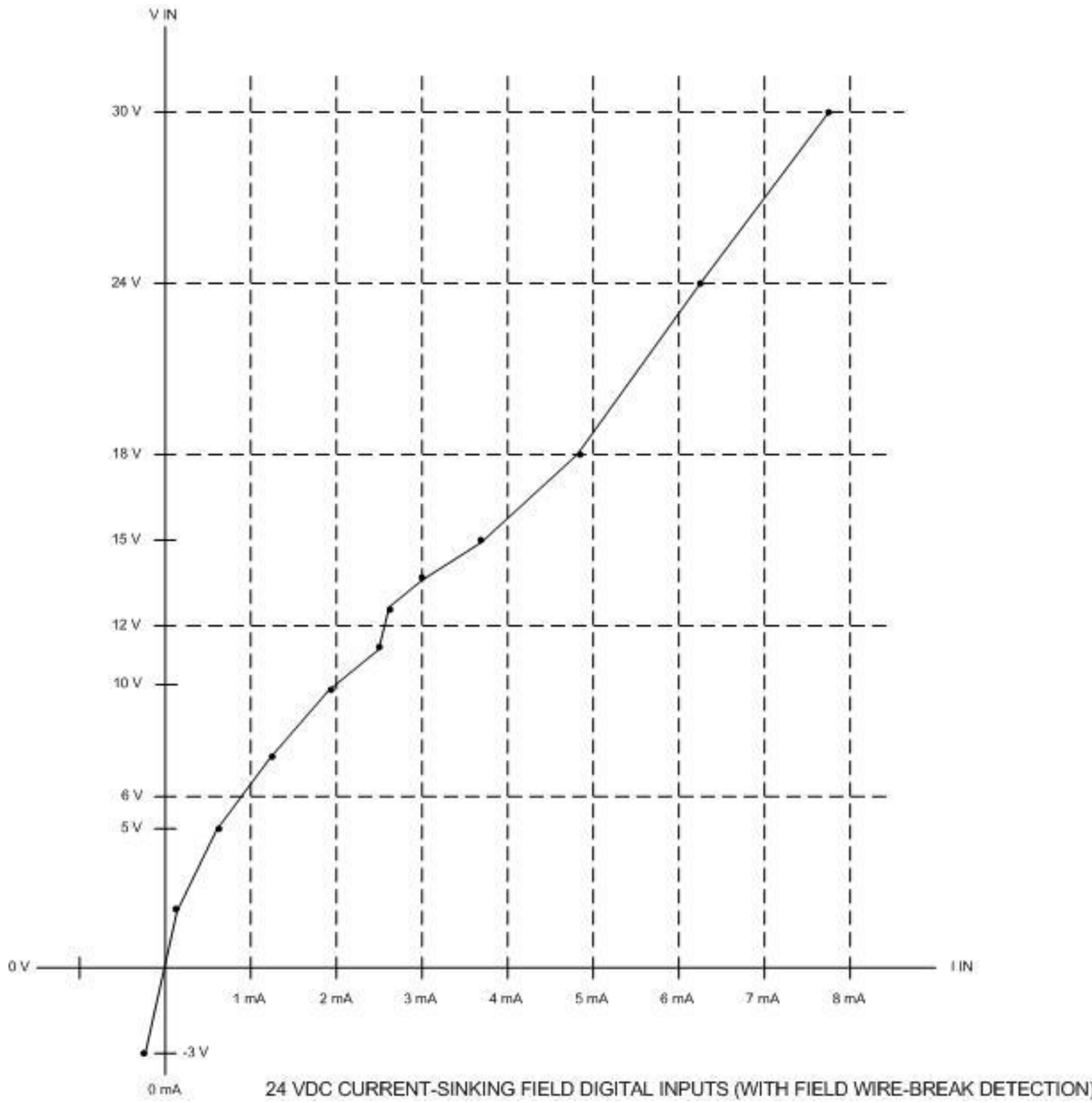
No other external power supplies may be connected to other base unit termination block PS+ or PS- terminals located in the same branch.

External power supply information (5X00357G01 - G05) - (ECSOEDIG01, G02, G03, G05)

When using the Enhanced Compact Sequence of Events module, the required voltage source may be obtained from the internal auxiliary power supply (Controller backplane) or it may be obtained from an external power supply.

If an external power supply is used, there are steps to be undertaken before connecting the external power supply to the Enhanced Compact Sequence of Events Digital Input module base unit terminal block, Refer to *Using an External Power Supply* (see page 799).

Voltage-current curve (5X00357G05) - (ECSOEDI)



Specifications (5X00357G05) - (ECSOEDI)

DESCRIPTION	VALUE
Voltage category	24 VDC
Reverse polarity protection	Yes, each channel incorporates a front-end diode bridge
Operating voltage	15-30 VDC
Input voltage	For "1" signal = 15 to 30 VDC For "0" signal = -3 to 5 VDC

DESCRIPTION	VALUE
Input current	For "1" signal = 6mA typ., 8.5 mA Max For wire-break detect = ≤ 0.2 mA guaranteed to assert a wire break detected state For "0" signal = 0.5 mA Max
Field Contact Shunt Resistance (used only for wire break detect)	10,000 ohms +/- 5%
Input Characteristic	IEC 61131-2, Type 1
Number of channels Channels per common	16 1,5X00357G05/1C31238H01 16, 5X00357G05/5X00034G01
Galvanic isolation	Between channels and I/O bus = Yes Between channels = Yes, 5X00357G05/1C31238H01 No, 5X00357G05/5X00034G01
Current draw, from I/O bus base unit, 24 V main power	45 mA typical for all inputs off 75 mA typical for all inputs on
Power dissipation of module Sum of 24V main power and 24V field channel power	1.08 W typical for all inputs off 3.94 W typical for all inputs on
Status Display	Green LED per channel. LEDs located in logic card circuit
Total module response time (1 foot (0.305 M) long field cable is assumed)	"0" Open to "1" Close = 4.1 msec typ "1" Close to "0" Open = 4.03 msec typ
Resolution	1/8 msec for time tagging an event
Accuracy (time tagged)	1 msec relative to clock from I/O bus 1/8 msec relative to other module channels
LSW card Propagation delay - field card output to present input state register	3.75 mesc. Min. 4.0 msec. typ. 4.25 msec. Max.
LSW card digital debounce circuit delay time	4.0 msec. typ.
Diagnostic Function	Field wire break detect. A 10 Kohm resistor must be installed across each field contact.

Note: *Any module digital input state change time that is less than the LSW card digital debounce time will be rejected by the module and will not appear in the present input state register.*

FDW card signal propagation delay. This is the typical time elapsed from the time that a field contact opens or closes until the time that associated channel's output signal (INn/ where n = 1 to 16) changes states. Assumes a 1 foot (0.305 m) long test cable.

Input voltage level	Delay time for contact opening	Delay time for contact closing
24 VDC	0.03 msec. typ.	0.1 msec. typ.

There is an additional propagation delay due to field cable capacitance charging when the field contact opens. This delay is per 1,000 feet of field cable and assumes a 30 pF/foot cable capacitance.

Note: *There is no additional propagation delay to consider when the field contact closes.*

Input voltage level	Additional delay time for contact opening
24 VDC	0.06 msec. typ.

6.9.11 Event buffer read procedure - (ECSOEDI)

The Event Buffer read procedure consists of the following steps. An I/O bus error is defined as any of the following bus cycles:

- An unsuccessful cycle.
- A module needs Attention cycle
- A module is unconfigured cycle
- A no response cycle

1. Read the module's Buffer Status register at I/O address 0 to determine if the module Event buffer should be read.
2. Write to the module's Buffer Control register at I/O address 0 to set the register's Freeze bit and to specify the event buffer address of the next word to be read. The event buffer address will be called N. The event buffer address should always be written as zero unless there is an error retry. This starts the read address at zero. If the Buffer Status register's Buffer Over-flow bit is set, then set the Buffer Control register's Clear Buffer Over-flow bit.
3. Read the module's Buffer Status register at I/O address 0 to determine the number of words to be read. This number should always be an even number. If there is an I/O bus error during this read operation, the Buffer Status register should be read again before reading any event buffer event data
4. Read the module Event Buffer register at I/O address 1 to obtain the data from event buffer address N. The I/O module counter which indicates the number of event buffer words to be read is reset during the first Event Buffer register read operation and cannot be read again.
5. Read the module Event Buffer register at I/O address 1 to obtain the data from event buffer address N+1.
6. Read the module Event Buffer register at I/O address 1 to obtain the data from event buffer address N+2.

7. Read the module Event Buffer register at I/O address 1 to obtain the data from event buffer address N+3.
8. Continue reading the module's Event buffer register until all of the available event buffer data has been read. After all the event buffer data has been read, perform the following steps.
9. Write to the module Buffer Control register at I/O address 0 in order to clear the register's Freeze bit. At the same time set the register's event buffer address bits to 0. The register's Clear Buffer Over-flow bit should also be cleared.
10. Read the module's Buffer Status register at I/O address 0 in order to determine if the other event buffer contents should be read. If there is data available in the other event buffer, then repeat steps 2 - 9 for the other event buffer.

The following defines the response to an I/O bus error during the event buffer reading procedure. If there is an I/O bus error during a write operation, the write operation should be repeated. If there is an I/O bus error during a read of the module's Buffer Status register located at I/O address 0, read the Buffer Status register again.

If there is an I/O bus error during a read of the module's Event Buffer register located at I/O address 1, the instructions described in Step 2 of the previously documented procedure should be repeated using the event buffer address of the missed data. Next read the module's Event Buffer register location to get the missed data before continuing reading the event buffer until done.

If the Ovation Controller attempts to read the module's Event Buffer register located at I/O address 1 before setting the Buffer Control register's Freeze bit, the reply will be invalid.

If the Ovation Controller reads more than the specified number of event buffer words, the extra words read will be invalid data.

To dump (to clear) the contents of the next event buffer to be read, perform the following actions:

1. Set the Buffer Control register's Freeze bit.
2. Read one word from the Event Buffer register to reset the counter.
3. Clear the Buffer Control register's Freeze bit.

6.9.12 Register configuration/address information - (ECSOEDI)

Register configuration/address information Register (D)

The Module Configuration Register is module I/O register 13 (0xD) and is a write register. The register bit assignments are defined in the following table.

BIT	FUNCTION
0	1 = Configure module. Module will not operate until this bit is set to a logic 1.
1	1 = Force Internal Error – LSW card Int. Error LED is illuminated. Only module registers 0xC, 0xD, 0xE and 0xF may be read.
2, 3, 4, 7, 9, 11. 14, 15	Not used – force to logic 0
6	1 = Allow asserted field card BLOWN FUSE signal to illuminate module E (External error) LED and to force a module Attention Status (bit set only for Group 1 modules) 0 = Ignore field card BLOWN FUSE signal

BIT	FUNCTION
8	1 = Allow asserted field card WETVOLTOK/ signal (field card wetting voltage power supply status) to illuminate the module I (Internal Error) LED and to force a module Attention Status. Allow asserted field card GND FAULT/ signal (field card input ground fault status) to illuminate the module E (external Error) LED (bit set only for Group 4 modules) 0 = Ignore field card WETVOLTOK/ signal. Ignore field card GND FAULT/ signal in regards to controlling the module E LED state
10	1 = Allow asserted field card GND FAULT/ signal (field card input ground fault status) to force a module Attention Status. (bit may be set only for Group 4 modules) 0 = Ignore field card GND FAULT/ signal in regards to controlling the module Attention Status state.
12	Disable Chatter 1 = disable chatter control – input can chatter and each event will be recorded in the event buffer until the event buffer overflows (if input channel not masked off) 0 = enable chatter control (default state)
13	Chatter Control Flag Reset Option Select 1 = reset chatter control counter for each channel upon event buffer unfreeze 0 = decrement chatter counter for each channel every 100 milliseconds (default state)

For Group 1 modules, set bit 6 and clear bits 8 and 10.

For Group 2, 3 and 5 modules, clear bits 6, 8 and 10
For Group 4 modules, clear bit 6 and set bit 8. Bit 10 is set depending on application requirements.
Bits 12 and 13 are set/cleared depending on application requirements.

Module status (read) register

The Module Status Register is module I/O register 13 (0xD) and is a read register. The register bit assignments are defined below.

BIT	FUNCTION
0	1 = module configured 0 = module unconfigured, I/O addresses below 12 (0xC) cannot be read.
1	State of Module Configuration register bit 1 1 = Internal Error forced 0 = Internal Error not forced
2-4	not used - should be logic 0
6	State of Module Configuration register bit 6 1 = Allow asserted field card BLOWN FUSE signal to illuminate module E (External error) LED and to force a module Attention Status (bit set only for Group 1 modules) 0 = Ignore field card BLOWN FUSE signal
7	1 = Blown field card Auxiliary power supply fuse or low Auxiliary power supply voltage (asserted only for Group 1 modules only if Module Configuration register bit 6 is set and the field card BLOWN FUSE signal is active)
8	State of Module Configuration register bit 8 1 = Allow asserted field card WETVOLTOK/ signal (field card wetting voltage power supply status) to illuminate the module I (Internal Error) LED and to force a module Attention Status. Allow asserted field card GND FAULT/ signal (field card input ground fault status) to illuminate the module E (external Error) LED (bit set only for Group 4 modules) 0 = Ignore field card WETVOLTOK/ signal. Ignore field card GND FAULT/ signal in regards to controlling the module E LED state

Bit	Function
9	1 = Contact wetting voltage power supply failure (asserted only for Group 4 modules if Module Configuration register bit 8 is set and the field card WETVOLTOK/ signal is asserted)
10	State of Module Configuration register bit 10 1 = Allow asserted field card GND FAULT/ signal (field card input ground fault status) to force a module Attention Status. (bit may be set only for Group 4 modules) 0 = Ignore field card GND FAULT/ signal in regards to controlling the module Attention Status state.
11	1 = Ground Fault (asserted only for Group 4 modules if Module Configuration register bit 8 is set and the field card GND FAULT/ signal is asserted). Bit 11's state is independent of the Module Configuration register bit 10 state.
12	State of Module Configuration register bit 12, Disable Chatter Read Back 1 = disable chatter control - input can chatter and each event will be recorded in the event buffer until the event buffer overflows (if input channel not masked off) 0 = enable chatter control (default state)
13	State of Module Configuration register bit 13, Chatter Control Flag Reset Option Select Read Back 1 = reset chatter control counter for each channel upon event buffer unfreeze 0 = decrement chatter counter for each channel every 100 milliseconds (default state)
14	1 = Clock synchronized
15	1 = Field wiring not intact on one or more input channels if wire break detection is enabled for those channels (Group 5 only) 0 = Field wiring intact on all channels or wire break detection is not enabled for any channel.

Bit 15 is the logical OR of the sixteen inverted Channel Wire Break Detect Register bits.

Registers 2, 3, 4, B, C & E - (ECSOEDI)

Present Input State Register (2)

The Present Input State Register is module I/O register 2 and is a read register. The register bit assignments for a current-sinking digital input field card are defined below.

Bits	Function
0 - 15	1 = Channel (1 - 16) field input voltage above minimum "1" threshold. 0 = Channel (1 - 16) field input voltage below Maximum "0" threshold.

Positive Transition Latched Register (3)

The Positive Transition Latched Register is module I/O register 3 and is a read register. The register bit assignments are defined below.

Bits	Function
0 - 15	1 = A low to high event transition in Channel (1 - 16) was detected. 0 = No detected low to high event transition in Channel (1 - 16)

Negative Transition Latched Register (4)

The Negative Transition Latched Register is module I/O register 4 and is a read register. The register bit assignments are defined below.

BITS	FUNCTION
0 - 15	1 = A high to low event transition in Channel (1 - 16) was detected. 0 = No detected high to low event transition in Channel (1 - 16)

Channel Wire Break Detect Register (B)

The Channel Wire Break Detect Register is module I/O register 11 (0xB) and is a read only register. The register bit assignments are defined below.

BITS	FUNCTION
0 - 15	1 = Channel (1 - 16) field wiring intact or Channel (1 - 16) wire break detect not enabled 0 = Channel (1 - 16) field wiring not intact.

Channel Wire Break Detect Mask write Register (C)

The Channel Wire Break Detect Mask Register is module I/O register 12 (0xC) and is a write register. The contents may be read back by the Ovation Controller. Upon module power up, all register bits are cleared to logic 0. The register bit assignments are defined below.

BITS	FUNCTION
0 - 15	1 = Channel (1 - 16) field input wire break detection enabled. 0 = Channel (1 - 16) field input wire break detection disabled.

Channel Wire Break Detect Mask read Register (C)

The Channel Wire Break Detect Register is module I/O register 12 (0xC) and is a read register. Upon module power up, all register bits are cleared to a logic 0 value. The register bit assignments are defined below.

BITS	FUNCTION
0 - 15	1 = Channel (1 - 16) wire break detect is enabled. 0 = Channel (1 - 16) wire break detect is disabled.

Channel Event Tagging Mask write Register (E)

The Channel Event Tagging Mask Register is module I/O register 14 (0xE) and is a write register whose contents may be read back by the Ovation Controller. Upon module power up, all register bits are cleared to a logic 0 value. The register bit assignments are defined below.

BITS	FUNCTION
0 - 15	1 = Channel (1 - 16) field input checked for change of state every 1/8 milliseconds 0 = Channel (1 - 16) field input change of state monitoring disabled. Channel (1 - 16) chatter counter and Channel (1 - 16) Chatter Control flag are reset.

Channel Event Tagging Mask read Register (E)

The Channel Event Tagging Mask Register is module I/O register 14 (0xE) and is a read register. This registers equal the contents of the Channel Event Tagging Mask Register. Upon module power up, all register bits are cleared to a logic 0 value. The register bit assignments are defined below.

BITS	FUNCTION
0 - 15	1 = Channel (1 - 16) field input checked for change of state every 1/8 milliseconds 0 = Channel (1 - 16) field input change of state monitoring disabled. Channel (1 - 16) chatter counter and Channel (1 - 16) Chatter Control flag are reset.

6.9.13 Diagnostic Logic card LEDs - (ECSOEDI)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	The External Error LED is illuminated when faults external to the module are present. ▪ For Group 1 modules, the External Error LED is illuminated only when the field card Auxiliary power supply fuse opens or the Auxiliary power supply voltage level is low (BLOWN FUSE = 1) and the Module Configuration register bit 6 is set. Module Configuration bit 6 must be cleared for all other module groups. ▪ For Group 2, 3 or 5 modules, the External Error LED should not be illuminated. The Module Configuration register bit 6 should be cleared and the field card BLOWN FUSE signal is ignored. The Module Configuration register bit 8 should also be cleared. ▪ For Group 4 modules (contact input), the External Error LED is illuminated only when the field card detects a ground fault in the field wiring (GND FAULT/ = 0) and the Module Configuration register bit 8 is set.
I (Red)	The Internal Error LED is illuminated to indicate internal electronics module faults. ▪ The Internal Error LED is illuminated when Module Configuration Register bit 1 (Force Error) is set. ▪ The Internal Error LED is illuminated for Group 4 electronics modules when the field card's internal 48V/10V contact wetting voltage power supply fails (WETVOLTOK/ = 1) and the Module Configuration Register bit 8 has been set. Module Configuration bit 8 must be cleared for all other module groups. ▪ The Internal Error LED is illuminated when the I/O Bus Controller has not accessed the electronics module for at least a period of 2 seconds.

LED	Description
1 - 16 (Green)	Digital Input Channel State LEDs ▪ For any Group 1, 2, 3 or 5 electronics module current-sinking digital input channel, the channel's digital input state LED is guaranteed to illuminate when the digital input channel's input voltage exceeds the minimum required input voltage for a "1" signal. For any Group 4 electronics module, the channel's digital input state LED is guaranteed to illuminate when the channel's field contact is closed, the sum of the field wiring resistance and contact resistance is less than 100 ohms and the field card's internal 48V/10V wetting power supply is functioning correctly. ▪ Each digital input channel state LED is located on the LSW logic card. The field card's opto-coupler output transistor interfaces a voltage comparator via a pull-up resistor connected to the logic card's VCC voltage bus through a series pull-up resistor. The voltage comparator compares the opto-coupler's output voltage to a fixed reference voltage in order to determine the digital input channel's state. The voltage comparator output transistor's uncommitted collector terminal is routed to the LSW logic card where it is connected to the logic card VCC voltage bus via a pull-up resistor and the digital input channel state LED.

Note: *The logic card's I/O Bus communications watchdog timer turns off the Communications OK LED and illuminates the module I LED if the I/O Controller fails to access the Enhanced Compact Sequence of Events Module within 2 seconds.*

Upon a timeout, the watchdog timer will clear the Event Mask register, clear the event buffers and clear Module Configuration Register.

A watchdog timer for one shot registers would clear the one shot registers if no reads occur to Positive Transition Latched Register or Negative Transition Latched Register within a period of 5 seconds. After a timeout, the collection of one shot information is prevented until the Controller resumes reading either Positive Transition Latched Register or Negative Transition Latched Register. The first read would be a throw away which would re-activate the watchdog timer. The second read would yield valid register data.

6.9.14 Environmental Specifications - (ECSOEDI)

AMBIENT AIR TEMPERATURES

The operating ambient air temperature range is from 0 C to 60 C. The temperature is measured approximately 0.5 inches from any point on the module while it is mounted in its normal vertical or horizontal position, and while subject to the air movements which result from natural convection only (that is, no forced air movement).

HUMIDITY (non-condensing)

The humidity range is from 0% to 95% relative humidity, non-condensing, through an ambient air temperature range of 0 C through 60 C, but with a Maximum wet bulb temperature not over 35 C (95 F).

VIBRATION

The module shall remain operational while subject to testing defined in IEC 68-2-6 over the following curve: 0.15mm displacement from 10 to 57 Hz and 2G's from 57 to 500 Hz, when attached to a properly mounted DIN rail.

SHOCK

The module will remain operational and reliable after being subjected to testing defined in IEC 68-2-27 over the following curve: 15 G's for 11 milliseconds and 1/2 sine wave.

POWER SUPPLY VOLTAGE

	Minimum	Nominal	Maximum
Main Primary Voltage:	21.0 V	24.0 V	25.0 V
Main Secondary Voltage:	21.0 V	24.0 V	25.0 V

The two main supply voltages are the redundant power feeds to the electronics module and are diode auctioneered on the electronics module's logic card.

6.10 32 Channel 24V DC Single-Ended Digital Input module (Windows Ovation 3.4 and above)

The Ovation 32 Channel 24V DC Single-Ended Digital Input module monitors the state ("0" or "1") of 32 single-ended field digital inputs. The 32 Channel 24V DC Single-Ended Digital Input module is designed to meet IEC 61131-2 type 3 characteristics for 24VDC digital inputs in industrial automation.

Note: *The Ovation 32 Channel 24V DC Single-Ended Digital Input module is only available for Ovation software releases 3.4 and later.*

Power for all 32 field contacts is supplied by the Ovation 24VDC Auxiliary cabinet power supply.

The 32 Channel 24V DC Single-Ended Digital Input module consists of an Electronics module (Emod) and a Personality cavity insert. A Personality module (Pmod) is not required.

Note: *The 32 Channel 24V DC Single-Ended Digital Input requires the use of an Ovation 4-slot I/O base (5X00497G01) which provides additional wire terminations to support the 32 channels. The 32 Channel 24V DC Single-Ended Digital Input cannot be used with the standard I/O Bases (1B30035H01, 1X00014H01, or 5X00334G01).*

The I/O Module General Information (see page 25) section contains environmental, installation, wiring, and fuse information for I/O modules.

6.10.1 Electronics modules (Emod) - 32 Channel 24V DC Single-Ended Digital Input

- **5X00499G01** - 32 Channel 24V DC Single-Ended Digital Output Electronics module

6.10.2 Personality modules (Pmod) - 32 Channel 24V DC Single-Ended Digital Input

- **1X00690H01** - The 32 Channel 24V DC Single-Ended Digital Input does not require a Pmod for any electrical connections. A cavity insert is used in the Pmod location to cover the unused Pmod connector and provide terminal wiring information.

6.10.3 Subsystems - 32 Channel 24V DC Single-Ended Digital Input

32 Channel 24V DC Single-Ended Digital Input Subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
32 Channel 24V DC Single-Ended Digital Input	32	5X00499G01	1X00690H01

Note: *The 32 Channel 24V DC Single-Ended Digital Input requires the use of an Ovation 4-slot I/O base (5X00497) to provide additional wire terminations to support the 32 channels.*

6.10.4 Terminal block wiring information - 32 Channel 24V DC Single-Ended Digital Input

Wiring for the 32 Channel 24V DC Single-Ended Digital Input is illustrated in the following figure. The following table lits and defines the abbreviations used in the diagram.

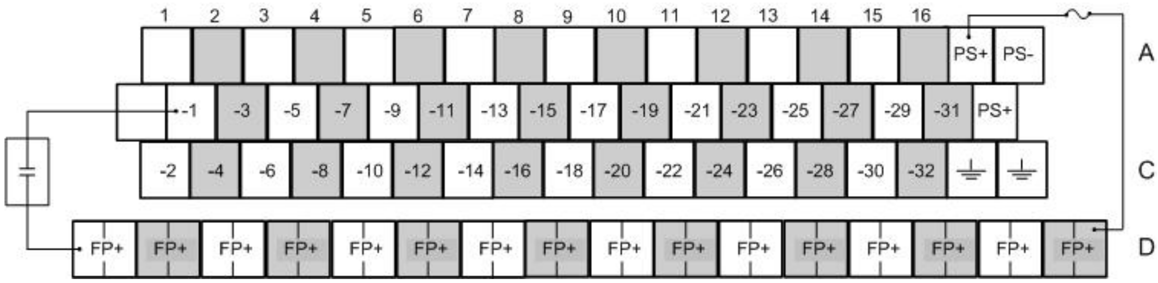


Figure 87: Terminal block connections for the 32 Channel Single-Ended Digital Input module

Abbreviations used in wiring diagrams

Abbreviation	Definition
	Earth ground terminals.
-1 through -32	Digital Input Negative terminals (connect to field device contact negative side)
FP+	Fused Power Terminal Connection (connect to field device contact positive side) All FP+ terminals are tied together on module **Note:** *Sixteen (16) screws are supplied for terminations. Two (2) wires per screw terminal are used to achieve termination points for all 32 channels.*
PS+, PS-	Auxiliary Power Supply terminals. No external connections required when using Ovation +24V DC Auxiliary Power Supply. Ovation Aux. Supply provided to module through branch.
	Reserved terminal. No connection allowed on these unmarked terminals.
+24V DC Auxiliary power is supplied through an internal branch or through terminal block connections (PS+/PS-). Power is fused on the Emod, then supplied to all FP+ connection terminals for connection to the positive side of the field device contact. The negative side of the field device is connected through a digital input negative terminal (-1 through -32) to the module where its status is monitored.	

6.10.5 Field connection wiring diagrams - 32 Channel 24V DC Single-Ended Digital Input

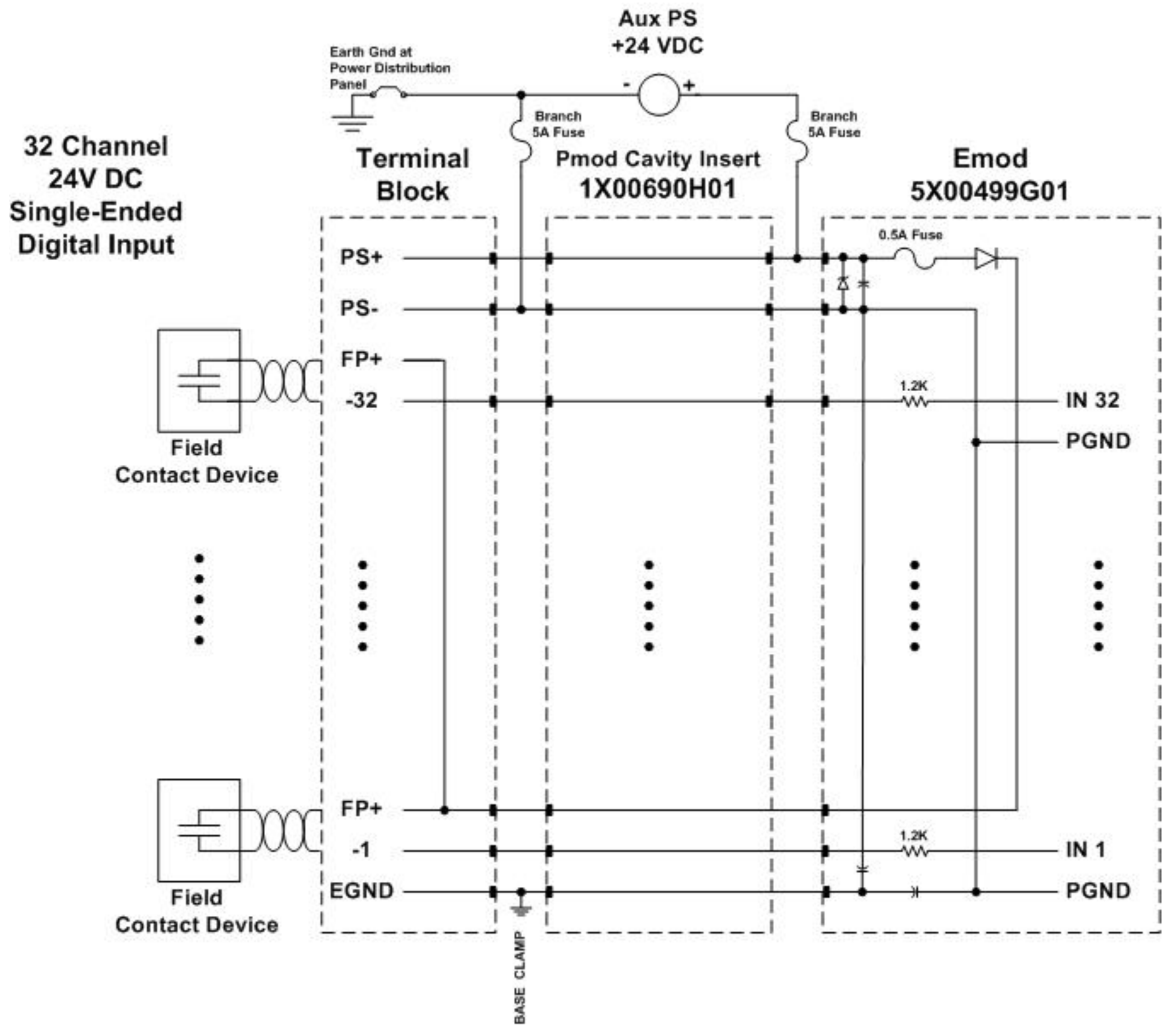


Figure 88: Wiring diagram - 32 Channel 24V DC Single-Ended Digital Input module

6.10.6 Register configuration/status information - 32 Channel 24V DC Single-Ended Digital Input

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window (Bit Pattern field on the Hardware tab) at an Operator Station sSee the *Ovation Operator Station User Guide).*

32 Channel 24V DC Single-Ended Digital Input Configuration/Status (address 13 or D in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configure module 1 = configure 0 = not configured, causing an attention status	Module Configured 1 = configured* 0 = not configured

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
1	Force Error 1 = force an attention status 0 = no forced error*	Forced error 1 = forced error set 0 = no forced error*
2-6	Not defined	Not defined, 0 = Permanent Value
7	Not defined	Fuse status 1 = Blown fuse detected 0 = Fuse OK*
8	Not defined	Ch1 - Ch4 Status 1 = Fault detected on Ch1 - Ch4 0 = No fault detected on Ch1 - Ch4*
9	Not defined	Ch5 - Ch8 Status 1 = Fault detected on Ch5 - Ch8 0 = No fault detected on Ch5 - Ch8*
10	Not defined	Ch9 - Ch12 Status 1 = Fault detected on Ch9 - Ch12 0 = No fault detected on Ch9 - Ch12*
11	Not defined	Ch13 - Ch16 Status 1 = Fault detected on Ch13 - Ch16 0 = No fault detected on Ch13 - Ch16*
12-15	Not defined	Not defined, 0 = Permanent Value
* Default value		

6.10.7 Diagnostic LEDs - 32 Channel 24V DC Single-Ended Digital Input

Logic card LED indications

LED	Description
P (green)	Power OK LED. Lit when module main power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit to indicate the Auxiliary 24V DC field power is not present, is below threshold, or Auxiliary 24V DC fuse is blown.
I (Red)	Internal Fault LED. Lit when: ▪ The Force Error bit (Bit-1) of the Configuration Register is set. ▪ The Ovation Controller is not communicating with the module. ▪ A channel fault exits.
1 - 32 (Green)	Point Status LED. Each of the 32 channel LEDS will light when the input voltage of the corresponding channel is greater than the minimum On Input Voltage.

Note: *Fuse Rating: 0.5A, 250V Fast-acting Fuse 5X20 mm*

6.10.8 Specifications - 32 Channel 24V DC Single-Ended Digital Input

32 Channel 24V DC Single-Ended Digital Input Specifications

DESCRIPTION	VALUE
Number of channels (IEC 61131-2, Type 3)	32
Input Voltage category	24 VDC
Input Operating Voltage	0 to 30 VDC
Channels per Common	32
Input range (single-ended or differential)	Refer to the following Digital Input Range table.
Digital Filter Contact Debounce	3ms +/- 5%
Cable length	1000 feet maximum @ 50pF/ft or better
Diagnostics Internal module operating faults.	Blown fuse detection, 10.0 VDC threshold
Galvanic isolation: Between channels and I/O Bus Between channels	Yes, 1000 VDC/Vrms No
Module power	▪ Drawn from Main: 0.70W typ; 0.81W max. with all inputs off 1.49W typ; 1.71W max. with all inputs on ▪ Drawn from Auxiliary: 0.96W typ; 1.13W max with all inputs off 2.88 typ; 3.31W max with all inputs on ▪ Power Dissipation in Emod/Pmod: 1.66W typ; 1.94W max. with all inputs off 4.37W typ; 5.03W max with all inputs on
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

Digital Input ranges

INPUT LEVEL	ON INPUT VOLTAGE UH (VDC)		OFF INPUT VOLTAGE UL (VDC)		ON INPUT CURRENT IH (MA)	
	MIN	MAX	MIN	MAX	MIN	MAX
24 VDC	8.2	30	0	7.2	2.43	2.6
Field input voltages equal to or greater than the minimum ON voltage (UH) and field input currents equal to or less than the maximum ON input current (IH) will guarantee a logic one be read by the digital input module.						

SECTION 7

Digital Output modules

IN THIS SECTION

7.1 Digital Output module - (DO)

The Ovation Digital Output module provides a means to switch up to 60 VDC at moderate currents (for example, relay coils and lamps). The Digital Output module contains 16 current sinking transistor outputs capable of switching 60 VDC loads at up to 500mA.

The Digital Output module provides configurable communication timeout periods and LEDs to indicate the status of each output.

The Digital Output module is a CE Mark certified module.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

7.1.1 Electronics modules (Emod) - (DO)

- **1C31122G01** provides for switching 60 VDC loads.

7.1.2 Personality modules (Pmod) - (DO)

- **1C31125G01** is used to interface the digital output module to the field through the terminal blocks.
- **1C31125G02** is used to interface the digital output module to the relay modules when power is supplied locally (from the I/O backplane auxiliary power supply). It can also be used to interface the digital output module to the field through the terminal blocks.
- **1C31125G03** is used to interface the digital output module to the relay modules when power is supplied remotely (from the relay modules). It can also be used to interface the digital output module to the field through the terminal blocks.

CAUTION: When 1C31125G03 is used, the returns for the remote power supply and the local power supply are connected together. Therefore, to avoid problems with differences in earth ground potentials, ensure that the power supply return lines are earth grounded at only ONE point.

7.1.3 Subsystems - (DO)

Digital Output subsystems [1]

DESCRIPTION[1]	CHANNELS	ELECTRONICS MODULE OR PANEL KIT	PERSONALITY MODULE
5-60 VDC Single ended Direct	16	1C31122G01	1C31125G01
Relay Panel Interface: Local Power Supply Field Power Supply	 16 16	 1C31122G01 1C31122G01	 1C31125G02 1C31125G03
Relay Panels: Solid State Relay Panel (AC) Solid State Relay Panel (DC) G2R Relay Panel (Low Power Electro-mechanical)	16 16 16	5A22410G01 5A22410G02 5A22411G01	

Description[1]	Channels	Electronics module or Panel Kit	Personality module
KU Relay Panel [2] (High Power Electro-mechanical)	16	5A22412G01 - G03	
[1] All configurations listed in the table are CE Mark certified, unless they use AC/DC solid state relay panels. [2] Two panels (8 relays each) are included in the KU Relay Panel kit 5A22412G01, G02, and G03.			

7.1.4 External power supply information - (DO)

The Digital Output module may obtain voltage from the internal auxiliary power supply (backplane) or from an external power supply.

If an external power supply is used, *Using an External Power Supply (see page 799)* contains steps to be undertaken before connecting the external power supply to the Digital Output module base unit terminal block. The external power supply DC output voltage level depends on the Digital Output module application.

7.1.5 Relay Panels - (DO)

Relay panels are used to switch high currents and high voltages as required by various field devices. The Digital Output module interfaces to the relay modules through Groups 2 and 3 of the Personality modules and a standard cable.

The following table provides information about the three standard relay modules.

Relay contact ratings must be adhered to when utilizing the Digital Output Relay Panel assemblies. The application must include external current limiting protection for the Digital Output Relay Panel assemblies.

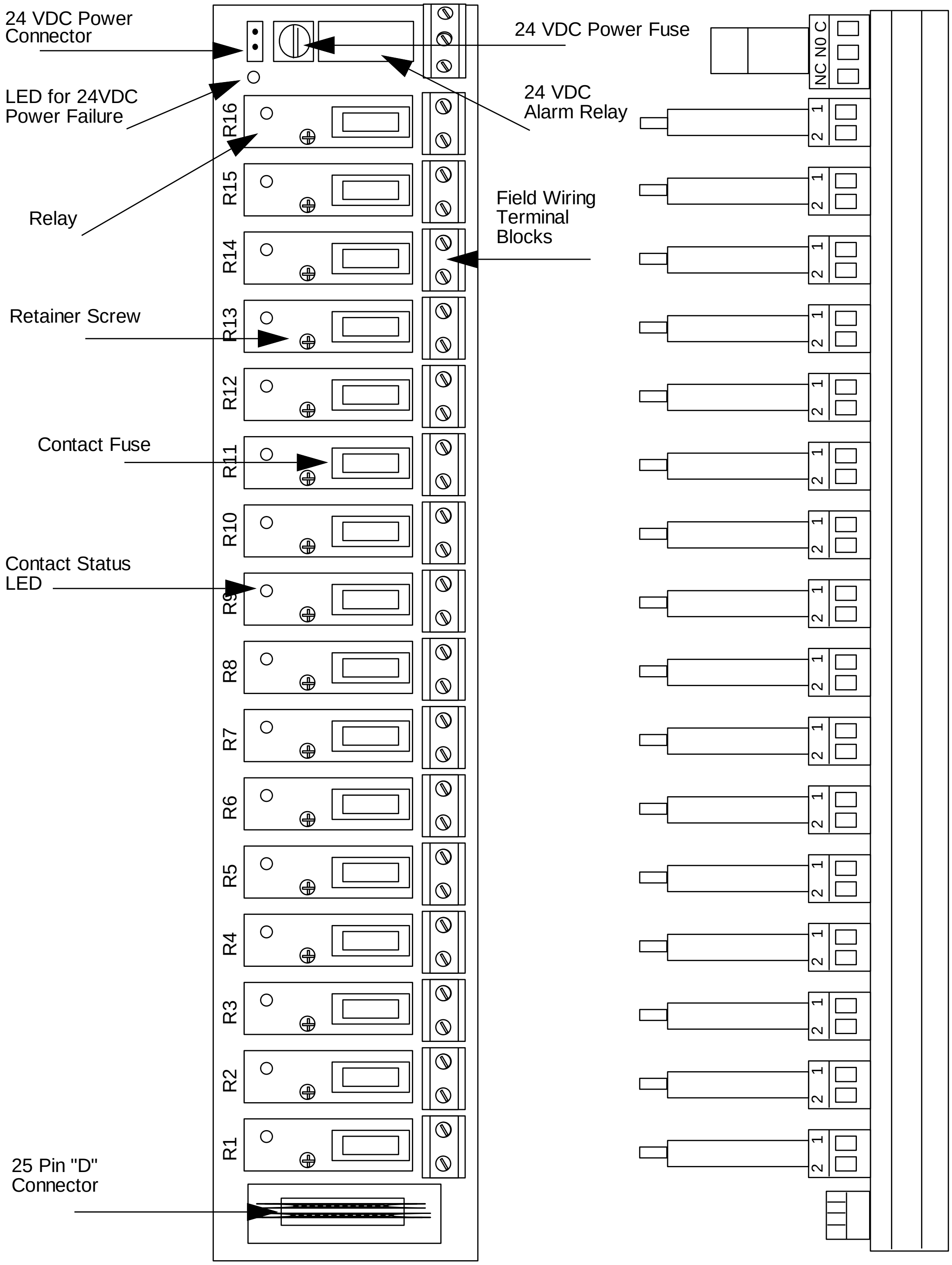
Digital Output relay panels

Relay module	CE Mk	Size	Channels	Contact Type	Contact Rating	Input Power	Connect Cable
5A22410G01 Solid State	No	35.86 cm L (14.12 in) 7.75 cm W (3.05 in) 10.46 cm H (4.12 in)	16	Solid State (1 normally open)	3.5 amps @250 VAC at 25 °C 1.65 amps @250 VAC at 60 °C	246mA typ 310mA Max @26.4V	5A26148
5A22410G02 Solid State	No	35.86 cm L (14.12 in) 7.75 cm W (3.05 in) 10.46 cm H (4.12 in)	16	Solid State (1 normally open)	1.0 amps @200 VDC at 60 °C	246mA typ 310mA Max @26.4V	5A26148

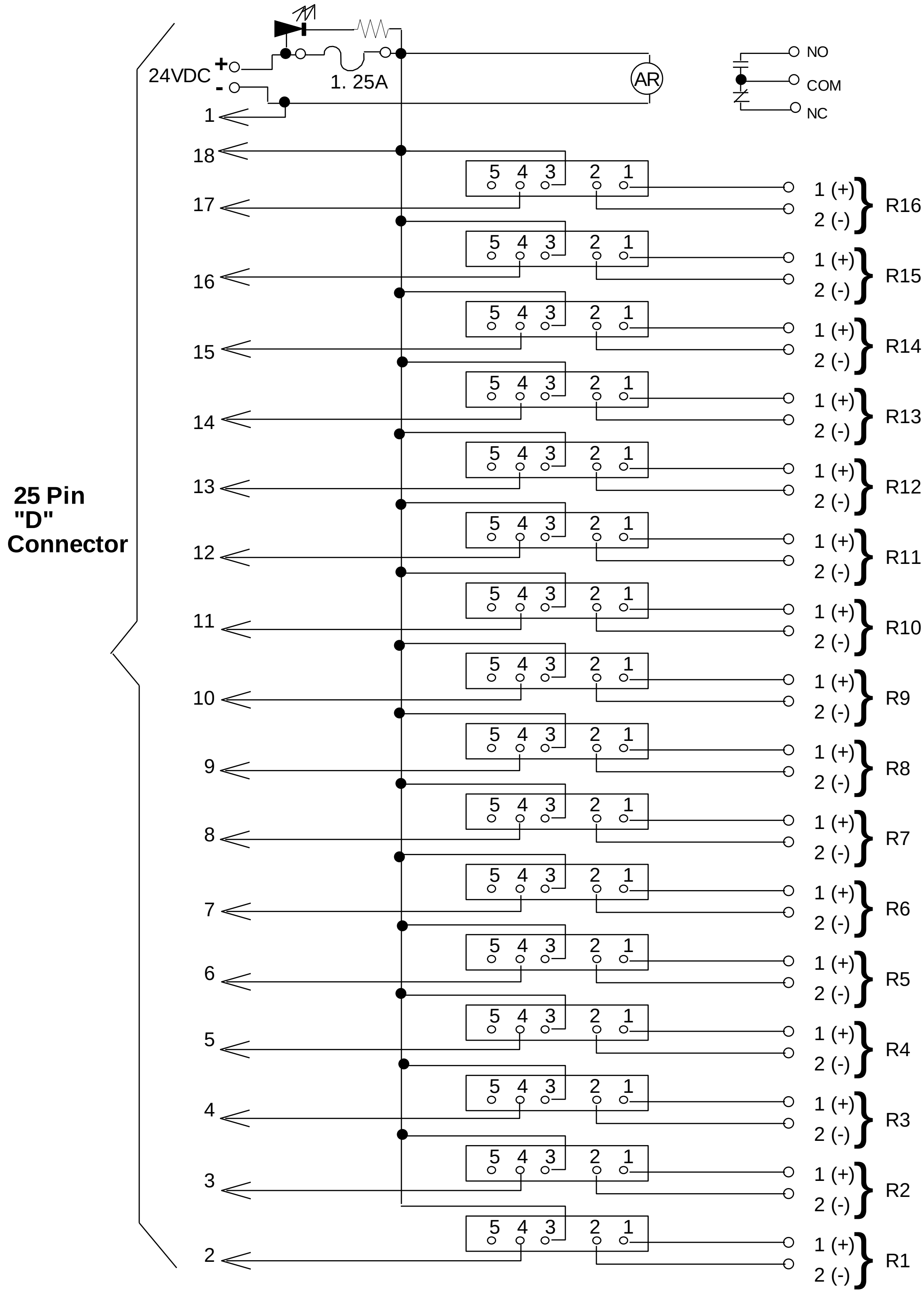
Relay Module	CE Mk	Size	Channels	Contact Type	Contact Rating	Input Power	Connect Cable
5A22411G01 G2R Style (Low Power Electro-mechanical)	Yes	45.09 cm L (17.75 in) 7.75 cm W (3.05 in) 6.05 cm H (2.38 in)	16	Mechanical (1 Form C)	10 amps @250 VAC 10 amps @30 VDC	453mA typ 610mA Max @26.4V	5A26148
5A22412G01 [1] KUEP Style (High Power Electro-mechanical) Contains two 5A22412H01 panels and 16 4960A71H16 relays.	Yes	49.5 cm L (19.5 in) 7.75 cm W (3.05 in) 9.53 cm H (3.75 in)	16 (using two panels)	Mechanical (2 Form C)	10 amps @250 VAC 3 amps @150 VDC	1.32A typ 1.8A Max @26.4V (for 2 relay panels) [2]	5A26149
5A22412G02 [1] KUEP Style (High Power Electro-mechanical) Contains two 5A22412H01 panels and 16 4960A71H05 relays.	Yes	49.5 cm L (19.5 in) 7.75 cm W (3.05 in) 9.53 cm H (3.75 in)	16 (using two panels)	Mechanical (Form X)	10 amps @250 VAC 10 amps @150 VDC	940mA typ 1.27A Max @26.4V (for 2 relay panels) [2]	5A26149
5A22412G03 [1] KUEP Style (High Power Electro-mechanical) Contains two 5A22412H01 panels and up to 16 project specific relays.	Yes	49.5 cm L (19.5 in) 7.75 cm W (3.05 in) 9.53 cm H (3.75 in)	16 (using two panels)	Project Specific	Project Specific	Project Specific	5A26149

[1] Two panels required for 16 outputs.
[2] If one panel is used, half the power is needed.

7.1.6 Solid State Relay module for DIN Rail Layout (5A22410H01 / 5A22410H02) - (DO)



7.1.7 Solid State Relay module Terminations (5A22410H01 / 5A22410H02) - (DO)



7.1.8 Specifications - (LI)

- **Electronics module (1C31174)**
- **Personality module (1C31177)**

The following tables provide specifications for the Loop Interface module:

- General Specifications
- Analog input
- Analog output
- Digital input
- Digital output.

Loop Interface General Specifications

DESCRIPTION	VALUE
Module power	Main: 2.7 W typical; 3.5 W Maximum Aux (when used): **Digital Inputs:** 0.13W (24V) typical 0.27 W (48V) typical **Digital Outputs:** (power-dependent on loads for 2 outputs @ 100mA each) 4.8 W (24V) typical 9.6 W (48V) typical **Analog Inputs:** (2 inputs @ 20mA each) 0.96 W (24V) typical
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

Loop Interface Analog Input module Specifications

DESCRIPTION	VALUE
Number of analog input points	2
Input range	0 to +10 V (G01) 0 to +5 V (G02) 4 to 20 mA (G03 - G04) AI1 and AI2 current inputs must be terminated (even if not used) to prevent point fault generation.
Resolution	13-Bits (including polarity)
Guaranteed accuracy (@25°C) [1]	±0.10% of upper range value ±10μV ±1/2LSB @99.7% confidence
Temperature coefficient	±0.24% of the upper range value ±24μV over 0 to 60°C.

DESCRIPTION	VALUE
Input impedance: 0 to 10V groups 0 to 5V groups, and 4 to 20mA groups	 2 M ohmσ 1 M OHMΣ
Sampling rate	10 samples per second under normal conditions. 8 samples per second during auto calibration.
Offset and gain temperature drift compensation	Automatic
Diagnostics	Internal module operating faults. Out of range detection. Open loop/blown fuse detection for current loops.
Dielectric isolation: Channel to channel Channel to logic	 1000 V AC/DC 1000 V AC/DC
Normal mode rejection	60 dB at 50 Hz ± 1/2% or 60 Hz ± 1/2% 30 dB (typical) at 50 Hz ± 5% or 60 Hz ± 5%
Common mode rejection	120 dB at DC; power line frequency and its harmonics ± 1/2% without line frequency tracking. 100 dB (typical) for nominal line frequency ± 5% and harmonics without line frequency tracking.
[1] See additional information for CE Mark certified systems.	

Loop Interface Analog Output module Specifications

DESCRIPTION	VALUE
Number of points	1 - Analog output is not present for Group 4 (electric drive) modules. AO current outputs in G03 - G04 must be terminated (even if not used) to prevent point fault generation.
Maximum update time	2 mSec
Output range	0 - 10 V@ minimum 1 K ohms load impedance (10mA Maximum load) (G01 - G02) 4 - 20 mA @ Maximum 750 Ohms load impedance (0 Ohms minimum) (G03)
Resolution	12 bits
Guaranteed accuracy (@25°C ± 1°C) [1]	±0.10% of span
Temperature coefficient	0 to 10 V groups: 30 ppm/°C 4 to 20mA groups: 45 ppm/°C
User loop voltage	Power for current loop output is supplied by module.
Diagnostics	Internal module operating faults ▪ Overcurrent ▪ Undercurrent
Dielectric isolation: Channel ground to channel ground Channel ground to logic ground	 Maximum ± 1000 V AC/DC Maximum ± 1000 V AC/DC

DESCRIPTION	VALUE
Output loading	0 - 10 V@ minimum 1 K ohms load impedance (10mA Maximum load) 4 - 20 mA @ Maximum 750 ohms load impedance (0 ohms minimum)
[1] See additional information for CE Mark certified systems (see page 791).	

Loop Interface Digital Input module Specifications

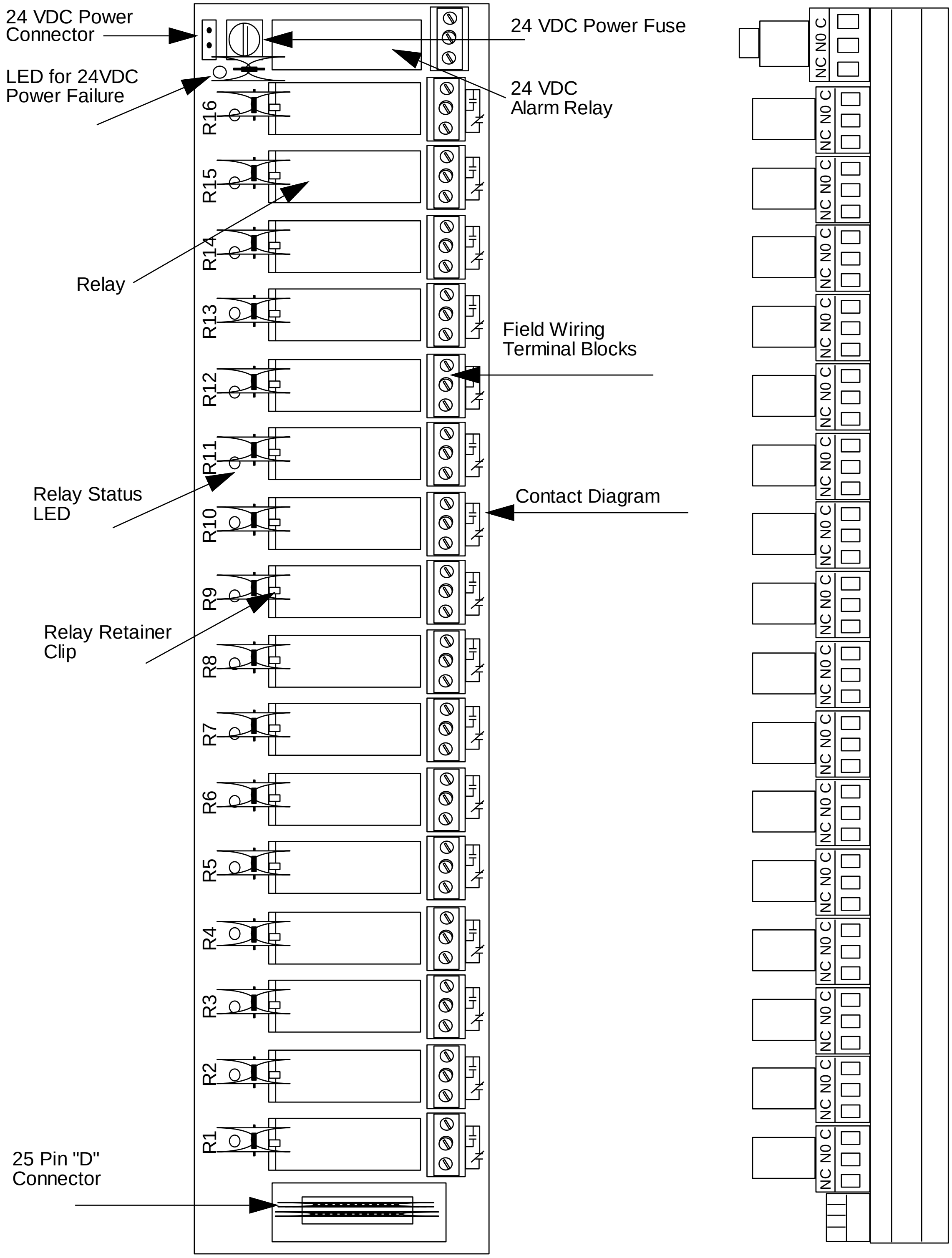
DESCRIPTION	VALUE
Number of points	Two digital inputs dedicated as priority raise and lower inputs. If priority raise and lower inputs are not desired, shorting wires should be placed across the inputs (+1 to -1 and +2 to -2) to eliminate possible false turn on from noise.
Input range	24V or 48V typ 18 -60 VDC
Propagation delay of contact change of state	1.9 mSec minimum; 35.0 mSec Maximum
Cable length (quality is 50pF/ft or better)	1000 feet Maximum
Diagnostics	Internal module operating faults ▪ Auxiliary power supply blown fuse detection (enabled/disabled) ▪ Priority raise and lower error, also referred to as runbacks, (both raise and lower active)
Dielectric isolation: Channel ground to channel ground Channel ground to logic ground	 Maximum 1000V AC/DC Maximum 1000V AC/DC
External (auxiliary) power supply	If desired, the digital input auxiliary supply voltage may be the same voltage as that used for the digital outputs. This voltage is provided as an output between terminals Vf+ and V-. This fused voltage (Vf+) is monitored as an additional digital input. Input characteristics are identical to the other two digital inputs.

Loop Interface Digital Output module Specifications

DESCRIPTION	VALUE
Number of points	2
Output voltage Off voltage (Maximum) On voltage (Maximum)	 5 VDC minimum, 60 VDC maximum (auxiliary power supply) 1.0 VDC @ 500mA
Output current Off current (Maximum) On current for individual output (Maximum) On current for two outputs combined (Maximum)	 25µA @ Tamb = 25°C, VDS=60 VDC 250µA @ Tamb = 60°C, VDS=60 VDC 500 mA 880 mA limited by fuse rating

Description	Value
External (auxiliary) supply voltage	Voltage = 5 VDC minimum, 60 VDC Maximum The return line and auxiliary power supply voltage is common to both points but is galvanically isolated from logic ground. This auxiliary supply voltage originates from the terminal block (on inputs V+ and V-) and is fused on the personality module. The fused voltage is distributed back out to the terminal blocks as +1, +2 for the digital outputs and Vf+ for the digital inputs. Each digital output is diode clamped to this fused auxiliary supply voltage to prevent damage from inductive load surges. The fused auxiliary supply voltage is monitored as an additional digital input. Input characteristics are identical to the digital inputs.
Diagnostics	Internal module operation faults Auxiliary supply blown fuse detection (enabled/disabled)
Maximum propagation time	14.5 mSec for Rload=500W This time is comprised of the microprocessor firmware digital output update rate, which is once per loop, or approximately every 12 ms, plus the delay time for the output, which is 2.5 ms Max at Rload = 500 W.
Dielectric isolation: Channel ground to logic ground	 Maximum ±1000V AC/DC

7.1.9 G2R Style Relay module for DIN Rail Layout (5A22411H01) - (DO)



7.1.10 Blown Fuse Detection Circuit - (DO)

Bit 6 in the status register enables the Controller to monitor the status of the field supply fuse, and it also gives a visual indication of the status via the “EXTERNAL ERROR” LED.

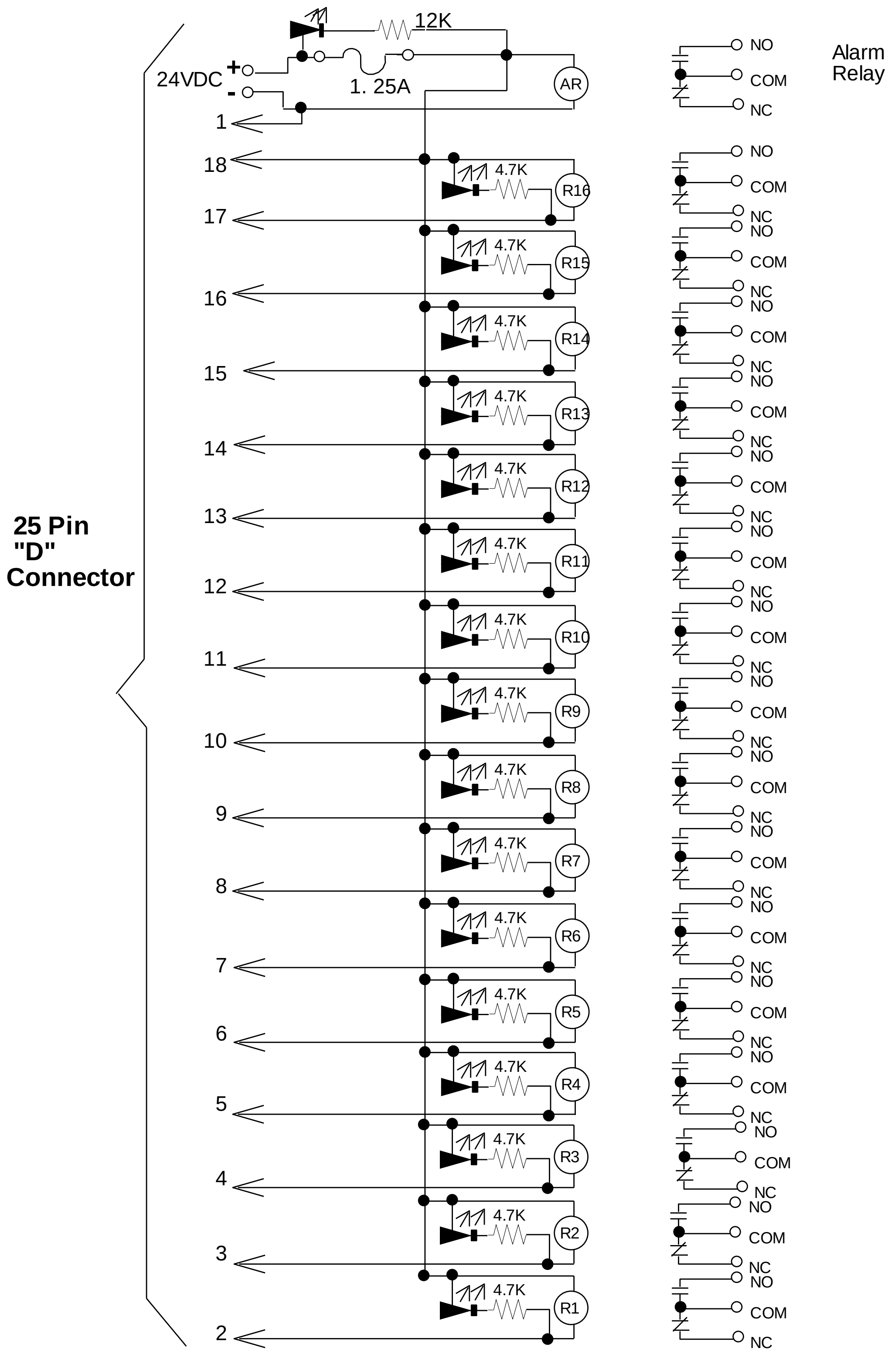
The Controller enables this feature by writing a “1” to Bit 7 of the configuration register. If enabled and the field supply voltage is between 15VDC and 60VDC, the circuit indicates that the field supply fuse is OK by turning OFF the “EXTERNAL ERROR” LED and clearing Bit 6 of the module status register. If enabled and the field supply voltage is less than 0.4VDC, the circuit indicates that the field supply fuse is blown by turning ON the “EXTERNAL ERROR” LED and setting Bit 6 of the module status register.

If the card is operated with a field supply voltage less than 15V, the output circuit continues to operate properly. However, the blown fuse detection may not give an accurate indication of the fuse state. In this case, the Controller has the capability to disable the detection circuit by writing a “0” to Bit 7 of the configuration register. When Bit 7 is a “0” the “EXTERNAL ERROR” LED is turned OFF and the blown fuse status bit (Bit 6 of the status register) is cleared which indicates the fuse is OK.

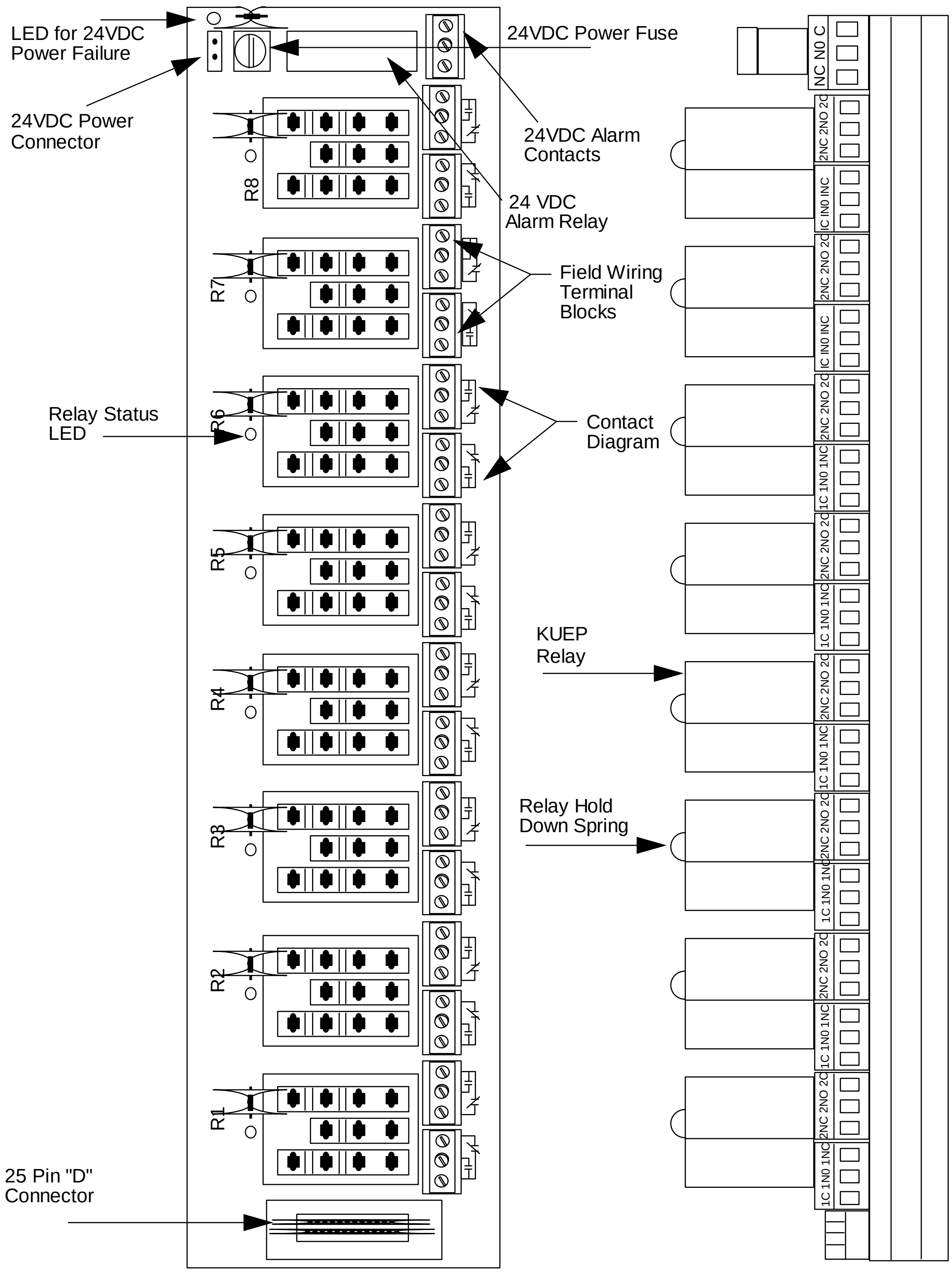
In summary, this feature is specified to operate as follows:

- 15VDC < Field supply voltage < 60VDC => Fuse is OK
- 0.4VDC < Field supply voltage < 15VDC => UNDEFINED
- Field supply voltage < 0.4VDC => Fuse is blown
- After a power-on reset the blown fuse detection circuit is disabled.

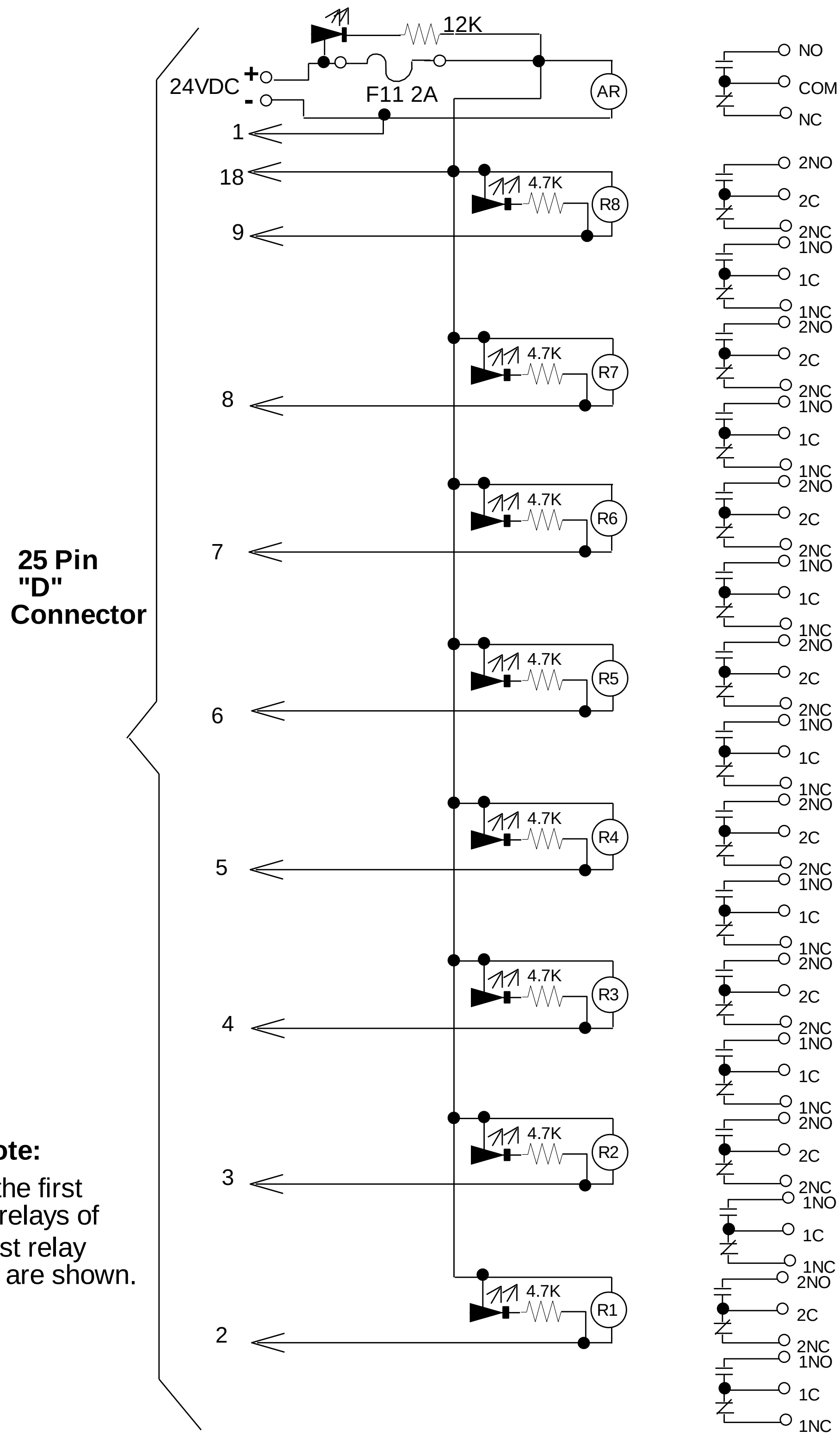
7.1.11 G2R Style Relay module terminations (5A22411H01) - (DO)



7.1.12 KUEP Style Relay module for DIN Rail Layout (5A22412G01 / 5A22412G02) - (DO)



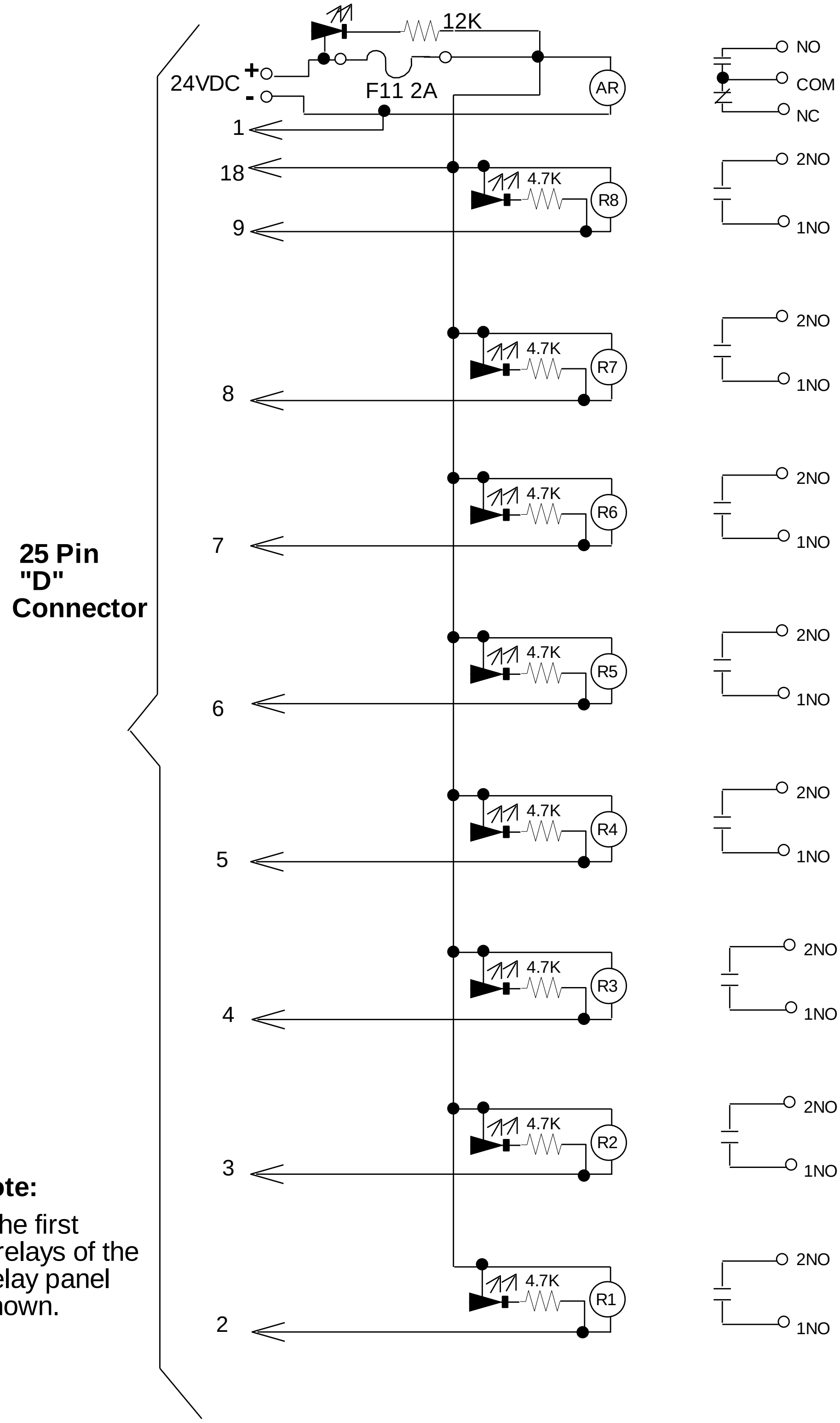
7.1.13 KUEP (2 Form C) Relay module Terminations (5A22412G01) - (DO)



Note:

Only the first eight relays of the first relay panel are shown.

7.1.14 KUEP (Form X) Relay module terminations (5A22412G02) - (DO)



Note:

Only the first eight relays of the first relay panel are shown.

7.1.15 Terminal block wiring information - (DO)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit. The diagram for the Digital Output personality module is shown in the following figure. The following table lists and defines the abbreviations used in that diagram.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

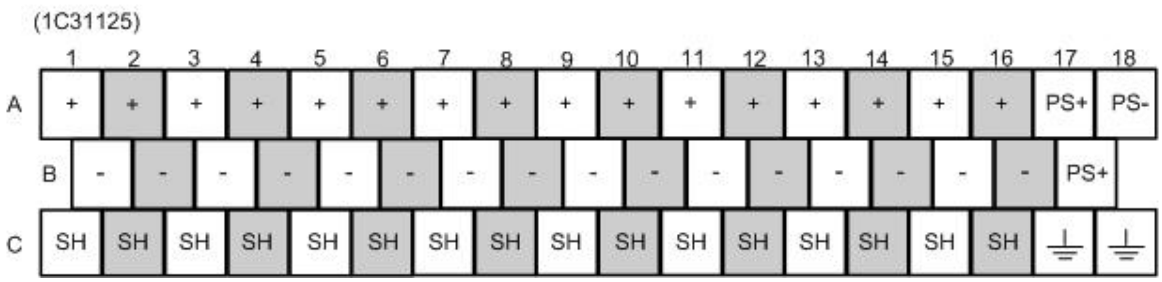
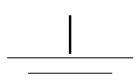


Figure 89: Terminal Block Connections for the Digital Output Personality Modules

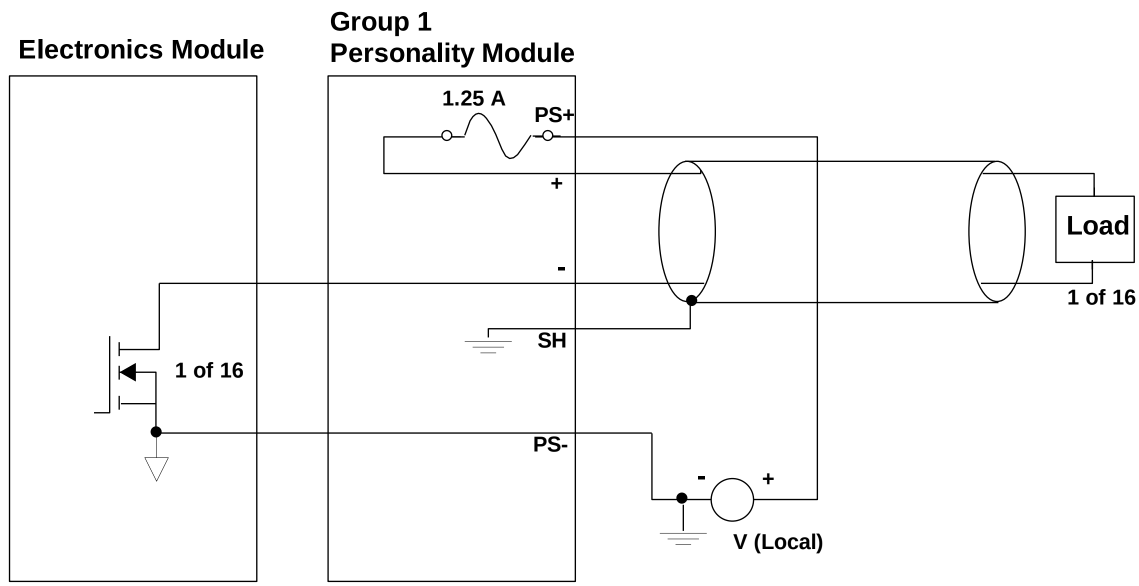
Abbreviations Used in Wiring Diagrams

Abbreviation	Definition
	Earth Ground terminals.
+	Digital output positive terminal connections.
-	Digital output negative terminal connections.
PS+, PS-	Auxiliary power supply terminals.
SH	Shield.

Note: *Do **not** use unmarked terminal block locations.*
*Shield terminals (SH) are **not** connected in CE Mark systems.*

You should always adhere to channel specifications and polarity when connecting load devices to the digital output module. This ensures proper operation of the digital output module and avoids potential damage to either the digital output module or load device.

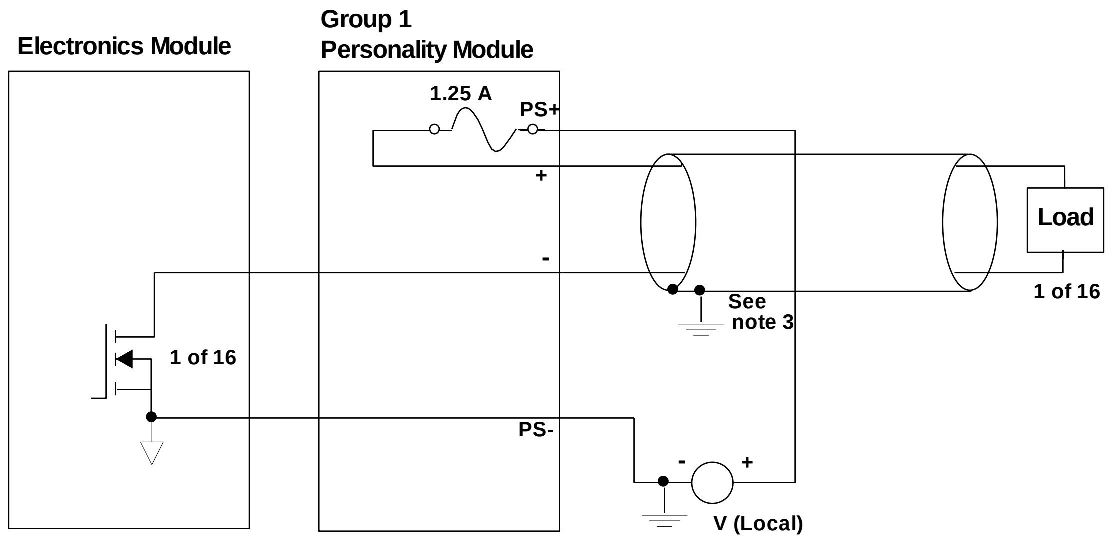
7.1.16 Field connection wiring diagram - (DO)



Notes
1. V (Local) is the I/O backplane auxiliary power supply.
2. Shielded cables are required for IEC 801-5 compliance.

Figure 90: Field Connection for the Digital Output Personality Module (Group 1) (Non-CE Mark Certified Systems)

7.1.17 Field connection wiring diagram (Group 1) (CE Mark) - (DO)

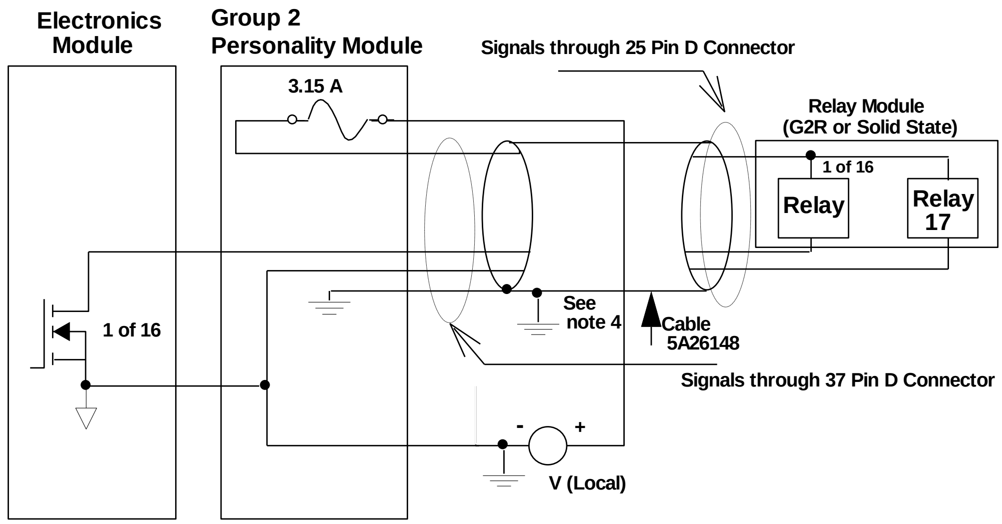


Notes

1. V (Local) is the I/O backplane auxiliary power supply.
2. Shielded cables are required for IEC 801-5 compliance.
3. All field wiring must be braid shielded and grounded at the entry point of the cabinet using the recommended hardware (see the appropriate "Cable Guidelines" information for your system).

Figure 91: Field Connection for the Digital Output Personality Module (Group 1) (CE Mark Certified System)

7.1.18 Wiring diagram to relay module (G2R or Solid State) locally powered - (DO)

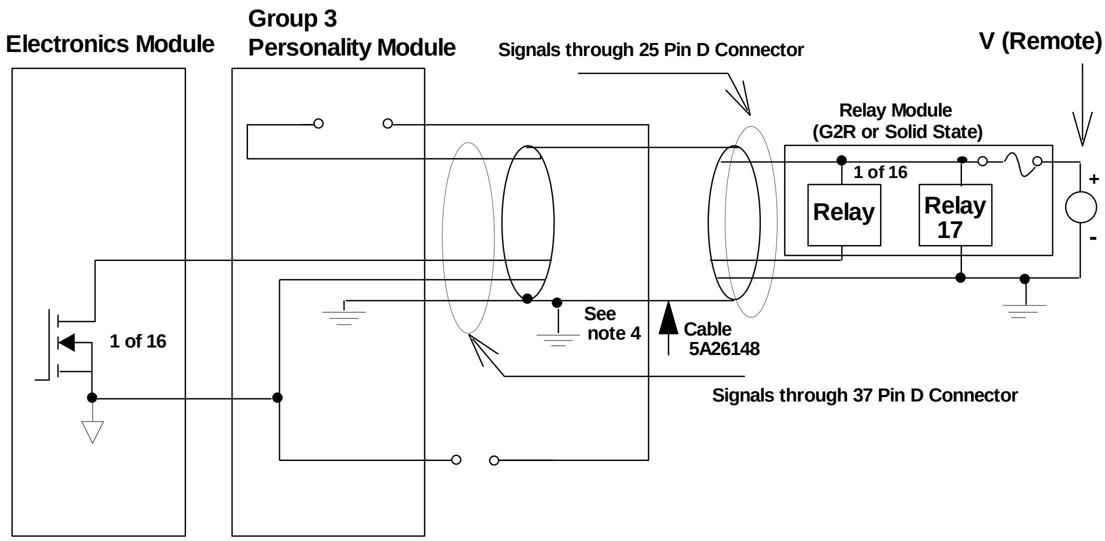


Notes

1. V (Local) is the I/O backplane auxiliary power supply.
2. Shielded cables are required for IEC 801-5 compliance.
3. Relay 17 is used to indicate the status of the power supply.
4. For CE Mark certified systems where cable 5A26148 exits the cabinet or a suited set of EMC cabinets: The cable shield must be grounded at the entry point of the cabinet using the recommended hardware(see the appropriate "Cable Guidelines" information for your system).
5. Solid State Relay Configurations not CE Mark Certified.

Figure 92: Digital Output Module to Relay Module (G2R or Solid State) Locally Powered

7.1.19 Wiring diagram to relay module (G2R or Solid State) - (DO)

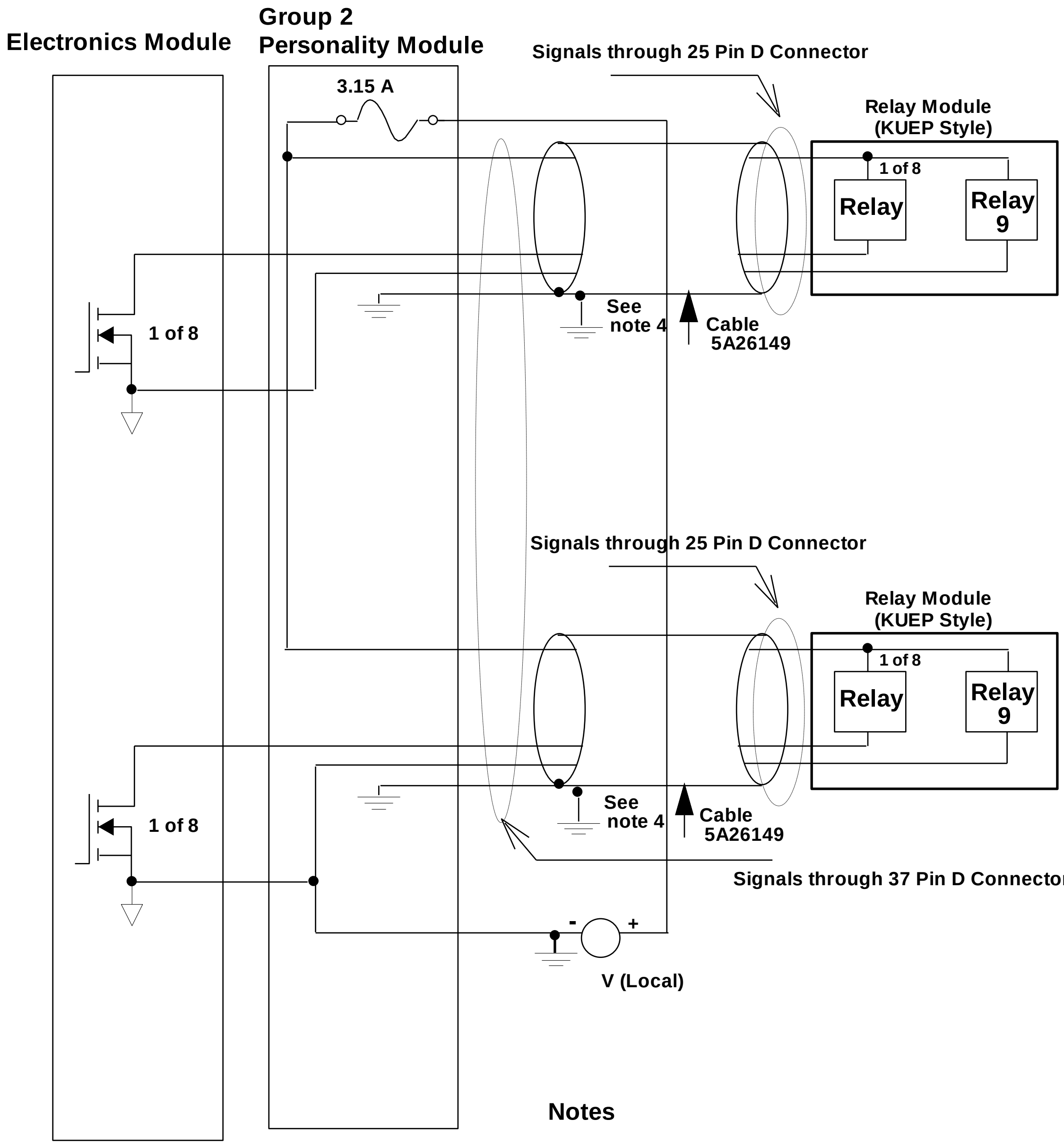


Notes

1. V (Remote) is a supply provided via the relay module.
2. Shielded cables are required for IEC 801-5 compliance.
3. Relay 17 is used to indicate the status of the power supply.
4. For CE Mark certified systems where cable 5A26148 exits the cabinet or a suited set of EMC cabinets: The cable shield must be grounded at the entry point of the cabinet using the recommended hardware (see the appropriate "Cable Guidelines" information for your system).
5. Solid State Relay Configurations not CE Mark Certified.

Figure 93: Digital Output Module to Relay Module (G2R or Solid State)

7.1.20 Wiring diagram to relay module (KUEP Style) locally powered (CE Mark) - (DO)

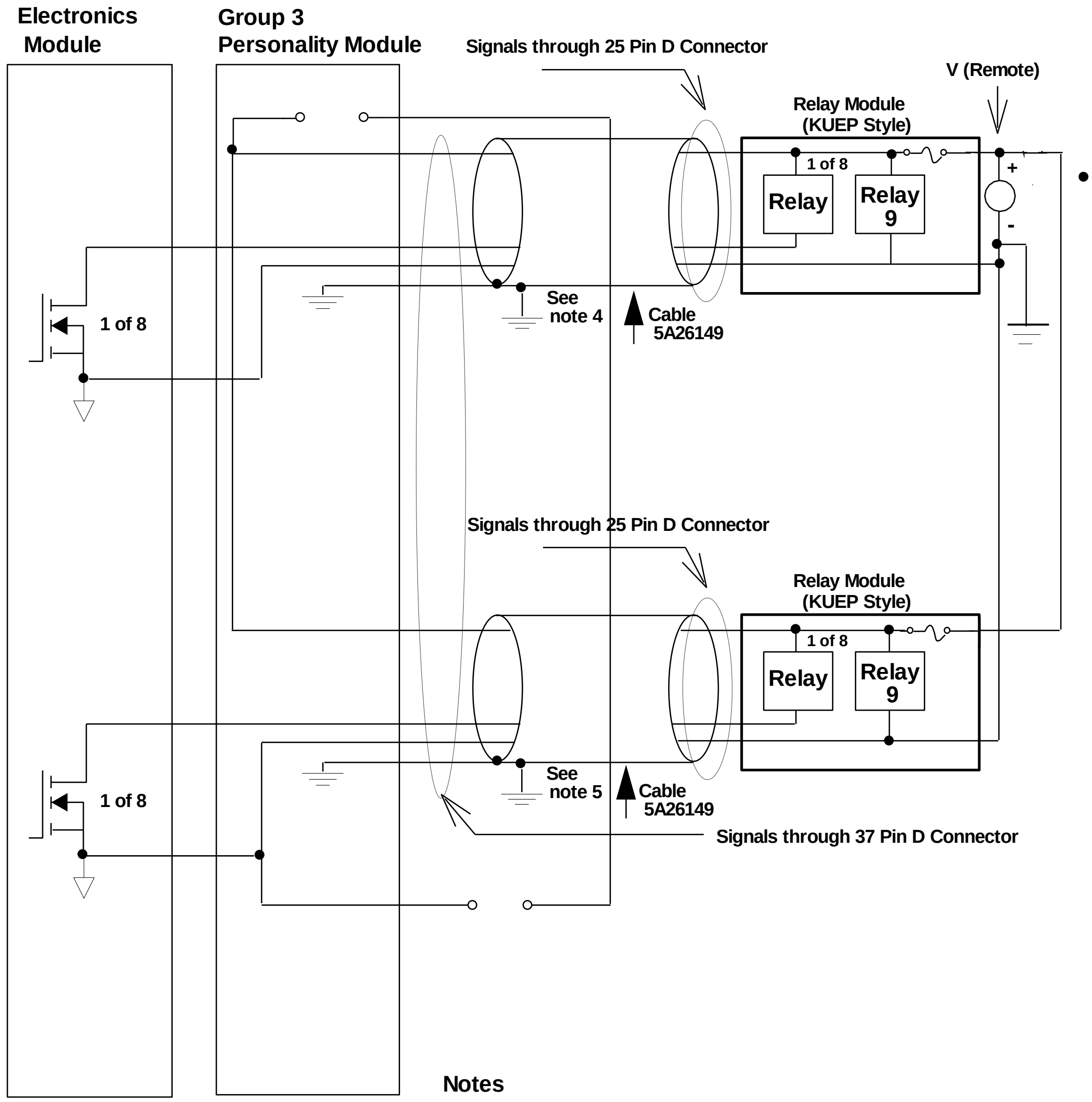


Notes

1. V (Local) is the I/O backplane auxiliary power supply.
2. Shielded cables are required for IEC 801-5 compliance.
3. Relay 9 is used to indicate the status of the power supply.
4. For CE Mark certified systems where cable 5A26149 exits the cabinet or a suited set of EMC cabinets: The cable shield must be grounded at the entry point of the cabinet using the recommended hardware (see the appropriate "Cable Guidelines" information for your system).

Figure 94: Digital Output Module to Relay Module (KUEP Style) Locally Powered (Non-CE and CE Mark)

7.1.21 Wiring diagram to relay module (KUEP style remotely powered (CE Mark) - (DO)



Notes

1. V (Remote) is a supply provided via the relay module.
2. Shielded cables are required for IEC 801-5 compliance.
3. Relay 9 is used to indicate the status of the power supply.
4. For CE Mark certified systems where cable 5A26149 exits the cabinet or a suited set of EMC cabinets: The cable shield must be grounded at the entry point of the cabinet using the recommended hardware (see the appropriate "Cable Guidelines" information for your system).

Figure 95: Digital Output Module to Relay Module (KUEP Style) Remotely Powered (Non-CE and CE Mark)

7.1.22 Relay panel application diagrams - (DO)

The following figures illustrate three types of applications for relay panels.

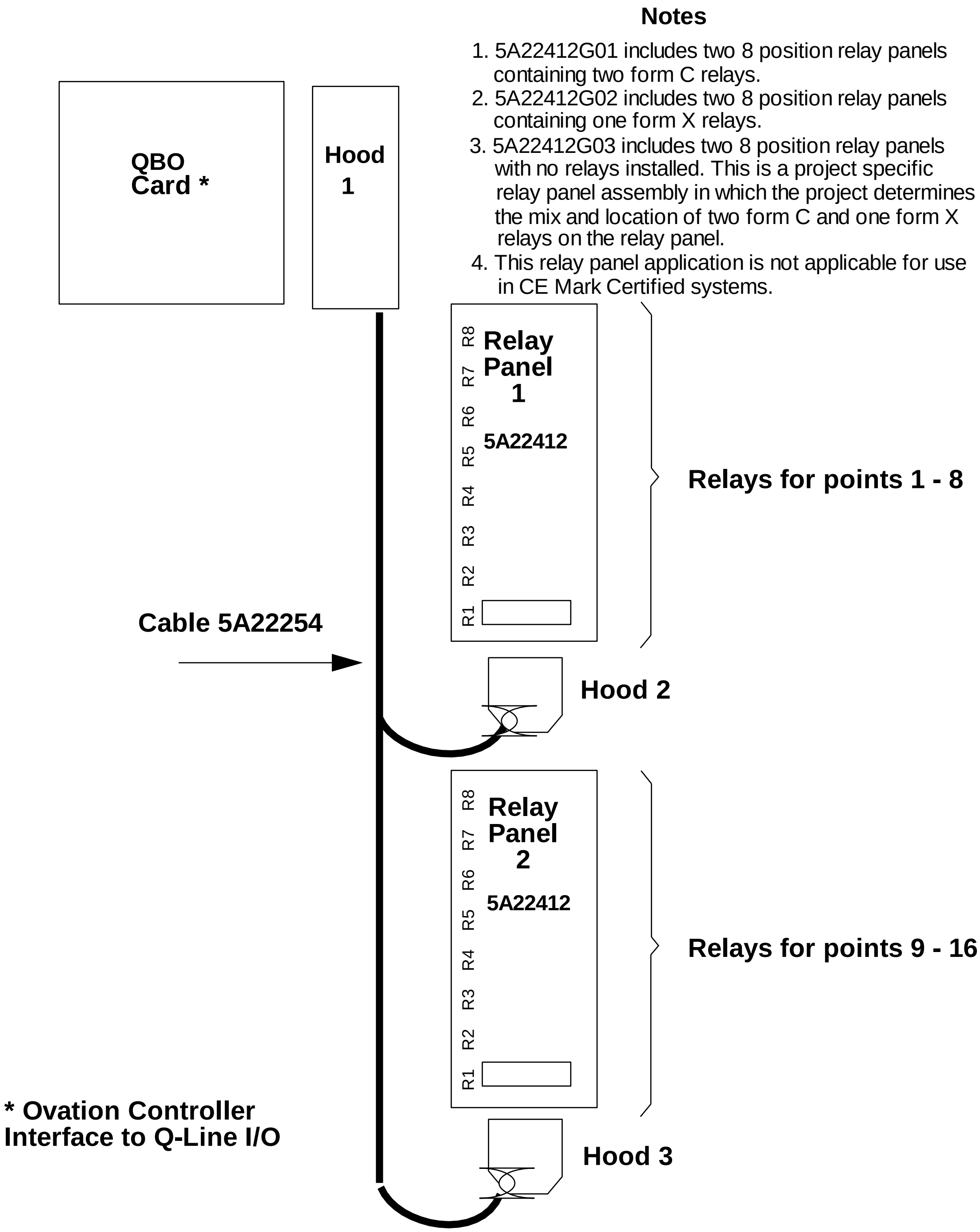


Figure 96: Relay Panels to Q-Line (QBO Card)

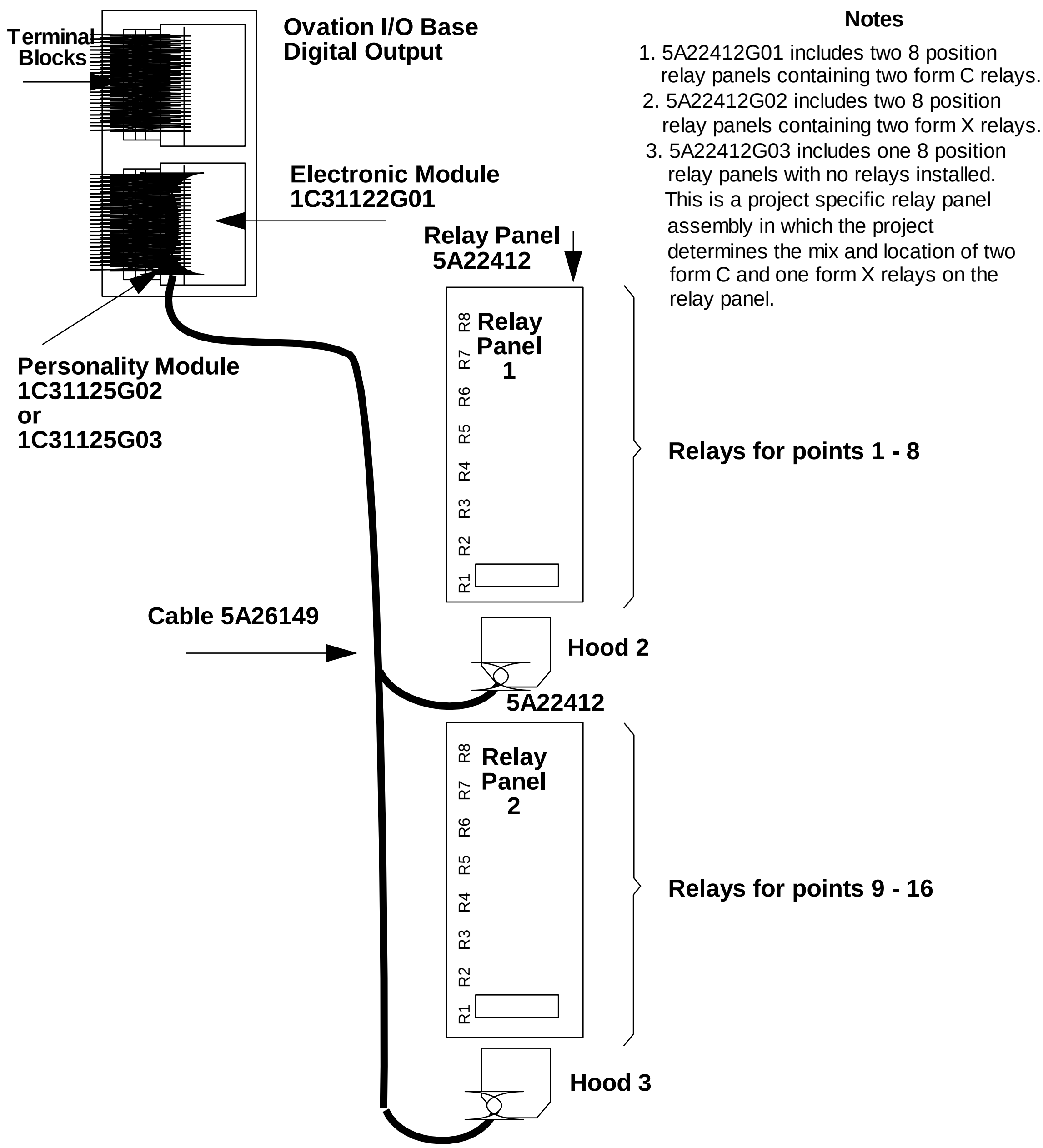


Figure 97: KUEP Relay Panels to Ovation I/O Base

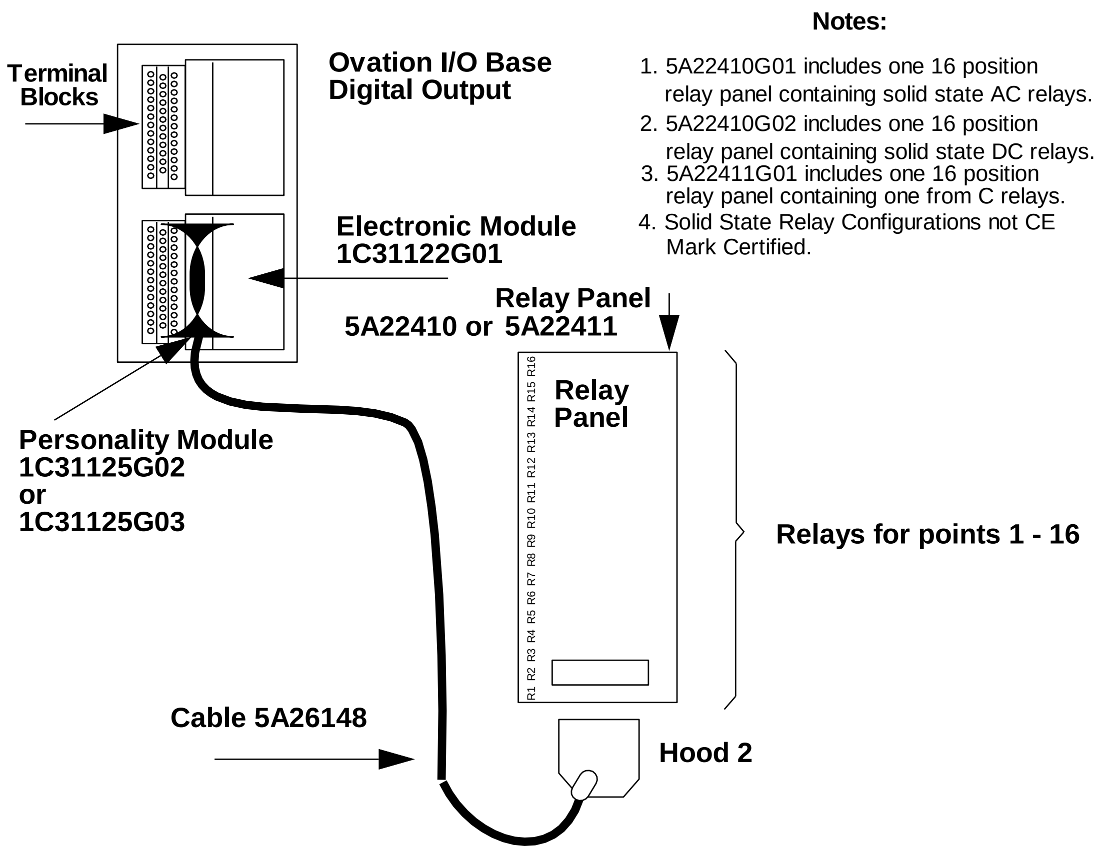


Figure 98: Solid State or G2R Relay Panels to Ovation I/O Base

7.1.23 Register configuration/address information - (DO)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Digital Output Configuration/Status Register (Address 13 or D in Hex)

<table>
<tr><th>Bit</th><th>Data Description - Configuration Register (Write)</th><th>Data Description - Status Register (Read)</th></tr>
<tr><td>0</td><td>Configured (active high)</td><td>Configured (active high)
(1=configured; 0=unconfigured)</td></tr>
<tr><td>1</td><td>Forced Error (active high)</td><td>Forced Error (active high)
(1=forced error; 0=no forced error)</td></tr>
<tr><td>2- 4</td><td>Communications Timeout Setting [1]
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>500 millisecs</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>250 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>125 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>62.5 millisecs</td></tr>
</table></td><td>Communications Timeout Setting [1]
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>500 millisecs</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>250 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>125 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>62.5 millisecs</td></tr>
</table></td></tr>
<tr><td>5</td><td>Outputs hold their state on communications timeout (active high)</td><td>Outputs hold their state on communications timeout (active high)</td></tr>
<tr><td>6</td><td>Not used</td><td>Indicates the status of the blown fuse detection circuit (high = field supply fuse is blown)</td></tr>
<tr><td>7</td><td>Enable blown detection circuit (active high)</td><td>Enable blown detection circuit (active high)</td></tr>
<tr><td colspan="3">[1] The tolerance on the timeout period is +/- 35%.</td></tr>
</table>

Bit definitions for this register are encoded as shown in the above table and described below:

Bit 0: When Bit 0 is set, the module is configured. The Controller configures the module by writing a “1” to bit 0 of the configuration register. Once configured, it remains configured until a power up/down reset is generated. After a power-up condition, the configuration register is cleared.

Bit 1: When Bit 1 is set, the internal error LED is turned on and data registers can be written but not read.

Bits 2-4: These bits are used to select the communication timeout period.

Bit 5: When Bit 5 is set, the digital outputs hold their last state on a communications watchdog timeout. When Bit 5 is cleared, the digital outputs are cleared (output transistor is shut off) on a communications watchdog timeout.

Bit 6: This bit indicates the status of the blown fuse detection circuit (see page 392). When Bit 6 of the status register is set, the field supply fuse is blown.

Bit 7: When Bit 7 is set, the blown fuse detection circuit is enabled.

CAUTION: This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

7.1.24 Diagnostic Logic card LEDs - (DO)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit when the field supply fuse is blown and the blown fuse detection circuit is enabled. Blown Fuse bit (Bit 7) of the Configuration Register (see page 407) enables or disables the fuse detection circuit (high = enabled).
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1 of the Configuration Register (see page 407)) is active, or the Controller stops communicating with the module.
1 - 16 (Green)	If the LED is lit, this indicates that the output is in the ON state. If the LED is not lit, this indicates that the output is in the OFF state.

7.1.25 Specifications - (DO)

- **Electronics module (1C31122)**
- **Personality module (1C31125)**

Description	Value
Number of channels	16
Output voltage Off voltage (Maximum) On voltage (Maximum)	 60 VDC 1.0 V @ 500mA 0.2 V @ 100mA
Output current **Off** Current (Maximum) **On** current for all 16 outputs combined (Max)	 25µA @ TA = 25°C, VDS = 60 VDC 250µA @ TA = 60°C, VDS = 60 VDC Limited by fuse rating

Description	Value
Personality module Group 1 Personality module Group 2 [1] Personality module Group 3 [1] **On** current for individual output (Max)	890mA Maximum for all 16 outputs 2.2A Maximum for all 16 outputs Limited by the fuse located on the relay module 500 mA
Blown fuse detection [2] Operating voltage range	15V ≤ field supply voltage ≤ 60V
Maximum propagation time	2.5 mSec for Rload=500Ω
Dielectric isolation: [3] Channel to logic	1000V AC/DC
Module power	Main: 2.2 W typical, 3.3 W Maximum Aux used with no relay panels: 8 outputs on @ 100mA each 19.2 W (24V) typical 38.4 W (48V) typical Aux used with the following relay panels: Solid State panel with 16 relays: 5.9 W (24V) typical G2R panel with 16 relays: 10.87 W (24V) typical KUEP panel with 8 Form C relays: 15.84 W (24V) typical 2 KUEP panels with 16 Form C relays: 31.68 W (24V) typical KUEP panel with 8 Form X relays: 11.28 W (24V) typical 2 KUEP panels with 16 Form X relays: 22.56 W (24V) typical
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
Inductive Kick Protection method	Diode[4]

[1] The personality module Groups 2 and 3 are used to interface with the relay modules (see page 383).
[2] You can configure the card to disable the blown fuse detection function.
[3] All 16 channels have a common return which is galvanically isolated from the logic ground.
[4] Inductive kick diode located on the personality module. Diode is specified to protect the MOSFET when connected to loads within the digital output channel specifications (Off voltage = 60VDC and On current = 500mA).

Note: *The output channels maintain proper operation when subjected to IEC 61131-2, second edition, 2003-02 Section 9.12 Voltage Drops and Interruptions Immunity testing (condition tested with the standard Ovation power supply providing both the main and auxiliary power to the Digital Output Module).*

7.2 High Side Digital Output (24 VDC) module (for Windows Ovation 3.0.4 and above) - (HSDO)

The Ovation High Side Digital Output 24VDC (HSDO) module is an intelligent microcontroller-based digital output module. The HSDO consists of two modules, (electronics and personality), that are inserted into an Ovation I/O module base unit. The HSDO module contains sixteen optically isolated digital output channels. Each digital output channel is capable of sourcing up to 500 mA of output current.

These sixteen optically isolated digital output channels share a common 24VDC power source. Power for all sixteen digital output channels is supplied from either of the following power sources:

- Ovation power supply AUX output. *(Maximum total output current limited to 2A per module when 24V Aux. power is used.)*

  OR

- External 24VDC power source. *(Maximum total output current limited to 4A per module.)*

Each digital output channel has an intelligent power switch which contains a high-side power MOSFET switch used to switch 24VDC power to an external load.

Series isolation diodes are located between each intelligent power switch output pin and the output terminals of all sixteen digital output channels. The presence of these isolation diodes permit the 24VDC HSDO module to operate in either of the following two modes:

- Single/simplex mode (independent of any other module).

  OR

- Redundant mode (connected in parallel with another 24VDC HSDO module).

When the 24VDC HSDO module operates in redundant mode, a cable assembly is necessary to link together the personality modules of the two redundant 24VDC HSDO modules. Refer to the *HSDO to HSDO Cable Assembly Routing Information - Redundant Configuration (see page 415).*

Note: *When this cable assembly is installed, customer field signal wiring only needs to be connected to one base unit terminal block.*

7.2.1 Electronics modules (Emod) - (HSDO)

- **5X00270G01** provides 24VDC 500 mA output switching capability.

7.2.2 Personality modules (Pmod) - (HSDO)

- **5X00273G01** provides voltage suppression networks for each digital output channel, 24VDC field power filtering and connectors to permit redundant mode operation.

7.2.3 Subsystem - (HSDO)

High Side Digital Output (24VDC) subsystems

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
24VDC	16	5X00270G01	5X00273G01

7.2.4 Module block diagram - (HSDO)

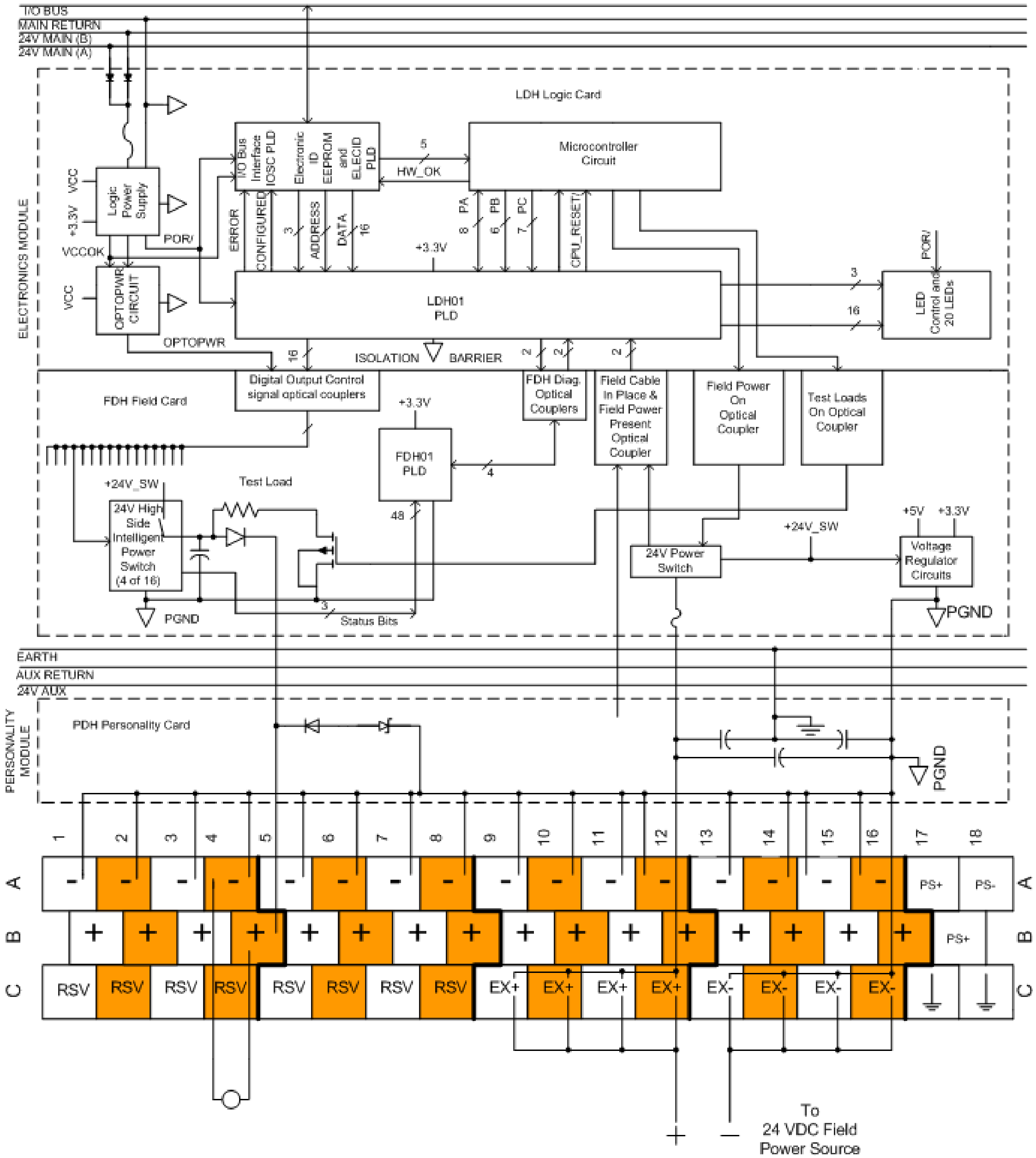


Figure 99: 24 VDC High Side Digital Output Module Block Diagram

7.2.5 Redundant module interconnection - (HSDO)

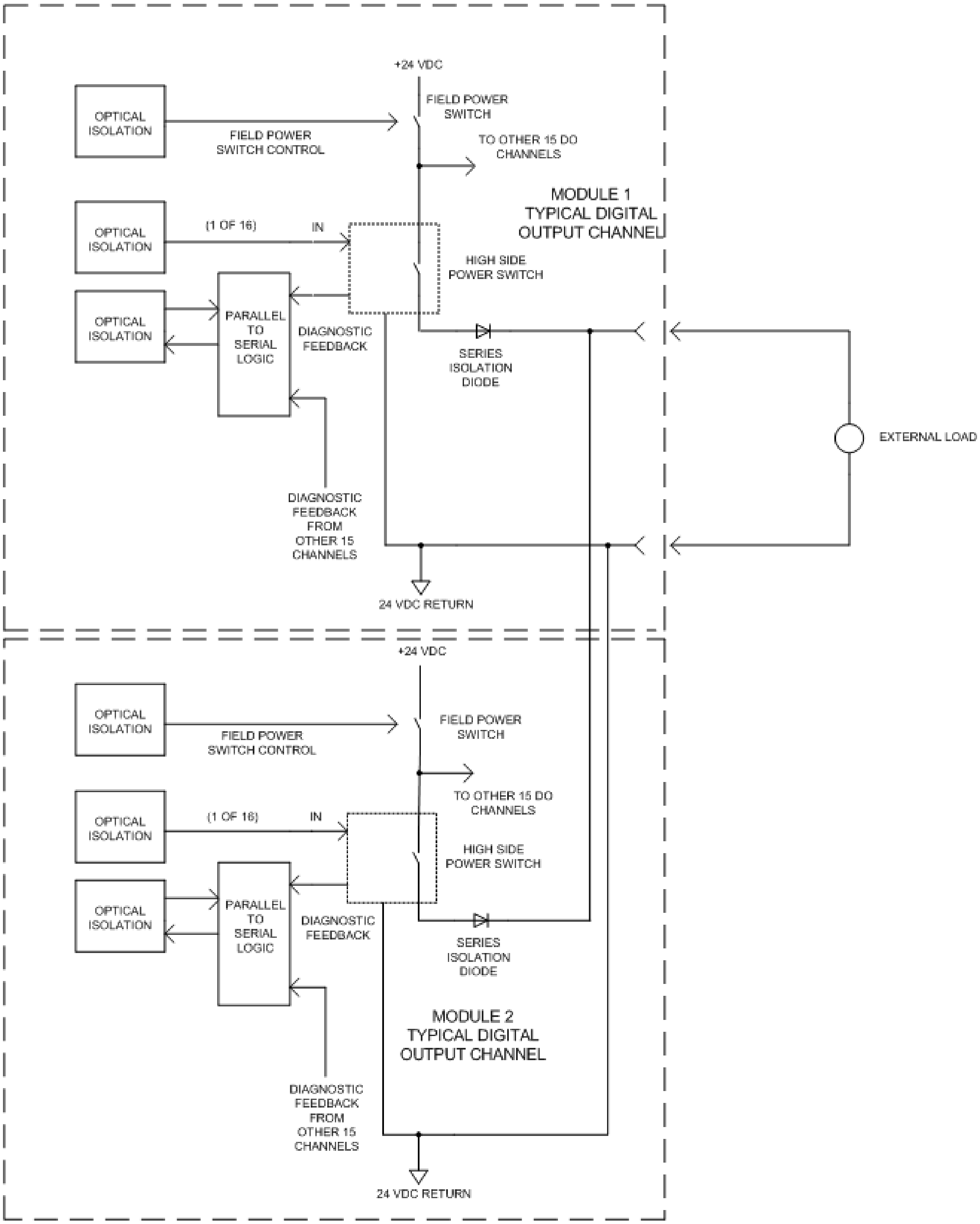


Figure 100: Redundant Module Interconnection for the 24VDC HSDO Module

7.2.6 Field signal wiring information - (HSDO)

Each Personality module has a simplified wiring diagram label affixed to its side; this label appears above the base unit terminal block. This diagram indicates how the wiring from external field loads is to be connected to the HSDO module's base unit terminal block.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

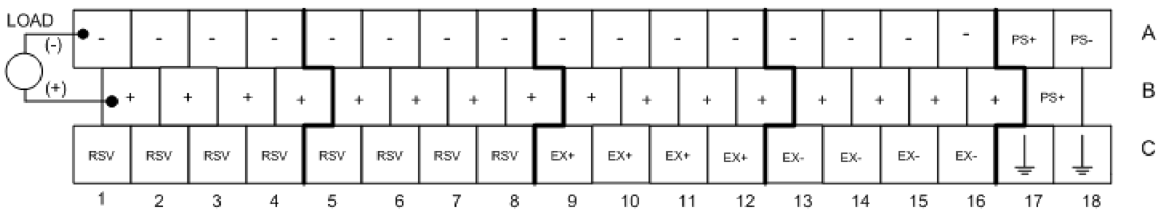
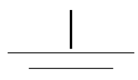


Figure 101: Field Signal Terminal Connections for the HSDO Module Base Unit

Abbreviations used in diagram

ABBREVIATION/SYMBOL	DEFINITION
	Earth ground terminals.
+	Digital output positive terminal connection.
-	Digital output negative terminal connection.
RSV	Reserved terminal. No connections allowed on these terminals.
EX+, EX-	24VDC Field Power input terminals.
PS+, PS-	Cabinet Auxiliary 24VDC power source terminals.

Note: *Do **not** make connections to any base unit terminal labeled RSV.*

- When HSDO modules are operated in redundant pairs, field wiring is only connected to the base unit terminals of one HSDO module in the redundant pair.

7.2.7 Field power wiring information for module base unit terminal blocks - (HSDO)

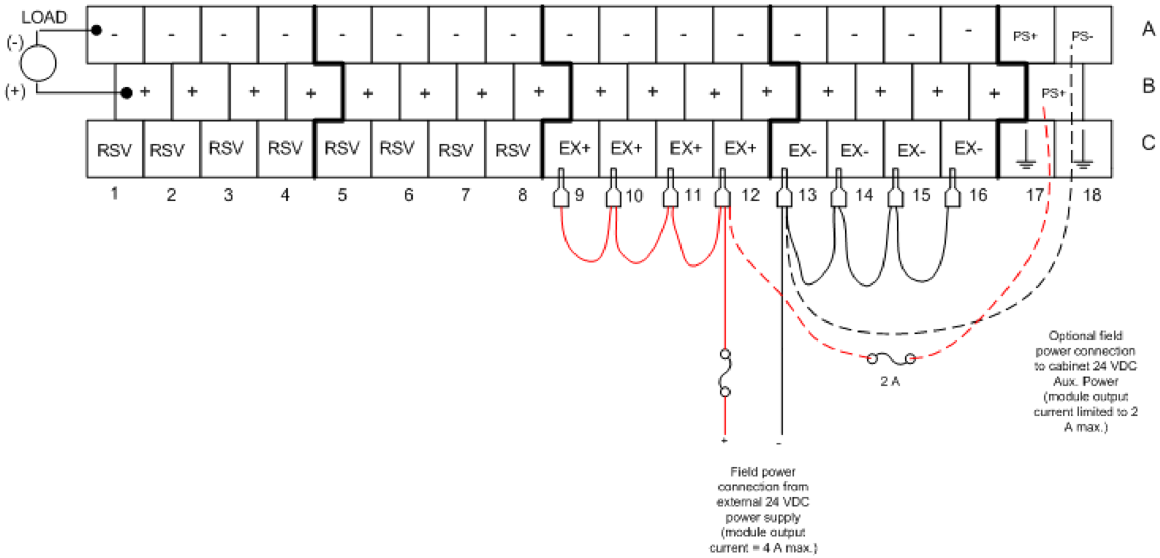


Figure 102: Field Power Terminal Connections for the HSDO Module Base Unit

Note: *HSDO module field power connections must be made to both redundant HSDO modules' base unit terminal blocks.*

Using an external 24VDC field power source:

- Connect the external 24VDC field power source positive to all four of the base unit EX+ terminals. The external 24VDC field power source positive connection must be fused.
- Connect the external 24VDC field power source return to all four of the base unit EX- terminals.

Using the cabinet Auxiliary 24VDC power source:

- Connect one of the two base unit PS+ terminals to all four base unit EX+ terminals. This connection must be fused using a 2A IEC 60127-2 quick-acting fuse.
- Connect the base unit PS- terminal to all four base unit EX- terminals.

Note: *For the cabinet Auxiliary 24 VDC field power scheme, the Maximum HSDO module digital output current is limited to a Maximum of 2A due to current capacity limitations of the Ovation Base Unit block terminals.*

7.2.8 Module cables for High Side Digital Output 24VDC - (HSDO)

The following power cable/wire assemblies are used for the 24VDC HSDO module.

PART NUMBER	DESCRIPTION
1X00392G01	HSDO to HSDO interface cable assembly (used only for redundant mode operations).
1X00395G01	HSDO field power wire assembly - 24VDC Return.
1X00395G02	HSDO field power wire assembly - 24VDC.

7.2.9 HSDO to HSDO Cable Assembly Routing Information Redundant Configuration - (HSDO)

An HSDO to HSDO cable assembly (1X00392G01), is required for redundant HSDO module configurations. The diagram below illustrates redundant HSDO module placement and the routing configuration of the HSDO to HSDO cable assembly.

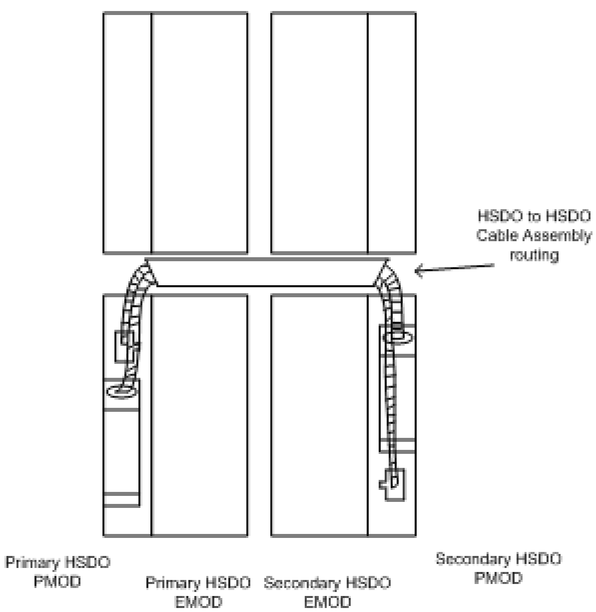


Figure 103: HSDO to HSDO Cable Assembly Routing - Redundant Configuration

Note: *The 1X00392G01 cable assembly is not required for HSDO modules operating in single/simplex mode configurations.*

7.2.10 Module channel fault register - (HSDO)

The Module Channel Fault Register is module I/O register 12 (0xC in Hex). Word address 12 (0xC in Hex) serves as a channel fault register. Each module digital output channel is assigned a bit in this register. Each channel's fault bit is cleared if no digital output faults have been detected for that channel. If the module's microcontroller detects a channel digital output fault, then a register fault bit is set for that channel.

The Module Status register Bit 14, Digital Output fault, is the logical OR of all sixteen Module Channel fault register fault bits.

Module channel fault register bit assignments (address 12 or 0xC).

BIT	READ DEFINITION
0 - 15	Channel 1 - 16 Digital Output Fault

7.2.11 Field power shutoff - (HSDO)

An HSDO module shuts off its field power for one of the two following scenarios:

All the following conditions must be true:

- ☐ Module detects a power switch output short circuit to +24V fault.
- ☐ Module is configured for redundant mode operation.
- ☐ Module observes that its partner HSDO module is alive.
- ☐ Module observes that the partner HSDO module is healthy.

OR WHEN

All of the following conditions must be true:

- ☐ The HSDO module was configured with redundant operation enabled, but then becomes unconfigured for at least three seconds.
- ☐ Module observes that its partner HSDO module is alive.
- ☐ Module observes that the partner HSDO module is healthy.

7.2.12 Register configuration/address information - (HSDO)

The Module Configuration/Module Status register is module I/O register 13 (0xD). Word address 13 (0xD in Hex) is used to configure the HSDO module and to provide status information to the Controller. The Module Status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern Field on the Hardware Tab). (Refer to the *Ovation Operator Station User Guide.)* The Module Configuration/Module Status register assignments are defined in the following table:

Module configuration/module status register low byte bit assignments (address 13 or 0xD in Hex)

<table>
<tr><th>BIT</th><th>DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE DEFINITION)</th><th>DATA DESCRIPTION - STATUS REGISTER (READ DEFINITION)</th></tr>
<tr><td>0</td><td>Configure module - (1 = configure).</td><td>Module Configured (1 = configured).
(0 = unconfigured).</td></tr>
<tr><td>1</td><td>Force Error (1 = force internal error).</td><td>Forced Error (1 = forced error).
(0 = no forced error).</td></tr>
<tr><td>2</td><td>I/O Bus Communications Timeout Bit 0.
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout period</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16.777 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4.194 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2.097 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1.049 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>524 millisecs</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>262 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>131 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>65 millisecs</td></tr>
</table></td><td>I/O Bus Communications Timeout Bit 0.
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout period</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16.777 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4.194 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2.097 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1.049 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>524 millisecs</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>262 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>131 millisecs</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>65 millisecs</td></tr>
</table></td></tr>
<tr><td>3</td><td>I/O Bus Communications Timeout Bit 1.</td><td>I/O Bus Communications Timeout Bit 1.</td></tr>
<tr><td>4</td><td>I/O Bus Communications Timeout Bit 2.</td><td>I/O Bus Communications Timeout Bit 2.</td></tr>
<tr><td>5</td><td>I/O Bus Communications Timeout Action.
1 = Digital Outputs hold their state upon an I/O Bus Communications timeout.
I/O Bus Communications Timeout.
0 = Digital Outputs reset upon an I/O Bus Communications Timeout.</td><td>I/O Bus Communications Timeout Action selection.</td></tr>
<tr><td>6</td><td>Not Used.</td><td>Not Used.</td></tr>
<tr><td>7</td><td>Field card power status handling.
1 = Module External Error if no 24 VDC field power present.</td><td>Field card power status handling section.</td></tr>
</table>

Bit definitions for this registers low byte are encoded as shown in the previous table and described below:

Bit 0: When Bit 0 is set, the module is configured. The module digital outputs cannot be controlled until the Controller has set Module Configuration register bit 0.

Bit 1: Bit 1 is the Force-Error Bit. When Bit 1 is set, the modules Internal Error LED is illuminated. The module goes into Attention status.

Bits 2 - 4: These three Bits select the I/O Bus Communication Timeout period.

Bit 5: I/O Bus Communications Timeout Action Bit.

Bit 5 is set: When no communications between the Controller and the HSDO module occur during a time period specified by bits by Bits 4, 3, and 2, the following happens:

- Module digital outputs hold their last value.
- Communications OK LED is off and the Internal Error LED is illuminated.

Bit 5 is cleared: When no communications between the Controller and module takes place during a time period defined by Bits 4, 3, and 2, the following happens:

- Module digital outputs are turned off.
- Communications OK LED is off and the Internal Error LED is illuminated.

Bit 6: This bit is not used.

Bit 7: This bit is the Field Card Power Status Handling Bit.

Bit 7 is set: If the module's external 24VDC power supply voltage is not present, the following happens:

- External Error LED is illuminated.
- Module goes into Attention status.

Bit 7 is cleared: If the module's external 24VDC power supply voltage is not present, the following happens:

- External LED is not illuminated.
- Module does not go into Attention status. With no field power present, the module digital outputs do not function.

Module Configuration/Module Status Register High Byte Bit Assignments (Address 13 or 0xD in Hex)

<table>
<tr><th>BIT</th><th>DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE DEFINITION)</th><th>DATA DESCRIPTION - STATUS REGISTER (READ DEFINITION)</th></tr>
<tr><td>8</td><td>Dynamic Digital Output Test Time Interval Bit 0.
<table>
<tr><th>Bit 10</th><th>Bit 9</th><th>Bit 8</th><th>Dynamic Digital Output Test Interval</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>24 hours</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>12 hours</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>8 hours</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>4 hours</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>2 hours</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1 hour</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>30 minutes</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>15 minutes</td></tr>
</table></td><td>Field_Cable_Absent
1 = Field interface cable absent in redundant mode.
0 = Field interface cable present or single mode operation.</td></tr>
</table>

Bit	Data Description - Configuration Register (Write Definition)	Data Description - Status Register (Read Definition)
9	Dynamic Digital Output Test Time Interval Bit 1.	Cross_Cable_Absent 1 = Cross connect cable absent in redundant mode. 0 = Cross connect cable present or single mode operation.
10	Dynamic Digital Output Test Time Interval Bit 2.	Partner Not Responding Absent 1 = Partner not responding in redundant mode. 0 = Partner responding or single mode operation.
11	Not Used.	Application Code Invalid 1 = Application code stored in internal module memory is not valid.
12	Not Used.	Internal Logic Card fault.
13	Not Used.	No Field Power
14	Digital Output Fault Handling Method Selection: 1 = Alarm only upon Digital Output fault. 0 = Alarm and shut off field power upon Digital Output fault.	Digital Output fault.
15	Redundant/Single operation mode selection: 1 = Select Redundant mode operation. 0 = Select Single mode operation.	Redundant/Single operating mode selection: 1 = Redundant mode operation selected. 0 = Single mode operation selected.

Bit definitions for this registers high byte are encoded as shown in the above table and described below:

Bits 8 - 10: These three Configuration Register Bits select the Dynamic Digital Output Test Time Interval.

Bit 11: When Status Register Bit 11 is set, the module microcontroller application firmware stored in internal memory is not valid.

Bit 12: When Status Register Bit 12 is set, at least one of three internal logic card faults are detected by the modules internal microcontroller's self tests: Microcontroller Register fault, Microcontroller RAM Fault, Boot Loader Firmware Code Checksum error.

Bit 13: When Status Register Bit 13 is set, there is no 24VDC field power present to power the modules intelligent power switches.

Bit 14: Bit 14 is the Digital Output fault Handling Bit.

Bit 14 is set: The module never shuts off its power in the event of a digital output fault.

Bit 14 is cleared: Module field power shuts off for a digital output fault if all of the following conditions are true:

- Digital Output is a power switch short circuit to 24V.
- Module is operating in redundant mode.
- Partner HSDO module is alive.
- Partner HSDO module is healthy.

Bit 14 Digital Output Fault - This Status Register bit is set for one of the following conditions:

- Digital output fault.
- Internal logic fault.

- Application code invalid.

Bit 15: Single or Redundant mode selection bit.

CAUTION: This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

7.2.13 Diagnostics - (HSDO)

For both stand-alone and redundant High Side Digital Output module configurations, power switch diagnostic bits are accessed every 25 milliseconds. If a digital output fault is detected on a channel, the corresponding Module Channel Fault register fault bit is set. When any bit in the Module Channel Fault register is set, the Module Status register (register 0xD) Digital Output fault bit (Bit 14) is also set.

These digital output fault conditions can be detected and reported:

- Power switch output short circuit to ground.
- Power switch output short circuit to +24V (switch cannot be turned off).
- Power switch power supply under-voltage.
- Power switch open circuit (switch cannot be turned on).

When HSDO modules operate in a redundant module configuration, a dynamic power switch turn-off test is performed periodically. By communicating over the cross-connect cable serial link, the two HSDO modules coordinate their dynamic power switch turn-off testing so that both modules do not shut off their power switch outputs at the same time.

Upon module insertion, after communication between modules is established, and after 12 additional seconds have elapsed, the HSDO module performs the dynamic power switch turn-off test. The HSDO module will then performs test periodically at a time interval ranging from 15 minutes to 24 hours. This time interval is selected by the values of Module Configuration register bits 10, 9 and 8.

The Ovation 24VDC High Side Digital Output LDH logic card contains 20 LEDs to display module status. The following figure illustrates the LED array:

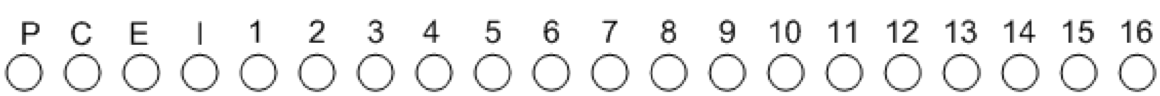


Figure 104: LED Configuration for the24VDC High Side Digital Output Electronics Module

The following table lists the module LEDs and describes what each indicates.

24VDC High Side Digital Output

LED	DESCRIPTION
P - (green)	Power OK LED. This LED is lit when the Electronics module card 5VDC power is okay.
C - (green)	Communications OK LED, which is lit when the Controller is communicating with the module.
E - (red)	External Error LED - This LED is lit when both of the following conditions are true: Field power is absent ▪ Module Configuration register Bit 7 is set.
I - (red)	Internal Error LED - This LED is lit when one or more of the following conditions are true: Controller is not communicating with the module. Internal microcontroller sets its internal error bit. ▪ Module Configuration Error Bit 1 is set.
1 - 16 (green)	Channel 1 - 16 Status - Lit when the Channel 1 power switch is turned on and not lit when the Channel 1 - 16 power switch is turned off.

Note: *All switches are turned off when dynamic testing occurs. The* ***LEDs*** *which were on, indicate that the output switch is active, and blink off for 25 mSec, or 50 mSec during the test.*

7.2.14 Specifications - (HSDO)

- **Electronics module (5X00270)**
- **Personality module (5X00273)**

Description	Value
Number of Digital Output Channels.	16
Output Voltage	
On Voltage (Minimum)	22.5VDC @ 500mA (VS = 24VDC)
Off Voltage (Maximum)	0.6VDC
Output Current	
On current for individual output (Maximum).	500 mA
On current for individual output (Minimum).	6 mA (minimum load current required for proper diagnostic operation).
Off current for individual output (Maximum).	100 uA
On current for all 16 outputs combined (Maximum).	4 A (2A if field power source equals auxiliary power).
Output Short Circuit to Supply Common Minimum current limit Maximum current limit	 750 mA 1.5 A ***Note:*** *After a channel output short circuit to supply common short circuit fault is cleared, the channel resumes normal operation. Multiple digital output channels can handle output short circuit to supply common faults until the total module field supply current exceeds 4A, which is the rating of the Electronics module's 4A quick acting IEC 60127-2 fuse.*
Field Power Operating Voltage Range: Minimum: Maximum:	 21.6 VDC 26.4 VDC
Field Circuit Current	4 A Max. (2 A Max. if 24 VDC Aux. power is used) Actual field current is dependent on the number of ON digital output channels and the external load impedances.
Output State Transition Time (I/O Bus access to Output state change) OFF to ON, nominal ON to OFF, nominal	 100 microseconds 200 microseconds
Dielectric Isolation	1,000 VDC for one minute, field to logic 500 VAC RMS for one minute, field to logic
Module Main Power (Nominal) (Maximum)	 2.16 W 3 W
Module Field Power	48 W (VS=24V, 8 Channels on @ 250mA / channel) typical 105.6W (VS = 26.4V) Maximum
Operating Temperature Range	0º to 60º C (32º to 140º F)
Storage Temperature Range	-40º to 85º C (-40º to 185º F)
Humidity (non-condensing)	0 to 95% relative humidity non-condensing

DESCRIPTION	VALUE
Note: *All 16 digital output channels have a common return which is the field power supply common.*	

7.3 Relay Output - (RO)

An Ovation Relay Output module consists of an Electronics module, a base assembly, and relays. The Relay Output module provides a means to switch high AC voltages at high currents to field devices. There are two versions of the Relay Output base assembly which contain either 12 or 16 relays within each base. The 12 Relay Output base assembly provides the additional advantage of being able to switch larger DC voltages at high currents.

Each Relay Output base assembly incorporates an integral Relay Output Electronics module to interface between the relays and the Ovation I/O Controller. The Relay Output Electronics module provides configurable communication timeout periods and LEDs to indicate the status of each output.

The Relay Output module is a CE Mark certified module.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

7.3.1 Electronics modules (Emod) - (RO)

- **1C31219G01** provides an interface between the Ovation Controller and the mechanical relays that are used to switch high AC voltages at high currents. This module plugs into the Relay Output base assembly.

Note: *The Relay Output base assembly does not incorporate a Personality module.*

7.3.2 Base assemblies - (RO)

There are two different styles of Relay Output with Contact Monitoring base assemblies:

- **5X00564G01** is configured with 16 Form C (G2R style) relays which switch high AC voltages at high currents. Each relay contains one Form C contact arrangement which is brought to terminal blocks for user connections.
- **5X00564G02** is configured at the project level with either 12 Form C (KUEP style) or 12 Form X (KUEP style) relays which switch high AC and DC voltages at high currents.

  In the case of the Form C relay, only one of the contact pairs within the relay is available at the terminal blocks for user connection. The KUEP style relay bases (1C31222G01) have the advantage of being able to switch larger DC voltages at higher currents than the G2R style relay bases (1C31223G01).

Relay contact ratings must be adhered to when utilizing the Relay Output module Assemblies. The application must include external current limiting protection for the Relay Output module Assemblies.

7.3.3 Panel kits - (RO)

There are several different styles of Relay Output panel kits:

- **5A26457G01** contains a Relay Output Electronics module a relay output base assembly, and 16 Form C relays (G2R style).
- **5A26458G01** contains a Relay Output Electronics module, a relay output base assembly, and 12 Form C relays (KUEP style).
- **5A26458G02** contains a Relay Output Electronics module, a relay output base assembly, and 12 Form X relays (KUEP style).
- **5A26458G03** contains a Relay Output Electronics module, and a relay output base assembly. This is a project-specific base assembly in which the project determines the mix of the Form C and Form X relays on a panel. The KUEP Form C relay is 4960A71H16 and the KUEP Form X relay is 4960A71H05.
- **5A26458G04** contains a Relay Output Electronics module, a relay output base assembly, and 12 Form C relays (KUEP style) and labeled with the country of assembly.
- **5A26458G05** contains a Relay Output Electronics module, a relay output base assembly, and 12 Form X relays (KUEP style) and labeled with the country of assembly.

CAUTION! When using the Relay Output Base Assemblies, the Power Distribution Module (5X00489G01) must have the Main GND and AUX GND referenced together. Therefore, ensure that the Main grounding bar (J10) and AUX grounding bar (J11) are installed and referenced to earth on the Power Distribution Module.

Relay Output bases must be installed only on I/O branches containing +24V typical Aux power (before auctioneering diode drop within Ovation auxiliary power supply).

Do NOT install Relay Output modules/bases on the same branch with Ovation bases with different voltage wired as Aux power (for example, DI modules using 125V AC).

7.3.4 External power supply information (RO)

It is recommended that the Relay Output base assembly obtain relay coil voltage from the internal Ovation auxiliary power supplies. These supplies distribute power through the Controller backplane and ROP panel to base assemblies. Use of external power supplies for relay coil power is **NOT** recommended.

7.3.5 Using bases (RO)

Proper relay operation is temperature dependent and is determined by the following:

- Temperature rise of the coil after being energized for extended periods.
- Temperature rise of the coil due to large relay contact currents.
- Ambient temperature.

The following table provides general user guidelines which can be referenced when configuring cabinets with Relay Output bases.

Operating Temperature Summary for Relay Output Bases

CABINET TYPE	AMBIENT CABINET OPERATING TEMPERATURE	RELAY BASE STYLE
Controller	0 to 50°C (32 to 122°F)	G2R
Extended I/O	0 to 60°C (32 to 140°F)	G2R
Remote I/O (Ventilated)	0 to 60°C (32 to 140°F)	G2R
Remote I/O (Sealed)	0 to 50°C (32 to 122°F) @ 175 W Maximum	G2R
Remote I/O (Sealed)	0 to 40°C (32 to 104°F) @ 225 W Maximum	G2R
Controller	0 to 50°C (32 to 122°F)	KUEP Form X
Extended I/O	0 to 60°C (32 to 140°F)	KUEP Form X
Remote I/O (Ventilated)	0 to 60°C (32 to 140°F)	KUEP Form X
Remote I/O (Sealed)	0 to 50°C (32 to 122°F) @ 175 W Maximum	KUEP Form X
Remote I/O (Sealed)	0 to 40°C (32 to 104°F) @ 225 W Maximum	KUEP Form X
Controller	0 to 40°C (32 to 104°F)	KUEP Form C
Extended I/O	0 to 45°C (32 to 113°F)	KUEP Form C
Remote I/O (Ventilated)	0 to 45°C (32 to 113°F)	KUEP Form C
Remote I/O (Sealed)	0 to 35°C (32 to 95°F) @ 175 W Maximum	KUEP Form C
Remote I/O (Sealed)	0 to 25°C (32 to 77°F) @ 225 W Maximum	KUEP Form C

7.3.6 Terminal block wiring information (RO)

Each relay base assembly employs terminal blocks which are permanently marked with appropriate relay contact designations at each position. The terminal block marking indicates how field wiring is connected to each terminal block position in the respective relay base assemblies.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

The terminal block markings for the G2R style Relay Output base assembly and for the KUEP style Relay Output base assemblies are illustrated below. The following table lists and defines the abbreviations used in those diagrams.

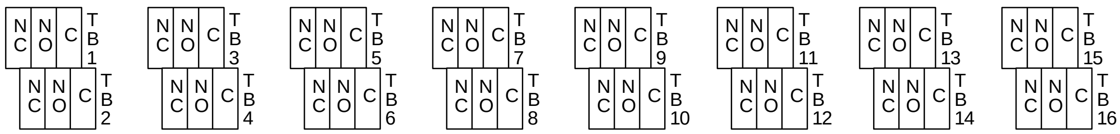
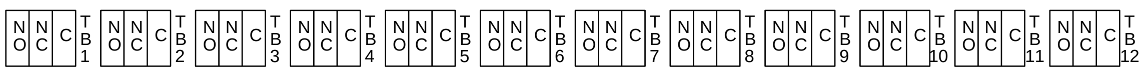
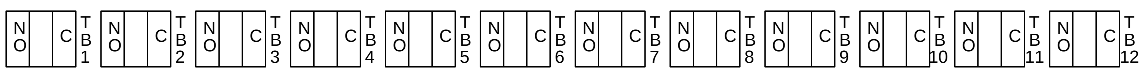


Figure 105: Terminal Block Connections for the G2R Relay Output Base Assembly



Form C Relays Installed



Form X Relays Installed

Figure 106: Terminal Block Connections for the KUEP Relay Output Base Assembly

Abbreviations Used in Wiring Diagrams

ABBREVIATION	DEFINITION
NC [1]	Normally Closed contact connection
NO	Normally Open contact connection
C	Common contact connection

[1] Do **NOT** use the NC terminal position when using the KUEP style base assembly with a Form X style relay inserted. The terminal position should remain unconnected.

7.3.7 Base unit layouts - (RO)

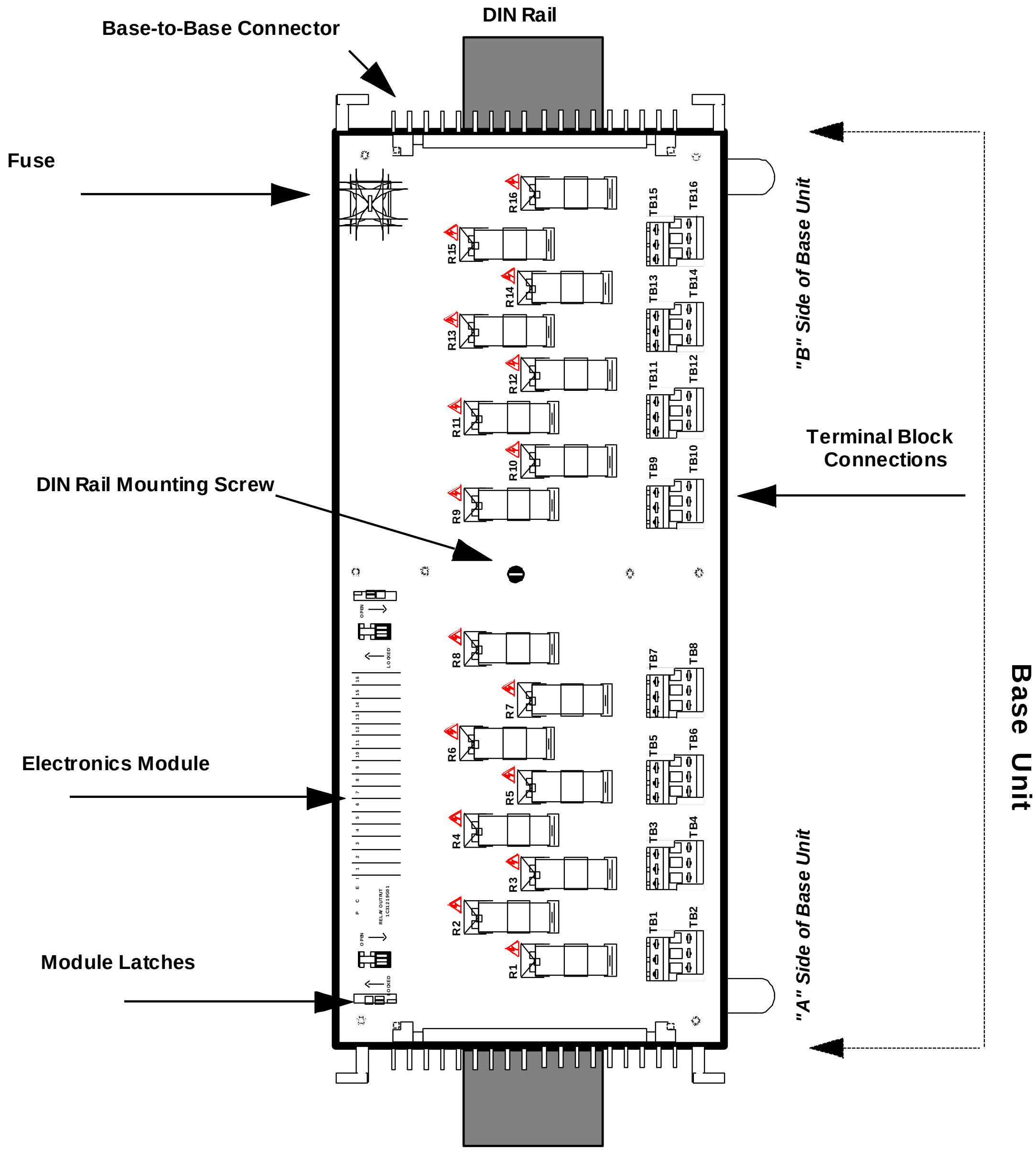


Figure 107: Relay Output Panel G2R

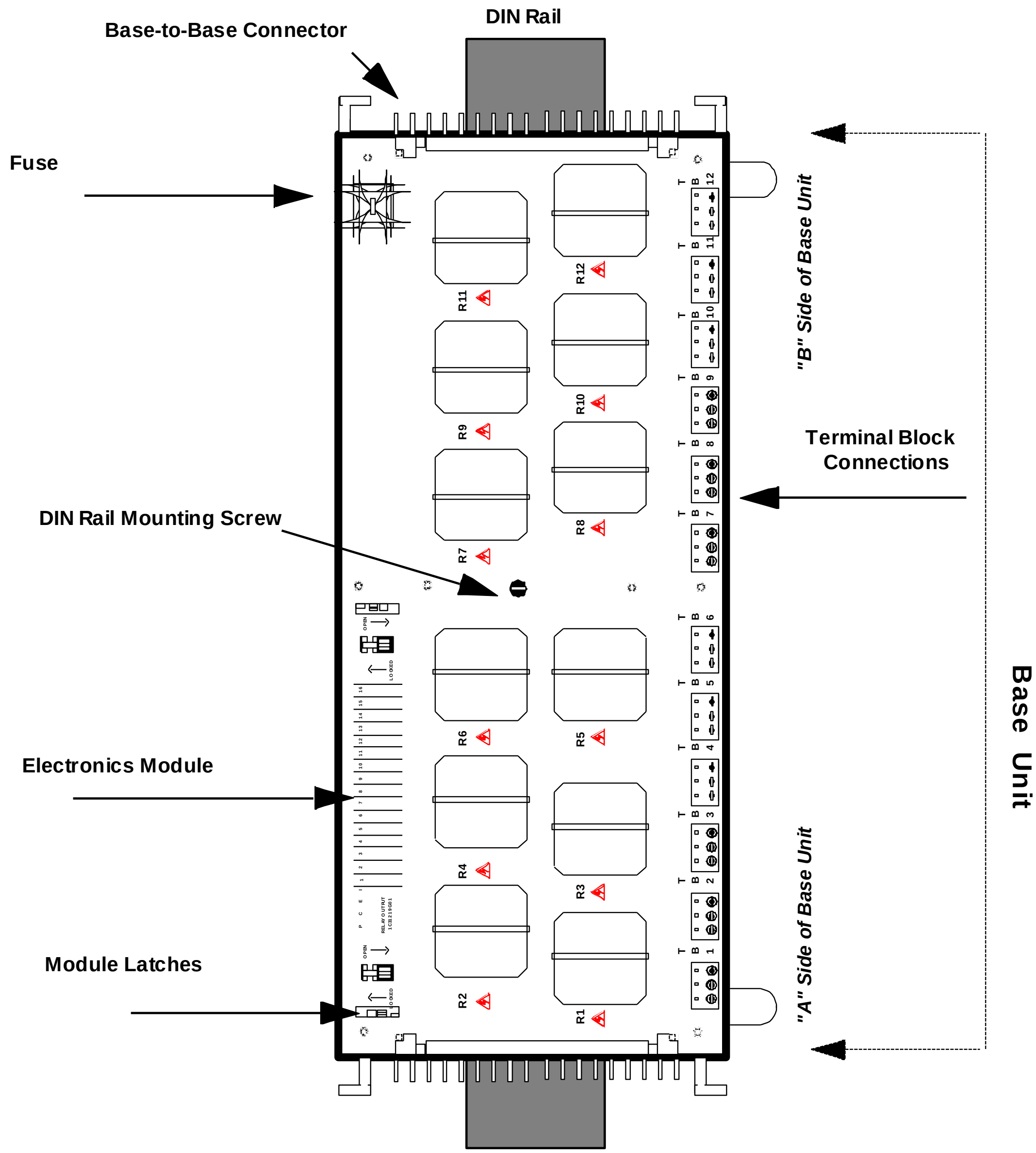


Figure 108: Relay Output KUEP

7.3.8 Field connection wiring diagrams for the Relay Output module

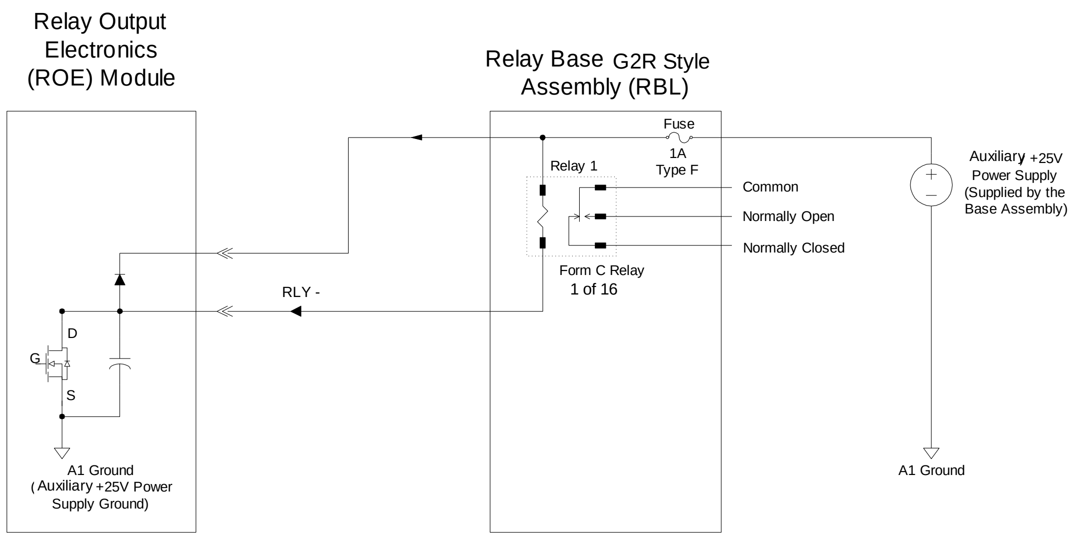


Figure 109: Relay Base G2R Style Assembly Field Wiring

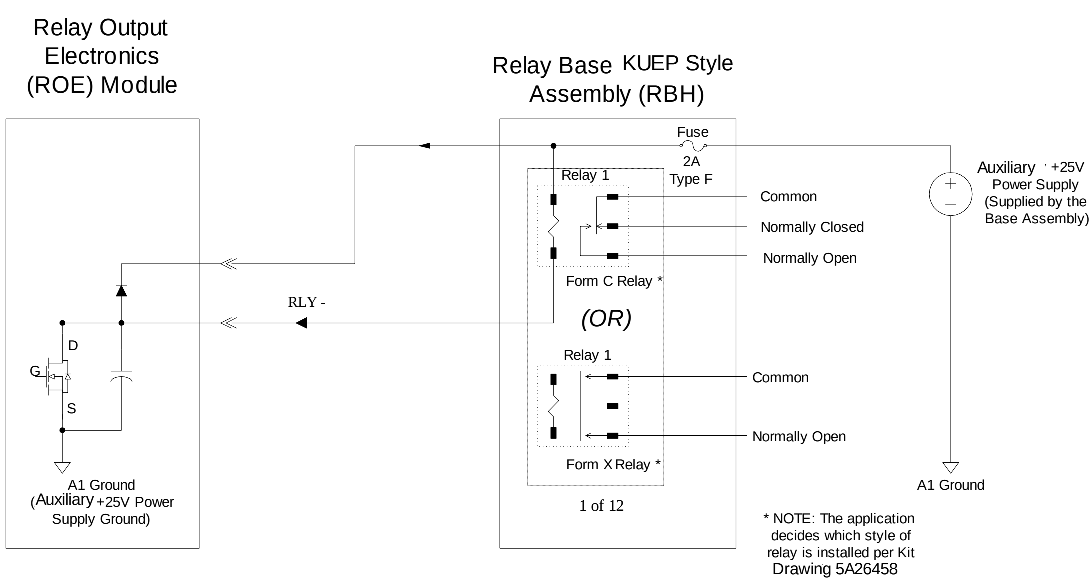


Figure 110: Relay Base KUEP Style Assembly Field Wiring

7.3.9 Field connection wiring diagrams (CE Mark) - (RO)

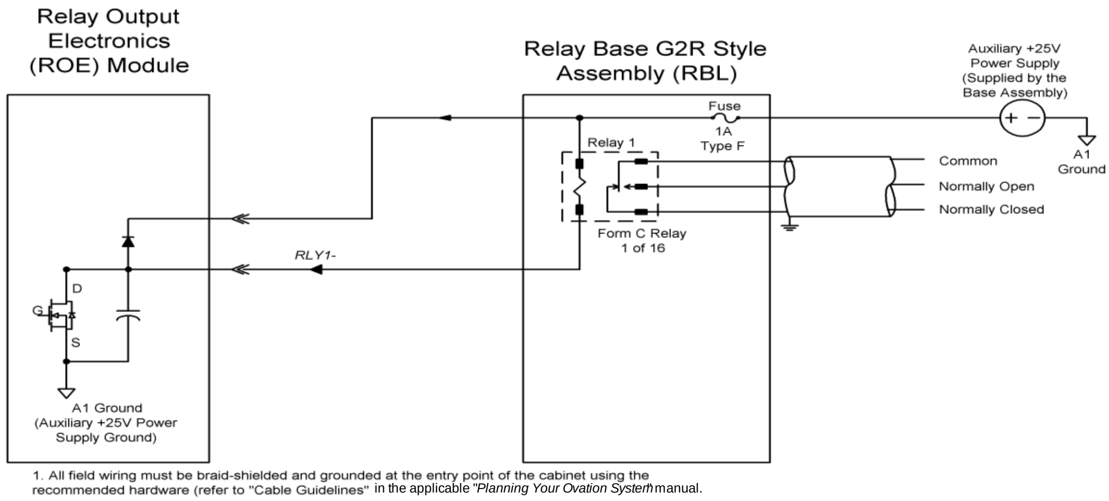


Figure 111: Relay Base G2R Style Assembly Field Wiring (CE Mark)

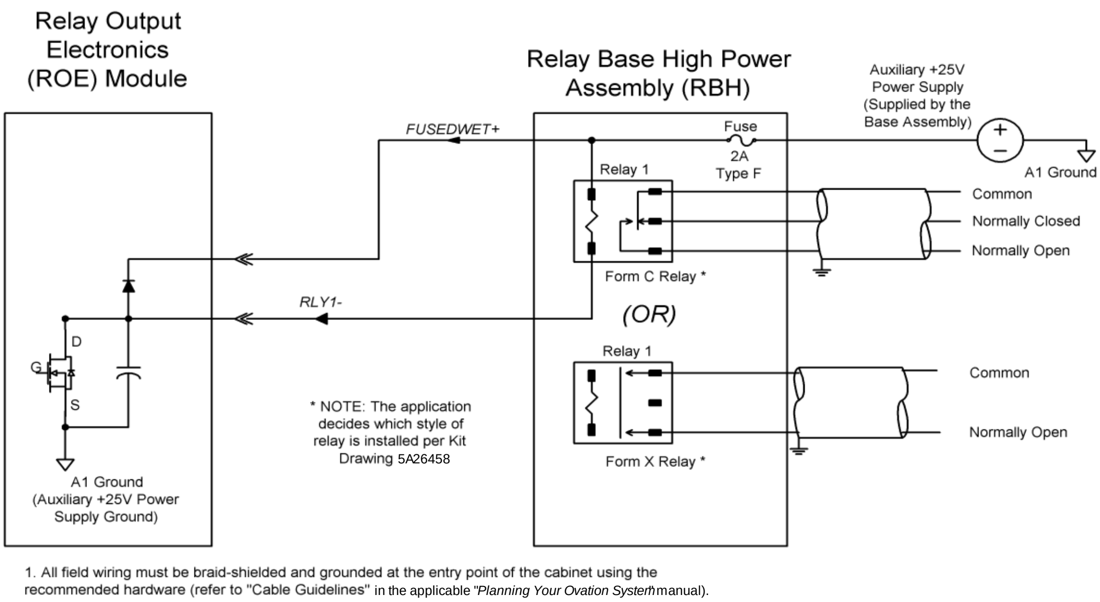


Figure 112: Relay Base KUEP Style Assembly Field Wiring (CE Mark)

7.3.10 Register configuration/address information - (RO)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). Refer to the (*Ovation Operator Station User Guide*.)

Relay Output configuration/status register (address 13 or D in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configured (active high)	Configured (active high) (1 = configured; 0 = unconfigured)
1	Forced Error (active high)	Forced Error (active high) (1 = forced error; 0 = no forced error)
2 - 4	Communications Timeout Setting [1] BIT 4 / BIT 3 / BIT 2 / TIMEOUT 0 / 0 / 0 / 16 seconds 0 / 0 / 1 / 4 seconds 0 / 1 / 0 / 2 seconds 0 / 1 / 1 / 1 seconds 1 / 0 / 0 / 500 milliseconds 1 / 0 / 1 / 250 milliseconds 1 / 1 / 0 / 125 milliseconds 1 / 1 / 1 / 62.5 milliseconds	Communications Timeout Setting [1] BIT 4 / BIT 3 / BIT 2 / TIMEOUT 0 / 0 / 0 / 16 seconds 0 / 0 / 1 / 4 seconds 0 / 1 / 0 / 2 seconds 0 / 1 / 1 / 1 seconds 1 / 0 / 0 / 500 milliseconds 1 / 0 / 1 / 250 milliseconds 1 / 1 / 0 / 125 milliseconds 1 / 1 / 1 / 62.5 milliseconds
5	Outputs hold their state on communications timeout (active high)	Outputs hold their state on communications timeout (active high)
6	Not used	Indicates the status of the blown fuse detection circuit (high = field supply fuse is blown)
7	Enable blown fuse detection circuit (active high)	Enable blown fuse detection circuit (active high)
8	Not used	Base ID0 Bit [2] (Set by the Base Assembly)
9	Not used	Base ID1 Bit [2] (Set by the Base Assembly)
10	Not used	Base ID2 Bit [2] (Set by the Base Assembly)
11 - 15	Not used	Not used

[1] The tolerance on the timeout period is +/- 35%.

[2] Refer to the following table for Base ID values.

Bit 0: When Bit 0 is set, the module is configured. The Controller configures the module by writing a “1” to Bit 0 of the configuration register. Once configured, it remains configured until a power-up/down reset is generated. After a power-up condition, the configuration register clears.

Bit 1: When Bit 1 is set, the internal error LED is turned on and data registers can be written but not read.

Bits 2-4: These bits are used to select the communication timeout period.

Bit 5: When Bit 5 is set, the digital outputs hold their last state on a communications watchdog timeout. When Bit 5 is cleared, the digital outputs are cleared (output transistor is shut off) on a communications watchdog timeout.

Bit 6: This bit indicates the status of the blown fuse detection circuit. When Bit 6 of the status register is set, the field supply fuse is blown.

Bit 7: When Bit 7 is set, the blown fuse detection circuit is enabled.

Bits 8-10: The Base Assembly (KUEP or G2R style) straps three bits in hardware which identify which type of base the ROE is plugged into. The type of base can therefore be determined from reading these bits.

Bits 11-15: Not used.

CAUTION! This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

Relay Output Base ID Bits

Bit 10 (Base ID2)	Bit 9 (Base ID1)	Bit 8 (Base ID0)	Base Type
0	0	0	KUEP Style
0	0	1	G2R Style
All others	All others	All others	Reserved for Future Use

7.3.11 Blown fuse detection circuit (RO)

Bit 6 in the status register enables the Controller to monitor the status of the field supply fuse, and it gives a visual indication of the status via the EXTERNAL ERROR LED.

The Controller enables this feature by writing a “1” to Bit 7 of the configuration register. If enabled and the field supply voltage is between 18VDC and 25.5VDC, the circuit indicates the field supply fuse is OK by turning OFF the “EXTERNAL ERROR” LED and clearing Bit 6 of the module status register. If enabled and the field supply voltage is less than 0.4VDC, the circuit indicates the field supply fuse is blown by turning ON the “EXTERNAL ERROR” LED and setting Bit 6 of the module status register.

In summary, this feature is specified to operate as follows:

- 18 VDC < Field supply voltage < 25.5VDC => Fuse is OK
- 0.4 VDC < Field supply voltage < 18VDC => UNDEFINED
- Field supply voltage < 0.4VDC => Fuse is blown

Note: *After a powering reset, the blown fuse detection circuit is disabled. System level configuration software must set the respective configuration bit if blown fuse detection is desired.*

7.3.12 Diagnostic Logic card LEDs (RO)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit when the field supply fuse is blown and the blown fuse detection circuit is enabled. Blown Fuse bit (Bit 7) of the Configuration Register (see page 432) enables or disables the fuse detection circuit (high = enabled).
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1 of the Configuration Register (see page 432)) is active or the Controller stops communicating with the module.
1 - 16 (Green)	If the LED is lit, this indicates that the output is in the ON state. If the LED is not lit, this indicates that the output is in the OFF state.

7.3.13 Specifications - (RO)

- Electronics module (**1C31219G01**)
- Base Assembly (**1C31223G01, 1C31222G01**)

Relay Output Electronics module specifications (1C31219G01)

DESCRIPTION	VALUE
Number of channels	16
Blown fuse detection [1] Operating voltage range	18V ≤ auxiliary supply voltage ≤ 25.5V

DESCRIPTION	VALUE
Module power	Main: 1.88 W typical, 2.5 W Maximum Auxiliary: 0.3 W typical, 0.35 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
[1] You can configure the module to enable/disable the blown fuse detection function.	

Relay Output Base Specifications (1C31223G01, G2R Style)

DESCRIPTION	VALUE
Number of relays	16
Relay Type	G2R electromechanical style with 1 Form C contact style
Relay contact ratings [3]	10 amps @250 VAC, PF=1 10 amps @30 VDC
Maximum propagation time	Operate time: 15 mSec, bounce approximately = 3 mSec Release time: 10 mSec, bounce approximately = 8 mSec
Dielectric isolation: Channel to Channel Relay contacts to logic	 2300 VAC 2200 VAC
Relay base power	Auxiliary power: 9.1 W typical, 11.68 W Maximum
Auxiliary power supply [1]	25V typical (before output auctioneering diode drop within Ovation auxiliary power supply) 25.5V Maximum@60°C
Operating temperature range [2]	0 to 60°C (32°F to 140°F)
Storage temperature range	-40 to 70°C (-40°F to 158°F)
Humidity (non-condensing)	35 - 85%
[1] Use of the internal Ovation auxiliary power supply is recommended for relay output modules. [2] See additional application derating (see page 449) information. [3] 1A @240 VAC 300,000 operations IEC 61131-2 applications. No DC ratings considered.	

Relay Output Base Assembly Specifications (1C31222G01, KUEP Style)

DESCRIPTION	VALUE
Number of channels	12

DESCRIPTION	VALUE
Relay Type	KUEP electromechanical style: 5A26458G01 Kit - 1 Form C contact type 5A26458G02 Kit - 1 Form X contact type 5A26458G03 Kit - Project specific
Relay contact ratings [3]	Form C relays: 10 amps @240 VAC, PF=0.8 3 amps @150 VDC Form X relays: 10 amps @240 VAC, PF=0.8 10 amps @150 VDC
Typical propagation time	Operate time: 15 mSec, excluding bounce Release time: 10 mSec, excluding bounce
Dielectric isolation: Channel to Channel Relay contacts to logic	 2300V AC 2200 VAC
Relay base power	Auxiliary power: 23.45 W typical, 30.1 W Maximum (5A26458G01 Kit - Form C relays) 15.9 W typical, 20.41 W Maximum (5A26458G02 Kit - Form X relays)
Auxiliary power supply [1]	25V typical (before output auctioneering diode drop within Ovation auxiliary power supply) 25.5V Maximum @42°C (108°F) (Form C relays) 25.5V Maximum @60°C (140°F) (Form X relays)
Operating temperature range [2]	0 to 45°C (32°F to 113°F) (5A26458G01 Kit - Form C relays) 0 to 60°C (32°F to 140°F) (5A26458G02 Kit - Form X relays)
Storage temperature range	KUEP X: -40 to 70°C (-40°F to 158°F) KUEP C: -40 to 50°C (-40°F to 122°F)
[1] Use of internal Ovation auxiliary power supply is recommended for Relay Output modules. [2] See additional application derating information contained in *Using Relay Output Bases (see page 449).* [3] 1A @240 VAC 100,000 operations IEC 61131-2 applications. No DC ratings considered.	

7.4 Relay Output with Contact Monitoring - (ROCM)

An Ovation Relay Output with contact Monitoring module consists of an Electronics module, a base assembly, and relays. The Relay Output module provides a means to switch high AC voltages at high currents to field devices. It provides a single FORM X relay contact to drive the field devices. In addition, the module has two monitoring circuits per channel, which provide a feedback to the standard Ovation Contact Input module or Digital Input Module to indicate the contact state of the relay.

Each Relay Output with Contact Monitoring base assembly incorporates an integral Relay Output Electronics module to interface between the relays and the Ovation I/O Controller. The Relay Output Electronics module provides configurable communication timeout periods and LEDs to indicate the status of each output.

The Relay Output with Contact Monitoring contains shorting jumpers to enable or disable both contact monitoring circuits on a per channel basis. The Relay Output with Contact Monitoring contains the field terminal headers, which accept pluggable terminal blocks in either right angle screw compression or vertical crimp pin styles. In addition, the Relay Output with Contact Monitoring Base contains the contact monitoring terminal headers, which accept pluggable terminal blocks. The pluggable terminal blocks contain a screw hold down to the terminal header for mechanical stability.

Note: *I/O Module General Information* *(see page 25)* *contains environmental, installation, wiring, and fuse information for I/O modules.*

7.4.1 Electronics modules (Emod) - (ROCM)

- **1C31219G01** provides an interface between the Ovation Controller and the mechanical relays that are used to switch high AC voltages at high currents. This module plugs into the Relay Output base assembly.

Note: *The Relay Output base assembly does not incorporate a Personality module.*

7.4.2 Base assemblies - (ROCM)

There are two different styles of Relay Output with Contact Monitoring base assemblies:

- **5X00564G01** contains eight (8) high power relays that are pre-installed with Form X relays in the base assembly. The G01 does not have Field output or Contact monitoring output terminal blocks installed. This group is used for marshalling configurations with pre-terminated pluggable cable assemblies.
- **5X00564G02** accommodates eight (8) high power relays that are pre-installed with Form X relays in the base assembly. The G02 has Field output and Contact Monitoring terminal blocks installed. This group is used for direct customer terminations.

You must adhere to relay contact ratings when utilizing the Relay Output with Contact Monitoring module assemblies. The application must include external current limiting protection for the Relay Output with Contact Monitoring module assemblies.

7.4.3 Emod and base assembly combinations - (ROCM)

The following table depicts a clear definition of the valid electronics module and the base module:

MODULE DESCRIPTION	EMOD STYLE	BASE MODULE STYLE
Relay Output with Contact Monitoring Assembly, KUEP Form X, Marshalling (No terminal blocks installed)	**1C31219G01**	**5X00564G01**
Relay Output with Contact Monitoring Assembly, KUEP Form X, Customer Termination(Terminal blocks installed	**1C31219G01**	**5X00564G02**

7.4.4 External power supply information - (ROCM)

Emerson recommends that the Relay Output with Contact Monitoring base assembly obtain relay coil voltage from the internal Ovation auxiliary power supplies. These supplies distribute power through the Controller backplane and ROP panel to base assemblies. Use of external power supplies for relay coil power is **NOT** recommended.

7.4.5 Operating Temperature - (ROCM)

Proper relay operation is temperature dependent and is determined by the following:

- Temperature rise of the coil after being energized for extended periods.
- Temperature rise of the coil due to large relay contact currents.
- Ambient temperature.

The following table provides general user guidelines which can be referenced when configuring cabinets with High Power Relay Output with Contact Monitoring bases:

Operating Temperature Summary for Relay Output Bases

CABINET TYPE	AMBIENT CABINET OPERATING TEMPERATURE	RELAY BASE STYLE
Controller	0 to 50°C (32 to 122°F)	Relay Output with Contact Monitoring
Extended I/O	0 to 60°C (32 to 140°F)	Relay Output with Contact Monitoring
Remote I/O (Ventilated)	0 to 60°C (32 to 140°F)	Relay Output with Contact Monitoring
Remote I/O (Sealed)	0 to 50°C (32 to 122°F) @ 175 W Maximum	Relay Output with Contact Monitoring
Remote I/O (Sealed)	0 to 40°C (32 to 104°F) @ 225 W Maximum	Relay Output with Contact Monitoring

7.4.6 Register configuration/address information - (ROCM)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). Refer to the (*Ovation Operator Station User Guide*.)

Relay Output configuration/status register (address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configured (active high)	Configured (active high) (1 = configured; 0 = unconfigured)
1	Forced Error (active high)	Forced Error (active high) (1 = forced error; 0 = no forced error)
2 - 4	Communications Timeout Setting [1] Bit 4 / Bit 3 / Bit 2 / Timeout 0 0 0 16 seconds 0 0 1 4 seconds 0 1 0 2 seconds 0 1 1 1 seconds 1 0 0 500 milliseconds 1 0 1 250 milliseconds 1 1 0 125 milliseconds 1 1 1 62.5 milliseconds	Communications Timeout Setting [1] Bit 4 / Bit 3 / Bit 2 / Timeout 0 0 0 16 seconds 0 0 1 4 seconds 0 1 0 2 seconds 0 1 1 1 seconds 1 0 0 500 milliseconds 1 0 1 250 milliseconds 1 1 0 125 milliseconds 1 1 1 62.5 milliseconds
5	Outputs hold their state on communications timeout (active high)	Outputs hold their state on communications timeout (active high)
6	Not used	Indicates the status of the blown fuse detection circuit (high = field supply fuse is blown)
7	Enable blown fuse detection circuit (active high)	Enable blown fuse detection circuit (active high)
8	Not used	Base ID0 Bit [2] (Set by the Base Assembly)
9	Not used	Base ID1 Bit [2] (Set by the Base Assembly)
10	Not used	Base ID2 Bit [2] (Set by the Base Assembly)
11 - 15	Not used	Not used

[1] The tolerance on the timeout period is +/- 35%.

[2] Refer to the following table for Base ID values.

Bit 0: When Bit 0 is set, the module is configured. The Controller configures the module by writing a “1” to Bit 0 of the configuration register. Once configured, it remains configured until a power-up/down reset is generated. After a power-up condition, the configuration register clears.

Bit 1: When Bit 1 is set, the internal error LED is turned on and data registers can be written but not read.

Bits 2-4: These bits are used to select the communication timeout period.

Bit 5: When Bit 5 is set, the digital outputs hold their last state on a communications watchdog timeout. When Bit 5 is cleared, the digital outputs are cleared (output transistor is shut off) on a communications watchdog timeout.

Bit 6: This bit indicates the status of the blown fuse detection circuit. When Bit 6 of the status register is set, the field supply fuse is blown.

Bit 7: When Bit 7 is set, the blown fuse detection circuit is enabled.

Bits 8-10: The Base Assembly (RBHI) straps three bits in hardware which identify which type of base the ROE is plugged into. The type of base can therefore be determined from reading these bits.

Bits 11-15: Not used.

CAUTION! This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indicating a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any effect that change may have on the system. Under some conditions, a different timeout may cause the module to go into its respective fail-safe mode.

Relay Output Base ID Bits

Bit 10 (Base ID2)	Bit 9 (Base ID1)	Bit 8 (Base ID0)	Base Type
1	0	0	RBHI

7.4.7 Base unit layouts - (ROCM)

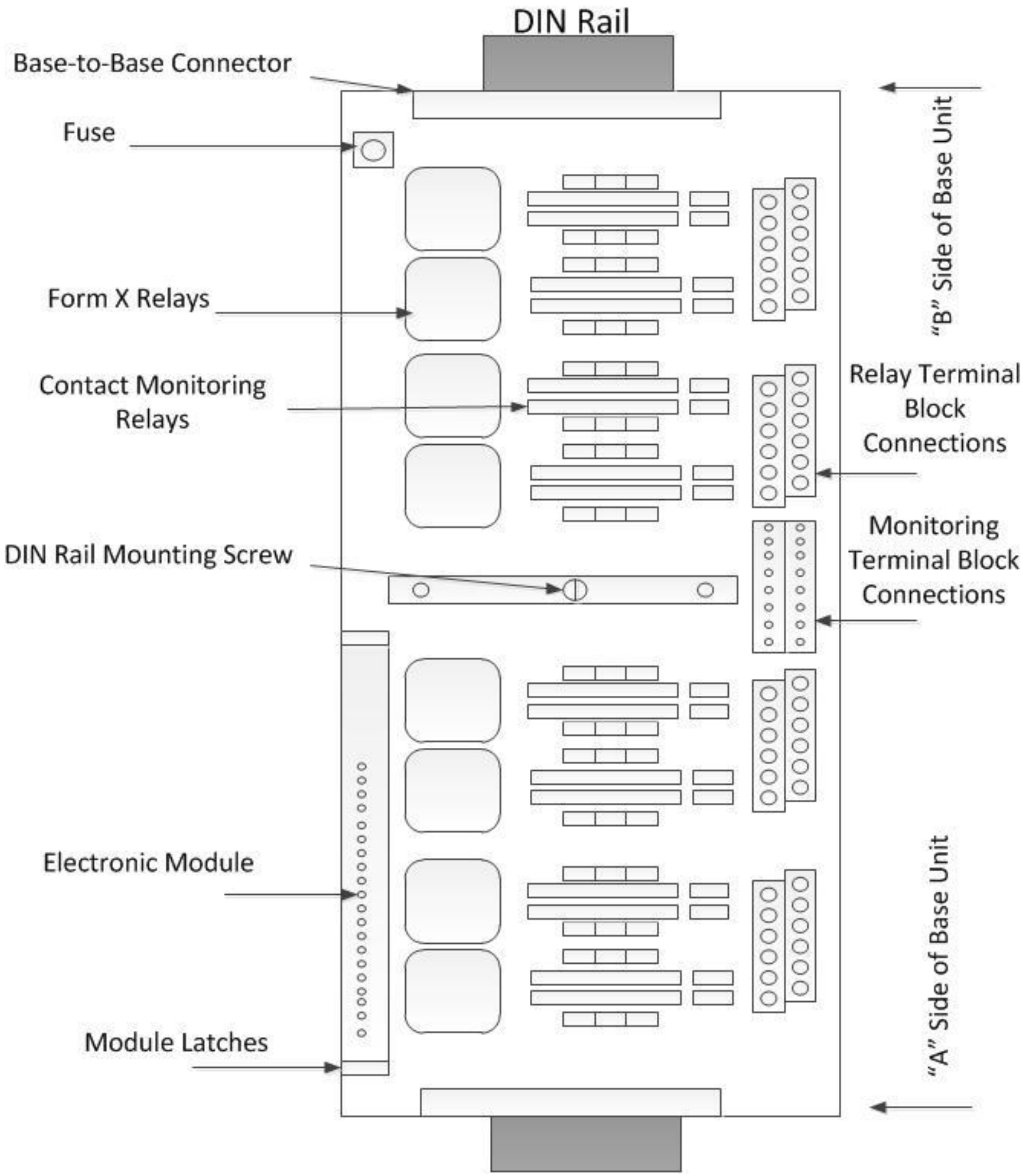


Figure 113: Relay Output with Contact Monitoring Panel

7.4.8 Blown fuse detection circuit - (ROCM)

Bit 6 in the status register enables the Controller to monitor the status of the field supply fuse, and it gives a visual indication of the status through the EXTERNAL ERROR LED (see page 443).

The Controller enables this feature by writing a “1” to Bit 7 of the configuration register. If enabled and the field supply voltage is between 18VDC and 25.5VDC, the circuit indicates the field supply fuse is OK by turning OFF the “EXTERNAL ERROR” LED and clearing Bit 6 of the module status register. If enabled and the field supply voltage is less than 0.4VDC, the circuit indicates the field supply fuse is blown by turning ON the “EXTERNAL ERROR” LED and setting Bit 6 of the module status register.

In summary, this feature is specified to operate as follows:

- 18 VDC < Field supply voltage < 25.5VDC => Fuse is OK
- 0.4 VDC < Field supply voltage < 18VDC => UNDEFINED
- Field supply voltage < 0.4VDC => Fuse is blown

Note: *After a powering reset, the blown fuse detection circuit is disabled. System level configuration software must set the respective configuration bit if blown fuse detection is desired.*

7.4.9 Terminal block wiring information - (ROCM)

Each relay base assembly employs terminal blocks which are permanently marked with appropriate relay contact designations at each position. The terminal block marking indicates how field wiring is connected to each terminal block position in the respective relay base assemblies.

The terminal block markings for the Relay Output with Contact Monitoring base assembly are illustrated below. The following tables list and define the abbreviations used in those diagrams.

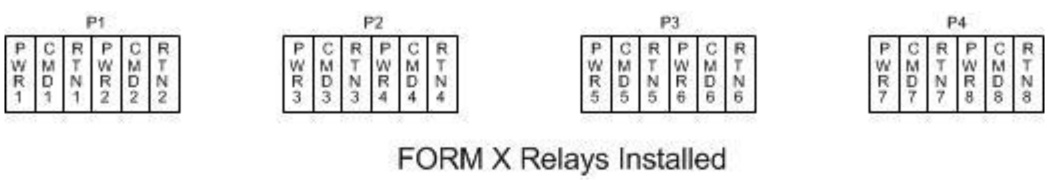


Figure 114: Terminal Block Connection for the Form X Relay Output with Contact Monitoring

Abbreviations Used in Wiring Diagrams

ABBREVIATION	DEFINITION
PWR	Equipment Power
CMD	Equipment Command
RTN	Equipment Power Return

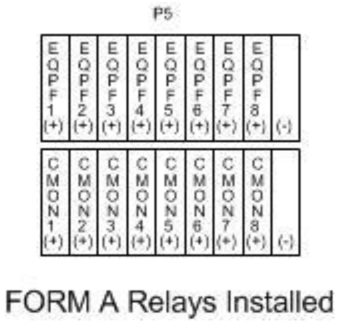


Figure 115: Terminal Block Connection for the Form A Relay Output with Contact Monitoring

Abbreviations Used in Wiring Diagrams

Abbreviation	Definition
EQPF (+)	Equipment Power Fail signal (**ON** = Power Ok, **OFF** = Power Fail)
CMON (+)	Contact Monitor signal (**ON** = Form X Contact Open, **OFF** = Form X Contact Closed)
(-)	Return

7.4.10 Field connection wiring diagram - (ROCM)

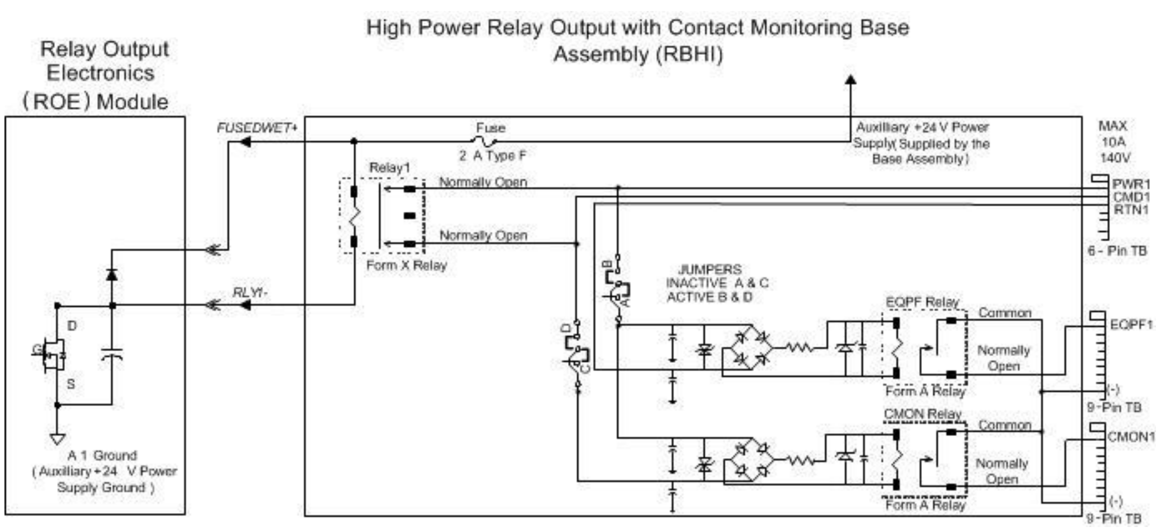


Figure 116: Relay Output with Contact Monitoring with Field Wiring

7.4.11 Diagnostic Logic card LEDs - (ROCM)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.

LED	DESCRIPTION
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit when the field supply fuse is blown and the blown fuse detection circuit is enabled. Blown Fuse bit (Bit 7) of the Configuration Register (see page 439) enables or disables the fuse detection circuit (high = enabled).
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1 of the Configuration Register (see page 439)) is active or the Controller stops communicating with the module.
1 - 16 (Green)	If the LED is lit, this indicates that the output is in the ON state. If the LED is not lit, this indicates that the output is in the OFF state.

7.4.12 Specifications - (ROCM)

- Electronics module (**1C31219G01**)
- Base Assembly (**5X00564G01, 5X00564G02**)

Relay Output Electronics module specifications (1C31219G01)

DESCRIPTION	VALUE
Number of channels	16
Blown fuse detection [1] Operating voltage range	18V ≤ auxiliary supply voltage ≤ 25.5V
Module power	Main: 1.88 W typical, 2.5 W Maximum Auxiliary: 0.3 W typical, 0.35 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
[1] You can configure the module to enable/disable the blown fuse detection function.	

Relay Output Base Specifications (5X00564G01/5X00564G02)

DESCRIPTION	VALUE
Number of relays	8
Relay Type	KUEP Form X
Maximum propagation time	Operate time: 15 mSec, bounce approximately = 3 mSec Release time: 10 mSec, bounce approximately = 8 mSec
Dielectric isolation: Channel to Channel Relay contacts to logic	 1350 VAC 1400 VAC
Relay base power	Auxiliary power: 10.2 W typical, 13.5 W Maximum

DESCRIPTION	VALUE
Auxiliary power supply [1]	24V typical (before output auctioneering diode drop within Ovation auxiliary power supply) 25.5V Maximum@60°C
Operating temperature range [2]	0 to 60°C (32°F to 140°F)
Storage temperature range	-40 to 70°C (-40°F to 158°F)
Humidity (non-condensing)	35 - 85%
[1] Use of the internal Ovation auxiliary power supply is recommended for relay output with contact monitoring module. [2] See additional application derating (see page 449) information.	

7.4.13 Contact input monitoring circuits - (ROCM)

The High Power Relay Output with Contact Monitoring contains two monitor circuits that allow the Ovation system to detect the actual state of the relay output contact utilized to drive the connected field device. The two monitoring circuits are:

- Equipment Power Fail (EQPF): contains a 1 FORM A (NO) relay, which is closed when equipment power for that channel is present.
- Field Contact Monitor (CMON): contains a 1 FORM A (NO) relay, which is closed when the field circuit is open.

  Both the EQPF and CMON circuits contain common mode surge capacitors and a normal mode Metal Oxide Varistor (MOV) to protect the channels against fast transients and surges. The normal mode MOV also provides protection against inductive kicks associated from inductive loads, which are driven by the field contacts.

Monitoring Circuit State Definitions

MONITOR CIRCUIT	MONITORING RELAY LOGIC STATE
EQPF	Monitor Relay Closed = Equipment Power Present Monitor Relay Open = Equipment Power Present , (<20 V)
CMON	Monitor Relay Closed = Field Contact Open Monitor Relay Open = Field Contact Closed

The channel off state is determined by the voltage drop of the monitor relay coil. The voltage drop resistance is specified at 6V or less for the drop out state. The lower operating limit for the channel monitoring circuits is 100 VAC or 100 VDC and the upper operating limit is 140VAC or 140 VDC.

Monitoring Circuit Operating Ranges

MONITOR CIRCUIT	THRESHOLD VALUE	CONDITION
EQPF	Voltage < 6VAC, VDC	Guaranteed Drop Off

Monitor Circuit	Threshold Value	Condition
CMON	100 < Voltage < or = 140 VAC, VDC	Proper operating range

When the Relay output is the de-energized state, the field contact monitor circuit generates a small leakage current through the load device. The operational load threshold value should be greater than the maximum value of the monitor circuit leakage. This condition should be verified before using the device to ensure proper operation.

Contact Monitoring Leakage Current

Monitor Circuit	Threshold Value	Condition
CMON	I leakage = 8mA @ 140Vrms	Maximum
	I leakage = 5mA @ 140VDC	Maximum

The field contact monitor circuit detects current flow through the field device in its OFF state. Therefore, a small voltage drop occurs across the field device when this current flows. The field device is normally a low impedance device and there is a small impact on the voltage threshold to the monitor circuitry. However, there is a maximum allowable device loading specification to ensure proper monitor operation over the assembly operational parameters.

Contact Monitoring Load Specification

Monitor Circuit	Threshold Value	Condition
CMON	Load Impedance = 500 ohms @ 100Vrms	Maximum
	Load Resistance = 3.5 Kohms @ 100VDC	Maximum

7.5 Fused Relay Output modules - (FRO)

The Ovation Fused Relay Output Assembly provides a means to switch high current and voltage devices located in the field. You have a choice between a fused low power relay output assembly and a fused high power relay output assembly for differing applications. The Fused Low Power Relay Output Assembly employs a 1 FORM C contact arrangement for driving field devices. The Fused High Power Relay Output Assembly allows a choice between a 1 FORM C or a 1 FORM X relay contact arrangement depending upon which KUEP form factor relay is installed.

The Fused Relay Output Bases provide the capability to provide contact wetting power from a common external wetting source or optionally isolate contact wetting on an individual channel basis. Additionally, the Fused Relay Output Bases incorporate individual channel fusing eliminating the need for additional external fusing. The Fused Relay Output Bases incorporate headers which accept pluggable terminal blocks in either right angle screw compression or vertical crimp pin styles.

A Ovation Fused Relay Output module consists of an Electronics module, a base assembly containing fuses and relays. The module provides a means to switch high AC voltages at high currents to field devices. There are two versions of the Fused Relay Output base assembly which contain either 12 or 16 relays within each base. The 12 Fused Relay Output base assembly provides the additional advantage of being able to switch DC voltages at high currents.

Each Fused Relay Output base assembly incorporates an integral Fused Relay Output Electronics module to interface between the relays and the Ovation I/O Controller. The Fused Relay Output Electronics module provides configurable communication timeout periods and LEDs to indicate the status of each output.

The Fused Relay Output Assembly incorporates a backward compatible addressing scheme so that it is compatible with existing I/O bases.

Note: *I/O Module General Information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

Integral fusing elements are provided for the protection of the Fused Relay Output module assembly. The project shall ensure proper application of the panel with respect to applied powering scheme and integral fusing. Any additional components required for the installation shall be provided at the project level.

7.5.1 Electronics modules (Emod) - (RO)

- **1C31219G01** provides an interface between the Ovation Controller and the mechanical relays that are used to switch high AC voltages at high currents. This module plugs into the Relay Output base assembly.

Note: *The Relay Output base assembly does not incorporate a Personality module.*

7.5.2 Base assemblies - (FRO)

There are several different styles of Relay Output base assemblies:

- **5X00430G01** Fused High Power Relay Base Assembly, 12 Form C Relays included, No Output Termination Blocks Pre-Installed.
- **5X00430G02** Fused High Power Relay Base Assembly, 12 Form X Relays included, No Output Termination Blocks Pre-Installed.
- **5X00430G03** Fused High Power Relay Base Assembly, 12 Form C Relays included, Output Termination Blocks Pre-Installed.
- **5X00430G04** Fused High Power Relay Base Assembly, 12 Form X Relays included, Output Termination Blocks Pre-Installed.
- **5X00431G01** Fused Low Power Relay Base Assembly, 16 Form C Relays included, No Output Termination Blocks Pre-Installed.
- **5X00431G02** Fused Low Power Relay Base Assembly, 16 Form C Relays included, Output Termination Blocks Pre-Installed.

Fused Relay Output module Subsystem [1]

DESCRIPTION	RELAYS	ELECTRONICS MODULE	BASE UNIT [1]
Low power, Marshaling	16	1C31219G01	5X00431G01
Low power, blocks installed	16	1C31219G01	5X00431G02
High power, Form C, Marshaling	12	1C31219G01	5X00430G01
High power, Form X, Marshaling	12	1C31219G01	5X00430G02
High power, Form C, blocks installed	12	1C31219G01	5X00430G03
High power, Form X, blocks installed	12	1C31219G01	5X00430G04
[1] Relay Outputs do not use standard Ovation I/O bases. Use the listed base units for Relay Output applications. Also note that the Relay Output module does not use a Personality module.			

7.5.3 External power supply information - (FRO)

It is recommended that the Relay Output base assembly obtain relay coil voltage from the internal Ovation auxiliary power supplies. These supplies distribute power through the Controller backplane and ROP panel to base assemblies. Use of external power supplies for relay coil power is **NOT** recommended.

7.5.4 Using bases - (FRO)

Proper relay operation is temperature dependent and is determined by the following:

- Temperature rise of the coil after being energized for extended periods.
- Temperature rise of the coil due to large relay contact currents.
- Ambient temperature.

The following table provides general user guidelines which can be referenced when configuring cabinets with Relay Output bases.

Operating Temperature Summary for Relay Output Bases

CABINET TYPE	AMBIENT CABINET OPERATING TEMPERATURE	RELAY BASE STYLE
Controller	0 to 50°C (32 to 122°F)	G2R
Extended I/O	0 to 60°C (32 to 140°F)	G2R
Remote I/O (Ventilated)	0 to 60°C (32 to 140°F)	G2R
Remote I/O (Sealed)	0 to 50°C (32 to 122°F) @ 175 W Maximum	G2R
Remote I/O (Sealed)	0 to 40°C (32 to 104°F) @ 225 W Maximum	G2R
Controller	0 to 50°C (32 to 122°F)	KUEP Form X
Extended I/O	0 to 60°C (32 to 140°F)	KUEP Form X
Remote I/O (Ventilated)	0 to 60°C (32 to 140°F)	KUEP Form X
Remote I/O (Sealed)	0 to 50°C (32 to 122°F) @ 175 W Maximum	KUEP Form X
Remote I/O (Sealed)	0 to 40°C (32 to 104°F) @ 225 W Maximum	KUEP Form X
Controller	0 to 40°C (32 to 104°F)	KUEP Form C
Extended I/O	0 to 45°C (32 to 113°F)	KUEP Form C
Remote I/O (Ventilated)	0 to 45°C (32 to 113°F)	KUEP Form C
Remote I/O (Sealed)	0 to 35°C (32 to 95°F) @ 175 W Maximum	KUEP Form C
Remote I/O (Sealed)	0 to 25°C (32 to 77°F) @ 225 W Maximum	KUEP Form C

7.5.5 Terminal block wiring information - (FRO)

Each relay base assembly employs terminal blocks which are permanently marked with appropriate relay contact designations at each position. The terminal block marking indicates how field wiring is connected to each terminal block position in the respective relay base assemblies.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

The terminal block markings for the G2R style Relay Output base assembly and for the KUEP style Relay Output base assemblies are illustrated below. The following table lists and defines the abbreviations used in those diagrams.

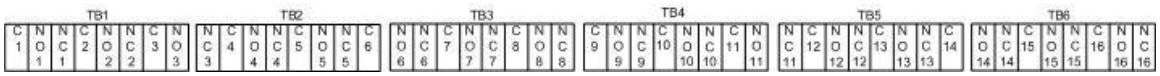


Figure 117: Terminal Block Connections for the Fixed Low Power Relay Output Base Assembly

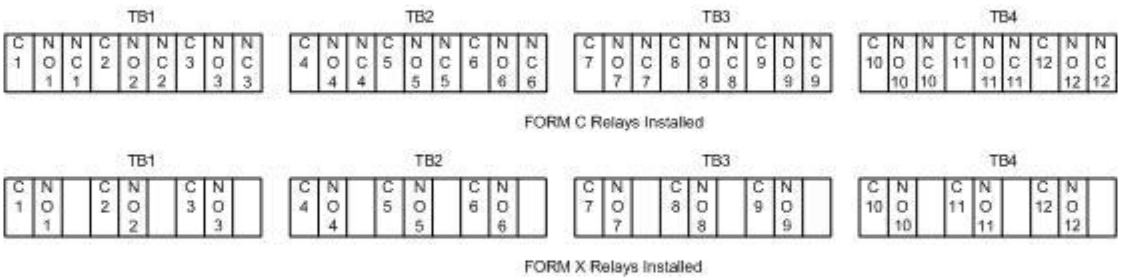


Figure 118: Terminal Block Connections for the Fixed High Power Relay Output Base Assembly

Abbreviations Used in Wiring Diagrams

Abbreviation	Definition
NC [1]	Normally Closed contact connection
NO	Normally Open contact connection
C	Common contact connection
[1] Do **NOT** use the NC terminal position when using the KUEP style base assembly with a Form X style relay inserted. The terminal position should remain unconnected.	

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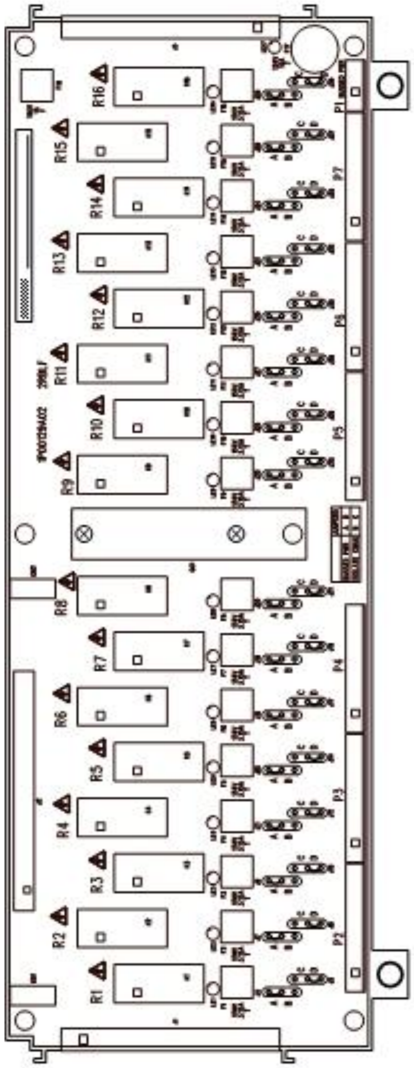
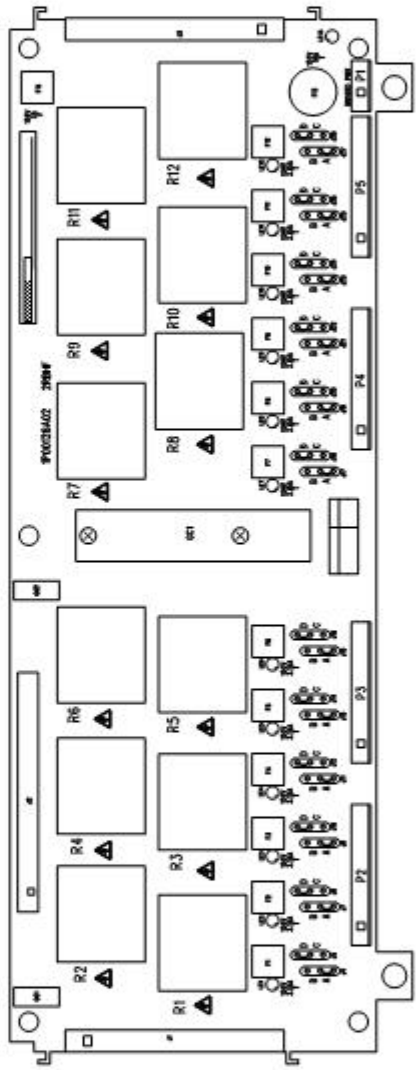
7.5.6 Base unit layouts - (FRO)



G2R Style



KUEP Style

7.5.7 Field connection wiring diagrams - (FRO)

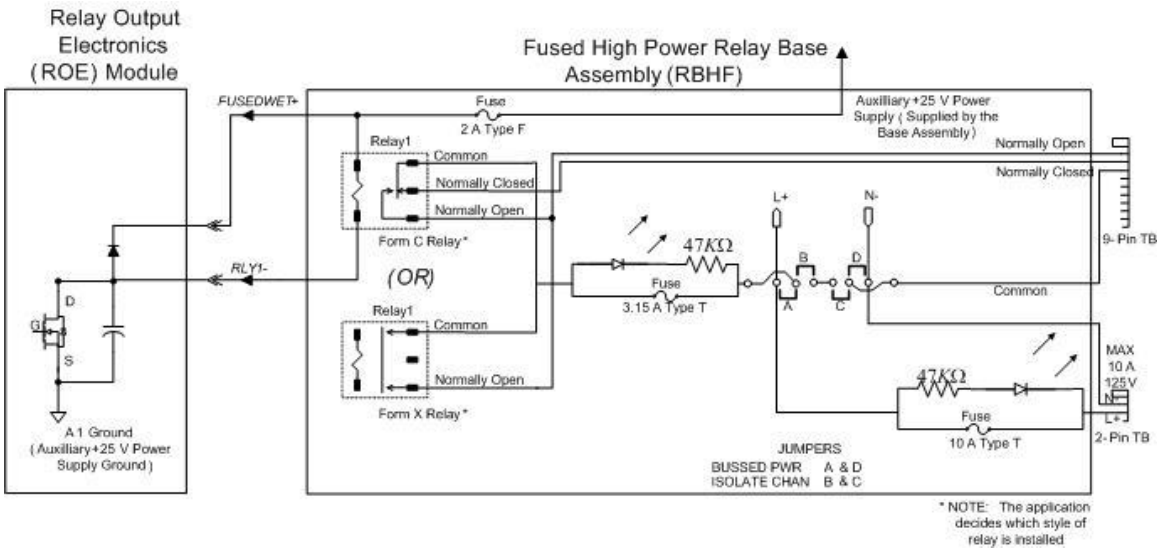


Figure 119: Fused high power relay output field wiring

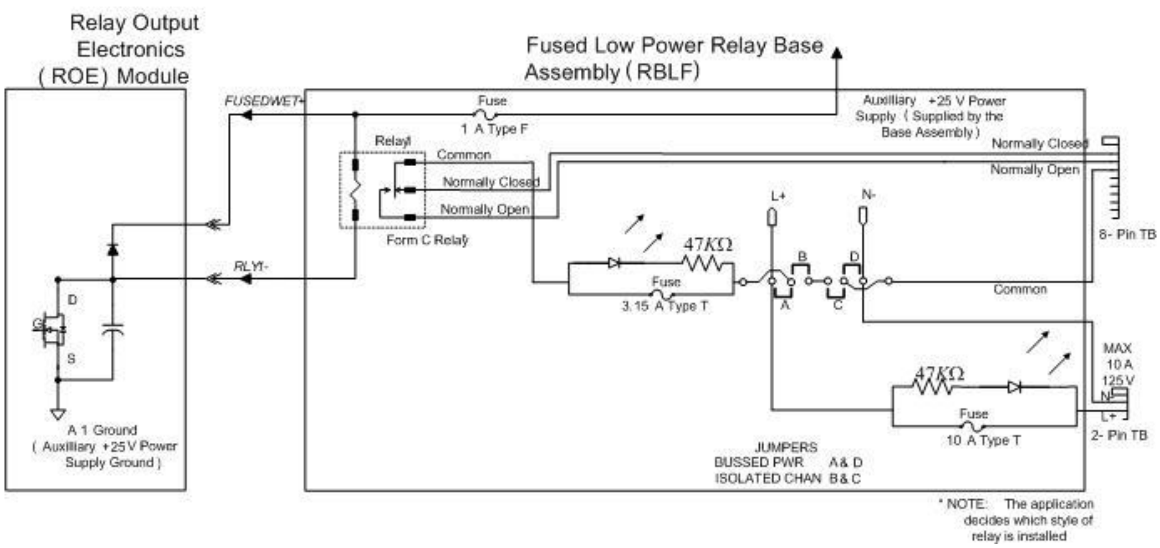


Figure 120: Fused low power relay output field wiring

7.5.8 Register configuration/address information - (FRO)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). Refer to the (*Ovation Operator Station User Guide*.)

Relay Output configuration/status register (address 13 or D in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Configured (active high)	Configured (active high) (1 = configured; 0 = unconfigured)
1	Forced Error (active high)	Forced Error (active high) (1 = forced error; 0 = no forced error)
2 - 4	Communications Timeout Setting [1] BIT 4 / BIT 3 / BIT 2 / TIMEOUT 0 0 0 16 seconds 0 0 1 4 seconds 0 1 0 2 seconds 0 1 1 1 seconds 1 0 0 500 milliseconds 1 0 1 250 milliseconds 1 1 0 125 milliseconds 1 1 1 62.5 milliseconds	Communications Timeout Setting [1] BIT 4 / BIT 3 / BIT 2 / TIMEOUT 0 0 0 16 seconds 0 0 1 4 seconds 0 1 0 2 seconds 0 1 1 1 seconds 1 0 0 500 milliseconds 1 0 1 250 milliseconds 1 1 0 125 milliseconds 1 1 1 62.5 milliseconds
5	Outputs hold their state on communications timeout (active high)	Outputs hold their state on communications timeout (active high)
6	Not used	Indicates the status of the blown fuse detection circuit (high = field supply fuse is blown)
7	Enable blown fuse detection circuit (active high)	Enable blown fuse detection circuit (active high)
8	Not used	Base ID0 Bit [2] (Set by the Base Assembly)
9	Not used	Base ID1 Bit [2] (Set by the Base Assembly)
10	Not used	Base ID2 Bit [2] (Set by the Base Assembly)
11 - 15	Not used	Not used

[1] The tolerance on the timeout period is +/- 35%.

[2] Refer to the following table for Base ID values.

Bit 0: When Bit 0 is set, the module is configured. The Controller configures the module by writing a “1” to Bit 0 of the configuration register. Once configured, it remains configured until a power-up/down reset is generated. After a power-up condition, the configuration register clears.

Bit 1: When Bit 1 is set, the internal error LED is turned on and data registers can be written but not read.

Bits 2-4: These bits are used to select the communication timeout period.

Bit 5: When Bit 5 is set, the digital outputs hold their last state on a communications watchdog timeout. When Bit 5 is cleared, the digital outputs are cleared (output transistor is shut off) on a communications watchdog timeout.

Bit 6: This bit indicates the status of the blown fuse detection circuit. When Bit 6 of the status register is set, the field supply fuse is blown.

Bit 7: When Bit 7 is set, the blown fuse detection circuit is enabled.

Bits 8-10: The Base Assembly (KUEP or G2R style) straps three bits in hardware which identify which type of base the ROE is plugged into. The type of base can therefore be determined from reading these bits.

Bits 11-15: Not used.

CAUTION: This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

Fused Relay Output Base ID Bits

Bit 10 (Base ID2)	Bit 9 (Base ID1)	Bit 8 (Base ID0)	Base Type
0	1	0	RBHF
0	1	1	RBLF

7.5.9 Blown fuse detection circuit - (FRO)

Bit 6 in the status register enables the Controller to monitor the status of the field supply fuse, and it gives a visual indication of the status via the EXTERNAL ERROR LED.

The Controller enables this feature by writing a "1" to Bit 7 of the configuration register. If enabled and the field supply voltage is between 18VDC and 25.5VDC, the circuit indicates the field supply fuse is OK by turning OFF the "EXTERNAL ERROR" LED and clearing Bit 6 of the module status register. If enabled and the field supply voltage is less than 0.4VDC, the circuit indicates the field supply fuse is blown by turning ON the "EXTERNAL ERROR" LED and setting Bit 6 of the module status register.

In summary, this feature is specified to operate as follows:

- 18 VDC < Field supply voltage < 25.5VDC => Fuse is OK
- 0.4 VDC < Field supply voltage < 18VDC => UNDEFINED
- Field supply voltage < 0.4VDC => Fuse is blown

Note: *After a powering reset, the blown fuse detection circuit is disabled. System level configuration software must set the respective configuration bit if blown fuse detection is desired.*

7.5.10 Diagnostic Logic card LEDs - (FRO)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED. Lit when the field supply fuse is blown and the blown fuse detection circuit is enabled. Blown Fuse bit (Bit 7) of the Configuration Register (see page 432) enables or disables the fuse detection circuit (high = enabled).
I (Red)	Internal Fault LED. Lit whenever the Force Error bit (Bit 1 of the Configuration Register (see page 432)) is active or the Controller stops communicating with the module.
1 - 16 (Green)	If the LED is lit, this indicates that the output is in the ON state. If the LED is not lit, this indicates that the output is in the OFF state.

7.5.11 Specifications - (FRO)

- Electronics module (**1C31219G01**)
- Base Assembly (**5X00431G01-G02, 5X00430G01-G04**)

Relay Output Electronics module specifications (1C31219G01)

DESCRIPTION	VALUE
Number of channels	16
Blown fuse detection [1] Operating voltage range	18V ≤ auxiliary supply voltage ≤ 25.5V

Description	Value
Module power	Main: 1.88 W typical, 2.5 W Maximum Auxiliary: 0.3 W typical, 0.35 W Maximum
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
[1] You can configure the module to enable/disable the blown fuse detection function.	

Fused Low Power Relay Output Base Specifications (5X00431G01 - G02) (G2R)

Description	Value
Number of relays	16
Relay Type	Form C
Maximum propagation time	Operate time: 15 mSec, bounce approximately = 3 mSec Release time: 10 mSec, bounce approximately = 8 mSec
Dielectric isolation: Relay contacts to logic	 1500 VAC
Relay base auxiliary power	9.1 W typical, 11.68 W Maximum
Auxiliary power supply [1]	25V typical (before output auctioneering diode drop within Ovation auxiliary power supply) 25.5V Maximum@60°C
Channel ratings [3]	3.15A @ 150VAC
Bus power ratings [4]	10A @ 150 VAC
Operating temperature range [2]	0 to 60°C (32°F to 140°F)
Storage temperature range	-40 to 70°C (-40°F to 158°F)
Humidity (non-condensing)	35 - 85%
[1] Use of the internal Ovation auxiliary power supply is recommended for relay output modules. [2] See additional application derating (see page 449) information. [3] Channel rating is limited to 3.15A by the internal channel fuse. Standard fuse carry current derating apply. (0.5%/°C above 30°C) [4] Bus rating is limited to 10A by the internal channel fuse. Standard fuse carry current derating apply. (0.5%/°C above 30°C)	

Fused High Power Relay Output Base Assembly Specifications (5X00430G01 - G04) (KUEP)

Description	Value
Number of channels	12
Relay Type	5X00430G02-G04 - Form C 5X00430G01-G03 - Form X
Typical propagation time	Operate time: 15 mSec, excluding bounce Release time: 10 mSec, excluding bounce

DESCRIPTION	VALUE
Dielectric isolation: Relay contacts to logic	 1500 VAC
Relay base auxiliary power	Auxiliary power: 23.45 W typical, 30.1 W Maximum (Form C relays) 15.9 W typical, 20.41 W Maximum (Form X relays)
Auxiliary power supply [1]	25V typical (before output auctioneering diode drop within Ovation auxiliary power supply) 25.5V Maximum @42°C (108°F) (Form C relays) 25.5V Maximum @60°C (140°F) (Form X relays)
Operating temperature range [2]	0 to 45°C (32°F to 113°F) (Form C relays) 0 to 60°C (32°F to 140°F) (Form X relays)
Channel ratings [3]	3.15A @ 150VAC[5]
Bus power ratings [4]	10A @ 150 VAC[5]
Storage temperature range	KUEP C: -40 to 50°C (-40°F to 122°F) KUEP X: -40 to 70°C (-40°F to 158°F)

[1] Use of internal Ovation auxiliary power supply is recommended for Relay Output modules.
[2] See additional application derating information contained in *Using Relay Output Bases (see page 449).*
[3] Channel rating is limited to 3.15A by the internal channel fuse. Standard fuse carry current derating apply. (0.5%/°C above 30°C)
[4] Bus rating is limited to 10A by the internal channel fuse. Standard fuse carry current derating apply. (0.5%/°C above 30°C)
[5] The panel is designed to 150VDC. However, the power source must have the return ("-") lead referenced to earth. Projects must review the power scheme to determine applicability.

7.6 32 Channel 24V DC Single-Ended Digital Output module (Windows Ovation 3.4 and above)

The Ovation 32 Channel 24V DC Single-Ended Digital Output module contains 32 24-volt single-ended digital output channels. Each digital output channel is capable of sourcing up to 500 mA of output current with a 2A maximum total output current limit per module.

Note: *The Ovation 32 Channel 24V DC Single-Ended Digital Output module is only available for Ovation software releases 3.4 and later.*

The digital output module switches high-side 24V DC power to 32 external loads. Switched power for all 32 digital output channels is derived from the Ovation 24V DC Auxiliary Power Supply. All 32 digital output channels share a common return with the Auxiliary 24V DC power supply.

Note: *The 32 Channel 24V DC Single-Ended Digital Output requires the use of an Ovation 4-slot I/O base (5X00497G01) which provides additional wire terminations to support the 32 channels. The 32 Channel 24V DC Single-Ended Digital Output cannot be used with the standard I/O Bases (1B30035H01, 1X00014H01, or 5X00334G01).*

The I/O Module General Information *(see page 25)* *section contains environmental, installation, wiring, and fuse information for I/O modules.*

7.6.1 Electronics modules (Emod) - 32 Channel 24V DC Single-Ended Digital Output

5X00500G01 - providing 32 Channels of 24V DC High-Side, Single-Ended Digital Output switching

7.6.2 Personality modules (Pmod) - 32 Channel 24V DC Single-Ended Digital Output

1X00691H01 - The 32 Channel 24V DC Single-Ended Digital Output module does not require a Pmod for any electrical connections to field terminals. A cavity insert is used in the Pmod location to cover the unused Pmod connector and provide terminal wiring information.

7.6.3 Subsystems - 32 Channel 24V DC Single-Ended Digital Output

32 Channel 24V DC Single-Ended Digital Output subsystems

DESCRIPTION	CHANNELS	ELECTRONICS MODULE OR PANEL KIT	PERSONALITY MODULE
32 Channel 24V DC High-Side, Single-Ended Digital Output	32	5X00500G01	1X00691H01

Note: *The 32 Channel 24V DC Single-Ended Digital Output requires the use of an Ovation 4-slot I/O Base (5X00497G01) which provides additional wire terminations to support the 32 channels.*

The 32 Channel 24V DC Single-Ended Digital Output cannot be used with the standard I/O Bases (1B30035H01, 1X00014H01, or 5X00334G01).

7.6.4 Terminal block wiring information - 32 Channel 24V DC Single-Ended Digital Output

The terminal block wiring diagram for the 32 Channel 24V DC Single-Ended Digital Output module is illustrated in the following figure. The following table lists and defines abbreviations used in the diagram.

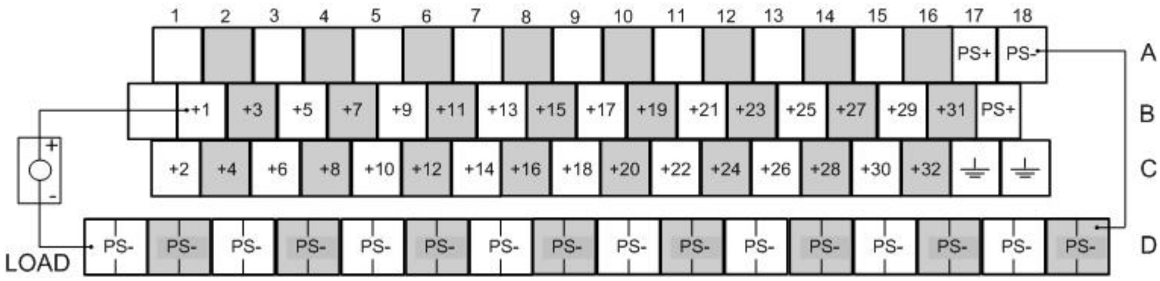
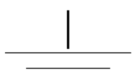


Figure 121: Terminal block connections for the 32 Channel Single-Ended Digital Output module

Abbreviations used in wiring diagrams

Abbreviation	Definition
	Earth ground terminals.
+1 through +32	Digital Output Positive terminal connection
PS-	Auxiliary 24V DC Power Supply Return. All PS- terminals are tied together internally on the Digital Output module/base. Two (2) terminal connections per terminal strip screw are used to support 32 channels.
PS+ / PS-	Auxiliary 24V DC Power Supply Terminals. No external connections are required when using Ovation +24V DC Auxiliary Power Supply. Ovation Aux Supply provided to module through branch.
	Reserved terminal. No connection allowed on these unmarked terminals.
+24V DC Auxiliary power enters module through an internal branch connection or terminal block connection (PS+/PS-). Power is fused on the module then delivered to each channel's power switch. The high-side power is switched to each channels' positive output terminal (+1 through +32) for connection to the field device positive terminal. Each field device return signal is tied to the PS- connection on the base terminal strip. All PS- connections are tied together at the base terminal strip and connected to PS- of the Auxiliary Power Supply.	

7.6.5 Field connection wiring diagram - 32 Channel 24V DC Single-Ended Digital Output

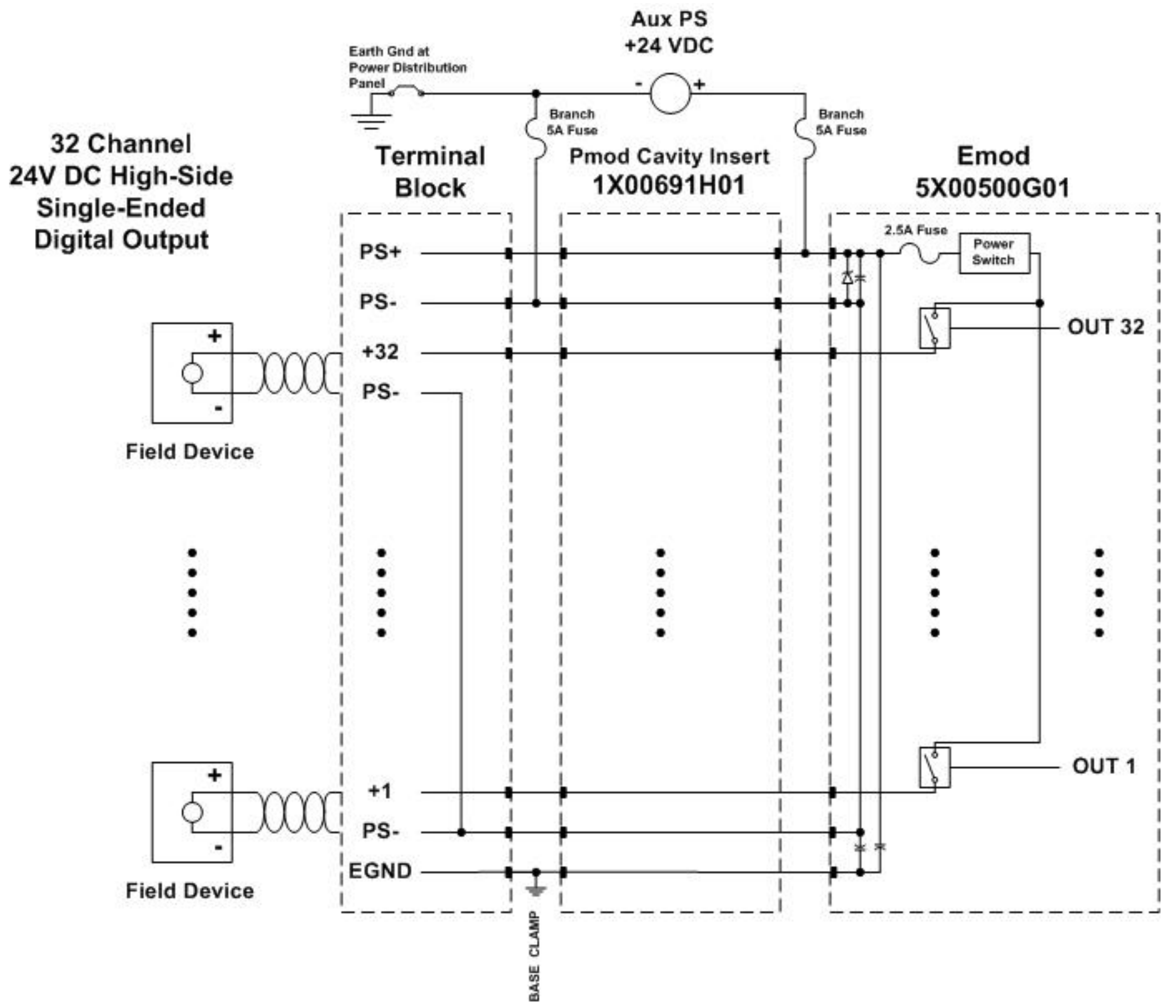


Figure 122: Wiring diagram - 32 Channel 24V DC Single-Ended Digital Output module

7.6.6 Register configuration/status information - 32 Channel 24V DC Single-Ended Digital Output

The Module Configuration / Status Register is module I/O register 13 (0xD) and is a write register.

32 Channel Single-Ended Digital Output Configuration/Status (Address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	1 = configured 0 = not configured	1 = configured* 0 = not configured
1	1 = forced error 0 = no forced error	1 = forced error set by Controller 0 = no forced error*
2 - 4	Timer Bit 0 - 2	Timer Bit 0 - 2

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
5	1 = Hold Outputs on Timeout 0 = Reset Outputs on Timeout	1 = Outputs held on Timeout 0 = Outputs reset on Timeout
6	Not defined	Not defined. 0 = permanent value
7	Not defined	1 = Blown fuse detected 0 = Fuse OK*
8 - 14	Not defined	Not defined. 0 = permanent value
15	Not defined	1 = Channel fault exists (see registers 0xB and 0xC for fault) 0 = No channel faults exist
* Default value		

Channel Status Register - 32 Channel 24V DC Single-Ended Digital Output

Word addresses 11 (0xB in Hex) and 12 (0xC in Hex) are used to report fault status of the individual digital output channels. A reported fault may indicate channel short-circuit, overload condition, or switch IC case temperature above limit.

Channel Status Register (Address 11 - 0xB in Hex)

Bit	Description (Read Only)
0	1 = Channel 1 Fault Exists 0 = No Fault Reported on Channel 1
1	1 = Channel 2 Fault Exists 0 = No Fault Reported on Channel 2
2	1 = Channel 3 Fault Exists 0 = No Fault Reported on Channel 3
3	1 = Channel 4 Fault Exists 0 = No Fault Reported on Channel 4
4	1 = Channel 5 Fault Exists 0 = No Fault Reported on Channel 5
5	1 = Channel 6 Fault Exists 0 = No Fault Reported on Channel 6
6	1 = Channel 7 Fault Exists 0 = No Fault Reported on Channel 7
7	1 = Channel 8 Fault Exists 0 = No Fault Reported on Channel 8
8	1 = Channel 9 Fault Exists 0 = No Fault Reported on Channel 9
9	1 = Channel 10 Fault Exists 0 = No Fault Reported on Channel 10
10	1 = Channel 11 Fault Exists 0 = No Fault Reported on Channel 11

Bit	Description (Read Only)
11	1 = Channel 12 Fault Exists 0 = No Fault Reported on Channel 12
12	1 = Channel 13 Fault Exists 0 = No Fault Reported on Channel 13
13	1 = Channel 14 Fault Exists 0 = No Fault Reported on Channel 14
14	1 = Channel 15 Fault Exists 0 = No Fault Reported on Channel 15
15	1 = Channel 16 Fault Exists 0 = No Fault Reported on Channel 16

Channel Status Register (Address 12 - 0xC in Hex)

Bit	Description (Read Only)
0	1 = Channel 17 Fault Exists 0 = No Fault Reported on Channel 17
1	1 = Channel 18 Fault Exists 0 = No Fault Reported on Channel 18
2	1 = Channel 19 Fault Exists 0 = No Fault Reported on Channel 19
3	1 = Channel 20 Fault Exists 0 = No Fault Reported on Channel 20
4	1 = Channel 21 Fault Exists 0 = No Fault Reported on Channel 21
5	1 = Channel 22 Fault Exists 0 = No Fault Reported on Channel 22
6	1 = Channel 23 Fault Exists 0 = No Fault Reported on Channel 23
7	1 = Channel 24 Fault Exists 0 = No Fault Reported on Channel 24
8	1 = Channel 25 Fault Exists 0 = No Fault Reported on Channel 25
9	1 = Channel 26 Fault Exists 0 = No Fault Reported on Channel 26
10	1 = Channel 27 Fault Exists 0 = No Fault Reported on Channel 27
11	1 = Channel 28 Fault Exists 0 = No Fault Reported on Channel 28
12	1 = Channel 29 Fault Exists 0 = No Fault Reported on Channel 29
13	1 = Channel 30 Fault Exists 0 = No Fault Reported on Channel 30
14	1 = Channel 31 Fault Exists 0 = No Fault Reported on Channel 31

Bit	Description (Read Only)
15	1 = Channel 32 Fault Exists 0 = No Fault Reported on Channel 32

7.6.7 Diagnostics - 32 Channel 24V DC Single-Ended Digital Output

Logic card LED indications

LED	Description
P (green)	The Power OK LED is lit when the module main power is OK.
C (green)	The Communication OK LED is lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED is lit to indicate Auxiliary 24V DC field power is not present, is below threshold, or the Auxiliary 24V DC fuse is blown.
I (Red)	The Internal Fault LED is lit under the following conditions: ▪ The Force Error bit (Bit-1) of the Configuration Register is set. ▪ The Ovation Controller is not communicating with the module. ▪ A Channel Fault exists.
1 - 32 (Green)	Each of the 32 channel LEDs represent the states of the Channel 1 through Channel 32 power switches.

Note: *24V Auxiliary Fuse Rating: 2.5A, 250V Fast-acting Fuse 5X20 mm*

7.6.8 Specifications - 32 Channel 24V DC Single-Ended Digital Output

32 Channel 24V DC Single-Ended Digital Output module specifications

Description	Value
Number of channels	32
Output Type	IEC 61131-2 - protected output current sourcing DC output
Output Current per Channel Output Short Circuit to Supply Common Current Limit	500 mA Max, but not more than 2A max. for total 32 channels. 1.2 typ - 1.7A max per channel
Maximum On Voltage	20V
Maximum Off Leakage Current	5uA per channel
Output Delay Time	29.2us Typ, 40us Max (Off to On) - no load 336us Typ, 400us Max (On to Off) - no load

DESCRIPTION	VALUE
Bus I/O Communications Watchdog Timer	Bit 4 / Bit 3 / Bit 2 / Time Out Period 0 0 0 16.777 seconds +/- 10% 0 0 1 4.194 seconds +/- 10% 0 1 0 2.097 seconds +/- 10% 0 1 1 1.049 seconds +/- 10% 1 0 0 524 milliseconds +/- 10% 1 0 1 262 milliseconds +/- 10% 1 1 0 131 milliseconds +/- 10% 1 1 1 65 milliseconds +/- 10%
Diagnostics	Blown fuse detection
Module power	Drawn from Main: 2.35W typ; 2.7W max. (all channels on) Drawn from Auxiliary: 1.2W typ; 1.4W max. (all channels on) 47.6W typ; 57.5W max (all channels on @ 2A limit) Power Dissipation within module: 3.53W typ; 4.05W max. (all channels on)
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
Inductive Kick Protection	Zener Diode -14V max. for 16.5ms with KUEP-3D15-24 relay

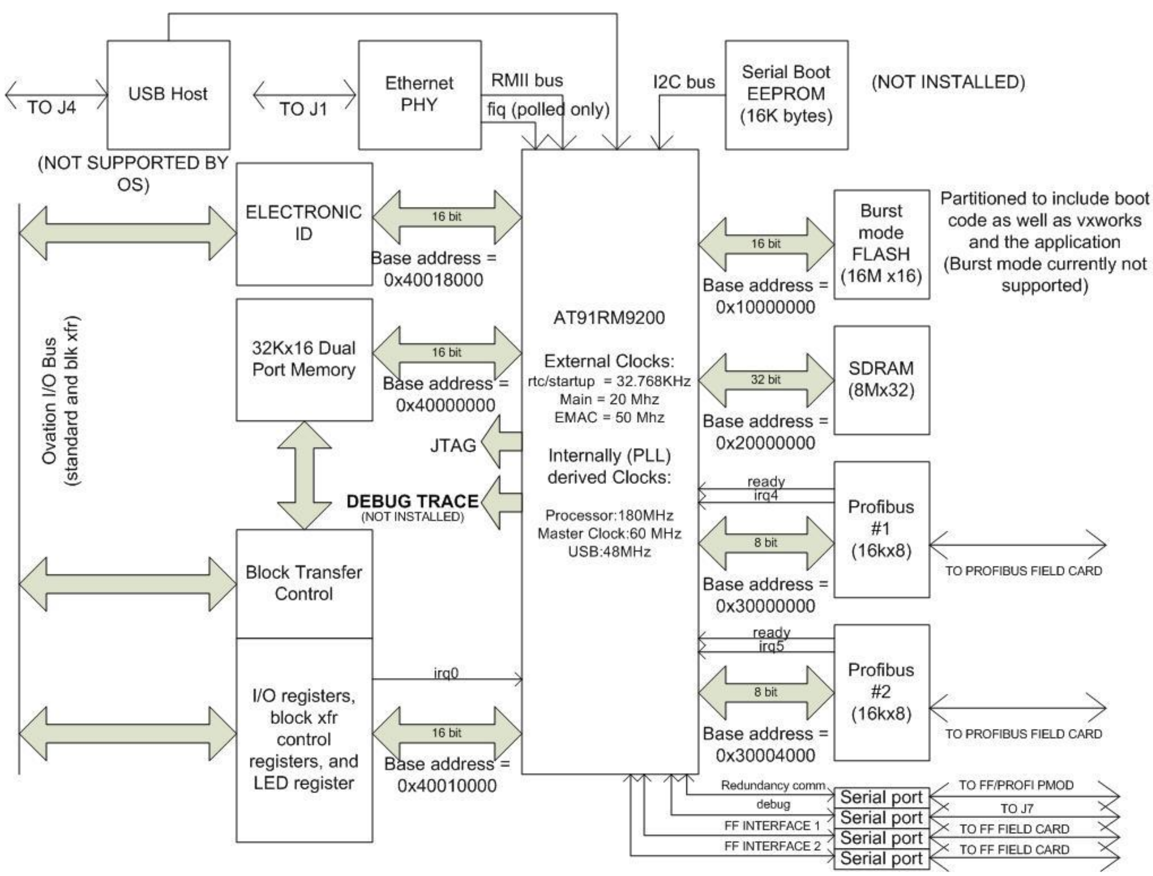
S E C T I O N 8

Features of the Ovation Bus modules

IN THIS SECTION

8.1 Types of the Ovation bus module

8.2 Logic card block diagram for the Ovation bus modules



8.3 DeviceNet module

8.3.1 Subsystems - DeviceNet

DeviceNet subsystems

CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
2	5X00376G01	5X00375G01

8.3.2 Logic card side connector pin assignments - Ovation bus modules (DP)

ROW A, PIN NO.	SIGNAL NAME	ROW A, PIN NO.	SIGNAL NAME
1	CONNECT2/*	1	NO CONNECTION
9	24V RETURN	9	24V RETURN
10	24V RETURN	10	24V RETURN
11	ADDRESSPWR	11	ADDRESS0/**
12	CAL/EEPROM PE	12	ADDRESS3/
13	ADDRESS2/	13	ADDRESS1/
14	24V RETURN	14	24V RETURN
15	SYNC- ***	15	SYNC+ ***
16	24V RETURN***	16	24V RETURN***
17	CLOCK- *	17	CLOCK+ ***
18	24V RETURN***	18	24V RETURN***
19	DATA- *	19	DATA+ *
20	24V RETURN	20	24V RETURN
21	+24VOLTS (B)*	21	+24VOLTS (B)*
22	+24VOLTS (A)*	22	+24VOLTS (A)*
23	24V RETURN	23	24V RETURN
24	24V RETURN	24	24V RETURN
32	CONNECT1/ *	32	NO CONNECTION

* Short Pin.

** 24V Return for module installed in B-side of base, open for module installed in A-side of base.

*** Backplane signal not used by module.

***Note:** Rows A and B pins 2 through 8, and 25 through 31 are not used and, therefore, are not shown.*

8.3.3 Interface - DeviceNet

Two DeviceNet Interfaces are provided on the Profibus/DeviceNet field card. Each Interface is based on a communication processor with a communication interface for the DeviceNet network and an integral dual port memory for communication with the host processor.

Communication between the dual port memory and the host processor on the logic card is through an 8-bit parallel interface mapped into the memory space of the host processor. The circuitry includes a galvanically isolated CAN interface for connection to the DeviceNet network.

Each connection to the network is through a female 5-pin connector or through the Ovation base. These two connectors (one for each interface) are available on a personality module. Line termination and biasing are part of the network mating connector per standard.

The EC1 processor provides an RS232 port for troubleshooting purposes. These ports (one for each interface) are made available through a 5-pin header and can only be accessed with the module cap removed.

MAIN FEATURES

1. DeviceNet field cards provide 2 independent galvanically isolated DeviceNet channels. Each channel uses a galvanically isolated 5W switching regulator to convert 24 VDC DeviceNet network power to 5VDC to power DeviceNet field side components. This provides galvanic isolation between the DeviceNet field network and the Ovation module. Additionally, the personality card uses individual channel isolated ground and power planes to achieve channel to channel isolation.
2. Each DeviceNet channel uses an EC-1 ASIC microcontroller, to act as a DeviceNet master Controller.
3. Each EC-1 provides CMOS level CAN differential signals to and from the galvanically isolated DeviceNet transceiver chip PCA82C251. The PCA82C251 then translates them to CAN level differential signal for DeviceNet communication.
4. Two DeviceNet standard 5-pin Combicon connectors are located on the DeviceNet personality module and require standardized DeviceNet cabling.

5. The DeviceNet personality also routes the 5 standard DeviceNet signals from the Combicon connectors to the Ovation base to provide Maximum DeviceNet cabling flexibility.

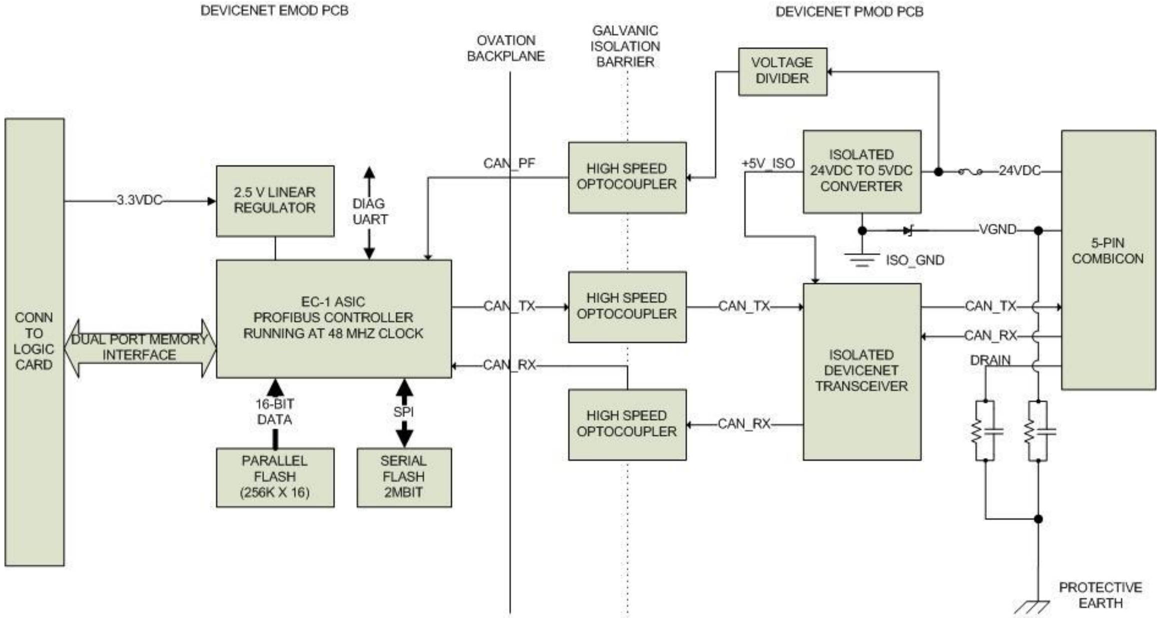
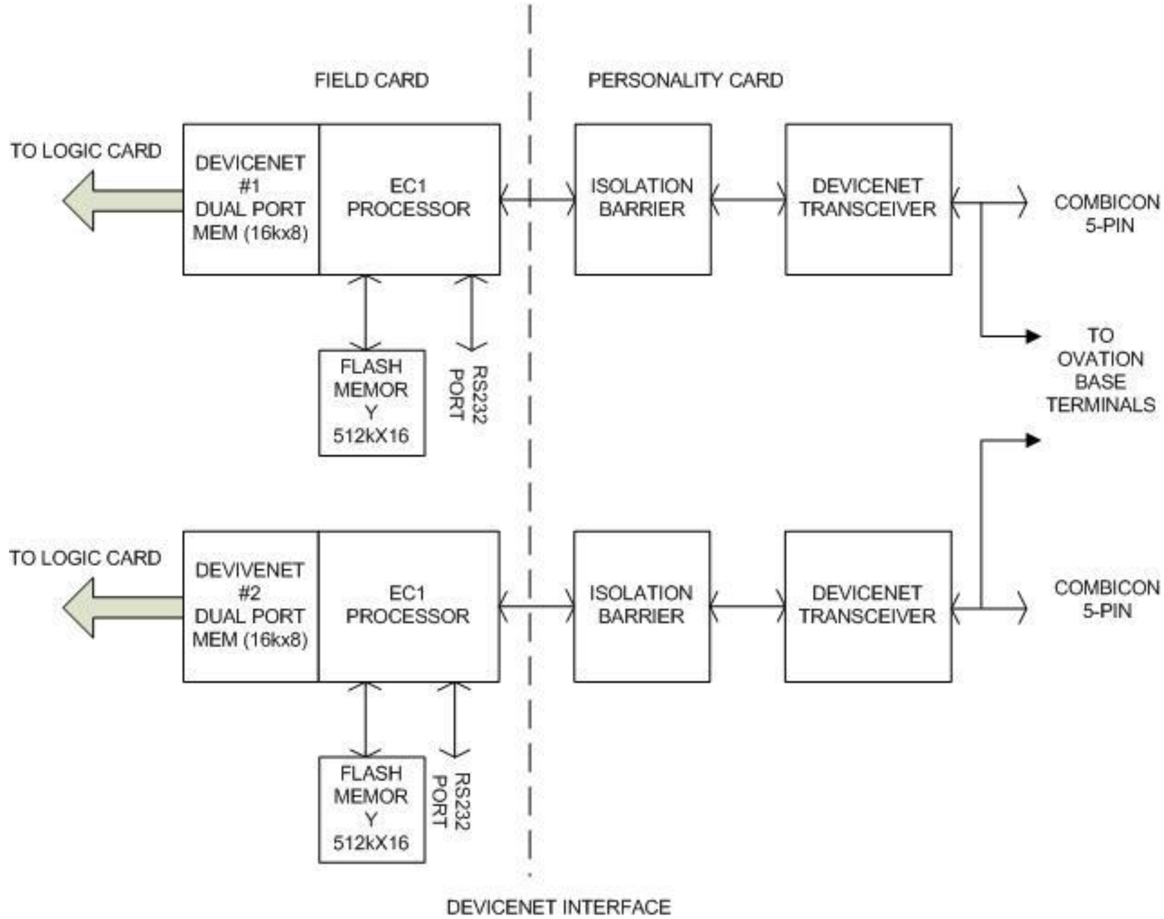


FIGURE X. DEVICENET EMOD AND PMOD BLOCK DIAGRAM

8.3.4 Module block - DeviceNet



8.3.5 Terminal block pin assignments - DeviceNet

The terminal block is a 53-position compression-style terminal block arranged in 3 rows. The "A" row, highest relative to the base, has 18 positions. The middle, or "B" row has 17 positions. The "C" row, nearest to the base, has 18 positions.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Maximum working voltage is 150 V peak DC or RMS AC.

Current rating is 5 amps.

Maximum wire size: 12 AWG single wire or two 14 AWG wires/terminal.

The base unit termination block assignments are shown in the following table.

Base unit termination block assignments

ROW C PIN NO.	SIGNAL NAME	ROW B PIN NO.	SIGNAL NAME	ROW A PIN NO.	SIGNAL NAME
1 - 3	RSV	1 - 3	RSV	1 - 3	RSV
4	CROSS CONNECT TX	4	CROSS CONNECT RX	4	RSV
5	RSV	5	CROSS CONNECT GND	5	CH1 V+
6	RSV	6	RSV	6	CH1 Can H
7	RSV	7	RSV	7	CH1 Drain
8	RSV	8	RSV	8	CH1 Can L
9	RSV	9	RSV	9	CH1 V-
10	RSV	10	RSV	10	CH2 V+
11	RSV	11	RSV	11	CH2 Can H
12	RSV	12	RSV	12	CH2 Drain
13	RSV	13	RSV	13	CH2 Can L
14	RSV	14	RSV	14	CH2 V-
16	RSV	16	RSV	16	RSV
17	EARTH GROUND	17	PS+	17	PS+
18	EARTH GROUND			18	PS-

Note: *PS+ and PS- are not used. The cross connect redundancy signals are the same as those accessed with the RS232 redundancy connector on the PMOD. No connections are permitted to terminals marked RSV.*

Note: *Connection to the DeviceNet is made through a 9-pin female "D subminiature" connector on the PMOD. There is one connector for each channel.*

8.3.6 EMOD backplane connectors - DeviceNet

This connector is located on the DeviceNet field card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	NOT USED	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	NOT USED	7	NOT USED
9	NOT USED	10	NOT USED	9	NOT USED
11	NOT USED	12	NOT USED	11	NOT USED
13	NOT USED	14	CH2 CAN PF	13	NOT USED
15	CH2 CAN RX	16	CH2 CAN TX	15	NOT USED
17	NOT USED	18	NOT USED	17	NOT USED
19	CH1 CAN PF	20	CH1 CAN TX	19	NOT USED
21	CH1 CAN RX	22	CH2 PB RX	21	NOT USED
23	CH2 PB TX	24	CH2 PB ENAB	23	NOT USED
25	RPTR CTL*	26	CH1 PB RX	25	NOT USED
27	CH1 PB TX	28	CH1 PB ENAB	27	NOT USED
29	DGND	30	+5V	29	NOT USED
31	ARM9 RS232 RXDXD	32	ARM9 RS232 TXD	31	NOT USED
33	EC1 CH2 RS232 RXD	34	EC1 CH2 RS232 TXD	33	NOT USED
35	NOT USED	36	+3.3V	35	NOT USED
37	EC1 CH1 RS232 RXD	38	EC1 CH1 RS232 TXD	37	NOT USED

8.3.7 PMOD backplane connectors - DeviceNet

This connector is located on the DeviceNet personality card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	EARTH GROUND*	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	NOT USED	7	NOT USED
9	NOT USED	10	NOT USED	9	DGND
11	CH2 V+	12	+3.3V	11	NOT USED
13	CH2 CAN H	14	CH2 CAN PF	13	NOT USED
15	CH2 DRAIN	16	CH2 CAN TX	15	CH2 CAN RX
17	CH2 CAN L	18	NOT USED	17	NOT USED
19	CH2 V-	20	CH1 CAN TX	19	CH1 CAN PF
21	CH1 V+	22	NOT USED	21	NOT USED
23	CH2 PB TX	24	NOT USED	23	NOT USED
25	RPTR CTL*	26	NOT USED	25	NOT USED
27	CH1 PB TX	28	NOT USED	27	NOT USED
29	CH1 V-	30	+5V	29	NOT USED
31	NOT USED	32	ARM9 RS232 TXD	31	ARM9 RS232 RDXD
33	NOT USED	34	EC1 CH2 RS232 TXD	33	EC1 CH2 RS232 RXD
35	NOT USED	36	+3.3V	35	NOT USED
37	NOT USED	38	EC1 CH1 RS232 TXD	37	EC1 CH1 RS232 RXD

* EARTH GROUND is connected to pin B1 as well.

8.3.8 Diagnostic LEDs - DeviceNet

Logic card LED indications

LED	Description
P (green)	Power OK LED. Lit when the logic board's +5V and +3.3V digital supply voltage level is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (red)	Internal Fault LED. Lit when the forced error bit (bit 1) of the configuration register is set, or when the Ovation Controller is not communicating with the module.
1 - 5	No LED.
6 ACT (green)	Ethernet activity.
7 FDX (yellow)	Full duplex Ethernet communication.
8-12 S4 - S0 (red)	General purpose red LEDs. Lit under firmware control of the ARM9 processor.
13 - 16	No LED.

Field card LED indications Channels 1 and 2

LED	LED State	Meaning
RDY (red)	ON	Device is ready.
	5 Hz Flashing	Firmware Download in progress.
	1Hz Flashing	Device in Bootloader mode and is awaiting firmware download.
	Non-Cyclic Flashing	Hardware or runtime error.
	OFF	Device has no power or hardware defect.
RUN (green)	ON	Communication is established with at least one field device.
	5 Hz Flashing	If MNS LED is GREEN then Device is established, but communication is stopped, If MNS LED is flashing RED then NO slave has been found.
	Non-Cyclic Flashing	At power up it indicates configuration missing, at runtime it indicates watchdog timeout.
	OFF	No Communication.
MNS Module/ Network Status (Combined red/green)	OFF	Device is not on-line ▪ The device has not completed the Dup ▪ MAC_ID test yet. ▪ The device may not be powered
	Steady Green	The device is operating in a normal condition and the device is on-line with connections in the established state.
	Flashing Green	The device is operating in a normal condition and the device is on-line with no connections in the established state.
	Flashing Red	Any one or more of the following conditions: ▪ Recoverable fault ▪ One or more I/O connections has timed out ▪ No network power present.
	Steady Red	Device has an unrecoverable fault and may need replacing

8.3.9 Specifications - DeviceNet

- **Electronics module 5X00376G01**
- **Personality module 5X00375G01**

Description	Value			
Voltage		Minimum	Nominal	Maximum
	Main Primary Voltage	21.0V	24.0V	25.0V
	Main Secondary Voltage	21.0V	24.0V	25.0V
	Aux. Voltage	22.8V	24.0V	25.5V
Ovation I/O Bus Current (+24V Main)	132 mA typ.*			
Ovation I/O Bus Power (+24V Main)	3.168 W typ.*			
Input Under-voltage Lockout	17-18.5 volts			

Description	Value
Input Over-voltage Crowbar	29-35 volts
Number of segments per module	2
Interface characteristics	RS485, 12 Mbaud Max
Ethernet	10/100 MBaud, Auto-negotiation supported MDIX not supported, Standard RJ45 connection on the EMOD Access only with cap removed
ARM9 Diagnostic Port	RS232, 57.6 Kbaud Max, 5 pin header on the logic card, Access only with cap removed
Dielectric Isolation	+/- 1,000 V DC or peak AC for one minute, channel to channel or channel to logic
International Electromagnetic Compatibility	Specification EN55011 EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-5 EN61000-4-6
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	40°C to 85°C (40°F to 185°F) per Ovation standard.
Humidity (non-condensing) range	0% to 95%
Vibration	0.15mm displacement from 10 to 57 Hz and 2G's from 57 to 500 Hz
Shock	15G's for 11 milliseconds and 1/2 sine wave.

8.4 Foundation Fieldbus module

8.4.1 Subsystems - Foundation Fieldbus

Foundation Fieldbus subsystems

Channels	Electronics module	Personality module
2 (non-redundant)	5X00301G01	1C31238H01 (cavity insert)
2 (redundant)	5X00301G01	5X00327G01

8.4.2 Logic card side connector pin assignments - Ovation bus modules (DP)

Row A, Pin No.	Signal Name	Row A, Pin No.	Signal Name
1	CONNECT2/*	1	NO CONNECTION
9	24V RETURN	9	24V RETURN
10	24V RETURN	10	24V RETURN
11	ADDRESSPWR	11	ADDRESS0/**

Row A, Pin No.	Signal Name	Row A, Pin No.	Signal Name
12	CAL/EEPROM PE	12	ADDRESS3/
13	ADDRESS2/	13	ADDRESS1/
14	24V RETURN	14	24V RETURN
15	SYNC- ***	15	SYNC+ ***
16	24V RETURN***	16	24V RETURN***
17	CLOCK- *	17	CLOCK+ ***
18	24V RETURN***	18	24V RETURN***
19	DATA- *	19	DATA+ *
20	24V RETURN	20	24V RETURN
21	+24VOLTS (B)*	21	+24VOLTS (B)*
22	+24VOLTS (A)*	22	+24VOLTS (A)*
23	24V RETURN	23	24V RETURN
24	24V RETURN	24	24V RETURN
32	CONNECT1/ *	32	NO CONNECTION

* Short Pin.

** 24V Return for module installed in B-side of base, open for module installed in A-side of base.

*** Backplane signal not used by module.

***Note:** Rows A and B pins 2 through 8, and 25 through 31 are not used and, therefore, are not shown.*

8.4.3 Interface - Foundation Fieldbus

Two Foundation Fieldbus interfaces are provided on the Foundation Fieldbus field card. Each interface provides an ARM7 processor for stack management, Fieldbus Interface Chip (FINCH) and a Media Attachment Unit (Shortbow MAU). Communication between the ARM7 processor and the host processor on the logic card is through an asynchronous serial interface running at up to 38.4 Kbaud.

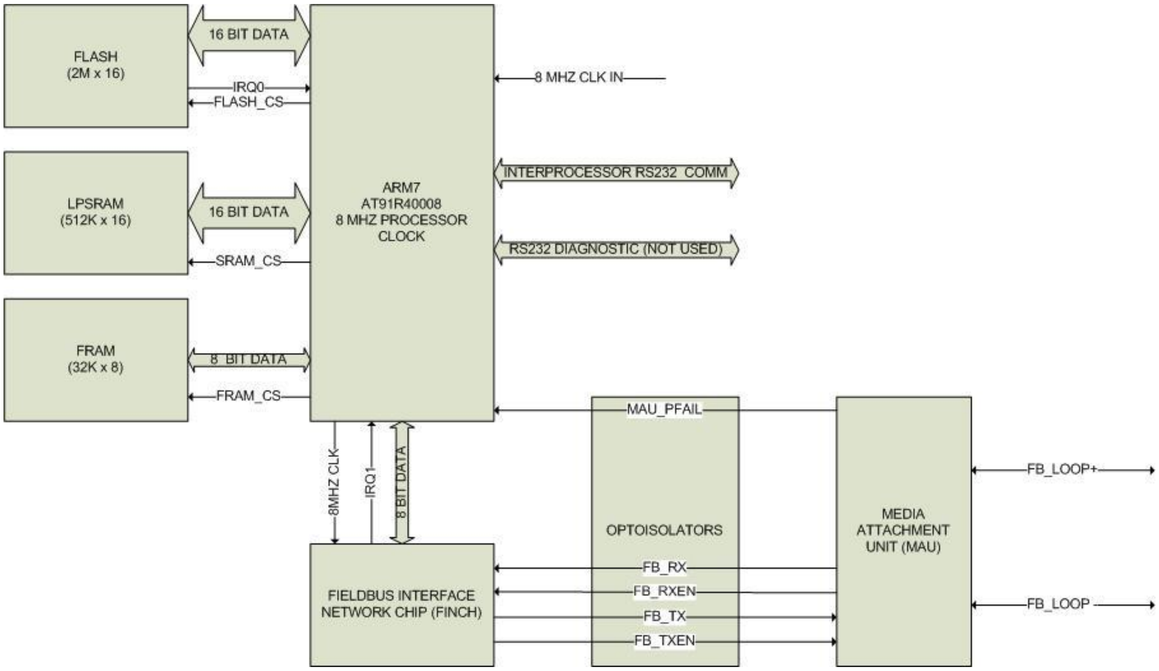
The connection to the Fieldbus network is via the base unit's terminal block. Foundation Fieldbus Power conditioners and Power supplies must be provided externally. A Personality Module is provided that includes an RJ45 jack for the redundancy cable as well as two 9-pin D connectors (one per channel) to access a second serial port on the ARM7 processor. The second serial port is intended for troubleshooting purposes; however, the fact that the interface is present does not imply software support.

Additionally, a JTAG port is available to support emulation and firmware development. This port is only available with the modules removed from the case. Note that the JTAG port is not available for boundary scan testing.

Main features

1. Each Foundation Fieldbus Field Card contains 2 independent galvanically isolated Fieldbus channels. Each channel provides galvanic isolation between the Fieldbus field power and the main 24VDC power supply. Additionally, the Foundation Fieldbus Field Card employs signal separation to achieve channel to channel isolation.
2. Foundation Fieldbus Field cards use a Foundation Fieldbus approved H1 host Controller stack and are in compliance with IEC standard 61158.
3. Each Fieldbus channel uses an ARM7 microcontroller to control the Fieldbus data communications. Each ARM7 uses a 38.4 kbaud UART interface to interface data with the Ovation module logic card. This allows the logic card to have positive control over the Fieldbus network traffic.
4. Each Fieldbus channel uses a Shortbow Media Attachment Unit (MAU) application specific integrated circuit (ASIC) to translate CMOS level logic to current modulated (+ and - 10 mA) Fieldbus signals. The Shortbow derives its power from the 9 - 32 VDC (typically 24VDC) Fieldbus network.
5. Fieldbus signals coming from the MAU are optically coupled and translated to CMOS logic prior to the FINCH and microprocessor to maintain galvanic isolation.

6. Each Fieldbus channel uses a Fieldbus Interface Chip ASIC or FINCH to translate Manchester encoded CMOS logic level signals coming from the MAU into 8-bit register values to be passed to the microcontroller.

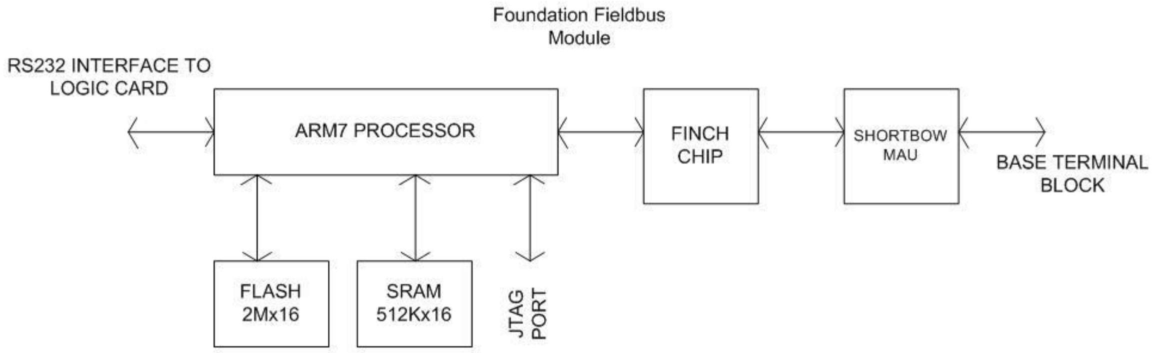


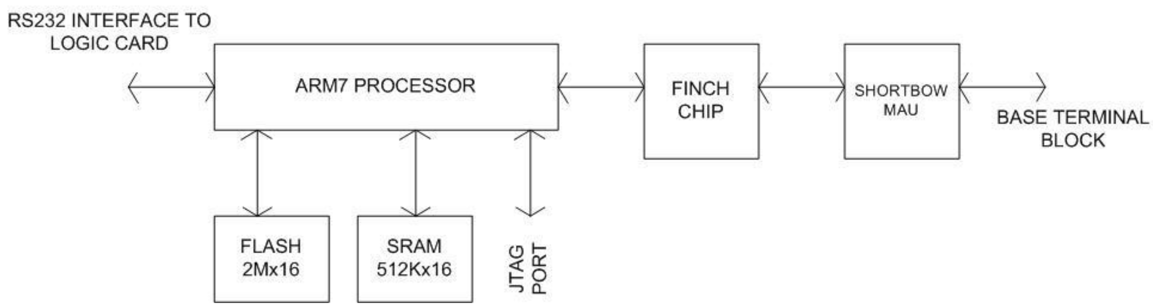
8.4.4 Redundancy module - Foundation Fieldbus

Foundation Fieldbus solutions support redundancy. Redundant modules each sit on the same segment, although only one is the master. The other is in backup mode and does not control the segment. If a module is in control, it is in control over both segments available on each module. Assume control is passive as far as the Module is concerned. That is, the decision to place a module in control or backup is made by the Controller.

Redundant modules communicate over a private RS232 port. Logically, this port goes to USART port 1 on the ARM 9 (where available ports are 0-3). Physically, the connection is made through an RJ45 jack located on the respective PMOD (PPB or PFF). The pinout of the RJ45 jack is such that a standard null modem CAT5 Ethernet cable can be used.

8.4.5 Module block diagram - Foundation Fieldbus





8.4.6 Terminal block pin assignments - Foundation Fieldbus

The terminal block is a 53-position compression-style terminal block arranged in 3 rows.

- The "A" row, highest relative to the base, has 18 positions.
- The middle, or "B" row, has 17 positions.
- The "C" row, nearest to the base, has 18 positions.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. Refer to:* Marshaling Base Unit *(see page 35) for more information.*

Maximum working voltage is 150 V peak DC or RMS AC.

Current rating is 5 amps.

Maximum wire size: 12 AWG single wire or two 14 AWG wires terminal.

The base unit termination block assignments are shown in the following table.

Base unit termination block assignments

Row C Pin No.	Signal Name	Row B Pin No.	Signal Name	Row A Pin No.	Signal Name
1 - 2	RSV	1 - 2	RSV	1 - 2	RSV
3	FIELDBUS #1+	3	FIELDBUS #1-	3	RSV

Row C Pin No.	Signal Name	Row B Pin No.	Signal Name	Row A Pin No.	Signal Name
4	CROSS CONNECT TX	4	CROSS CONNECT RX	4	RSV
5	RSV	5	CROSS CONNECT GND	5	RSV
6 - 9	RSV	6 - 9	RSV	6 - 9	RSV
10	FIELDBUS #2+	10	FIELDBUS #2-	10	RSV
11 - 16	RSV	11 - 16	RSV	11 - 16	RSV
17	EARTH GROUND	17	PS+	17	PS+
18	EARTH GROUND			18	PS-

Note: *PS+ and PS- are not used. The cross connect redundancy signals are the same that are accessed with the RS232 redundancy connector on the PMOD. No connections are permitted to terminals marked RSV.*

8.4.7 EMOD backplane connectors - Foundation Fieldbus

This connector is located on the Foundation Fieldbus field card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Pin Assignments:

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	NOT USED	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	+3.3V	7	NOT USED
9	NOT USED	10	NOT USED	9	NOT USED
11	NOT USED	12	NOT USED	11	NOT USED
13	NOT USED	14	NOT USED	13	NOT USED
15	CH2 RXD	16	CH2 TXD	15	NOT USED
17	NOT USED	18	NOT USED	17	NOT USED
19	CH2 LOOP-	20	CH2 LOOP+	19	NOT USED
21	NOT USED	22	NOT USED	21	NOT USED
23	NOT USED	24	NOT USED	23	NOT USED
25	NOT USED	26	NOT USED	25	NOT USED
27	NOT USED	28	NOT USED	27	NOT USED

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
29	DGND	30	NOT USED	29	NOT USED
31	ARM9 RS232 RXDXD	32	NOT USED	31	NOT USED
33	CH1 LOOP-	34	CH1 LOOP+	33	NOT USED
35	NOT USED	36	NOT USED	35	NOT USED
37	CH1 RXD	38	CH1 TXD	37	NOT USED

8.4.8 PMOD backplane connectors - Foundation Fieldbus

This connector is located on the Foundation Fieldbus personality card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Pin Assignments:

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	NOT USED	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	+3.3V	7	NOT USED
9	NOT USED	10	NOT USED	9	NOT USED
11	NOT USED	12	NOT USED	11	NOT USED
13	NOT USED	14	NOT USED	13	NOT USED
15	NOT USED	16	CH2 TXD	15	CH2 RXD
17	NOT USED	18	NOT USED	17	NOT USED
19	NOT USED	20	CH2 LOOP+	19	CH2 LOOP-
21	NOT USED	22	NOT USED	21	NOT USED
23	NOT USED	24	NOT USED	23	NOT USED
25	NOT USED	26	NOT USED	25	NOT USED
27	NOT USED	28	NOT USED	27	NOT USED
29	NOT USED	30	NOT USED	29	DGND
31	NOT USED	32	ARM9 RS232 TXD	31	ARM9 RS232 RXD
33	NOT USED	34	CH1 LOOP+	33	CH1 LOOP-
35	NOT USED	36	NOT USED	35	NOT USED

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
37	NOT USED	38	CH1 TXD	37	CH1 RXD

8.4.9 Diagnostic Logic card LEDs - Foundation Fieldbus

LED	Description
P (green)	Power OK LED. Lit when the logic board's +5V and +3.3V digital supply voltage level is OK.
C (green)	Communication OK LED. Lit when Ovation Controller is communicating with module.
E, I, 1 - 5	No LED.
6 ACT (green)	Ethernet activity.
7 FDX (yellow)	Full duplex Ethernet communication.
8 - 12 S4 - S1 (red)	General purpose red LEDs. Lit under firmware control of the ARM9 processor.
13 - 16	No LED.

8.4.10 Specifications - Foundation Fieldbus

Personality module (**1X00458G01**)

Description	Value
Voltage	**Min.** / **Nominal** / **Max** *Main Primary Voltage*: 21.0V / 24.0V / 25.0V *Main Secondary Voltage*: 21.0V / 24.0V / 25.0V
Ovation I/O Bus Current (+24V Main)	76 mA type., 90 mA Max.
Ovation I/O Bus Power (+24V Main)	1.82 W type., 2.16 W Max.
Input Undervoltage Lockout	17-18.5 volts
Input Overvoltage Crowbar	29-35 volts
Current and Power Draw from the Fieldbus	17.2 ma/channel type .4128W/channel type
Number of segments per module	2
Interface characteristics	Current Modulation (+/- 10 ma): 31.25 Kbaud
Ethernet (for diagnostics)	10/100 MBaud, Auto-negotiation supported MDIX not supported, Standard RJ45 connection on the EMOD, Access only with cap removed
ARM9 Diagnostic Port	RS232, 57.6 Kbaud Max 5 pin header on the logic card, Access only with cap removed
ARM7 Diagnostic Port using PMOD 5X00327601	RS 232 , 57.6 Kbaud Max 9 pin D connector (female) on the Foundation Fieldbus PMOD

Description	Value
Dielectric Isolation	+/- 1,000 V DC or peak AC for one minute, channel to channel or channel to logic
International Electromagnetic Compatibility	Specification EN55011 EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-5 EN61000-4-6
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	per Ovation standard
Humidity (non-condensing) range	0% to 95%
Vibration	0.15mm displacement from 10 to 57 Hz and 2G's from 57 to 500 Hz
Shock	15G's for 11 milliseconds and 1/2 sine wave.

8.5 Profibus DP module (DP)

8.5.1 Subsystems - Profibus (DP)

Profibus subsystems

Channels	Electronics module	Personality module
2	5X00300GO1	5X00321G01

8.5.2 Logic card side connector pin assignments - Ovation bus modules (DP)

Row A, Pin No.	Signal Name	Row A, Pin No.	Signal Name
1	CONNECT2/*	1	NO CONNECTION
9	24V RETURN	9	24V RETURN
10	24V RETURN	10	24V RETURN
11	ADDRESSPWR	11	ADDRESS0/**
12	CAL/EEPROM PE	12	ADDRESS3/
13	ADDRESS2/	13	ADDRESS1/
14	24V RETURN	14	24V RETURN
15	SYNC- ***	15	SYNC+ ***
16	24V RETURN***	16	24V RETURN***
17	CLOCK- *	17	CLOCK+ ***
18	24V RETURN***	18	24V RETURN***

Row A, Pin No.	Signal Name	Row A, Pin No.	Signal Name
19	DATA- *	19	DATA+ *
20	24V RETURN	20	24V RETURN
21	+24VOLTS (B)*	21	+24VOLTS (B)*
22	+24VOLTS (A)*	22	+24VOLTS (A)*
23	24V RETURN	23	24V RETURN
24	24V RETURN	24	24V RETURN
32	CONNECT1/ *	32	NO CONNECTION
* Short Pin. ** 24V Return for module installed in B-side of base, open for module installed in A-side of base. *** Backplane signal not used by module.			

Note: *Rows A and B pins 2 through 8, and 25 through 31 are not used and, therefore, are not shown.*

8.5.3 Interface - Profibus (DP)

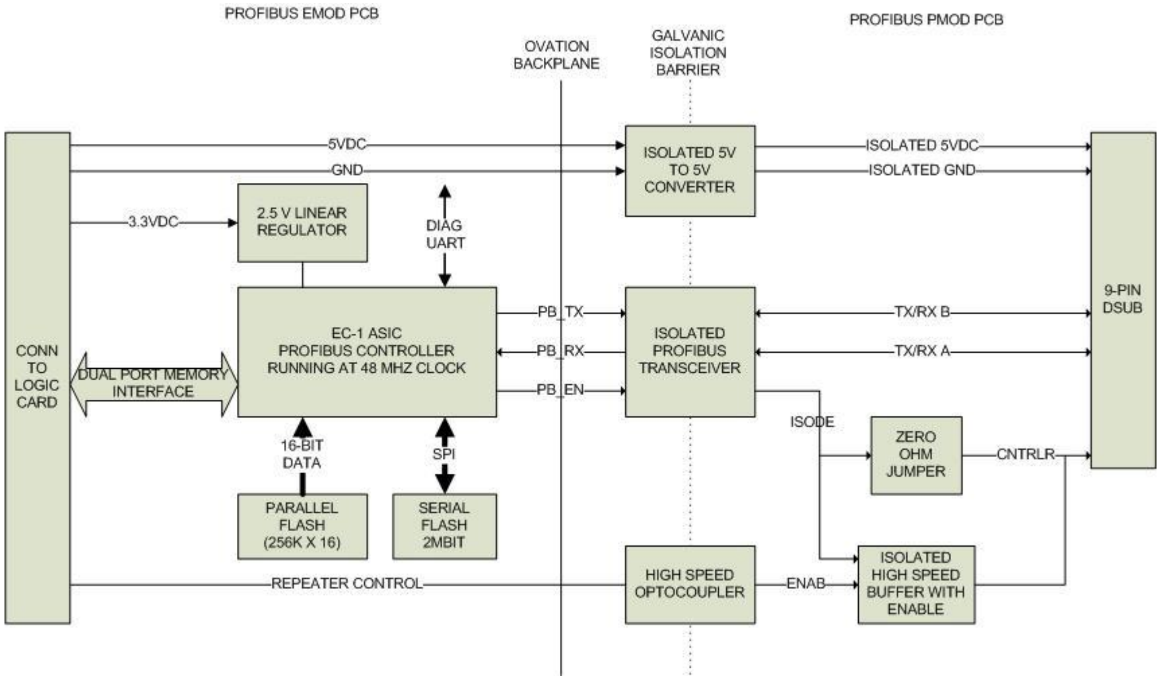
Two Profibus DP Interfaces are provided on the Profibus/DeviceNet field card. Each Interface is based on the Hilscher™ EC1 communication processor. This device is an 80C186 core with communication interface for the Profibus DP network and an integral dual port memory for communication with the host processor. Communication between the dual port memory and the host processor on the logic card is through an 8-bit parallel interface mapped into the memory space of the host processor. The circuitry includes a galvanically isolated RS485 interface for connection to the Profibus DP network. Each connection to the network is through a female 9-pin D connector per the Profibus DP standard. These two D connectors (one for each interface) are available on a personality module. Line termination and biasing are part of the network mating connector per standard. The EC1 processor provides an RS232 port for troubleshooting purposes. These ports (one for each interface) are made available through an RJ45 jack. Access is only available with the module cap removed.

The personality module also provides an accessible RJ-45 Jack for the redundancy cross connect cable.

MAIN FEATURES

1. Profibus field cards provide 2 independent galvanically isolated Profibus channels. Each channel uses a galvanically isolated 1W DC to DC converter to power the Profibus field side components such as ADM2486 which is also isolated. This provides galvanic isolation between the Profibus field network and the Ovation module. Additionally, the Personality card uses individual channel isolated ground and power planes separated by 0.063 inches minimum to achieve channel to channel isolation.
2. Each Profibus channel uses an EC-1 ASIC microcontroller, to act as a Profibus master Controller (IEC 61784 and 61158).
3. Each EC-1 interfaces to the Ovation module logic card (LPB) via a dual port memory built in to the ASIC. The dual port is an 8-bit bidirectional interface that allows the logic access to the Profibus data.

4. Each EC-1 provides CMOS level single ended transmit and receive signals to and from the galvanically isolated Profibus transceiver chip. The ADM2486 then translates them to an RS485 level differential signal for Profibus communication.
5. Two Profibus mandated 9-pin d-subminiature connectors are located on the Profibus Personality Module and require standardized Profibus cabling.
6. In the event a Profibus repeater is used in a redundant application, each Profibus channel is equipped with a tri-state buffer driver circuit which can be enabled or disabled depending on which channel needs to signal the repeater. This circuit is not supported by the logic card nor recognized by Profibus standards.

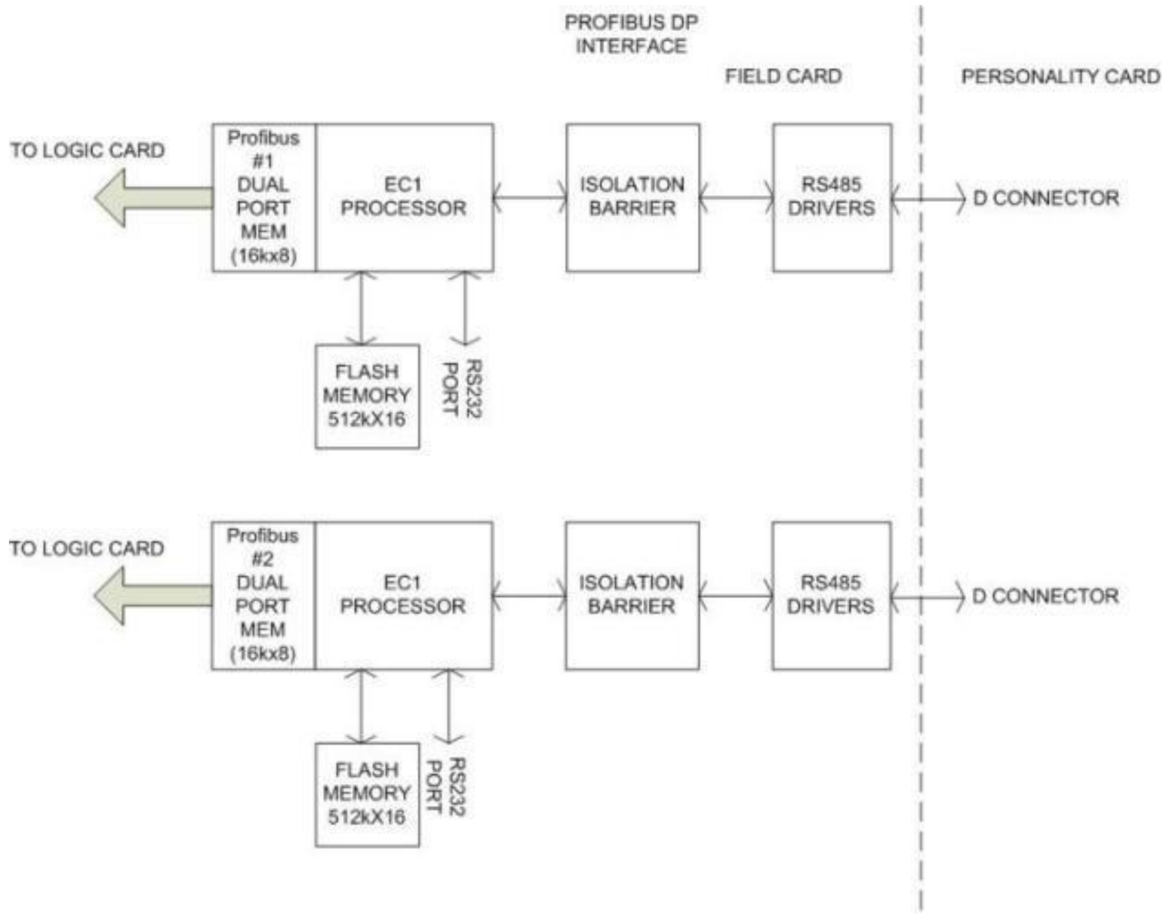


8.5.4 Redundancy module - Profibus (DP)

Profibus DP solutions support redundancy. Redundant modules each sit on the same segment, although only one is the master. The other is in backup mode and does not control the segment. If a module is in control, it is in control over both segments available on each module. Assume control is passive as far as the Module is concerned. That is, the decision to place a module in control or backup is made by the Controller.

Redundant modules communicate over a private RS232 port. Logically, this port goes to USART port 1 on the ARM 9 (where available ports are 0-3). Physically, the connection is made through an RJ45 jack located on the respective PMOD (PPB or PFF). The pinout of the RJ45 jack is such that a standard null modem CAT5 Ethernet cable can be used.

8.5.5 Module block diagram & DP field card/personality card - Profibus (DP)



8.5.6 Terminal block pin assignments - Profibus (DP)

The Profibus DP module base unit has a 53-position compression-style terminal block arranged in 3 rows. The "A" row, highest relative to the base, has 18 positions. The middle, or "B" row has 17 positions. The "C" row, nearest to the base, has 18 positions.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Maximum working voltage is 150 V peak DC or RMS AC.

Current rating is 5 amps.

Maximum wire size is 12 AWG single wire or two 14 AWG wires/terminal.

The base unit termination block assignments are show in the following table.

Row C Pin No.	Signal Name	Row B Pin No.	Signal Name	Row A Pin No.	Signal Name
1 - 3	RSV	1 - 3	RSV	1 - 3	RSV

Row C Pin No.	Signal Name	Row B Pin No.	Signal Name	Row A Pin No.	Signal Name
4	CROSS CONNECT TX	4	CROSS CONNECT RX	4	RSV
5	RSV	5	CROSS CONNECT GND	5	RSV
6 - 16	RSV	6 - 16	RSV	6 - 16	RSV
17	EARTH GROUND	17	PS+	17	PS+
18	EARTH GROUND			18	PS-

Note: *PS+ and PS- are not used. The cross connect redundancy signals are the same that are accessed with the RS232 redundancy connector on the PMOD. No connections are permitted to terminals marked RSV.*

Note: *Connection to the Profibus is made through a 9 pin female "D subminiature" connector on the PMOD. There is one connector for each channel.*

8.5.7 EMOD backplane connectors - Profibus (DP)

This connector is located on the Profibus field card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	NOT USED	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	NOT USED	7	NOT USED
9	NOT USED	10	NOT USED	9	NOT USED
11	NOT USED	12	NOT USED	11	NOT USED
13	NOT USED	14	CH2 CAN PF	13	NOT USED
15	CH2 CAN RX	16	CH2 CAN TX	15	NOT USED
17	NOT USED	18	NOT USED	17	NOT USED
19	CH1 CAN PF	20	CH1 CAN TX	19	NOT USED
21	CH1 CAN RX	22	CH2 PB RX	21	NOT USED
23	CH2 PB TX	24	CH2 PB ENAB	23	NOT USED
25	RPTR CTL*	26	CH1 PB RX	25	NOT USED
27	CH1 PB TX	28	CH1 PB ENAB	27	NOT USED
29	DGND	30	+5V	29	NOT USED
31	ARM9 RS232 RXDXD	32	ARM9 RS232 TXD	31	NOT USED
33	EC1 CH2 RS232 RXD	34	EC1 CH2 RS232 TXD	33	NOT USED

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
35	NOT USED	36	+3.3V	35	NOT USED
37	EC1 CH1 RS232 RXD	38	EC1 CH1 RS232 TXD	37	NOT USED

8.5.8 PMOD backplane connectors - Profibus (DP)

This connector is located on the Profibus DP personality card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	Earth Ground*	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	NOT USED	7	NOT USED
9	NOT USED	10	NOT USED	9	NOT USED
11	NOT USED	12	NOT USED	11	NOT USED
13	NOT USED	14	NOT USED	13	NOT USED
15	NOT USED	16	NOT USED	15	NOT USED
17	NOT USED	18	NOT USED	17	NOT USED
19	NOT USED	20	NOT USED	19	NOT USED
21	NOT USED	22	CH2 PB RX	21	NOT USED
23	NOT USED	24	CH2 PB ENAB	23	CH2 PB TX
25	NOT USED	26	CH1 PB RX	25	RPTR CTL*
27	NOT USED	28	CH1 PB ENAB	27	CH1 PB TX
29	NOT USED	30	+5V	29	DGND
31	NOT USED	32	ARM9 RS232 TXD	31	ARM9 RS232 RXDXD
33	NOT USED	34	EC1 CH2 RS232 TXD	33	EC1 RS232 RXD
35	NOT USED	36	+3.3V	35	NOT USED
37	NOT USED	38	EC1 CH1 RS232 TXD	37	EC1 CH1 RS232 RXD

* EARTH GROUND is connected to pin B1 as well.

8.5.9 Logic card diagnostic LEDs - Profibus (DP)

LED	DESCRIPTION
P (green)	Power OK LED. Lit when the logic board's +5V and +3.3V digital supply voltage level is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E	No LED.
I (red)	Internal Fault LED. Lit when the forced error bit (bit 1) of the configuration register is set, or when the Ovation Controller is not communicating with the module.
1 - 5	No LED.
6 ACT (green)	Ethernet activity.
7 FDX (yellow)	Full duplex Ethernet communication.
8-12 S4 - S0 (red)	General purpose red LEDs. Lit under firmware control of the ARM9 processor.
13 - 16	No LED.

8.5.10 Specifications - Profibus (DP)

Description	Value
Voltage	Main Primary Voltage 21.0V Min. 24.0V Nominal 25.0V Max. Main Secondary Voltage 21.0V Min. 24.0V Nominal 25.0V Max.
Ovation I/O Bus Current (+24V Main)	160 mA typ.*, 214 mA Max.
Ovation I/O Bus Power (+24V Main)	3.84 W typ.*, 5.136 W Max.
Input Under-voltage Lockout	17-18.5 volts
Input Over-voltage Crowbar	29-35 volts
Number of segments per module	2
Interface characteristics	RS485, 12 Mbaud Max
Ethernet	10/100 MBaud, Auto-negotiation supported MDIX not supported, Standard RJ45 connection on the EMOD Access only with cap removed
Redundancy Port	RS232, 57.6 Kbaud Max, RJ45 jack on the PMOD.
ARM9 Diagnostic Port	RS232, 57.6 Kbaud Max, 5 pin header on the logic card. Access only with cap removed.
Dielectric Isolation	+/- 1,000 V DC or peak AC for one minute, channel to channel or channel to logic.
International Electromagnetic Compatibility	Specification EN55011 EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-5 EN61000-4-6
Operating temperature range	0 to 60°C (32°F to 140°F).
Storage temperature range	Per Ovation standard.
Humidity (non-condensing) range	0% to 95%
Vibration	0.15mm displacement from 10 to 57 Hz and 2G's from 57 to 500 Hz.
Shock	15G's for 11 milliseconds and 1/2 sine wave.

8.6 Ethernet Link Controller

8.6.1 Subsystems - Ethernet Link Controller

Ethernet Link Controller subsystems

Channels	Electronics module	Personality module
2	5X00419GO1	1X000569H01

8.6.2 Logic card side connector pin assignments - Ovation bus modules (DP)

Row A, Pin No.	Signal Name	Row A, Pin No.	Signal Name
1	CONNECT2/*	1	NO CONNECTION
9	24V RETURN	9	24V RETURN
10	24V RETURN	10	24V RETURN
11	ADDRESSPWR	11	ADDRESS0/**
12	CAL/EEPROM PE	12	ADDRESS3/
13	ADDRESS2/	13	ADDRESS1/
14	24V RETURN	14	24V RETURN
15	SYNC- ***	15	SYNC+ ***
16	24V RETURN***	16	24V RETURN***
17	CLOCK- *	17	CLOCK+ ***
18	24V RETURN***	18	24V RETURN***
19	DATA- *	19	DATA+ *
20	24V RETURN	20	24V RETURN
21	+24VOLTS (B)*	21	+24VOLTS (B)*
22	+24VOLTS (A)*	22	+24VOLTS (A)*
23	24V RETURN	23	24V RETURN
24	24V RETURN	24	24V RETURN
32	CONNECT1/ *	32	NO CONNECTION

* Short Pin.

** 24V Return for module installed in B-side of base, open for module installed in A-side of base.

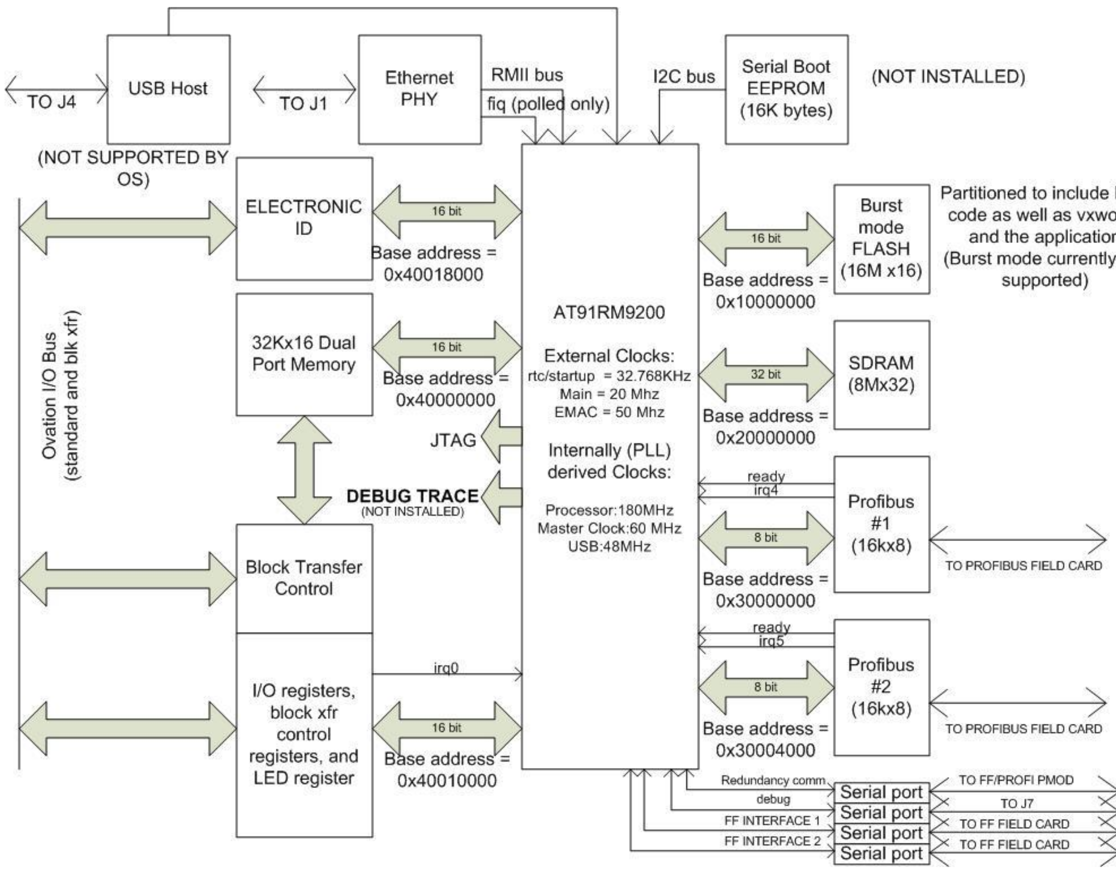
*** Backplane signal not used by module.

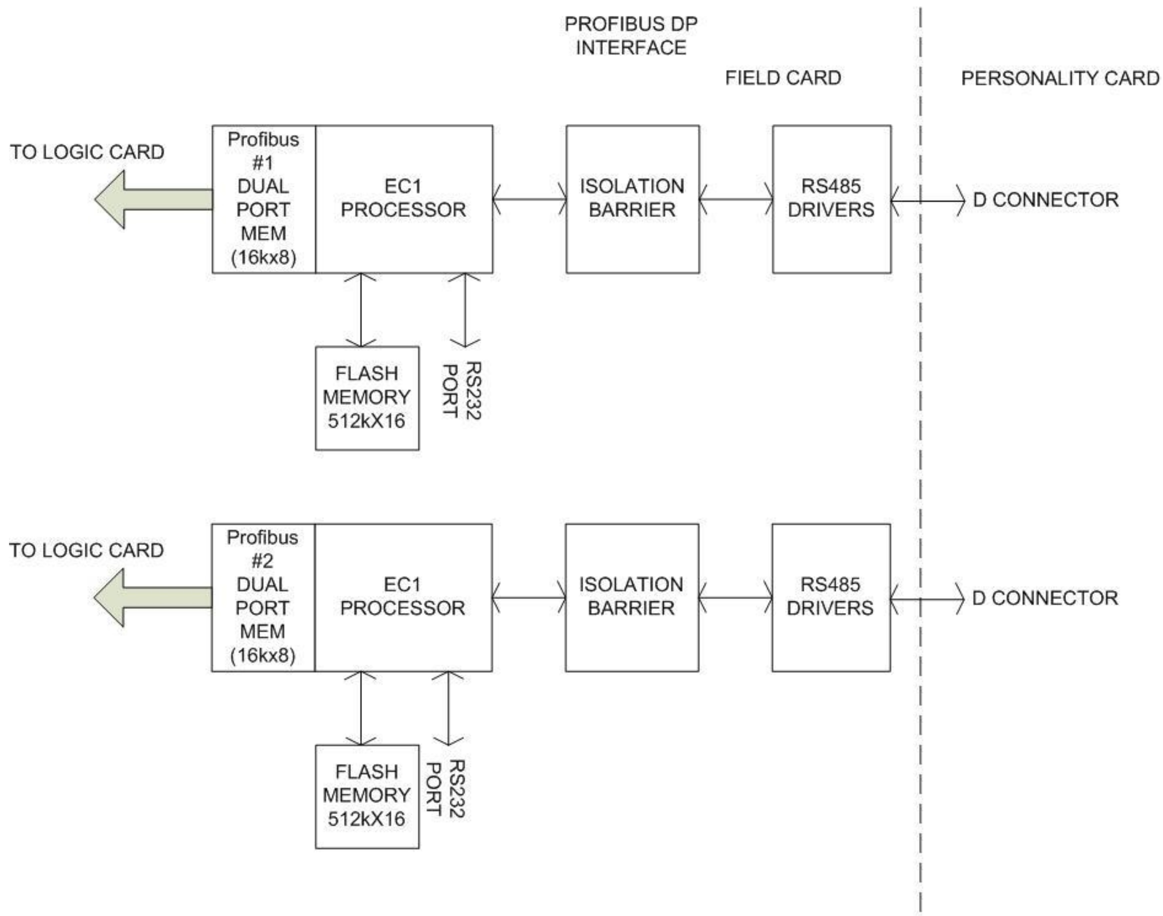
Note: *Rows A and B pins 2 through 8, and 25 through 31 are not used and, therefore, are not shown.*

8.6.3 Interface - Ethernet Link Controller

The Ethernet Link Controller provides a single Ethernet link directly off the LPB board using an 8 position RJ45 modular connector accessible without removing Emod cap. An Ethernet CAT5e cable with right angle RJ45 connector is required to mate to the Ethernet Link Controller module to avoid a tight cable radius bend.

8.6.4 Module block diagram & field card/personality card - Ethernet Link Controller





8.6.5 Terminal block pin assignments - Ethernet Link Controller

The Ethernet Link Controller module base unit has a 53-position compression-style terminal block arranged in 3 rows. The "A" row, highest relative to the base, has 18 positions. The middle, or "B" row has 17 positions. The "C" row, nearest to the base, has 18 positions.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

Maximum working voltage is 150 V peak DC or RMS AC.

Current rating is 5 amps.

Maximum wire size is 12 AWG single wire or two 14 AWG wires/terminal.

The base unit termination block assignments are show in the following table.

Row C Pin No.	Signal Name	Row B Pin No.	Signal Name	Row A Pin No.	Signal Name
1 - 3	RSV	1 - 3	RSV	1 - 3	RSV
4	CROSS CONNECT TX	4	CROSS CONNECT RX	4	RSV

Row C Pin No.	Signal Name	Row B Pin No.	Signal Name	Row A Pin No.	Signal Name
1 - 3	RSV	1 - 3	RSV	1 - 3	RSV
5	RSV	5	CROSS CONNECT GND	5	RSV
6 - 16	RSV	6 - 16	RSV	6 - 16	RSV
17	EARTH GROUND	17	PS+	17	PS+
18	EARTH GROUND			18	PS-

Note: *PS+ and PS- are not used. The cross connect redundancy signals are the same that are accessed with the RS232 redundancy connector on the PMOD. No connections are permitted to terminals marked RSV.*

Note: *Connection to the Ethernet Link Controller is made through a 9 pin female "D subminiature" connector on the PMOD. There is one connector for each channel.*

8.6.6 EMOD backplane connectors - Ethernet Link Controller

This connector is located on the Ethernet Link Controller field card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	NOT USED	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	NOT USED	7	NOT USED
9	NOT USED	10	NOT USED	9	NOT USED
11	NOT USED	12	NOT USED	11	NOT USED
13	NOT USED	14	CH2 CAN PF	13	NOT USED
15	CH2 CAN RX	16	CH2 CAN TX	15	NOT USED
17	NOT USED	18	NOT USED	17	NOT USED
19	CH1 CAN PF	20	CH1 CAN TX	19	NOT USED
21	CH1 CAN RX	22	CH2 PB RX	21	NOT USED
23	CH2 PB TX	24	CH2 PB ENAB	23	NOT USED
25	RPTR CTL*	26	CH1 PB RX	25	NOT USED
27	CH1 PB TX	28	CH1 PB ENAB	27	NOT USED
29	DGND	30	+5V	29	NOT USED
31	ARM9 RS232 RXDXD	32	ARM9 RS232 TXD	31	NOT USED
33	EC1 CH2 RS232 RXD	34	EC1 CH2 RS232 TXD	33	NOT USED

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
35	NOT USED	36	+3.3V	35	NOT USED
37	EC1 CH1 RS232 RXD	38	EC1 CH1 RS232 TXD	37	NOT USED

8.6.7 PMOD backplane connectors - Ethernet Link Controller

This connector is located on the Ethernet Link Controller personality card and interfaces to the base unit.

Connector Type: 152 position male High-Density Interconnect (HDI) arranged in 4 rows of 38 pins. The actual connector is selectively loaded so that only 64 positions are available for use.

Row A Pin No.	Signal Name	Row B Pin No.	Signal Name	Row D Pin No.	Signal Name
1	Earth Ground*	1	NOT USED	1	NOT USED
2	NOT USED	2	NOT USED	2	NOT USED
3	NOT USED	3	NOT USED	3	NOT USED
5	NOT USED	6	NOT USED	5	NOT USED
7	NOT USED	8	NOT USED	7	NOT USED
9	NOT USED	10	NOT USED	9	NOT USED
11	NOT USED	12	NOT USED	11	NOT USED
13	NOT USED	14	NOT USED	13	NOT USED
15	NOT USED	16	NOT USED	15	NOT USED
17	NOT USED	18	NOT USED	17	NOT USED
19	NOT USED	20	NOT USED	19	NOT USED
21	NOT USED	22	CH2 PB RX	21	NOT USED
23	NOT USED	24	CH2 PB ENAB	23	CH2 PB TX
25	NOT USED	26	CH1 PB RX	25	RPTR CTL*
27	NOT USED	28	CH1 PB ENAB	27	CH1 PB TX
29	NOT USED	30	+5V	29	DGND
31	NOT USED	32	ARM9 RS232 TXD	31	ARM9 RS232 RXDXD
33	NOT USED	34	EC1 CH2 RS232 TXD	33	EC1 RS232 RXD
35	NOT USED	36	+3.3V	35	NOT USED
37	NOT USED	38	EC1 CH1 RS232 TXD	37	EC1 CH1 RS232 RXD

* EARTH GROUND is connected to pin B1 as well.

8.6.8 Diagnostic Logic Card LEDs - Ethernet Link Controller

LED	Description
P (green)	Power OK LED. Lit when the logic board's +5V and +3.3V digital supply voltage level is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (red)	Fault LED. Lit when the forced error bit (bit 1) of the configuration register is set, or when the Ovation Controller is not communicating with the module.
I, 1 - 5	No LED.
6 ACT (green)	Ethernet activity.
7 FDX (yellow)	Full duplex Ethernet communication.
8-12 S4 -S0 (red)	General purpose red LEDs. Lit under firmware control of the ARM9 processor.
13 - 16	No LED.

8.6.9 Specifications - Ethernet Link Controller

Description	Value
Voltage	Main Primary Voltage 21.0V Min. 24.0V Nominal 25.0V Max. Main Secondary Voltage 21.0V Min. 24.0V Nominal 25.0V Max.
Ovation I/O Bus Current (+24V Main)	160 mA typ.*, 214 mA Max.
Ovation I/O Bus Power (+24V Main)	3.84 W typ.*, 5.136 W Max.
Input Under-voltage Lockout	17-18.5 volts
Input Over-voltage Crowbar	29-35 volts
Number of segments per module	2
Interface characteristics	RS485, 12 Mbaud Max
Ethernet	10/100 MBaud, Auto-negotiation supported MDIX not supported, Standard RJ45 connection on the EMOD Access only with cap removed
Redundancy Port	RS232, 57.6 Kbaud Max, RJ45 jack on the PMOD
ARM9 Diagnostic Port	RS232, 57.6 Kbaud Max, 5 pin header on the logic card Access only with cap removed
Dielectric Isolation	+/- 1,000 V DC or peak AC for one minute, channel to channel or channel to logic
International Electromagnetic Compatibility	Specification EN55011 EN61000-4-2 EN61000-4-3 EN61000-4-4 EN61000-4-5 EN61000-4-6
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	Per Ovation standard
Humidity (non-condensing) range	0% to 95%
Vibration	0.15mm displacement from 10 to 57 Hz and 2G's from 57 to 500 Hz

DESCRIPTION	VALUE
Voltage	Main Primary Voltage 21.0V Min. 24.0V Nominal 25.0V Max. Main Secondary Voltage 21.0V Min. 24.0V Nominal 25.0V Max.
Shock	15G's for 11 milliseconds and 1/2 sine wave

SECTION 9

Specialty I/O modules

IN THIS SECTION

9.1 Link Controller module - (LC)

9.1.1 Overview - (LC)

The Link Controller (LC) module provides the Ovation Controller with a serial data communications link to a third-party device or system. This communication is done via a serial RS-232, RS-422, or RS-485 data link. Two ports (one programming and one application) are provided.

This module is not described in this document. (See *Ovation LC Module Interface User Guide*.)

The Link Controller module is a CE Mark certified module.

Note*: I/O Module general information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

9.1.2 Electronics modules (Emod) - (LC)

- **1C31166G01** not for new projects. Used for spares and replacements only.
- **1C31166G02** provides for communication to a third-party device or system.

9.1.3 Personality modules (Pmod) - (LC)

- **1C31169G01** provides for an RS-232 serial link (in CE Mark certified systems, the application port cable must be less than 10 meters (32.8 ft)).
- **1C31169G02** provides for an RS-485 serial link (also may be used to provide for an RS-422 serial link).

9.1.4 Subsystems - (LC)

Link Controller subsystems[1]

Range	Channels	Electronics Module	Personality Module
RS232	One (1) Serial Port (Able to handle many points)	1C31166G01[2] or 1C31166G02	1C31169G01
RS485/RS422 Four wire	One (1) Serial Port (Able to handle many points)	1C31166G01[2] or 1C31166G02	1C31169G02
[1] All module configurations listed in the table are CE Mark Certified. 1C31166G02 pending CE Mark Certification. [2] Not for new projects. Used for spares and replacements only. To use this module, the appropriate SLC algorithm must reside in the Ovation Controller. (See *Ovation Algorithm Reference Manual*.)			

9.2 Loop Interface module - (LI)

9.2.1 Overview - (LI)

The Ovation single-loop Controller is designed to interface to the analog and digital I/O necessary to control a single process loop. In addition, the Ovation single-loop Controller displays this process information and provides for manual control via a local operator interface station.

The Ovation single-loop interface module provides the following field inputs and outputs necessary to interface to a single loop:

- Two galvanically isolated analog inputs.
- One analog output.
- Two galvanically isolated digital inputs.
- Two digital outputs (the outputs share a common ground with each other, but are galvanically isolated from the other I/O circuits and from the logic portion of the module).

In addition, the single-loop interface module contains an RS-422 serial port for communications with a loop interface module (SLIM) and an interface for communications over the Ovation serial I/O bus.

The Loop Interface module is a CE Mark certified module.

Note: I/O Module general information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.

9.2.2 Electronics modules (Emod) - (LI)

- **1C31174G01** provides analog inputs 0 to +10V, and analog outputs 0 to +10V, digital inputs 24/48 VDC and digital outputs 60 VDC.
- **1C31174G02** provides analog inputs 0 to +5V, and analog outputs 0 to +10V, digital inputs 24/48 VDC and digital outputs 60 VDC.
- **1C31174G03** provides analog inputs 4 to 20mA, and analog outputs 4 to 20mA, digital inputs 24/48 VDC and digital outputs 60 VDC.
- **1C31174G04** provides analog inputs 4 to 20mA, and no analog output (Electric Drive), digital inputs 24/48 VDC and digital outputs 60 VDC.

9.2.3 Personality modules (Pmod) - (LI)

- **1C31177G01** provides voltage analog inputs and configurable remote or local shield grounding.
- **1C31177G02** provides current analog inputs and locally powered, local shield grounding.
- **1C31177G03** provides current analog inputs and field powered, remote shield grounding.

9.2.4 Module Groups - (LI)

There are two basic styles of single-loop interface modules, Normal (non-electric drive) and Electric Drive:

- **Normal (non-electric drive) Type** - This type of module calculates the process variable for display at the SLIM by converting analog input 1 to engineering units. The output to the field is the analog output. This type of module may use a group 1, 2, or 3 Electronics module.
- **Electric Drive Type** - Two types of Electric Drive modules are supported. Electric Drive module types are available with group 4 Electronics modules only. The mode of the Electric Drive is controlled through software.
  - **Electric Drive Type (Mode 1)**
    This type of module calculates the process variable from analog input 1, and the output (Demand) is calculated by the Controller as in Normal (non-electric drive) card styles. However, the output to the field are the two digital outputs. The output (Demand) from the Controller is compared to the process position (analog input 2), and raise and output pulses are generated accordingly to control the process. Digital output 1 corresponds to rise, and digital output 2 corresponds to lower. The outputs are pulsed with the duty cycle proportional to the speed of the rise or lower action. The raise/lower ON/OFF times are specified in the control algorithm.
  - **Electric Drive Type (Mode 2)**
    As in Electric Drive (Mode 1), this type of module calculates the process variable from analog input 1, and its field output are two digital outputs. However, in all operating modes except Local, a demand of zero (0) forces a hard (non-pulsing) lower. This means that digital output 2 is forced active LOW and remains LOW until the demand is not equal to 0. Local mode operation is unchanged.

9.2.5 Subsystems - (LI)

Loop Interface subsystems[1, 4]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Normal (Non-electric) Drive modules			
0-10V Analog Inputs/Output 0-10V AI/AO - user defined Digital Inputs[2]	6 6	1C31174G01 1C31174G21	1C31177G01 1C31177G01
0-5V Analog Inputs, 0-10V Analog Output 0-5V AI, 0-10V AO - user defined Digital Inputs[2]	6 6	1C31174G02 1C31174G22	1C31177G01 1C31177G01
4-20mA AI/AO Locally powered analog inputs 4-20mA AI/AO Field powered analog inputs 4-20mA AI/AO - user defined Digital Inputs[2] Locally powered analog inputs 4-20mA AI/AO - user defined Digital Inputs[2] Field powered analog inputs	6 6 6 6	1C31174G03 1C31174G03 1C31174G23 1C31174G23	1C31177G02 1C31177G03 1C31177G02 1C31177G03

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE

When defining points for a normal (non-electric) drive Loop Interface module, the following point types are required for each channel:

I/O CHNL	NAME	TYPE	INPUT SOURCE OR OUTPUT DESTINATION	TERMINAL BLOCK CONNECTION
1	Priority Raise or user-defined [2]	Input	Loop Interface module	DI1
2	Priority Lower or user-defined [2]	Input	Loop Interface module	DI2
3	User Defined	Output	Loop Interface module	DO1
4	User Defined	Output	Loop Interface module	DO2
5	Process Variable Input (dedicated)	Input	Loop Interface module	AI1
6	Set point Input (optional)	Input	Loop Interface module	AI2
None	Output	Output	Loop Interface module	AI3[3]
Two additional channels are used at Emod Revision 5 or higher:				
6	Controller Process Variable	Output	Analog	No Terminations
7	Controller Set Point	Output	Analog	No Terminations

Electric Drive modules

4-20mA Inputs; No Output Locally powered analog inputs	4	1C31174G04	1C31177G02 1C31177G03
4-20mA Inputs; No Output Field powered analog inputs	4	1C31174G04	1C31177G02
4-20mA Inputs; No Output - user defined Digital Inputs[2] Locally powered analog inputs	4	1C31174G24	1C31177G03
4-20mA Inputs; No Output - user defined Digital Inputs[2] Field powered analog inputs	4	1C31174G24	

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE

When defining points for an electric drive Loop Interface module, the following point types are required for each channel:

I/O CHNL	NAME	TYPE	INPUT SOURCE OR OUTPUT DESTINATION	TERMINAL BLOCK CONNECTION
1	Priority Raise or user-defined [2]	Input	Loop Interface module	DI1
2	Priority Lower or user-defined [2]	Input	Loop Interface module	DI2
None	Output Raise Pulse (dedicated)	Output	Loop Interface module	DO1[3]
None	Output Lower Pulse (dedicated)	Output	Loop Interface module	DO2[3]
5	Process Variable Input (dedicated)	Input	Loop Interface module	AI1
6	Process Position (dedicated)	Input	Loop Interface module	AI2
None	Output	Output	Output is compared to Process Position. Raise/Lower pulses (DO1, DO2) are generated as applicable.	No Terminations
Two additional channels are used at Emod Revision 5 or higher:				
7	Controller Process Variable	Output	Analog	No Terminations
8	Controller Set Point	Output	Analog	No Terminations

[1] This module controls **ONE** process loop. To use this module, the MASTATION algorithm must reside in the Ovation Controller. (See the *Ovation Algorithm Reference Manual*.)

[2] Priority Raise and Lower inputs can be disabled and used as user-defined input points. Configuration instructions are included in Kit 1C31174G20.

[3] This output may not appear on the termination list, but must be terminated for proper operation.

[4] All module configurations listed in the table are CE Mark Certified.

9.2.6 Modes of Operation - (LI)

There are four modes of operation for the Loop Interface module:

- Cascade
- Auto
- Manual (also supports Timed-out Manual sub-mode)
- Local (also supports Timed-out Local sub-mode)

Operation modes

MODE	SOURCE FOR OUTPUT (DEMAND)	SOURCE FOR SETPOINT
Cascade	Controller	Controller

Mode	Source for Output (Demand)	Source for Setpoint
Auto	Controller	Controller or SLIM
Manual	Controller or SLIM	Controller or SLIM
Local [1]	SLIM	SLIM
[1] When in Local mode, the Loop Interface module accepts mode change requests from the SLIM only.		

9.2.7 Priority Raise and Lower - (LI)

For the Ovation Loop Interface module, the digital inputs perform priority raise and lower functions. The digital inputs are used as priority raise or lower for the output. Priority action takes precedence over any output request from the Controller or SLIM. Priority Raise and Lower may be used with either of the two module types (Normal (non-electric) or Electric Drive).

If desired, digital inputs as priority raise and lower can be disabled and used as user-defined digital input points. In order to disable digital inputs as priority raise and lower functions, the module must be configured per instructions on drawing 1C31174 (Groups 21-24).

9.2.8 Manual station control - (LI)

The Single-Loop Interface module may communicate to the Small Loop Interface module (SLIM) via its RS-422 serial port. The serial port connector is located on the personality module. Alternatively, the serial port wiring may be connected directly at the terminal block.

A single SLIM communicates with one Loop Interface module. Multiple Loop Interface modules per single SLIM are not supported. SLIMs are not required for the loop interface module operation. (The loop interface module may be used without a SLIM.)

9.2.9 Normal & inverse analog output - (LI)

A wire jumper between terminals IAO and logic GND can be used to set the analog output to Inverse Operation.

Normal (default - no wire installed) operation of the analog output means that when the output value is 0% (as seen at the SLIM or Controller), the analog output is a minimum (0V for groups 1 and 2, or 4mA for groups 3 and 4 modules). When the output value is 100%, the actual analog output is at its Maximum value (+10V for group 1, +5V for group 2, and 20mA for groups 3 and 4 modules).

Inverse (wire jumper installed) operation of the analog output means that when the output value is 0% (as seen at the SLIM or Controller), the analog output is a Maximum (+10V for group 1, +5V for group 2, and 20mA for groups 3 and 4 modules). When the output value is 100%, the analog output is its minimum value (0V for groups 1 and 2, or 4mA for groups 3 and 4 modules).

9.2.10 External power supply information - (LI)

If the Loop Interface subsystem uses the 1C31177G02 Personality module (configured for two 4 to 20 mA current analog inputs that are locally powered), the required voltage supply may be obtained from the internal Ovation auxiliary power supply (available through the terminal block), or it may be obtained from an external power supply.

If an external power supply is used, *Using an External Power Supply* (see page 799) contains steps to be undertaken before connecting the external power supply to the Loop Interface module base unit terminal block. The Loop Interface module auxiliary supply voltage level (24 VDC or 48 VDC) depends on the external transmitter devices being interfaced to the Loop Interface module's analog inputs.

9.2.11 Terminal block wiring information - (LI)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

The diagrams for the Loop Interface Personality modules are illustrated in below. The following table lists and defines the abbreviations used in those diagrams.

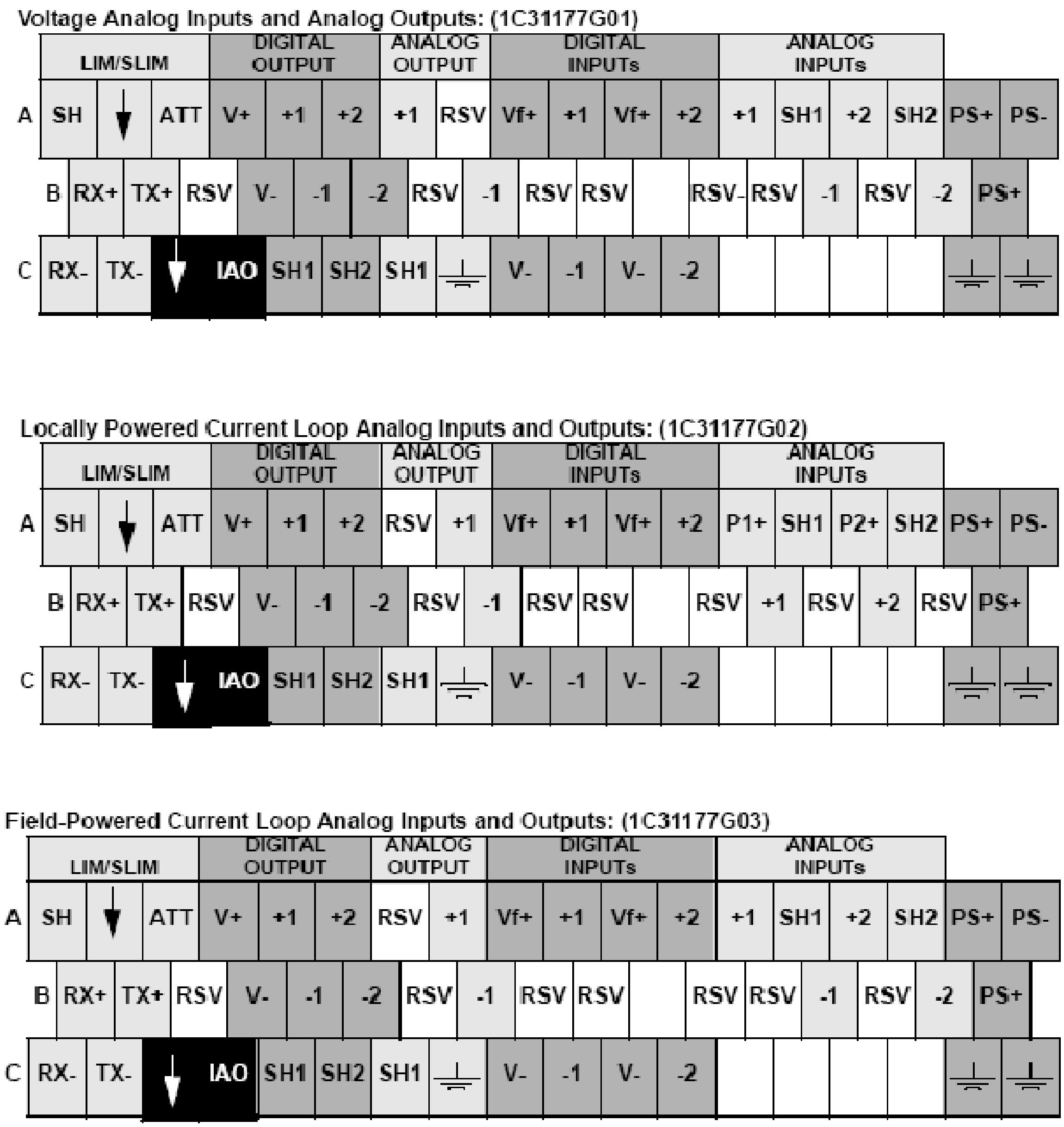


Figure 123: Terminal Block Connections for the Loop Interface Personality Modules

Loop Interface terminal block wiring information

SECTION	**ABBREVIATION**	**DEFINITION**
LIM/SLIM (see page 603) [1]	SH [2]	Shield terminal connection
	↓	Logic ground
	ATT	Attention
	RX ±	Receive data
	TX ±	Transmit data
DIGITAL OUTPUT	V ±	Voltage source terminal connection
	± 1, ± 2	Positive or negative terminal connection
	SH1, SH2 [2]	Shield terminal connection
ANALOG OUTPUT [3]	± 1	Positive or negative terminal connection
	SH1 [2]	Shield terminal connection
	⏚	Earth ground terminals
	IAO	When connected to logic ground, results in an inverse analog output (see page 503) operation.
DIGITAL INPUTS [4]	± 1, ± 2	Positive or negative terminal connection
	V-	Fused voltage source terminal ground connection
	Vf+	Fused voltage source terminal connection
ANALOG INPUTS [5]	± 1, ± 2	Positive or negative terminal connection
	SH1, SH2 [2]	Shield terminal connection
	P1+, P2+	Positive terminal connection for current loop power
PS ±	PS ±	Auxiliary power supply terminals
Earth GND	⏚	Earth ground terminals
RSV	RSV	Reserved. No connections allowed on these terminals.

[1] No connections to terminals are required when using a SLIM cable (5A26166) connected to a Loop Interface Personality module. In CE Mark systems, SLIM cable 5A26429 MUST be used and grounded at the entry point of the cabinet using the recommended hardware (refer to the appropriate "Cable Guidelines" information for your system).

[2] Not used on CE Mark certified systems.

[3] For Group 3 current Loop Interface modules, analog output **MUST** be connected for proper operation, or an analog output error is reported.

[4] If digital inputs as priority and raise and lower are not desired (but are enabled), a shorting wire **MUST** be placed across inputs (+1 to -1 and +2 to -2) to eliminate false turn on from noise.

[5] For Group 3 and 4 current Loop Interface modules, analog inputs **MUST** be connected for proper operation, or an analog input error is reported.

Note: *Do **not** use unmarked terminal block locations or locations marked RSV.*
*Shield terminals (SH) are **not** connected in CE Mark systems.*
The analog output is not present on electric drive modules.

9.2.12 Field connection wiring diagram - (LI)

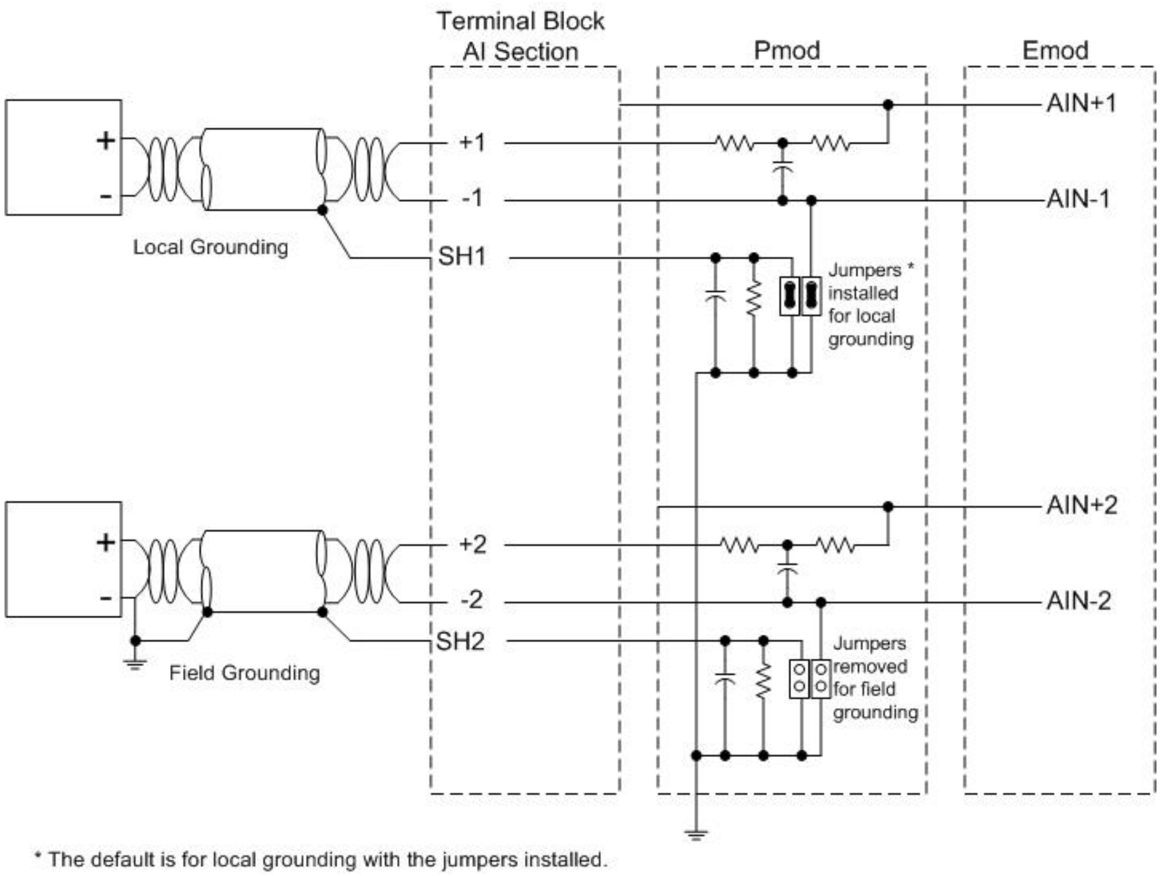
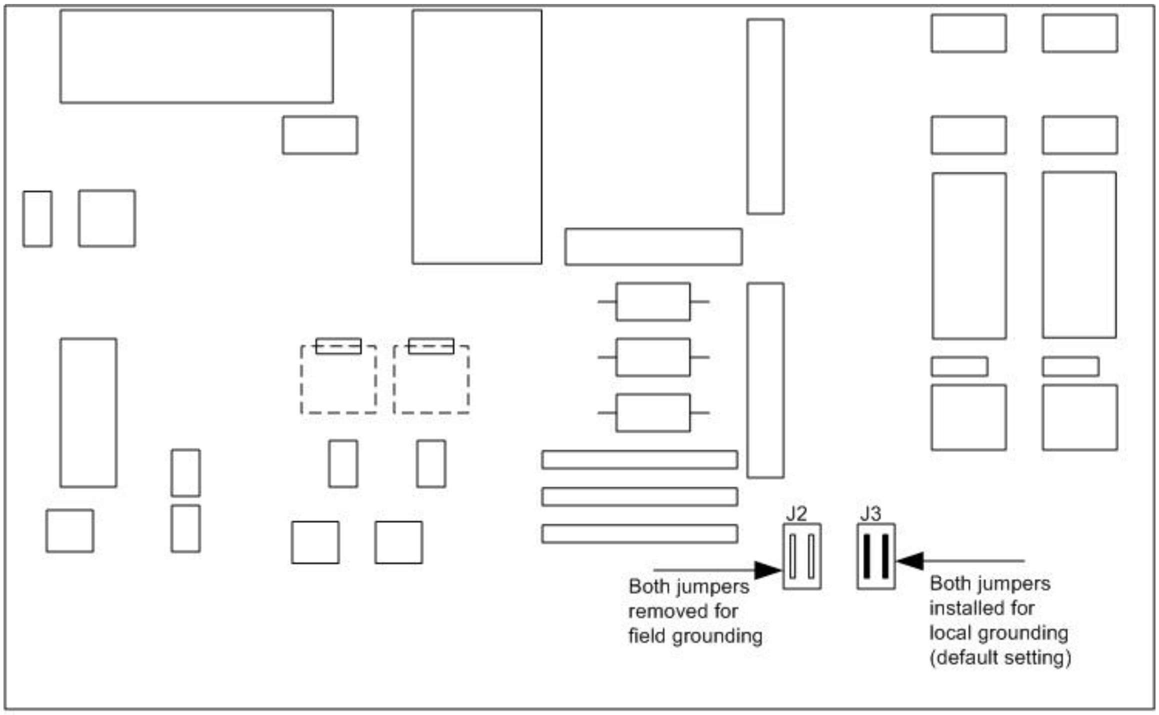


Figure 124: Voltage Analog Input Field Connections



Note
Circuit board must be removed from Personality module housing to access jumpers.

Figure 125: Jumper Settings for Voltage Analog Input Personality Module

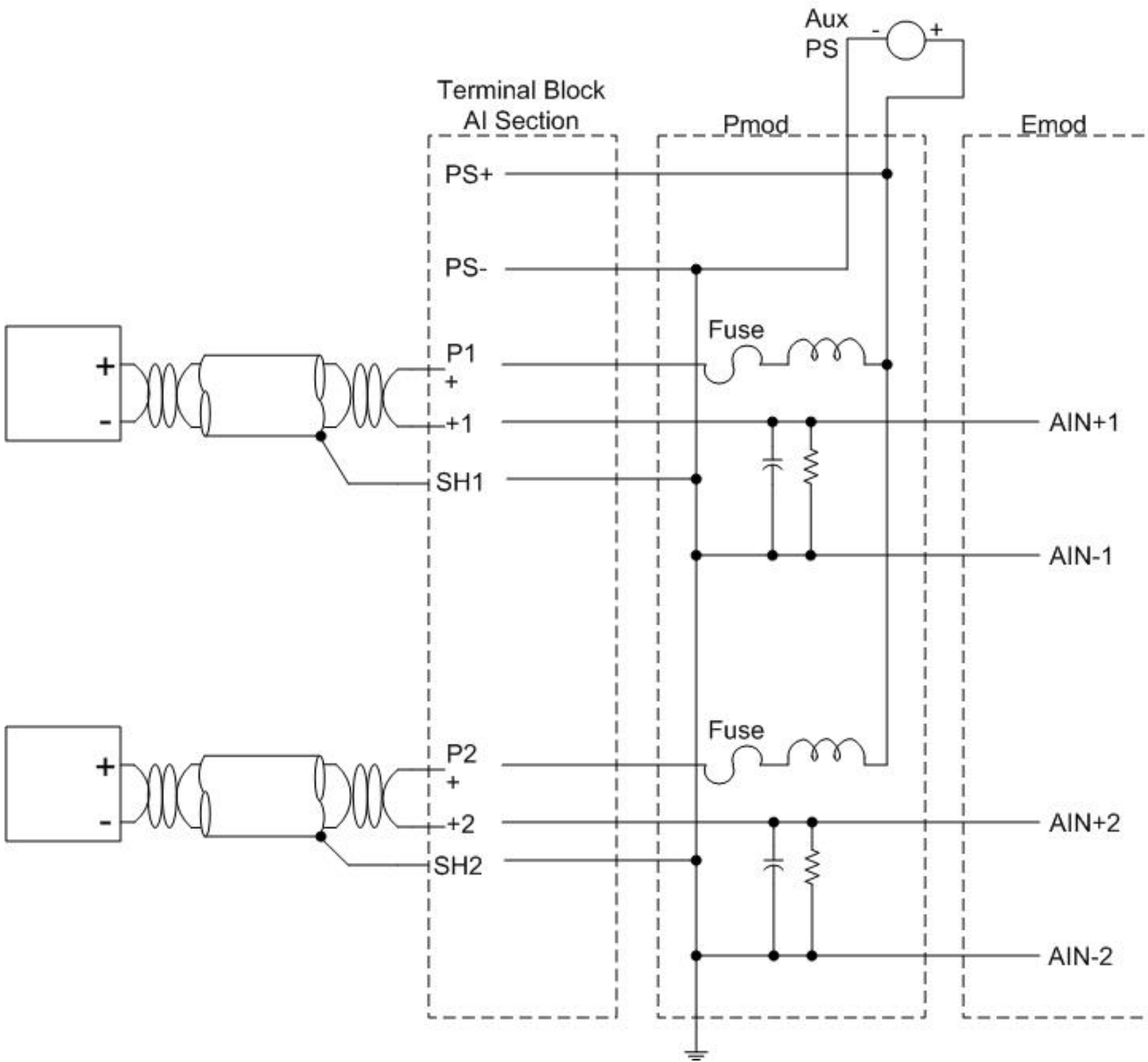


Figure 126: Locally Powered Current Analog Input Field Connections

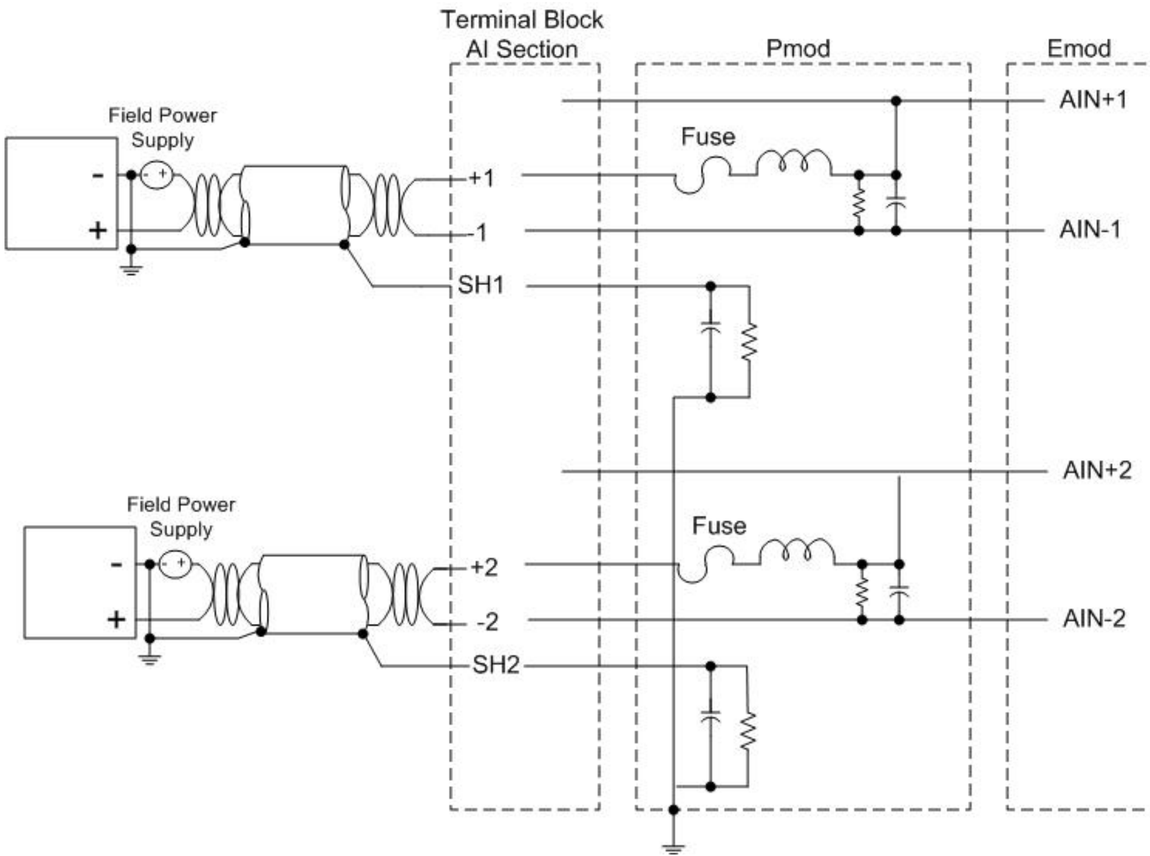
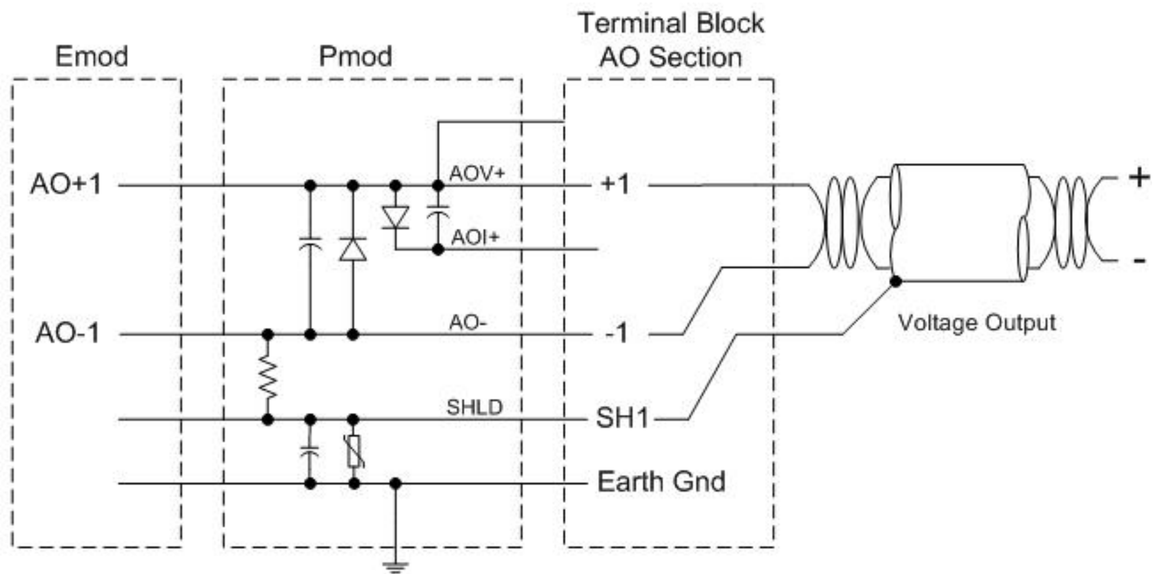
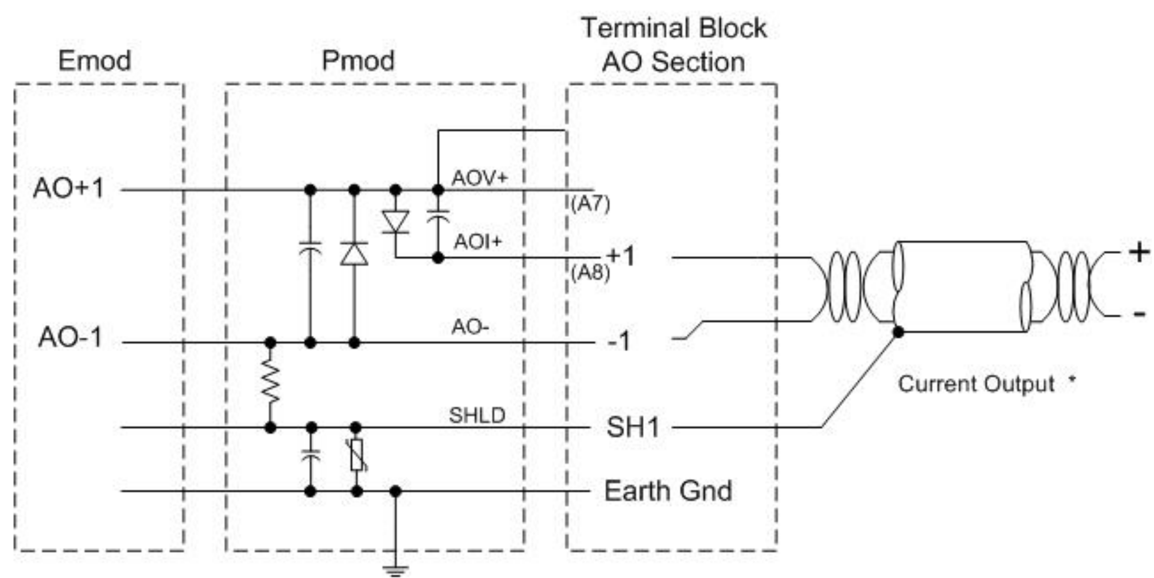


Figure 127: Field Powered Current Analog Input Field Connections





* Connect meter between AOV+ and AOI (A7 and A8) to measure current without disconnecting loop.

Figure 128: Analog Output Field Connections

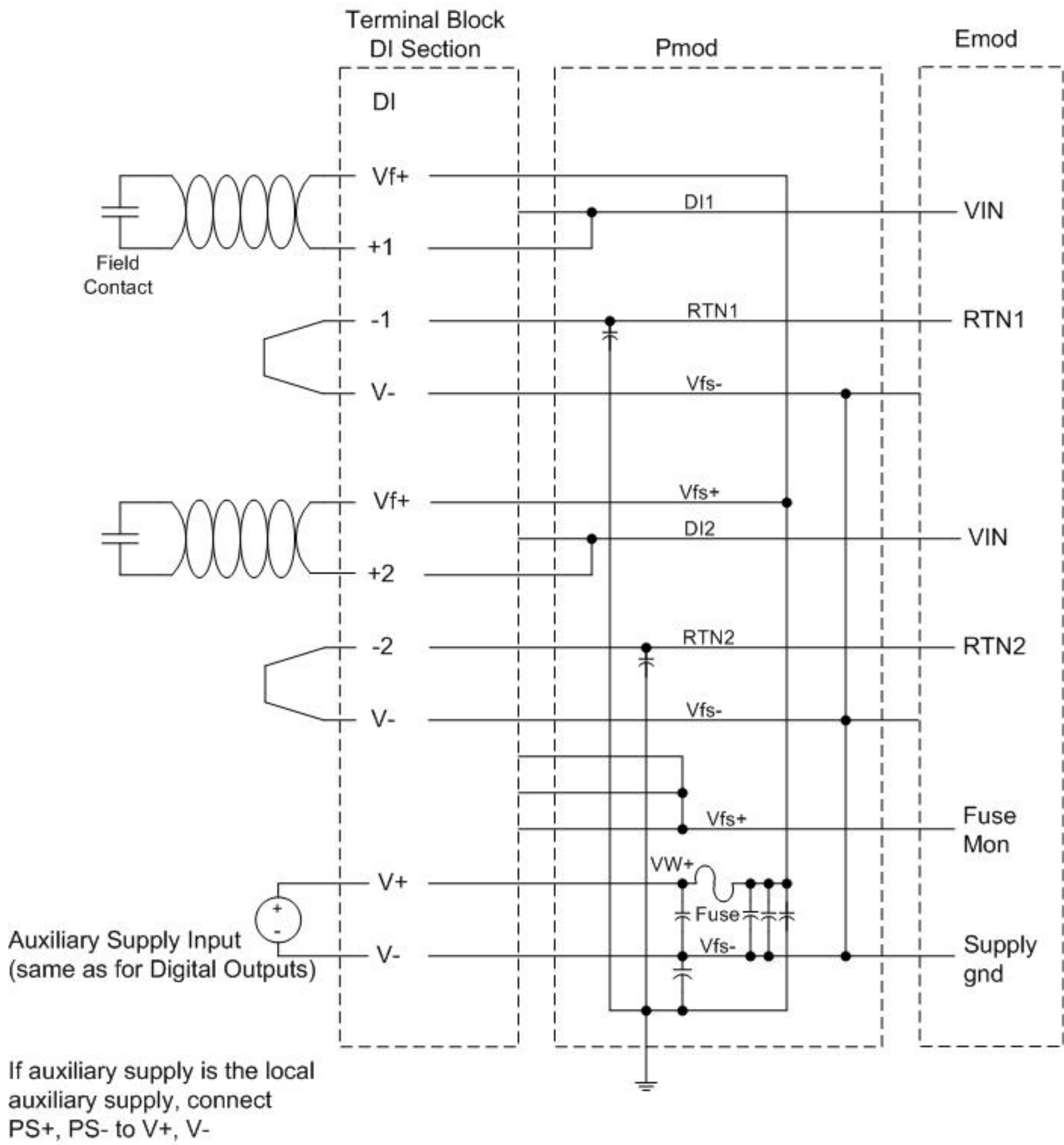


Figure 129: Digital Inputs (local auxiliary supply) Field Connections

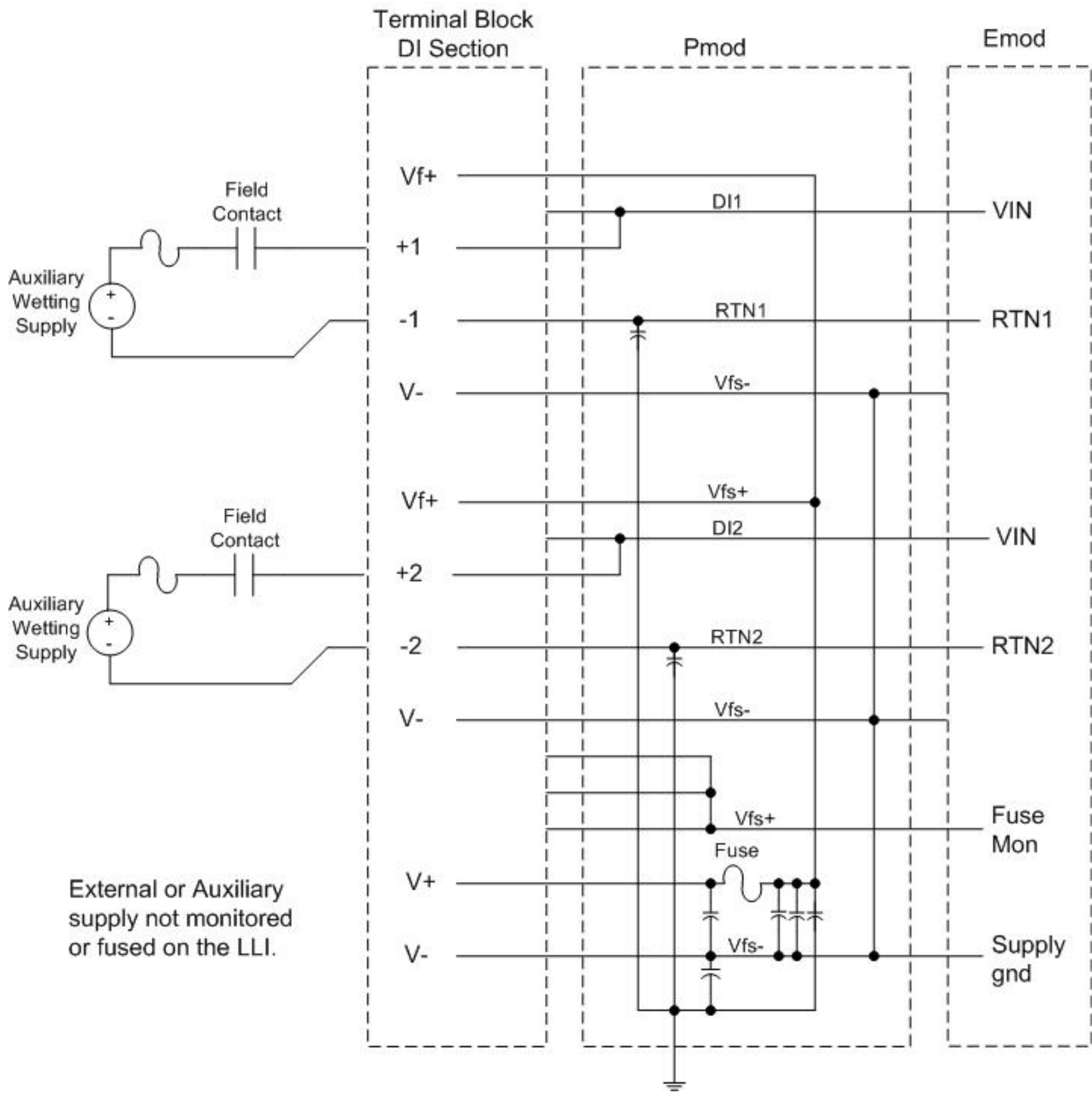


Figure 130: Digital Inputs (field auxiliary supply) Field Connections

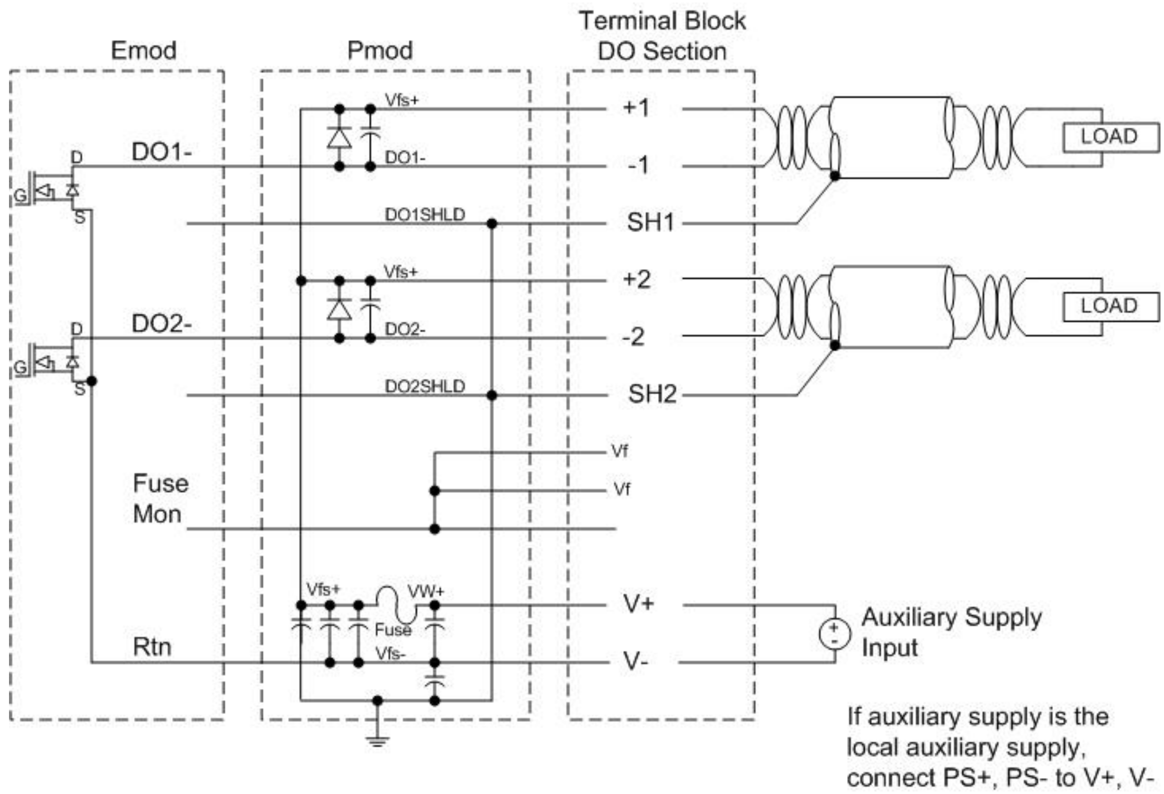


Figure 131: Digital Outputs (local aux supply) Field Connections

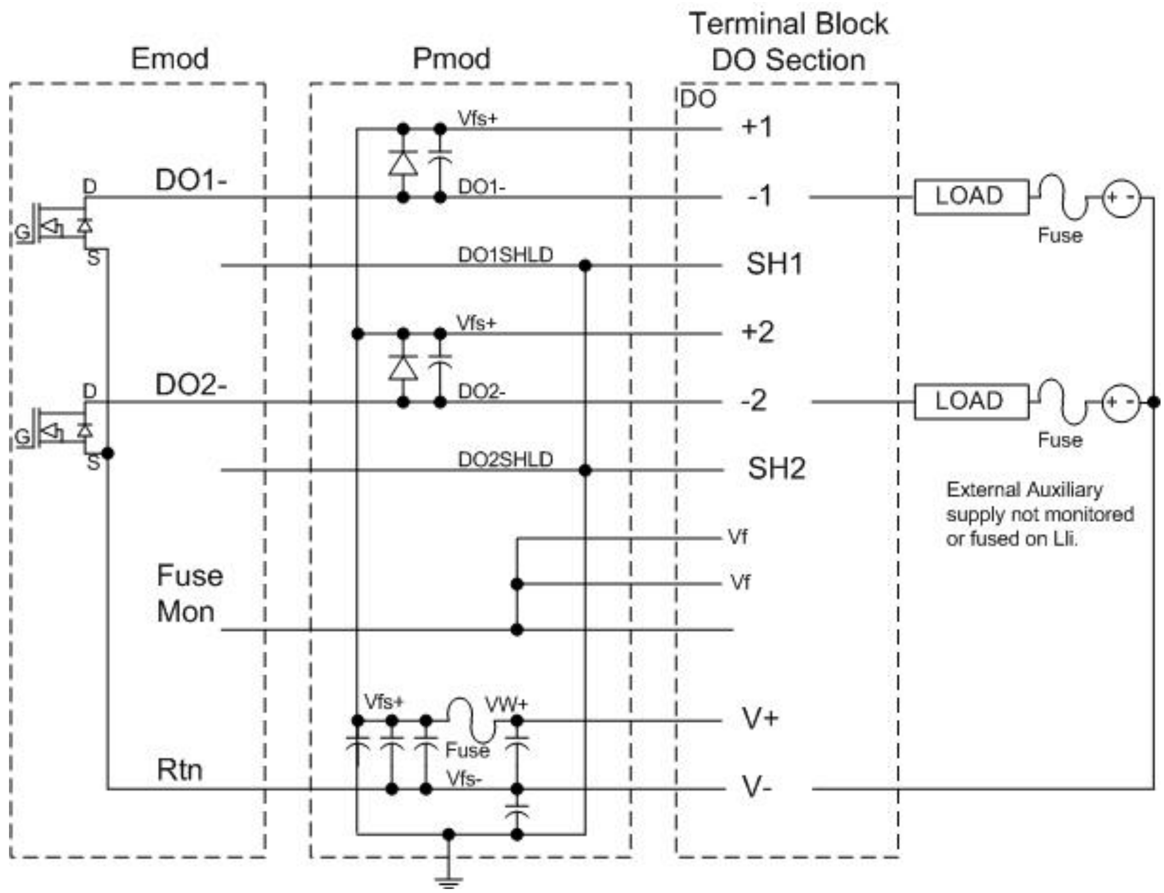
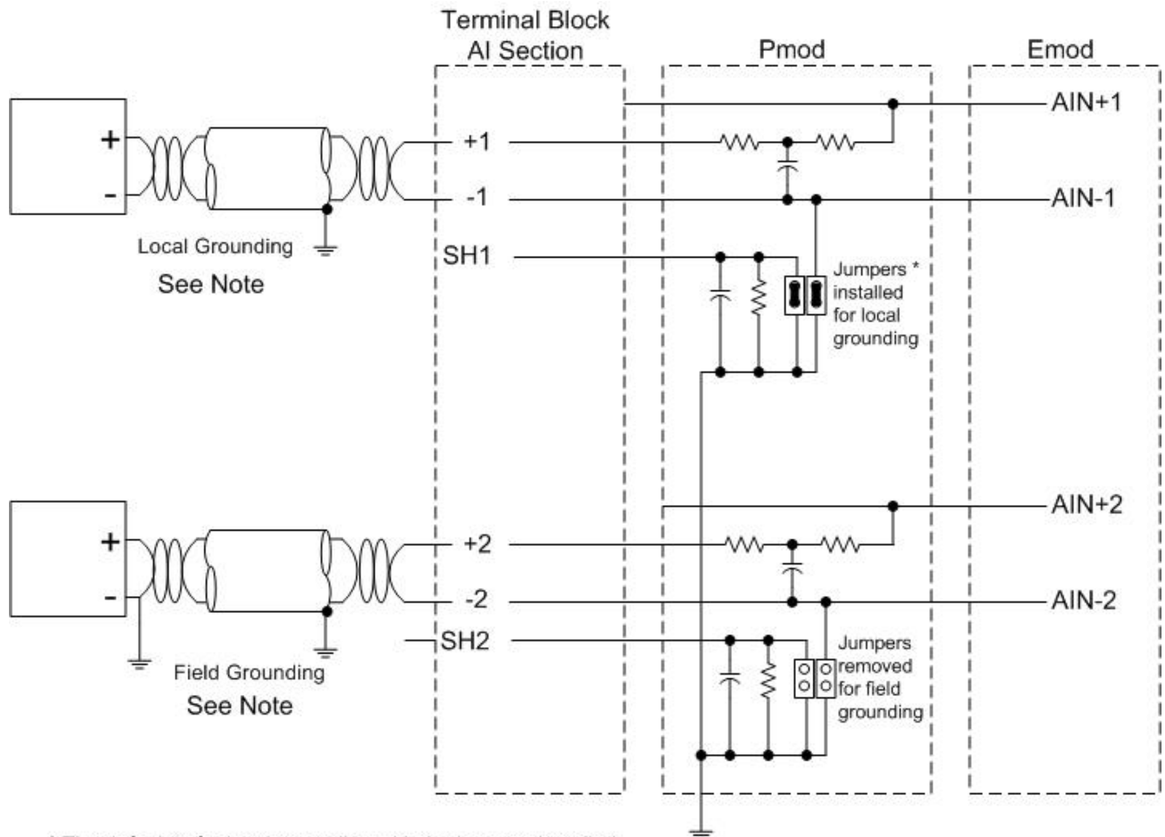


Figure 132: Digital Outputs (field aux supply) Field Connections

9.2.13 Field connection wiring (CE Mark) - (LI)

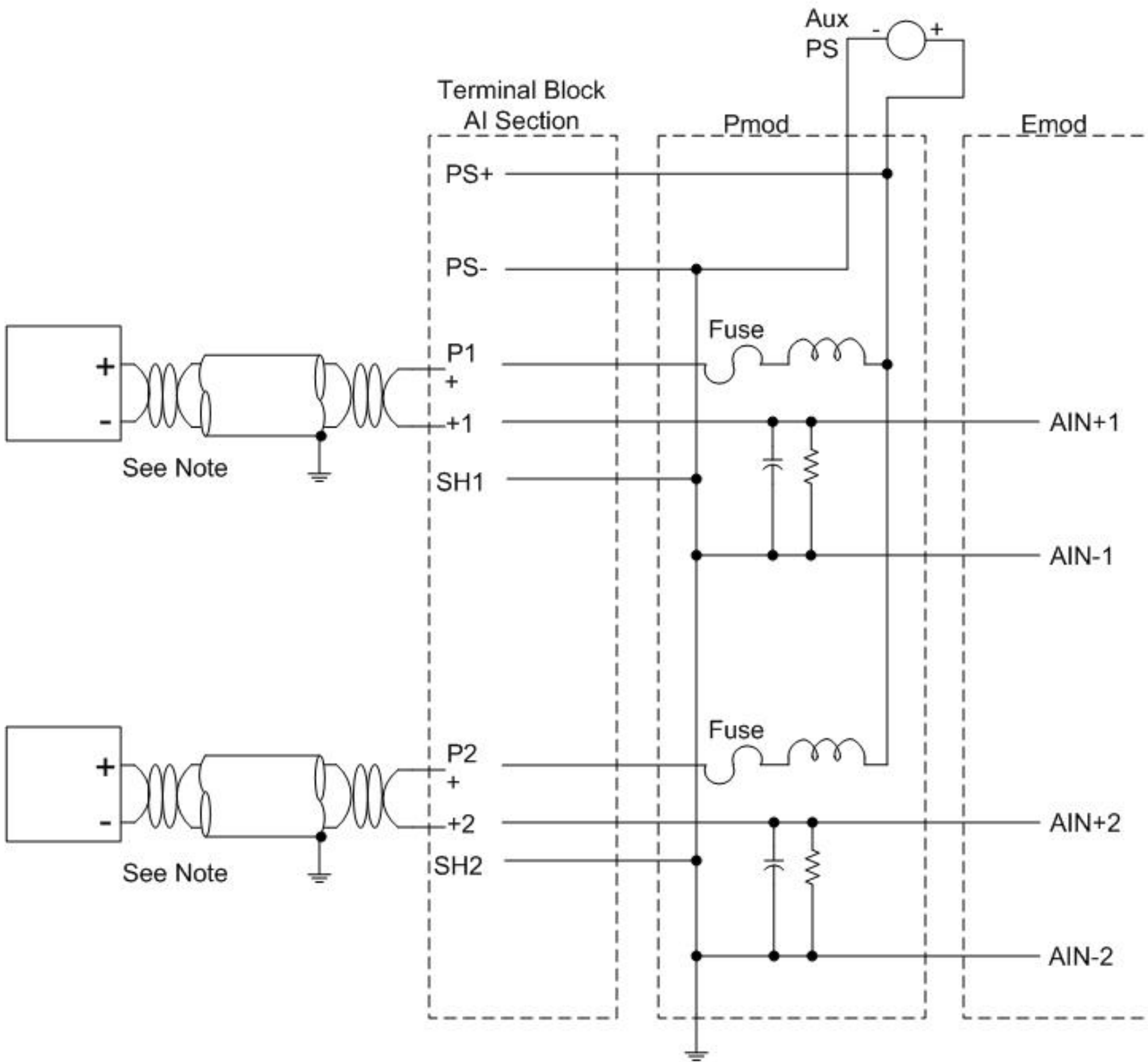


* The default is for local grounding with the jumpers installed.

Note

All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to the Cable Guidelines section in the applicable *Planning Your Ovation System* manual).

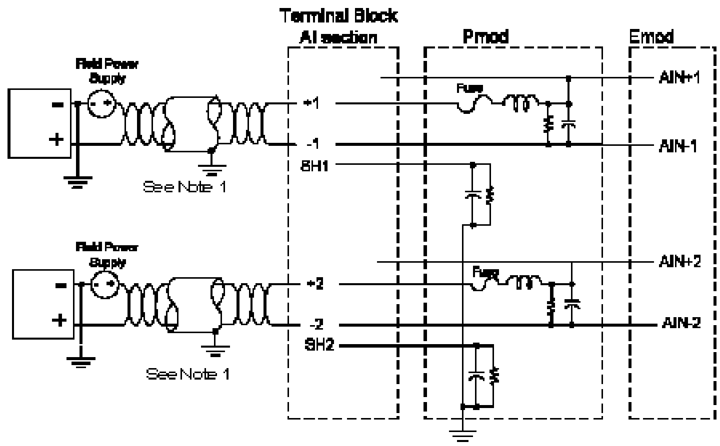
Figure 133: Voltage Analog Input Field Connections (CE Mark)



Note

All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to the Cable Guidelines section in the applicable *Planning Your Ovation System* manual).

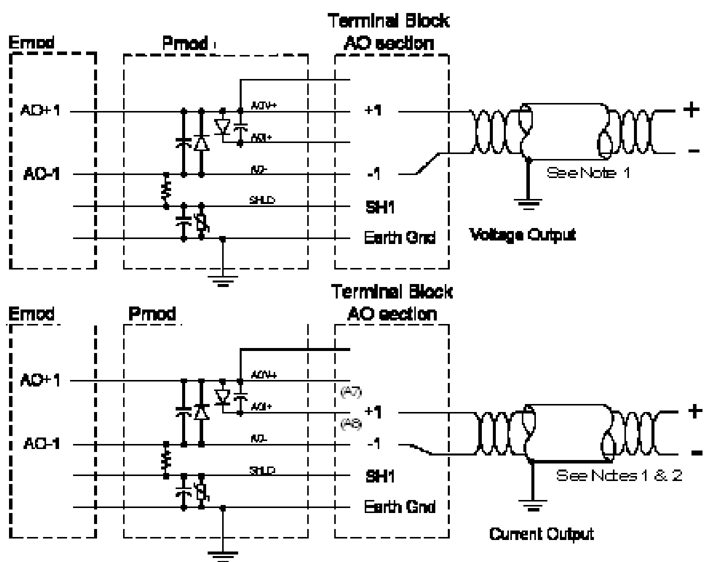
Figure 134: Locally Powered Current Analog input Field Connections (CE Mark)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware

Figure 135: Field Powered Current Analog Input Field Connections (CE Mark)

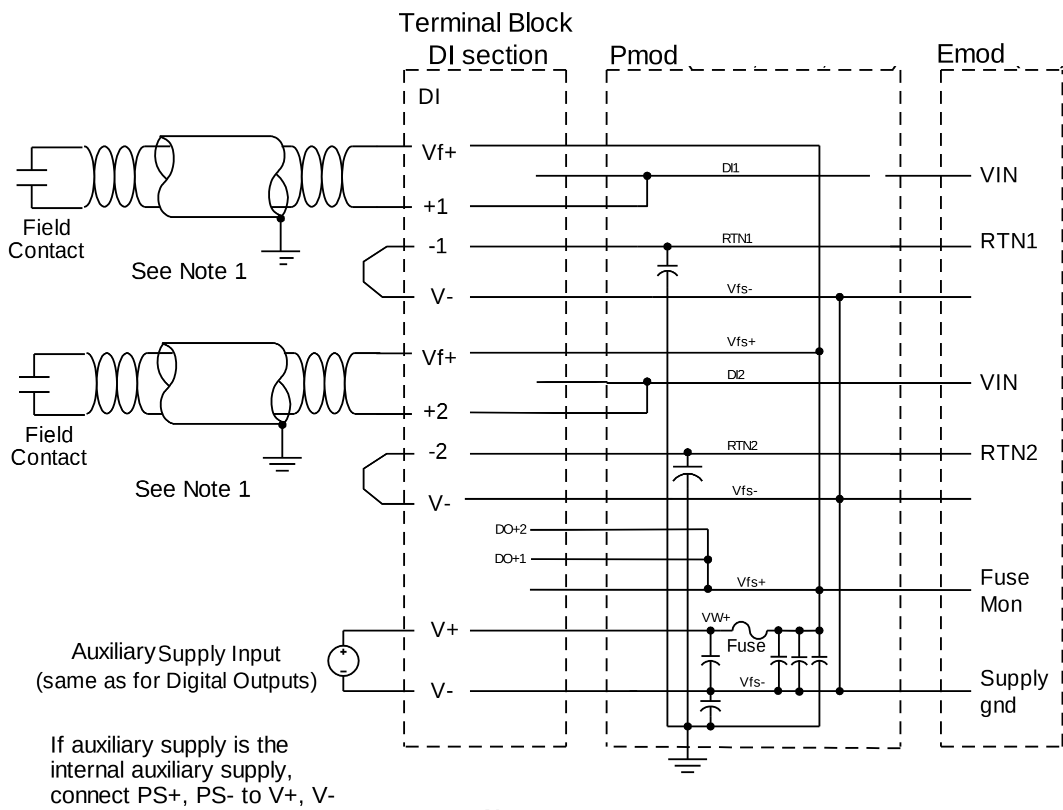


Notes

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to Cable Guidelines in the applicable "*Planning Your Ovation System*").

2. Connect meter between AOV+ and AOI+ (A7 and A8) to measure current without disconnecting loop.

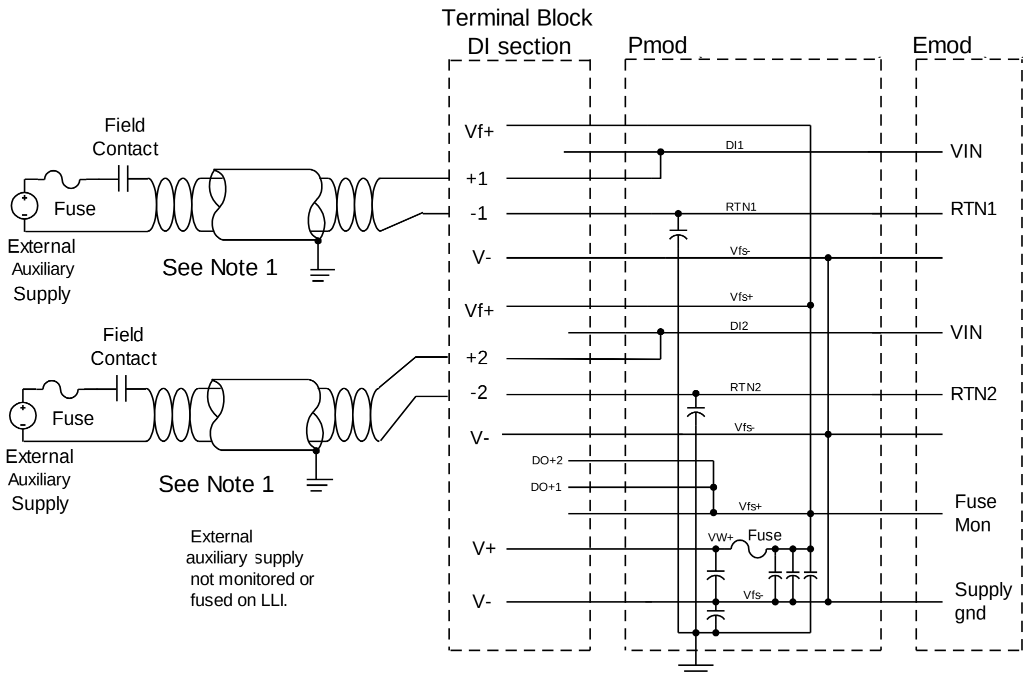
Figure 136: Analog Output Field Connections (CE Mark)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to Cable Guidelines in the applicable *Planning Your Ovation System*).

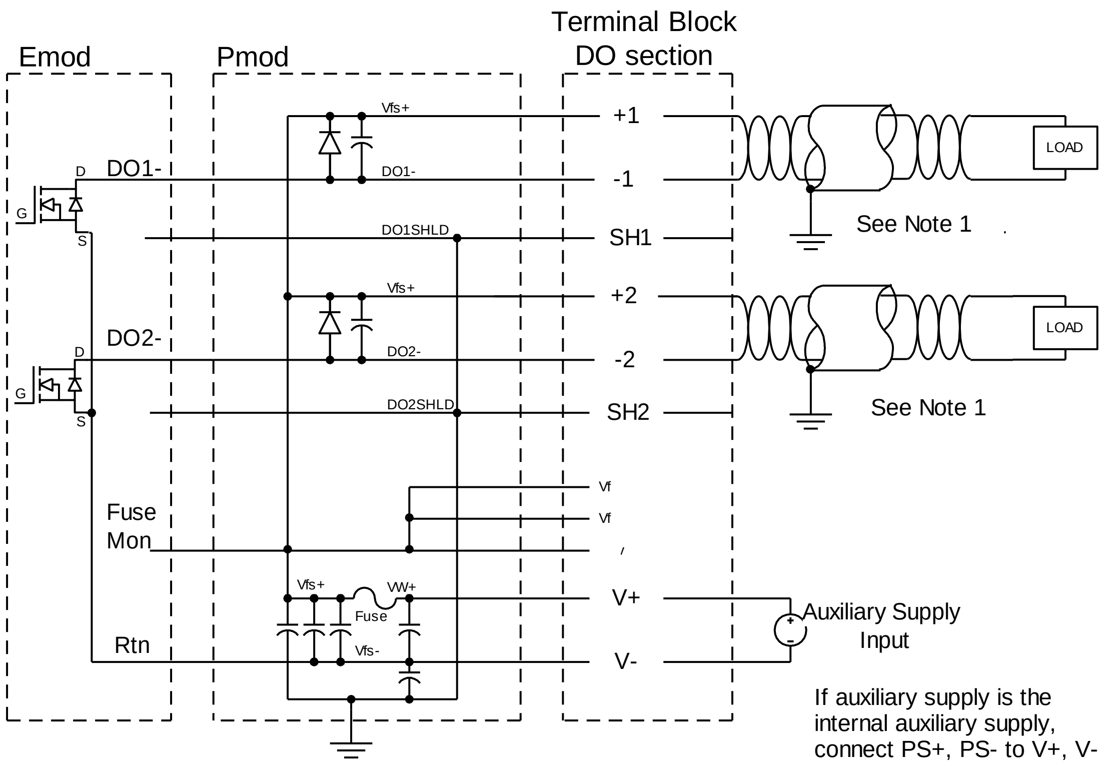
Figure 137: Digital Inputs (local auxiliary supply) Field Connections (CE Mark)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to Cable Guidelines in the applicable "*Planning Your Ovation System*").

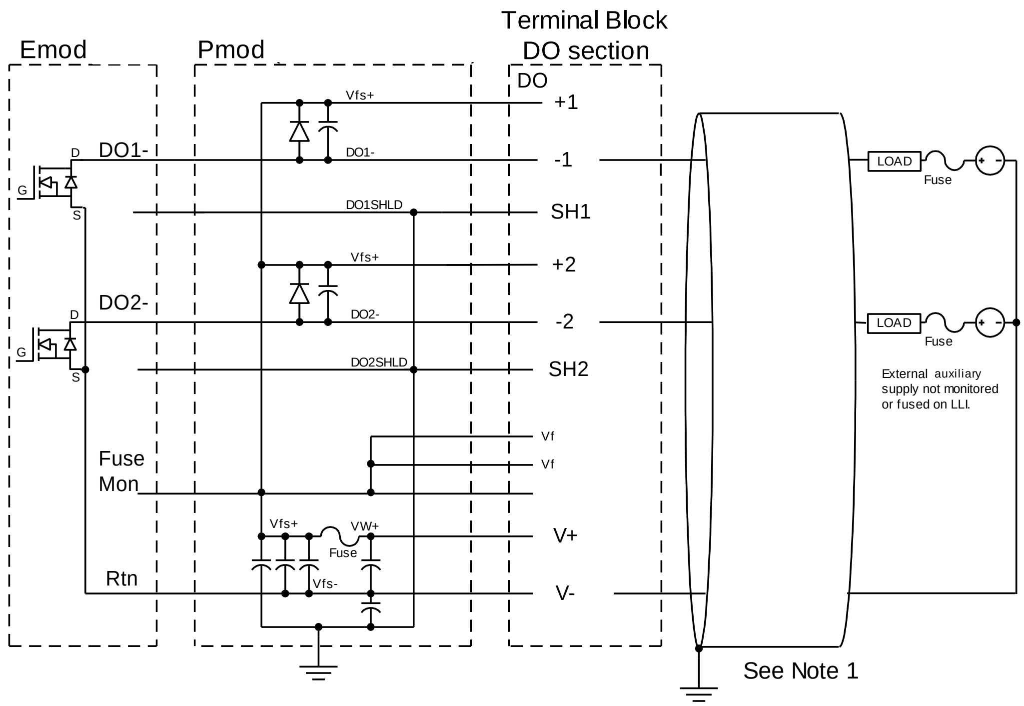
Figure 138: Digital Inputs (field auxiliary supply) Field Connections (CE Mark)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to Cable Guidelines in the applicable *"Planning Your Ovation System."*).

Figure 139: Digital Outputs (local auxiliary supply) Field Connections (CE Mark)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to Cable Guidelines in the applicable "*Planning Your Ovation System*").

Figure 140: Digital Outputs (field auxiliary supply) Field Connections (CE Mark)

9.2.14 SLIM serial port connector - (LI)

The Personality module SLIM connector is used to connect the Loop Interface module to a SLIM module.

SLIM Connector (J1 RS-485) Pin Assignments

PIN NUMBER	SIGNAL NAME (FUNCTION)	SIGNAL DIRECTION
1	SP-COMMON	NA
2	RX - (Receive Data)	Input
3	Shd (Cable Shield)	NA
4	RX+ (Receive Data)	Input
5	SLIM-ATT/(SLIM Cable Connector Attached) [1]	Input
6	TX+ (Transmit Data)	Output
7	No connection	NA
8	TX- (Transmit Data)	Output
9	SP-COMMON	NA

Pin Number	Signal Name (Function)	Signal Direction

Front View of J1 Connector (Female DB 9)

1 SLIM cable 5A26166 is used to connect the SLIM to the Loop Interface Personality module in non-CE Mark systems. In CE Mark certified systems, SLIM cable 5A26429 must be used and grounded at the entry point of the cabinet (use recommended hardware described in Cable Guidelines in the applicable " *Planning Your Ovation System*").

9.2.15 Register configuration/address information - (LI)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (See the *Ovation Operator Station User Guide*.)

Loop interface configuration/status register (address 13 or D in Hex)

<table>
<tr><th>Bit</th><th>Data Description - Configuration Register (Write)</th><th>Data Description - Status Register (Read)</th></tr>
<tr><td>0</td><td>Configure module (1=configure)</td><td>module is configured (1=configured; 0=unconfigured)</td></tr>
<tr><td>1</td><td>Force Error (1=error; 0=no error)</td><td>Internal or Forced Error (1=error; 0=no error)</td></tr>
<tr><td>2 - 4</td><td>Communications Timeout Setting
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>500 millisecs.</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>250 millisecs.</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>125 millisecs.</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>62.5 millisecs.</td></tr>
</table></td><td>Communications Timeout Setting
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>500 millisecs.</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>250 millisecs.</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>125 millisecs.</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>62.5 millisecs.</td></tr>
</table></td></tr>
</table>

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
5	For non-Electric Drive modules: 1 = Digital outputs hold state on Controller timeout 0 = Digital outputs shut off on Controller timeout.	For non-Electric Drive modules: 1 = Digital outputs hold their state on Controller Timeout. 0 = Digital Outputs are shut off on Controller timeout.
6	Not used.	1 = LIM connector not attached.
7	Not used.	1 = LIM communications error.
8	Not used.	1 = Inverse analog output operation.
9	Not used.	1 = Digital inputs as priority and raise and lower are disabled. 0 = Digital inputs as priority and raise and lower are enabled.
10	Not used.	1 = Electric module (Beck) Drive.
11	Not used.	1 = EEPROM program enabled.
12	Not used.	Not used.
13	1 = Enable blown fuse detection for digital input.	1 = Blown fuse detection for digital inputs enabled.
14	1 = 50 Hz system, 0 = 60 Hz system.	1 = 50 Hz system, 0 = 60 Hz system.
15	Not used.	1 = One of the bits in register C is set.

CAUTION: This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

Word address 14 (E in Hex) serves the purpose of the Secondary Configuration/Status Register.

Secondary configuration/status register (address 14 or E in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	For Electric Drive modules: 1 = Mode 2 Electric Drive 0 = Normal (Mode 1) Electric Drive	For Electric Drive modules: 1 = Mode 2 Electric Drive 0 = Normal (Mode 1) Electric Drive
1	For Electric Drive modules: 1 = Digital output pulses start with the ON time. 0 = Digital output pulses start with the OFF time.	For Electric Drive modules: 1 = Digital output pulses start with the ON time. 0 = Digital output pulses start with the OFF time.
2	Enable blown fuse detection for digital outputs.	Blown fuse detection for digital outputs is enabled.
3 - 8	Not Used.	Not Used.
9*	1 = Controller defined setpoint 0 = Normal setpoint	1 = Controller defined setpoint enabled 0 = Normal setpoint
10*	1 = Controller defined process variable. 0 = Normal PV operation.	1 = Controller defined process variable enabled. 0 = Normal process variable operation.
11 - 15*	Not Used.	Not Used.
* Software supported only for Rev 5 and higher Emod.		

Word address 12 (C in Hex) serves the purpose of reporting the point quality.

Point quality register (address 12 or C in Hex)

BIT	WRITE DEFINITION	READ DEFINITION
0	Not used	1 = Analog Input 1 auto calibration reasonability check failed.
1	Not used	1 = Analog Input 1 over-range, blown fuse or open loop.
2	Not used	1 = Analog Input 1 auto calibration reasonability check failed.

BIT	WRITE DEFINITION	READ DEFINITION
3	Not used	1 = Analog Input 1 over-range, blown fuse or open loop.
4	Not used	1 = Analog Input auxiliary supply blown fuse monitored and detected.
5	Not used	1 = Analog Output over current.
6	Not used	1 = Analog Output undercurrent.
7	Not used	1 = Priority Raise or Lower error (both raise and lower inputs are active).
8 - 15	Not used	Internal (Initialization) Error Codes.

9.2.16 Diagnostic Logic Card LEDs - (LI)

LED	DESCRIPTION
P (Green)	Power OK LED. Lit when the +5V power is OK.
C (Green)	Communications OK LED. Lit when the Controller is communicating with the module.
I (Red)	Internal Error LED. Lit whenever there is any type of error with the module. Possible causes are: ▪ I/O bus communications watchdog timeout. ▪ Forced error issued by the Controller. ▪ Initialization error (SRAM error, invalid group, and so forth). ▪ Microcontroller watchdog timer timeout or module reset.
1 AO (Red)	Analog Output Error. Lit whenever there is an over current or undercurrent condition on the analog output section (Group 3 and 4 only).
2 AI1,(Red)	Analog Input Error. Lit whenever there is an input error. Possible causes are: ▪ Input voltage over-range for 10 seconds. ▪ Broken current loop input/blown fuse for module configured as current input. ▪ Offset calibration voltage out of range for five consecutive calibrations (40 seconds).
3 AI2 (Red)	same as LED # 2.
4 Fuse (Red)	Blown Fuse Error. Lit if the auxiliary supply voltage for either the digital inputs or digital outputs is not present and blown fuse detection is enabled for either the digital outputs or the digital inputs.
5 SLIM (Red)	SLIM Communication Error. Lit if there is a SLIM serial port communications error.
6 DO1 (Green)	Digital Output Status. Lit when digital output 1 is active.
7 DO2 (Green)	Digital Output Status. Lit when digital output 2 is active.
8 DI1 (Green)	Digital Input Status. Lit when digital input 1 is active.
9 DI2 (Green)	Digital Input Status. Lit when digital input 2 is active.
10	No LED.
11	No LED.
12	No LED.
13	No LED.
14	No LED.

LED	DESCRIPTION
15	No LED.
16	No LED.

9.3 Pulse Accumulator module - (PA)

9.3.1 Overview - (PA)

The Pulse Accumulator module accumulates pulses for two input channels and provides the information to the Controller. There are three possible configurations:

- Counting pulses over a defined period of time allows the module to measure the speed of the input pulses (frequency).
- Counting pulses until instructed to stop counting either by the Ovation Controller or by an external field control input.
- Measuring the time duration of a pulse.

The Pulse Accumulator module is a CE Mark certified module.

Note: I/O Module general information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.

9.3.2 Electronics modules (Emod) - (PA)

- **1C31147G01** provides for pulse accumulation at one of three possible pulse input levels:
  - ☐ 24/48 V (CT+ and CT- inputs). May be referenced to either negative or positive field signal power supply common. Applicable for CE Mark.
  - ☐ 12 V medium speed (MC+ and HM- inputs). Not applicable for CE Mark.
  - ☐ 5 V medium speed (HC+ and HM-). Not applicable for CE Mark.
- **1C31147G02** provides for pulse accumulation at 5 V high speed (HC+ and HM-). Not applicable for CE Mark certified systems.

9.3.3 Personality modules (Pmod) - (PA)

- **1C31150G01** accepts 24/48 V count and control inputs from dry contacts or from solid-state low-side switch drivers. The input signals are low-true and are referenced to the branch internal auxiliary power supply return (common negative).
- **1C31150G02** accepts 24/48 V count and control inputs from dry contacts or from solid-state high-side switch drivers. The input signals are high-true and are referenced to the branch internal auxiliary power supply positive rail (common positive).
- **1C31150G03** provides dedicated 24/48 V count and control field input power for just this Pulse Accumulator Electronics module. The field input power is obtained from an external DC power supply that is connected to two base unit terminal block terminals (DSA and DSB).

***Pulse Accumulator Subsystem*[1]**

Count Input Level	Control (Enable and Snapshot) Input Level	Channels	Electronics Module	Personality Module
24/48 V Medium Speed	24/48 V Medium Speed Local field pwr. common neg. Local field pwr. common pos. Ext. field pwr. common pos. or neg.	2 2 2	1C31147G01 1C31147G01 1C31147G01	1C31150G01 1C31150G02 1C31150G03
5/12 V Medium Speed	24/48 V Medium Speed Local field pwr. common neg. Local field pwr. common pos. Ext. field pwr. common pos. or neg.	2 2 2	1C31147G01 1C31147G01 1C31147G01	1C31150G01 1C31150G02 1C31150G03
5 V High Speed	24/48 V Medium Speed Local field pwr. common neg. Local field pwr. common pos. Ext. field pwr. common pos. or neg.	2 2 2	1C31147G02 1C31147G02 1C31147G02	1C31150G01 1C31150G02 1C31150G03
[1] To use this module, the algorithm RPACNT or RPAWIDTH must reside in the Ovation Controller. Refer to the appropriate Algorithm Reference Manual for your system for detailed information about the RPACNT and RPAWIDTH algorithms.				

9.3.4 Subsystems - (PA)

***Pulse Accumulator subsystems* [1]**

Range	Channels	Electronics Module	Personality Module
Field count: +5/12V (medium speed) + 24/48V (medium speed) Field controls: +24/48V	2	1C31147G01	1C31150G01
Field count: +5/12V (medium speed) + 24/48V (medium speed) Field controls: +24/48V	2	1C31147G01	1C31150G02
Field count: +5/12V (medium speed) +24/48V (medium speed) Field controls: +24/48V	2	1C31147G01	1C31150G03
Field count: +5V (high speed)	2	1C31147G02	1C31150G01

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Field count: +5V (high speed)	2	1C31147G02	1C31150G02
Field count: +5V (high speed)	2	1C31147G02	1C31150G03
[1] +24/48V medium-speed configurations are CE Mark Certified.			

9.3.5 Terminal block wiring information - (PA)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the field wiring to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

*Do **not** use unmarked terminal block locations.*

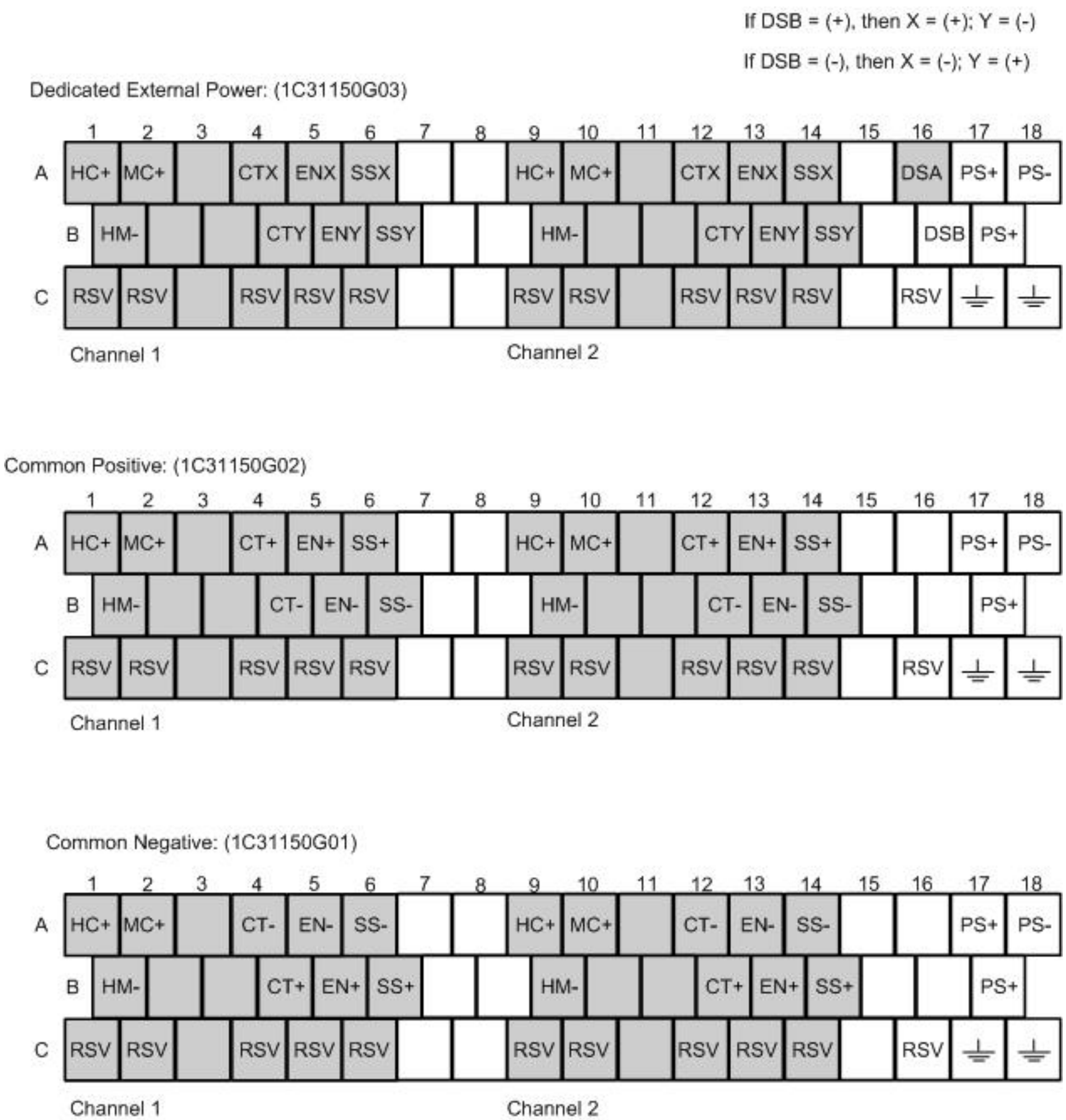
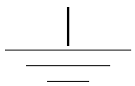


Figure 141: Terminal Block Connections for the Pulse Accumulator Pmod

The following table lists and defines the diagram abbreviations.

Abbreviations Used in Wiring Diagrams

ABBREVIATION	DEFINITION
	Earth ground terminal.
CTX	24/48V count terminal connection using external power.[1]
CTY	24/48V count terminal connection using external power.[1]
CT+	24/48V positive count terminal connection.[1]
CT-	24/48V negative count terminal connection.[1]
DSA	Dedicated external supply.
DSB	Dedicated external supply.
ENX	24/48V external enable connection using external power.
ENY	24/48V external enable connection using external power.
EN+	24/48V positive external enable connection.
EN-	24/48V negative external enable connection.
HC+	+5V high/medium speed count connection.
HM-	5/12V high/medium speed count reference.
MC+	+12V medium speed count connection.[1]
PS+, PS-	Auxiliary power supply terminals.
RSV	Reserved terminal. No connections allowed on these terminals, except when specified for terminals C4 or C12.
SSX	24/48V snapshot connection using external power.
SSY	24/48V snapshot connection using external power.
SS+	24/48V positive snapshot connection.
SS-	24/48V negative snapshot connection.

[1] 1C31147G01 Electronics module only

9.3.6 Field connection wiring diagrams - (PA)

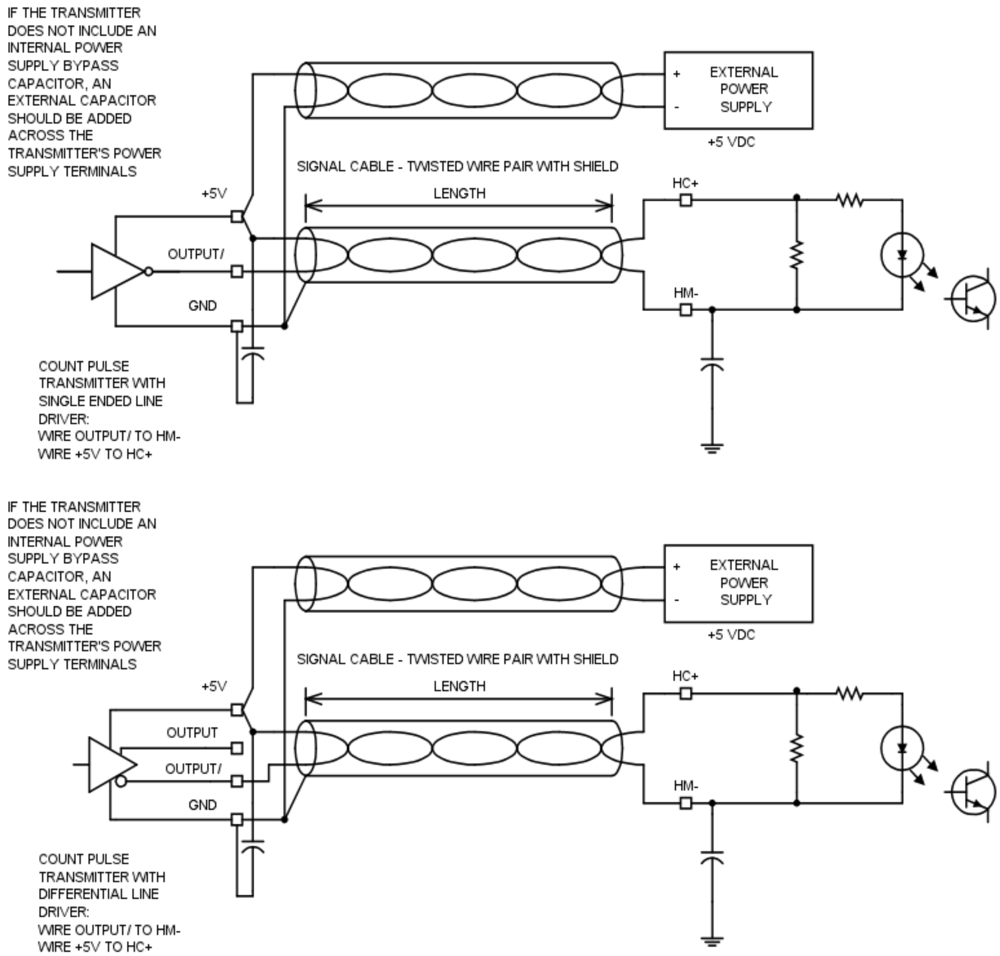


Figure 142: 5 V High Speed Count Field Connections - All Pmods

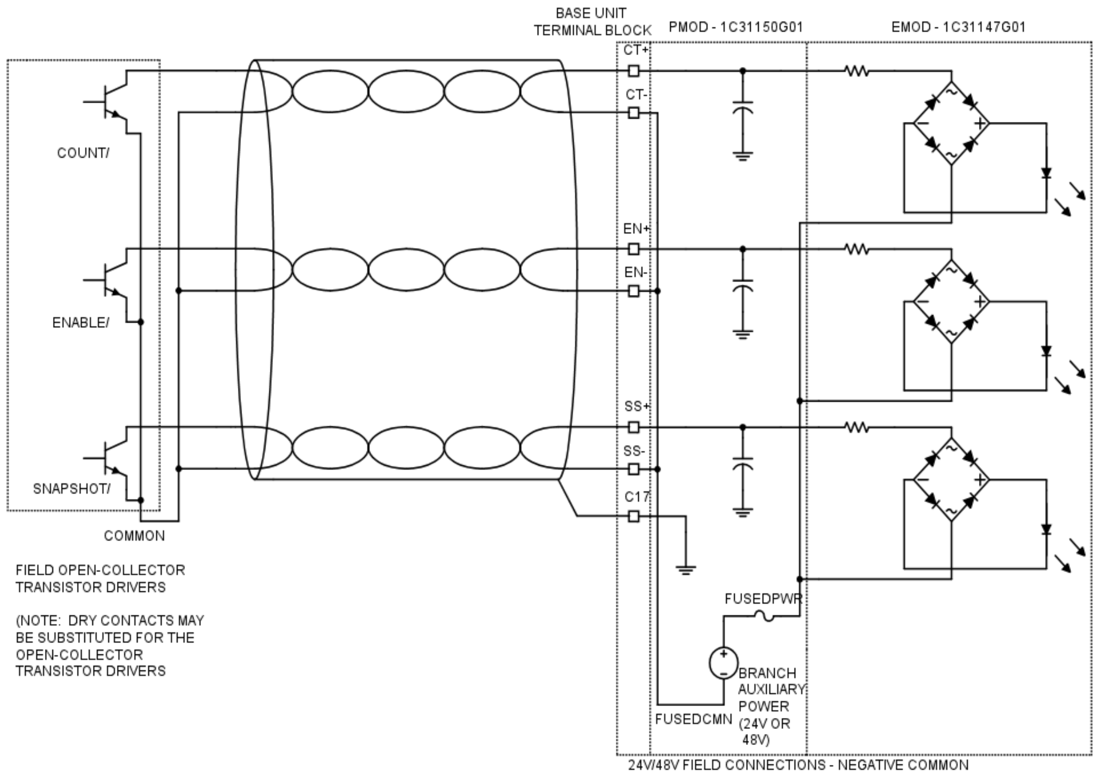


Figure 143: 24V/48V Pmod 1C31150G01 - Common Negative

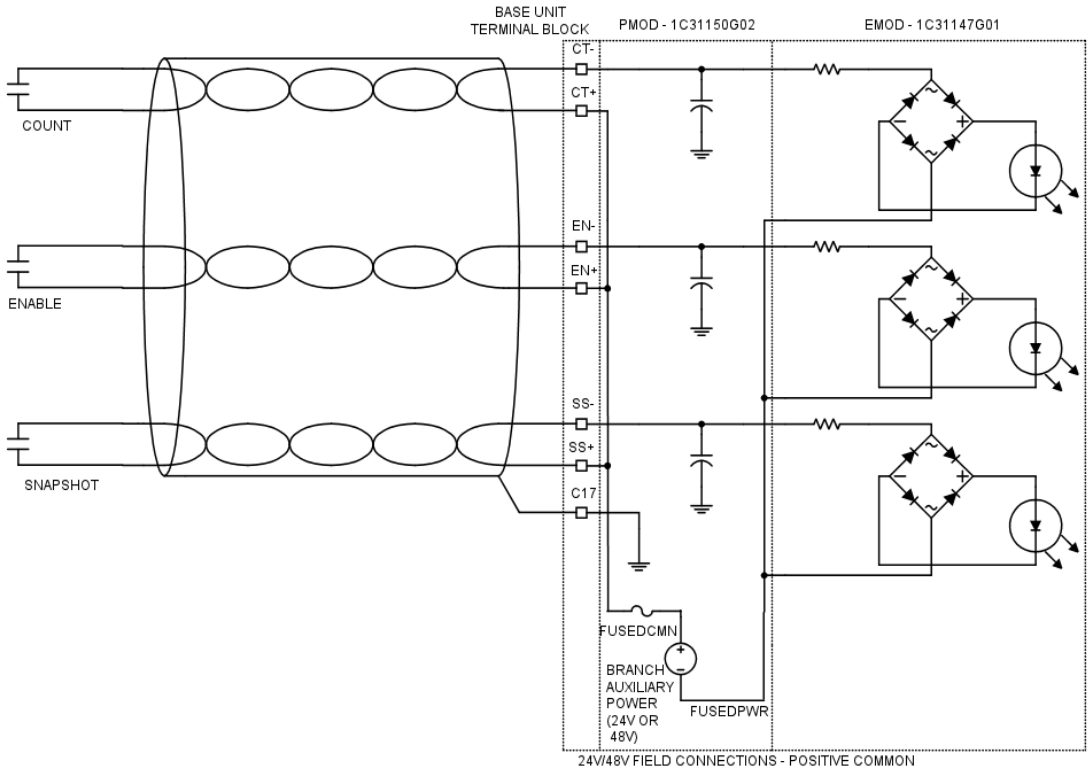


Figure 144: 24V/48V Pmod 1C31150G02 - Common Positive

9.3.7 Medium speed count field connections - (PA)

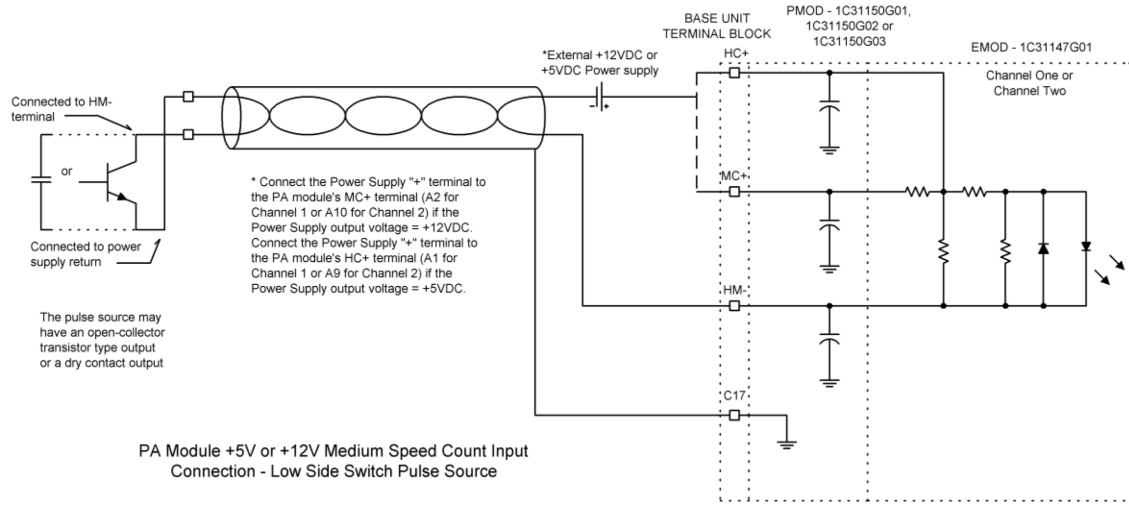


Figure 145: +5V/+12V Medium Speed - All Pmods - Low Side Switch Pulse Source

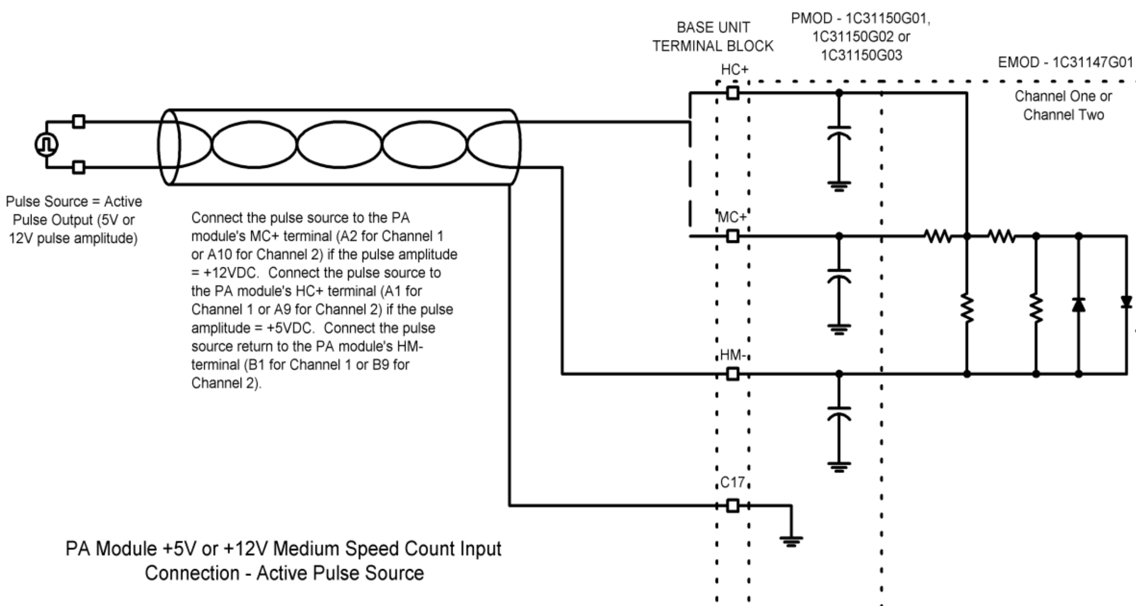


Figure 146: +5V/+12V Medium Speed - All Pmods - Active Pulse Source

9.3.8 Active pulse source count field connections - (PA)

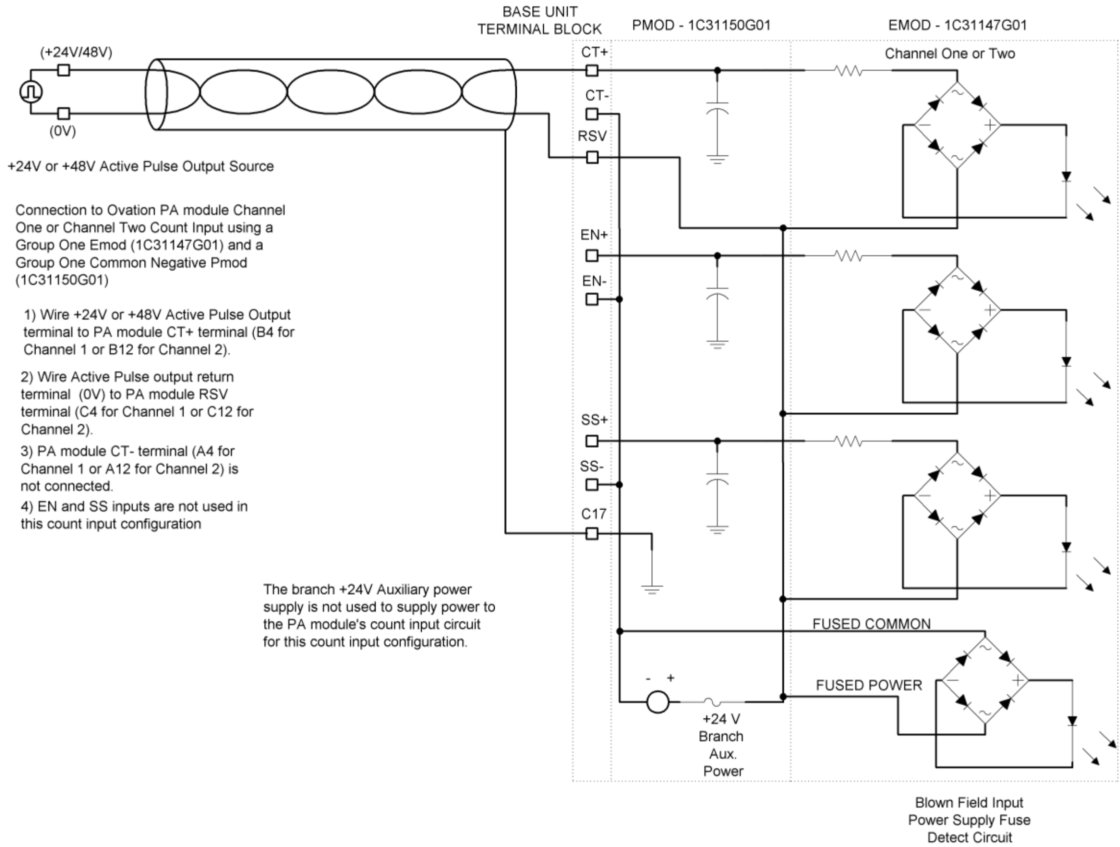


Figure 147: 24V/48V Active Pulse Source - Pmod 1C31150G01 - Common Negative

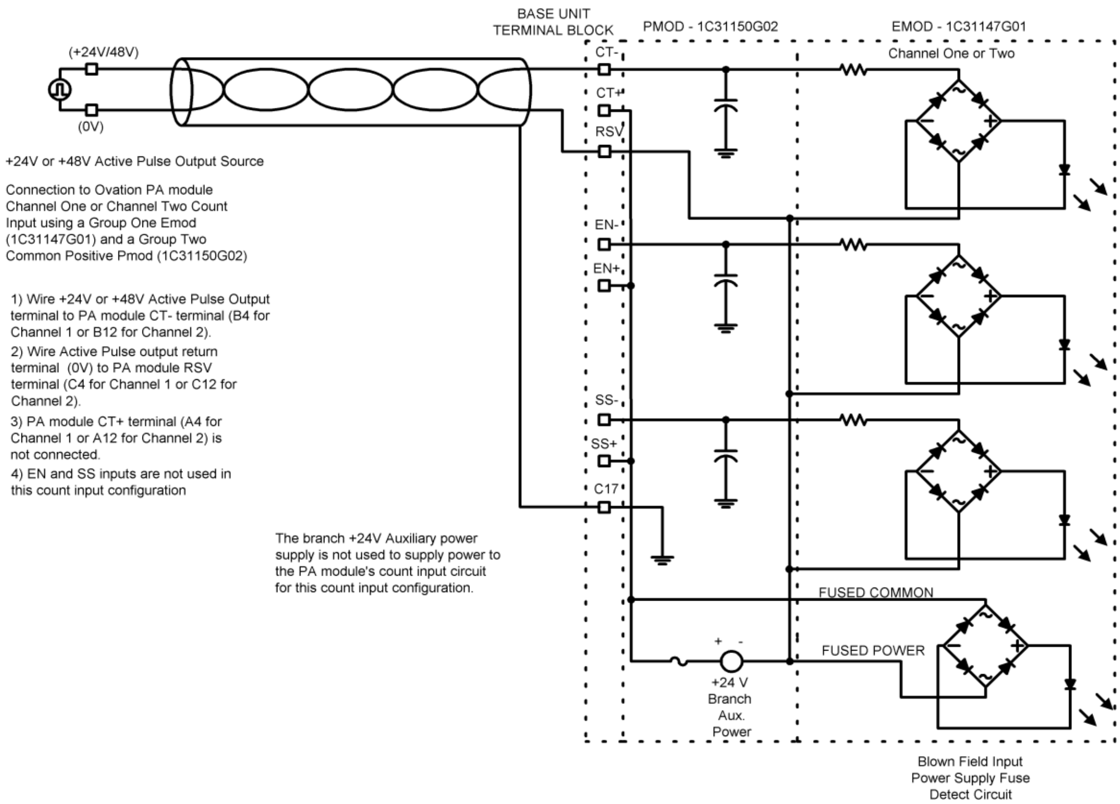
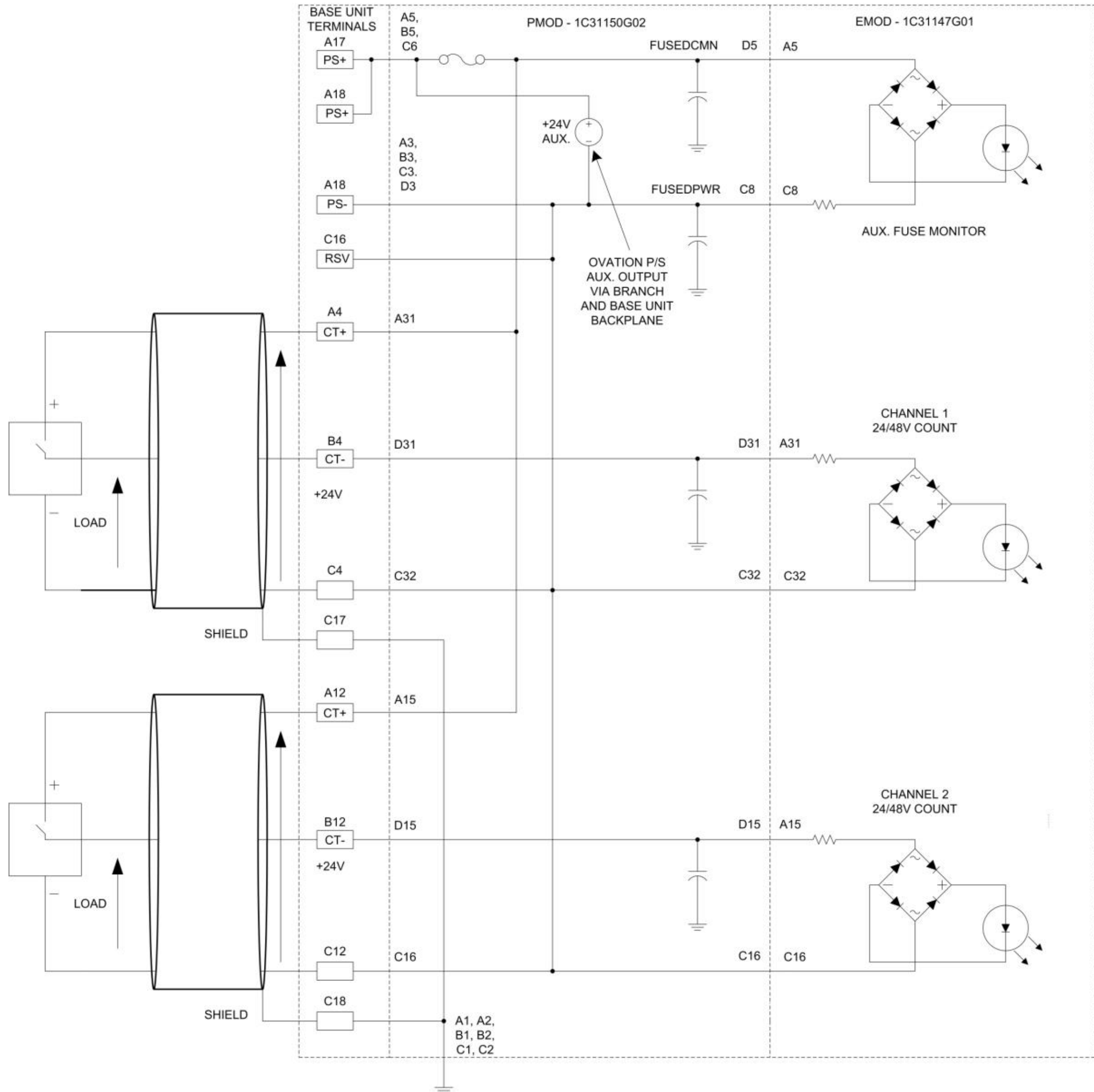
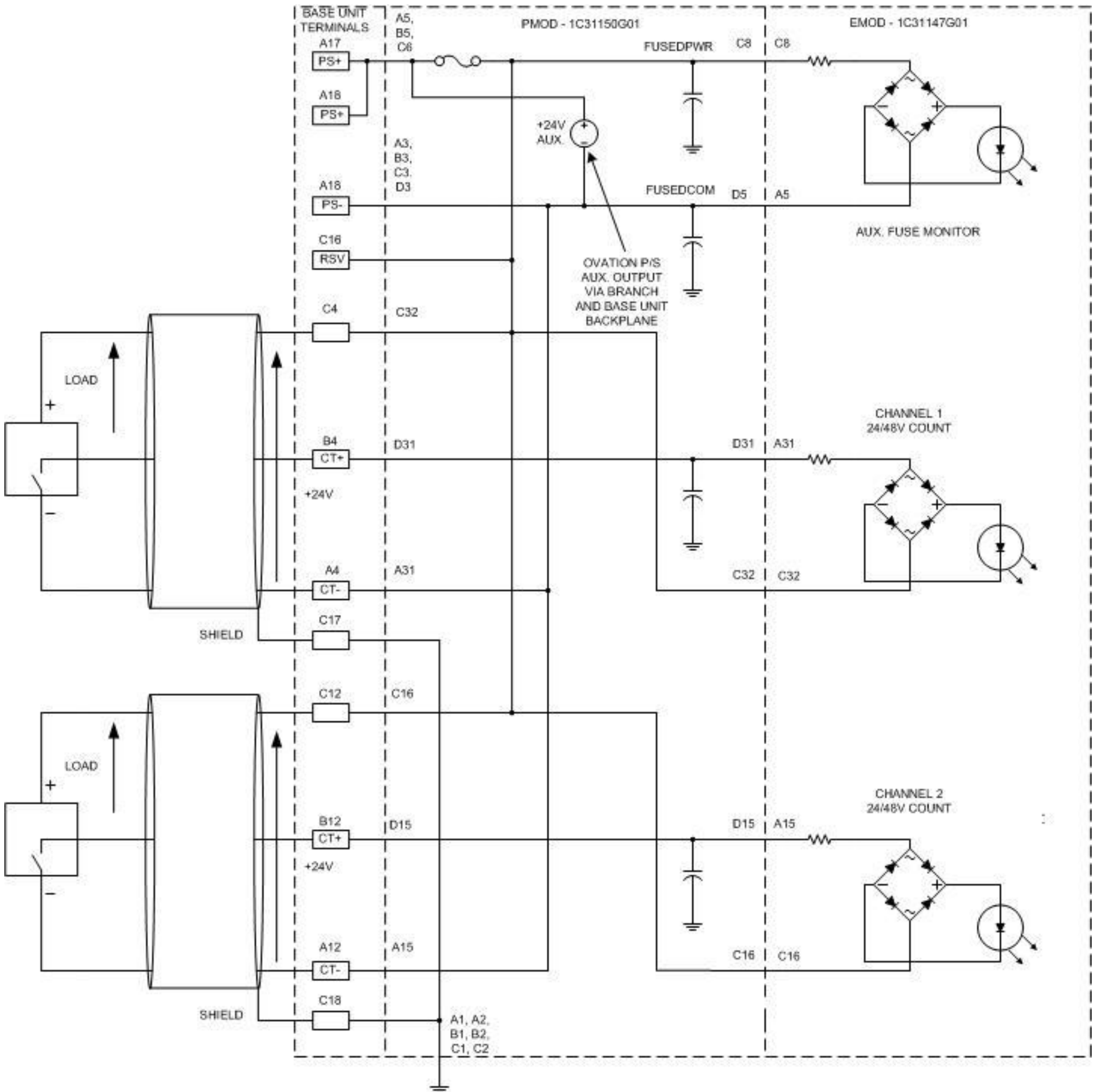


Figure 148: 24V/48V Active Pulse Source - Pmod 1C31150G02 - Common Positive

9.3.9 Three wire sensor field connections - (PA)

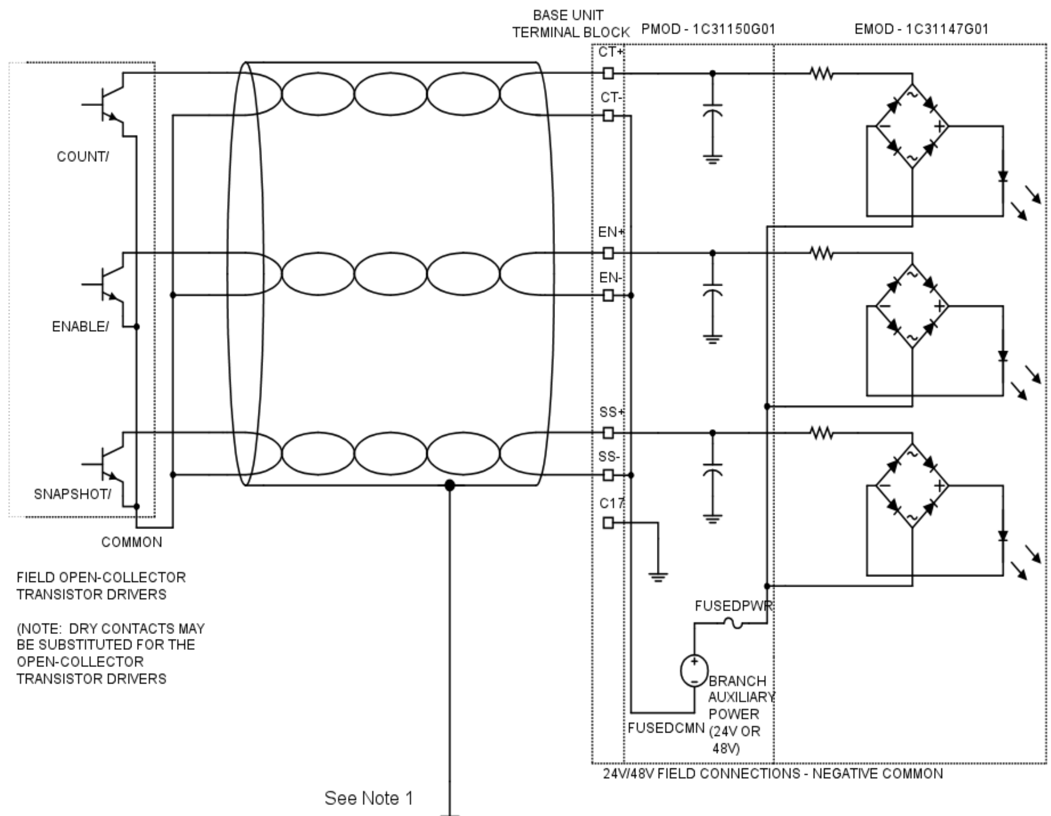


THREE WIRE SENSOR WITH SOLID-STATE HIGH-SIDE SWITCH OUTPUT 24V
Pmod 1C31150G02 – Common Positive



THREE WIRE SENSOR WITH SOLID-STATE LOW-SIDE SWITCH OUTPUT 24V
Pmod 1C31150G01 – Common Negative

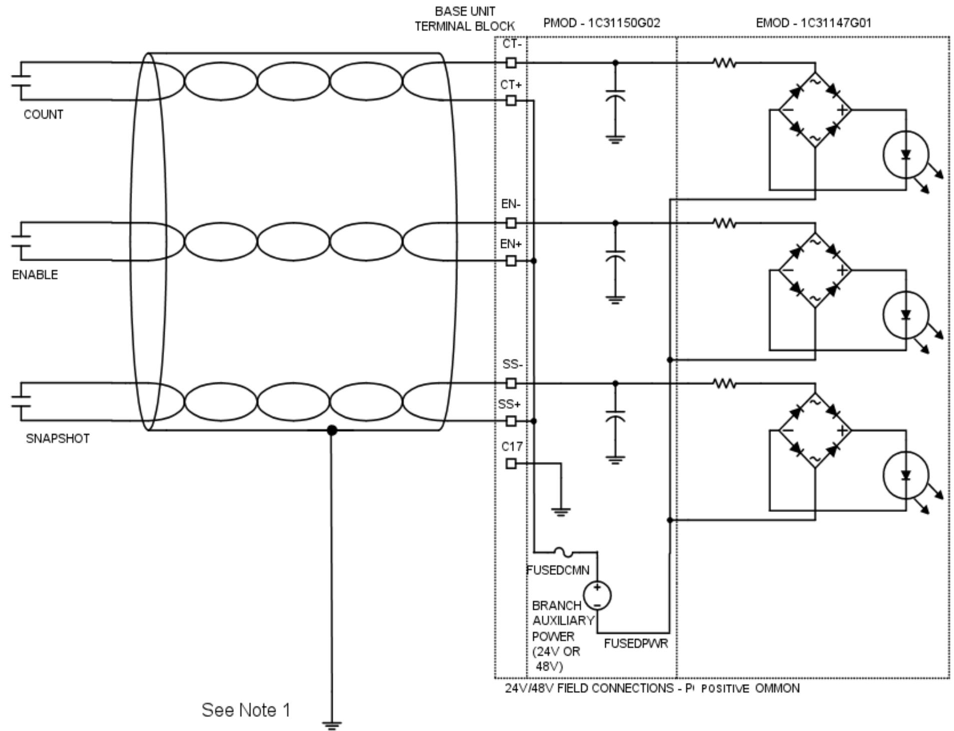
9.3.10 Field connection wiring diagrams (CE Mark) - (PA)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to the applicable "Cable Guidelines" information for your system).

Figure 149: 24V/48V Common Negative - Pmod 1C31150G01 (CE Mark)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to the applicable "Cable Guidelines" information for your system).

Figure 150: 24V/48V Common Positive - Pmod 1C31150G02 (CE Mark)

9.3.11 Active pulse source count field connections (CE Mark) - (PA)

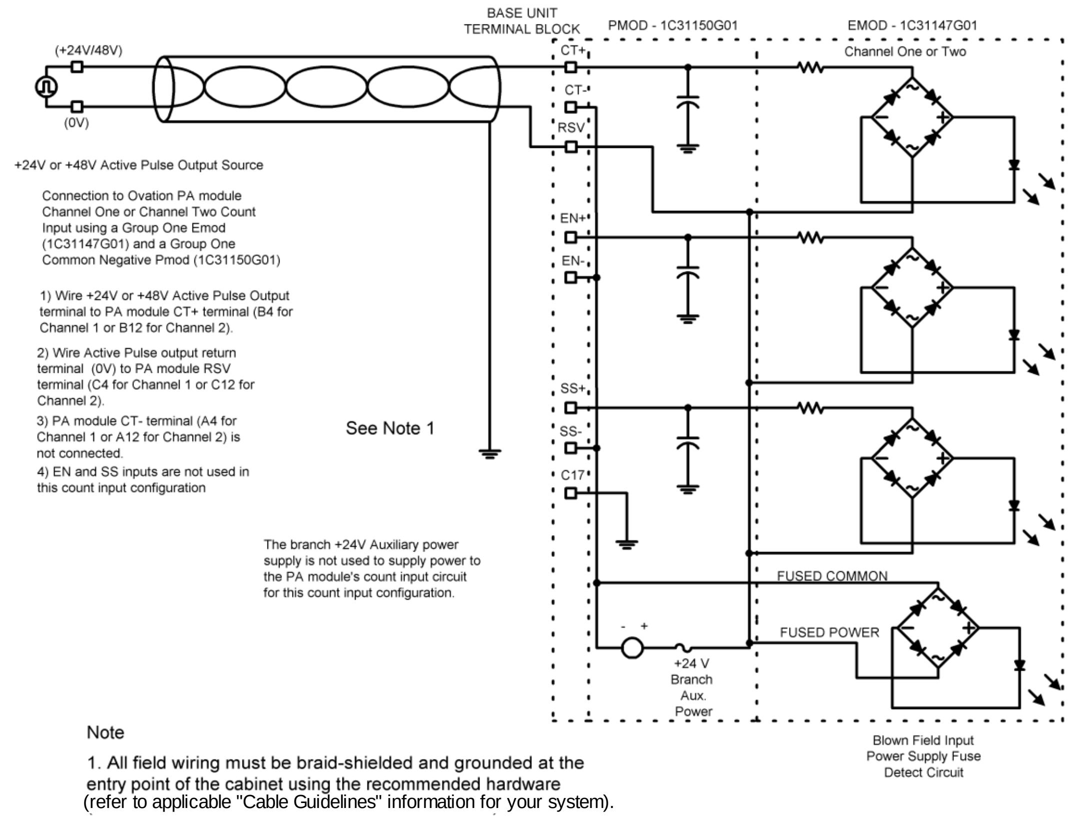


Figure 151: 24V/48V Active Pulse Source - Pmod 1C31147G01 - Common Negative (CE Mark)

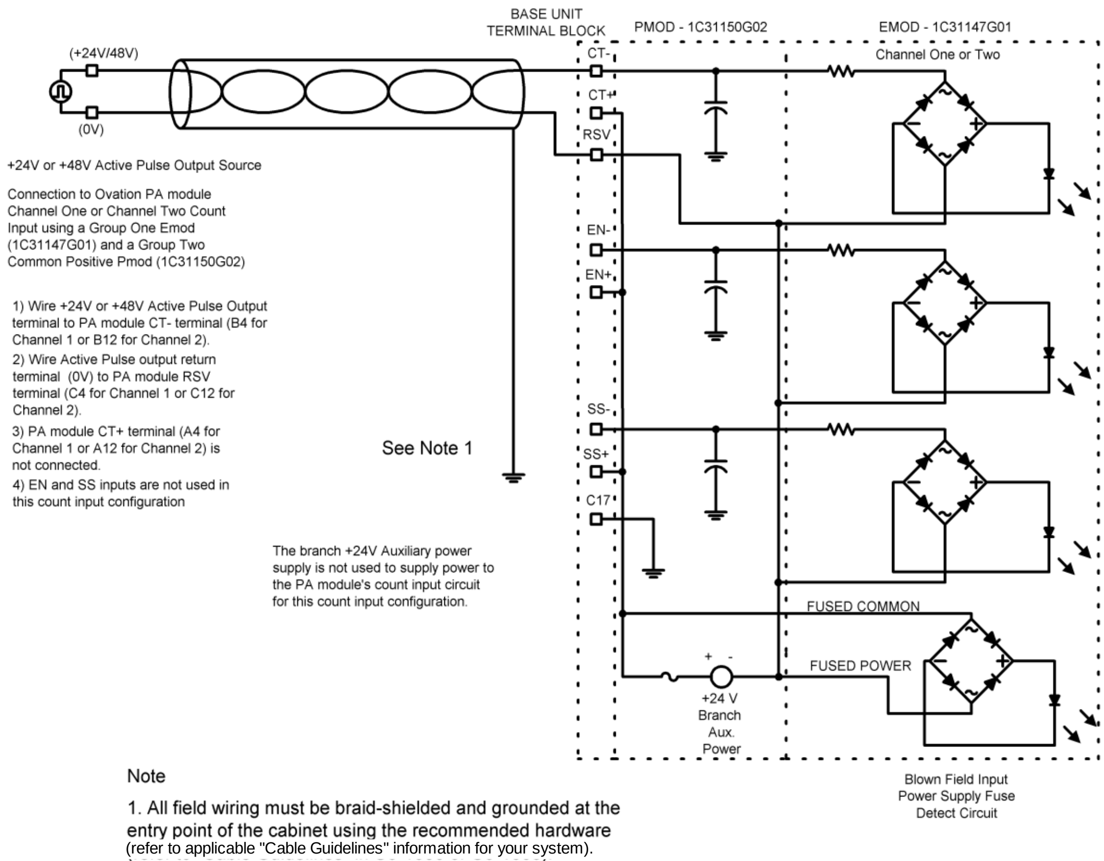
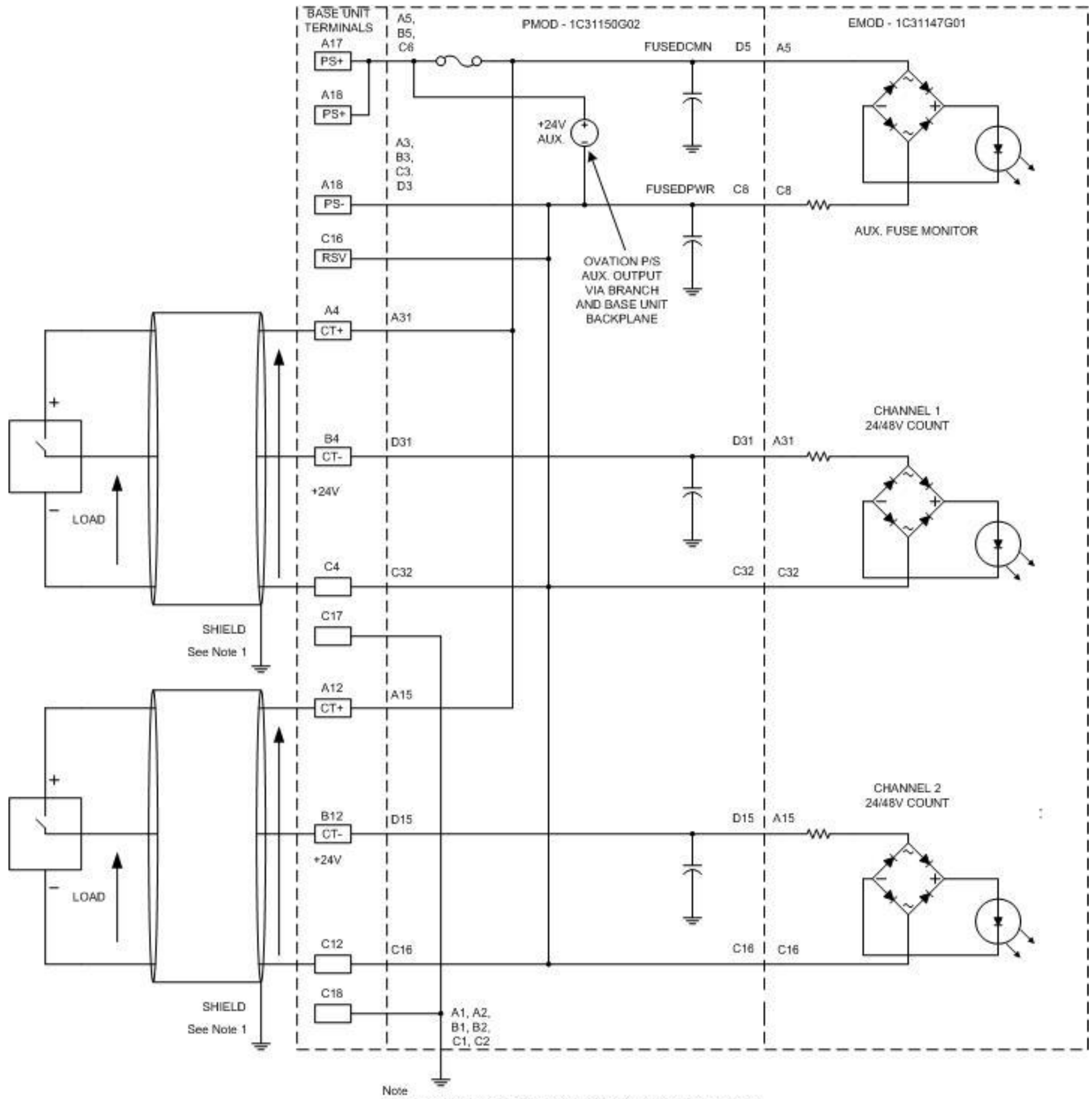


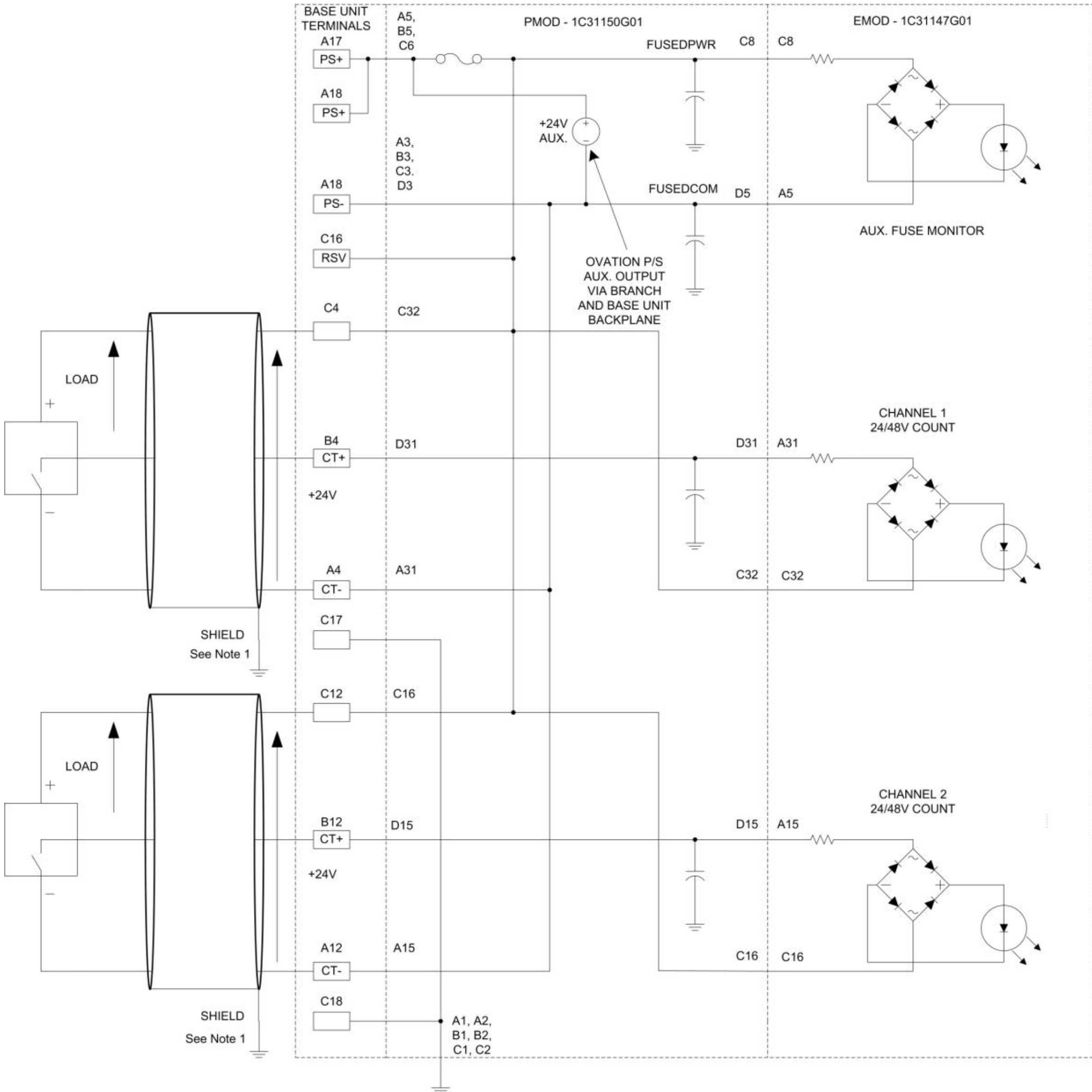
Figure 152: 24V/48V Active Pulse Source - Pmod 1C31147G02 - Common Positive (CE Mark)

9.3.12 Three wire sensor field connections (CE Mark) - (PA)



Note
1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to applicable "Cable Guidelines" information for your system).

THREE WIRE SENSOR WITH SOLID-STATE HIGH-SIDE SWITCH OUTPUT 24V
Pmod 1C31150G02 – Common Positive (CE Mark)



Note
1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to applicable "Cable Guidelines" information for your system).

THREE WIRE SENSOR WITH SOLID-STATE LOW-SIDE SWITCH OUTPUT 24V
Pmod 1C31150G01 – Common Negative (CE Mark)

9.3.13 Register configuration/address information - (PA)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. Bits 2 through 15 are for Channel 1. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). (see *Ovation Operator Station User Guide*.)

Channel 1 pulse accumulator configuration/status register (address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module 1 = configure module so all module registers can be written to. 0 = unconfigure module, registers that are assigned offset addresses below 12 (C in Hex) cannot be written to, disables both pulse counters.	Module Configured 1 = module is configured and all module registers can be read from. 0 = module is not configured, registers that are assigned offset addresses below 12 (C in Hex) cannot be read from, both pulse counters are disabled.
1	Forced Internal Error 1 = force an attention status to be read by the Ovation Controller when it accesses registers with offset addresses less than 12 (C Hex) 0 = no forced error The logic card's ERROR signal is the logical OR of the Internal Error and External Error (Blown Fuse) status signals.	Forced Internal Error 1 = forced error set by the Ovation Controller. 0 = no forced error. The logic card's ERROR signal is the logical OR of the Internal Error and External Error (Blown Fuse) status signals.
2	Enable pulse counter 1 = enable pulse counter.	Enable pulse counter configuration bit status.
3	Reset on Snapshot 1 = reset pulse counter if a counter snapshot occurs. 0 = do not reset pulse counter if a counter snapshot occurs.	Reset on Snapshot configuration bit status.
4	Compare and Snapshot 1 = if the Compare register contents match the pulse counter contents, snapshot the pulse counter contents.	Compare and Snapshot configuration bit status.
5	De-bounce count input 1 = Enable the external COUNT input de-bounce circuit. 0 = Bypass the external COUNT input de-bounce circuit.	De-bounce count input configuration bit status.
6	Not Used	Blown Fuse 1 = Blown Personality module field input power supply fuse.
7	Reset on read 1 = Reset the pulse counter upon a Controller read of the Channel 1 Count register. 0 = Do not reset the pulse counter upon a Controller read of the Channel 1 Count register.	Reset on read configuration bit status.

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
8	Increment count upon trailing edge of pulse 1 = Increment the pulse counter upon the trailing edge of the external input COUNT pulse. 0 = Increment the pulse counter upon the leading edge of the external input COUNT pulse.	Increment count upon trailing edge of pulse configuration bit status.
9	Snapshot on trailing edge of external signal 1 = Snapshot the pulse counter contents upon the trailing edge of the external SNAPSHOT input. 0 = Snapshot the pulse counter contents upon the leading edge of the external SNAPSHOT input.	Snapshot on trailing edge of external signal configuration bit status.
10	ENABLE for counter OFF input 1 = The assertion of the external ENABLE input disables the pulse counter. 0 = The assertion of the external ENABLE input enables the pulse counter.	ENABLE for counter OFF input configuration bit status.
11	Disable de-bounce on ENABLE and SNAPSHOT inputs. 1 = Bypass the external ENABLE and SNAPSHOT inputs de-bounce circuits. 0 = Enable the external ENABLE and SNAPSHOT inputs de-bounce circuits.	Disable de-bounce on ENABLE and SNAPSHOT inputs configuration bit status.
12	Not Used	1 = The external ENABLE input is asserted. 0 = The external ENABLE input is not asserted.
13	Not Used	Not Used.
14 - 15	00 = Pulse counter input is the external COUNT input. 01 = Pulse counter input is the 1 KHz internal timebase. 10 = Pulse counter input is the 10 KHz internal timebase. 11 = Pulse counter input is the 100 KHz internal timebase. Count Select Bits.	Count Select Bit configuration bits status.

Word address 14 (E in Hex) provides Channel 2 configuration and status.

Channel 2 Pulse Accumulator configuration/status register (address 14 or E in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Not Used	Not Used
1	Not Used	Not Used
2	Enable pulse counter 1 = enable pulse counter.	Enable pulse counter configuration bit status.

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
3	Reset on Snapshot 1 = reset pulse counter if a counter snapshot occurs. 0 = do not reset pulse counter if a counter snapshot occurs.	Reset on Snapshot configuration bit status.
4	Compare and Snapshot 1 = if the Compare register contents match the pulse counter contents, snapshot the pulse counter contents.	Compare and Snapshot configuration bit status.
5	De-bounce count input 1 = Enable the external COUNT input de-bounce circuit. 0 = Bypass the external COUNT input de-bounce circuit.	De-bounce count input configuration bit status.
6	Not Used	Blown Fuse 1 = Blown Personality module field input power supply fuse.
7	Reset on read 1 = Reset the pulse counter upon a Controller read of the Channel 1 Count register. 0 = Do not reset the pulse counter upon a Controller read of the Channel 1 Count register.	Reset on read configuration bit status.
8	Increment count upon trailing edge of pulse 1 = Increment the pulse counter upon the trailing edge of the external input COUNT pulse. 0 = Increment the pulse counter upon the leading edge of the external input COUNT pulse.	Increment count upon trailing edge of pulse configuration bit status.
9	Snapshot on trailing edge of external signal 1 = Snapshot the pulse counter contents upon the trailing edge of the external SNAPSHOT input. 0 = Snapshot the pulse counter contents upon the leading edge of the external SNAPSHOT input.	Snapshot on trailing edge of external signal configuration bit status.
10	ENABLE for counter OFF input 1 = The assertion of the external ENABLE input disables the pulse counter. 0 = The assertion of the external ENABLE input enables the pulse counter.	ENABLE for counter OFF input configuration bit status.
11	Disable de-bounce on ENABLE and SNAPSHOT inputs 1 = Bypass the external ENABLE and SNAPSHOT inputs de-bounce circuits. 0 = Enable the external ENABLE and SNAPSHOT inputs de-bounce circuits.	Disable de-bounce on ENABLE and SNAPSHOT inputs configuration bit status.
12	Not Used	1 = The external ENABLE input is asserted. 0 = The external ENABLE input is not asserted.

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
13	Not Used	Not Used
14 - 15	00 = Pulse counter input is the external COUNT input. 01 = Pulse counter input is the 1 KHz internal timebase. 10 = Pulse counter input is the 10 KHz internal timebase. 11 = Pulse counter input is the 100 KHz internal timebase. Count Select Bits.	Count Select Bit configuration bits status

9.3.14 Diagnostic Logic card LEDs - (PA)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module.
E (Red)	External Fault LED.[1] Lit when the field supply fuse is blown. (Bit 6) of the Status Register is set.
I (Red)	Internal Fault LED.[1] Lit whenever the Force Error bit (Bit 1) of the Configuration Register is set or when a timeout of the watchdog timer occurs when the Controller stops communicating with the module.
1 (Green)	Lit when the Channel external ENABLE input is active.
2 (Green)	Lit when the Channel external ENABLE input is active.
3 - 16	No LED.
[1] The logical OR of the Internal Fault LED and External Fault LED indication is input to the I/O Slave Controller as an ERROR flag. This forces an attention status.	

9.3.15 Specifications - (PA)

- **Electronics module (1C31147)**
- **Personality module (1C31150)**

Pulse Accumulator Specifications

Description	Value
Number of channels	2

Description	Value
Number of channels	2
Field input voltage range [1]	Field count: +5V (high speed) +5/12V (medium speed) + 24/48V Field controls: +24/48V **Note:** *See Cable characteristics tables below for more information.*
24/48 V field input power [2]	Common positive (1C31150G02) Common negative (1C31150G01) Dedicated (user-defined) contact power (1C31150G03)
Configurable functions	Count pulses Measure pulse width Measure period Measure speed
Counter output	15 bit count (bits 14 - 0) Bit 15 (MSB) is an update bit indicating new data available Counter overflow status
Field inputs	External count input (leading or trailing edge) OR Selectable internal timebase: 100 KHz, 10 KHz, 1 KHz See the table below for more information.
Input filter	+5V High Speed Count: 1 μSec. to 5 μSec. +5/12V Medium Speed Count: 16 μSec. to 38 μSec. +24/48V Count:150 μSec to 450 μSec +24/48V Controls: 150 μSec to 450 μSec
Contact debounce (24/48 V field inputs)	Configurable: Minimum: 1.4 mSec, Maximum: 2.0 mSec
Dielectric isolation: Channel to channel Channel to logic	 1000V AC/DC 1000V AC/DC
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%
Module power from logic supply	Main: 1.6 W typical: 2.0 W Maximum Aux: When used, both count inputs = 50% duty cycle 0.17 W (24V) typical 0.35 W (48V) typical
[1] All field inputs must be in a shielded cable. [2] Open loop/blown fuse detection for 24/48V power.	

Field Input Pulse Accumulator Specifications

Count Inputs	On Time msec. Min.	Off Time msec. Min.	Count Rate Max.	Description
Count Outputs				

Count Inputs	On Time msec. Min.	Off Time msec. Min.	Count Rate Max.	Description
(MC+/HM-) 12V (HC+/HM-) 5V	0.03	0.03	20 KHz	Medium speed without de-bounce circuit enabled (1C31147G01)
(MC+/HM-) 12V (HC+/HM-) 5V	2.5	2.5	200 Hz	Medium speed with de-bounce circuit enabled (1C31147G01)
(HC+/HM-) 5V	0.007	0.007	70 KHz	High speed without de-bounce circuit enabled (1C31147G02)
(HC+/HM-) 5V	2.5	2.5	200 Hz	High speed with de-bounce circuit enabled (1C31147G02)
(CT+/CT-) 24V/48V	1	1	500 Hz	Without de-bounce circuit enabled (1C31147G01)
(CT+/CT-) 24V/48V	2.5	2.5	200 Hz	With de-bounce circuit enabled (1C31147G01)
Control Inputs				
24V/48V	1	1	500 Hz	Without de-bounce circuit enabled
24V/48V	2.5	2.5	200 Hz	With de-bounce circuit enabled

Cable characteristics for 5V/12V medium speed

Conductor AWG	Maximum length
16	2200 ft.
18	1400 ft.
20	900 ft.
22	600 ft.
24	370 ft.
25	300 ft.
Cable type: Shielded twisted pair	

Cable characteristics for 5V high speed

Conductor AWG	Maximum length
16	1100 ft.
18	700 ft.
20	450 ft.
22	300 ft.
24	185 ft.
25	150 ft.
Cable type: Shielded twisted pair, 110 - 140 ohm impedance	

Cable characteristics for 24/48V: cable type is shielded twisted pair.

5/12 volt medium speed COUNT input signals

VOLTAGE	VIN OFF	VIN ON			IIN OFF MA	IIN ON MA		
	V Max.	V Min.	V Nom.	V Max.	Max.	Min.	Nom.	Max
5V Input	0.8	3.9	--	5.0	1.5	12.0	--	21.0
12V Input	0.8	9.75	--	12.5	1.5	12.0	--	21.0

The 5V medium speed COUNT input impedance is typically 250 ohms. This is a two-leaded input signal.

5 volt high speed COUNT input signals

VIN OFF	VIN ON			IIN OFF MA	IIN ON MA		
V Max.	V Min.	V Nom.	V Max.	Max.	Min.	Nom.	Max
0.8	3.9	--	5.0	3.0	25.0	--	42.0

The 5V high speed COUNT input impedance is typically 125 ohms. This is a two-leaded input signal

24/48 volt medium speed COUNT input signals

INPUT LEVEL	ON INPUT VOLTS		OFF INPUT VOLTS	ON INPUT MA		OFF INPUT MA
	Min.	Max.	Max.	Min.	Max.	Max.
Control Signals						
24 VDC	18	60	9	2.0	5.1	0.6
48 VDC	18	60	9	2.0	5.1	0.6
Count Signals						
24 VDC	18	60	9	3.0	7.7	0.9
48 VDC	18	60	9	3.0	7.7	0.9

This signal level applies to the control inputs and to the 24/48 Volt COUNT input depending upon the group and the wiring.

This input accepts either a 24V or 48V input. The Electronics module accepts a positive or a negative field signal common. The Personality module determines if the field signal common is positive or negative.

9.4 Servo Driver module - (SVD)

9.4.1 Overview - (SVD)

The Ovation Servo Driver module, also referred to as the RSR module, provides an interface between an Ovation Controller and an electro-hydraulic servo valve actuator. Each controlled turbine valve is connected to an electro-hydraulic actuator (servo-motor). A servo-motor is a fluid operated piston. Admission of high pressure hydraulic fluid to the piston cylinder is regulated by a smaller pilot valve. The pilot valve passes hydraulic fluid underneath the piston to raise it and the controlled valve, or it diverts hydraulic fluid to the upper side of the piston to lower it and the controlled valve.

Steam turbines are used in many electrical power generation plants. The electrical load on a steam turbine's electric generator fluctuates as the electric power consumption increases or decreases. The Digital Electro-Hydraulic (DEH) control system provides turbine control to adjust steam turbine shaft rotational speed in response to varying electric generator loads. Very large amounts of force are required to move valves on large turbines. Therefore, an interposing device is required between the DEH control system and the controlled valves.

A valve position set point is maintained by the Ovation Servo Driver Electronics module. The set point is normally altered by the Ovation Controller via the I/O bus. Inside the Electronics module, a microcontroller provides closed loop proportional-plus-integral (PI) control for real time valve position control.

***Note**: I/O Module general information (see page 25) contains environmental, installation, wiring, and fuse information for I/O modules.*

The valve position set point causes the Servo Driver module to generate an output control signal that drives the electro-hydraulic servo valve actuator coil. The feedback loop is closed with the valve's position measurement being obtained from a DC-LVDT or an AC-LVT that is mounted on the valve stem.

The Electronics module interfaces two Electro-Hydraulic (EH) actuators in the field. The module provides two independent channels that are galvanically isolated from each other.

The Servo Driver is a CE Mark certified module.

9.4.2 Electronics modules (Emod) - (SVD)

- **1C31199G01** provides +/- 16 Volts DC to a DC LVDT.
- **1C31199G02** provides 19 Volts AC peak-to-peak 1 KHz to an LVT.
- **1C31199G03** provides 19 Volts AC peak-to-peak 3 KHz to an LVT.
- **1C31199G04** w/Readback DC LVDT Output
- **1C31199G05** w/Readback 1kHz Output
- **1C31199G06** w/Readback 3kHz Output

9.4.3 Personality modules (Pmod) - (SVD)

- **1C31201G01** has an RJ-45 modular jack to provide access to a local RS-232 serial port. Both field interface channels contain three resistors connected in series that are used to provide a single coil drive output.
- **1C31201G02** has an RJ-45 modular jack to provide access to a local RS-232 serial port. Both field interface channels contain two coil drive outputs, each output with its own series resistor.

9.4.4 Subsystems - (SVD)

Servo Driver subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
±16 Volts DC to a DC LVDT 60 mA into a 60 ohm coil (CD1) or 40 mA into an 80 ohm coil (CD2) or 40 mA into a 40 ohm (CD3) coil	6	1C31199G01	1C31201G01
19 Volts AC peak-to-peak 1 KHz to an AC LVT 8 mA into two 1000 ohm coils	6	1C31199G02	1C31201G02
19 Volts AC peak-to-peak 3 KHz to an AC LVT 8 mA into two 1000 ohm coils	6	1C31199G03	1C31201G02
±16 Volts DC to a DC LVDT (Firmware) 60 mA into a 60 ohm coil (CD1) or 40 mA into an 80 ohm coil (CD2) or 40 mA into a 40 ohm (CD3) coil	6	1C31199G04	1C31201G01
19 Volts AC peak-to-peak 1 KHz to an AC LVT (Firmware) 8 mA into two 1000 ohm coils	6	1C31199G05	1C31201G02
19 Volts AC peak-to-peak 3 KHz to an AC LVT (Firmware) 8 mA into two 1000 ohm coils	6	1C31199G06	1C31201G02

When using the Point Builder to define points for a Servo Driver module, only the following point types are valid for each channel:

I/O Channel	Name	Type	Input Source or Output Destination	Terminal Block Connection [2]
1	Position Feedback (Device 1)	Input	Servo Driver	N/A
2	Position Feedback (Device 2)	Input	Servo Driver	N/A
3	Raw Demodulator Voltage (Device 1)	Input	Servo Driver	N/A
4	Raw Demodulator Voltage (Device 2)	Input	Servo Driver	N/A
5	Demand (Device 1)	Output	N/A	N/A
6	Demand (Device 2)	Output	N/A	N/A

[1] This module interfaces to, and provides position control for two Electro-Hydraulic (EH) actuators in the field.

[2] The terminal block connection depends upon the application being used. Refer to wiring diagrams.

9.4.5 Operation - (SVD)

The Servo Driver module operates as a two-channel closed-loop servo card or as a single-channel closed loop servo card that accommodates dual LVDTs. A configuration flag is set/reset to select the option.

The dual-channel option uses a single sine-wave or DC feedback to detect valve position for each channel. The feedback signal's amplitude is proportional to valve position. A programmable gain amplifier is used to increase the resolution of the feedback signal and is adjusted for optimum performance during a calibration sequence.

Starting with revision 0C, RSR firmware supports a cascaded PI configuration in which the output of PI 1 is used as the target position input for PI 2. Additional features to support cascading operation are flags to select direct/indirect PI operation, and an anti-windup feature called "retreat." Some of these new features are actually independent of cascading, but all are described in detail in this document.

When a sine-wave input is used as the feedback, it is assumed that the feedback signal provided is proportional to valve position and linear. The sine-wave input is rectified and the result is uni-polar. The input can accommodate a signal of increasing or decreasing amplitude as the valve is stroked from 0 to 100%. Depending on the customer mechanical hookup, a failed signal would then appear to the card as a valve flying open, or a valve flying closed, and the resulting control action would be to close the valve or to open the valve.

The single channel option executes only one PI loop in the microcontroller firmware. Prior to executing the PI loop, the feedback positions from each channel are high selected.

Another option is the "failInPlaceFlag" option. If the option is set and the Controller stops updating the module, the target position remains at the most recent position. If the "failInPlaceFlag" option is not set, the target position is set to -5%.

Another important option is the proportional output option. If this option is selected, the output voltage is set equal to demand position. The result is that 0 to 105% demand gives 0 to 10.2 volts on the output.

The proportional output, failInPlaceFlag, and redundant LVDT options are single flags that affect both channels.

9.4.6 AD/DA Conversion and Timing - (SVD)

The Servo Driver operates on a basic five millisecond period. During the five millisecond period, four interrupts occur. During each of the first three interrupts, AD readings of position feedback are recorded for each channel. After the third AD reading is taken, the three values are middle-selected and the PI algorithm is called.

The fourth interrupt in the five millisecond period handles watchdog timing, contingency timing, and sequencing of diagnostics.

9.4.7 Module modes - (SVD)

The Servo Driver operates in the following modes:

- Start mode
- Normal mode
- Local-Manual mode
- Calibrate mode

9.4.8 Start mode - (SVD)

In **start** mode, the following occurs:

- Feedback position is determined.
- Diagnostics are executed.
- The module typically transitions into normal mode immediately.

  If the module does not transition to normal mode, you can determine the reason by examining register E, which contains SFEs, or by using a laptop to enter the “diag**”** command and print diagnostic information.

When the Servo Driver starts or restarts, its primary objective is to avoid an indeterminate output that would result in valve movement and possible damage to the valve or turbine. There are a number of hardware and software features that prevent an indeterminate output.

The hardware is designed so that when the Servo Driver starts, the power supply to the servo output is turned off. With no current flow to the servo valve, it is left under the influence of its mechanical bias adjustment, the assumed state prior to starting. In addition, the coil drive D/A converter is not turned on until it receives the first output pattern.

As part of the microcontroller’s start sequence, the power supply is turned on, and then a pattern is written to the coil drive D/A converter representing 0 volts. The result is that the servo output is under software control, no current flows between the Servo Driver and the servo valve, and no valve movement occurs.

The Servo Driver does not remain in Start mode unless a diagnostic error is detected. The Servo Driver transitions from Start to Local mode if all of the following functions execute and return “normal” or “ok” status codes:

- Program the FPGA.
- Initialize default PI constants.
- EPROM checksum check.
- Read out configuration constants from EEPROM.
- Go to Factory Configure Mode if PE pin is 1.
- EEPROM checksum check.
- RAM read/write test.
- UART scratchpad read/write test.
- Shared memory readback check.

The Servo Driver sets target valve demand equal to demand feedback before transferring to Local mode.

9.4.9 Normal mode - (SVD)

In **normal** mode, the following occurs:

- Servo Driver moves the valve to the position requested by the Controller.

Note: *Normal is the preferred mode of the Servo Driver card.*

9.4.10 Local-manual mode - (SVD)

Local-manual mode is a transition mode used if the Controller is required to track valve position on startup. In the Servo Driver module, there is no requirement for tracking. Local-manual mode is a transition mode with no restrictions to normal mode.

Local-manual mode is also used for calibration sequences.

9.4.11 Calibrate mode - (SVD)

Calibrate mode is a submode of local-manual mode. Calibration sequences are commanded from the Controller or through the local serial port.

The Servo Driver is calibrated by entering a command through a personal computer connected to the local serial port.

The following calibrate sequences are supported:

- Zero Hot Cal - CALBOT

  This calibration sequence is executed to re-establish the 0% position. It is useful after the valve has been fully calibrated and the mechanical assembly has been heated and expanded. It avoids fully opening the valve.

  Feedback gain is not adjusted during the hot cal sequence.

- Top Hot Cal - CALTOP

  This calibration sequence is executed to re-establish the 100% position. It is useful after the valve has been fully calibrated and the mechanical assembly has been heated and expanded. It avoids fully closing the valve.

  Feedback gain (demodgain) is not adjusted during the hot cal sequence.

- Full Calibration - CALFULL

  This calibration sequence is executed to re-establish 0% position, 100% position, and feedback gain.

  Arbitrary limits are established for the full calibrate sequence. A valve with an 8 inch stroke that can expand by 1/8 inch is envisioned. For this valve, thermal expansion is 1/64 or 1.5%. Since the A/D converter range limit is +/- 10.4 volts the limit at 100% is arbitrarily set at 10.0 volts, or 2% of the electrical range from the end of the converter range. The target range for 100% when adjusting gain is 9.9 volts to 10.0 volts.

  When full calibration is requested, the valve first travels to 0%. At 0%, demodulator gain is adjusted until the feedback voltage is near 10 volts. The demodulator gain at this point is the Maximum possible demodulator gain.

  Then, the valve travels to 100%. If the voltage is greater than 10 volts, or off-scale, demodulator gain is reduced, and a reading of the voltage is taken. This reading is the 100% calibration valve.

Then, the valve travels to 0% and a voltage reading is taken. This reading is the 0% calibration value.

After the 0% calibration valve is determined, the new values are written to EE memory.

9.4.12 Using the serial port for calibration and settings - (SVD)

The local serial port is used in the field to calibrate and diagnose Servo Driver problems. It is used in the factory to cause the Servo Driver to perform necessary testing prior to shipment. This interface is implemented using the external UART.

The settings of the local serial port are:

- Baud rate = 19200
- Bits = 8 bits
- Stop Bits = One stop bit
- Parity = No parity

Any of the commands in Calibration Procedure (see page 560), and Tuning Constant Commands (see page 573) can be entered through the local serial port.

Commands to change constants and initiate calibration sequences always refer to channel 1 or channel 2. The command **V.1** or **V.2** selects the channel.

Once the channel is selected, it is indicated by a prompt character sequence, such as:

***1*>**

OR

***2*>**

Status messages are printed during calibration sequences and indicate the channel number (or valve number), such as:

'V1-Calibrate - Go to 100%'

OR

'V2-Calibrate - Reduce feedback gain'

9.4.13 Using the serial port for calibration connections - (SVD)

The Personality module RS-232 connector connects the Servo Driver module to the COM1 or COM2 serial port of a personal computer.

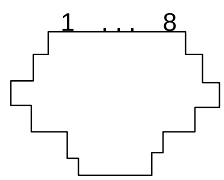
Use cable **5A26448** or make a cable using the information.

RS-232 Connector (RJ45) Pin Assignments

PIN NUMBER	SIGNAL NAME (FUNCTION)	SIGNAL DIRECTION
1	Not used	Not used
2	Not used	Not used

PIN NUMBER	SIGNAL NAME (FUNCTION)	SIGNAL DIRECTION
3	TXD2 (Transmit Data)	Output
4	Not used	Not used
5	RXD2 (Receive Data)	Input
6	GND (Logic Common) 1	Not used
7	Not used	Not used
8	Not used	Not used

Front View of RJ45 Connector (Modular Jack)



1 This serial port is not electrically isolated from logic common.

9.4.14 Performing calibration - (SVD)

Calibration is performed by connecting a PC (running terminal emulation software) or a dumb terminal to the Servo Driver, then typing commands on the PC keyboard or terminal. Using a PC is recommended because you can record/reload tuning constants to/from a disk.

The goals of calibration are:

- Determine the endpoints of mechanical stroke.
- Help the plant set up the LVDT for optimum performance.
- Perform the calibration quickly to avoid startup delay.

Calibration required - (SVD)

Calibration is required after the following:

- After a mechanical overhaul.

  If the mechanical stroke remains the same after the overhaul, and the same LVDT is installed, simply adjust the LVDT so the position feedback on the Ovation system indicates 0% (with the valve fully closed), then tighten down the LVDT assembly (that is, return to its former position).

- After the LVDT is changed.

  Calibration is required to find the null point and proper demodulator gain adjustment. However, if it is the same model you can save time by entering the same constants before running the calibration sequence.

- If a secondary wire pair is swapped.

  The valve positioner is not affected because the demodulator is a diode rectifying type. Also, you can swap secondary pairs (A and B). The result is a change in sign of the calibration values. Arithmetic in valve positioner firmware yields the correct result. However, you should follow the recommended hookup that yields negative values at 0% and positive values at 100%, and avoid confusion.

Calibration procedure - (SVD)

1. Use a standard cable to make the connection (see page 558) between the PC (or dumb terminal) and the Servo Driver.
2. Configure the serial port on the PC as described in “Settings (see page 558).”
3. To run a calibration sequence, perform the following:
   a) Connect a serial cable between the COM port and the user port on the Servo Driver.
   b) Start the terminal emulation software.
   c) Ensure the settings are correct.
   d) Type **HELP**<**return**> at the prompt to see a list of commands (described in the following table).

   Note the following:
   - Commands are case sensitive.
   - Syntax is strict.
   - There is no line buffering.
   - Backspace invalidates any typed command.
4. Type **CALFULL**<**return**> to run the full calibration sequence.
5. If any constants are entered manually, type `SC`<**return**> to save the new constants to the EEPROM.
6. Use the command **CALFULL** after an overhaul, to fully calibrate the valve.
7. Use the command **CALBOT** just prior to starting, to re-establish the 0% calibration value if thermal expansion is detected.

Calibration Commands

COMMAND	DESCRIPTION
CALBOT<return>	Calibrate zero%
CALTOP<return>	Calibrate 100%
CALFULL<return>	Full Calibration
RAISE<return>	Raise (automatically switches card to local mode) (Hit <return> to repeat.)
LOWER<return>	Lower (automatically switches card to local mode) (Hit <return> to repeat.)
DC<return>	Dump configuration constants from EEPROM.
SC<return>	Save configuration constants to EEPROM.

COMMAND	DESCRIPTION
DG<return>	Display group 1 data - This function would repeatedly display important operating parameters such as demand, feedback, gain, and so forth.
DFSC<return>	Sets all parameters constants to default values and save configuration constants to EEPROM.
HELP<return>	Displays a command list.
EXIT<return>	Exits test mode. raise/lower function, or calibration sequence. Causes a soft reset of the valve positioner.

Calibration ideal - (SVD)

During the calibration sequence, observe the valve to ensure it is moving, and that it is moving in the proper direction. Also, review the calibration constants and compare them with the ideal setup described below:

- The range of calibration values corresponds to the hexadecimal range of the AD converter, and is presented to the user in decimal, ranging from 0 to 65535.
- When an LVDT is properly adjusted and calibrated, the calibration constants (0% and 100%) is equal in amplitude and opposite in sign. The amplitudes for this ideal setup would be approximately 30,000. This result suggests the following:
  - The LVDT is adjusted so that its electrical null point (where secondary A amplitude = secondary B) matches the midpoint of the mechanical stroke.
  - The programmable gain amplifier on the demodulator is adjusted so that the electrical “stroke” stays within the input range of the AD converter. Thus, the valve positioner can detect incremental movement for all valve positions.
  - If thermal expansion occurs, the valve positioner continues to detect incremental movement because the calibration is not to the extreme end of the AD converter range, and because the magnitude of thermal expansion is small.

Simplify diagnostics - (SVD)

Rolled servo wires can cause the valve to move in the opposite direction. Be sure to observe and verify the correct movement of the valve. If only one pair is rolled, then the two pairs compete with each other. Use the following procedure to simplify diagnosis:

1. Disconnect one pair of wires.
2. Calibrate the valve, verifying the correct movement of the valve.
3. Reconnect the first pair of wires.
4. Disconnect the other pair of wires.
5. Calibrate the valve, verifying the correct movement of the valve.
6. Reconnect all the servo wires.
7. Calibrate the valve, verifying the correct movement of the valve.

On-Board diagnostics - (SVD)

The mechanical bias adjustment of the servo valve can affect the results of on-board diagnostics. A set-screw on the servo valve causes a deflection from center position of the servo valve spool. This allows hydraulic fluid to escape the actuator, and the valve to close at a controlled rate, in the absence of an electrical signal.

For a typical hookup, a small negative voltage on the servo valve is required to center the spool, and hold the valve in a steady position. This voltage is typically from -100 to -300 mV. Servo valves are delivered from the factory with this adjustment. On board diagnostics assume that the servo valve is set up in this way. If another setup is used, program the Ovation Controller to ignore the results of diagnostic bits.

Setting up redundant LVTs - (SVD)

During redundant LVT operation, only one software PI executes. The output voltage writes to both DACs. Therefore, there are four identical servo output voltages. By connecting one coil to channel 1 and the other to channel 2, you can take advantage of duplicate DAC and output driver hardware.

1. In order to configure the Servo Driver for redundant LVT operation, enter the command

   RDNDNT=1

2. Save the configuration flag to EEPROM by using the command:

   SC **<return>**

3. Once the wires are hooked up properly, calculate the valve by typing:

   CALFULL <**return**>

   During the calibration, the channel undergoing calibration displays on the terminal screen.

Calibrating redundant LVTs - (SVD)

Calibrating redundant LVTs on the Serve Driver is difficult because improper setup can create a situation where the feedbacks from the LVTs indicate that the valve should be moved in the opposite direction. Then, during the calibration sequence, the valve does not move to the endpoint properly and record valid data. Another complicating factor is that in the redundant configuration, the position feedbacks are high-selected.

The servo driver is a two-channel Controller. Each channel is calibrated independently. The channel to be calibrated is selected by typing one of the following:

V1 to select valve 1

OR

V2 to select valve 2.

During the calibration, all the printed messages indicate the valve number.

Once all the wiring is properly connected, it is possible to calibrate the Servo Driver with the redundant flag set to **1**. In this situation, the channel not being calibrated simply follows along with the channel under calibration.

For initial calibration, after an overhaul, or for a new installation, it is recommended that you clear the redundant flag and calibrate each LVT independently. During this process only one servo coil would be connected. The calibration process follows:

1. Clear the redundant flag by typing RDNDNT=0<return>, then save the setting to EEPROM.
2. Disconnect the second servo coil, leaving one servo coil connected to channel 1.
3. Calibrate channel 1.
4. Disconnect the servo coil connected to channel 1.
5. Connect the other servo coil to channel 2 servo coil output.
6. Calibrate channel 2.
7. Connect servo coil to channel 1.
8. Set the redundant flag and save setting to EEPROM.

9.4.15 Valve position control - (SVD)

In normal, local, and calibrate modes, the Servo Driver always controls valve position. The PI routine runs unconditionally every 10 milliseconds. Typically, it executes the PI equation. The PI routine has some conditionally executed parts to handle seating and backseating which are described in the next section Seating, Backseating, and Retreat for the Servo Driver module (see page 564).

9.4.16 Seating, backseating, and retreat - (SVD)

Seating and BackSeating are similar functions, with the exception that Seating closes the valve, and BackSeating opens it. Therefore, only Seating is described.

Retreat is an anti-windup function. It is important to remember that when the RSR servo output is near 0 volts, the valve is stationary. When the servo output moves away from the midpoint, the valve moves to the desired position, and the servo output goes back to near 0 volts.

Retreat is a feature that occurs after Seating. It is highly programmable.

When the target position is less than seat limit, the RSR goes into a seating mode. In this mode the RSR wants to close the valve as fast as possible. It accomplishes this by driving the output hard to the rail in the direction of valve closure.

Retreat occurs after a timer has expired (retreatHoldT), and once the valve position is close to where the RSR wants it to be (ABS|Target-Feedback| < posErrorRetreat). When a valve retreats, the servo output goes from the rail to a programmed value (exitSeatVal) at a predefined rate (retreatRate).

In a typical scenario, you would determine the voltage required to null the servo spool; that is, overcome the mechanical bias adjustment. Let's assume the value is –200 mV. Then you would set exitSeatVal to –200 mV plus an arbitrary amount in the direction of valve closure, 100 mV perhaps. So, the user would set exitSeatVal to –100 mV. Also, assume the user leaves the other associated constants to their default values. When seating is entered, the servo output goes to +10 volts and remains there for at least 10 seconds. When the 10 second timer expires, and when position feedback is within 2 percent of the target position (probably 0), the servo output ramps from 10 volts to –100 mV at 10% per second. Ten volts is about 50% of output range, so the servo output would return to –100 mV after 5 seconds. At –100 mV, the servo spool is letting a small amount of fluid escape, thus closing the valve.

If the target position went higher, thus removing the RSR from seating, the servo output would be readily available to begin to move the valve, and would not rely on integral action to bring it from 10 volts back to 0.

When the RSR is moving between these various modes, the PI tracks the output when it is begin driven by one of the non-normal modes such as seating. Therefore, the transition back to normal operation is bumpless.

If the system is not properly tuned, the valve could start to go open when the servo output reaches the retreat value. If this occurs and ABS|Target-Feedback| > posErrorRetreat, a bit is set in register D to announce the condition. The RSR sends the output back to the rail and does not allow the channel to retreat again until seating is exited. You should ensure that the bits in register D generate alarms to notify the operator should this occur.

9.4.17 PI position control - (SVD)

The equation for PI position control is:

$$K_p\left[e(t)+\frac{1}{k_i}\int e(t)dt\right]$$

$$K_p * e(t) + \left[\frac{1}{k_i}\int e(t)dt\right]_{Min(-IntLim)}^{Max(+IntLim)} + Offset$$

where:

K^p = Proportional gain

K^I = Integral time

e(t) = Position error

Offset = Offset constant

Integral action can be limited by IntLim tuning constant to ±IntLim. And output can be scaled for different span of mV by providing different then default outputMin (default -10200mV) and outputMax (default 10200mV) tuning coefficients.

If seating or backseating is in effect, normal PI Controller calculation is halted.

Cascading of the PI controllers can be selected by entering "**CASCADE = 1**" and saving the setting by typing "**SC**".

When cascading is selected, the -10V to +10 output of PI 1 is converted to 0% to 100% target position. This target position value is then used as the target position, or demand, for PI 2.

Cascade Close in Seat can be selected by entering "CCS = 1" and saving the setting by typing "SC".

When cascading is selected and Cascade Close in Seat is selected, if PI 1 is in seat, output of PI 2 is set to casSeatVal.

In addition, Cascade Close function can be implemented in Cascade mode. Cascade Close function allows transferring PI 2 hardware output to demanded voltage value and keeping it at this that value as long as demand exists. Cascade Close demand is send to the card by position demand register of PI 2 in Cascaded mode as this card register is freed in Cascade configuration due to the fact that in Cascade mode demand to PI 2 is sent from PI 1 output. There are two sub modes for Cascade Close mode. One allows keeping controller output frozen while second one allows tracking of an output value. Diagram bellow shows SAMA diagram for Cascade mode.

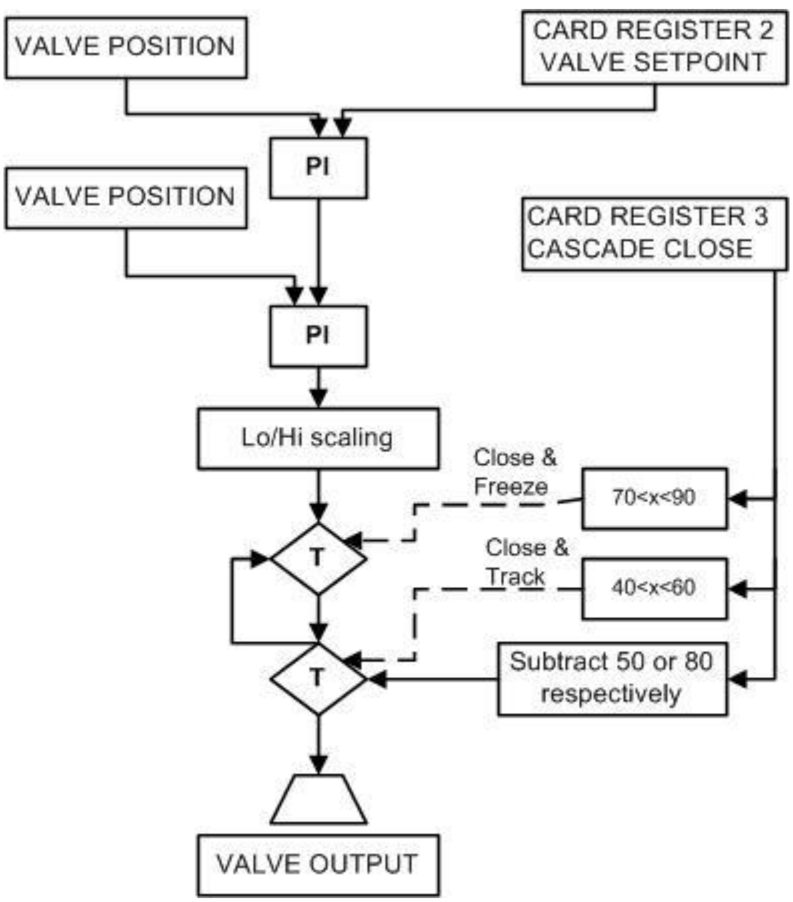


Figure 153: General structure of Cascade mode

Release constant can be used to perform function equivalent to the process of exiting from Seating. Release is Equivalent to exitSeatVal tuning Constance but is related to exit from Cascade close. Ramp for Release is defined in retreatRat constant, ramp is the same as for exitSeatVal.

Cascaded mode allows executing Cascade Close on V2 when there is Seat performed on V1 and CasCloseInSeat flag is set. Output will be driven to CasCloseInSeatVal in such case, Exit procedure will be executed based on Release tuning constant.

9.4.18 Controller interface - (SVD)

The following topics define direct-access Ovation shared memory registers from the Controller point-of-view. The Servo Driver configuration allows I/O points to be defined. These I/O points are configured as standard Ovation hardware points. There is a special algorithm to interface with the Servo Driver.

The RSRSTATUS algorithm performs the following:

- Displays the status registers and command register for the Ovation Servo driver (RSR) card.
- Calibrates channel 1 and channel 2 of the RSR card using a standard graphic (diagram 8757) instead of using the RSR serial port.
- Uploads and downloads configurable parameters used by the RSR card.

If a point assigned to the ENBL input and point is TRUE, then the STAT1, STAT2 and CMD outputs updated. If ENBL is FALSE, then the last value of the STAT, STAT2 and CMD is retained.

Note: Controller interface and RSRSTATUS algorithm are supported by rev. 0G or above of RSR firmware.

9.4.19 Serial bus watchdog timer - (SVD)

The timeout value for the Servo Driver module for Solaris applications is selected in the I/O Builder Servo Driver configuration dialog box (described in the *Ovation Init and AdMin User Guide* or for Windows applications in the *Ovation Developer Studio User Guide*). Make sure this time period value is **greater than** the value of the Control Task time period that defines the points associated with this module.

Bits 2, 3, and 4 of the configuration register (register D) determine the length of a watchdog timer. The 3-bit codes and associated times are standard for Ovation I/O.

Initially, the timer is set to the Maximum time, which is 16 seconds. The microcontroller periodically reads the configuration register and determines the timeout time.

If the timer expires, the Internal Error LED bit sets, and the LED turns on. The Communications OK LED extinguishes. As long as the timer does not expire, the Communications OK LED illuminates and the Internal Error LED bit clears.

9.4.20 Memory map - (SVD)

The following table describes the Controller register for the Servo Driver module and defines the I/O Channel Number that must be selected in the Point Builder Hardware tab (shown below) when configuring points associated with this module (refer to the *Ovation Init and AdMin User Guide* or *Ovation Developers Studio User Guide* for your Ovation system).

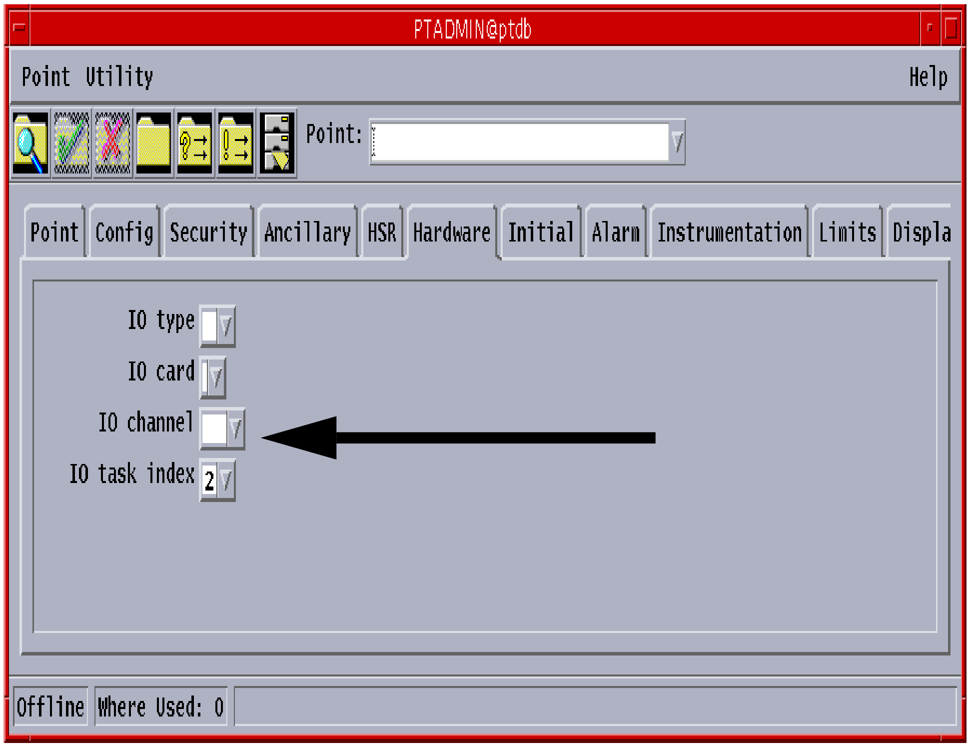


Figure 154: Example of Hardware Tab in Point Builder

Operating mode memory map

Servo Driver Card Register	I/O Channel Number in the Point Builder	R/W	Definition
0	N/A	N/A	Indirect ram pointer (Output FIFO Put Pointer).
1	N/A	N/A	Indirect ram data register.
2	5	W	Demand - Channel 1 (-1560 to 32760 equals -5.0 to 105.0%).
3	6	W	Demand - Channel 2 (-1560 to 32760 equals -5.0 to 105.0%).
4	1	R	Position feedback - Channel 1 (-1560 to 32760 equals -5.0 to 105%).
5	2	R	Position feedback - Channel 2 (-1560 to 32760 equals -5.0 to 105%).

<table>
<tr><th>Servo Driver Card Register</th><th>I/O Channel Number in the Point Builder</th><th>R/W</th><th>Definition</th></tr>
<tr><td>6</td><td>3</td><td>R</td><td>If bit 7 reg. D = 0 then: Raw demodulator voltage - channel 1 (standard format where +/-0xFFF (bit 12 is sign, +0xC000) equals +/- 10.235 volts)
If bit 7 reg. D = 1 then: registers 6 and 7 contain output DAC setting.</td></tr>
<tr><td>7</td><td>4</td><td>R</td><td>If bit 7 reg. D = 0 then: Raw demodulator voltage - Channel 2 - same format as Channel 1
If bit 7 reg. D = 1 then: registers 6 and 7 contain output DAC setting.</td></tr>
<tr><td>8
Channel 1</td><td>N/A</td><td>R</td><td><table>
<tr><th>Status Register 1</th><th></th></tr>
<tr><td>Bits 0-7</td><td>modes apply for Channel 1</td></tr>
<tr><td>Bits 0-1</td><td>0 = START Mode</td></tr>
<tr><td></td><td>1 = LOCAL Mode</td></tr>
<tr><td></td><td>2 = Normal Mode</td></tr>
<tr><td>Bits 2-4</td><td>0 = not calibrating</td></tr>
<tr><td></td><td>1 = CAL_0</td></tr>
<tr><td></td><td>2 = CAL_100</td></tr>
<tr><td></td><td>3 = CAL_FULL</td></tr>
<tr><td></td><td>4 = CAL_NULL</td></tr>
<tr><td></td><td>7 = CAL_FINISHED (channel 1)</td></tr>
</table></td></tr>
<tr><td>8
Channel 2</td><td>N/A</td><td>R</td><td><table>
<tr><th>Status Register 1</th><th></th></tr>
<tr><td>Bits 8-F</td><td>modes apply for Channel 2</td></tr>
<tr><td>Bits 8-9</td><td>0 = START Mode</td></tr>
<tr><td></td><td>1 = LOCAL Mode</td></tr>
<tr><td></td><td>2 = Normal Mode</td></tr>
<tr><td>Bits 10-12</td><td>0 = not calibrating</td></tr>
<tr><td></td><td>1 = CAL_0</td></tr>
<tr><td></td><td>2 = CAL_100</td></tr>
<tr><td></td><td>3 = CAL_FULL</td></tr>
<tr><td></td><td>4 = CAL_NULL</td></tr>
<tr><td></td><td>7 = CAL_FINISHED (channel 2)</td></tr>
</table></td></tr>
</table>

Servo Driver Card Register	I/O Channel Number in the Point Builder	R/W	Definition	
9 Channel 1	N/A	R	**Status Register 2**	
			Bits 0-7	modes apply for Channel 1
				0 = Retreat in Progress
				1 = Retreat Disabled
				2 = Contingency (immediate)
				3 = Contingency (filtered)
9 Channel 2	N/A	R	**Status Register 2**	
			Bits 8-F	modes apply for Channel 2
				8 = Retreat in Progress
				9 = Retreat Disabled
				10 = Contingency (immediate)
				11 = Contingency (filtered)
				12 = (0x1000) is set if cascade flag is set, 0 otherwise
				13 = (0x2000) is set if DAC output is selected for register 6 and 7, 0 otherwise

Servo Driver Card Register	I/O Channel Number in the Point Builder	R/W	Definition	
A Channel 1	N/A	W	**Command Register 1**	
			Bits 0-7	modes apply for Channel 1
			Bits 0-2	Control calibration requests for Channel 1
				000 - No calibration
				001 - Travel to 0%, record endpoint (CAL 0 Hot).
				010 - Travel to 100%, record endpoint (CAL 100 Hot).
				011 - Full calibration, travel to 0, then 100, then back to 0. Demodulator gain is adjusted if necessary.
				100 Go to NULL point.
			Bits 3-5	Control raise and lower functions for Channel 1
				000 - No Command. (RSR will try to go to normal mode.)
				100 - Local mode (stay in place).
				101 - Raise 0.5% (module will clear bit 3 to acknowledge).
				110 - Lower 0.5% (module will clear bit 4 to acknowledge).
			Bit 7	Selects channel number for register 6 and 7 point data.
				0 - Feedback voltage (default).
				1 DAC setting.

<table>
<tr><th>Servo Driver Card Register</th><th>I/O Channel Number in the Point Builder</th><th>R/W</th><th>Definition</th></tr>
<tr><td>A
Channel 2</td><td>N/A</td><td>W</td><td>
<table>
<tr><th>Command Register 1</th><th></th></tr>
<tr><td>Bits 8-10</td><td>Control calibration requests for Channel 2.</td></tr>
<tr><td></td><td>000 - No calibration.</td></tr>
<tr><td></td><td>001 - Travel to 0%, record endpoint (CAL 0 Hot).</td></tr>
<tr><td></td><td>010 - Travel to 100%, record endpoint (CAL 100 Hot).</td></tr>
<tr><td></td><td>011 - Full calibration, travel to 0, then 100, then back to 0. Demodulator gain is adjusted if necessary.</td></tr>
<tr><td></td><td>100 - Go to NULL point.</td></tr>
<tr><td>Bits 11-13</td><td>Control raise and lower functions for Channel 2.</td></tr>
<tr><td></td><td>000 - No command. (RSR will try to go to normal mode).</td></tr>
<tr><td></td><td>100 - Local Mode (stay in place).</td></tr>
<tr><td></td><td>101 - Raise 0.5% (module will clear bit 11 to acknowledge).</td></tr>
<tr><td></td><td>110 - Lower 0.5% (module will clear bit 12 to acknowledge).</td></tr>
</table>
</td></tr>
<tr><td>B</td><td>N/A</td><td></td><td>Not used</td></tr>
<tr><td>C</td><td>N/A</td><td></td><td>Reserved</td></tr>
<tr><td>D</td><td>N/A</td><td>R/W</td><td>Module Configuration Status Register (see page 598)</td></tr>
<tr><td>E</td><td>N/A</td><td>R</td><td>Severe Errors Status Register (see page 594)</td></tr>
<tr><td>F</td><td>N/A</td><td></td><td>Electronic ID</td></tr>
</table>

9.4.21 Tuning constant commands - (SVD)

The following commands are used to set the values of important tuning constants. The syntax of each command is indicated and must be followed.

Tuning Constant Commands

COMMAND	UNITS & RANGE	DESCRIPTION
piGain = 9.20	0-255	PI Controller gain outside of deadband. This value is the higher of two gain values used in the position PI loop. This value is used when the valve is moving. When the valve is in a stable position, a lower value is used to avoid noise-induced control action.
piResetT = 1000	0-65535 [ms]	PI Controller reset time outside of deadband. Used in PI equation along with the gain value described previously. This value is one of two used in the PI equation. This one is used when the valve is in motion, and causes faster wind-up. It is given in milliseconds.
piGainDb = 1.40	0-255	PI Controller gain inside of deadband. When the valve is in a steady position, the PI gain is reduced to this value. This helps avoid noise-induced control action.
piResetTDb = 10000	0-65535 [ms]	PI Controller reset time inside of deadband. This is one of two values used, and causes slower control action. It is given in milliseconds.
retreatRate	0-100 [% per sec.]	% per second rate of output retreat.
DIRECT =1	0 or 1	PI mode. In direct mode (DIRECT=1), the output goes in a direction with respect to target position. In indirect mode (DIRECT=0), the output goes negative when the target position moves negative with respect to position feedback.
posErrorRetreat =2.0	0-105.01	The output does not retreat until ABS| posFB - TargetPos| <posErrorRetreat
exitSeatVal=5000	-10200 to +10200 [mV]	When the RSR is seating the valve, then decides to retreat, this is the output in mV to which the output goes.
exitBkSeatVal =-5000	-10200 to +10200 [mV]	When the RSR is backseating the valve, then decides to retreat, this is the output in mV to which the output goes.
CASCADE=0	0 or 1	If this flag is set to 1, the two PI's are cascaded.
intgrlLimit=100	0-100 [%]	Limits the windup of integral part of the PI.
outputOffset=0.0	-99.9 to 100	Offset value added to result of the PI connection.
OutputMin=-10200	-10200 to +10200 [mV]	Minimum tuning constant for output – voltage [mV} on output equivalent to 0%.
OutputMax=10200	-10200 to +10200 [mV]	Maximum tuning constant for output – voltage [mV] on output equivalent to 100%.
CALrate=6.4	0-100 [% per sec.]	Calibration demand change rate in %per second.
Release=-10000	-10200 to +10200 [mV]	The retreat value to get back from cascade close – put lower then cascade close if you do not want this feature.

<table>
<tr><th>Command</th><th>Units & Range</th><th>Description</th></tr>
<tr><td>CCS</td><td>0 or 1</td><td>A flag to determine behavior of V2 (and output) in cascade mode when main (V1) PI goes to seat. If CCS is set then cascade Close to CasCloseInSeatVal followed by Retreat is executed on V2 if seat is executed on V1. No further action on V2 after seat in V1 if flag is cleared.</td></tr>
<tr><td>CasCloseInSeatVal=10000</td><td>-10200 to +10200 [mV]</td><td>Value for output when CasCloseInSeat is executed (see above description for CCS).</td></tr>
<tr><td>reheatHoldT= 10,000</td><td>0-65535 [ms]</td><td>mSec that output is saturated before reheat begins.</td></tr>
<tr><td>demodGain = 12345</td><td>1.01-4096</td><td>The LVDT secondary feedback sum is multiplied by this value to achieve a voltage range representing 0 to 100% position that is close to the input range of the A/D converter. The value prints as a raw decimal value. The hexadecimal equivalent is written to the feedback D/A converter to adjust feedback gain. This value can be entered by the customer, but it is also modified automatically during the full calibration sequence. Feedback gain can be calculated by the following formula:

gain = 4096 / D/A converter input word (decimal value)

Examples of some gain values are as follows:
<table>
<tr><th>DAC word</th><th>Decimal value</th><th>Gain</th></tr>
<tr><td>0</td><td>0</td><td>Infinity[1]</td></tr>
<tr><td>1</td><td>1</td><td>4096</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>8</td><td>8</td><td>512</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>100H</td><td>256</td><td>16</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>800H</td><td>2048</td><td>2</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>FFFH</td><td>4095</td><td>1.00024</td></tr>
</table>
[1] Feedback gain D/A converter output saturates.</td></tr>
<tr><td>errorDbF = 1.0</td><td>0 -100</td><td>When the absolute value of the difference between target position and actual position is greater that this value, the valve is considered to be in motion. Gain and reset values are selected to cause rapid control action. When the difference is less than this value, control action is softened.</td></tr>
<tr><td>errorDbS = 0.2</td><td>0-100</td><td>When the absolute value of the difference between target position and actual position is less than this value, the valve is considered to be stable. Gain and reset values are selected to soften control action. When the difference is greater than this value, gain is increased to yield sharper control action.</td></tr>
<tr><td>seatLimit = 0.0</td><td>-5 to 105</td><td>When target valve position is equal to or less than this value, seating action controls the output.</td></tr>
</table>

Command	Units & Range	Description
backSeatLimit =100.0	-5 to 105	When the target valve position is equal to or greater than this value, backseating action controls the output.
contingency =10.0	0-65535	If the absolute value of the difference between Servo Driver target position and actual position is greater than this value, a contingency condition may exist. The condition must exist until a timer expires for it to be reported. The timer is described below: A situation could arise where the Servo Driver target position and the Controller's target are not equal. One example would be if the shutdown input were true, the Servo Driver set the target position to 0, but the Controller did not track. In this situation, contingency would not be reported if the valve went to 0% position.
contingencyTime =10000	0-65535 [ms]	If the error between target position and actual position exceeds contingency for this amount of time, then the condition is reported to the Controller. This number is given in milliseconds.
calhndrd = 30000	0-65535	This value is displayed in decimal. It is the converted hexadecimal A/D converter reading for the 100% position. It can be entered by the customer; however, it is normally determined automatically by the calibration sequence.
calzero = 0	0-65535	This value is displayed in decimal. It is the converted hexadecimal A/D converter reading for the 0% position. It can be entered by the customer; however, it is normally determined automatically by the calibration sequence.

Configuration Commands

Command	Description
FIP = 1<return>	Fail-in-place flag. If the fail-in-place flag is set, the valve holds its last position when switching from **normal** mode to **local** mode. If the fail-in-place flag is clear (FIP = 0), the valve's target position is forced to -5% when switching from normal to local mode.
RDNDNT = 1<return>	Redundant LVDT option. If the redundant LVDT option is selected, the Servo Driver executes only one PI control loop. However, it continues to process both position feedback channels, middle-selects each to reject some noise, then high-selects between the two feedback values. If the option is not selected (RDNDNT = 0), the Servo Driver behaves as a two-independent-channel closed loop servo control. ***Note:*** *This command has a different meaning for the Valve Positioner module.*
PROP = 1<return>	Proportional output option. If the proportional output option is selected, the PI routine is not called. Instead, the position target in percent is copied directly to the output, in which case 0 to 100% demand would yield 0 to 10 volts at the output. Normally the proportional output is not selected (PROP = 0), resulting in a closed loop PI control subsystem.
CASCADE=0	If this flag is set to 1, the two PI's are cascaded.

Miscellaneous Commands

Command	Description
V1<return>	Selects valve 1. The valve selected is indicated by the prompt character sequence. Subsequent commands affect only the selected channel.
V2<return>	Selects valve 2. The valve selected is indicated by the prompt character sequence. Subsequent commands affect only the selected channel.
EXIT<return>	Permits test and calibrate modes to be exited by executing a soft reset.
DG<return>	Display group data - This function repeatedly displays important operating parameters such as demand, feedback, and feedback voltage.
HELP<return>	Print command list
diag<return>	This command displays important status information in hexadecimal format. Included is the operating mode for each channel, SFE register, signal register, and restriction register as follows: mod1=0xmm mod2=0xnn restricts=0xrrrrrrrr sgnls=0xssss sfe's=0xeeee where mm = Hex value for channel 1 mode: 0 through 5 are **start** modes 0x14 through 0x19 are **local** modes 0x28 through 0x2B are **normal** modes 0x3C through 0x3F are **test** modes nn = Mode for channel 2 rrrrrrrr = Restriction bit set as follows: bit 0 - PROM checksum error bit 1 - Memory diagnostic error bit 2 - Channel 1 contingency bit 3 - Channel 2 contingency bit 4 - Ovation serial bus not configured bit 5 - Mismatch of tuning constants between module and Controller bit 6 - Controller is not updating module bit 7 - Channel 1 - Controller is not tracking bit 8 - Channel 2 - Controller is not tracking bit 9 - EEPROM checksum error bit 10 - Hold until oscillator is stable bit 11 - Channel 1 - valve is under serial port control or calibrating bit 12 - Channel 2 - valve is under serial port control or calibrating ssss = Signal bits as follows: bit 10 - Channel 1 contingency bit 11 - Channel 2 contingency bit 12 - Display group is on bit 13 - Display group is turned on, display needs initialized eeee = Severe fatal error bits as follows: bit 0 - EEPROM checksum bit 1 - PROM checksum bit 2 - Shared memory readback error bit 3 - Processor memory readback error bit 4 - FPGA error on startup bit 5 - UART readback error bit 6 - Processor diagnostic error bit 7 - Not used bit 8 - PSD302 memory readback error

9.4.22 RSR calibration diagrams - (SVD)

Two diagrams are linked to the Servo Driver module:

There are two calibration diagrams linked to an RSR module:

- Example Diagram 8579 = Read-only information diagram.
- Example Diagram 8799 = Actual tuning diagram.

  Note: The actual graphics are specific for each system. The graphics shown here are used as examples only.

Diagram 8579

Diagram 8579 is provided in the standard Ovation release and is used to display current values for configuration parameters and PI controller tuning. You cannot perform any tuning through this diagram since it is a read-only diagram. You can access diagram 8579 from a control sheet that contains an RSRSTATUS algorithm.

The following diagram is an example of a sample control sheet containing an RSRSTATUS algorithm.

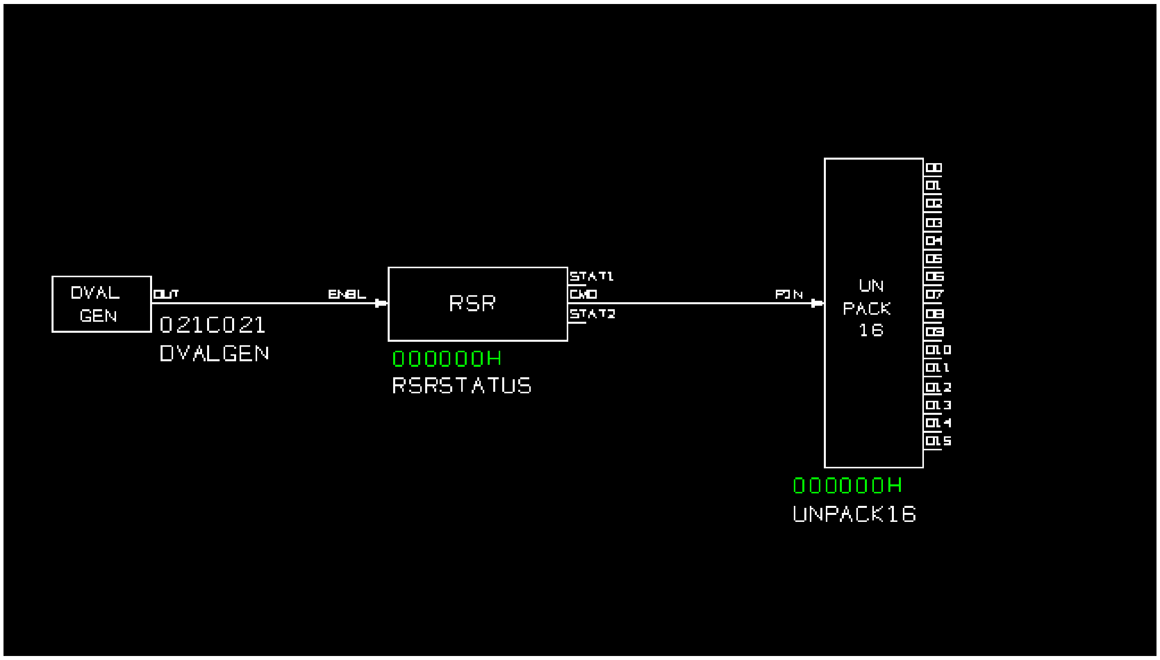


Figure 155: Project specific example of RSR Control Sheet

Select the RSRSTATUS diagram from the control sheet and the 8579 diagram appears. Use this diagram to view current values for RSR module settings.

Some of the values that are displayed in the 8579 diagram are:

- contingencyTime
- posErrorRetreat
- retreatRate
- retreatHoldT
- Channel 1 and Channel 2 values

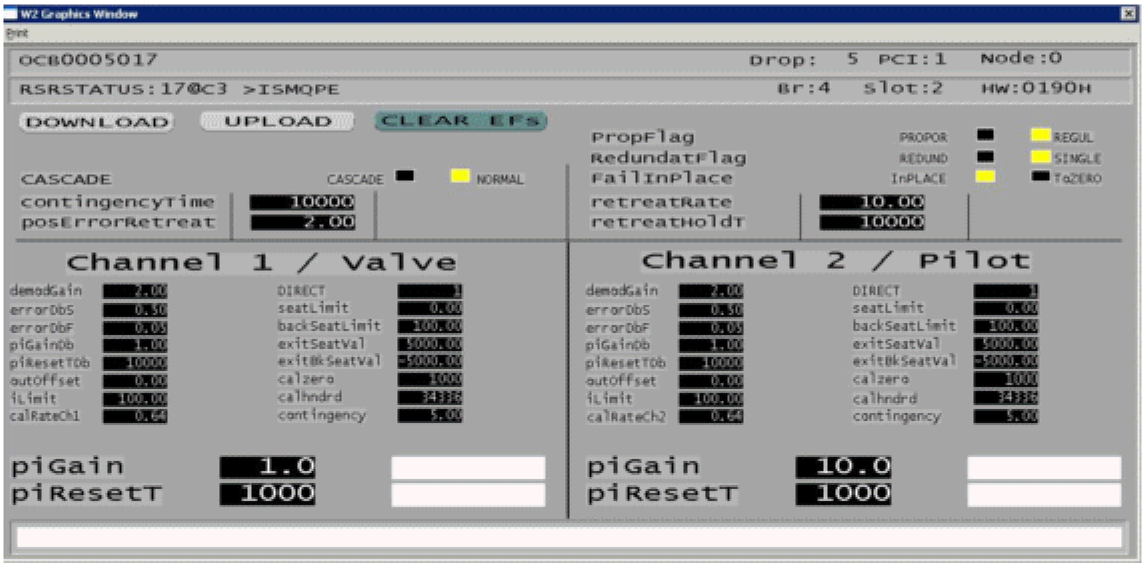


Figure 156: Project specific example of RSR Information Diagram 8579

Accessing Diagram 8799

In order to perform tuning calibrations on the RSR module, you need to use a tuning diagram such as diagram 8799. This diagram is accessed from a custom graphic. You can use the Ovation Graphics Builder to create code that will call the 8799 calibration diagram.

The following is an example of calling the 8799 diagram from diagram 1000 by using a standard OL_BUTTON command in Ovation Graphics Builder:

OL_BUTTON 6300 8916 HORZ SQUARED TEXT_LABEL VECTOR 363 1313 1 "RSR TUNING 8799" EXEC_POKE 7 2 6 0 5 \OCB0005017\ ID \OCB0005017\ ID 3 83 3 117 8799 18 0 0 0 0 13 \RSR-DMD3\ ID \RSR-POS3\ ID \RSR-FBK3\ ID \RSR-DMD4\ ID \RSR-POS4\ ID \RSR-FBK4\ ID \RSRSTA1\ ID \RSRSTA2\ ID \RSRCMD\ ID \OCB0005013\ ID \OCB0005012-MODE\ ID \OCB0005002\ ID \OCB0005001-MODE\ ID

OL_BUTTON 938 1860 HORZ SQUARED TEXT_LABEL VECTOR 416 1707 1 "RSR TUNING" EXEC_POKE 7 2 6 0 5 \OCBRSR50\ ID \OCBRSR50\ ID 3 83 3 117 8799 20 0 0 0 0 15 \RSR-DMD1\ ID \RSR-POS1\ ID \RSR-FBK1\ ID \RSR-DMD2\ ID \RSR-POS2\ ID \RSR-FBK2\ ID \RSRSTA1\ ID \RSRSTA2\ ID \RSRCMD\ ID \RSR1H1A\ ID \RSR1H1A-MODE\ ID \RSR1H1B\ ID \RSR1H1B-MODE\ ID \RSR-ODMD1\ ID \RSR-ODMD2\

where:

OCBRSR50 – RSRSTATUS algorithm number
RSRSTA1 – RSRSTATUS point
RSRSTA2 – RSRSTATUS point
RSRCMD – RSRSTATUS point
RSR1H1A – channel 1 MASTATION algorithm number
RSR1H1A-MODE – channel 1 MAMODE algorithm number
RSR1H1B – channel 2 MASTATION algorithm number
RSR1H1B-MODE – channel 2 MAMODE algorithm number
RSR-POS1 – channel 1 Position Feedback
RSR-POS2 – channel 2 Position Feedback
RSR-FBK1 – channel 1 Raw Demodulator Voltage
RSR-FBK2 – channel 2 Raw Demodulator Voltage
RSR-DMD1 – channel 1 Demand
RSR-DMD2 – channel 2 Demand
RSR-ODMD1 – output 1 from RSR alg.(output PI 1)
RSR-ODMD2 - output 1 from RSR alg. (output PI 2)

Diagram 8799

Diagram 8799 consists of three main sections: Common, Channel 1 and Channel 2:

- Common section contains configuration pushbuttons and tuning constant entry fields common for both channels.
- Channel 1 section contains configuration pushbuttons, tuning constant entry fields and message lines used only for Channel 1.
- The Channel 2 section contains configuration pushbuttons, tuning constant entry fields and message lines used only for Channel 2.

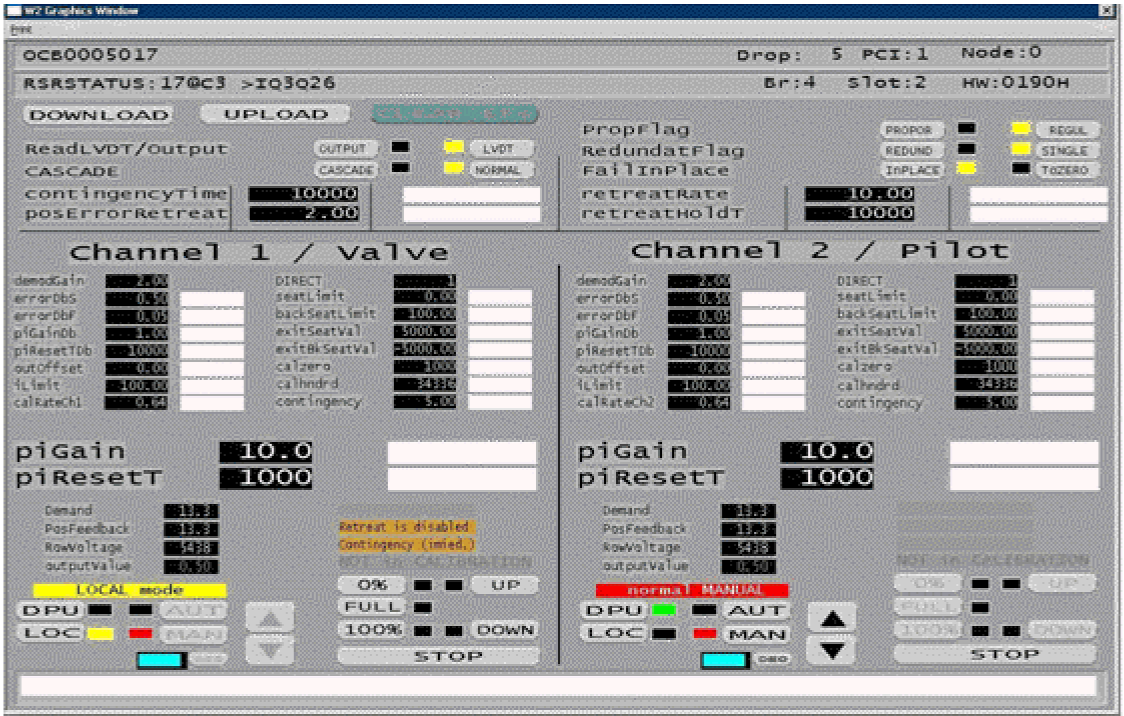


Figure 157: Project specific example of RSR Tuning Diagram 8799

Using the Graphic Interface for Calibration (Common) - (SVD)

Calibration is performed by using command buttons and by entering tuning constants in the entry fields. Some pushbuttons are accompanied with rectangular confirmation boxes and when the function is selected the color of the selection changes from black to yellow.

The following command pushbuttons are used to set configuration values:

Command Pushbuttons

PUSH - BUTTON	DESCRIPTION	COMMENTS
Download	Write data command given to RSR.	
Upload	Read data command given to RSR.	
ClearEF's	Clear Diagram entry field command.	
Integral	Integration Value is displayed in InteglationV for both channels - the yellow rectangle confirms selection.	
LVDT	Feedback voltage is displayed in RawVoltage and OutputValue for both Channels - the yellow rectangle confirms selection.	
CASCADE	Cascade flag to 1 - the yellow rectangle confirms selection.	Refer to *Valve Position Control for the Servo Driver module* (see page 563)

PUSH - BUTTON	DESCRIPTION	COMMENTS
NORMAL	Cascade flag to 0 (normal configuration) - the yellow rectangle confirms selection.	Refer to *Valve Position Control for the Servo Driver module* (see page 563)
CASCLOSE	A flag to determine behavior of V2 (and output) in cascade mode when main (V1) PI goes to seat. If selected then cascade Close to CasCloseInSeatVal followed by Retreat is executed on V2	
CASCLOSEIN-SEAT	A flag to determine behavior of V2 (and output) in cascade mode when main (V1) PI goes to seat. If selected then seat is executed on V1. No further action on V2 after seat in V1 if flag is cleared.	
REGUL	Proportional output option flag to 0 - the yellow rectangle confirms selection.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
REDUND	Redundant LVDT option flag to 1 - the yellow rectangle confirms selection.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
SINGLE	Redundant LVDT option flag to 0 - the yellow rectangle confirms selection.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
INPLACE	Fail-in-place flag to 1 - the yellow rectangle confirms selection.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
TOZERO	Fail-in-place flag to 0 - the yellow rectangle confirms selection.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)

Tuning Constants Entry Fields

COMMAND	DESCRIPTION	COMMENTS
contingencyTime	The time in milliseconds - if the error between the target position and actual position exceeds contingency for this amount of time, then the condition is reported to the controller.	Refer to *Valve Position Control for the Servo Driver module* (see page 563)
posErrorRetreat	The output does not retreat until ABS| posFB - TargetPos| <posErrorRetreat).	Refer to *Valve Position Control for the Servo Driver module* (see page 563)
retreatRate	Volts per second rate of output reheat.	Refer to *Valve Position Control for the Servo Driver module* (see page 563)
retreatHoldT	The time in milliseconds - reheat occurs after this time has expired, and (ABS|Target-Feedback| <posErrorRetreat).	Refer to *Valve Position Control for the Servo Driver module* (see page 563)
CasCloseIn-SeatVal	*Value for output when CasCloseInSeat is executed (see above description for CCS)*	Refer to: Tuning Constant Commands for the Servo Driver Module (see Tuning constant commands for the Servo Driver module (see page 573))

Using the Graphic Interface for Calibration (Channel 1 and 2) - (SVD)

Calibration is performed by using command pushbuttons and entering tuning constants in the entry fields. Some pushbuttons are accompanied with rectangular confirmation boxes and when the function is selected the box color changes. The full, hot and top hot calibration sequences can be started by selecting the appropriate pushbuttons.

The calibration sequence can be stopped at any time throughout the process and it is not possible to start calibration for both channels at the same time. When the calibration of any channel is in progress the following pushbuttons are disabled: DOWNLOAD, UPLOAD, CLEAR EF's, OUTPUT, LVDT.

When calibration is finished, the tuning of the PI position control should be performed. This can be performed in RSR local or normal mode. When local mode is selected the only way to change the valve position demand is to press the UP or DOWN pushbuttons. Normal mode is selected by pressing the DPU pushbutton, the valve position demand is changed by pressing the raise or lower pushbuttons or by entering demand in the DEO entry field.

The following command pushbuttons are used to set the configuration values.

Command Pushbuttons

PUSH - BUTTON	DESCRIPTION	COMMENTS
0%	Calibrate zero% - the yellow rectangle confirms selection.	Refer to *Performing Calibration for the Servo Driver module* (see page 559)
100%	Calibrate 100% - the yellow rectangle confirms selection.	Refer to *Performing Calibration for the Servo Driver module* (see page 559)
FULL	Full calibration - the yellow rectangle confirms selection.	Refer to *Performing Calibration for the Servo Driver module* (see page 559)
STOP	Stop Calibration - the yellow rectangle confirms selection.	
UP	Raise - The yellow rectangle confirms selection.	Refer to *Performing Calibration for the Servo Driver module* (see page 559)
DOWN	Lower - The yellow rectangle confirms selection.	Refer to *Performing Calibration for the Servo Driver module* (see page 559)
DPU	RSR channel 1or 2 to normal mode - the green rectangle confirms selection.	
LOC	RSR channel 1or 2 to local mode - the yellow rectangle confirms selection.	
AUT	MA station channel 1 or 2 - the blue rectangle confirms selection.	
MAN	The red rectangle confirms selection.	
	Raise MA station channel 1 or 2 output.	

Push - button	Description	Comments
	Lower MA station channel 1 or 2 output.	
DEO	MA station channel 1 or 2 output digital entries.	20s ramp is assigned to this button.
SLO	MA station channel 1 or 2 output digital entries.	255s ramp is assigned to this button.
FAS	MA station channel 1 or 2 output digital entries.	1s ramp is assigned to this button.

Tuning Constants Entry Fields

Command	Description	Comments
piGain	PI Controller gain outside deadband.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
piResetT	PI Controller reset time outside deadband.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
demodGain	The A/D converter gain to achieve a voltage range representing 0 to 100%	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
errorDbs	When the absolute value of the difference between target position and actual position is less than this value, the valve is considered to be in stable.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
errorDbF	When the absolute value of the difference between target position and actual position is less than this value, the valve is considered to be in motion.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
piGainDb	PI Controller gain inside deadband.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
piResetDb	PI Controller reset time inside deadband.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
outoffset	RSR output offset for the proportional mode.	You should only use outoffset if I limit is reduced or equal 0, if I Limit is 100% outoffset should be 0. Outoffset is a working point of P regulator.
ilimit	Integration limit - 100% no limit 0% no integration.	
calRateCh1(2)	Automatic calibration demand change rate - Channel 1 or channel2.	
contingency	The difference between Servo Driver target position and actual position.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
Release	The retreat value to get back from cascade close – put lower then cascade close and exitSeatValue if you do not want this feature.	

COMMAND	DESCRIPTION	COMMENTS
DIRECT	PI mode.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
seatLimit	When the target valve position is equal to or less than this value, seating action controls the output.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
backSeatLimit	When the target valve position is equal to or greater than this value, backseating action controls the output.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
exitSeatVal	When the RSR is seating the valve, then decides to retreat, this is the output in mV to which the output goes.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
exitBkSeatVal	When the RSR is backseating the valve, then decides to retreat, this is the output in mV to which the output goes.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
calzero	The converted to decimal hexadecimal A/D converter reading for the 0%.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
calhndrd	The converted to decimal hexadecimal A/D converter reading for the 100%.	Refer to *Tuning Constant Commands for the Servo Driver module* (see page 573)
OutputMin	Minimum tuning constant for output – voltage [mV} on output equivalent to 0%	
OutputMax	*Maximum tuning constant for output – voltage [mV] on output equivalent to 100%*	

Message and Status Lines

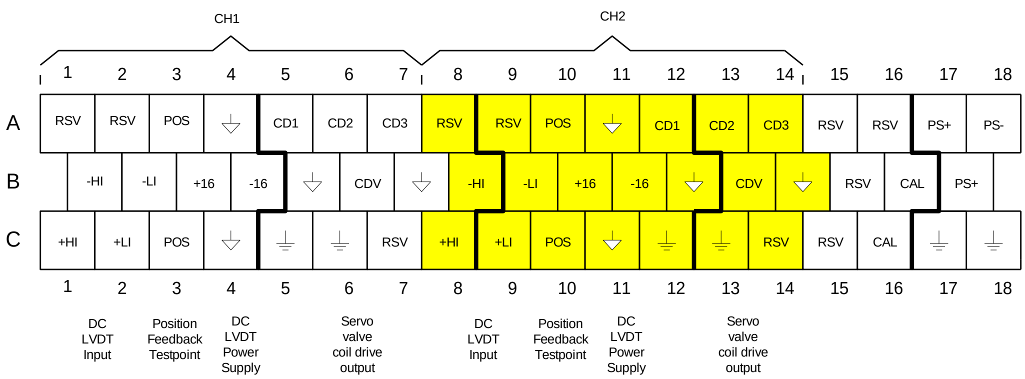
FIGURE 2 REFERENCE	DESCRIPTION
1	RSR status: ▪ LOCAL mode ▪ normal MANUAL ▪ normal AUTO
2	Three message lines: ▪ Retreat in progress ▪ Retreat is disabled ▪ Contingency
3	Calibration status: ▪ Not in calibration ▪ CAL0 in Progress ▪ CAL100 in Progress ▪ FULL Calibration in Progress ▪ Calibration is Finished
4	General Messages.

9.4.23 Terminal Block Wiring Information - (SVD)

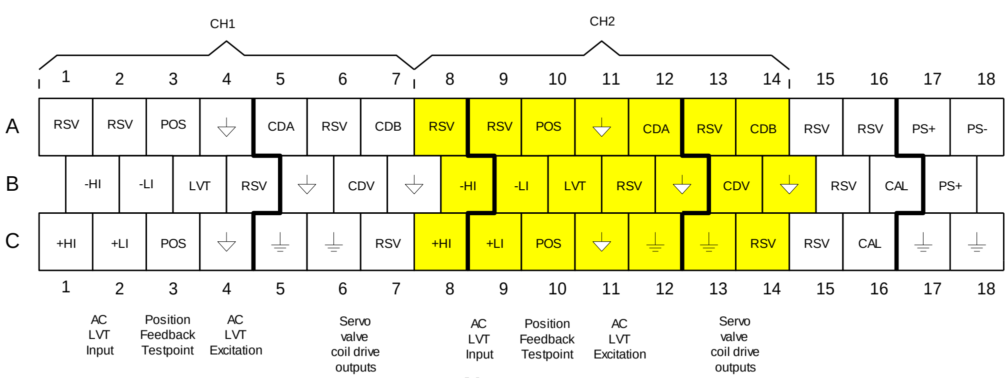
Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

DC LVDT I/O Modules (for use with Group 1 Electronic and Personality Modules)



AC LVT I/O Modules (for use with Group 2 and 3 Electronic Modules and Group 2 Personality Modules)

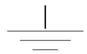
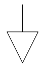


Notes

1. Do not make connections to RSV termination blocks.
2. Do not make connections to CDV termination blocks (they are outputs of the FSR field board's Coil Drive buffers).
3. All of the field interface signals must use twisted-pair copper wire conductors inside a shielded cable assembly. The cable assembly shield must be tied to earth ground via one or more of the following termination block earth ground terminals: C5, C6, C12, or C13.

Figure 158: Terminal Block Connections for the Servo Driver Personality Modules

Abbreviations Used in Wiring Diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals.
	Isolated circuit common ground.
+16, -16	DC LVDT Power Supply voltages, +16 VDC and -16 VDC.
CAL	A jumper may be installed across the two CAL inputs in order to force the module to enter factory test mode.
CDA	Primary 1000 ohm servo-valve coil drive output (AC LVT modules).
CDB	Secondary 1000 ohm servo-valve coil drive output (AC LVT modules).
CDV	Output of FSR field brand coil drive buffer (no connections allowed).
CD1 - CD3	CD1 = 60 ohm, 60 mA servo-valve coil drive output (DC LVDT modules). CD2 = 80 ohm, 40 mA servo-valve coil drive output (DC LVDT modules). CD3 = 40 ohm, 40 mA servo-valve coil drive output (DC LVDT modules).
+HI, -HI	Position feedback inputs - high range (DC LVDTs only).
+LI, -LI	Position feedback inputs - low range (DC LVDTs or AC LVTs).
LVT	AC LVT primary winding sinusoidal excitation output.
POS	Demodulated and amplified position feedback DC voltage (0.0 to 7.5 VDC)
PS+, PS-	Auxiliary power supply terminals (not used).
RSV	Reserved terminals. No connections allowed on these terminals.

9.4.24 Field Connection Wiring Diagrams DC LVDT Channel 1 - (SVD)

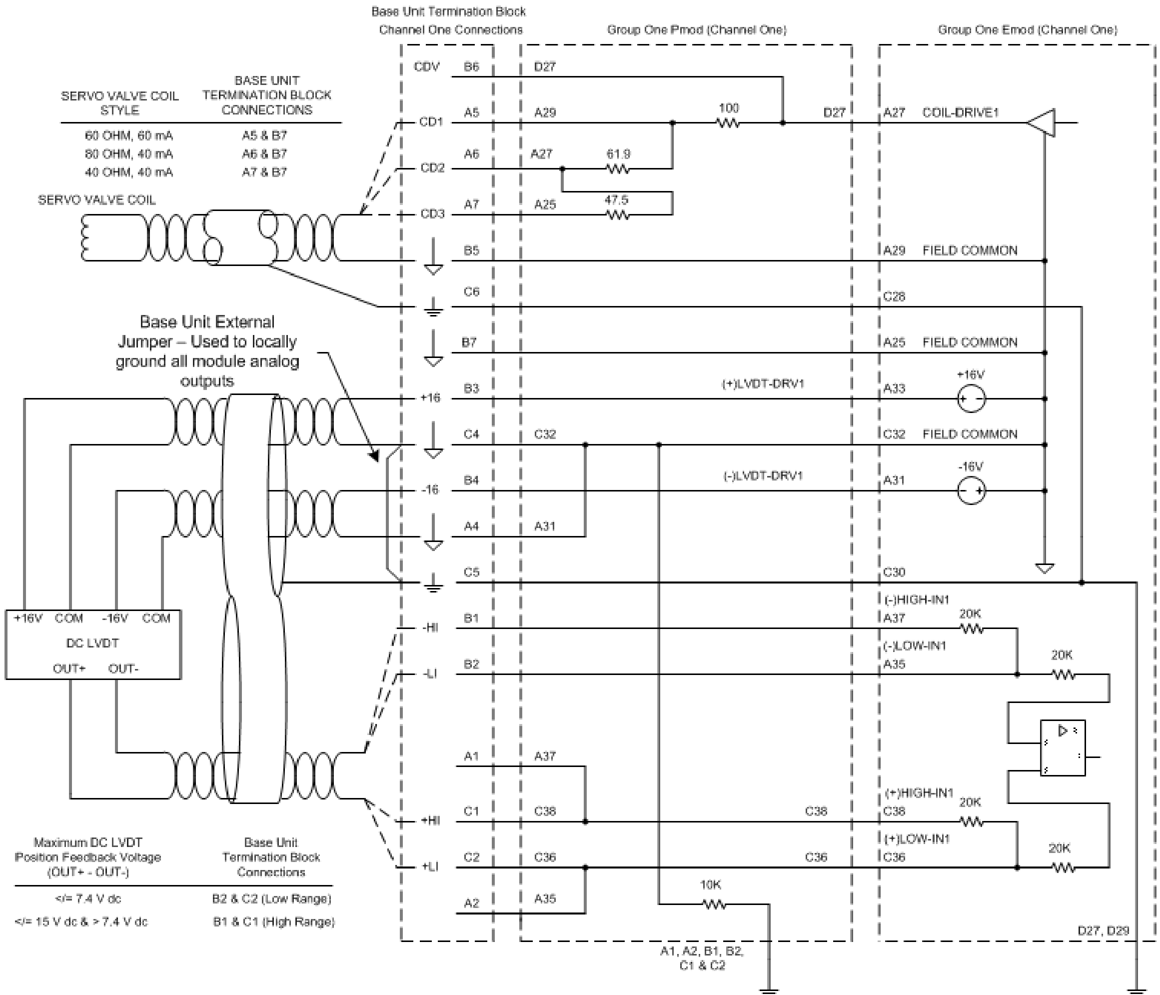


Figure 159: Analog Input/Output Connection DC LVDT Channel 1 Servo Driver

Analog I/O Connection DC LVDT Channel 2 - (SVD)

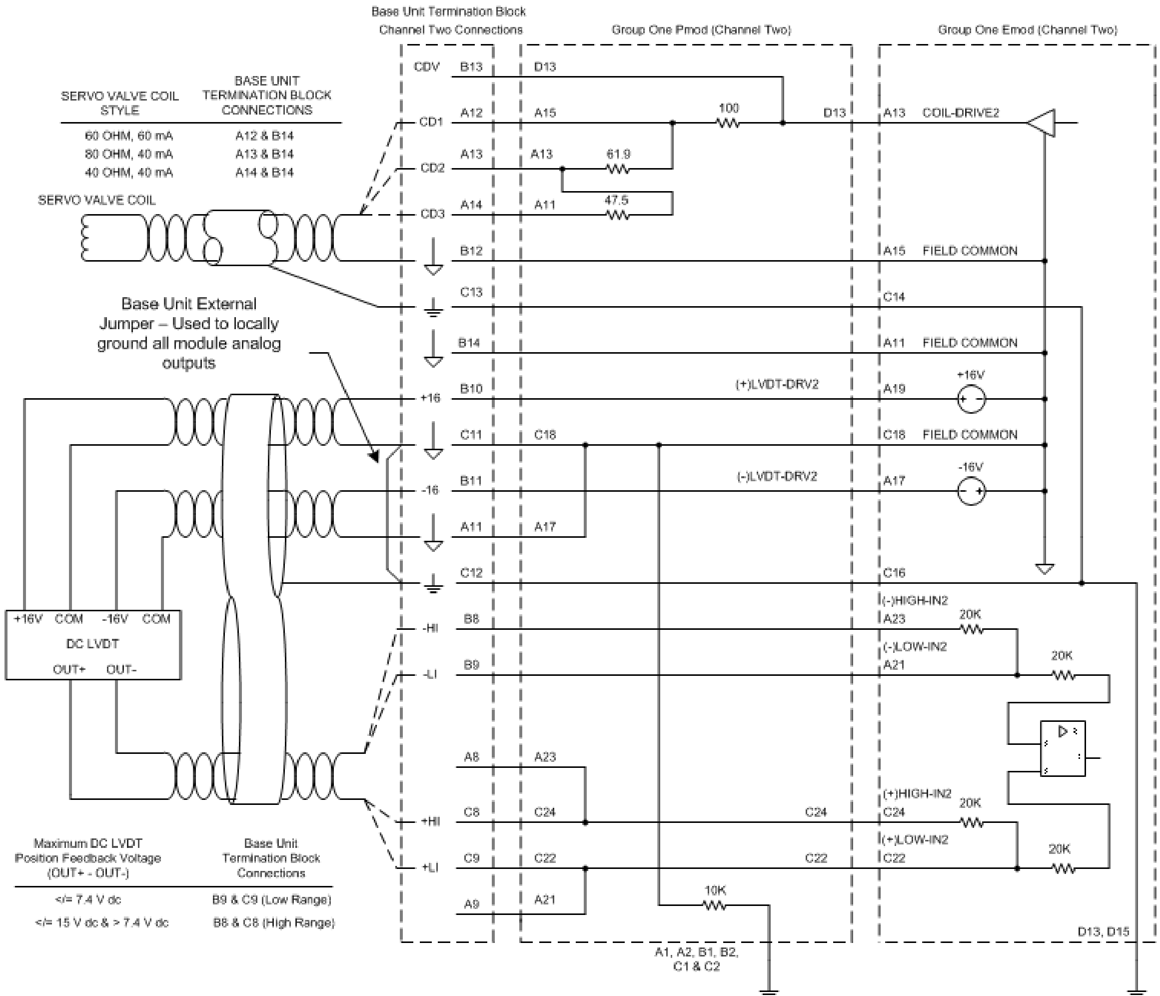


Figure 160: Analog Input/Output Connection DC LVDT Channel 2 Servo Driver

Analog I/O Connection AC LVT Channel 1 - (SVD)

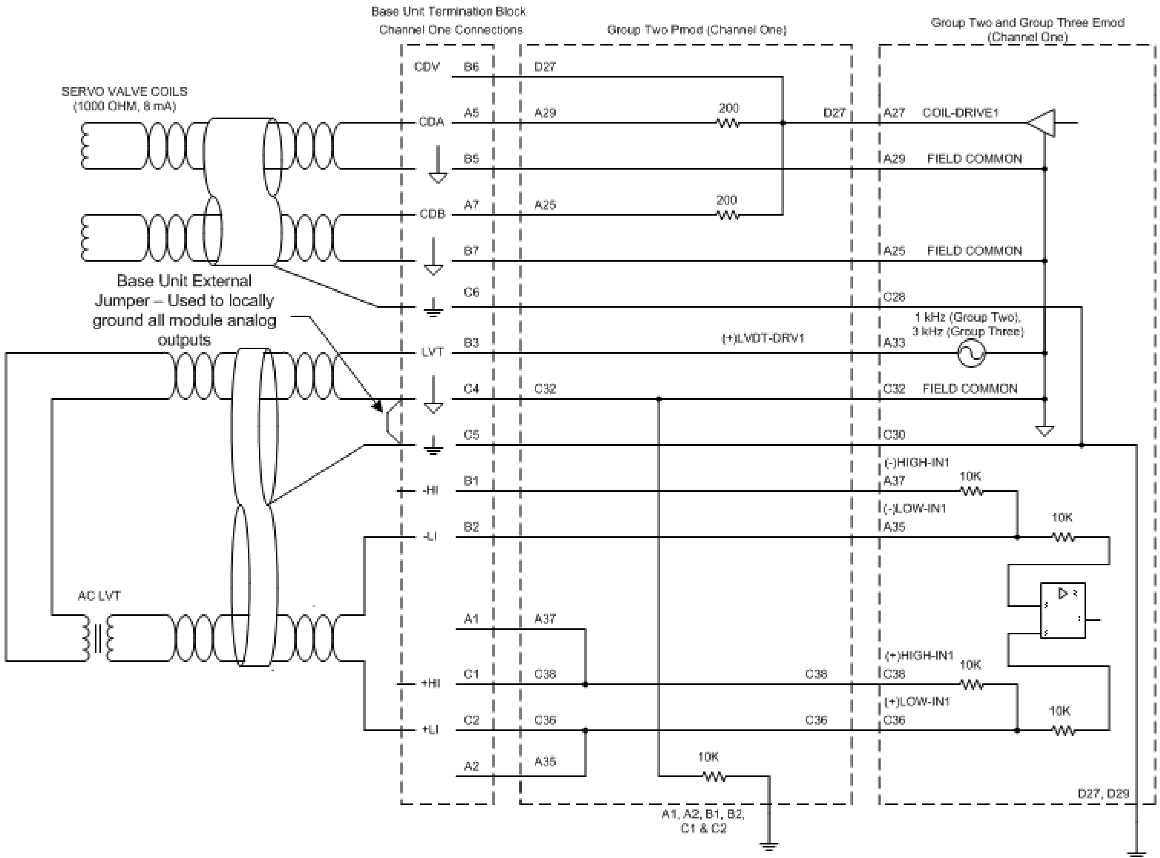


Figure 161: Analog Input/Output Connection AC LVT Channel 1 Servo Driver

Analog I/O Connection AC LVT Channel 2 - (SVD)

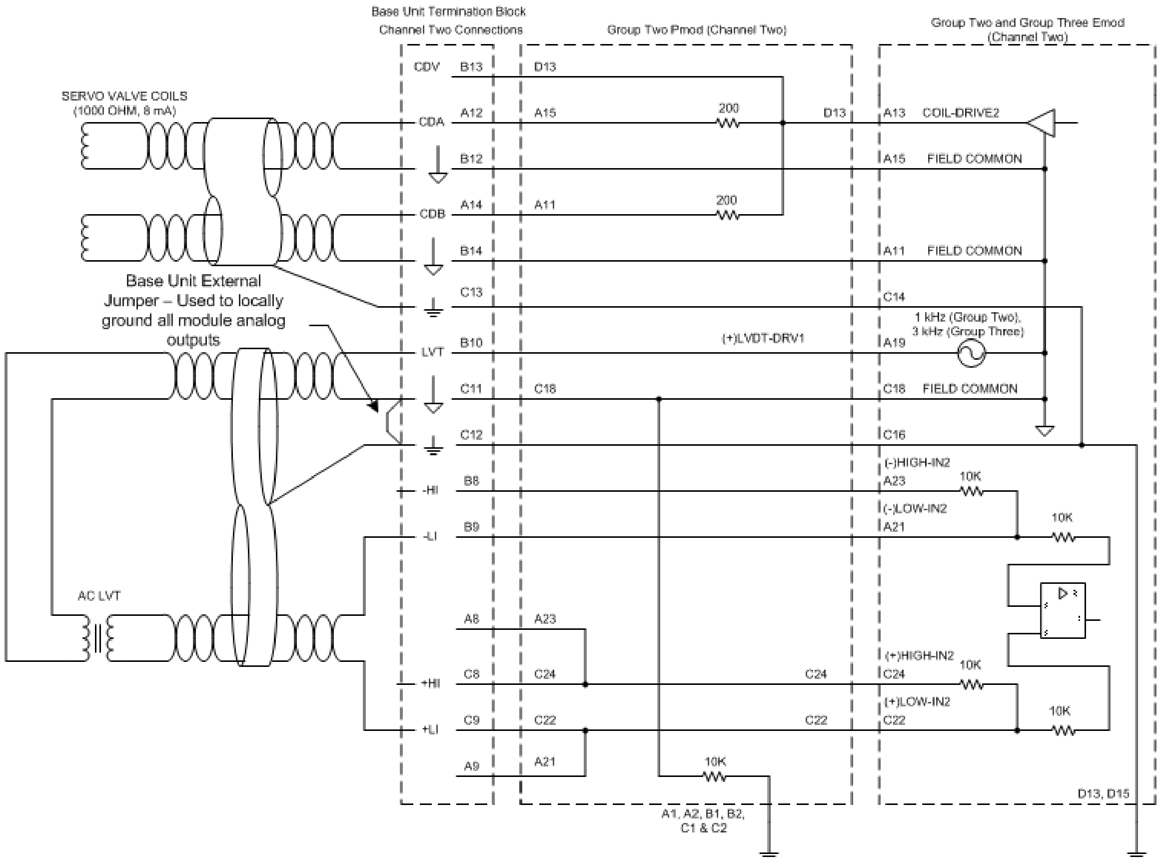


Figure 162: Analog Input/Output Connection AC LVT Channel 2 Servo Driver

9.4.25 Field Connection Wiring Diagrams, DC LVDT Channel 1 (CE Mark) - (SVD)

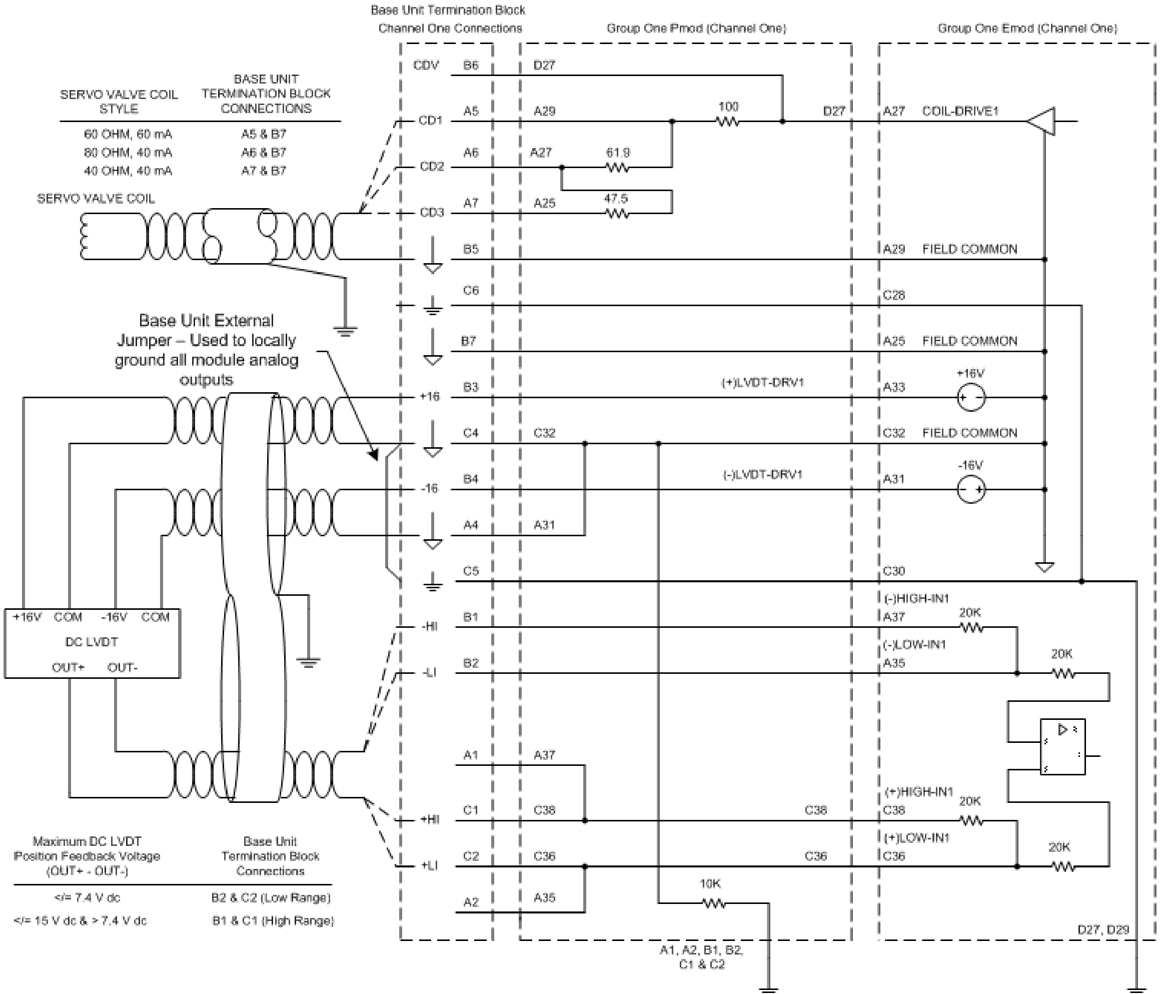


Figure 163: Analog Input/Output Connection DC LVDT Channel 1 (CE Mark)

***Note:** All field wiring must be braid shielded and grounded at the entry point of the cabinet using the recommended hardware. (Refer to the applicable "Cable Guideline" information for your system.)*

Analog I/O Connection DC LVDT Channel 2 (CE Mark) - (SVD)

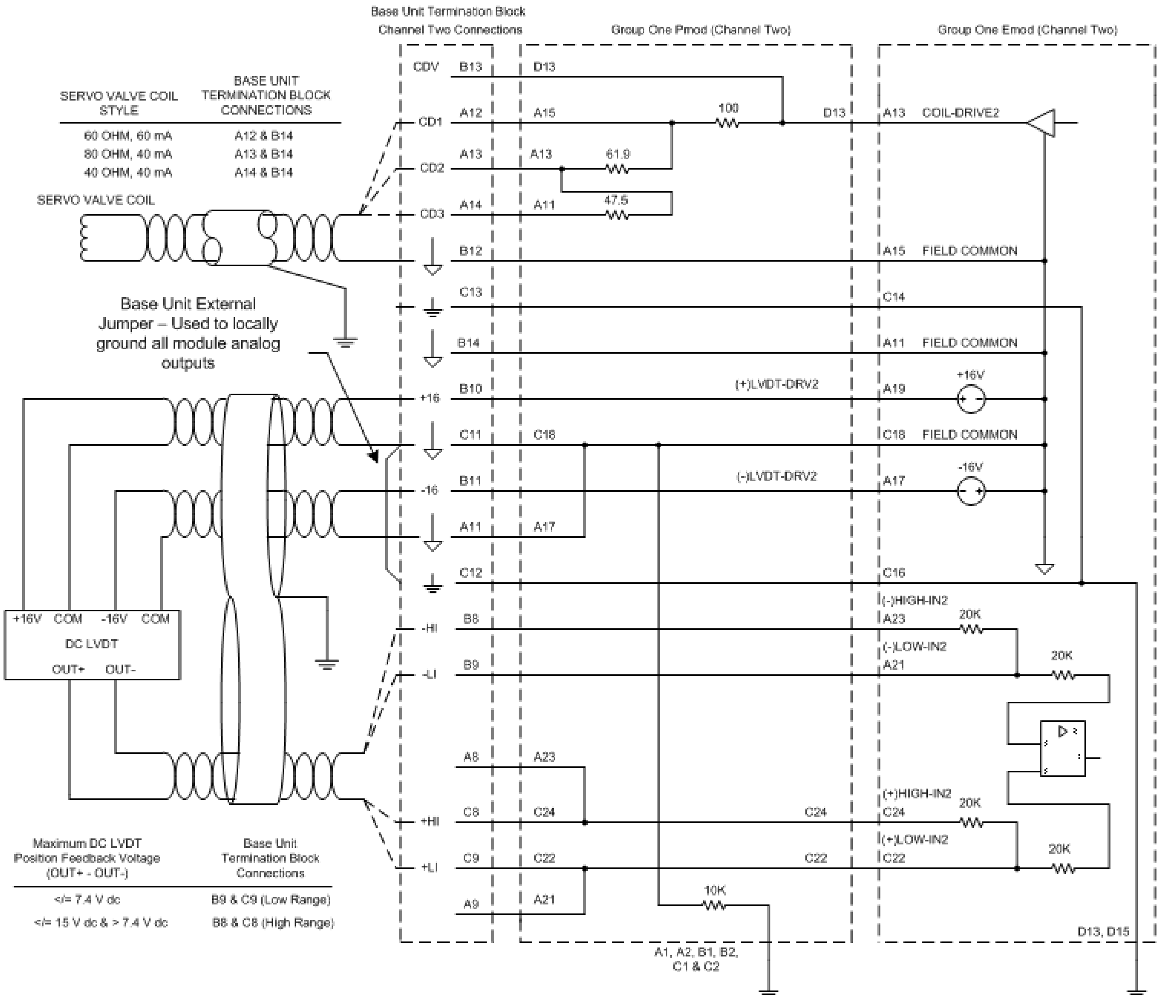


Figure 164: Analog Input/Output Connection DC LVDT Channel 2 (CE Mark)

Note: *All field wiring must be braid shielded and grounded at the entry point of the cabinet using the recommended hardware. (Refer to the applicable "Cable Guideline" information for your system.)*

Analog I/O Connection AC LVT Channel 1 (CE Mark) - (SVD)

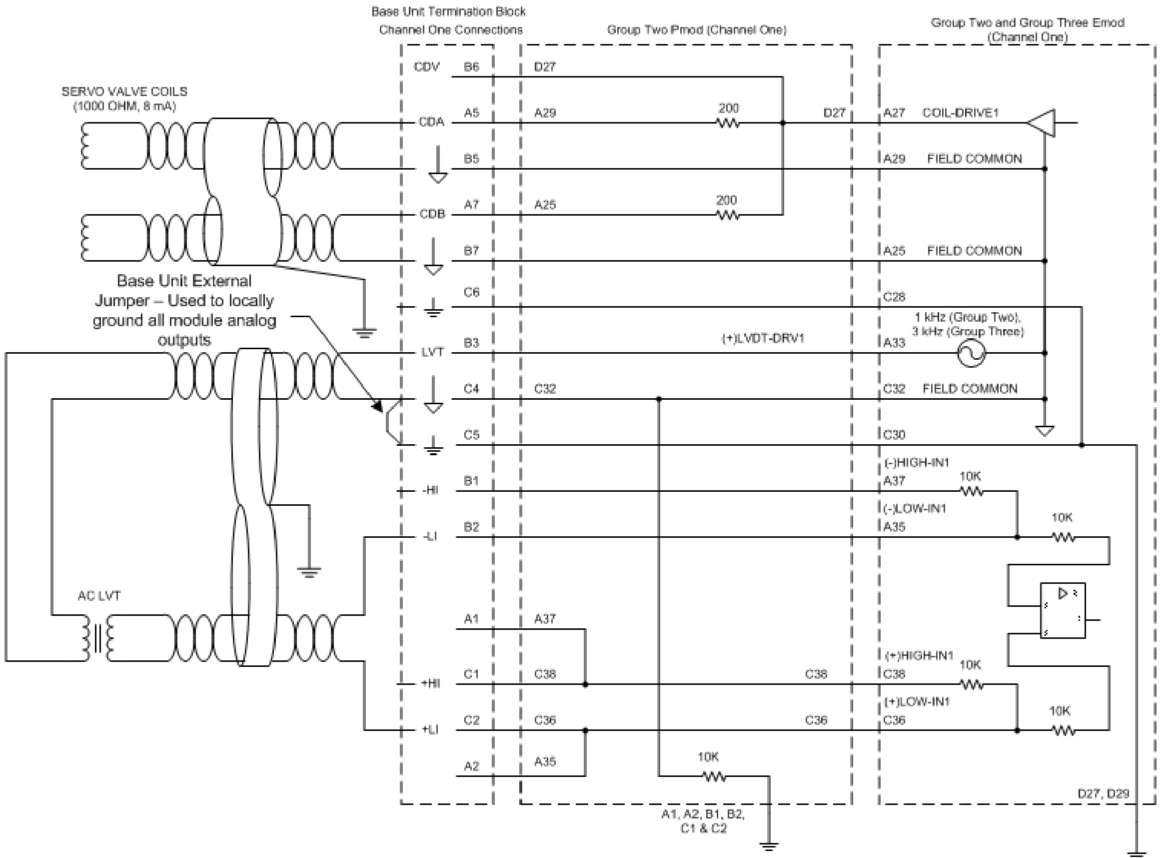


Figure 165: Analog Input/Output Connection AC LVT Channel 1 Servo Driver (CE Mark)

Note: *All field wiring must be braid shielded and grounded at the entry point of the cabinet using the recommended hardware. (Refer to the applicable "Cable Guideline" information for your system.)*

Analog I/O Connection AC LVT Channel 2 (CE Mark) - (SVD)

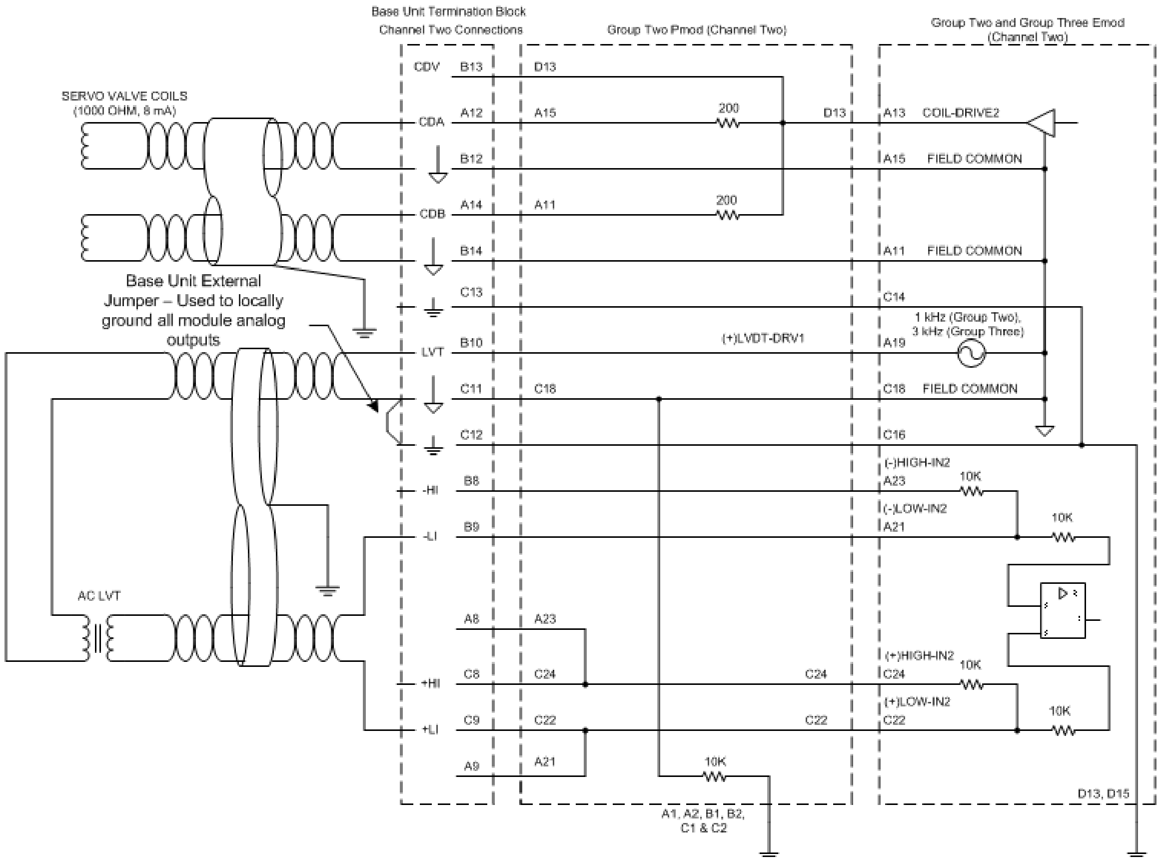


Figure 166: Analog Input/Output Connection AC LVT Channel 2 Servo Driver (CE Mark)

Note: *All field wiring must be braid shielded and grounded at the entry point of the cabinet using the recommended hardware. (Refer to the applicable "Cable Guideline" information for your system.)*

9.4.26 Severe Errors Status Register - (SVD)

Word address 14 (E in Hex) provides for additional module configuration and module status. The bit definitions for this register are encoded.

Severe Error Status Register (Address 14 or E in Hex)

BIT	DATA DESCRIPTION - CONFIGURATION REGISTER (WRITE)	DATA DESCRIPTION - STATUS REGISTER (READ)
0	Not applicable	EEPROM checksum error
1	Not applicable	PROM checksum error
2	Not applicable	Shared memory readback error
3	Not applicable	Processor memory readback error

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
4	Not applicable	FPGA error
5	Not applicable	UART error
6	Not applicable	Processor diagnostic error
7	Not used	Not used
8	Not applicable	PSD 302 memory readback error
9	Not used	Not used
10	Not used	Not used
11	File transfer bit - Reserved	File transfer bit - Reserved
12	Controller-to-Servo Driver buffer control bit. If Bit 12 and Bit 14 of register D are equal, then the buffer is not busy, and the Controller can write into the buffer. If the two bits differ, then the Servo Driver should be in the process of unloading the buffer and will toggle Bit 14 when all data is removed. The Controller should not write into the buffer if the two bits are unequal. When the Controller has data to be transferred to the Servo Driver, and the two bits are equal, it first writes the data, then toggles this bit. (The buffer occupies indirect registers 80 to BF inclusive. This buffer is accessed by the Controller using addresses 0 through 3F.)	Not applicable
13	Servo Driver-to-Controller buffer status bit. If Bit 13 and Bit 15 of register D are equal, then the buffer is not busy (empty). When this bit and Bit 15 become unequal, there is data in the buffer. The bits being unequal signals the Controller to remove all data from the buffer. When all the data is removed, this bit should be toggled by the Controller. The buffer occupies indirect registers C0 to FF inclusive. This buffer is accessed by the Controller using addresses 40 through 7F.)	Not applicable

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
14	Not applicable	Controller-to- Servo Driver buffer status bit. If Bit 14 and Bit 12 are equal, then the buffer is not busy (empty). When this bit and Bit 12 become unequal, there is data in the buffer. The bits being unequal signals the Servo Driver to remove all data from the buffer. When all the data is removed, this bit should be toggled by the Servo Driver. (The buffer occupies indirect registers 80 to BF inclusive. This buffer is accessed by the Controller using addresses 0 through 3F.)
15	Not applicable	Servo Driver -to-Controller buffer control bit If Bit F15 and Bit 13 are equal, then the buffer is not busy, and the Servo Driver can write into the buffer. If the two bits differ, then the Controller should be in the process of unloading the buffer and will toggle bit 13 when all data is removed. The Servo Driver should not write into the buffer if the two bits are unequal. When the Servo Driver has data to be transferred to the Controller, and the two bits are equal, it first writes the data, then toggles this bit. (The buffer occupies indirect registers C0 to FF inclusive. This buffer is accessed by the Controller using addresses 40 through 7F.)

9.4.27 Diagnostics - (SVD)

The Servo Driver runs diagnostics to ensure that the circuit is operating properly. When a problem is detected, a number of things may occur. If the error is considered to be a severe fatal error, the card will *dive.* This means that the output circuit will de-power, and the on-board processor will *idle.* For some fatal errors, the processor will be reset. Word register E in the serial bus shared memory contains important severe fatal error bits.

Other problems may cause a restriction bit to be set. Restriction bits prevent the module from changing modes. During startup, each mode uses a bit mask to determine if errors exist that would prevent the mode change. As the mode advances from start, to local, then to normal, the restriction mask has fewer and fewer bits set.

During restart, there is a 20 second time delay to allow the oscillator to stabilize. Diagnostics are run during this delay. The EPROM checksum is fully calculated.

EPROM Checksum Error - (SVD)

The EPROM checksum is calculated completely on restart. After restart, the checksum program is called during idle time. Each call to the checksum adds one word to the sum.

Memory Read/Write Check - (SVD)

A failure of any memory to read back correctly is considered a severe fatal error. The memory check routine accesses memory in the PSD302 chip, on-chip memory, and serial bus shared memory.

EEPROM Checksum - (SVD)

On restart, tuning constants are read out of a 64x16 EE memory. If the checksum calculation indicates an error, an SFE bit is set and all modes are restricted. This error occurs in the factory during manufacturing, but should never occur in the field.

UART Check - (SVD)

A byte is written to the UART scratchpad register and read back. If the data does not read back correctly, an SFE bit is set and all modes are restricted.

FPGA Error - (SVD)

During restart, the FPGA is loaded by the 80196 Controller. Control and status lines connected to the FPGA must conform to the defined; sequence, otherwise an SFE bit is set and all modes are restricted.

Controller Watchdog Timer - (SVD)

Microcontroller Firmware maintains a timer that is reset every time the Controller updates the Servo Driver with a new demand position. If the timer expires and the Servo Driver is in the normal operating mode, the module reverts back to the local operating mode.

The duration of the timer is set by three bits located in register D.

The microcontroller assumes an update has occurred when two conditions exist. First, it tests the CYCLEOK bit, which is an indication that a serial bus cycle to the module has occurred.

In addition to changing modes when the timer expires, a restriction bit is set to prevent return to normal mode. Updating demand clears the restriction bit.

When the module switches to local mode, demand value is set to -5% if the “failInPlaceFlag” is cleared. If the “failInPlaceFlag” bit is set, demand value remains where it was when the mode change occurred.

9.4.28 Register configuration/address information - (SVD)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern Field on the Hardware tab). Refer to the applicable *Operator Station User Guide* for information about the Point Information window.

Servo Driver Configuration/Status Register (Address 13 or D in Hex)

<table>
<tr><th>Bit</th><th>Data Description - Configuration Register (Write)</th><th>Data Description - Status Register (Read)</th></tr>
<tr><td>0</td><td>Configure module
(1 = configure)</td><td>Module is configured
(1 = configured; 0 = unconfigured)</td></tr>
<tr><td>1</td><td>Force Error
(1 = error; 0 = no error)</td><td>Internal or Forced Error
(1 = error; 0 = no error)</td></tr>
<tr><td>2 - 4</td><td>Communications Timeout Setting [1]
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>500 millisec</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>250 millisec</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>125 millisec</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>62.5 millisec</td></tr>
</table></td><td>Communications Timeout Setting [1]
<table>
<tr><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Timeout</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>16 seconds</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>4 seconds</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>2 seconds</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1 seconds</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>500 millisec</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>250 millisec</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>125 millisec</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>62.5 millisec</td></tr>
</table></td></tr>
<tr><td>5</td><td>Not used.</td><td>Not used.</td></tr>
<tr><td>6</td><td>Not used.</td><td>Not used.</td></tr>
<tr><td>7</td><td>Severe fatal error (SFE) bit
Look at register E for more specific error information (error bits 0 through 6 in register E are OR'd to calculate this bit).</td><td>Severe fatal error (SFE) bit
Look at register E for more specific error information (error bits 0 through 6 in register E are OR'd to calculate this bit).</td></tr>
<tr><td>8</td><td>Not used.</td><td>Not used.</td></tr>
<tr><td>9</td><td>Not used.</td><td>Ch1 - Retreat in progress.</td></tr>
<tr><td>10</td><td>Not used.</td><td>Ch2 - Retreat in progress.</td></tr>
<tr><td>11</td><td>Not used.</td><td>Ch1 - Retreat is disabled.</td></tr>
<tr><td>12</td><td>Not used.</td><td>Ch2 - Retreat is disabled.</td></tr>
<tr><td>13</td><td>Channel 1 contingency.</td><td>Channel 1 contingency.</td></tr>
<tr><td>14</td><td>Channel 2 contingency.</td><td>Channel 2 contingency.</td></tr>
<tr><td>15</td><td>EEPROM constants download request.</td><td>EEPROM constants download request.</td></tr>
</table>

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
[1] The tolerance on the timeout period is +/- 35%.		

CAUTION: This module contains Communications Timeout Settings (Timeout Action and Timeout Selection) that are initially configured in the Developer Studio or the DBID tool. The default Timeout Selection is 16 seconds, with the Timeout Action set to LATCH. These settings are normally adjusted by a Project Engineer or an Emerson Field Service Engineer after determining the affects the setting will have on the system. Any Timeout Selection change made while the module is in the LATCH Timeout Action, will have no effect on the system (with the exception of the system indication a Communication Error.)

The Timeout Action must be changed to RESET, either through the DBID tool or in the Developer Studio, before any new Timeout Selection has an effect on the system. It is recommended that before you make any changes to the Timeout Selection, you conduct a thorough evaluation of any affect that change may have on the system. Under some conditions a different timeout may cause the module to go into its respective fail-safe mode.

Word address 14 (E in Hex) provides for additional module configuration and module status. The bit definitions for this register are encoded.

Severe Error Status Register (Address 14 or E in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Not applicable.	EEPROM checksum error.
1	Not applicable.	PROM checksum error.
2	Not applicable.	Shared memory readback error.
3	Not applicable.	Processor memory readback error.
4	Not applicable.	FPGA error.
5	Not applicable.	UART error.
6	Not applicable.	Processor diagnostic error.
7	Not used.	Not used.
8	Not applicable.	PSD 302 memory readback error.
9	Not used.	Not used.
10	Not used.	Not used.
11	File transfer bit - Reserved.	File transfer bit - Reserved.

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
12	Controller-to-Servo Driver buffer control bit. If Bit 12 and Bit 14 of register D are equal, then the buffer is not busy, and the Controller can write into the buffer. If the two bits differ, then the Servo Driver should be in the process of unloading the buffer and will toggle Bit 14 when all data is removed. The Controller should not write into the buffer if the two bits are unequal. When the Controller has data to be transferred to the Servo Driver, and the two bits are equal, it first writes the data, then toggles this bit. (The buffer occupies indirect registers 80 to BF inclusive. This buffer is accessed by the Controller using addresses 0 through 3F.)	Not applicable.
13	Servo Driver-to-Controller buffer status bit. If Bit 13 and Bit 15 of register D are equal, then the buffer is not busy (empty). When this bit and Bit 15 become unequal, there is data in the buffer. The bits being unequal signals the Controller to remove all data from the buffer. When all the data is removed, this bit should be toggled by the Controller. The buffer occupies indirect registers C0 to FF inclusive. This buffer is accessed by the Controller using addresses 40 through 7F.)	Not applicable.
14	Not applicable.	Controller-to- Servo Driver buffer status bit. If Bit 14 and Bit 12 are equal, then the buffer is not busy (empty). When this bit and Bit 12 become unequal, there is data in the buffer. The bits being unequal signals the Servo Driver to remove all data from the buffer. When all the data is removed, this bit should be toggled by the Servo Driver. (The buffer occupies indirect registers 80 to BF inclusive. This buffer is accessed by the Controller using addresses 0 through 3F.)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
15	Not applicable.	Servo Driver -to-Controller buffer control bit If Bit F15 and Bit 13 are equal, then the buffer is not busy, and the Servo Driver can write into the buffer. If the two bits differ, then the Controller should be in the process of unloading the buffer and will toggle bit 13 when all data is removed. The Servo Driver should not write into the buffer if the two bits are unequal. When the Servo Driver has data to be transferred to the Controller, and the two bits are equal, it first writes the data, then toggles this bit. (The buffer occupies indirect registers C0 to FF inclusive. This buffer is accessed by the Controller using addresses 40 through 7F.)

9.4.29 Diagnostic Logic card LEDs - (SVD)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communications OK LED. Lit when the Controller is communicating with the module. Successful completion of sequence resets the watchdog timer.
E (Red)	External Fault LED.
I (Red)	Internal Fault LED. Possible causes: ▪ Force Error bit (Bit 1) of the Configuration Register is set. ▪ Also lit when a timeout of the watchdog timer occurs when Controller stops communicating with module.
1 MODE (Green) Channel 1	Lit whenever the module is operating in Normal mode. Not lit whenever the module is operating in local manual mode.
2 CONTINGCY (Red) Channel 1	Lit to indicate Contingency Condition.
3 BACKSEAT (Green) Channel 1	Lit whenever seating or backseating is in effect.
4 PI DETUNE (Green) Channel 1	Lit whenever PI is detuned.
5 MODE (Green) Channel 2	Lit whenever the module is operating in Normal mode. Not lit whenever the module is operating in local manual mode.
6 CONTINGCY (Red) Channel 2	Lit to indicate Contingency Condition.
7 BACKSEAT (Green) Channel 2	Lit whenever seating or backseating is in effect.
8 PI DETUNE (Green) Channel 2	Lit whenever PI is detuned.
9 - 16	No LED.

9.4.30 Specifications - (SVD)

- **Electronics module (1C31199)**
- **Personality module (1C31201)**

DESCRIPTION	VALUE
Servo driver field interface channels.	Two
DC LVDT position feedback input range. (1C31199G01)	Low Range Input 0 to 7.4 V DC (Maximum range) 0 to 1.5 V DC (minimum range) High Range Input 0 to 15 V DC (Maximum range) 0 to 5.0 V DC (minimum range)
AC LVT position feedback input range. (1C31199G02, 1C31199G03)	Low Range Input 0.2 to 20 V AC peak-to-peak (Maximum range) 0.2 to 5.0 V AC peak-to-peak (minimum range)
DC LVDT position feedback input impedance. (1C31199G01)	Low Range Input 40 K ohms differential input with floating source 20 K ohms one input line referenced to common High Range Input 80 K ohms differential input with floating source 40 K ohms one input line referenced to common
AC LVT position feedback input impedance. (1C31199G02, 1C31199G03)	Low Range Input 20 K ohms differential input with floating source 10 K ohms one input line referenced to common
DC LVDT supply output voltages. (1C31199G01)	+16 V dc ± 5%, 30 mA Max. load current (-)16 V dc ± 5%, 30 mA Max. load current Supply output voltage matching: ±1.5% over temperature range
AC LVT excitation output voltage. (1C31199G02, 1C31199G03)	19 V AC peak-to-peak ± 11% @ 1.0 KHz ± 10% (1C31199G02) 19 V AC peak-to-peak ± 11% @ 3.0 KHz ± 10% (1C31199G03) 500 Ohms minimum load impedance
Peak servo valve coil output voltage. (1C31199G01 DC LVDT)	CD1 100 Ohms output, 60 Ohms coil, ±3.85 V or CD2 162 Ohms output, 80 Ohms coil, ±3.4 V or CD3 210 Ohms output, 40 Ohms coil, ±1.65 V
Peak servo valve coil output voltages. (1C31199G02, 1C31199G03 AC LVT)	CDA output, 1000 Ohms coil, ± 8.55 V and CDB output, 1000 Ohms coil, ± 8.55 V
Servo valve coil output voltage accuracy. (1C31199G01-G03)	0.4% of full scale output
Servo driver field interface dielectric isolation.	±1000 V dc (for both channels) Both channels' field interface circuits have 50 V and 150 V short term isolation from the logic common/Ovation I/O bus. Each channel's field interface circuit has 50 V and 150 V short term isolation from the other channel's field interface circuit.
Serial port.	RS-232, non-isolated
Serial port baud rate.	9600

DESCRIPTION	VALUE
Module power.	6.7 W typ. (1C31199G01 DC LVDT) 9.8 W Max. (1C31199G01 DC LVDT) 5.3 W typ. (1C31199G02-G03 AC LVT) 6.3 W Max. (1C31199G02-G03 AC LVT)
Logic board processor.	80C196KB (16-bit microcontroller)
Operating temperature range.	0 to 60°C (32°F to 140°F)
Storage temperature range.	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing).	0 to 95%

9.5 Small Loop Interface module (SLIM)

9.5.1 Overview - SLIM

The Small Loop Interface module (SLIM) provides the displays, keyboards inputs, and accompanying logic needed for the operator to monitor and control the I/O functions of an Ovation Loop Interface module - (LI) (see page 499) or an Ovation Valve Positioner module - (RVP) (see page 627).

Information is presented to the operator by various bar-graphs, LEDs, numeric displays and alphanumeric displays on the front panel of the SLIM. The keyboard allows the operator to send control information to the Ovation Loop Interface module to control the process.

The SLIM module is a CE Mark certified module.

9.5.2 Features - SLIM

Using keys on the front of the SLIM panel, the operator has the following capabilities:

- Raise output.
- Lower output.
- Raise set point.
- Lower set point.
- Change SLIM mode (Group 1 only).
- Group 1 SLIMs operate in four modes: CONTROL, MONITOR, TUNING, LOOP. Group 2 operates in CONTROL mode only.
- Change alphanumeric and numeric displays.
- Change Loop Interface mode to Auto, Manual, Local (all groups) or Cascade (Group 1 only).
- Change tuning constants (Group 1 only).
- Runs bar-graphs, LEDs, and alphanumeric and numeric displays to monitor Loop Interface I/O activities.
- Scans keypad to control Loop Interface.
- Sends and receives information to and from the Loop Interface through a serial port.
- Flags a break in the communication link with the Ovation Loop Interface.
- Allows loop control even if the Ovation Controller is down.
- Displays:
  - Two 40-segment bar-graph (for process variable and setpoint).
  - One 30-segment bar-graph (for output).
  - One 4-digit numeric (for setpoint, output, process variable or analog input).
  - One 4-digit alphanumeric (for engineering units, status or SLIM mode information).
  - Thirteen status LEDs (for SLIM modes, Loop Interface modes as well as high and low limit conditions output).
- Control keys:
  - Four keys to raise and lower set point and outputs.
  - Seven function keys.

9.5.3 Groups and Modes - SLIM

The SLIM card is packaged in one of two possible assemblies. The keyboards are the same, except Group 2 does not have the LOOP, CASC, and MODE buttons.

Group 1	Allows the operator to choose from among four modes of operation for the SLIM and four for the Loop Interface.
Group 2	Offers no choice of modes for the SLIM; it always operates in the CONTROL mode. Offers three choices of operation of the Ovation Loop Interface.

The four modes of operation for the SLIM are as follows:

CONTROL MODE:	Allows the operator to send control information to the Ovation Loop Interface through a keyboard; displays the process variable, the setpoint, and output value for the Ovation Loop Interface on a bar-graph, and displays PV, SP, or OUT with proper engineering units on an alphanumeric display.
MONITOR MODE: (Group 1 only)	Displays the process variable, the set point, and output values for the Ovation Loop Interface on a bar-graph and displays the analog input values on an alphanumeric display. Note that the Loop Interface does not contain an AI3 input.
TUNING MODE: (Group 1 only)	Displays the gain, reset, rate, and derivative gain values for the Ovation Loop Interface it is communicating with and enables the operator to change the values. Requires a password.
LOOP MODE: (Group 1 only)	Displays the Loop Number of the Loop Interface to which the SLIM is currently communicating.

Note: *Only one Ovation Loop Interface may be connected to a SLIM.*

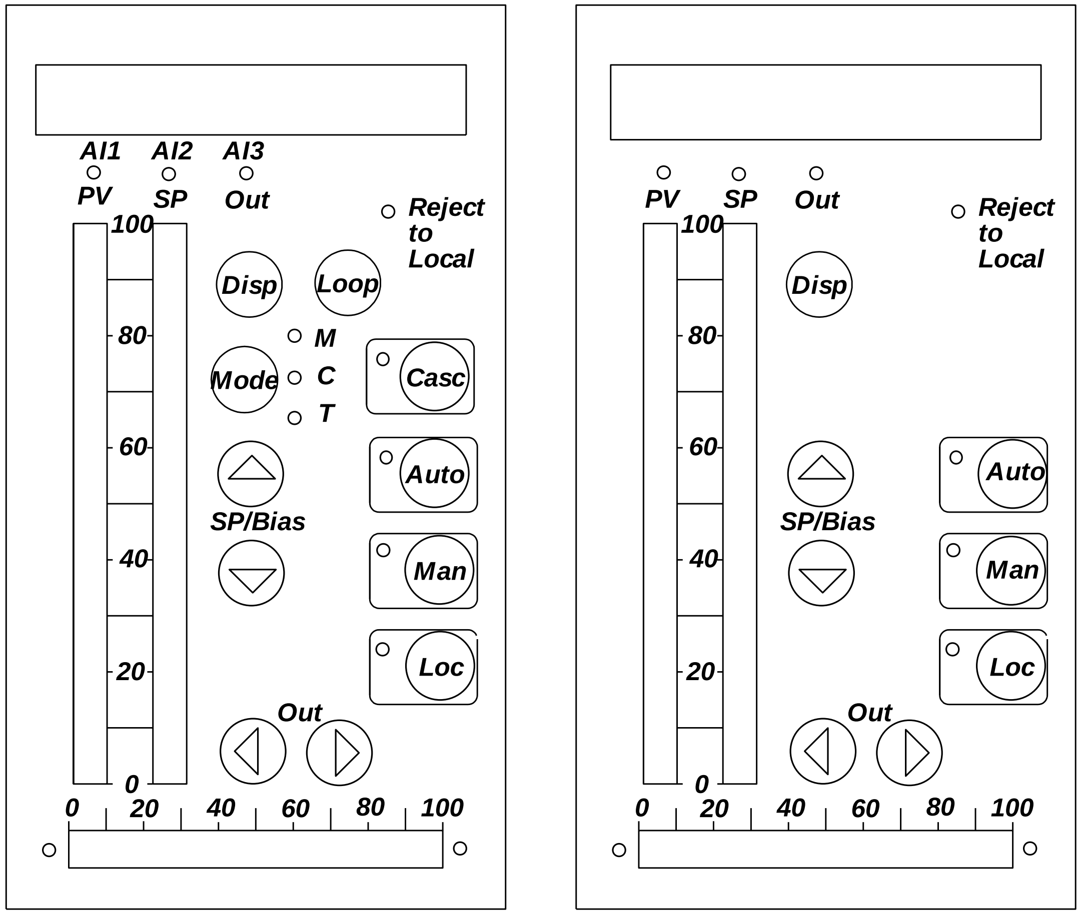


Figure 167: Keyboards for Group 1 and Group 2 SLIMs

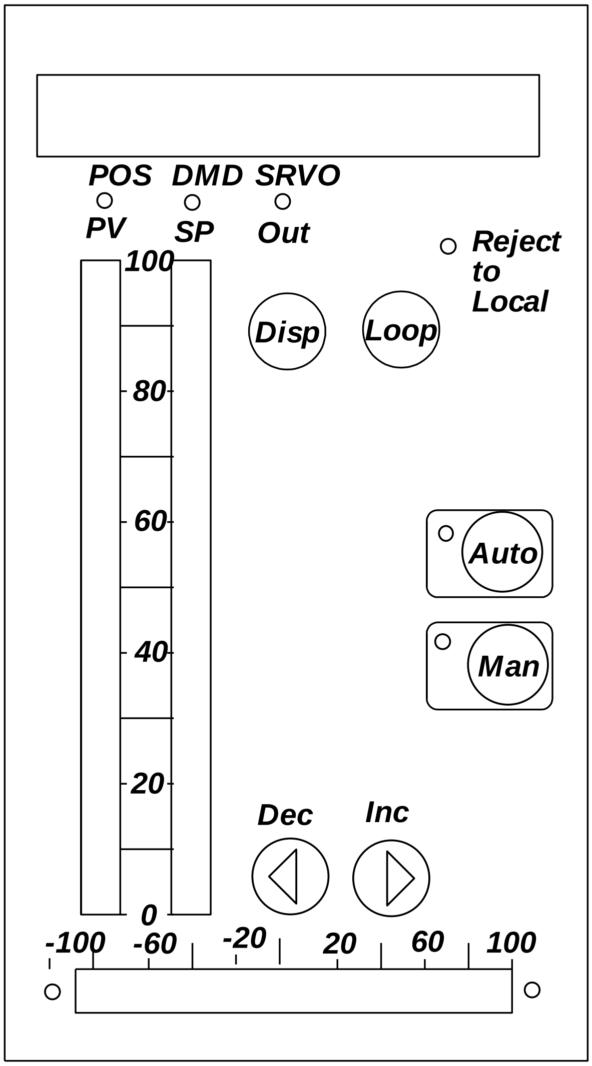


Figure 168: Keyboards for Group 3 and Group 4

9.5.4 Wiring - SLIM

Power cables to the SLIM must be single stranded #16 AWG copper conductors with ring lugs on both ends. Power required at the terminal block of the SLIM is 0.5A at +12 VDC. No shielding is required. A backup power supply is optional.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

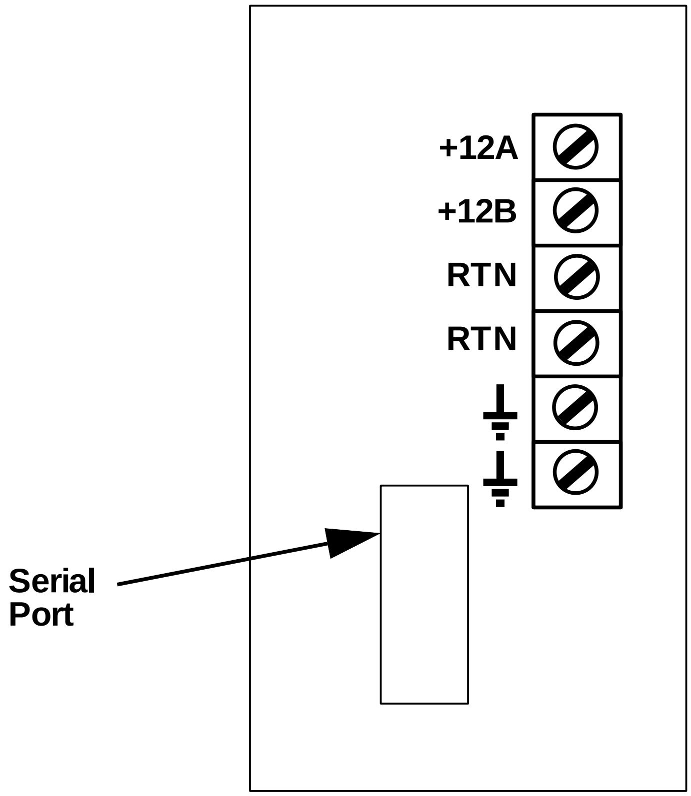


Figure 169: Wiring

In installations with more than one SLIM, each SLIM should have its own pair of conductors directly from the power supply. If SLIMs are connected in parallel, conductors must be able to accommodate the total current requirement for all SLIMs; voltage must measure +12 VDC at the last SLIM in the line.

9.5.5 Serial Port - SLIM

The Serial Port receives display and status data from the Loop Interface and also sends operator inputs from the keyboard to the Loop Interface. The port can communicate with only one Loop Interface.

Serial Port Card-Edge Connector

COMPONENT SIDE PIN	DESCRIPTION
1	Transmit **+**
2	Transmit **-**
3	Shield (Signal Ground)
4	Receive **+**
5	Receive **-**
6 through 10	Not Used

9.5.6 Assemblies - SLIM

- Cable assembly **5A26166** is used to connect the Ovation Loop Interface module to the SLIM.
- Cable assembly **5A26429** is used to connect the Ovation Loop Interface module to the SLIM in CE Mark certified systems.
- SLIM Power Supply Tray **4D33743Gxx** is used to power the SLIM.

9.5.7 Specifications - SLIM

- Current input
  - 0.30 A typical @ 12 V +5%, -10%
    0.50 A Maximum
- Isolation
  - 500 VDC output to chassis ground
- Humidity (non-condensing)
  - 0 to 95%

9.6 Speed Detector module - (SD)

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9.6.1 Overview - (SD)

The Speed Detector module determines the speed of a piece of equipment by measuring the frequency of the output signal from a tachometer. The tachometer output can be sinusoidal or a pulse train.

The G01 Speed Detector provides a 16-bit output at an update rate of 5 milliseconds for over-speed detection, and a 32-bit output at a variable update rate for speed regulation.

The G03 Speed Detector provides a 32-bit speed output and a 16-bit acceleration output. The G03 Speed Detector measures partial rotation and maintains a buffer of samples to achieve a 200 Hz (5-msec) update rate at normal sync speed. The G03 can issue a relay closure upon excess acceleration, excess speed, or excess summation of speed and acceleration. The Ovation Controller can also have control of the relay output. When there is an event that causes the relay to be energized, the coil is latched and is not un-latched until a handshake pulse is received from the Ovation controller to acknowledge the event. Limit values for speed and acceleration can be loaded onto the module via Ovation IO points. Since the limits are movable by the Ovation control sheet, it is then possible to incorporate test features into the Ovation control system such as 2-of-3 speed channel testing, and mechanical overspeed limit testing.

The G01 and G03 are not plug compatible. The Ovation configuration and programming are different. The G01 and G03 are compatible with respect to the terminal block wiring assignments.

9.6.2 Electronics modules (Emod) - (SD)

- **1C31189G01** uses tachometer to determine speed.
- **1C31189G03** uses tachometer to determine speed (Enhanced).

9.6.3 Personality modules (Pmod) - (SD)

- **1C31192G01** required personality card for Speed Detector.

9.6.4 Subsystems - (SD)

Speed Detector subsystems -- G01

Speed Detector subsystems (G01) [1, 2]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
16 bit speed (Low Res) 200 Hz Min - 51200 Hz Max	1	1C31189G01	1C31192G01
32 bit speed (High Res) 0.72 Hz Min - 65535 Hz Max	1	1C31189G01	1C31192G01
When using the Point Builder to define points for a Speed Detector module, only the following point types are valid for each channel:			

RANGE		CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
I/O Channel	**Name**	**Type**		**Terminal Block Connection**
1	High Resolution (speed value)	Input (can select I/O 1 or 3)		In
3	Low Resolution (speed value)	Input (can select I/O 1 or 3)		In
5	Open Wire	Input		Not applicable
11	Overspeed	Input		Not applicable
12	Latched Overspeed	Input		Not applicable
13	Trip Relay Status	Input		Not applicable
1	Trip Relay	Output		Relay
2	Reset Calculations	Output		Not applicable
[1] All module configurations listed in the table are CE Mark Certified. [2] This module interfaces to **ONE** speed sensor to determine the rotation speed of a field device.				

Ch. 11--This channel is the instantaneous status of the overspeed calculation. If it is true (=1), the most recent overspeed calculation result is that the machine is in an overspeed condition. This bit comes from bit 10 in the module status record and clears (= 0) as soon as the overspeed condition disappears.

Ch 12--This channel is a latched version of Ch. 11 and is located at bit 11 of the status register. Once set true it remains true until the Ovation controller reads the status register. When the Ovation controller reads the status register, this bit will be cleared if there is no overspeed condition.

Ch. 13--This channel reports the instantaneous status of the relay coil drive circuit. This bit is located in the module status register at bit 12. If it is true (= 1) the relay coil is driven to actuate the output relay.

Note: *The Ovation controller will read the status register and clear bit 11 both for scanning the module record, and for IO scanning if any of IO channels 11, 12, or 13 are defined. If channel 11 is used on a control sheet, then the logic must accommodate the possibility that the IO scan will miss the overspeed condition in a case where the condition is coming in and out quickly, and is cleared when the module record is scanned.*

Speed Detector subsystems -- G03

Speed Detector subsystems (G03) [1, 2 (] ***(Applies to 1C31189G03 EMOD and 1C31189G01 PMOD***

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
16 bit acceleration (Low Res) +/-31767 RPM/min	1	1C31189G03	1C31192G01
32 bit speed (High Res) 0.72 Hz Min - 65535 Hz Max	1	1C31189G03	1C31192G01
When using the Point Builder to define points for a Speed Detector module, only the following point types are valid for each channel:			

RANGE		CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
I/O Channel	**Name**		**Type**	**Terminal Block Connection**
1	High Resolution (speed value)		Input	In
4	Low Resolution (acceleration value)		Input	In
5	Open Wire		Input	Not applicable
11	Overspeed		Input	Not applicable
12	Overspeed Latched		Input	Not applicable
13	Relay Activated		Input	Not applicable
6	SpeedLimit or 0 - 65535 rpm		Output	Relay
5	AccellLimit or (Acell+Speed Limit +/- 32767)		Output	Not applicable
3	SimulateSpeed		Output	Not applicable
4	AckRelay		Output	Not applicable

[1] All module configurations listed in the table are CE Mark Certified.
[2] This module interfaces to **ONE** speed sensor to determine the rotation speed of a field device.

Ch. 11--This channel is the instantaneous status of the overspeed calculation. If it is true (=1), the most recent overspeed calculation result is that the machine is in an overspeed condition. This includes both the overspeed calculation, or the over-acceleration or over-speed+acceleration calculation. This bit comes from bit 10 in the module status record and clears (= 0) as soon as the overspeed condition disappears. The overspeed condition is reflected by the overspeed LED as well.

Ch. 12--This channel is a latched version of Ch. 11 and is located at bit 11 of the status register. Once set true, it remains true until the Ovation Controller acknowledges the event by pulsing channel 4.

Ch. 13--This channel reports the status of the relay coil drive circuit. This bit is located in the module status register at bit 12. If it is true (= 1) the relay coil is driven to actuate the output relay. Relay activation from overspeed conditions are latched in firmware and are not released until the Ovation Controller acknowledges the condition by pulsing channel 4, as described above. The relay can also be activated by the Ovation Controller.

Note: *If the Controller is updating the speed limit IO point, the configured limit is ignored. The acceleration limit IO can be positive or negative. Positive values indicate the customer preference for relay action on high acceleration, whereas negative values are for high amplitudes of deceleration. i.e. Positive acceleration will not cause relay action if the limit is negative.*

9.6.5 Terminal Block Wiring Information - (SD)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

***Note:** For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

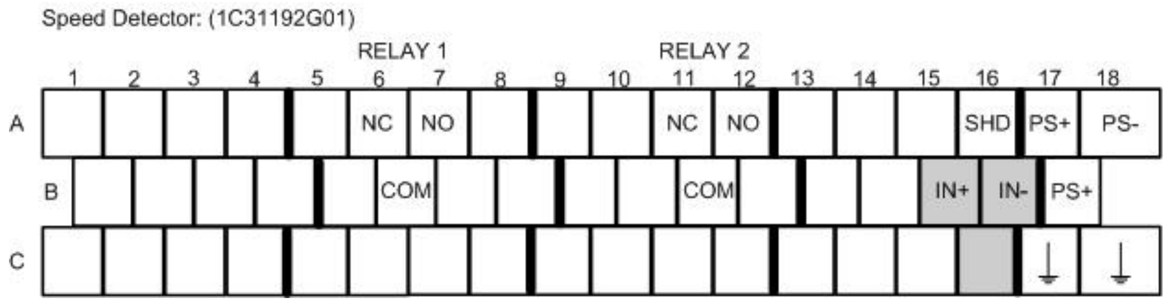


Figure 170: Terminal Block Connections for the Speed Detector Personality Module

The following table lists and defines the abbreviations used in this diagram.

Abbreviations Used in Wiring Diagrams

ABBREVIATION	DEFINITION
⏚	Earth ground terminals used to connect to input signal's shield (see the following figure for field connections).
COM	Common terminal of relay's contact.
IN+, IN-	Positive and negative terminal connections of input signal.
NC	Normally closed terminal of relay's contact.
NO	Normally open terminal of relay's contact.
SHD	Shield (see page 614) of input signal's cable.

All field signals leaving/entering the cabinet should be in shielded cables. The frequency input signal from the signal source must be in twisted-pair shielded cables. The shield must be grounded (see page 614).

***Note:** Do **not** use unmarked terminal block locations.*

9.6.6 Field Connection Wiring Diagrams - (SD)

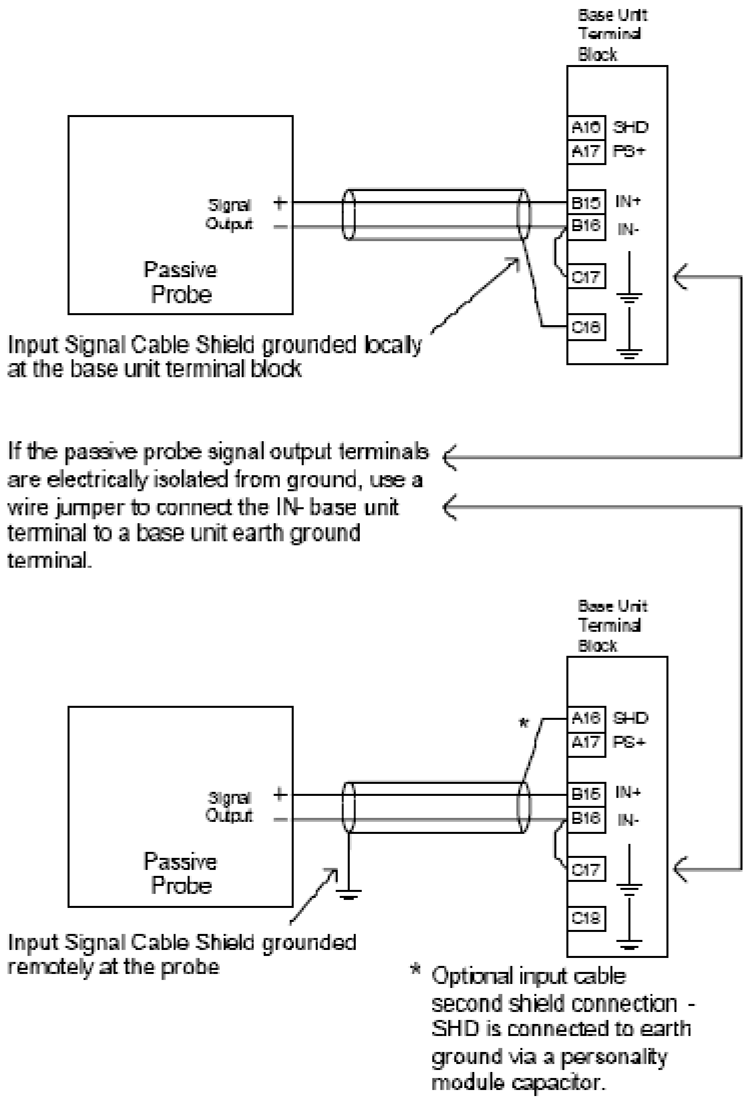


Figure 171: Passive Probe Field Connections for the Speed Detector PMod

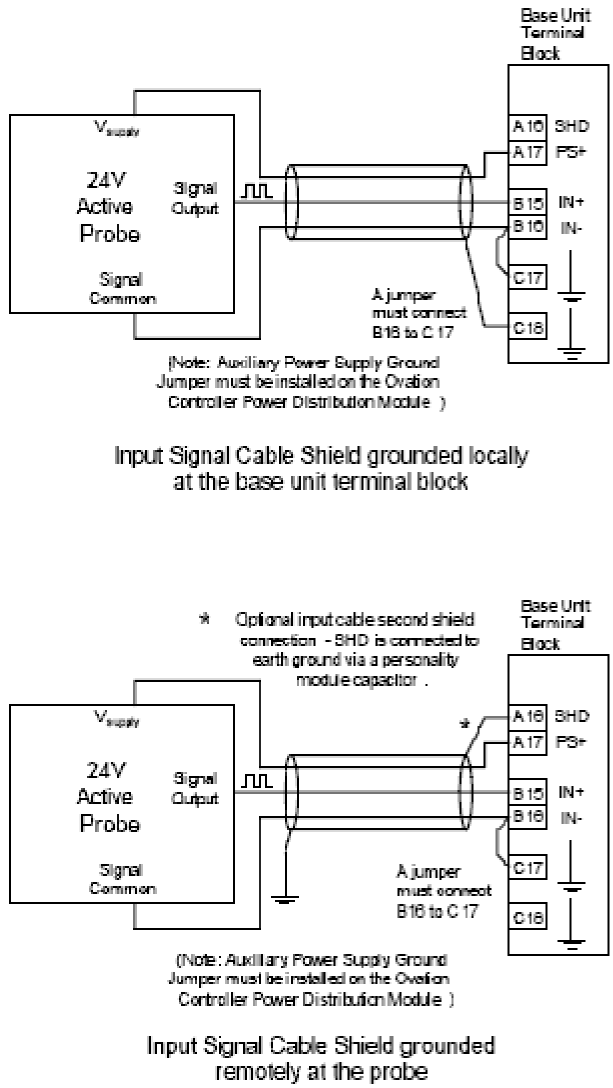


Figure 172: Active Probe Field Connections for the Speed Detector PMod

WARNING! Active speed probes that employ internal clocks for hysteresis, internal oscillation for proximity detection, or chopper stabilization may result in a noisy acceleration measurement vs. a passive probe because the sensor output transitions will jitter in the time domain according to the sensor's internal clocking.

9.6.7 Field Connection Wiring Diagram (Passive Probe) (CE Mark) - (SD)

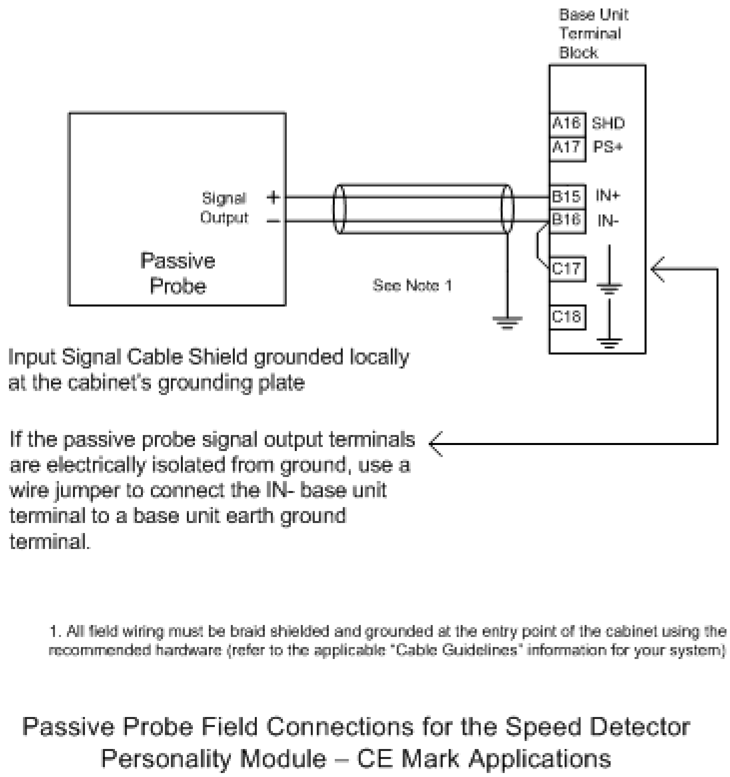


Figure 173: Passive Probe Field Connections for the Speed Detector Pmod (CE Mark)

9.6.8 Field Connection Wiring Diagram (Active Probe) (CE Mark) - (SD)

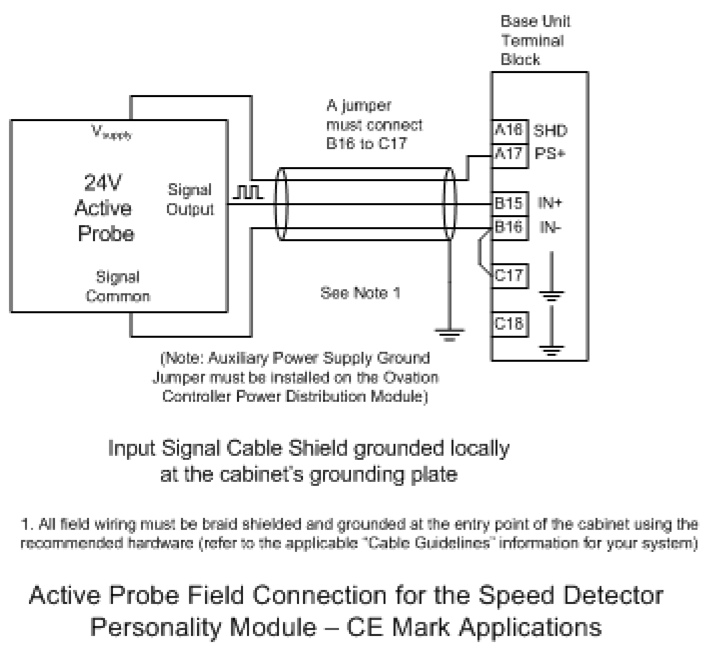


Figure 174: Active Probe Field Connections for the Speed Detector Pmod (CE Mark)

WARNING! Active speed probes that employ internal clocks for hysteresis, internal oscillation for proximity detection, or chopper stabilization may result in a noisy acceleration measurement vs. a passive probe because the sensor output transitions will jitter in the time domain according to the sensor's internal clocking.

9.6.9 Update rate and settings for G01 - (SD)

Update Rate

The update rate of the 16 bit speed output is 5 milliseconds. Input frequencies less than 200 Hz result in a 16 bit speed output of 0x0000. Input frequencies greater than 51,200 Hz result in a 16 bit speed output of 0xFFFF.

The update rate of the 32 bit speed output is variable. It is a function of the speed sensor output frequency (FREQ) and the user specified Pulse Count per Update (PULSES).

Update Rate = PULSES/FREQ

Example: Input frequency is 10 KHz, User specified pulse count per update is 60 (due to 60 teeth in the sensor gear). The 32 bit speed output update rate equals 60/10,000 or 6 milliseconds.

The maximum update rate of the 32 bit speed output is 1.39 seconds. The 1.39 second limit is set by the Speed Detector module hardware. If the user specified pulse count per update setting and speed sensor input frequency requires an update rate longer than 1.39 seconds, the Speed Detector module will still complete the 32 bit speed output update within 1.39 seconds.

Speed sensor input frequencies less than 0.72 Hz result in a 32 bit speed output that equals 0x0000 0000.

Speed sensor input frequencies greater than 65,535 Hz result in a 32 bit speed output that equals 0xFFFF FFFF.

Update Settings

Determine the update period of the 32-Bit speed output. Normally, this is used to control the speed of equipment where accuracy is important. A longer update period permits a higher accuracy output. Therefore, the Maximum update period allowed by the control loop should be used to update the Speed Detector module's 32-Bit speed output.

Example: The Ovation control system runs at a 50 millisecond loop time. The equipment operates at 10,000 Hz. The largest Pulse Count per Update setting that should be written to register 0EH = 10,000 Hz x 0.050 seconds) = 500

Another factor that should be considered is the number of teeth in the speed sensor's gear. The Speed Detector module provides the speed sensor output signal frequency. The Ovation control system regulates equipment speed in revolutions per minute (rpm) using the measured Speed Detector module speed sensor output frequency (Hz) as follows:

Equipment speed (rpm) = 60 x frequency (Hz) / number of teeth in the gear.

To eliminate errors due to mechanical differences of teeth in the gear, complete revolutions of the speed sensor's gear must be counted when measuring frequency. To implement this requirement, the Pulse Count per Update setting written to Speed Detector module register 0EH should be specified as an integer multiple of the speed sensor gear teeth quantity.

Example: There are 60 teeth in the speed sensor's gear. With a 50 millisecond loop time and with the equipment operating at 10,000 Hz, the largest speed a Speed Detector module Pulse Count per Update setting (written to register 0EH) is 500. The largest integer multiple of 60 teeth that is less than the Maximum pulse count per update setting of 500 is 8. Therefore, a Pulse Count per Update value of 8 x 60 = 480 should be written to register 0EH as the Pulse Count per Update. The Pulse Count per Update is set to 480 in order to be a multiple of the number of teeth in the gear. The Pulse Count per Update setting of 480 provides an update every (480/10,000 = 48 milliseconds) which is fast enough for a 50 millisecond control loop.

For this example, a value of 01EOH (480) should be written to the Speed Detector.

9.6.10 Speed Calculations

On the G03 module there is no 16-bit speed reading. There is a 32-bit speed reading in RPM and a 16-bit acceleration reading in RPM/min. The speed reading update rate exceeds 200 Hz at sync speed using the recommended configuration settings. At lower speeds, the recalculation of speed occurs every 4.6 msec or at the sample rate, whichever is slower.

Each rotation is subdivided by configuration into an integral number of partial rotations. Each partial rotation is sampled. An interrupt to the onboard microcontroller occurs per each sample and provides pulses (teeth) and ticks of the 24 Mhz clock.

Note: *If the machine is equipped with a toothed wheel with a prime number of teeth, the G03 must be configured with that number of teeth, and updates-per-rev equal to 1.*

The samples are buffered. Upon each update the pulses and time are accumulated to form a fraction based on a full rotation, as follows:

(pulses) / (24 Mhz ticks)

The fraction is then rescaled in order to convert it to RPM.

Speed calculations are buffered, then are used as an input to the acceleration calculation. When 8 msec worth of speed readings are accumulated, acceleration is recalculated. The acceleration calculation uses the difference between the newest speed calculation and an older speed calculation from 45 msec of previous history. Typically, acceleration is updated for every other update of speed.

Example 1: Machine with 60-tooth wheel operating at 1000 rpm.

For this example, there are six samples of 10 pulses (teeth) per rotation. The sample rate is 6000 samples per minute, or 100 samples per second. The sample period is 10 msec. In this case, the sample period exceeds the sample period of 4.6 msec (see additional info below), so the sample rate and update rate (recalculation) would be equal to 100 hz or every 10 msec. The sample period is greater than 8 msec, so acceleration is also recalculated every 10 msec.

Example 2: Machine with 60-tooth wheel operating at 3000 rpm.

If the machine is rotating at 3000 rpm there are 18000 samples per minute or 300 samples per second, or a sample ever 3.3 msec. However, firmware limits the update period to 4.6 msec, or 218 updates per second. This scheme allows ample time to calculate speed and acceleration while providing updates to the Ovation Controller at a rate exceeding 200 updates per second.

Recommended settings for machines equipped with a 60-tooth wheel

SPEED - RPM	CONFIGURATION	SAMPLE PERIOD
3600	10 teeth x 6	2.8 msec
6000 (BFP)	15 teeth x 4	2.5 msec
3000	10 teeth x 6	3.3 msec
1800	6 teeth x 10	3.3 msec
1500	6 teeth x 10	4 msec

9.6.11 Acceleration Calculations

Acceleration is the derivative of speed, and derivative calculations are inherently noisy. Noise is reduced on the G03 because the speed sampling starts and stops at the same tooth edge, and by extending the sample time of the acceleration calculation. Calculated speed values are buffered to maintain approximately 45 msec worth of samples for the acceleration calculation.

Acceleration is recalculated at ½ the rate that speed is recalculated at sync speed, or every 8 msec, whichever is slower.

The equation for the new acceleration measurement is:

Accel = (newspeed – oldspeed) / (~45 msec)

Once a new acceleration value is calculated, a smoothing algorithm is applied. The algorithm is called SES, or Simple Exponential Smoothing, and works according to this equation:

newAccel = (newAccelCalculated * 1/N) + (previousAccel *(1 – 1/N))

where N = 8 or 16 depending on customer configuration.

A rule of thumb for SES is that 86% of a step change would be seen after N samples for 1/N sampling.

> **Warning!** Active speed probes that employ internal clocks for hysteresis, internal oscillation for proximity detection, or chopper stabilization may result in a noisy acceleration measurement vs. a passive probe because the sensor output transitions will jitter in the time domain according to the sensor's internal clocking.

9.6.12 Relay activation for G03

Relay function on the G03 is the same as the G01 except there are a number of events logically OR'd that will activate the relay. In addition, any Relay activation is latched until acknowledged by the controller.

G03 firmware will activate the relay if:

1. Excess acceleration if acceleration I/O point is continually written to the G03 module.
2. Excess summation of speed and acceleration if acceleration I/O point is continually written to the G03 module.
3. Speed exceeding I/O point limit if speed limit I/O point is continually written to the G03, or speed exceeding configured limit if no I/O update.

The G03 also has a mode where the Ovation Controller can activate the relay. Acknowledge from the Ovation Controller is not required for this mode.

9.6.13 G03 Acceleration Limit and Response

The acceleration limit is an IO point. If the Controller is continuously updating this value and the value of this I/O point is exceeded, the relay is activated. The limit can be an acceleration-only value in rpm/Min.

The smoothing algorithm causes a delay in relay activation. The delay differs based on whether 1/8 or 1/16 smoothing is selected.

The table below shows the amount of a step change in acceleration as seen by the Ovation controller after certain specific times. The value seen by the Ovation Controller is the value used when deciding to activate the relay.

PERCENT ACCELERATION REPORTED	1/8 SMOOTHING	1/16 SMOOTHING
2.5%	28 to 37 msec	37 to 46 msec
5%	37 to 46 msec	46 to 55 msec
10%	46 to 55 msec	55 to 64 msec
20%	64 to 73 msec	83 to 92 msec
50%	101 to 110 msec	147 to 156 msec
75%	147 to 156 msec	248 to 257 msec

For example if the machine suddenly accelerates at 1000 rpm/min, 100 rpm/minute will be reported within 55 msec if 1/8 smoothing is selected. If 1/16 smoothing is selected, 50 rpm/minute is reported within 55 msec. For response within 55 msec at 1000 rpm/minute acceleration, the I/O point value would be 100 or 50 rpm respectively.

The G03 can be configured for a speed+acceleration limit. In this case, the module calculates a predicted speed that would occur 1 minute into the future, then actuates the relay if (speed + (acceleration * 1 minute)) is exceeded. The delay in the acceleration calculation in this case is the same as described above. The IO point limit value is then in RPM. This method allows for higher acceleration values at lower speed without activating the relay.

The comparable speed-only limit of 103% would be reached after 6.5 seconds at 1000 rpm/min acceleration.

9.6.14 G03 Relay Closure Times

All relay activations from the module microcontroller cause the relay to be latched. The control sheet must then issue a pulse to the G03 by setting AckRelay (channel 4, digital output) true for at least 50 msec.

For the G01 and G03, elapsed time from coil excitation to contact closure is 2 msec or greater and is listed in the specification section.

For the G01 and G03, the 32-bit calculation of speed requires 1.8 to 2.2 msec. Likewise, the acceleration calculation requires 1.8 to 2.2 msec.

For the G03, the full amplitude of a step change in speed is seen by the module after a full rotation. A portion of the step change is seen by the module after each sample subsequent to the event. A machine running at 3600 rpm rotates once every 16.7 msec.

Relay closure upon excess acceleration is affected by the sampling scheme and by smoothing. The sampling scheme uses 45 msec worth of speed readings.Therefore, based on the sampling scheme alone, 50% of an acceleration step change would be seen 45 msec after the event, and the full value would require 90 msec. This is because the oldest samples show no acceleration, but the newest samples show 100% of the value, but are averaged across the 45 msec sampling period. Delay due to smoothing continues to apply as sampling progresses.

The actual response also depends on the relationship between the actual start time of the event and the sampling of pulses and time which is implemented in hardware, those events being asynchronous.

This 2 msec delay from the relay, the calculation delay, and the smoothing delay described herein are incorporated in the dated provided in the table in *G03 Acceleration Limit and Response* *(see page 621).*

9.6.15 Speed Simulation

The G03 module will provide a simulated speed value if *simulateSpeed*, the digital output at channel 3, is active.

Upon activation of *simulateSpeed*, the present speed value is recorded, and then is subsequently increased at 300 RPM/minute. During this time, acceleration calculations are suspended and the acceleration value is set to 0. The overspeed limit calculations and relay operation remain intact.

This feature allows the speed channel to be tested against programmed speed limits, relay closure, and for testing of equipment downstream of the relay.

Once *simulateSpeed* is deactivated, the output value to the Ovation Controller immediately goes to the value as calculated from the field input.

9.6.16 Register configuration/address information for G01 - (SD)

Word address 13 (D in Hex) is used to configure the module and provide status information to the Controller. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern field on the Hardware tab). Refer to the applicable *Ovation Operator Station User Guide* for information about the Point Information window.

Speed Detector Configuration/Status Register (Address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module (1 = configure; 0 = unconfigure, causing a stoppage of both output measurements)	Module Configured (1 = configured; 0 = unconfigured causing a stoppage of both output measurements)
1	Force Internal Error (1 = force an attention status to be read by Controller; 0 = no forced error)	Forced Internal error (1 = forced error set by Controller; 0 = no forced error)
2 - 3	Not used	Not used
4	Not used	Bit 4 = 1, Open wire condition detected.
5	1 = enable open wire test	Bit 5 = 1, Open wire test enabled.
6 - 9	Not used	Not used
10	Not used	Bit 10 = 1, currently in overspeed condition.
11	Not used	Bit 11 = 1, an overspeed condition detected since last read of register D. Reading register D clears this bit.
12	Not used	Bit 12 = 0, relay open. Bit 12 = 1, relay energized.
13	Not used	Not used.
14	Relay control 1	Relay control 0
15	Relay control 2	Relay control 1

Word address 14 (E in Hex) provides the Pulse Count per update setting for the secondary Configuration/status register.
Word address 12 (C in Hex) provides the Overspeed Condition setting.

9.6.17 Register configuration/address information for G03 - (SD)

Bit	Definitions
0	0 = The Speed Detector module is not configured. 1 = The Speed Detector module is configured.
1	0 = A Forced Internal Error command has not been issued by the Controller. 1 = A Forced Internal Error command has been issued by the Controller.
2	not used – Group One Modules, SPD_FILT_CTL – Group Three Modules 1 = speed filtering enabled 0 = speed filtering disabled
3	not used – Group One Modules, ACC_FILT_SEL – Group Three Modules 0 = 1/8 Accel filtering 1 = 1/16 Accel filtering

BIT	DEFINITIONS
4	This is a Digital Input point bit, OpenWire 0 = No speed sensor open wire condition has been detected. 1 = A speed sensor open wire condition has been detected.
5	0 = The Speed Detector module's speed sensor input open wire test has not been enabled. 1 = The Speed Detector module's speed sensor input open wire test has been enabled.
6	not used – Group One Modules, DIS_ALL_FILT – Group Three Modules 0 = normal filtering 1 = disable all filtering (may be set for slow machines that rotate at speeds less than 100 rpm)
7	not used – Group One Modules, ACCEL_ONLY_LIM – Group Three Modules 0 = The module I/O register 0xB contents specify a trip limit in expressed in rpm and compared to the calculated sum of the current machine speed + current machine acceleration * 1 minute 1 = The module I/O register 0xB contents specify a trip limit expressed in rpm/Min and compared to the current machine acceleration
8	0 = The latest 5 ms speed loop sample period speed sensor pulse count is < 128 (Group One modules) 1 = The latest 5 ms speed loop sample period speed sensor pulse count is > 127 (Group One modules) 0 – Group Three modules
9	0
10	This is a Digital Input point bit, Overspeed 0 = There is currently no input over-speed, predicted over-speed (current speed + current acceleration * 1 minute) (bit 7 = 0) or over-acceleration (bit 7 = 1) condition detected. 1 = An input over-speed, predicted over-speed (current speed + current acceleration * 1 minute) (bit 7 = 0) or over-acceleration (bit 7 = 1) condition is currently detected.
11	This is a Digital Input point bit, OverSpdLatched 0 = No input over-speed, predicted over-speed (current speed + current acceleration * 1 minute) (bit 7 = 0) or over-acceleration (bit 7 = 1) condition has been detected since the Ovation Controller last read the contents of the Speed Detector module's Module Status register. 1 = An input over-speed, predicted over-speed (current speed + current acceleration * 1 minute) (bit 7 = 0) or over-acceleration (bit 7 = 1) has been detected since the Ovation Controller last read the contents of the Speed Detector module's Module Status register. The act of reading the Module Status register will clear bit 11.
12	This is a Digital Input point bit, RelayStatus 0 = The FSD field board's relay coil has not been commanded to energize. 1 = The FSD field board's relay coil has been commanded to energize.
13	0
14-15	00 - Mode 1. The FSD relay coil is energized by one or both of these conditions: 1) The Ovation Controller sets Register 0xA bit 0. 2) The Speed Detector module microcontroller detects an over-speed condition, a predicted future over-speed condition (bit 7 = 0) or an over-acceleration condition (bit 7 = 1) 01 - Mode 2. The FSD relay coil is energized by one condition: The Speed Detector module microcontroller detects an over-speed condition, a predicted future over-speed condition (bit 7 = 0) or an over-acceleration condition (bit 7 = 1) 10 - Mode 3. The FSD relay coil is energized by one condition:Z The Ovation Controller sets Register 0xA bit 0. 11 - Mode 4. Same as Mode 3, except in the event of an Ovation Controller time-out condition (where the Ovation Controller Watchdog timer has timed out). In this situation, the Speed Detector module microcontroller will energize the FSD board relay coil if an over-speed condition, a predicted future over-speed condition (bit 7 = 0) or an over-acceleration condition (bit 7 = 1)

Note: *If the tooth count on the toothed wheel is a prime number, set updates per rev to 1, and the tooth count equal to the number of teeth on the wheel.*

9.6.18 Diagnostic Logic card LEDs - (SD)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK (above min required operating level).
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module at least once every two seconds.
E (Red)	External Error LED. Lit when the Open Wire (Bit 6 of module reply status register) is detected.
I (Red)	Internal Error LED. Lit when the Force Error bit (Bit 1 of register D) is detected. Also lit when a timeout of the watchdog timer occurs when Controller stops communicating with module for two seconds.
1 (Green)	Lit when overspeed is detected.
2 (Green)	Lit when relays are energized.
3 - 16	No LED.

9.6.19 Specifications - (SD)

- **Electronics module (1C31189)** [1]
- **Personality module (1C31192)**

Description	Value
Number of Channels	1
Input Frequency Range	G01 0.72 Hz to 5 kHz for the 32-Bit Speed Output 200 Hz to 51,200 Hz for the 16-Bit Speed Output G03 The sampling rate is limited to 1KHz, resulting in a limit to the Input Frequency range. 0.89 Hz to 65,535 Hz for 32-bit speed reading (10 pulses per update)
Speed Measurement Resolution	1/65535 Hz for the 32-Bit Speed Output 1 Hz for the 16-Bit Speed Output (G01) G03 – 1 rpm/Min for acceleration measurement.
Guaranteed Speed Measurement Accuracy (@25×C) Acceleration accuracy	Maximum error for the 16-Bit Speed Output is 0.0033% of Sensor Frequency Speed Input Max. error for the 32-Bit Speed Output is the greater of 0.0025% or $[(25/10^6) + (2/(24 \times 10^6 \times \text{Update Period}))] \times 100\%$ of Speed Sensor Frequency Input Update Period = PULSES/FREQ (in seconds) FREQ = Speed Sensor output frequency PULSES = User specified Speed Sensor Pulse Count per 32-Bit Speed Output value update +- 2 rpm/Min for 1/16 filtering, or +-4 rpm/Min for 1/8 filtering
Speed Output Update Rate Also see Update rate and settings for G01 - (SD) (see page 617) and Update rate for G03 - (SD) (see page 619)	Update Rate = 5 milliseconds for the 16-Bit Speed Output (G01) Update Rate = PULSES/FREQ (in seconds) for the 32-Bit Speed Output FREQ = Speed Sensor output frequency G01 - PULSES = User specified Speed Sensor Pulse Count per 32-Bit Speed Output value update G03 - PULSES = User specified tooth count per update.

DESCRIPTION	VALUE
Relay	Type - 2 form C Switching Time - 2 millisec. typical, 4 millisec. Max. Contact Load Current - 0.5 A Max. @ 125 VAC, 2 A Max @ 30 VDC Contact Switching Capacity - 62.5 VA or 60 Max. G03 functions are the same a G01, except for how they are activated.
Differential Input Impedance	50 K OHM
Diagnostics	Open Speed Sensor Wires Detection (Speed Sensor source resistance must be </= 5000 ohms). Over-speed detection.
Dielectric Isolation: Field Circuit to Logic Common	1000 VAC/DC or 500 VAC RMS for one minute, field to logic.
Max. Input Withstand Voltage	140 VAC rms or 150 VDC
Max. Usable Input Voltage	200 V peak-to-peak
Max. Off-State Input Voltage	0.2 V peak-to-peak
Input Duty Cycle	20% Min. - 80% Max.
Max. Input DC Offset	150 VDC -0.5 x Max. Input Voltage (peak-to-peak)
Normal Mode Rejection	Maximum 140 VAC or 150 VDC
Module Power	4.8 W typical, 6.25 W Maximum
Operating Temp. Range	0×C to 60×C (32×F to 140×F)
Storage Temperature Range	-40×C to 85×C (-40×F to 185×F)
Humidity (Non-Condensing)	0 to 95%
[1] Refer to the following table for information about different revisions of 1C31189.	

Minimum Input Voltage (Peak-to Peak)

1C31189G01 REVISION 1	1C31189G01 REVISIONS 2 /3	1C31189G01 REVISION 4 OR LATER	1C31189G03	INPUT SIGNAL FREQUENCY RANGE
n/a	n/a	n/a	1 volt	From 0.089 Hz up to 0.72 Hz
5 volts	1 volt	1 volt	1 volt	From 0.72 Hz up to 5 Hz
5 volts	1 volt	0.5 volt	0.5 volt	From 5 Hz up to 1 KHz
5 volts	1 volt	1 volt	1 volt	From 1 KHz up to 10 KHz
5 volts	1 volt	2 volts	2 volt	From 10 KHz up to 20 KHz
10 volts	10 volts	10 volts	10 volt	From 20 KHz up to 40 KHz
20 volts	20 volts	20 volts	20 volt	From 40 KHz up to 50 KHz
40 volts	40 volts	40 volts	40 volt	From 50 KHz up to 65535 Hz

9.7 Valve Positioner module - (RVP)

9.7.1 Overview - (RVP)

The Digital Electro-Hydraulic (DEH) system controls steam turbine valve positions in order to adjust steam flow for turbine speed control, or to change generator load when connected to the grid. The Ovation Valve Positioner I/O module provides an interface between the DEH Ovation Controller and an electro-hydraulic servo valve actuator. Valve styles controlled by the Ovation Valve Positioner I/O module include throttle valves, governor valves, interceptor valves, extraction valves, and bypass valves. The Ovation Valve Positioner module provides closed-loop valve positioning control.

A valve position set point is maintained by the module. The set point is normally altered by the Ovation Controller via the Ovation I/O bus. If the Ovation Valve Positioner module operates in Local Manual mode, the set point is controlled by a SLIM operator interface station. Inside the Electronics module, an 80C196 micro-controller provides real-time closed loop proportional-plus-integral (PI) control.

The Ovation Valve Positioner I/O module generates redundant output control signals which drive the electro-hydraulic servo valve actuator coils. The feedback loop is closed with the valve's position measurement being obtained from a Linear Variable Differential Transformer (LVDT) that is mounted on the valve stem.

The Valve Positioner module can perform the following:

- Calibration
- Diagnostics
- 10 millisecond loop time
- SLIM interface for local control
- Local serial interface for testing and calibration
- Shutdown input
- Seating and backseating logic

The Valve Positioner module is a CE Mark certified module.

9.7.2 Electronics modules (Emod) - (RVP)

- **1C31194G01** 17 V ac p-p 1 kHz LVDT primary winding excitation output., ±10.24 V dc servo valve actuator coil drive output voltage. RVP design.
- **1C31194G02** 23.75 V ac p-p 3 kHz LVDT primary winding excitation output., ±10.24 V dc servo valve actuator coil drive output voltage. RVP design.

Note: *For Solaris applications, when using the I/O Builder to configure the Valve Positioner (VP) module, note that whatever voltage/current description is displayed in the Slot position at the top of the window does NOT impact the configuration of the VP module.*

9.7.3 Personality modules (Pmod) - (RVP)

- **1C31197G01** has 330 ohm resistors that provide up to ±24 mA into 82 ohm servo coils. Use with any Valve Positioner Electronics module.
- **1C31197G02** has 360 ohm resistors that provide up to ±16 mA into 250 ohm servo coils. Use with any Valve Positioner Electronics module.
- **1C31197G03** has 240 ohm resistors that provide up to ±8 mA into 1000 ohm servo coils. Use with any Valve Positioner Electronics module.
- **1C31197G04** has 160 ohm resistors that provide up to ±36 mA into 125 ohm servo coils. Only two coils may be driven by 1C31197G04. Use with any Valve Positioner Electronics module. The C3+ and C3- coil outputs are not available.
- **1C31197G05** has 120 ohm resistors that provide up to ±50 mA into 85 ohm servo coils. Only two coils may be driven by 1C31197G05. Use with any Valve Positioner Electronics module. The C3+ and C3- coil outputs are not available. 1C31197G05 Accommodates 4-20 mA feedback input at terminals B9/C9. See *VP personality module 1C31197G05 recommendations* for tuning constant suggestions.

***Note:** When using the I/O Builder to configure the Valve Positioner (VP) module for Solaris applications, note that whatever voltage/current description displays in the Slot position at the top of the window does NOT impact the configuration of the VP module.*

9.7.4 Subsystems - (RVP)

Valve Positioner Subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Valve Positioner Controller			
17 Volts AC LVDT: 24.9 mA	8	1C31194G01	1C31197G01
17 Volts AC LVDT: 16.8 mA	8	1C31194G01	1C31197G02
17 Volts AC LVDT: 8.3 mA	8	1C31194G01	1C31197G03
17 Volts AC LVDT: 36 mA	8	1C31194G01	1C31197G04
24 Volts Fused DC LVDT: 50 mA	8	1C31194G01	1C31197G05
23.75 Volts AC LVDT: 24.9mA	8	1C31194G02	1C31197G01
23.75 Volts AC LVDT: 16.8 mA	8	1C31194G02	1C31197G02
23.75 Volts AC LVDT: 8.3 mA	8	1C31194G02	1C31197G03
23.75 Volts AC LVDT: 36 mA	8	1C31194G02	1C31197G04
24 Volts Fused DC LVDT: 50 mA	8	1C31194G02	1C31197G05

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Valve Positioner Controller			

When using the Point Builder to define points for a Valve Positioner module, only the following point types are valid for each channel:

I/O Channel	Name	Type	Input Source or Output Destination	Terminal Block Connection [2]
1	Shutdown Status	Input	Valve Positioner	DI1
2	Auxiliary (wetting) Voltage Sense	Input	Valve Positioner	DI2
3	SLIM ON Signal	Input	Valve Positioner	DI3
4	Position Feedback	Input	Valve Positioner	
5	Coil 1 Voltage (Read-back)	Input	Valve Positioner	Coil 1
6	Coil 2 Voltage (Read-back)	Input	Valve Positioner	Coil 2
7	Coil 3 Voltage (Read-back)	Input	Valve Positioner	Coil 3
8	Raw Demodulator Voltage	Input	Valve Positioner	
9	VP Status	Input	Valve Positioner	
10	Demand Feedback	Input	Valve Positioner	
11	VP Command	Output	Valve Positioner	
12	VP Demand	Output	Valve Positioner	
13	Partner Position Feedback	Output	Valve Positioner	

[1] This module provides an interface between an Ovation Controller and **ONE** Electro-Hydraulic (EH) servo-valve actuator in the field. To use this module, the MASTATION algorithm must reside in the Ovation Controller. (See the *Ovation Algorithm Reference Manual*.)

[2] The terminal block connection depends upon the application being used. Refer to wiring diagram.

9.7.5 Guidelines (Redundant) - (RVP)

Two Ovation Valve Positioner (VP) cards operate as a Primary/Backup pair to control a single steam valve. The steam valve is fitted with two LVDTs, one connected to each Valve Positioner. Each VP then drives one coil in a high pressure hydraulic servo valve. The coils are completely isolated. Under normal conditions current through each coil is equal and the effect on the servo valve spool is additive.

The Valve Positioners communicate serially to determine which VP should be Primary, and which should be Backup. Critical parameters of the redundant subsystem are exchanged over the serial link. These critical parameters are also exchanged over the Ovation bus, thus providing a redundant data path.

The Backup VP suspends its software PI routine, and replicates the servo output of the Primary. It then takes over control if the Primary fails. There are three types of failures that the subsystem detects and responds to:

- Hardware Failures - Each VP continuously runs internal diagnostics and ceases operation if a diagnostic fails. A failure is indicated when both the serial communications and Ovation line watchdog timers expire. The VP card continuously executes these diagnostics:
  - ☐ Micro-controller RAM
  - ☐ Ovation RAM
  - ☐ EPROM Checksum
  - ☐ DA Converter Readback
  - ☐ Ovation Watchdog Timer
  - ☐ Redundant Communications Watchdog Timer

- Coil Drive - If the Primary VP detects a shorted or open servo coil, it transfers control to the Backup VP. Refer to, Coil Setup.
- LVDT Failures - LVDT failures are detected by measuring the derivative of position feedback. As with the servo coil, there are setup requirements that enable the detection of LVDT problems. Refer to, LVDT Setup (see page 636).

The VP pair utilizes the SLIM serial port for VP-to-VP communications. The serial link is a VP-to-VP connection, not the “party-line” bus utilized with the SLIM.

Because the effect on the servo spool from the servo coils is additive, a failover event is NOT bumpless (that is, the valve dips, or moves in the direction indicated by the mechanical bias setting, during the failover period). Catastrophic hardware failures, or removal of the Primary VP, are the worst failures because the Backup must wait for various timers to expire and then engage the PI loop.

If, for example, the failover required one second to complete (determined by the Controller loop time), and the valve was programmed to drift shut in 30 seconds under control of the mechanical bias-setting, the valve could drift 3% (=1/30).

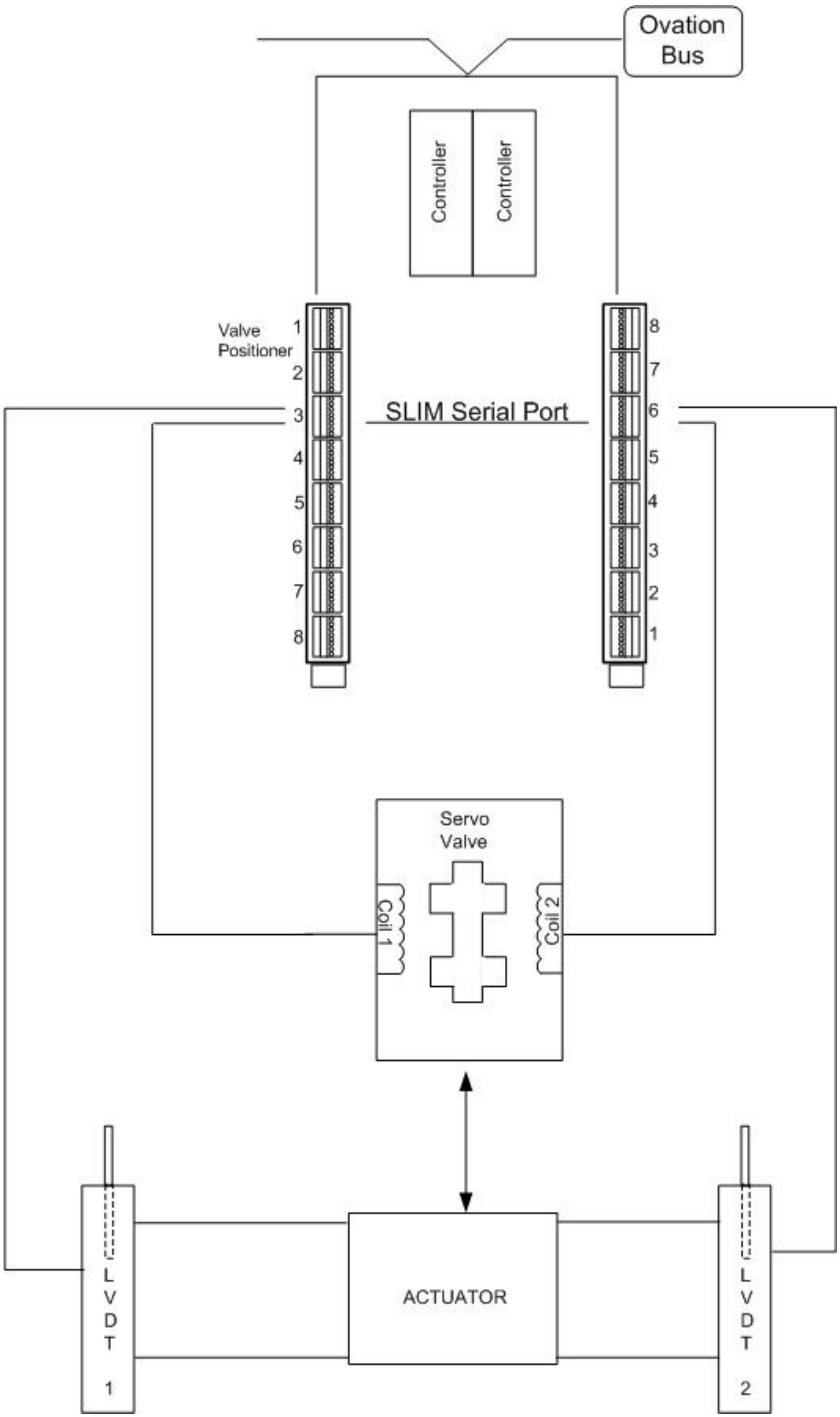

Ovation Bus
Controller
Controller
Valve Positioner
1
2
3
4
5
6
7
8
SLIM Serial Port
8
7
6
5
4
3
2
1
Servo Valve
Coil 1
Coil 2
ACTUATOR
LVDT 1
LVDT 2

Figure 175: Typical Redundant Ovation Valve Positioner Subsystem

In the example above, the valve is controlled by RVPs in branch 1, slot 3 and branch 2, slot 6. Each RVP reads the valve position from a six-wire LVDT. The RVPs communicate across the SLIM port to cooperate in driving the servo valve. The servo valve admits/releases hydraulic fluid from the actuator.

9.7.6 Module Serial Connection - (RVP)

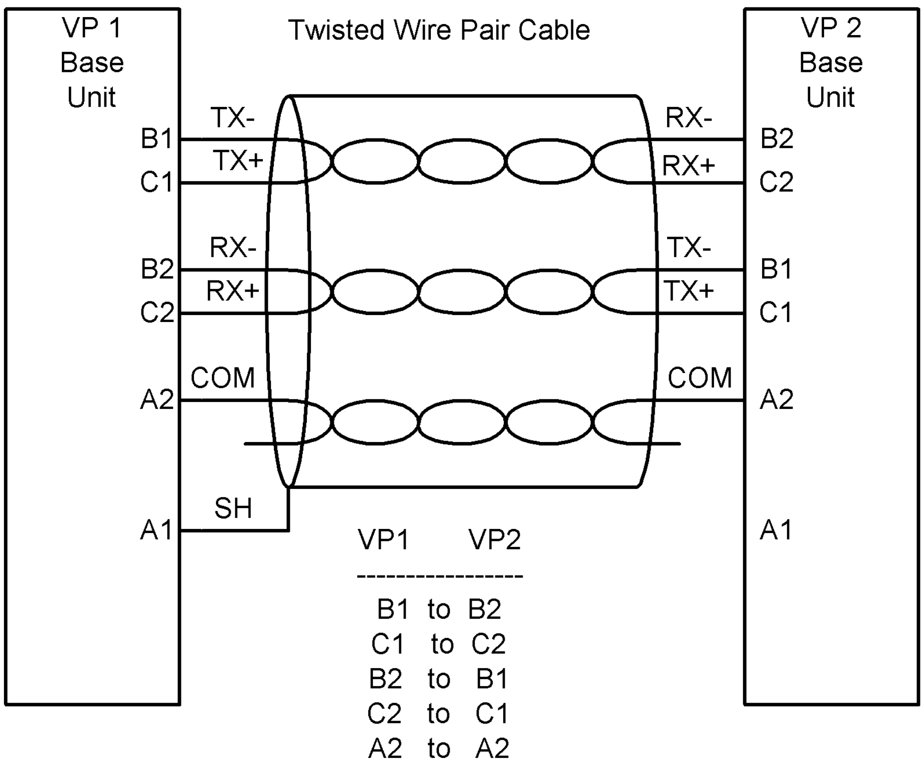


Figure 176: Redundant VP to VP Serial Connections

9.7.7 Firmware levels - (RVP)

The following table lists all VP module firmware releases that added functionality to the VP.

VP Firmware Level (E mod)	VP Revision Level (E mod)	Firmware Features
0B	5	First full production firmware release.
0C	6	Added support for VP Redundancy.
0D		Obsolete
0E		Obsolete

VP Firmware Level (E mod)	VP Revision Level (E mod)	Firmware Features
0F	9	Added support for the following: ▪ Calibration from the Controller using graphics. ▪ Upload/download of calibration constants to and from the Controller. ▪ New tuning constants **kServo** and **kServoDb** to replace hard-coded constants. They add flexibility in dealing with differing coil impedances. ▪ Reduction of valve calibration time.
0G	11	Redundancy support changed so that multiple failovers are precluded. Improvements to calibration. Improved coil diagnostics for “coilCount = 0”. Math calculation for position feedback endpoint improved.
0H	13	Added “priority Demand” tuning constant to support Rockport project.
0I	15	Corrected communications error in redundancy link.
0J	16	Added anti-windup feature, changed default values of piGain, pi ResetTDb, and errorDbs, and calibration sequence improvements.
0K	18	Improved Serial Communications.
0L		Added the following enhancements: ▪ Added 3 control bits to override primary/backup modes and reset of the redundant RVP pair. ▪ Corrected problem of calibration at full open endpoint. ▪ Fixed startup sequence to avoid contest for primary status of redundant RVP. ▪ Increased startup wait time for oscillator settling from 10 seconds to 20 seconds. ▪ Use servo output to predict direction of motion as arbiter for redundant RVP when position feedbacks become unequal.
0M		This version includes the following: ▪ Made changes to seating and backseating. ▪ Cleaned up LED display for backup RVP in redundant RVP pair. ▪ Made a slight adjustment of the AD converter schedule.

9.7.8 Primary to Backup status transition - (RVP)

The firmware for the Valve Positioner module allows for Primary to Backup and Backup to Primary status transitions.

If the VP is in the Primary mode, it transitions to Backup mode if:

Note: *Prior to a decision to fail to the backup, the following conditions are tested, and if OK, the primary determines its own health is good and the subsequent tests are not executed:*

1. During calibration failovers are precluded.
2. If there was a recent failover a timer operates to preclude additional failovers for at least ½ second.

Then the failover conditions are checked:

1. The serial line status is OK and the partner is the primary.
2. The serial line status is OK, the backup is OK and armed, and a high derivative is detected on the position feedback. (See description of min2ndry tuning constant and LVDT setup requirements.)
3. The serial line status is OK, the backup is OK and armed, and excessive motion is seen for 10 subsequent position feedback scans. (See description of MaxDelta tuning constant.)
4. The serial line status is OK, the backup is OK and armed, and a failed servo coil is detected.
5. The serial line status is OK, the backup is OK and armed, the primary sees a difference between target position and actual position that exceeds tuning constant posErrDelta, and the position feedback and partner position feedback differ by more than LVDT Tracking. This condition is a “last choice” situation. The redundancy state machine is restarted to allow the other RVP to take over.

9.7.9 Backup to Primary status transition - (RVP)

If the VP is in the Backup mode, it transitions to Primary mode if:

1. The serial line status and partner alive status both indicate the partner is not alive.
2. The serial line status is OK, the partner is in the backup mode, and the RVP is armed.
3. The serial line status is OK, the partner has an error condition, and the RVP is armed. Error conditions include coil problem, a severe fatal error bit (hardware), or an excessive derivative of position feedback is detected.
4. The RVP is armed, the difference between the detected position feedbacks exceeds LVDT Tracking, and one of the following combinations of conditions is true:
   - ☐ The servo output is ramping, and in a direction to open the valve, the backup is moving toward the open position, and the primary is not moving, or is moving in the opposite direction.
   - ☐ The servo output is ramping, and in a direction to close the valve, the backup is moving toward the closed position, and the primary is not moving, or is moving in the opposite direction.

9.7.10 Disarm during Backup mode - (RVP)

If the VP is in the Backup mode, it will disarm if:

The difference between the detected position feedbacks exceeds LVDT Tracking, and one of the following combinations of conditions is true:

- The servo output is ramping, and in a direction to open the valve, the primary is moving toward the open position, and the backup is moving toward the closed position.
- The servo output is ramping, and in a direction to close the valve, the primary is moving toward the closed position, and the backup is moving in the opposite direction.

9.7.11 LVDT and coil setup requirements - (RVP)

The following items must be set up before operating redundant Ovation Valve Positioner modules:

LVDT setup requirements for a redundant subsystem:

- First, the linear range of the LVDT must exceed the mechanical range. This means that when the valve is at either endpoint, one of the secondary voltages is at its minimum. The secondary voltage must be large enough at the endpoint so that if a wire breaks and the secondary voltage goes to zero, the change of voltage is large enough to be readily detected. A good guideline is to ensure that each secondary always contributes at least 10%, positive or negative, to the demodulated voltage. That is,

  $$\mathrm{Min}\,(|A|, |B|) \,/\, (|A| + |B|) > 10\%$$

  This minimum secondary value is expressed in percentage, is tunable, and is called MIN2NDRY.
- Second, the LVDTs must be calibrated prior to being placed into redundant service, and for all possible positions, the feedback signal of the Primary should be near the feedback signal of the backup. This value is called LVDTTRACKING, and its default value is 1%.

Coil Setup Requirements

Coil diagnostics rely on a steady voltage across the coil. This voltage will be present if you adjust the servo valve per the Emerson recommendation.

The servo valve has a mechanical bias set-screw that pushes the spool to one side, allowing fluid to escape the actuator and slowly close the valve in the absence of electrical excitation.

In the standard setup approximately 200 mV across both coils opposes the mechanical bias adjustment and holds the spool in the center position, trapping the fluid in the actuator, and holding the valve in a fixed position.

Adjusting coil current changes spool position so that fluid can flow into or escape from the actuator. (Technically, the operation of the servo valve is dependent on current through the coil and the mechanical bias adjustment. However, the VP is set up to measure voltage across the coil and at the amplifier output, so voltage measurements are typically referenced in this description.)

9.7.12 Modes - (RVP)

Rapid or erratic valve movement can damage the turbine. The Valve Positioner enforces a set of rules to accomplish bumpless transfer between modes. The description of each mode includes mode transfer.

Start mode - (RVP)

When the Valve Positioner starts or is restarted, its primary objective is to avoid an indeterminate output that would result in valve movement, and possible damage to the valve or turbine. There are a number of hardware and software features that prevent an indeterminate output.

The hardware is designed so that when the Valve Positioner starts, the power supply to the servo output is turned off. With no current flow to the servo valve, it is left under the influence of its mechanical bias adjustment, the assumed state prior to power-up. In addition, the coil drive D/A converter is not turned on until it receives the first output pattern.

As part of the micro-controller’s start sequence, the power supply is turned on, and then a pattern is written to the coil drive D/A converter representing 0 volts. The result is that the servo output is under software control, no current flows between the Valve Positioner and the servo valve, and no valve movement has occurred.

The Valve Positioner does not remain in Start mode unless a diagnostic error is detected. The Valve Positioner transitions from Start to Local mode if all of the following functions execute and return “normal” or “ok” status codes:

- Program the FPGA.
- Go to Factory Configure Mode if PE pin is 1.
- Check PE pin. Go to Factory Test Mode, if required.
- EPROM checksum check.
- EEPROM checksum check.
- RAM read/write test.
- D/A converter readback diagnostic.
- UART scratchpad read/write test.
- Shared memory readback check.

The Valve Positioner sets target valve demand equal to demand feedback before transferring to Local mode.

Control mode - (RVP)

In normal, local, and calibrate modes, the Valve Positioner is always controlling valve position. The PI routine runs unconditionally every 10 msec. Typically, it executes the PI equation as described below. The PI routine has some conditionally executed parts to handle seating and back-seating.

SLIM Modes - (RVP)

The SLIM has four modes:

- Local
- Auto
- Cascade
- Manual

Only two of the four (local and auto) correspond to Valve Positioner modes. **Local mode** corresponds to Valve Positioner **local-manual** mode. However, the operator does not request "local' mode." It is only entered when the Controller stops or fails to update the Valve Positioner card.

SLIM **auto mode** corresponds to Valve Positioner **normal mode**. In this mode, the Controller is writing its desired position to the Valve Positioner. In normal mode, the valves' position and set point can be viewed on the SLIM, but the SLIM has no control over the Valve Positioner.

These modes should not be confused with auto and manual modes of software loops within the Controller. Remember that the Valve Positioner is always in normal mode, receiving its position from the Controller, unless the Controller fails, in which case the Valve Positioner switches to local mode.

When raise and lower on the SLIM are pressed, all Valve Positioners respond to the key action. This means that all valves move together as a group. It also suggests that no other devices (Loop Interfaces) should be connected on the serial bus with a group of Valve Positioners.

In abnormal situations, such as during maintenance, some valves may be in normal mode, and some may be in local mode. In this situation the valve in local mode responds to raise/lower action, but the valves in normal mode do not. The Controller application warns or notifies the operator of the mode of each valve.

Since the SLIM is connected to a group of Valve Positioners, each Valve Positioner must control its own transmit enable. Each SLIM enables its transmitter when placing a response into the transmit buffer. It also starts a 25 mSec timer, which, when expired, disables the transmitter.

SLIM Pushbuttons - (RVP)

The SLIM operation differs from normal operation when connected to the Ovation Loop Interface.

A standard SLIM (see page 603) is used to control a group of valves on a common serial bus.

The actions that occur when a SLIM push-button is used are described in the following table.

SLIM Pushbutton Actions

BUTTON	DESCRIPTION
Loop	The next Valve Positioner on the serial bus is selected. Set point and target position display on the vertical bar-graphs.
Display	Display cycles the top left hex display from target position, actual position, and servo voltage output.

BUTTON	DESCRIPTION
Loop	The next Valve Positioner on the serial bus is selected. Set point and target position display on the vertical bar-graphs.
Up	Up increases target valve position for the valve group. Only the valves in local mode respond to the Up button.
Down	Down decreases target valve position for the valve group. Only the valves in local mode respond to the Down button.
Manual, Auto, Cascade, Mode, Left, Right	Not used.

The SLIM indicators and LEDs provide information about the operation of the Valve Positioner.

SLIM Indicators and LEDs

INDICATOR	DESCRIPTION
PV Bar-graph	Indicates actual valve position
SP Bar-graph	Indicates target valve position of the selected valve
Output Bar-graph	The horizontal output bar-graph on the bottom of the SLIM indicates servo output voltage ranging from -10 volts to +10 volts, mapped to 0 to 100% available on the bar-graph. For a stable valve in a controlled position, approximately 50% (+/- mechanical bias adjustment) would be indicated.
Top Left digits	Indicators for set point, actual, or output voltage.
Top Right digits	Indicate engineering units of the value being displayed.
LEDs: M, C, and T	In local manual mode, C (control) is indicated. In normal mode, M is indicated (monitor). The operator does not have any control over the 'M' 'C' or 'T' function.
LEDs: Casc and Man	Not used.
Auto LED	Illuminated if the valve is in **normal** mode.
Loc LED	Illuminated if the valve is in **local** mode.

Local-Manual mode - (RVP)

The purpose of **local-manual** mode is:

- Maintain stable valve position when the Controller fails or is reset.
- Smooth operation using manual raise/lower function.
- Bumpless transfer to normal mode. (Tracking by the Controller is required, and is enforced by the Valve Positioner in local-manual mode.)

In local-manual mode, the Valve Positioner controls the valve using a set point that is only changed through the SLIM interface, or through the local serial interface.

Local-manual mode will be entered from normal mode if the Controller fails or stops updating the Valve Positioner card. When the Valve Positioner is powered up, local-manual mode is always entered as long as there are no diagnostic failures.

The preferred mode of Valve Positioner operation is normal mode. The Valve Positioner transfers from local-manual to normal if the following conditions are met: (1) Controller is updating the set point, thus keeping the watchdog timer from expiring. (2) Controller is tracking.

In local-manual mode, the following functions are performed:

- PI position control loop.
- Writes current valve position to Ovation memory.
- Writes coil voltages to Ovation memory.
- Open coil diagnostic.
- Shorted coil diagnostic.
- EPROM checksum diagnostic.
- RAM diagnostic.
- Watchdog timing.
- SLIM interface (Raise, Lower, and update SLIM values.)
- Valve contingency diagnostic.

Normal mode - (RVP)

Normal is the preferred mode of the Valve Positioner card. In normal mode, the Valve Positioner is receiving a position set point from the Controller and controlling valve position.

In normal mode, the following functions are performed:

- PI position control loop (Demand position comes from the Controller via the Ovation memory).
- Writes current valve position to Ovation I/O memory.
- Writes coil voltages to Ovation I/O memory.
- Open coil diagnostic.
- Shorted coil diagnostic.
- EPROM checksum diagnostic.
- RAM diagnostic.
- Watchdog timing.
- SLIM interface (Updates SLIM values, no raise/lower function.)
- Valve contingency diagnostic.

Calibrate mode - (RVP)

Calibrate mode is a sub-mode of local-manual mode. Calibration sequences are commanded through the local serial port.

The Valve Positioner is commanded to calibrate when the appropriate bit in the command word is set. This causes the Valve Positioner to enter the calibrate mode and begin its travel sequence. During the travel sequence, the Valve Positioner reports a position feedback calculated using the most recent calibration numbers. The controlling MASTATION enters manual mode and track the position demand feedback. The Valve Positioner moves the valve at a programmable rate during the travel sequence.

The Valve Positioner can exit calibrate mode **without** enforcing a bumpless transfer rule.

The following calibrate sequences are supported:

- Zero Hot Cal

  This calibration sequence is executed to re-establish the 0% position. It is useful after the valve has been fully calibrated and the mechanical assembly has been heated and expanded. It avoids fully opening the valve.

  Feedback gain is not adjusted during the hot cal sequence.

- Top Hot Cal

  This calibration sequence is executed to re-establish the 100% position. It is useful after the valve has been fully calibrated and the mechanical assembly has been heated and expanded. It avoids fully closing the valve.

  Feedback gain is not adjusted during the hot cal sequence.

- Null-Point Cal

  This calibration sequence causes the valve to travel to the electrical null point of the LVDT. Null point calibration can be requested at the same time as full calibration, in which case the movement sequence is the full calibration sequence. However, the valve stops at the null point when it is encountered.

- Full Calibration

  This calibration sequence is executed to re-establish 0% position, 100% position, and feedback gain.

  When full calibration is requested the module enters local mode, requiring the Controller to track. The module then moves the valve to the 0% position. The firmware checks for position feedback between the arbitrary limits of –9.7 volts and –7.8 volts. If the voltage is less (more negative) than –9.7 volts, the firmware reduces gain to make the voltage more positive than –9.7. If the voltage is more positive than –7.8 volts, the gain is increased until the voltage is more negative than -7.8 volts. During this sequence the gain is tested to ensure it does not go out of allowable range.

  At this point in the sequence, the demodulator gain has been set to a value that is a Maximum allowable value. The gain may be reduced at the other end of the stroke, but will not be increased.

  Now the valve moves to the 100% position. The feedback voltage is examined, and if it exceeds 9.7 volts, feedback gain is reduced. Once feedback voltage is less than +9.7 volts, it is recorded as the 100% calibration value.

  The valve moves back to 0% and the voltage at 0% is recorded. Feedback gain is not adjusted.

  The last step is to write 0% position, 100% position, and feedback gain to the EE memory.

Once the data is recorded in EE memory, the firmware clears a restriction flag, allowing the module to transfer from local mode back to normal mode.

9.7.13 Memory map - (RVP)

The following table describes the Controller registers for the Valve Positioner module, and also defines the I/O Channel Number that must be selected in the Point Builder Hardware tab (shown below) when configuring points associated with this module (See the *Ovation Init and Admin Tools User Guide* or *Ovation Developer Studio User Guide*.)

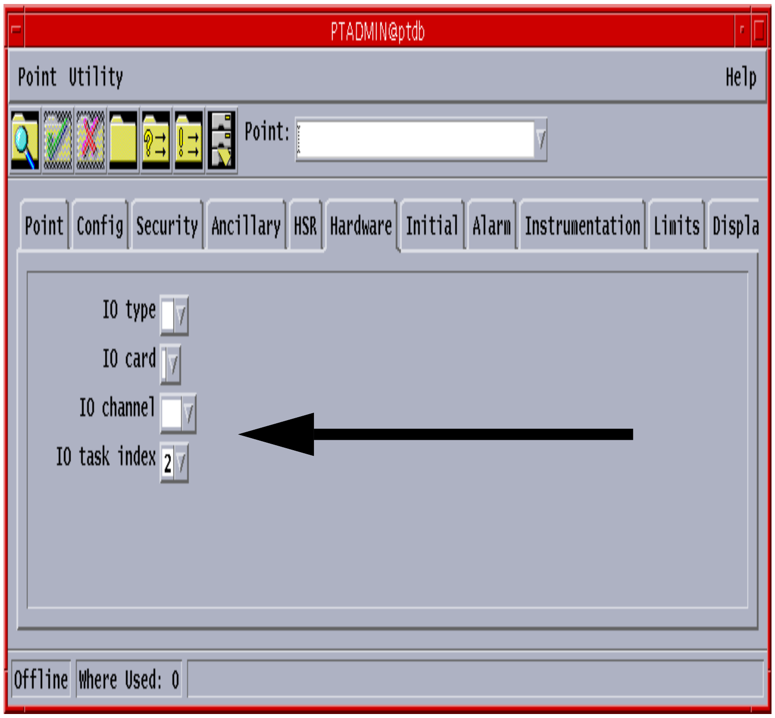


Figure 177: Point Builder Hardware Tab

Use the information in the following table to determine how to scan the card and retrieve card status bits. Status bits will influence your control strategy.

Operating Mode Memory Map

V. P. Card Register	I/O Channel Number in the Point Builder	R/W	Definition
0	N/A	N/A	Indirect ram pointer (Output FIFO Put Pointer).
1	N/A	N/A	Indirect ram data register.
2	4	R	Position feedback (-1560 to 32760 equals -5.0 to 105%).
3	5	R	Coil voltage 1 (traditionally called S1).
4	6, 13	R, W	Coil voltage 2 (traditionally called S2) (non-redundant configuration only).

V. P. Card Register	I/O Channel Number in the Point Builder	R/W	Definition
5	7	R	Coil voltage 3 (non-redundant configuration only).
6	8	R	Raw demodulator voltage.
7	N/A	R	Status Word 2 **Bits 0 - 15:** Not used.
8	9	R	Status Word 1 **Bits 0 - 3**; modes 0000 - not used 0001 - PE mode 0010 - start mode 0011 - test mode 0100 through 0111 - not used 1000 through 1011 - local modes 1000 - local mode 1001 - calibrating in local - seated 1010 - calibrating in local - backseated 1011 - calibrating in local 1100 through 1111 - normal modes 1100 - normal mode 1101 - calibrating in normal - seated 1110 - calibrating in normal - backseated 1111 - calibrating in normal mode
	1 2 3		**Bit 4:** Shutdown input status, 0 = inactive, 1 = activated. **Bit 5:** Auxiliary voltage sense. **Bit 6:** SLIM-ON signal. **Bit 7**: VP alive flag. The VP toggles this bit to indicate that it is running. **Bit 8**: At null point. **Bits 9 - 14: for redundant configuration** **Bit 9:** Quality- Used by redundant VP configuration. If **Bit 9** of the command register is set, the RVP will extinguish field-card power and enter a continuous reset loop. **Bit 10**: Primary/Backup status for redundancy: 0 = Primary 1 = Backup If **Bit 10** of the command register is set the RVP will operate as primary. In this condition the primary/backup negotiation between the primary and backup is not executed. **Bit 11:** LVDT Trouble - LVDT problem indicator for redundant configuration. Held True for five seconds. If **Bit 11** of the command register is set the RVP will operate as backup. In this condition the primary/backup negotiation between the primary and backup is not executed. **Bit 12**: RVP disarmed. **Bit 13**: Data Validation Error - The position demand over the Ovation and redundancy link do not match. **Bit 14**: Mode mismatch - In a redundant pair, one VP is in Normal mode and the other VP is in Local mode. **Bit 15**: poor quality calibration.

V. P. Card Register	I/O Channel Number in the Point Builder	R/W	Definition
9	10	R	Demand feedback (-1560 to 32760 equals -5.0 to 105%) = (Position feedback - bfpB / bfpM) (bfpM and bfpB are described below) For non-boiler feed pump applications, bfpM = 1.0 and bfpB = 0.0, therefore "Demand feedback" and "Position feedback" are exactly equal.
A	11	W	Command Register **Bits 1 - 2**: calibration requests 000 = no request 001 = zero hot cal request 010 = top hot cal 011 = full calibration 100 = go to null point 101 = invalid 110 = invalid 111 = full calibration and stop at null point. **Bit 3**: Not used. **Bit 4**: Partner Quality (redundant VP configuration) 0=OK, 1=BAD. **Bit 5:** Partner Alive Bit (redundant VP configuration) from register 8, bit 7 or Partner VP. **Bit 6**: Redundant VP's Partner's Primary/Backup Status. The Controller copies Bit 10 from the partner's status register 1 to inform the VP that the partner is a Primary or Backup drop. **Bit 7:** Not used. **Bit 8**: Arm RVP. When this bit is set, the backup RVP is re-armed and can take over control if the primary fails. When a backup RVP is disarmed, it does not take over control for certain types of failures. **Bits 9:** If set, the RVP will extinguish field-card power and enter a continuous reset loop. **Bit 10**: If set the RVP will operate as primary. In this condition the primary/backup negotiation between the primary and backup is not executed. **Bit 11**: If set the RVP will operate as backup. In this condition the primary/backup negotiation between the primary and backup is not executed.
B	12	W	Demand (-1560 to 32760 equals -5.0 to 105.0%).
C			Point Status Register.
D		R/W	Module Configuration Status Register (see page 672).
E		R	Secondary module Configuration Status Register.
F			Electronic ID.

Controller Primary/Backup Status Override - (RVP)

If Bit 9 of the command register is set, the ERVP will extinguish field-card power and enter a continuous reset loop.

If Bit 10 of the command register is set, the ERVP will operate as primary. In this condition, the primary/backup negotiation between the primary and backup is not executed.

If Bit 11 of the command register is set, the ERVP will operate as backup. In this condition, the primary/backup negotiation between the primary and backup is not executed.

The following is a control sheet showing how the bits are manually set/cleared during firmware testing.

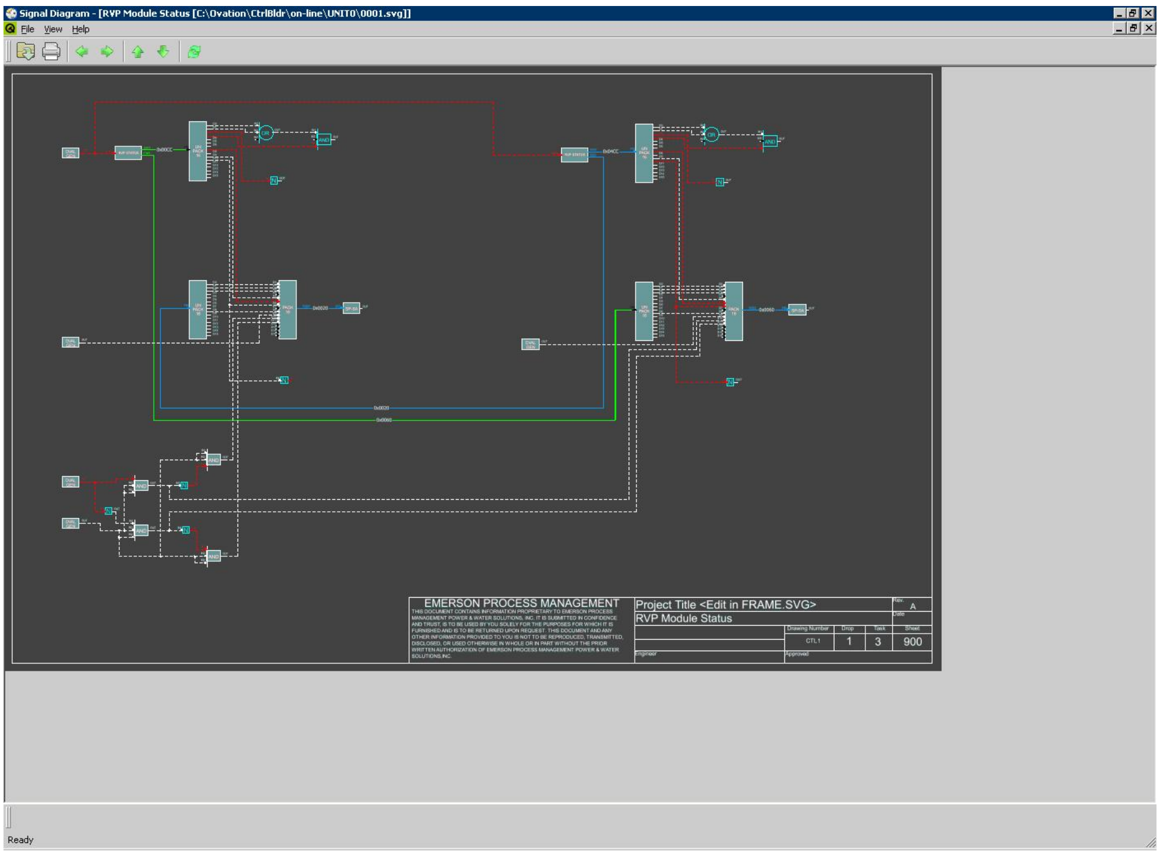


Figure 178: Sample control sheet showing how the bits are manually set/cleared during firmware testing

9.7.14 Configuration parameters - (RVP)

The following commands are used to set the values of important tuning constants. The format of each command is indicated and must be followed. The values shown for each command are default values.

Configuration commands

<table>
<tr><th>COMMAND</th><th>DESCRIPTION</th></tr>
<tr><td>piGain = 10.0</td><td>PI Controller gain outside of deadband. This value is the higher of two gain values used in the position PI loop. This value is used when the valve is moving. When the valve is in a stable position, a lower value is used to avoid noise-induced control action.</td></tr>
<tr><td>piResetT = 1000</td><td>PI Controller reset time outside of deadband. Used in PI equation along with the gain value described previously. This value is one of two used in the PI equation. This one is used when the valve is in motion, and causes faster wind-up. It is given in milliseconds.</td></tr>
<tr><td>piGainDb = 1.0</td><td>PI Controller gain inside of deadband. When the valve is in a steady position, the PI gain is reduced to this value. This helps avoid noise-induced control action.</td></tr>
<tr><td>piResetTDb = 10000</td><td>PI Controller reset time inside of deadband. This is one of two values used, and causes slower control action. It is given in units of milliseconds.</td></tr>
<tr><td>demodGain = 2048</td><td>The LVDT secondary feedback sum is multiplied by this value to achieve a voltage range representing 0 to 100% position that is close to the input range of the A/D converter. The value is printed as a raw decimal value. The hexadecimal equivalent is written to the feedback D/A converter to adjust feedback gain. This value can be entered by the customer, but it is also modified automatically during the full calibration sequence. Feedback gain can be calculated by the following formula:

gain = 4096 / D/A converter input word (decimal value)

Examples of some gain values are as follows:
<table>
<tr><th>DAC word</th><th>Decimal value</th><th>Gain</th></tr>
<tr><td>0</td><td>0</td><td>Infinity [1]</td></tr>
<tr><td>1</td><td>1</td><td>4096</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>8</td><td>8</td><td>512</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>100H</td><td>256</td><td>16</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>800H</td><td>2048</td><td>2</td></tr>
<tr><td>.</td><td>.</td><td>.</td></tr>
<tr><td>FFH</td><td>4095</td><td>1.00024</td></tr>
</table>
[1] Feedback gain D/A converter output saturates.</td></tr>
<tr><td>errorDbF = 0.5</td><td>When the absolute value of the difference between target position and actual position is greater that this value, the valve is considered to be in motion. Gain and reset values are selected to cause rapid control action. When the difference is less than this value, control action is softened.</td></tr>
</table>

COMMAND	DESCRIPTION
errorDbS = 0.05	When the absolute value of the difference between target position and actual position is less than this value, the valve is considered to be stable. Gain and reset values are selected to soften control action. When the difference is greater than this value, gain is increased to yield sharper control.
seatLimit = 0.0	When target valve position is equal to or less than this value, seating action controls the output.
backSeatLimit = 100.0	When the target valve position is equal to or greater than this value, backseating action controls the output.
contingency = 5.0	If the absolute value of the difference between Valve Positioner target position and actual position is greater than this value, then a contingency condition may exist. The condition must exist until a timer expires for it to be reported. The timer is described below. A situation could arise where the Valve Positioner target position and the Controllers' target are not equal. One example would be if the shutdown input was true, the Valve Positioner set the target position to 0, but the Controller did not track. In this situation contingency would not be reported if the valve went to 0% position.
contingencyTime = 10000	If the error between target position and actual position exceeds contingency for this amount of time, then the condition is reported to the Controller. This number is given in milliseconds.
manualRate = 300	This value selects the magnitude of adjustment when target position is controlled by the SLIM. This value is given in percent per minute.
bfpM = 1.0	Gain in the equation **y = bfpM * x + bfpB** where: y = actual demand; x = demand written by the Controller The purpose of this is to create staggered valve operation in the boiler feed-pump application. This value is normally set to 1.0.
bfpB = 0.0	Zero intercept in the equation **y = bfpM * x + bfpB** where: y = actual demand; x = demand written by the Controller The purpose of this is to create staggered valve operation in the boiler feed-pump application. This value is normally set to 0.0.
SlimAddr = 0	Each device on the SLIM serial bus has an address. This provides a method for the SLIM to talk individually to each card. The SLIM serial port is used for redundancy serial communications. Setting the address to zero (0) disables SLIM transmit/receive code.
calhndrd = 31200	This value is displayed in decimal. It is the converted hexadecimal A/D converter reading for the 100% position. It can be entered by the customer; however, it is normally determined automatically by the calibration sequence.
calzero = -31200	This value is displayed in decimal. It is the converted hexadecimal A/D converter reading for the 0% position. It can be entered by the customer; however, it is normally determined automatically by the calibration sequence.
calrateF = 200	This value is given in percent per minute and is the movement rate used when calibrating from the laptop computer via the serial port. It is typically the **F**aster rate. Calibration rates are given in target-demand-counts per 200 mSec loop time of the calibration procedure. Some example settings are: 200 3.2 % per second, about 30 seconds for full stroke. Since the calibration procedure strokes the valve twice, the entire process will take a minute. 100 1.6 % per second 500 8 % per second The calibration process adjusts target demand when the valve is uncalibrated. The actual time will vary depending on the accuracy of whatever leftover value constants are presently recorded for the calibration.

Command	**Description**
calrateS = 40	This value is given in percent per minute and is the movement rate used when calibrating via a command from the Ovation I/O interface. It is typically the **S**lower rate. **Note:** *When the raise/lower button is pressed, the Valve Positioner responds to the keystroke if the address is 1 through 8 inclusive. This means that all valves will move together.*
posErrDelta = 5.0	A tunable parameter which sets a limit for the difference between target and actual position. When the difference is greater than this limit, POSITION ERROR FLAG is set TRUE; otherwise it is FALSE. This variable is similar to **contingency** except that it is devoted to the redundant calculations. posErrDelta is a contingency deadband but is used only by the redundancy calculation. If the primary and backup VPs differ by this amount for a time period exceeding coilDiagTime, a "last resort" decision is made to fail over. To disable failover based on the comparison of two feedbacks only, set posErrDelta as follows: posErrDelta = 99
Maxdelta = 5.0	A tunable parameter which sets a limit for the difference between position feedback and previous position feedback. The default value is 5%. Expressing the value as a derivative would yield 5% per 10 msec (= looptime) or 500% per second. This value is intended to represent the Maximum rate of movement of the valve. This value has a function similar to MIN2NDRY. It is assumed that MAXDELTA will always be the smaller of the two. The purpose of this parameter is to establish a Maximum rate of motion under normal control. If the derivative of position feedback exceeds this value for 10 scans in a row (100 msec) the motion is deemed excessive and a failover occurs. This parameter should be greater than the most rapid motion as designated by controller ramp rates. The same restrictions for trip and fast-acting hydraulics apply to this parameter. Failover action due to this tuning constant can be disabled as follows: Maxdelta = 99
min2ndry = 10.0	The primary VP calculates the derivative of position feedback and if it exceeds this value from 1 scan to the next (10 msec), the VP determines the signal is faulty and this may initiate a failover in a redundant pair. Please also refer to the LVDT setup requirements for additional explanation of this tuning constant. Redundant VP failover due to high derivative can be disable by setting to a large value as follows: min2ndry = 99
lvdtTrack = 1.5	lvdtTrack is the Maximum difference between LVDT readings in a redundant configuration. This value informs the redundant VP pair when NOT to decide to initiate a failover. When there are two position feedback readings that agree, it is assumed that the reported position feedback is correct.
RDNDNT	If RDNDNT = 0, the VP is a standalone module If RDNDNT = 1, the VP is a redundant module This is the MOST important constant and MUST be set prior to inserting the VP into its mounting slot. If the VP is installed without this constant being set, and the unit is on line, the results are unpredictable. In some cases, such as when a VP module is being replaced by another VP from stock, the VP should be placed into an unused slot to power it up and modify the constant. Remember to type `SC` to save the constants to EEPROM memory. Setting this constant changes the Baud Rate for COM Port 2 (SLIM port) to 25 k baud.
demand = 10.0	This command sets target value position to 10%, sets the VP made to local, and sets a restriction bit to prevent the VP from entering Normal mode. Type "EXIT" to clear the restriction bit.
CoilCount = 2	If CoilCount = 1, the VP is a redundant module and only coil 1 from the VP is used. Failure to set this constant typically results in servo coil diagnostic failures, which cause the VP to fail to its Backup. If CoilCount = 2, coils 1 and 2 are used, and coil 3 (diagnostic) is disabled.

<table>
<tr><th>COMMAND</th><th>DESCRIPTION</th></tr>
<tr><td>diagtime = 20</td><td>Timer value in 100 millisecond increments for open/shorted coil diagnostic. The value shown here (= 20) means the open or shorted condition must exist continuously for 2 seconds before the condition is reported to the controller, or is used by the redundant RVP failover logic.

This timer also designates the time for a position error used by the redundancy calculation. The position error deadband is set by posErrDelta and is a “last resort” decision in the failover scheme.</td></tr>
<tr><td>diags</td><td>Displays status information in hexadecimal format. Included are the operating mode, restrictions, signals, and Severe Fatal Errors (SFE) bits. The following message is displayed:
mode=0xmmmm restrictions=0xrrrrrrr signals=0xssss sfe’s=0xeeee
where mmmm = Hex value of operating mode:

0 through 0x05 are start modes
0x14 through 0x19 are local modes
0x28 through 0x2B are normal modes
0x3C through 0x3F are test modes

rrrrrr = Restriction bit array:
Bit 0 - PROM checksum error
Bit 1 - Memory diagnostic error
Bit 2 - A/D, D/A subsystem error
Bit 3 - Contingency restriction
Bit 4 - Ovation I/O not configured
Bit 5 - Constants are mismatched
Bit 6 - Controller is not updating
Bit 7 - Controller is not tracking
Bit 8 - EEPROM checksum error
Bit 9 - Hold until oscillator is stable
Bit 10 - Serial port control (local mode) restriction
Bit 11 - Redundancy restriction
Bit 12 - Calibration restriction
Bit 13 - Priority demand restriction
Bit 28 - Partner alive flag restriction
Bit 29 - Redundant RVP position feedback error restriction
Bit 30 - Redundant RVP excessive motion restriction
Bit 31 - Redundant RVP step change restriction

ssss = Signal flags:
Bit 0 - Coil 1 diagnostic

Bit 1 - Coil 2 diagnostic
Bit 2 - Coil 3 diagnostic
Bit 3 - DAC diagnostic
Bit 4 - Coil 1 open
Bit 5 - Coil 1 short
Bit 6 - Coil 2 open
Bit 7 - Coil 2 short
Bit 8 - Coil 3 open
Bit 9 - Coil 3 short
Bit A - AD/DA error
Bit B - Contingency
Bit C - Repetitive display
Bit D - Raise pushbutton on SLIM
Bit E - Lower pushbutton on SLIM
Bit F - Repetitive diag. display

eeee = Severe fatal error bits:
Bit 0 - EEPROM checksum
Bit 1 - PROM checksum
Bit 2 - Shared memory error</td></tr>
</table>

COMMAND	DESCRIPTION
	Bit 3 - Processor memory error **Bit 4** - FPGA won't program **Bit 5** - UART readback error **Bit 6** - Processor error **Bit 7** - AD/DA error **Bit 8** - PSD memory error **Bit 9** - EE write sequence error
kServo = 20.0	kServo is a parameter, given in a percentage that models the impedance relationship of the Personality module (PMOD) and the servo coil. For example, if you have a PMOD with an impedance of 300 ohms, and the coil impedance is 82 ohms, then kServo should be set to 19.9 or 82 / (330 + 82) (group 1 personality module). VP diagnostic firmware uses this parameter to predict coil voltage based on amplifier output voltage. Wire resistance is included in servo coil resistance. You can take a direct measurement with a standard ohm-meter by first removing the VP and the personality module from the base unit. kServo is calculated as shown above. kServo is more easily determined by a voltage measurement method with the VP installed. First, remove any connection from B13 and measure the voltage. This terminal is normally unused anyway and so it is not connected. The voltage measurement is therefore measuring the amplifier output. The amplifier output is also applied to the series combination of the personality module resistor and the servo coils connected to B14 and B15. Next measure B14. Calculate kServo as follows: kServo = V_at_B14 / V_at_B13 For our example of a group 1 personality module, and 82 ohm coil, here are the voltages seen on the terminals. If the valve is on the seat, and seating is in effect the voltage at B13 will be 5 volts, and the voltage at B14 will be about 1 volt. If the VP is not set up for seating the voltage at B13 will be 10 volts and B14 will be 2 volts. If the valve is in a controlled position off the seat, and the mechanical bias screw is adjusted in the normal fashion, and the valve is stable, B13 will show about 1 volt, and B14 will be about 200 mV. Also measure B15. If B15 and B14 are not equal, then there may be a loose or intermittent connection, in which case additional diagnosis may be required. This parameter can be used when servo coils are wired in parallel. For this example kServo would be set to 11.7 or 40 / (300 + 40). If one of the coils burned out, the relationship would change to 21.0. By setting kServoDb to 5.0, an alarm would be generated when the servo coil went open circuit.
kServoDb = 5.0	Deadband value used to calculate the allowable coil voltage range when comparing predicted voltage to actual voltage.

Command	Description
priorityDemand = -5.0	For firmware revisions 0H and later, “priorityDemand” is the target position used when the shutdown input is activated. The default value is selected so that upgraded modules are backward compatible. You can set this value to an intermediate value in order to create your own scheme for handling of plant upsets. While the "priority demand input" or "Shutdown" input is active, the VP is in the local mode and the Controller must unconditionally track demand feedback. "priorityDemand" is only changeable thru the terminal interface.

9.7.15 LVDT setup requirements, redundant subsystem - (RVP)

First, the linear range of the LVDT must exceed the mechanical range. This means that when the valve is at either endpoint, one of the secondary voltages is at its minimum. The secondary voltage must be large enough at the endpoint so that if a wire breaks and the secondary voltage goes to zero, the change of voltage is large enough to be readily detected. A good guideline is to ensure that each secondary always contributes at least 10%, positive or negative, to the demodulated voltage. That is,

```
Min ( (|A| / FBVR ), (|B| / ( FBVR ) ) > 10%
where FBVR = feedback voltage range which is equal to
|A-B|at 0% + |A-B| at 100%. For the example shown below the range
is equal to
|1.0 - 4.2| + |4.5 - 0.9| = 6.8 volts
```

This minimum secondary value is expressed in percentage, is tunable, and is called MIN2NDRY. This is the minimum position feedback change that will be seen when one of the 4 secondary wires of a 6-wire LVDT breaks.

These values are determined by direct measurement, or from an LVDT spec sheet which shows A and B secondary voltages per linear displacement.

The table below shows an example of LVDT voltages at certain valve positions, and the effects of a failure (broken wire) of secondary.

Percent Position	A volts	B volts	A fails	B fails	A Delta	B delta
0	1.0000	4.2000	-14.71	61.76	14.71	61.76
25	1.8750	3.3750	-2.57	74.63	27.57	49.63
50	2.7500	2.5500	9.56	87.50	40.44	37.50
75	3.6250	1.7250	21.69	100.37	53.31	25.37
100	4.5000	0.9000	33.82	113.24	66.18	13.24

For a six-wire LVDT, it is apparent that this evaluation only needs to be performed at the endpoint where one of the voltages is at its minimum. All the other positions show a larger change in position feedback that is more easily detected by the derivative calculation.

For the example above, the minimum position feedback change due to secondary failure is 13.24% (0.9 / 6.8). min2ndry could be set to 12% for example.

There are two challenges associated with making the derivative calculation work effectively. The first is rapid motion during trip, and trip testing. If the valve moves 100% in 100 msec, then the RVP will see 10% feedback change every 10 msec scan cycle, and will work properly for the example above. If the valve moves 15% per 10 msec, the derivative scheme will not work and the value of min2ndry should be set to disable the function as follows:

```
min2ndry = 99%
```

The second challenge is rapid motion under normal control, but not associated with trip function. The previously mentioned rules also apply.

When the derivative of position feedback exceeds min2ndry, the primary RVP will initiate a failover regardless of the reason for the high derivative or the position reported by the backup RVP.

Second, the LVDTs must be calibrated prior to being placed into redundant service, and for all possible positions, the feedback signal of the Primary should be near the feedback signal of the backup. This value is called LVDTTRACKING, and its default value is 1.5%.

9.7.16 Seating and Backseating - (RVP)

Seating and backseating are important features of valve position control. The purpose of seating is to ensure that the hydraulic system is forcing the valve closed and admitting no steam into the turbine. Backseating is desirable because it can affect efficiency, and because, for certain valve assemblies, a leakoff into other steam systems is designed, assuming the valve is fully back-seated.

The demand position from the Controller to the Valve Positioner is designed for a range of -5% to 105% and resolution exceeding 13-Bits. Seating is in effect when the position demand is equal to or less than a programmable value, typically 0%. When seating is in effect, the output is driven to the Maximum possible value in the direction that closes the valve. A timer is started. After 10 seconds, the output is reduced to 50% of the Maximum value in the direction that closes the valve. A similar limit and function is provided for backseating.

For firmware revision 0M, setting and backseating operate as follows: If the target position is equal to or less than “seatLimit”, the output is set to the maximum value in the direction of closure and a 60-second timer is started. Once actual valve position is less than 5% the timer is checked and will be reduced to 10 seconds if the current value is greater than 10 seconds.

Regardless of actual valve position, and upon expiration of the timer the output is reduced to ½ of maximium in the direction of closure.

If the target position is greater than “backSeatLimit” the output is set to the maximum value in the direction of opening. Once the actual valve position is greater than 95% the output is reduced to ½ of maximum in the direction of opening.

The remaining description applies to firmware prior to revision 0M.

With revision 0J, the behavior of back-seating has changed, and an anti-windup feature is implemented that affects both seating and back-seating.

With revision J and beyond, when the VP is seating or back-seating, the integral accumulation is set to 0. The result is that when the target position returns to the normal operating range (seatLimit < targetPosition < backSeatLimit), the output voltage is 0.0 (plus proportional adjustment). In other words, the output voltage jumps to 0.0 and not require integration to bring the output back to a controlling value.

In conjunction with the straight line adjustment (implemented using bfpM and bfpB) of target position (which is the manufacturers "design" stroke of the valve rather than the "physical" stroke), a soft landing (which ramps the valve to the end to avoid the valve slamming to the backseat limit) is implemented for back-seating. When the target position exceeds backSeatLimit, the physical target position is ramped to the physical 100% position. At this point, the output voltage goes to 50%. The 10 seconds timing function is not implemented.

9.7.17 PI Position Control - (RVP)

The equation for PI position control is:

$$K_p\left[e(t)+\frac{1}{k_i}\int e(t)dt\right]$$

where:

Kp = Proportional gain

KI = Integral time

e(t) = Position error

If seating or backseating is in effect, normal PI Controller calculation is halted.

9.7.18 Shutdown input (Priority Demand Input) - (RVP)

Position control is affected by a shutdown input, intended to be used in emergency or abnormal situations. It is a standard 24 volt digital input circuit.

Typically, the Valve Positioner rapidly drives the valve to the 0% position when the shutdown input is energized. The Valve Positioner then transfers to **local-manual mode** for the purpose of requiring the Controller to track position feedback. Once the Controller tracks, the Valve Positioner transfers back to **normal** mode.

The state of the shutdown input is available to the Controller via a Valve Positioner module Ovation register.

A control bit in the shared memory can cause the Valve Positioner to ignore the shutdown input while in **normal** mode. This is used when the customer prefers trip logic in the Controller, not on the card. However, in **local-manual** mode, the Valve Positioner drives the valve shut when the shutdown input is energized, regardless of the state, or previous state, of the control bit.

For VP firmware revisions 0H and later, the shutdown input is redefined to “Priority Demand Input.” When the input is activated, the target position is set to a tunable constant. For compatibility with previous firmware revisions, the default value of priority Demand is -5%.

This allows you to rapidly move the valve to some intermediate position during upset conditions. You have the flexibility to create your own scheme to handle an upset.

While the “priority demand input” or “Shutdown” input is active, the VP is in the local mode and the Controller must unconditionally track demand feedback.

9.7.19 Calibration - (RVP)

Calibration is performed by connecting a PC (running terminal emulation software) or a dumb terminal to the Valve Positioner, then typing commands on the PC keyboard or terminal. Using a PC is recommended because you can record/reload tuning constants to/from a disk.

The goals of calibration are:

- To determine the endpoints of mechanical stroke.
- To help the plant set up the LVDT for optimum performance.
- To perform the calibration quickly to avoid startup delay.

Calibration Ideal - (RVP)

During the calibration sequence, observe the valve to ensure it is moving, and that it is moving in the proper direction. Also, review the calibration constants and compare them with the ideal setup described below:

- The range of calibration values corresponds to the hexadecimal range of the AD converter, and is presented to the user in decimal, ranging from -31768 to 31767.
- When an LVDT is properly adjusted and calibrated, the calibration constants (0% and 100%) is equal in amplitude and opposite in sign. The amplitudes for this ideal setup would be approximately 30,000. This result suggest the following:
  - The LVDT is adjusted so that its electrical null point (where secondary A amplitude = secondary B) matches the midpoint of the mechanical stroke.
  - The programmable gain amplifier on the demodulator is adjusted so that the electrical 'stroke' stays within the input range of the AD converter. Thus, the valve positioner can detect incremental movement for all valve positions.
  - If thermal expansion occurs, the valve positioner continues to detect incremental movement, because the calibration is not to the extreme end of the AD converter range, and because the magnitude of thermal expansion is small.

Calibration Required - (RVP)

Calibration is required after the following:

- After a mechanical overhaul.

  If the mechanical stroke remains the same after the overhaul, and the same LVDT is installed, simply adjust the LVDT so the position feedback on the Ovation system indicates 0% (with the valve fully closed), then tighten down the LVDT assembly (that is, return to its former position).
- After the LVDT is changed.

  Calibration is required to find the null point and proper demodulator gain adjustment. However, if it is the same model, you can save time by entering the same constants before running the calibration sequence.
- If a secondary wire pair is swapped.

  The valve positioner is not affected because the demodulator is a diode rectifying type. Also, the secondary pairs (A and B), can be swapped. The result is a change in sign of the calibration values. Arithmetic in valve positioner firmware yields the correct result. However, you should follow the recommended connection that yields negative values at 0% and positive values at 100%, and avoid confusion.

Using the Serial Port for Calibration Settings - (RVP)

The local serial port is used in the field to calibrate and diagnose Valve Positioner problems. It is used in the factory to cause the Valve Positioner to perform necessary testing prior to shipment. This interface is implemented using the external UART.

The settings of the local serial port are:

- Baud rate = 19200
- Bits = 8 bits
- Stop Bits = One stop bit
- Parity = No parity

Status messages are printed during calibration sequences, such as:

```
Calibrate - Go to 100%
```

OR

```
Calibrate - Reduce feedback gain
```

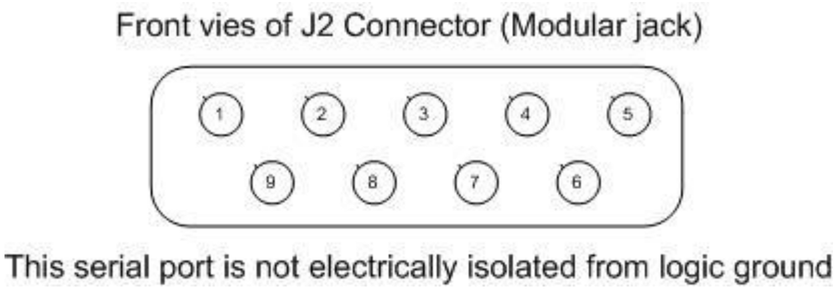
CAUTION: The EE memory can be corrupted if constants are modified during the calibration sequence. This occurs because the checksum is recalibrated based only on new values for 0%, 100%, and feedback gain, not on the entire EE memory image.

Using the Serial Port for Calibration Connections - (RVP)

The Personality module RS-232 connector is used to connect the Valve Positioner module to the COM1 or COM2 serial port of a personal computer. Use cable **5A26448** or make a cable using the information in the following table:

RS-232 Connector (J2) Pin Assignments

Pin Number	Signal Name (Function)	Signal Direction
1	Not used	Not used
2	Not used	Not used
3	TXD2/ (Transmit Data)	Output
4	Not used	Not used
5	RXD2/ (Receive Data)	Input
6	GND (Logic Common) [1]	Not used
7	Not used	Not used
8	Not used	Not used



To perform the calibration procedure using the serial port - (RVP)

1. Use a standard cable to make the connection (see page 656) between the PC (or dumb terminal) and the Valve Positioner.
2. Configure the serial port on the PC as described in “Settings.”
3. To run a calibration sequence, perform the following:
   a) Connect the serial cable between the COM port and the user port on the Valve Positioner.
   b) Start the terminal emulation software.
   c) Ensure the settings are correct.
   d) Type `HELP<`**return**`>` (See the following table).

   Note the following:

   - Commands are case sensitive.
   - Syntax is strict.
   - There is no line buffering.
   - Backspace invalidates any typed command.
4. Type **CALFULL<return>** to run the full calibration sequence.
5. If any constants are entered manually, type **SC<return>** to save the new constants to the EEPROM.
6. Use the command **CALFULL** after an overhaul, to fully calibrate the valve.
7. Use the command **CALBOT** just prior to startup, to reestablish the 0% calibration value if thermal expansion is detected.

Calibration Commands

COMMAND	DESCRIPTION
DC<return>	Dump configuration constants from EEPROM.
SC<return>	Save configuration constants to EEPROM.
DG<return>	Display group 1 data - This function repeatedly displays important operating parameters such as demand, feedback, gain, and so forth.
HELP<return>	Print command list.
EXIT<return>	Exits test mode, raise/lower function, or calibration sequence. Causes a soft reset of the valve positioner.

Performing calibration using a graphic - (RVP)

Calibration can be performed by using the Valve Positioner Upload/Download/Calibrate graphic (diagram 8719) to view and modify the VP tuning constants. All the constants can be modified. The 0% and 100% calibration values, and demodulator gain, can be determined by the calibration sequence, and can be adjusted by the user with this graphic.

The graphic has upload/download buttons so that the two sets of numbers can be synchronized (made the same). Synchronization is initiated by the user and must also maintain responsible for it. In addition to the constants, there are four fields that provide operator feedback.

The constants exist in two places:

- EE memory on the Valve Positioner module.
- In the VPSTATUS algorithm record (typically, the constants contained in the algorithm record are considered as the master set).

If a VP module fails and is replaced, you simply download the constants to the new VP and it is ready to operate. The constants are not automatically copied to the algorithm record upon completion of a calibration sequence.

Note: *Each constant shown on the graphic can also be entered through a serial port interface.*

Calibration goals - (RVP)

The goals of calibration are:

- ☐ To determine the endpoints of mechanical stroke.
- ☐ To help the plant set up the LVDT for optimum performance.
- ☐ To perform the calibration quickly to avoid startup delay.

To perform calibration using a graphic - (RVP)

1. Access a turbine valve graphic. The turbine valve graphic shows a list of all the turbine valves.
2. Click on the desired valve symbol to display the VP calibration graphic and show the constants associated with that particular VP and valve. This graphic is provided with the project graphics. Customizing of the turbine valve graphic and VP calibration graphic is not in the scope of this document.
3. Perform the desired calibrations. All the calibration procedures cause the VP to enter local mode. While the VP is calibrating in local mode, VP firmware adjusts target demand accordingly. The Controller unconditionally tracks the VP when it is in local mode.

4. Refer to the following table for descriptions of the graphic fields.

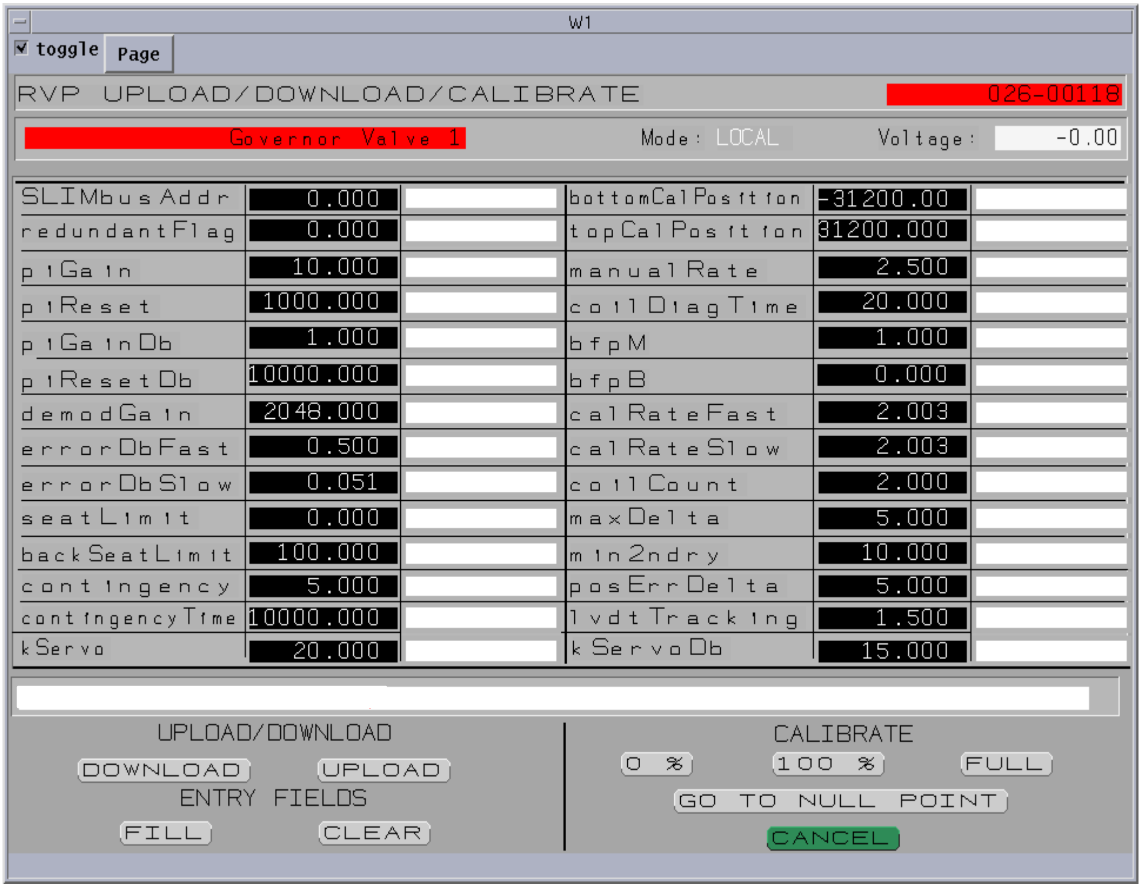


Figure 179: VP Upload/Download/Calibrate Graphic

Calibration Graphic Fields

Field	**Description**
CALIBRATE Buttons	
0%	Executes the CALZERO procedure. Demodulator gain is not adjusted during this procedure. When this procedure completes, upload the calibration data to the algorithm.
100%	Executes the CAL100 procedure. Demodulator gain is not adjusted during this procedure. When this procedure completes, upload the calibration data to the algorithm.
FULL	Executes the CALFULL procedure. Demodulator gain is adjusted during this procedure. When the procedure completes, upload the calibration data to the algorithm.
GO TO NULL POINT	Executes the GO TO NULL POINT procedure. During this procedure, the VP enters local mode and trims target position until position feedback voltage equals 0. Select the **CANCEL** button to exit this mode.
CANCEL	This button exits calibration.

FIELD	DESCRIPTION
UPLOAD/DOWNLOAD Buttons (Upload and download are **never** executed automatically.)	
UPLOAD	Copies the data set contained in VP memory to the algorithm record in the workstation.
DOWNLOAD	Copies the data set contained in the algorithm record to the VP and is written onto the VP's EE memory. Some limit-checking is performed prior to the download.
ENTRY FIELDS Buttons	
FILL	Fills all the text editing windows with the values in the algorithm record.
CLEAR	Clears all the values from the text editing windows.
Operator Feedback Fields	
Algorithm Record Name	Information field located on the top right of the graphic.
Voltage	Located below the algorithm name. The voltage shown is the voltage at the output of the programmable gain stage. If the VP is properly calibrated and nulled, the electrical 'stroke' occupies most of the +-10 volt range of the AD converter input, thus giving good resolution. This field shows activity as the valve is traveling during calibration, and as the demodulator gain is adjusted at the endpoint.
Mode (MA)	Located to the left of the Voltage field. VP firmware is designed to stay in 'normal' mode, and if it is not in 'normal' mode, to establish communications with the Controller and then enter the 'normal' mode. In 'normal' mode, the VP receives its target position from the Controller. The MA algorithm that drives the VP target position may be in AUTO, MANUAL, or LOCAL mode. When the VP is in 'normal' mode, it is not aware of the MA mode. It receives target position from the Controller in MA AUTO and MANUAL. The field usually shows AUTO unless there is an error condition or the VP enters local mode due to a calibration sequence. During calibration, the VP enters local mode, which corresponds to MA local mode. The MA unconditionally tracks the VP until the calibration sequence completes. When the operator selects a calibration sequence, the mode is shown as *local.* The voltage changes as the valve is moving. When the valve is at the endpoint and the demodulator gain is adjusting, the voltage changes as the gain is adjusted. A calibration complete message displays at the bottom field. In some cases in a full calibration, the results may yield poor values. A message displays telling the operator to repeat the calibration.
Valve Identification	Located to the left of the Mode field. Usually a text string that identifies the valve that is to be calibrated (name is provided by the turbine valve graphic).
Text Messages	Located under the table of values. This field displays messages about the progress of the calibration. For example, "calibration in progress" or "calibration complete."

To simplify diagnostics - (RVP)

Rolled servo wires can cause the valve to move in the opposite direction. Be sure to observe and verify the correct movement of the valve. If only one pair is rolled, then the two pairs compete with each other. Use the following procedure to simplify diagnosis:

1. Disconnect one pair of wires.
2. Calibrate the valve, verifying the correct movement of the valve.

3. Reconnect the first pair of wires.
4. Disconnect the other pair of wires.
5. Calibrate the valve, verifying the correct movement of the valve.
6. Reconnect all the servo wires.
7. Calibrate the valve, verifying the correct movement of the valve.

On-Board Diagnostics - (RVP)

The mechanical bias adjustment of the servo valve can affect the results of on-board diagnostics. A set-screw on the servo valve causes a deflection from center position of the servo valve spool. This allows hydraulic fluid to escape the actuator, and the valve to close at a controlled rate, in the absence of an electrical signal.

For a typical connection, a small negative voltage on the servo valve is required to center the spool, and hold the valve in a steady position. This voltage is typically from -100 to -300 mV. Servo valves are delivered from the factory with this adjustment. Onboard diagnostics assume that the servo valve is configures in this way. If another configuration is used, program the Ovation Controller to ignore the results of diagnostic bits.

WARNING - Notes for GE 4-wire and 5-wire single LVDT connections - (RVP)

> **WARNING!** The VP can detect position if only a single LVDT feedback signal is connected. The inputs of the unused VDT input should be grounded to avoid picking up noise.
>
> If LVDT A is connected, the 0% and 100% calibration constants will both be positive. If B is used, both constants are negative.

GE style 4-wire and 5-wire LVDTs with one feedback can be connected so that 0% position is the high amplitude voltage (absolute value) and 100% is the low amplitude voltage. This is the desired connection since, in the event of a failure or broken wire, the VP sees a low voltage, assumes the valve went open, and responds by closing the valve.

An alternate connection can be implemented where 0% corresponds to the low amplitude voltage, and 100% corresponds to high amplitude. There are two problems with this configuration.

1. Upon failure and loss of signal, the VP attempts to open the valve to the target position because the valve appeared to close inappropriately.
2. During calibration the sequence starts at 0%, where the demodulator gain is raised until the feedback reaches the limit of the AD converter. The result is a very high gain because the voltage at 0% is so low. Then, when the valve is moved to 100%, the voltage into the AD converter is out of range, and the degree to which it is out of range is not detectable. The sequence takes a very long time to reduce the gain until the signal is usable, and the customer is required to wait.

For a single LVDT configuration, you should complete the configuration, calibration, and then do the following test:

1. Set the valve position to an intermediate position, say 20%.
2. Disconnect the oscillator wire.
3. The valve then closes.

Performing Redundant VP calibration - (RVP)

VPs in a redundant subsystem can be calibrated as a pair or independently. The same commands are used to perform either calibration.

If you want to calibrate the VPs independently, the easiest method is to pull one of the VPs out of the mounting unit. In this case, calibration is the same as for a non-redundant VP. When a VP is calibrated and the Backup is not in service, and the RDNDNT flag is set, a warning message is printed to inform the operator that only one VP of the pair is being calibrated.

In any case, only the Primary VP or a pair can be calibrated. If you attempt to calibrate with the terminal connected to the Backup VP, the VP prints a message stating that the request is refused.

If you request a calibration of the Primary VP, and the Backup VP is also in service, the Backup is calibrated unconditionally. During calibration, the Primary disables the redundancy software state machine so failovers are eliminated.

The message packet exchange between the Primary and Backup VPs includes command/status bits related to calibration. The following table lists those commands and descriptions.

Redundant Calibration Commands

COMMAND	DESCRIPTION
RRVP_CAL_REC_TOP	Primary VP is commanding the Backup VP to record the 100% endpoint value.
RRVP_CAL_REC_BOT	Primary VP is commanding the Backup VP to record the 0% endpoint value.
RRVP_CAL_IN_ PROGRESS	Primary VP is informing the Backup VP that a calibration is in progress.
RRVP_CAL_BACKUP_ HOLD	Backup VP is performing a gain adjustment or is measuring the endpoint and is informing the Primary VP to wait for the process to be completed.
RRVP_CAL_WRITE_EE	Primary VP is commanding the Backup VP to commit the new calibration data to EEPROM memory at the end of the calibration process.
RRVP_CAL_HOT	Primary VP is informing the Backup VP that the calibration process is a “hot” calibration. A “hot” calibration is performed at only one end of the mechanical stroke. The important implication is that demodulator gain adjustment is not allowed during “hot” calibrations.

9.7.20 Terminal block wiring information - (RVP)

Each Personality module has a simplified wiring diagram label on its side, which appears above the terminal block. This diagram indicates how to connect the wiring from the field to the terminal block in the base unit.

Note: *For the Standard I/O Marshalling Base Unit, field terminations are located on the half shells and connected to the base. See* Marshaling Base Unit *(see page 35) for more information.*

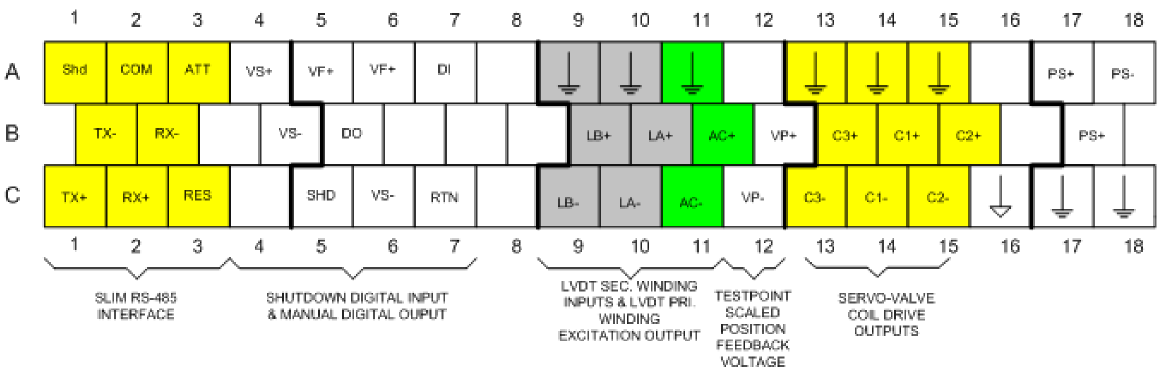


Figure 180: Terminal Block Connections for the Valve Positioner Personality Module

1. Do not use unmarked terminal block locations. Blank base unit termination block terminal locations must not have external connections.
2. If the SLIM communications cable assembly is terminated to the base unit termination block, a wire jumper must be installed between terminal A2 (COM) and A3 (ATT). The SLIM communications cable assembly shield should be connected to terminal A1 (Shd).
3. If the SLIM interface is to have a line receiver parallel termination resistor, a wire jumper must be installed between terminals C2 (RX+) and C3 (RES). This jumper is added if either the base unit termination block or the personality module SLIM female DB9 connector is used to interface the SLIM communications cable assembly.
4. All of the field interface signals must use twisted-pair copper wire conductors inside a shielded cable assembly. The cable assembly shield must be tied to earth ground via one or more of the Earth terminals.
5. In CE Mark systems, SLIM cable 5A26429 MUST be used and grounded at the entry point of the cabinet using the recommended hardware.
6. C3+ and C3- coil drive outputs are not available for Group 4 Personality modules.
7. Terminals VP+ and VP- are intended to provide a test point voltage that is to be measured by a high input impedance volt meter. If an external device is to be permanently connected to the VP+ and VP- terminals, an interposing buffer is required within the cabinet that houses the VP module. The buffer must have an input impedance greater than 100k ohms and must be able to accommodate an input span of +/- 10 volts.
8. Module analog outputs (LVDT Primary Winding Excitation and servo-valve coil drive outputs) should have their isolated power supply common grounded. Add a base unit terminal block jumper between terminals C16 (isolated analog power supply common) and C17 (cabinet earth ground).

***Note: C16/C17** is the recommended Earth GND to Signal GND connection.*

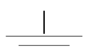
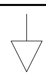
Oscillator signal coupling may occur in redundant RVP pairs where all signaling is placed in the same multi-conductor cable, or is in close proximity.

(For mechanical redundancy, putting all LVDT and coil signal pairs in the same cable is not recommended.)

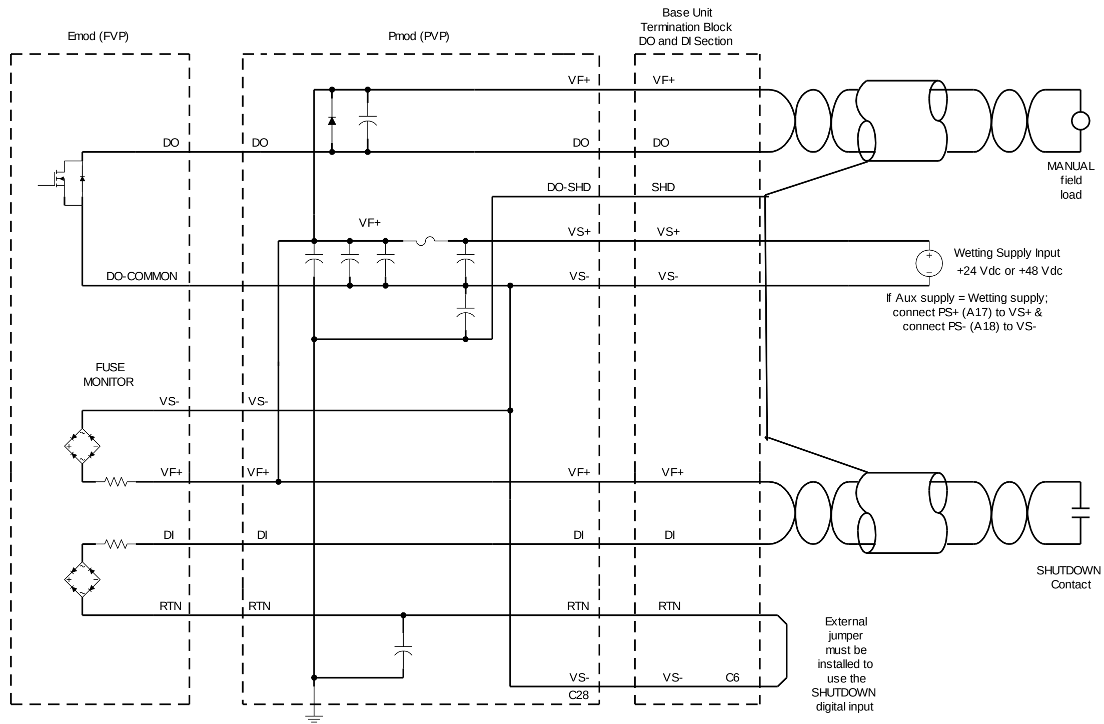
This coupling can be eliminated by shorting Earth ground to field board reference (Signal ground) by connecting C16 to C17.

A 3A41491H49 jumper can be used to make this connection. If this jumper is unavailable a short piece of 18 to 22 gauge wire can be substituted to make this connection.

Abbreviations used for Wiring Diagrams

ABBREVIATION	DEFINITION
	Earth ground terminals used to connect to input signal's shield.
	Isolated circuit common ground.
ATT	SLIM cable attached input, may have to be connected to COM.
AC+, AC-	LVDT primary winding AC excitation output.
C1+, C1-	Servo valve actuator coil #1 voltage output.
C2+, C2-	Servo valve actuator coil #2 voltage output.
C3+, C3-	Servo valve actuator coil #3 voltages output.
COM	Common terminal of the SLIM interface circuit.
DI	Shutdown digital input.
DO	Manual digital output.
LA+, LA-	LVDT secondary winding A input.
LB+, LB-	LVDT secondary winding B input.
PS+, PS-	Auxiliary power supply terminals.
RES	SLIM RS-485 receiver circuit input termination resistor. If receiver termination is desired, RES is connected to RX+.
RTN	Return for digital input. Connect to VS-.
RX+, RX-	RS-485 receive data (input). SLIM interface.
SHD	Shield of digital I/O signals' cable.
TX+, TX-	RS-485 transmit data (output). SLIM interface.
VF+	Fused auxiliary voltage source terminal connection
VS+, VS-	Auxiliary voltage input terminals (+24V or +48V).
VP+, VP-	De-modulated scaled valve position testpoint voltage.

9.7.21 Field connection wiring diagram - (RVP)



Note

A fault on the MANUAL digital output or on the SHUTDOWN/digital input that causes the personality module fuse to open will disconnect the internal auxiliary supply from both the digital input and the digital output circuit.

Figure 181: Digital Input/Output (internal aux supply) Field Connections

Analog I/O connection - (RVP)

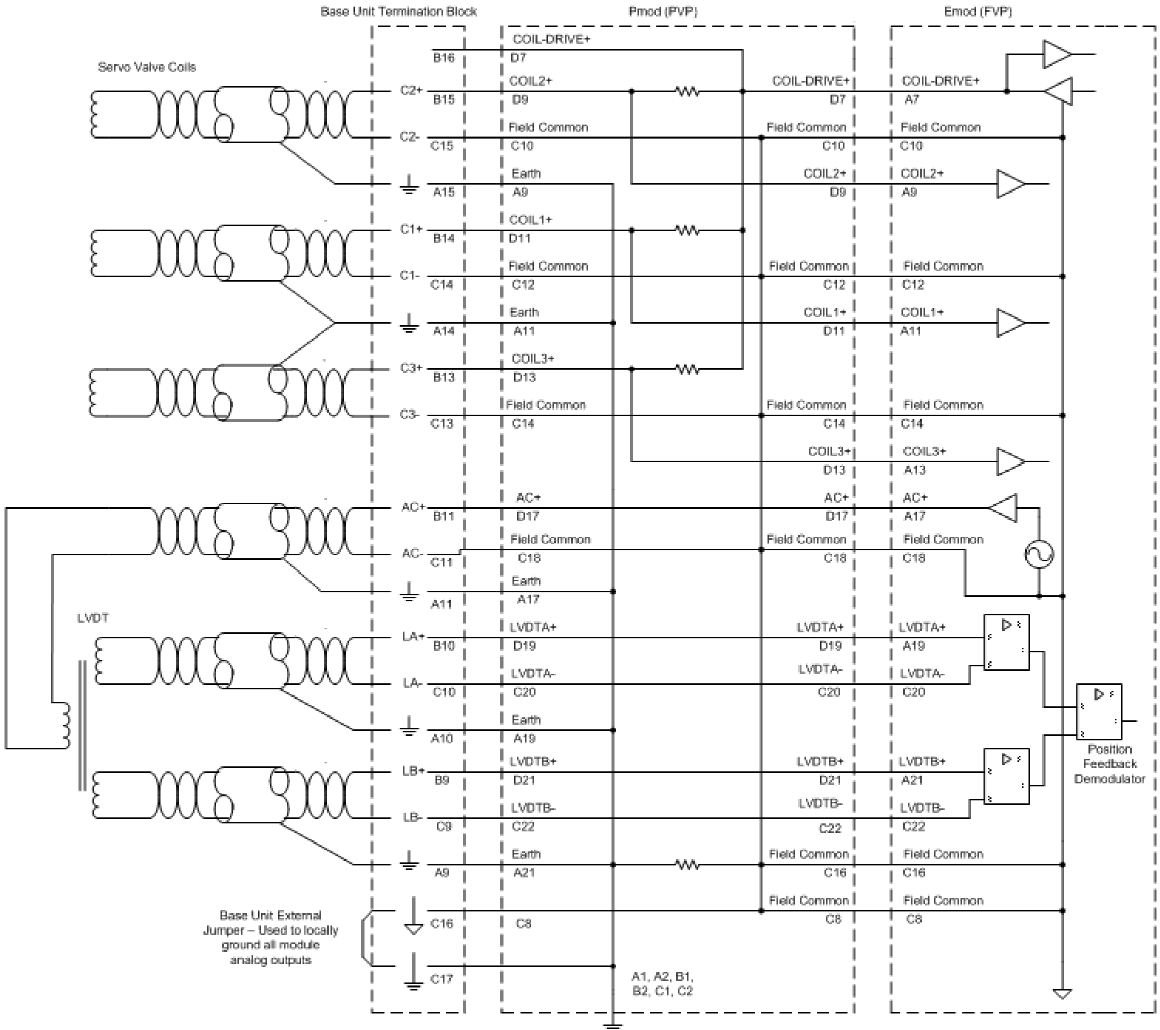


Figure 182: Analog Input/Output Connection

1. Negative voltages on terminals B15, B14, and B13 cause the valve to open. Positive voltages on these three terminals cause the valve to close.
2. The amplitude of this signal decreases as the valve opens. (LVDTA+ / LVDTA-)
3. The amplitude of this signal increases as the valve opens. (LVDTB+ / LVDTB-)

Analog I/O example using 3-Wire LVRT - (RVP)

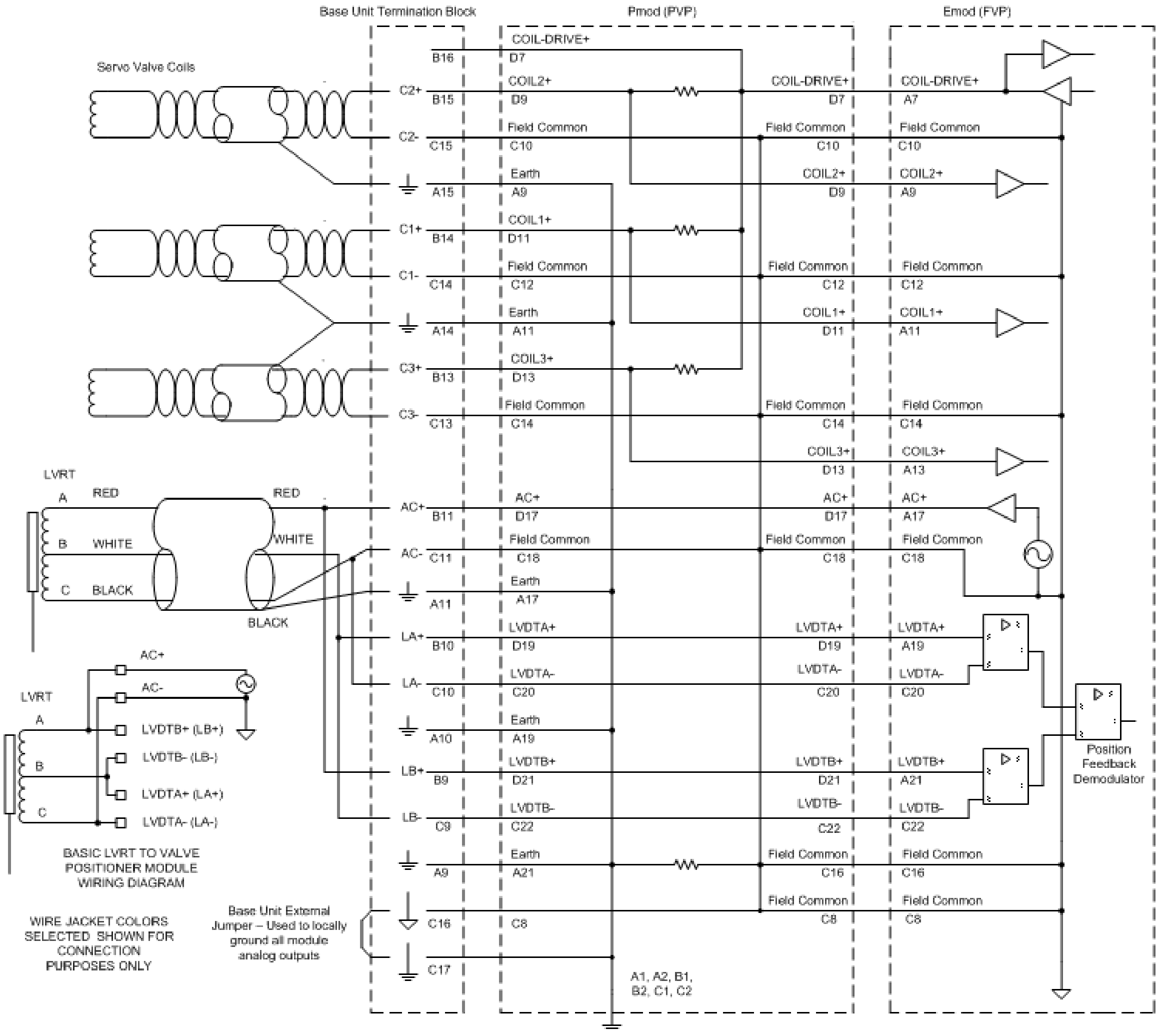


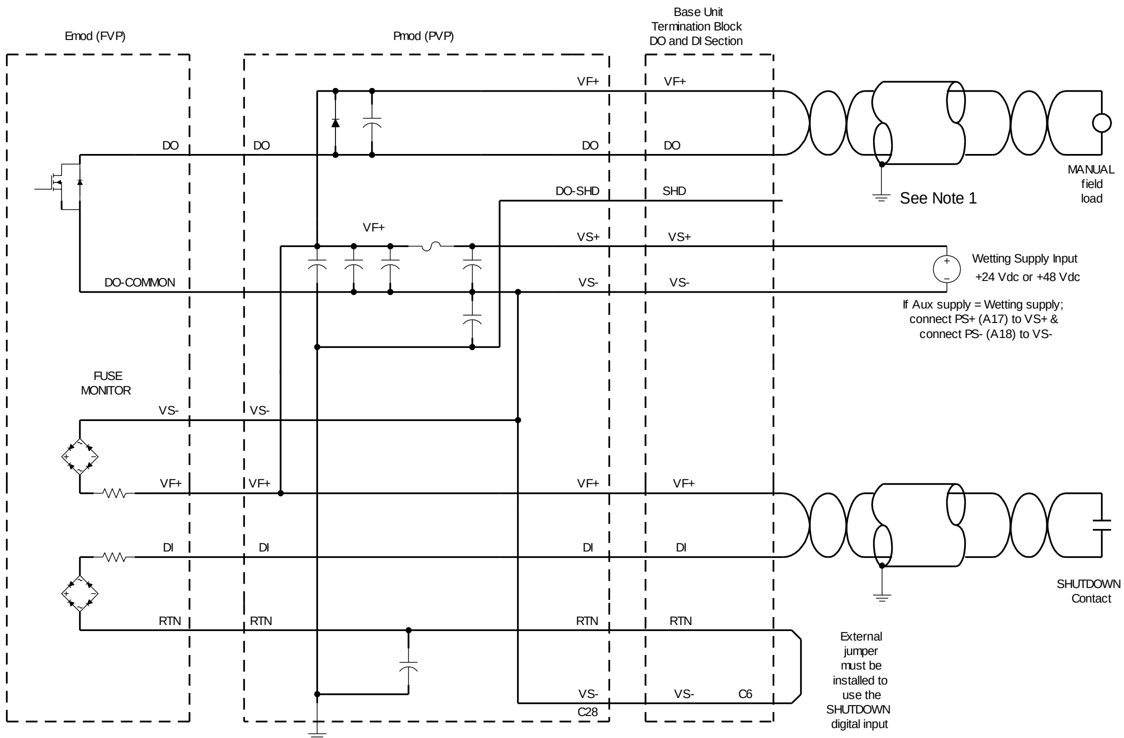
Figure 183: Analog Input/Output Example Using 3-Wire LVRT

1. Negative voltages on terminals B15, B14, and B13 cause the valve to open. Positive voltages on these three terminals cause the valve to close.
2. The amplitude of this signal decreases as the valve opens. (LVDTA+ / LVDTA-)
3. The amplitude of this signal increases as the valve opens. (LVDTB+ / LVDTB-)
4. Node A is connected to terminals AC+ and LB+,

   Node B is connected to terminals LB- and LA+,

   Node C is connected to terminals AC- and LA-.

9.7.22 Field connection wiring diagrams (CE Mark) - (RVP)



Note

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware (refer to "Cable Guidelines" in the applicable Ovation system installation manual).

Figure 184: Digital Input/Output (internal aux supply) Field Connections (CE Mark)

Analog I/O connection (CE Mark) - (RVP)

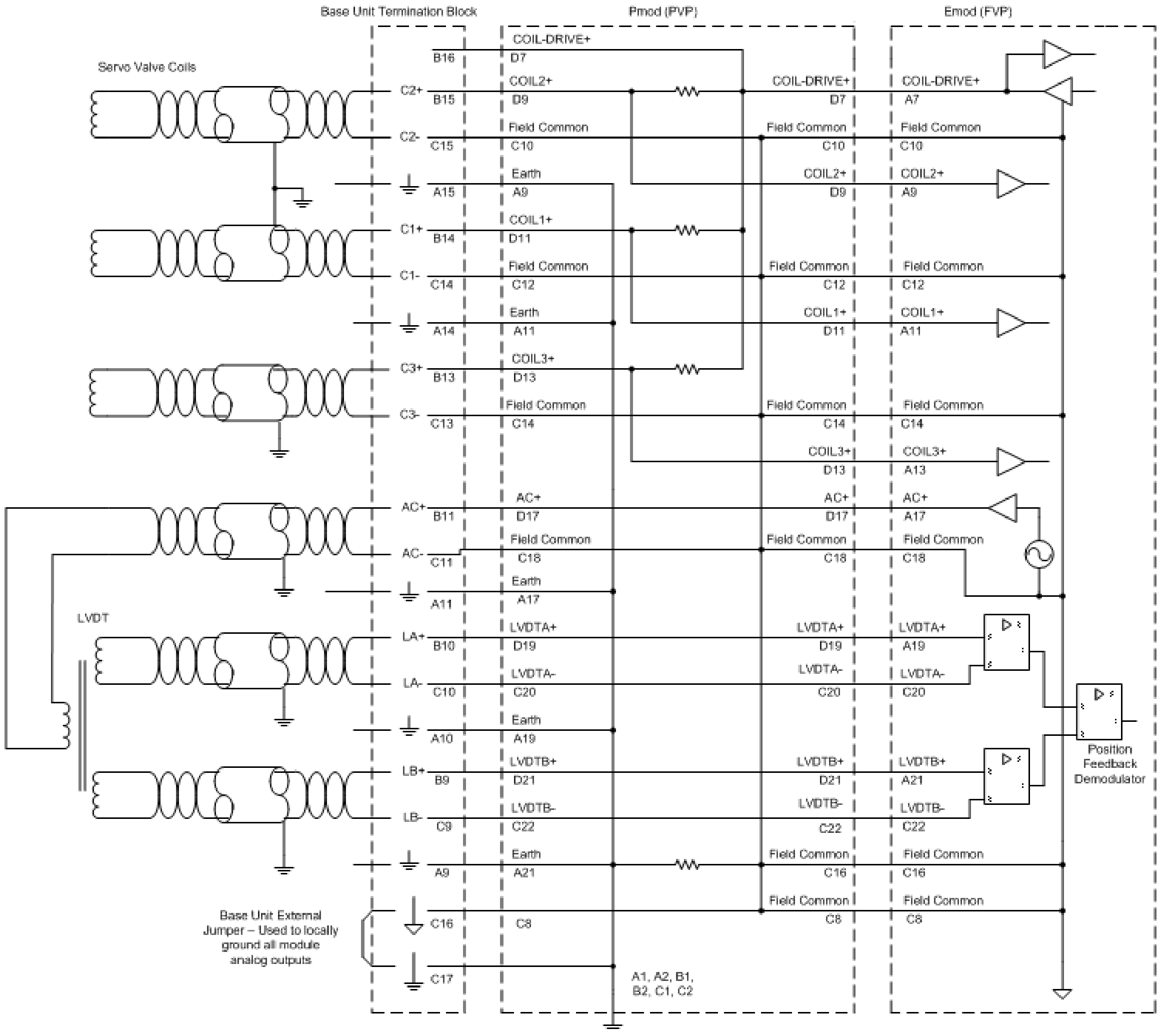


Figure 185: Analog Input and Analog Output Connection (CE Mark)

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware.
2. Negative voltages on terminals B15, B14, and B13 cause the valve to open. Positive voltages on these three terminals cause the valve to close.
3. The amplitude of this signal decreases as the valve opens. (LVDTA+ / LVDTA-)
4. The amplitude of this signal increases as the valve opens. (LVDTB+ / LVDTB-)
5. Node A is connected to terminals AC+ and LB+,

   Node B is connected to terminals LB- and LA+,

   Node C is connected to terminals AC- and LA-.

Analog I/O example using a 3-Wire LVRT (CE Mark) - (VP)

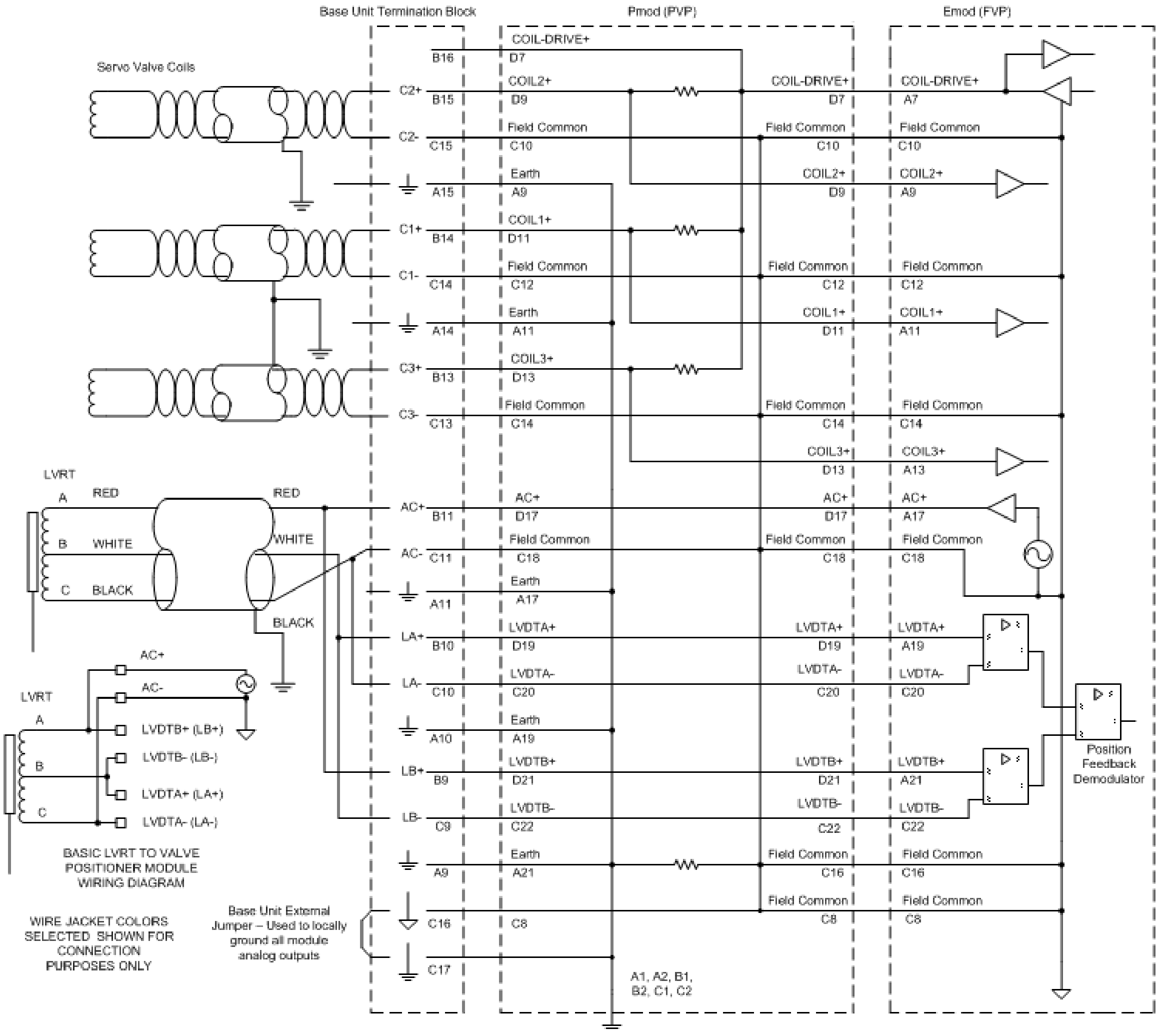


Figure 186: Analog Input/Output Example Using 3-Wire LVRT (CE Mark)

1. All field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware.
2. Negative voltages on terminals B15, B14, and B13 cause the valve to open. Positive voltages on these three terminals cause the valve to close.
3. The amplitude of this signal decreases as the valve opens. (LVDTA+ / LVDTA-)
4. The amplitude of this signal increases as the valve opens. (LVDTB+ / LVDTB-)
5. Node A is connected to terminals AC+ and LB+,

   Node B is connected to terminals LB- and LA+,

   Node C is connected to terminals AC- and LA-.

9.7.23 Swapping connections to affect the output - (RVP)

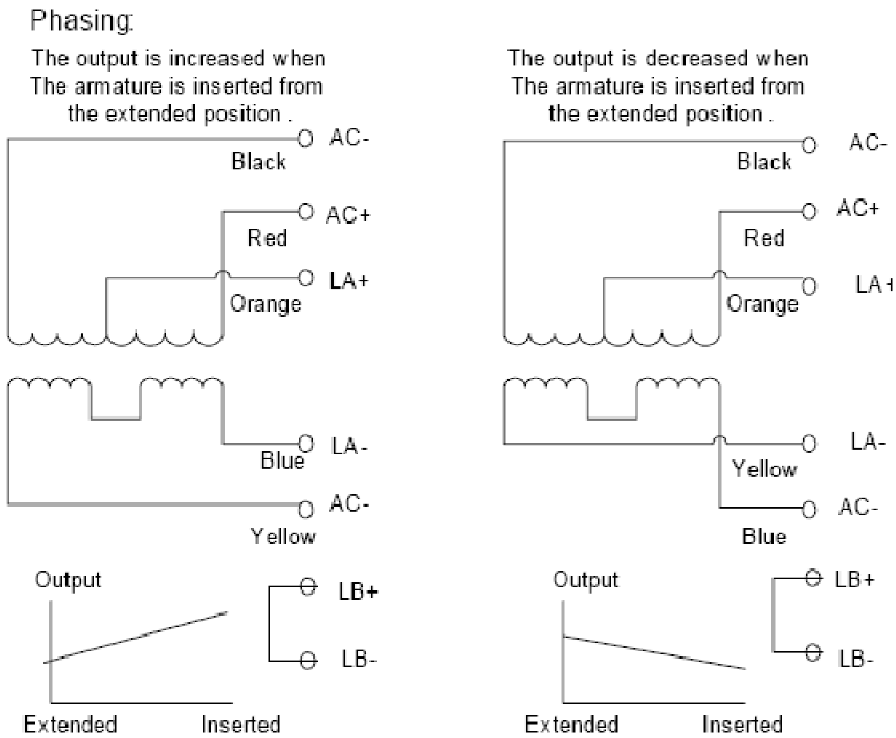


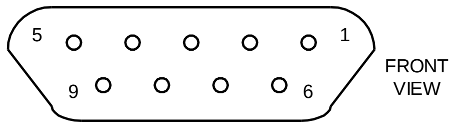
Figure 187: Swapping Connections to Effect the Output

9.7.24 SLIM serial port connector - (RVP)

The Personality module SLIM connector is used to connect the Valve Positioner module to a SLIM module (see page 603).

SLIM Connector (J1 RS-485) Pin Assignments

PIN NUMBER	SIGNAL NAME (FUNCTION)	SIGNAL DIRECTION
1	SP-COMMON	NA
2	RX - (Receive Data)	Input
3	Shd (Cable Shield)	NA
4	RX+ (Receive Data)	Input
5	SLIM-ATT/(SLIM Cable Connector Attached) 1	Input
6	TX+ (Transmit Data)	Output
7	No connection	NA
8	TX- (Transmit Data)	Output
9	SP-COMMON	NA

Pin Number	Signal Name (Function)	Signal Direction
Front View of J1 Connector (Female DB 9)  **1 The mating connector of the SLIM cable assembly must connect pin 5 to pin 9.**		

9.7.25 Register configuration/address information - (RVP)

Word address 13 (D in Hex) is used to write to the Module Configuration Register and to read the Module Status Register. The status register can be read by using the Point Information window at an Operator Station (see the Bit Pattern Field on the Hardware Tab). Refer to the applicable _Ovation Operator Station User Guide_ for information about the Point Information window.

Configuration/Status Register (Address 13 or D in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Configure module (1 = configure)	Module is configured (1 = configured; 0 = unconfigured)
1	Force Error (1 = error; 0 = no error)	Internal or Forced Error (1 = error; 0 = no error)
2 - 4	Communications Timeout Setting [1] **Bit 4 Bit 3 Bit 2 = Timeout** 0 0 0 = 16 seconds 0 0 1 = 4 seconds 0 1 0 = 2 seconds 0 1 1 = 1 second 1 0 0 = 500 milliseconds 1 0 1 = 250 milliseconds 1 1 0 = 125 milliseconds 1 1 1 = 62.5 milliseconds	Communications Timeout Setting [1] **Bit 4 Bit 3 Bit 2 = Timeout** 0 0 0 = 16 seconds 0 0 1 = 4 seconds 0 1 0 = 2 seconds 0 1 1 = 1 second 1 0 0 = 500 milliseconds 1 0 1 = 250 milliseconds 1 1 0 = 125 milliseconds 1 1 1 = 62.5 milliseconds
5	Not applicable	Ignore shutdown input (1 = ignore input; 0 = obey input) This function is only valid when the Controller is running in normal mode. Otherwise, the Valve Positioner obeys the shutdown input.
6	Redundant RVP Link Status Bit (1=good; 0=bad)	Redundant RVP Link Status Bit (1=good; 0=bad)
7	Not applicable	Severe Fatal Error - Check Register E
8	Not applicable	Coil 1 may be shorted

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
9	Not applicable	Coil 2 may be shorted
10	Not applicable	Coil 3 may be shorted
11	Not applicable	Coil 1 may be open
12	Not applicable	Coil 2 may be open
13	Not applicable	Coil 3 may be open
14	Not applicable	Contingency (1 = contingency; 0 = no contingency)
15	Not applicable	Handshake bit for download of calibration data
[1] The tolerance on the timeout period is +/- 35%.		

Word address 14 (E in Hex) provides for additional module configuration and module status. The bit definitions for this register are encoded as shown in the following table.

Secondary Configuration/Status Register (Address 14 or E in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Not applicable	EEPROM checksum error
1	Not applicable	PSD 302 EPROM checksum error
2	Not applicable	Shared memory readback error
3	Not applicable	Processor memory readback error
4	Not applicable	FPGA error
5	Not applicable	UART error
6	Not applicable	Processor diagnostic error
7	Not applicable	Coil drive D/A converter output readback error
8	Not applicable	PSD 302 RAM error
9	Not applicable	EEPROM write error
10 - 15	Not used	Not used

9.7.26 Diagnostics - (RVP)

One important feature of the servo valve is an adjustable mechanical bias mechanism. This mechanism creates a slight deflection in the valve spool so that a small amount of hydraulic fluid can escape the actuator and close the valve. Therefore, if there is no voltage applied to the servo valve, the actuator slowly moves toward the closed position. This deflection is typically overcome by -200 millivolts, so that when the valve is positioned and steady, this small voltage is seen on the servo valve.

The servo valve has two voltage coils, either of which can deflect the spool when excited.

The combination of these features provide the following:

- Redundancy feature that protects against broken wires or shorted coils
- Ability to be diagnosed
- A predictable shutdown mechanism for the following:
  - ☐ In the event the firmware diagnoses a catastrophic error and executes a shutdown

    OR
  - ☐ An error mode occurs that allows a hardware watchdog timer to expire and de-power the Electronics module's FVP field card.

The Valve Positioner continuously runs diagnostics to ensure that the circuit is operating properly. Certain conditions can cause the Valve Positioner to *dive,* essentially removing the output signal and allowing the valve to drift shut.

As a general rule, the card views error conditions on start up as *no-go* or fatal errors. This means that the Valve Positioner does not generate an output to the valve. See the following error descriptions for specifics.

DA readback error - (RVP)

The Valve Positioner has the ability to read and convert the coil drive D/A converter output signal that drives the valve. If the value readback (converted by the A/D converter) and the value that was output do not match within a deadband, and for a pre-defined period of time, a severe fatal error is assumed. In this case, the Valve Positioner is "flying blind." It cannot confidently determine valve position or control the output. The Valve Positioner removes drive power (dive) from the entire Electronics module's FVP field card and go through a reset sequence. The coil drive D/A converter readback check is a diagnostic that runs continuously.

EPROM Checksum Error - (RVP)

The EPROM checksum runs continuously as a low priority function. Failure of the checksum diagnostic is considered a severe fatal error.

Contingency Check Error - (RVP)

Contingency is defined as the difference between a target position and the actual position, when that difference is greater than a defined limit. In the Valve Positioner, the contingency bit is set if the difference exceeds a programmable limit (default value is 5%) for a programmable time period (default value is 10 seconds). Contingency is not a fatal condition.

Memory Read/Write Check Error - (RVP)

A failure of any memory to read back correctly is considered a severe fatal error.

Open coil diagnostic error - (RVP)

An open coil is detected by measuring voltage across the current limiting resistors on the servo output. When zero volts are detected, either the coil is open, the servo output is at zero, or the mechanical bias on the servo valve has been adjusted to yield that result. When an error condition is detected, an internal "open" bit is set.

For firmware revisions prior to 0F, the diagnostic works as described below. For later revisions, servo coil voltage is measured and compared to a model described by tuning constants "kServo" and "kServoDb." If the voltage does not fit into the model, due to being too large, *open coil* is attributed and the internal diagnostic bit is set. Then the timing sequence described below is used to post the error bit to the Controller.

Typically, the servo coil voltage is -200 mV when the valve is in a stable, controlled position and the servo valve mechanical bias is properly adjusted. If the servo output amplifier voltage amplitude falls below 100 mV, the internal bit is cleared, as though no error condition exists. If servo output voltage is greater than 100 mV, the difference between servo output voltage and coil voltage is compared to 50 mV, and if it is less, the 'open' bit is set.

If the open bit stays set for five seconds, the error condition is reported to the Controller in the module status register.

Shorted coil diagnostic - (RVP)

For each of the three coil outputs, an internal shorted bit is set if the converted value of terminal voltage is near 0 volts. Behavior of this diagnostic changes when servo output amplifier voltage is near zero.

For firmware revisions prior to 0F, the diagnostic works as described below. For later revisions servo coil voltage is measured and compared to a model described by tuning constants "kServo" and "kServoDb". If the voltage does not fit into the model, due to being too large, *open coil* is attributed and the internal diagnostic bit is set. Then the timing sequence is described in the following section and is used to post the error bit to the Controller.

Typically, the servo output coil is -200 mV when the valve is in a stable, controlled position and the servo valve mechanical bias is properly adjusted. If the servo output amplifier voltage falls below 50 mV, the internal bit is cleared, as though no error condition exists.

For servo output voltages greater in amplitude than 400 mV, the module status register voltage is compared to 50 mV, and a shorted bit is set if it is less. If the shorted coil bit remains active for five seconds, the condition is reported to the Controller in status word 1.

For servo amplifier voltage values between 50 and 400 mV, the comparison value is calculated as the servo amplifier voltage divided by eight. The timing described above is used. When the shorted bit becomes inactive, the corresponding bit in status word 1 is cleared immediately.

Diagnostics of LVDT problems (redundant) - (RVP)

Diagnosing an LVDT failure is complex. Depending on the failure, the valve may open, close, or go to a different intermediated position, which can be above or below the target position. If the valve is positioned at the LVDT null point, an oscillator failure would not be detected because the position feedback would continue to be equal to zero (0) volts.

- If (Position Feedback - Previous Position Feedback) < MAXDELTA, and POSITIONERRORFLAG is not set, all conditions are considered normal, and the REDUNDANCY STATE is set to NORMAL. Previous Position Feedback is set equal to Position Feedback prior to exiting the PI routine.
- If (Position Feedback - Previous Position Feedback) > MIN2NDRY and the backup is OK, the VP executes the failover.
- If (Position Feedback - Previous Position Feedback) > MAXDELTA, a problem is suspected. VP firmware refuses to accept the new position feedback value, and does not update Previous Position Feedback or run the PI loop. If REDUNDANCY STATE is NORMAL, it is updated to POOR. If it is POOR, it is updated to BAD. If it is BAD, and the backup is OK, the VP executes the failover. This means that it can take 30 msec for the VP to determine that it should execute its failover.
- If POSITION ERROR FLAG is set, and the partner's reported position is within LVDTTRACKING of Position Feedback, the condition is not due to a failed LVDT, but for another reason. No action to fail over is taken.
- If POSITION ERROR FLAG is set, and both Position Feedback voltage and Previous Position Feedback voltage are equal or close to zero volts, the problem is suspected to be a failed oscillator, or broken oscillator wire, and the failover is executed as long as the Backup is OK.
- If POSITION ERROR FLAG is set, and Position Feedback differs from Partner's Position Feedback by more than LVDTTRACKING, and the Backup is OK, an LVDT problem is suspected and the failover is executed.

9.7.27 Troubleshooting - (RVP)

Online replacement - (RVP)

A Valve Positioner module can be replaced online when the module fails. Use the following procedure to remove a Valve Positioner module and safely install a replacement module.

> **CAUTION!** Observe all the precautions and then modify the procedure steps to suit your particular situation.

1. Once the valve is closed and in a safe condition, remove the bad VP.
2. Insert the replacement VP into the base unit.
3. Download constants using the Valve Positioner Upload/Download/Calibrate graphic.
4. View the reported feedback position. It should be close to 0%. If it is, the valve can be operated without calibration.
5. View the servo voltage at terminal screws 14B and C, and 13B and C. Note that if the servo voltage has integrated to a few volts negative, and hydraulic fluid is applied suddenly, the valve *pops,* and the onboard PI responds and bring the valve back to the target position of 0%. If the target position of 0% is less than 'seatLimit', servo voltage is positive, thus forcing the valve closed.

6. With the valve closed, you can execute the 0% calibration sequence to find the exact reading for the 0% position. If you believe the 100% calibration is close, the valve can then be operated without calibrating the 100% position, since there is little flow change when the valve is fully opened.
7. Verify that the VP is in the normal operating mode as indicated by the card edge LED.
8. When you determine that it is time to operate the valve, un-isolate the valve hydraulically, drive the target position of the MA to the desired position, and then switch the MA back to ‘auto.’

Replacement precautions - (RVP)

- If the valve is closed, isolate it hydraulically to prevent any bump when inserting the new VP.
- Switch the MA driving the VP position to manual, and move the target position to zero. This is done to avoid jostling the valve when the new VP is inserted.
- For large machines, switch the valves to ‘single’ or ‘full arc’ mode from ‘sequential’ or ‘partial arc’ mode.
- Keep first stage, or impulse pressure, control loops in service to respond to any upset during the maintenance.
- If the replacement is due to a suspected or intermittent problem that can only be corrected by replacement, but the VP is operating, first close the valve by switching the MA to manual, driving the valve to 0%, and then isolate it hydraulically.

Demodulator gain - (RVP)

Demodulator gain directly affects the calibration values at the endpoints. Reducing demodulator gain can be helpful in diagnosing VP problems. Note that the VP must be re-seated, or must be reset, in order to make any new demodulator gain setting effective.

A simple test can be performed to verify correct wiring and polarity.

1. Set 0 and 100% calibration values to –31,000 and +31,000.
2. Reduce demodulator gain to a low value (2000).
3. Reseat or reset the VP to cause the new demodulator gain to take effect.
4. Set target position to 0%, 100%, then 50% and observe valve movement at all settings.

In this test, you are informing the VP that the electrical valve ‘stroke’ is +/- 10 volts, but you have adjusted demodulator gain so that the actual electrical stroke is much smaller. (Perhaps +/- 1 volt, depending upon the LVDT.) The idea is to force the actual electrical ‘stroke’ to be fully contained within the range of the VP input system.

By setting the target position to 0% or 100%, you can verify correct wiring and polarity. If the valve goes to the correct endpoints, then you should set the target position to 50% as an additional test. The valve should go to the LVDT’s midpoint and hold there.

If the valve does not go to the correct endpoint, then there is a wiring error, and you should first remove one of the servo wire pairs, and repeat the test. The next step would be to swap the wires of the remaining servo wire pair, followed by swapping the wire pairs of LVDT input A with input B.

When the valve moves correctly, verify that the valve operates according to the recommended practice where negative voltage opens the valve, and positive voltage closes it.

Automatic calibration problems - (RVP)

Another problem with demodulator gain can occur during automatic calibration. When the value is backseated and demodulator gain is undergoing an adjustment, it is also predicting the new calibration value at the seated position. If the seated position goes out of range, then the value is clipped and the user receives a message that a new calibration is necessary.

One of the underlying assumptions of the VP is that, in the worst case, the user positions the LVDT so that the 100% position is at the end of the linear range of the LVDT (possibly non-linear and accurate). Then during calibration, the firmware accepts a value of 100% that is higher in magnitude than the 0% calibration value. If the LVDT is not positioned this way, then you may receive a message that the calibration must be repeated.

If LVDT is not adjusted in this fashion, you can enter your own demodulator gain, reseat the VP, then perform both the 0% and 100% endpoint calibration. If the results do not yield a calibration value approaching the endpoint, then demodulator gain can be increased, and the process repeated.

LVDT wiring problems (6-wire LVDT) - (RVP)

When an LVDT is wired incorrectly, it is typically a case where secondary pair A is swapped with secondary pair B.

The LVDT inputs on the VP are implemented with an amplifier stage that includes diode rectification. Therefore, the two individual wires of a secondary can be swapped and it makes no difference to the VP.

The wires of the excitation oscillator could also be swapped with no effect. The excitation coil and secondary coils are all isolated, so the VP can see only the AC component.

If the secondaries are wired correctly, and the LVDT is in approximately the correct position, feedback voltage shown on the VP calibration graphic is negative when the valve is closed, and positive when the valve is open.

The position feedback voltage is also available on terminals B12 and C12. This signal is used for factory testing and can be used for response testing in the field. It is inverted from the signal shown on the calibration graphic. (One way to avoid confusion is to connect voltmeter GND to B12, and voltmeter input to C12.)

Valve wired backwards - (RVP)

If a servo valve is wired backwards (that is, the wire pair is rolled), the valve moves in the opposite direction. This is a positive feedback situation. The movement of the valve does not cure the position error, it increases it, thus causing the output voltage to move even faster, and drive the valve harder in the wrong direction.

One pair of servo coil wires, wired incorrectly - (RVP)

Another problem is with dual coil servo valves when one pair is wired correctly, and the other is rolled. Thus, the wire pairs are in opposition, and valve movement is indeterminate.

Use the following procedure to correct this problem:

1. Disconnect one of the pairs, since the valve moves with only one pair connected (typically, the first step when diagnosing wiring problems).

2. Calibrate the valve with only one pair of servo wires, since it is the LVDT being calibrated, not the servo valve.
3. After the correct direction of movement is established, reconnect the wires, and re-verify correct valve movement and responsiveness.

   For typical dual coil servos adjusted according to the recommendations, the coil voltage is a few hundred millivolts in a steady holding position, 200 mV perhaps. If one coil is disconnected, the valve remains in a steady position, but the coil voltage doubles to 400 mV.

   Once all wiring is connected, you should observe the movement of the valve, such as during a step change, to determine if PI gain is set properly.

9.7.28 Diagnostic Logic card LEDs - (RVP)

LED	Description
P (green)	Power OK LED. Lit when the +5V power is OK.
C (green)	Communication OK LED. Lit when the Ovation Controller is communicating with the module at least once every two seconds.
E (Red)	The "E" LED is illuminated if: ▪ The SLIM address is not zero AND there is no valid response from a SLIM. ***OR*** ▪ The "Ignore Shutdown" configuration bit is not set AND the wetting voltage for the shutdown input is not present.
I (Red)	Internal Error LED. Lit when the Force Error bit (Bit 1 of register D) is detected. Also lit when a timeout of the watchdog timer occurs when Controller stops communicating with module for two seconds.
1 - MANUAL (Green)	Lit whenever the module is operating in Local Manual mode.
2 - SERVO OK (Green)	Lit to indicate the servo coil diagnostics have passed. Only diagnostics for the number of coils specified by “coilCount” are executed. The coil open/short bits reported to the controller are delayed by a timer. The value is set in 100 mSec increments by the tuning constant “diagtime=xx”. However, the LED is extinguished immediately when the diagnostic has failed and the timer is counting towards expiration. Therefore, if the LED is blinking, the tuning constants kServo, kServoDb, and/or diagtime may be too tightly defined. If the LED blinks off during rapid valve movement, but the associated module status bit does not become active, then those three tuning constants are properly set.
3 - NORMAL (Green)	Lit whenever the module is operating in Normal mode. Blinks if it is the Primary in a redundant configuration.
4 - PI DETUNE (Green)	Lit whenever PI is detuned. The PI is detuned (more sluggish) when the valve is at setpoint. Please refer to definitions of errorDbS, errorDbF, piGainDb, and piResetTdb. In a redundant RVP configuration this LED is unconditionally extinguished on the backup RVP because this condition is associated with the PI loop running on the primary RVP. This LED will blink upon rapid valve movement or when the tuning parameters mentioned above are not set properly.
5 - CALIBRATE (Green)	Lit whenever the module is calibrating.

LED	DESCRIPTION
6 - BACKSEAT (Green)	Lit whenever seating or backseating is in effect. This LED is extinguished on the backup RVP of a redundant RVP pair because the condition is associated with the PI control of the primary RVP.
7 - CONTINGENCY (Red)	Lit whenever the module is operating in contingency condition. This LED will blink when the diagnostic detects position error greater than “contingency” during rapid valve movement, or if the valve is actually oscillating around the setpoint. The status bit reported to the controller is delayed by a timer set by “contingencyTime”.
8 - SHUTDOWN (Red)	Lit when the module is driving the valve fully closed due to the module shutdown digital input.
9	No LED.
10	No LED.
11	No LED.
12	No LED.
13	No LED.
14	No LED.
15	No LED.
16	No LED.

9.7.29 Specifications - (ERVP)

- **Electronics module (1C31194)**
- **Personality module (1C31197)**

ERVP Specifications

DESCRIPTION	VALUE
Valve positioning field interface channels	One
LVDT position feedback Input range	25 V AC peak to peak (LVDT A and LVDT B) Max
LVDT position feedback input impedance	20 k ohms (LVDT A and LVDT B) differential input with floating source 10 k ohms (LVDT A and LVDT B) one input line refer to common
LVDT excitation output voltage	17 V AC peak to peak ± 11% @ 1.0 KHz ± 10% (1C31194G03) 23.75 V AC peak to peak ± 11% @ 3.0 KHz ± 10% (1C31194G04) 500 Ohms minimum load impedance (1C31194G03 & G04) Drift 0.5% Max/yr
Peak servo valve coil output voltages	(1C31197G01) up to three 82 ohm coils, ±2.04 V (1C31197G02) up to three 250 ohm coils, ±4.20 V (1C31197G03) up to three 1000 ohm coils, ±8.26 V (1C31197G04) up to two 125 ohm coils, ±4.5 V

Description	Value
Servo valve coil output voltage accuracy	0.4% of full scale output
Field interface dielectric isolation	±1000 V DC The valve positioning field interface has 50 V and 150 V short term isolation from the logic common/Ovation I/O bus
SLIM interface serial port	RS-485
SLIM interface serial port baud rate	9600
SLIM interface dielectric isolation	±1000 V DC
Local serial port	RS-232, non-isolated
Local serial port baud rate	19200
SHUTDOWN digital input Input voltage range	24 V/48 V DC nominal 18 V DC minimum 60 V DC Maximum
Propagation delay of contact change of state	1.9 mSec minimum 25.5 mSec Maximum
Cable length	1000 feet Maximum (cable capacitance @ 50 pF/ft)
Dielectric isolation	±1000 V DC
MANUAL digital output Output voltage Off voltage (Maximum) On voltage (Maximum)	60 V DC 1.0 V @ 500 mA
Output current Off current (Maximum) On Current (Maximum)	0.25 mA @ 60 V 500mA
Maximum propagation time	2.5 mSec for Rload = 500 ohms
Dielectric isolation	±1000 V DC
Module power	Main: 4.3 2W typical, 6.5 W Maximum Aux: **Digital Input:** 0.09 W (24V) typical 0.18 W (48V) typical **Digital Output** (100mA load) 2.4 W (24V) typical 4.8 W (48V) typical
Logic board processor	80C196KB (16-bit microcontroller)
Operating temperature range	0 to 60°C (32°F to 140°F)
Storage temperature range	-40°C to 85°C (-40°F to 185°F)
Humidity (non-condensing)	0 to 95%

9.8 Enhanced Valve Positioner module - (ERVP)

9.8.1 Overview (ERVP)

The Digital Electro-Hydraulic (DEH) system controls steam turbine valve positions in order to adjust steam flow for turbine speed control, or to change generator load when connected to the grid. The Ovation Enhanced Valve Positioner I/O module provides an interface between the DEH Ovation Controller and an electro-hydraulic servo valve actuator. Valve styles controlled by the Ovation Enhanced Valve Positioner I/O module include throttle valves, governor valves, interceptor valves, extraction valves, and bypass valves. The Ovation Valve Positioner module provides closed-loop valve positioning control.

A valve position set point is maintained by the module. The set point is normally altered by the Ovation Controller via the Ovation I/O bus. If the Ovation Enhanced Valve Positioner module operates in Local Manual mode, the set point is controlled by a SLIM operator interface station. Inside the Electronics module, an 80C196 micro-controller provides real-time closed loop proportional-plus-integral (PI) control.

The Ovation Enhanced Valve Positioner I/O module generates redundant output control signals which drive the electro-hydraulic servo valve actuator coils. The feedback loop is closed with the valve’s position measurement being obtained from a Linear Variable Differential Transformer (LVDT) that is mounted on the valve stem.

The Enhanced Valve Positioner module can perform the following:

- Calibration
- Diagnostics
- 1 (one) millisecond loop time
- SLIM interface for local control
- Local serial interface for testing and calibration
- Shutdown input
- Seating and backseating logic

The Valve Positioner module is a CE Mark certified module.

9.8.2 Electronics module (Emod) - (ERVP)

- **1C31194G03** 17 V ac p-p 1 kHz LVDT primary winding excitation output., ±10.0 V dc servo valve actuator coil drive output voltage. RVP design.
- **1C31194G04** 23.75 V ac p-p 3 kHz LVDT primary winding excitation output., ±10.0 V dc servo valve actuator coil drive output voltage. RVP design.

Note: *For Solaris applications, when using the I/O Builder to configure the Valve Positioner (VP) module, note that whatever voltage/current description is displayed in the Slot position at the top of the window does NOT impact the configuration of the VP module.*

9.8.3 Personality module (Pmod) - (ERVP)

- **1C31197G01** has 330 ohm resistors that provide up to ±24 mA into 82 ohm servo coils. Use with any Valve Positioner Electronics module.
- **1C31197G02** has 360 ohm resistors that provide up to ±16 mA into 250 ohm servo coils. Use with any Valve Positioner Electronics module.
- **1C31197G03** has 240 ohm resistors that provide up to ±8 mA into 1000 ohm servo coils. Use with any Valve Positioner Electronics module.
- **1C31197G04** has 160 ohm resistors that provide up to ±36 mA into 125 ohm servo coils. Only two coils may be driven by 1C31197G04. Use with any Valve Positioner Electronics module. The C3+ and C3- coil outputs are not available.
- **1C31197G05** has 120 ohm resistors that provide up to ±50 mA into 85 ohm servo coils. Only two coils may be driven by 1C31197G05. Use with any Valve Positioner Electronics module. The C3+ and C3- coil outputs are not available. 1C31197G05 Accommodates 4-20 mA feedback input at terminals B9/C9. See *VP personality module 1C31197G05 recommendations* for tuning constant suggestions.

Note: *For Solaris applications, when using the I/O Builder to configure the Valve Positioner (VP) module, note that whatever voltage/current description is displayed in the Slot position at the top of the window does NOT impact the configuration of the VP module.*

9.8.4 Subsystems - (ERVP)

Valve Positioner Subsystems [1]

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE
Valve Positioner Controller			
17 Volts AC LVDT: 24.9 mA	8	1C31194G03	1C31197G01
17 Volts AC LVDT: 16.8 mA	8	1C31194G03	1C31197G02
17 Volts AC LVDT: 8.3 mA	8	1C31194G03	1C31197G03
17 Volts AC LVDT: 36 mA	8	1C31194G03	1C31197G04
24 Volts Fused DC LVDT: 50 mA	8	1C31194G03	1C31197G05
23.75 Volts AC LVDT: 24.9mA	8	1C31194G04	1C31197G01
23.75 Volts AC LVDT: 16.8 mA	8	1C31194G04	1C31197G02
23.75 Volts AC LVDT: 8.3 mA	8	1C31194G04	1C31197G03
23.75 Volts AC LVDT: 36 mA	8	1C31194G04	1C31197G04
24 Volts Fused DC LVDT: 50 mA	8	1C31194G04	1C31197G05

RANGE	CHANNELS	ELECTRONICS MODULE	PERSONALITY MODULE

When using the Point Builder to define points for a Valve Positioner module, only the following point types are valid for each channel:

I/O Channel	Name	Type	Input Source or Output Destination	Terminal Block Connection [2]
1	Shutdown Status	Input	Valve Positioner	DI1
2	Auxiliary (wetting) Voltage Sense	Input	Valve Positioner	DI2
3	SLIM ON Signal	Input	Valve Positioner	DI3
4	Position Feedback	Input	Valve Positioner	
5	Coil 1 Voltage (Read-back)	Input	Valve Positioner	Coil 1
6	Coil 2 Voltage (Read-back)	Input	Valve Positioner	Coil 2
7	Coil 3 Voltage (Read-back)	Input	Valve Positioner	Coil 3
8	Raw Demodulator Voltage	Input	Valve Positioner	
9	VP Status	Input	Valve Positioner	
10	Demand Feedback	Input	Valve Positioner	
11	VP Command	Output	Valve Positioner	
12	VP Demand	Output	Valve Positioner	
13	Partner Position Feedback	Output	Valve Positioner	

[1] This module provides an interface between an Ovation Controller and **ONE** Electro-Hydraulic (EH) servo-valve actuator in the field. To use this module, the MASTATION algorithm must reside in the Ovation Controller. (See the *Ovation Algorithm Reference Manual.)*

[2] The terminal block connection depends upon the application being used. Refer to wiring diagram.

9.8.5 Guidelines (Redundant) - (ERVP)

Two Ovation Valve Positioner (VP) cards operate as a Primary/Backup pair to control a single steam valve. The steam valve is fitted with two LVDTs, one connected to each Valve Positioner. Each VP then drives one coil in a high pressure hydraulic servo valve. The coils are completely isolated. Under normal conditions current through each coil is equal and the effect on the servo valve spool is additive.

The Valve Positioners communicate serially to determine which VP should be Primary, and which should be Backup. Critical parameters of the redundant subsystem are exchanged over the serial link. These critical parameters are also exchanged over the Ovation bus, thus providing a redundant data path.

The Backup VP suspends its software PI routine, and replicates the servo output of the Primary. It then takes over control if the Primary fails. There are three types of failures that the subsystem detects and responds to:

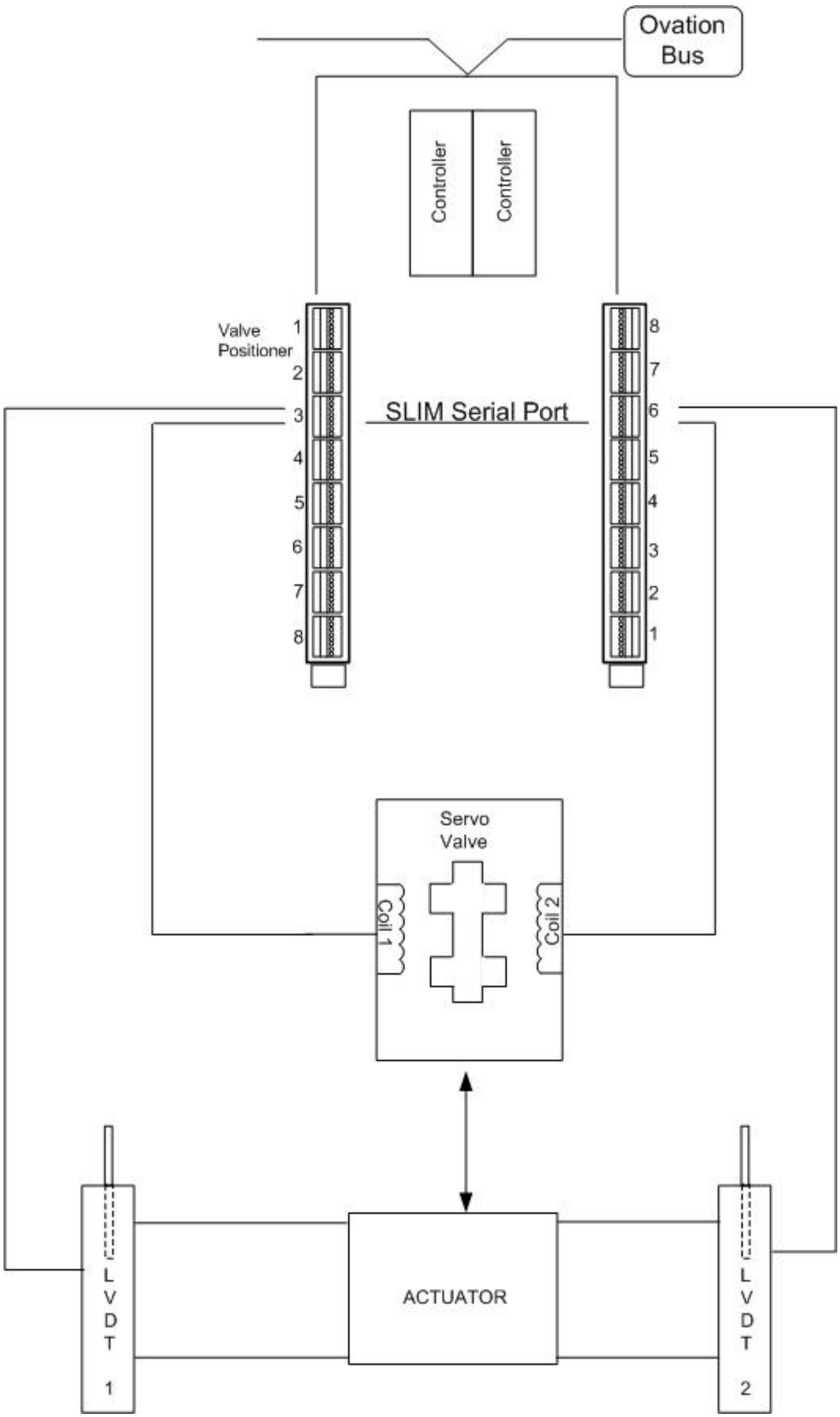
- Hardware Failures - Each VP continuously runs internal diagnostics and ceases operation if a diagnostic fails. A failure is indicated when both the serial communications and Ovation line watchdog timers expire. The VP card continuously executes these diagnostics:
  - Micro-controller RAM
  - Ovation RAM
  - EPROM Checksum
  - DA Converter Readback
  - Ovation Watchdog Timer
  - Redundant Communications Watchdog Timer

- Coil Drive - If the Primary VP detects a shorted or open servo coil, it transfers control to the Backup VP. Refer to, Coil Setup.
- LVDT Failures - LVDT failures are detected by measuring the derivative of position feedback. As with the servo coil, there are setup requirements that enable the detection of LVDT problems. Refer to, LVDT Setup (see page 636).

The VP pair utilizes the SLIM serial port for VP-to-VP communications. The serial link is a VP-to-VP connection, not the “party-line” bus utilized with the SLIM.

Because the effect on the servo spool from the servo coils is additive, a failover event is NOT bumpless (that is, the valve dips, or moves in the direction indicated by the mechanical bias setting, during the failover period). Catastrophic hardware failures, or removal of the Primary VP, are the worst failures because the Backup must wait for various timers to expire and then engage the PI loop.

If, for example, the failover required one second to complete (determined by the Controller loop time), and the valve was programmed to drift shut in 30 seconds under control of the mechanical bias-setting, the valve could drift 3% (=1/30).



Ovation Bus
Controller
Controller
Valve Positioner
1
2
3
4
5
6
7
8
SLIM Serial Port
8
7
6
5
4
3
2
1
Servo Valve
Coil 1
Coil 2
ACTUATOR
L V D T 1
L V D T 2

Figure 188: Typical Redundant Ovation Valve Positioner Subsystem

In the example above, the valve is controlled by RVPs in branch 1, slot 3 and branch 2, slot 6. Each RVP reads the valve position from a six-wire LVDT. The RVPs communicate across the SLIM port to cooperate in driving the servo valve. The servo valve admits/releases hydraulic fluid from the actuator.

9.8.6 Module Serial connection - (ERVP)

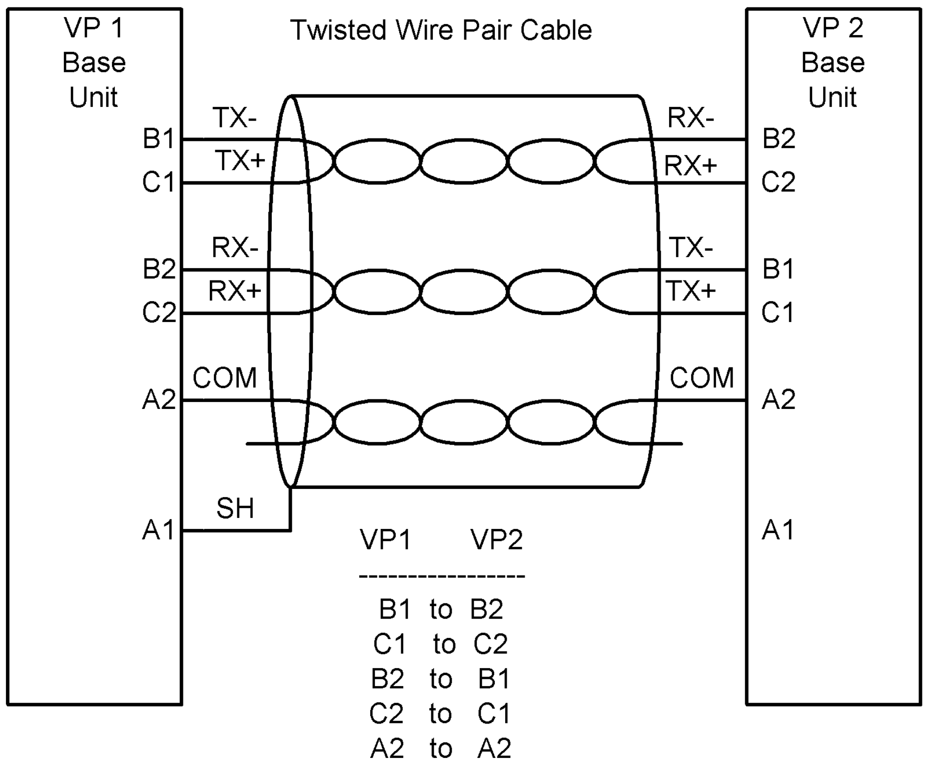


Figure 189: Redundant VP to VP Serial Connections

9.8.7 Firmware levels - (ERVP)

The following table lists all VP module firmware releases that added functionality to the VP.

VP Firmware Level (E mod)	VP Revision Level (E mod)	Firmware Features
0B	5	First full production firmware release.
0C	6	Added support for VP Redundancy.
0D		Obsolete
0E		Obsolete

VP Firmware Level (E mod)	VP Revision Level (E mod)	Firmware Features
0F	9	Added support for the following: ▪ Calibration from the Controller using graphics. ▪ Upload/download of calibration constants to and from the Controller. ▪ New tuning constants **kServo** and **kServoDb** to replace hard-coded constants. They add flexibility in dealing with differing coil impedances. ▪ Reduction of valve calibration time.
0G	11	Redundancy support changed so that multiple failovers are precluded. Improvements to calibration. Improved coil diagnostics for “coilCount = 0”. Math calculation for position feedback endpoint improved.
0H	13	Added “priority Demand” tuning constant to support Rockport project.
0I	15	Corrected communications error in redundancy link.
0J	16	Added anti-windup feature, changed default values of piGain, pi ResetTDb, and errorDbs, and calibration sequence improvements.
0K	18	Improved Serial Communications.
0L		Added the following enhancements: ▪ Added 3 control bits to override primary/backup modes and reset of the redundant RVP pair. ▪ Corrected problem of calibration at full open endpoint. ▪ Fixed startup sequence to avoid contest for primary status of redundant RVP. ▪ Increased startup wait time for oscillator settling from 10 seconds to 20 seconds. ▪ Use servo output to predict direction of motion as arbiter for redundant RVP when position feedbacks become unequal.
0M		This version includes the following: ▪ Made changes to seating and backseating. ▪ Cleaned up LED display for backup RVP in redundant RVP pair. ▪ Made a slight adjustment of the AD converter schedule.

9.8.8 Primary/backup status transitions - (ERVP)

he firmware for the Valve Positioner module allows for Primary to Backup and Backup to Primary status transitions.

If the VP is in the Primary mode, it transitions to Backup mode if:

Note: *Prior to a decision to fail to the backup, the following conditions are tested, and if OK, the primary determines its own health is good and the subsequent tests are not executed:*

1. During calibration failovers are precluded.
2. If there was a recent failover a timer operates to preclude additional failovers for at least ½ second.

Then the failover conditions are checked:

1. The serial line status is OK and the partner is the primary.
2. The serial line status is OK, the backup is OK and armed, and a high derivative is detected on the position feedback. (See description of min2ndry tuning constant and LVDT setup requirements.)
3. The serial line status is OK, the backup is OK and armed, and excessive motion is seen for 10 subsequent position feedback scans. (See description of MaxDelta tuning constant.)
4. The serial line status is OK, the backup is OK and armed, and a failed servo coil is detected.
5. The serial line status is OK, the backup is OK and armed, the primary sees a difference between target position and actual position that exceeds tuning constant posErrDelta, and the position feedback and partner position feedback differ by more than LVDT Tracking. This condition is a “last choice” situation. The redundancy state machine is restarted to allow the other RVP to take over.

9.8.9 Register configuration/address information - (ERVP)

ERVP Register configuration/address information

REGISTER	READ/WRITE	CHANNEL	DESCRIPTION
0	Read / Write		Standard Block Transfer address register.
1	Read / Write		Standard Block Transfer Data register.
2	Read		Receive pointer - Variable payload block.
3	Read		Transmit pointer - Variable payload block. transfer*
4	Read	1	Target position1 - -5 to 105%% = -1560 to 32760
4	Write	1	Position FB1 (same format)
5	Read	1	Target Position2 (same format as above)
5	Write	1	Position FB2 (same format)

REGISTER	READ/WRITE	CHANNEL	DESCRIPTION
6	Read	1	Position FB3
7	Read	1	Coil Voltage 1
8	Read	1	Status Word 1 (packed point)
9	Read		Coil Voltage 2
10	Write		Command Register
11	Read		Coil Voltage 3
12	Read / Write		TBD
13	Read / Write		Configuration / Status (see below for bit definitions).
14	Read		Status Word 2 (see below)
15	Read		Electronic ID (see applicable section)
Note: *Registers 4 and 5 each have 2 points.*			

9.8.10 Modes

Rapid or erratic valve movement can damage the turbine. The Valve Positioner enforces a set of rules to accomplish bumpless transfer between modes. The description of each mode includes mode transfer.

Start mode - (ERVP)

When the Valve Positioner starts or is restarted, its primary objective is to avoid an indeterminate output that would result in valve movement, and possible damage to the valve or turbine. There are a number of hardware and software features that prevent an indeterminate output.

The hardware is designed so that when the Valve Positioner starts, the power supply to the servo output is turned off. With no current flow to the servo valve, it is left under the influence of its mechanical bias adjustment, the assumed state prior to power-up. In addition, the coil drive D/A converter is not turned on until it receives the first output pattern.

As part of the micro-controller's start sequence, the power supply is turned on, and then a pattern is written to the coil drive D/A converter representing 0 volts. The result is that the servo output is under software control, no current flows between the Valve Positioner and the servo valve, and no valve movement has occurred.

The Valve Positioner does not remain in Start mode unless a diagnostic error is detected. The Valve Positioner transitions from Start to Local mode if all of the following functions execute and return "normal" or "ok" status codes:

- Program the FPGA.
- Go to Factory Configure Mode if PE pin is 1.
- Check PE pin. Go to Factory Test Mode, if required.
- EPROM checksum check.
- EEPROM checksum check.
- RAM read/write test.
- D/A converter readback diagnostic.
- UART scratchpad read/write test.
- Shared memory readback check.

The Valve Positioner sets target valve demand equal to demand feedback before transferring to Local mode.

Control mode - (ERVP)

In normal, local, and calibrate modes, the Valve Positioner is always controlling valve position. The PI routine runs unconditionally every 10 msec. Typically, it executes the PI equation as described below. The PI routine has some conditionally executed parts to handle seating and back-seating.

SLIM modes - (ERVP)

The SLIM has four modes:

- Local
- Auto
- Cascade
- Manual

Only two of the four (local and auto) correspond to Valve Positioner modes. **Local mode** corresponds to Valve Positioner **local-manual** mode. However, the operator does not request “local’ mode.” It is only entered when the Controller stops or fails to update the Valve Positioner card.

SLIM **auto mode** corresponds to Valve Positioner **normal mode**. In this mode, the Controller is writing its desired position to the Valve Positioner. In normal mode, the valves’ position and set point can be viewed on the SLIM, but the SLIM has no control over the Valve Positioner.

These modes should not be confused with auto and manual modes of software loops within the Controller. Remember that the Valve Positioner is always in normal mode, receiving its position from the Controller, unless the Controller fails, in which case the Valve Positioner switches to local mode.

When raise and lower on the SLIM are pressed, all Valve Positioners respond to the key action. This means that all valves move together as a group. It also suggests that no other devices (Loop Interfaces) should be connected on the serial bus with a group of Valve Positioners.

In abnormal situations, such as during maintenance, some valves may be in normal mode, and some may be in local mode. In this situation the valve in local mode responds to raise/lower action, but the valves in normal mode do not. The Controller application warns or notifies the operator of the mode of each valve.

Since the SLIM is connected to a group of Valve Positioners, each Valve Positioner must control its own transmit enable. Each SLIM enables its transmitter when placing a response into the transmit buffer. It also starts a 25 mSec timer, which, when expired, disables the transmitter.

SLIM pushbuttons - (ERVP)

The SLIM operation differs from normal operation when connected to the Ovation Loop Interface.

A standard SLIM (see page 603) is used to control a group of valves on a common serial bus.

The actions that occur when a SLIM push-button is used are described in the following table.

SLIM Pushbutton Actions

BUTTON	DESCRIPTION
Loop	The next Valve Positioner on the serial bus is selected. Set point and target position display on the vertical bar-graphs.
Display	Display cycles the top left hex display from target position, actual position, and servo voltage output.

BUTTON	DESCRIPTION
Loop	The next Valve Positioner on the serial bus is selected. Set point and target position display on the vertical bar-graphs.
Up	Up increases target valve position for the valve group. Only the valves in local mode respond to the Up button.
Down	Down decreases target valve position for the valve group. Only the valves in local mode respond to the Down button.
Manual, Auto, Cascade, Mode, Left, Right	Not used.

The SLIM indicators and LEDs provide information about the operation of the Valve Positioner.

SLIM Indicators and LEDs

INDICATOR	DESCRIPTION
PV Bar-graph	Indicates actual valve position
SP Bar-graph	Indicates target valve position of the selected valve
Output Bar-graph	The horizontal output bar-graph on the bottom of the SLIM indicates servo output voltage ranging from -10 volts to +10 volts, mapped to 0 to 100% available on the bar-graph. For a stable valve in a controlled position, approximately 50% (+/- mechanical bias adjustment) would be indicated.
Top Left digits	Indicators for set point, actual, or output voltage.
Top Right digits	Indicate engineering units of the value being displayed.
LEDs: M, C, and T	In local manual mode, C (control) is indicated. In normal mode, M is indicated (monitor). The operator does not have any control over the 'M' 'C' or 'T' function.
LEDs: Casc and Man	Not used.
Auto LED	Illuminated if the valve is in **normal** mode.
Loc LED	Illuminated if the valve is in **local** mode.

Local-manual mode - (ERVP)

The purpose of **local-manual** mode is:

- Maintain stable valve position when the Controller fails or is reset.
- Smooth operation using manual raise/lower function.
- Bumpless transfer to normal mode. (Tracking by the Controller is required, and is enforced by the Valve Positioner in local-manual mode.)

In local-manual mode, the Valve Positioner controls the valve using a set point that is only changed through the SLIM interface, or through the local serial interface.

Local-manual mode will be entered from normal mode if the Controller fails or stops updating the Valve Positioner card. When the Valve Positioner is powered up, local-manual mode is always entered as long as there are no diagnostic failures.

The preferred mode of Valve Positioner operation is normal mode. The Valve Positioner transfers from local-manual to normal if the following conditions are met: (1) Controller is updating the set point, thus keeping the watchdog timer from expiring. (2) Controller is tracking.

In local-manual mode, the following functions are performed:

- PI position control loop.
- Writes current valve position to Ovation memory.
- Writes coil voltages to Ovation memory.
- Open coil diagnostic.
- Shorted coil diagnostic.
- EPROM checksum diagnostic.
- RAM diagnostic.
- Watchdog timing.
- SLIM interface (Raise, Lower, and update SLIM values.)
- Valve contingency diagnostic.

Normal mode - (ERVP)

Normal is the preferred mode of the Valve Positioner card. In normal mode, the Valve Positioner is receiving a position set point from the Controller and controlling valve position.

In normal mode, the following functions are performed:

- PI position control loop (Demand position comes from the Controller via the Ovation memory).
- Writes current valve position to Ovation I/O memory.
- Writes coil voltages to Ovation I/O memory.
- Open coil diagnostic.
- Shorted coil diagnostic.
- EPROM checksum diagnostic.
- RAM diagnostic.
- Watchdog timing.
- SLIM interface (Updates SLIM values, no raise/lower function.)
- Valve contingency diagnostic.

Calibrate mode - (ERVP)

Calibrate mode is a sub-mode of local-manual mode. Calibration sequences are commanded through the local serial port.

The Valve Positioner is commanded to calibrate when the appropriate bit in the command word is set. This causes the Valve Positioner to enter the calibrate mode and begin its travel sequence. During the travel sequence, the Valve Positioner reports a position feedback calculated using the most recent calibration numbers. The controlling MASTATION enters manual mode and track the position demand feedback. The Valve Positioner moves the valve at a programmable rate during the travel sequence.

The Valve Positioner can exit calibrate mode **without** enforcing a bumpless transfer rule.

The following calibrate sequences are supported:

- Zero Hot Cal

  This calibration sequence is executed to re-establish the 0% position. It is useful after the valve has been fully calibrated and the mechanical assembly has been heated and expanded. It avoids fully opening the valve.

  Feedback gain is not adjusted during the hot cal sequence.
- Top Hot Cal

  This calibration sequence is executed to re-establish the 100% position. It is useful after the valve has been fully calibrated and the mechanical assembly has been heated and expanded. It avoids fully closing the valve.

  Feedback gain is not adjusted during the hot cal sequence.

- Null-Point Cal

  This calibration sequence causes the valve to travel to the electrical null point of the LVDT. Null point calibration can be requested at the same time as full calibration, in which case the movement sequence is the full calibration sequence. However, the valve stops at the null point when it is encountered.

- Full Calibration

  This calibration sequence is executed to re-establish 0% position, 100% position, and feedback gain.

  When full calibration is requested the module enters local mode, requiring the Controller to track. The module then moves the valve to the 0% position. The firmware checks for position feedback between the arbitrary limits of –9.7 volts and –7.8 volts. If the voltage is less (more negative) than –9.7 volts, the firmware reduces gain to make the voltage more positive than –9.7. If the voltage is more positive than –7.8 volts, the gain is increased until the voltage is more negative than -7.8 volts. During this sequence the gain is tested to ensure it does not go out of allowable range.

  At this point in the sequence, the demodulator gain has been set to a value that is a Maximum allowable value. The gain may be reduced at the other end of the stroke, but will not be increased.

  Now the valve moves to the 100% position. The feedback voltage is examined, and if it exceeds 9.7 volts, feedback gain is reduced. Once feedback voltage is less than +9.7 volts, it is recorded as the 100% calibration value.

  The valve moves back to 0% and the voltage at 0% is recorded. Feedback gain is not adjusted.

  The last step is to write 0% position, 100% position, and feedback gain to the EE memory.

  Once the data is recorded in EE memory, the firmware clears a restriction flag, allowing the module to transfer from local mode back to normal mode.

9.8.11 Channel assignments - (ERVP)

The following table lists the I/O Channel assignments:

I/O Channel assignments

I/O Channel	Name	Type	Details	Notes
1	Shutdown Status	DI	Digital input.	Same as existing.
2	Aux Voltage Sense	DI	Digital input.	Same as existing.
3	SLIM-ON Signal	DI	Digital input.	Same as existing.
4	Position FBI	AI	Analog input.	Same as existing.
5	Coil Voltage 1	AI	Analog input.	Same as existing.
6	Coil Voltage 2	AI	Analog input.	Same as existing.
7	Coil Voltage 3	AI	Analog input.	Same as existing.
8	Target Position 2	AO	Analog output.	

I/O Channel	Name	Type	Details	Notes
9	Status Word 1	AI	Analog input.	Same as existing. VP Status
10	Position FB2	AI	Analog input.	
11	Command Register	AO	Analog output.	Same as existing. VP Command
12	Target Position 1	AO	Analog output.	Same as existing. VP Demand
13	Position FB3	AI	Analog input.	
14	Status Word 2	AI	Analog input.	

9.8.12 I/O Channel Fields - (ERVP)

The following table lists the I/O Channel Field values:

I/O Channel Field values

I/O Channel	IT Field	HD Field	BP Field	YB / YS Fields
1 (DI) Shutdown Status	0x40000102 data_type: 0x01	baseAddr + 8	4	n/a
2 (DI) Aux Voltage Sense	0x40000102 data_type: 0x01	baseAddr + 8	5	n/a
3 (DI) SLIM-ON Signal	0x40000102 data_type: 0x01	baseAddr + 8	6	n/a
4 (AI) Position FBI	0x40000902 data_type: 0x09	baseAddr + 4	n/a	YB: 0.0 YS: 105.025641
5 (AI) Coil Voltage 1	0x40000e02 data_type: 0x0e	baseAddr + 7	n/a	YB: 0.0 YS: 10.235
6 (AI) Coil Voltage 2	0x40000e02 data_type: 0x0e	baseAddr + 9	n/a	YB: 0.0 YS: 10.235
7 (AI) Coil Voltage 3	0x40000e02 data_type: 0x0e	baseAddr + 11	n/a	YB: 0.0 YS: 10.235
8 (AO) Target Position 2	0xc0000402 data_type: 0x04	baseAddr + 5	n/a	n/a
9 (AI) Status Word 1	0x40001402 data_type: 0x14	baseAddr + 8	n/a	YB: 0.0 YS: 1.0
10 (AI) Position FB2	0x40000902 data_type: 0x09	baseAddr + 5	n/a	YYB: 0.0 YS: 105.025641

I/O CHANNEL	IT FIELD	HD FIELD	BP FIELD	YB / YS FIELDS
11(AO) Command Register	0xc0002902 data_type: 0x29	baseAddr + 10	n/a	n/a
12 (AO) Target Position 1	0xc0000402 data_type: 0x04	baseAddr + 4	n/a	n/a
13 (AI) Position FB3	0x40000902 data_type: 0x09	baseAddr + 6	n/a	YB: 0.0 YS: 105.025641
14 (AI) Status Word 2	0x40001402 data_type: 0x14	baseAddr + 14	n/a	YB: 0.0 YS: 1.0

9.8.13 I/O Bus Communication Timeout settings - (ERVP)

The following attributes are defined for the ERVP:

- Label: I/O Bus Timeout Bits
- Type: Pull-down list
- Size: 3 Bits
- Target: Register 13, 2, 3, 4.

Timeout Settings

DISPLAY	DATABASE / BIT VALUE
16 seconds	0 (000b)
4 seconds	1 (001b)
2 seconds	2 (010b)
1 second	3 (011b)
500 milliseconds	4 (100b)
250milliseconds	5 (101b)
125 milliseconds	6 (110b)
60 milliseconds	7 (111b)
Note: *Default value is 16 seconds.*	

9.8.14 Ignore Shutdown - (ERVP)

The ignore shutdown attribute is defined for the ERVP:

- Label: Ignore Shutdown Input
- Type: Checkbox
- Size: 1 Bit
- Target: Register 13, bit 5
- Default Value: Not checked (bit value = 0)

9.8.15 Feedback "A" Configuration - (ERVP)

The Feedback "A" Configuration attribute is unique to the ERVP.

- Label: Feedback "A" Configuration
- Type: Pulldown list
- Size: 2 bits
- Target: Register 13, bits 6 and 7

Feedback "A" Configuration

DISPLAY	DATABASE / BIT VALUE
6 - wire LVDT	0 (00b)
4 - wire LVDT	1 (01b)
4 - 20 mA	2 (10b)
Reserved	3 (11b)
Note: *Default value is 6 - wire LVDT.*	

9.8.16 Feedback "B" Configuration - (ERVP)

The Feedback "B" Configuration attribute is unique to the ERVP.

- Label: Feedback "B" Configuration
- Type: Pulldown list
- Size: 2 bits
- Target: Register 13, bits 8 and 9

Feedback "B" Configuration

DISPLAY	DATABASE / BIT VALUE
6 - wire LVDT	0 (00b)
4 - wire LVDT	1 (01b)
4 - 20 mA	2 (10b)

DISPLAY	DATABASE / BIT VALUE
Reserved	3 (11b)
Note: *Default value is 6 - wire LVDT.*	

9.8.17 RS485 Magnetostrictive sensor - (ERVP)

The RS485 Magnetostrictive sensor attribute is unique to the ERVP.

- Label: RS485 Magnetostrictive sensor
- Type: Pulldown list
- Size: 2 bits
- Target: Register 13, bits 10 and 11

Magnetostrictive sensor

DISPLAY	DATABASE / BIT VALUE
Not used	0 (00b)
Start / Stop protocol	1 (01b)
SSI protocol	2 (10b)
Reserved	3 (11b)
Note: *Default value is not used.*	

9.8.18 Dual Channel / Backup Feedback Enable - (ERVP)

The Dual Channel / Backup Feedback Enable attribute is unique to the ERVP.

- Label: Dual Channel / Backup Feedback
- Type: Pulldown list
- Size: 2 bits
- Target: Register 13, bits 12 and 13

Dual Channel / Backup Feedback Enable

DISPLAY	DATABASE / BIT VALUE
Reserved	0 (00b)
Dual Channel	1 (01b)
Backup Feedback	2 (10b)

DISPLAY	DATABASE / BIT VALUE
Note: *Default value is Reserved.*	

9.8.19 Module Configuration / Status Register (0xd) Configuration - (ERVP)

The configuration of register 13 (0xd) for the ERVP is as defined in the Dual Channel / Backup Feedback Enable (see page 701) section. The following register bits are standard for all Ovation I/O modules and are defined as follows:

- **Bit 0**: Module Configured: the Engineering Tools software hard codes this bit to 1.
- **Bit 1**: Forced / Internal Error: The Engineering Tools software hard codes this bit to 0.

9.8.20 Module Configuration / Status Register 13 Status - (ERVP)

For diagnostic / status purposes, the only applicable bits are as follows:

- **Bit 0**: Module Configures. Alarm on 0.
- **Bit 1**: Forced / Internal Error. Alarm on 1.

The other bits provide read-back values of the configuration settings and will not be alarmed.

An Ovation module (RM) point assigned to an ERVP Controller module should have the following alarm-related fields set by the Engineering Tools software:

- Alarm Group Bit Mask (E0): 0x0003
- Alarm Group Bit Sense (E1): 0x0001

9.8.21 Configuration Register 13 definitions - (ERVP)

Configuration Register 13 definitions

BIT NUMBER	DEFINITION
0	Set by the controller to configure the module.
1	Set by the Controller to force error (see 16DS033) (module alarm on 1).
2 – 4	I/O bus communication timeout setting (see 16DS033).
5	Ignore Shutdown configure bit.
6 and 7	Enumerated type to configure the "A" feedback as follows: 00 – 6-wire AC 01 – Single AC feedback on "A" input 10 – 4-20 feedback on "A" input (implies G05 PVP) 11 – Not used (TBD)
8 and 9	Enumerated type to configure the "B" feedback as follows: 00 – "A" and "B" used for 6-wire AC 01 – Single AC feedback on "B" input 10 – 4-20 feedback on "B" input (implies G05 PVP) 11 – Not used (TBD)

Bit number	Definition
10 and 11	Enumerated type to configure the RS485 magnetorestrictive sensor: 00 – Not enabled 01 – Magnetorestrictive Start/Stop device 10 – Magnetorestrictive SSI device 11 – Not used (TBD)
12	Dual channel feedback enable.
13	Backup feedback enable (bits 12 and 13 are mutually exclusive).
14	TBD
15	TBD

9.8.22 Status Register 13 definitions - (ERVP)

Status Register 13 definitions

Bit number	Definition
0	Module configured
1	Internal error
2 – 4	Module timeout setting
5	
6	Redundant Link Status bit: 0 = good 1 = bad Module alarm on 1
7	Severe Fatal Error (Module alarm on 1) (See reg E for specific error)
8	Coil 1 shorted (Module alarm on 1)
9	Coil 2 shorted (Module alarm on 1)
10	Coil 3 shorted (Module alarm on 1)
11	Coil 3 open (Module alarm on 1)
12	Coil 2 open (Module alarm on 1)
13	Coil 3 open (Module alarm on 1)
14	Contingency (Module alarm on 1)
15	Position Feedback trouble (Module alarm on 1)

9.8.23 Status Register 14 definitions - (ERVP)

Status Register 14 definitions

BIT NUMBER	DEFINITION
Bits 0 thru 15	Not Used (TBD)

9.8.24 Status Register 1 definitions - (ERVP)

Status register 1 is a packed point from the hardware standpoint and for I/O scanning. Specific bit definitions are provided in the following table:

Status Register 1 bit numbers and definitions

BIT NUMBER	DEFINITION
0 thru 3	RVP modes are a follows: 0000 – Not used 0001 – PE kine active - factory mode 0010 – Start mode 0011 – Test mode 0100 thru 0111 – not used 1000 – Local mode 1001 – Calibrating in local mode – seated 1010 – Calibrating in local mode – backseated 1011 – Calibrating in local mode 1100 – Normal mode 1101 – Calibrating in normal mode – seated 1110 – Calibrating in normal mode – backseated 1111 – Calibrating in normal mode
4	Shutdown input status.
5	Auxiliary voltage sense.
6	SLIM-ON signal.
7	RVP alive flag in redundant configuration.
8	At NULL point during calibration (this bit is not valid for 4-20 feedbacks, single winding feedbacks, or magnetorestrictive devices.
9	
10	Primary/backup status for dual RVP redundant configuration: 0 = Primary 1 = Backup 0 = Otherwise
11	Feedback "A" trouble For 6-wire feedbacks, this bit is set if one of the two windings does not show AC oscillation, required minimum amplitude, or exceeds the maximum amplitude as established during calibration. For 3 or 4 wire feedbacks, this bit is set if the signal does not show excitation, proper amplitude, or is outside the calibration values.

BIT NUMBER	DEFINITION
12	RVP disarmed (redundant only)
13	Feedback "B" trouble For 6-wire feedbacks, this bit is 0. For 3 or 4 wire feedbacks, this bit is set if the signal does not show excitation, proper amplitude, or is outside the calibration values. For 4-20 feedbacks, this bit is set if the feedback is less than 3 mA, or is greater than 21mA.
14	Magnetorestrictive sensor trouble For magnetorestrictive feedbacks, this bit is set if the response does not return in the designated timeframe, or is outside of the calibrated value. for the SSI device the data packet should arrive on a fixed schedule. For the Start/Stop device, the Stop response should return according to fixed timing, typically within 1.5 msec.
15	Are not used.

9.8.25 Register 4, 5, and 6 format (read) - (ERVP)

16 - bit integer, -1560 to 32760 equals -5 to 105%.

Valves operate between 0 and 100%. However, due to thermal expansion of the valve assembly, the position may indicate a value below 0 or above 100. The value is considered valid and good quality during those ranges. Likewise, the target position may range beyond 0 and 100 in order to influence the PI equation to saturate the output in one direction or the other.

9.8.26 Register 7, 9, and 11 format - (ERVP)

Standard AI format. Amplitude is in bits 0 through 11.

0 thru ~ 10.3 volts represented as 0xC000 thru 0xCFFF
-0 (count negative) thru ~ -10.3 volts represented as 0xFFFF thru 0xF000

This format is the same as the legacy RVP format.

9.8.27 Register 10 format, command register - (ERVP)

Register 10 is a packed point from the hardware and I/O scanning viewpoint. The following table list the bit number and definitions:

Register 10

Bit number	Definition
0 , 1 and 2	Calibration requests are as follows: 000 – No request 001 – Zero hot cal 010 – Top hot cal 011 – Full Calibration 100 – go to null point (This command is ignored for non-6 wire feedback devices.) 101 – Invalid 110 – Invalid 111 – Invalid
3	Not used.
4	Not used.
5	Partner active flag used in dual RVP redundant configurations.
6	Partner primary/backup status in dual RVP redundant configurations.
7	Not used.
8	Arm PVP command.
9	Extinguish field power command.
10	Primary mode command.
11	Backup mode command.
12	Not used.
13	Not used.
14	Not used.
15	Not used.

9.8.28 Diagnostics - (ERVP)

One important feature of the servo valve is an adjustable mechanical bias mechanism. This mechanism creates a slight deflection in the valve spool so that a small amount of hydraulic fluid can escape the actuator and close the valve. Therefore, if there is no voltage applied to the servo valve, the actuator slowly moves toward the closed position. This deflection is typically overcome by -200 millivolts, so that when the valve is positioned and steady, this small voltage is seen on the servo valve.

The servo valve has two voltage coils, either of which can deflect the spool when excited.

The combination of these features provides the following:

- Redundancy feature that protects against broken wires or shorted coils.
- Ability to be diagnosed.
- A predictable shutdown mechanism for the following:
  - In the event the firmware diagnoses a catastrophic error and executes a shutdown.

    OR
  - An error mode occurs that allows a hardware watchdog timer to expire and de-power the Electronics module's FVP field card.

The Valve Positioner continuously runs diagnostics to ensure that the circuit is operating properly. Certain conditions can cause the Valve Positioner to *dive,* essentially removing the output signal and allowing the valve to drift shut.

As a general rule, the card views error conditions on start up as *no-go* or fatal errors. This means that the Valve Positioner does not generate an output to the valve. See the following error descriptions for specifics.

9.9 Numalogic Fast Ethernet Remote Node (Windows Ovation 3.4 and above)

9.9.1 Overview

The Numalogic Fast Ethernet Remote Node (NFE-RN) is a remote I/O subsystem which provides an interface to the Numalogic PC700 series Remote I/O. The NFE-RN is comprised of a base assembly, power supplies, and redundant Numalogic Fast Ethernet Remote Node Controllers (NFE-RNCs). The NFE-RNCs contain four Ethernet ports.

***Note**: The Numalogic Fast Ethernet Remote I/O subsystem is only available for Ovation software releases 3.4 and later.*

The Ovation to Numalogic Fast Ethernet Remote Node controller provides 100MBps Ethernet connectivity between the existing OCR400 Controller and remotely located Numalogic P700 I/O systems. This controller provides four external ports available from an integral switch – a single 100BaseFX fiber optic connection and three 10/100BaseTX Fast Ethernet ports. One of these ports (typically the fiber port) can be used for connection to the OCR400 Controller. The other ports can be used for connection of up to two additional Remote Node Controllers.

The fundamental architecture incorporates a backplane with an associated plastic carrier for the redundant Remote Node Controllers. The backplane incorporates necessary power supply connectors, power supply status connectors, and Numalogic I/O bus ribbon cable connector. Additionally, the backplane provides a connector for the required redundant 8V Power supply that provides I/O power to the Numalogic modules.

Additionally, the system requires redundant 24V and 12V power supplies. The backplane distributes this power and power supply status information. A standard solution for providing power distribution as well as the backplane, 8V power supply and associated wiring is provided by drawing 5X00512.

***Note**: Two Numalogic Fast Ethernet Remote Node controllers will be required for each remote node to permit redundancy.*

9.9.2 Supported Numalogic modules

The supported Numalogic modules are the PC700 I/O modules:

- NL 710 120 VAC/DC Input module (accepts 16 discrete 120V AC/DC signals).
- NL 736 120 VAC Output module (provides 8 isolated outputs).
- NL 737 Relay Output module (provides 8 outputs).
- NL 752 4 Channel Digital to Analog Converter.
- NL 742E 1-5V 8 Channel Analog to Digital Converter.
- NL 742A 0-5V 8 Channel Analog to Digital Converter.

9.9.3 Subsystems - Numalogic Fast Ethernet

Numalogic Fast Ethernet Remote Node part numbers

PART NAME	PART NUMBER
Ovation Remote Node Numalogic I/O Interface Kit	5X00512
Ovation Remote Node Numalogic Controller Module	5X00467
Ovation Remote Node Numalogic Power Supply Module	5X00522
Ovation Remote Node Numalogic Base Unit	5X00468

9.9.4 Power Supply - Numalogic Fast Ethernet

Features:

- 12 V to 8 Volt non Isolated DC-DC converter
- Enable/Disable control from the RNC
- Voltage OK monitor

Numalogic I/O modules require 12 volt power to interface to the I/O bus. This power is supplied from the backplane from a redundant set of off the shelf power supplies. Additionally, a redundant set of 8 volt power supplies is required for the Numalogic Output cards. The Numalogic output cards use 8 volts to drive the output opto-isolators. This power supply must has the ability to be turned on and off under control of the RNC. This allows the RNC to turn off the outputs by a single command if a fault (or communication timeout) has occurred. Also, it allows the outputs to be initialized prior to enabling the outputs since Numalogic modules do not have a power on reset capability.

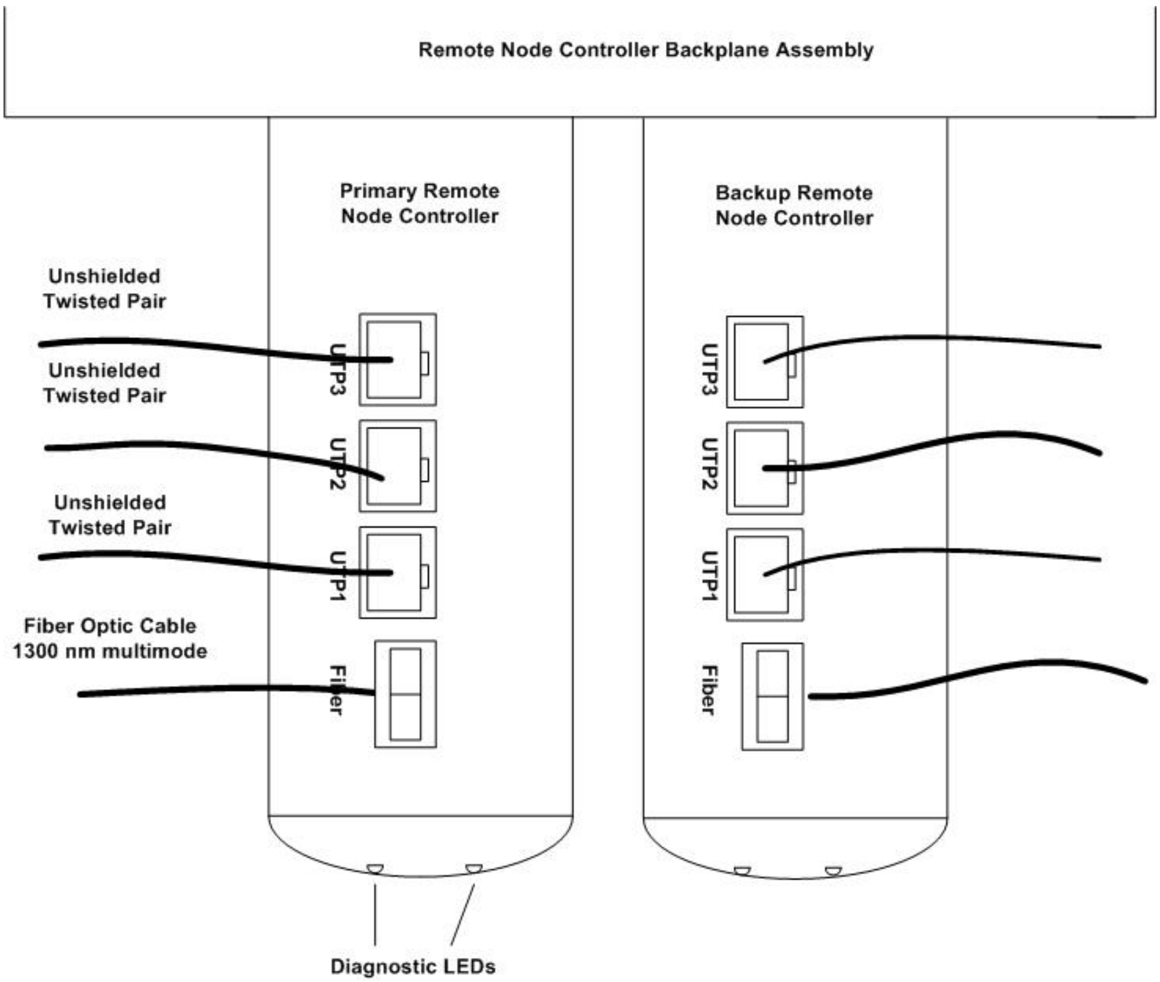
9.9.5 Electronics module connectors - Numalogic Fast Ethernet

There are four external ports available from the switch:

- A single 100BaseFX fiber optic connection.
- Three 10/100BaseTX Fast Ethernet ports.

One of the external ports (typically the fiber port) can be used for connection to the OCR400 Controller. The other external ports can be used for connection of up to two additional Remote Node Controllers.

Note: *Only three of the four external ports can be utilized at one time.*



9.9.6 Diagnostics - Numalogic Fast Ethernet

Numalogic Remote Node Controller LED Diagnostics

LED	DESCRIPTION
P (green)	Power OK LED. This LED is lit when the logic board's +5V and +3.3V digital supply voltage level is OK.

LED	Description
C (green)	Communication OK LED. This LED is lit when the Ovation Controller is communicating with the node.
E (red)	Fault LED. This LED is lit when the Ovation Controller is not communicating with the node.
ACT (green)	Ethernet Activity LED. This LED indicates Ethernet activity on the internal diagnostic port.
FDX (yellow)	Full-duplex Communications LED. This LED indicates full-duplex Ethernet communications on the internal diagnostic port.
MAC (green)	MAC LED. This LED indicates Ethernet activity between the onboard Ethernet switch and the MAC.
UTP1 (green)	Interface 1 Activity LED. This LED indicates Ethernet activity on interface 1.
UTP2 (green)	Interface 2 Activity LED. This LED indicates Ethernet activity on interface 2.
UTP3 (green)	Interface 3 Activity LED. This LED indicates Ethernet activity on interface 3.
FIBER (green)	Fiber LED. This LED indicates Ethernet activity on the fiber port.
IO (green)	IO LED. This LED is on when the 8V is enabled and the node is in control.
E5, E4, E3, E2, E1	Not in control: Single bouncing LED. In control: Multiple bouncing LEDs.

9.9.7 Specifications - Numalogic Fast Ethernet

Description	Value
24V Main Power Supply	Fast Ethernet Remote Electronics module +24V Main Current: 179 mA typ. 200 mA max. Fast Ethernet Remote Electronics module +24V Main Power: 4.3 W typ. 4.8 W max.
12V Power Supply	Fast Ethernet Remote Electronics module +12V Current: 17 mA typ. Backplane (transient - during I/O cycle): 156 mA Typ Total current from power supply Including power for Numalogic I/O: 6A Power supply must be equipped with a closed contact VOK status.
8V Power Supply	Vin range: 11.75V – 12.25V Vout: 7.8V min 8.3V max Load: 0 to 3.2A
Remote I/O UTP Ethernet Ports	10/100Mbps UTP ports: 3 Distance: 100m max IEEE 802.3 Compliant Auto negotiation support Configurable MDIX support Configurable
Remote I/O Fiber Optic Ethernet Ports	100Mbps Fiber Optic ports: 1 Distance: 2km Fiber Type: Multi Mode, 1300nm Connector: LC
Operating Temperature Range	0°C to 60°C

DESCRIPTION	VALUE
Humidity (non-condensing)	0% to 95% relative humidity, non-condensing, through an ambient air temperature range of 0°C through 60°C, but with a maximum wet bulb temperature not over 35°C (95°F).
Vibration	The module shall remain operational while subject to testing defined in IEC 68-2-6 over the following curve: 0.15mm displacement from 10 to 57 Hz and 2G's from 57 to 500 Hz, when attached to a properly mounted DIN rail.
Shock	The module will remain operational and reliable after being subjected to testing defined in IEC 68-2-27 over the following curve: 15 G's for 11 milliseconds and 1/2 sine wave.

SECTION 10

Noise minimization and causes

IN THIS SECTION

10.1 Electrical noise and causes

A wide variety of analog and/or digital circuits are associated with the Ovation System's installation. There are low-level voltage circuits, high-level voltage circuits, circuits that transfer information, and circuits that transfer power. These circuits are placed into two categories: noise-producing circuits and noise-sensitive circuits.

Noise problems typically occur when transmitting analog (voltage, current, and other measured values) or digital information (on/off conditions, pulse trains or similar data) via inter-connected or wired circuits. The information carried by signals in such circuits may become distorted during transfer and errors may result from this distortion.

The difference between the signal of transmitted information and the signal of that information as received is called **noise** (see the figures in Energy Level (see page 714) and Frequency (see page 715)). The noise minimization techniques briefly described in this section focus on preventing errors by either eliminating the noise, or when elimination is not possible, performing steps to lessen its impact.

The following topics discuss the causes of electrical noise in your Ovation system and the recommended techniques for eliminating or reducing that noise.

- Noise Discrimination (see page 714).
- Noise Sources (see page 715).
- Noise Classes (see page 716).
- Noise Rejection.
- Analog Signal Shielding Techniques (see page 720).
- Common Input Considerations (see page 722).

10.2 Noise Discrimination

Natural signal properties (such as the peaks of a digital signal) or conditions created during signal transmission (such as the voltage of the analog signal) are used to make the desired information in the signal appear different from the noise. The recovery of correct information from a noisy signal therefore depends upon the ability to subtract the noise from the desired information.

Three components of a signal that can be used to separate the desired information from a noisy signal are:

- Energy Level (see page 714).
- Frequency (see page 715).
- Noise Sources (see page 715) (of both Signal and Noise).

The following information explains how each of these components can be applied to minimize errors that may occur because of a noisy signal.

10.3 Noise energy level

The energy level is the total energy for the signal plus any induced noise. If there is a significant difference between the signal and the noise, then the noise is rejected easily by thresholding techniques (as identified as Desirable in the following figure). If there is not a significant difference between the signal and the noise, then the noise is not easily rejected (as identified as Undesirable in the following figure).

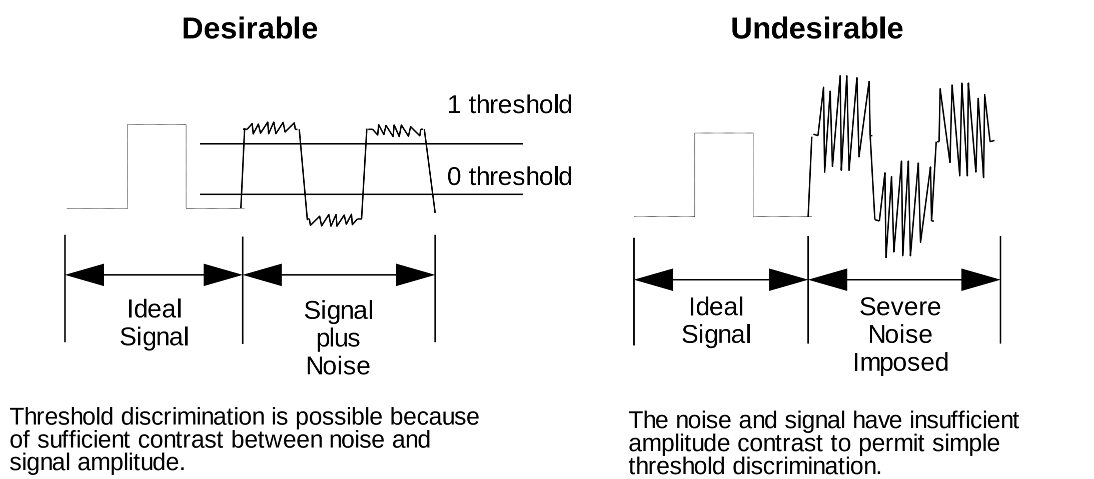
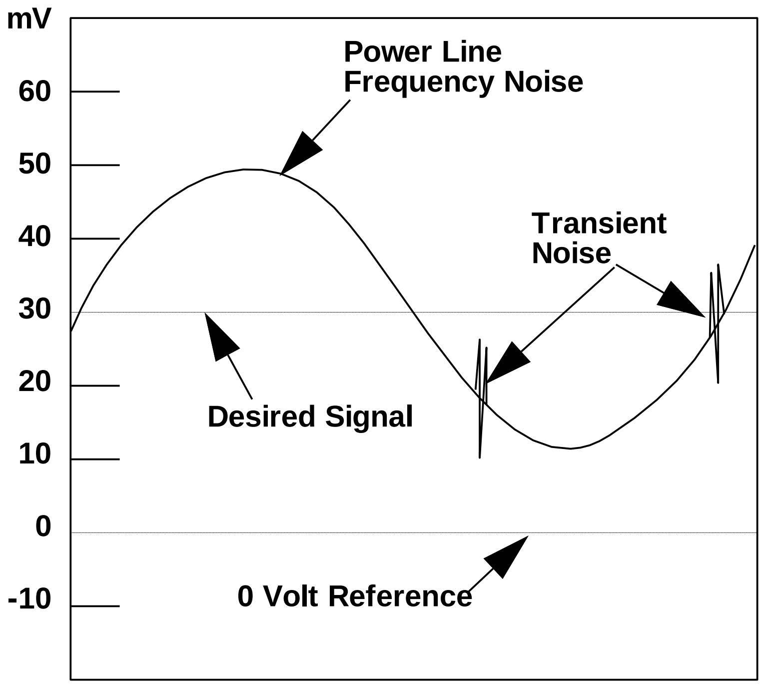


Figure 190: Amplitude Discrimination Example

10.4 Noise frequency

Most of the noise commonly encountered in industrial plants is related either to the **power line frequency** and its low harmonics, or to **switching transients**. The analog signals are usually lower in frequency than one cycle per second, while the digital signals between plant and Controller appear from zero to millions of cycles per second.

Both analog and digital signals can be discriminated easily by eliminating frequency content from external noise sources, such as switching transients, since the transients do not contain appreciable energy below 0.5 MHz frequency. Low pass filtering is useful in recovering analog signals from either power line or transient noise and for recovering digital signals from transient noise. The following figure shows an example of these two types of noise.



The signal above is shown at a 30mV level with both 14 mV RMS (60 Hz) and transient noise.

Figure 191: Typical Noisy Signal

10.5 Sources (Signal and Noise)

When signals are originally generated, most are relatively noise-free. The bulk of the noise present on a received signal has been added to the signal during its transmission. Isolation and segregation of signal sources and wiring from noise sources is highly effective as a recovery means. This technique, as well as the low-pass filtering previously mentioned, serves to reduce the recovery problem to one of amplitude or energy level discrimination.

10.6 Noise sources

The following devices and circuits are common sources of noise:

- Inductive devices, such as relays and solenoids.
- AC and DC power circuits, and wiring.
- Switch-gear.
- Fast-rise-time sources: thyristors and certain solid-state switching circuits.
- Variable-frequency or variable current devices.

10.7 Noise classes

Signal and power circuits, wiring, and cables are classified as high-level or low-level sources of noise and interference. See *Planning Your Ovation System*. A definition of each class of noise is given in the following table.

Noise class definitions

NOISE CLASS	LEVEL	DEFINITION
H	High	Includes AC/DC signals: a. 110VAC, 115VAC under 15A except brakes and fields. b. Up to 100A, 500VDC or 440VAC including brakes and fields. c. Over 100A, 500VDC, 440VAC. d. 2.3kV and over.
M	Medium	Includes digital I/O signals greater than 48V.
L	Low	Includes 24/48V digital I/O signals, and contact input.
Q	Very Low	Includes analog I/O signals as well as digital pulse inputs to high-speed counting circuits and data links.

10.8 What types of digital signal noise rejection are used?

The Ovation system employs three specific noise rejection measures for digital signal plant interconnections:

- Low pass filtering.
- Substantial signal levels (48 VDC or 115 VAC).
- Galvanically isolated.

Low pass filtering and the use of large signal level techniques provide frequency and energy level discrimination, respectively.

Galvanic isolation of the digital signal receiver from ground is important as a means for rejecting noise which causes both wires in a signal pair to change voltage-to-ground potentials. An example of this type of isolation is a signal source (transmitter) which is grounded at a point remote from the receiver, where transmitter and receiver grounds are not at the same voltage. In this case, ground potential difference appears as a voltage on both wires of the corresponding signal pair.

Another example in which galvanic isolation may be required to reject ground potential difference noise would be in circuits where coupling exists between signal wires, inducing a potential in both wires. Induced potentials can occur when signal wires are present in environments with changing electromagnetic or electrostatic fields. Isolation may be required in this case.

An optical isolator (also known as an opto-isolator) may be used to bring digital signals into the receiver. No receiver response to noise can occur unless signal line noise current flows. Low frequency current, which may flow as a result of equal noise voltage-to-ground potentials on both wires of the signal pair, is eliminated if the signal wires are not grounded at more than one point. This is called the **common-mode voltage**.

Note: *High frequency noise currents can flow using stray capacitance as part of their path. This requires the use of low pass filtering in addition to the galvanic isolation.*

10.9 Analog Signal Noise Rejection

Analog signal isolation is provided for the same reasons that are discussed for digital signals (see page 717). However, since analog signals are typically low level, filtering and isolation noise rejection techniques are more critical for analog signals than for digital signals.

Analog signal filtering is achieved by averaging applied signals for one cycle (or an integer multiple of cycles) of the AC power line frequency. Power line related noise, at the power line frequency and its harmonics, has exactly zero average value when the average is taken over exactly one cycle and is filtered out of the signal by this technique.

Transient noise (high frequency damped ringing) has zero average value for averages taken over time periods much longer than the duration of the transients.

10.10 Output Signal Noise Rejection

Digital output signals from the Ovation System to the plant are electromechanical or semiconductor outputs which are galvanically isolated from the Controller. Analog output signals from the Ovation system to the plant are either voltage or current outputs which are also galvanically isolated from the Controller.

10.11 Noise-Sensitive Circuit Noise Rejection

All transmitting, low-level analog and digital circuits must be assumed to be noise-sensitive and to require special protection against noise. Field signals from process transducers (thermocouples, RTDs, and so forth) are especially susceptible to noise. Noise can be coupled into these sensitive circuits in three ways:

- Electrostatic coupling via distributed capacitances.
- Electromagnetic coupling via distributed inductances.
- Conductive coupling, such as circuits sharing a common return.

Noise suppression for these noise sensitive circuits involves one or more of the following basic measures:

- Physical separation (see page 718) between noise-producing and noise-sensitive circuits.
- Twisted-pair wiring (see page 718) for signal connection within plant.
- Proper grounding (see page 719), especially avoiding multiple grounding of cable shields and proper shielding, especially cable shielding.
- Surge protection (see page 719) to IEEE and ANSI standards.

10.11.1 Physical Circuit Separation

Circuit separation is a simple and effective means of electrostatic and electromagnetic field induced noise control. This is because electrostatic and electromagnetic fields decay with increasing distance, producing lower amplitude noise and maintaining a good signal-to-noise ratio.

10.11.2 Twisted-Pair Wiring

Twisted-pair wiring suppresses noise by acting to eliminate circuit loops which are sensitive to stray electromagnetic fields. For this reason, it is recommended that all analog signal circuit connections should be made with twisted-pair wire. Digital signal connections should carry a group return (or common) wired in the same cable as the signal wires.

Twisted pairs are also recommended in digital circuits where unusually noisy environments exist. Twisting of the signal wire and its return conductor becomes increasingly important as the length of the two becomes greater, and as the distance from noise sources becomes less. In twisted pairs or small cables (less than 1/2 inch outer conductor circle diameter), a twist rate of at least one to two twists per foot is recommended.

10.11.3 Proper Grounding and Shielding

Proper grounding, along with shielding, causes noise-induced currents to flow in the shield, and from the shield to ground, rather than in the corresponding signal conductors. Shielding itself is useful in avoiding capacitively coupled noise. The shield's sole function is to decrease effective capacitance from conductors inside the shield to conductors outside. To accomplish this, the shield should be as continuous as possible and equipped with a “drain wire” for secure single-point grounding.

Conductors and corresponding returns may be grouped within a shield only if capacitive coupling between them is acceptable. Avoid the grouping of low-level and high-level analog inputs, contact inputs, and contact outputs within a single shield. Shields are used as current-carrying conductors on some systems. To be effective, shields are grounded at the same point as the signals within, except as otherwise noted within this document.

10.11.4 Surge protection

Surge protection to IEEE C37.90.1 -1989 (Reference ANSI C37.90.1-1989) standards is provided on most Ovation I/O modules. Check individual module descriptions for availability or possible additional conditions.

Ovation I/O modules, designated as being CE Mark compliant, have surge protection as shown in the following table when installed in CE Mark certified cabinets:

Surge Protection Levels

Specification	Level
EN 61000-4-3 (Radiated Field Immunity)	10 V/m
EN 61000-4-4 (Electrical Fast Transient Immunity)	1 Kv
EN 61000-4-5 (Surge Immunity)	1 Kv
EN 61000-4-6 (Conducted Radio Frequency Immunity)	*10 V rms
*The HART Analog Input and HART Analog Output modules meet a reduced level of 3V rms.	

10.12 Analog Signal Shielding Techniques

For noise suppression purposes, analog signals of less than one volt is considered low-level and (as is the case with all analog signals), require shielding. Individually twisted and shielded pairs should be used for all analog input signal wiring. Multi-pair cable can be used if each twisted pair in the cable has its own insulated shield. Use the following guidelines to shield signals:

- Ground the analog signal shield.
- Ground the shield at one end only, preferably to a single point at the signal source, except as otherwise noted in this document.
- Connect the low side of the signal to the shield at the signal source. If the shield cannot be conveniently grounded at or near the signal source, ground it at the Controller. An ideal analog signal field connection is shown in the following figure
- Run the shield (unbroken) from the transducer to the shield terminal of the Analog to Digital (A/D) front-end at the Analog Input module. (See *Planning Your Ovation System.)* Maintain shield continuity at junction boxes when they are used.

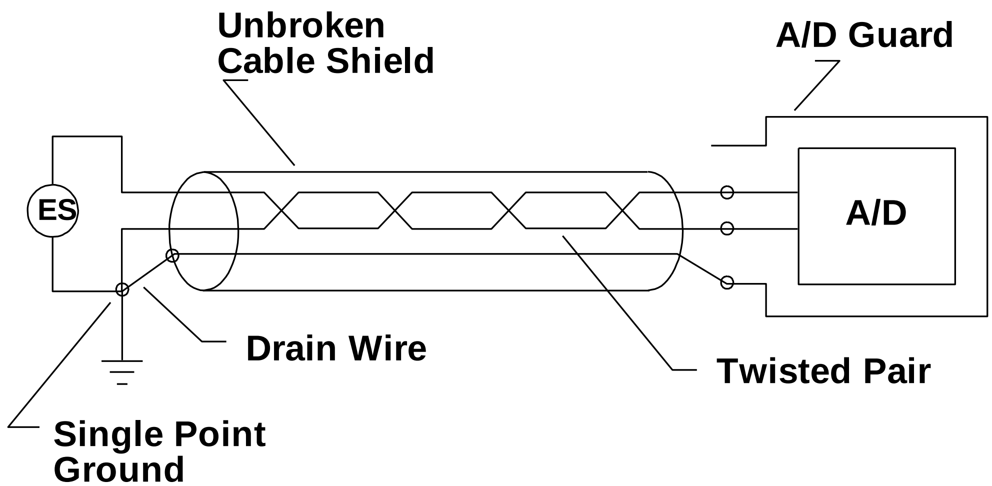


Figure 192: Ideal Analog Signal Field Connection

The following figure shows the typical recommended thermocouple analog signal wiring and the next figure shows the recommended sensor analog signal wiring.

Note: *See Personality Module Jumpers (see page 29) for details on how to access the jumpers.*

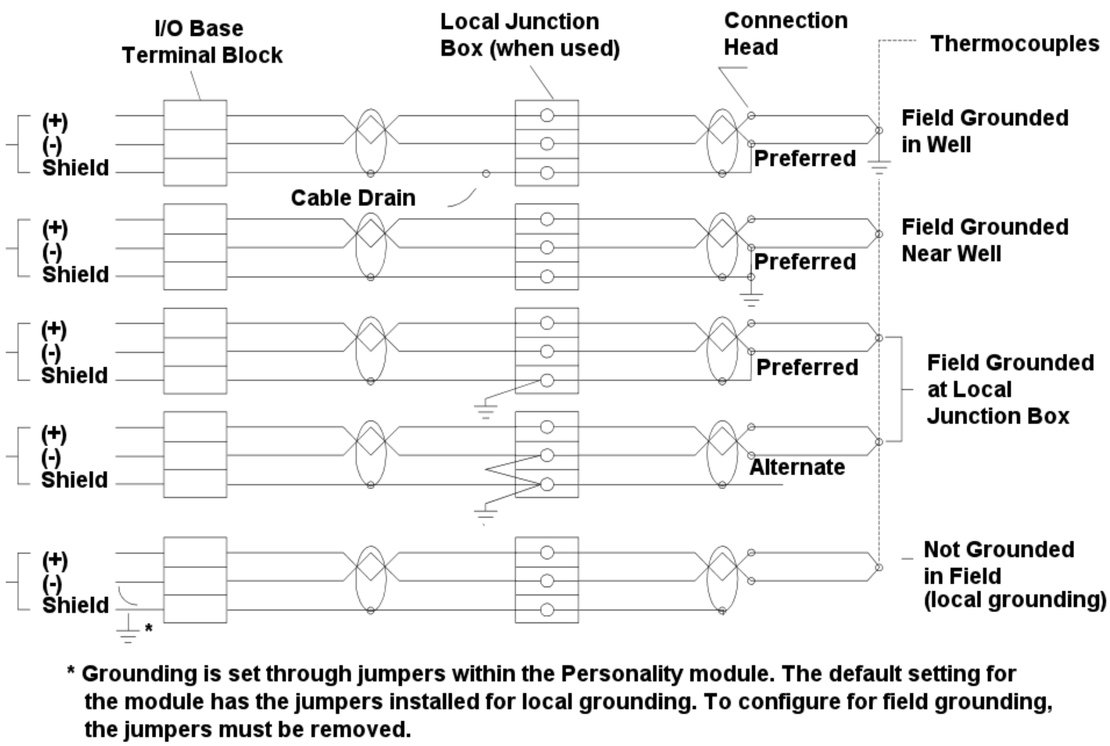


Figure 193: Typical Thermocouple Analog Signal Wiring by User

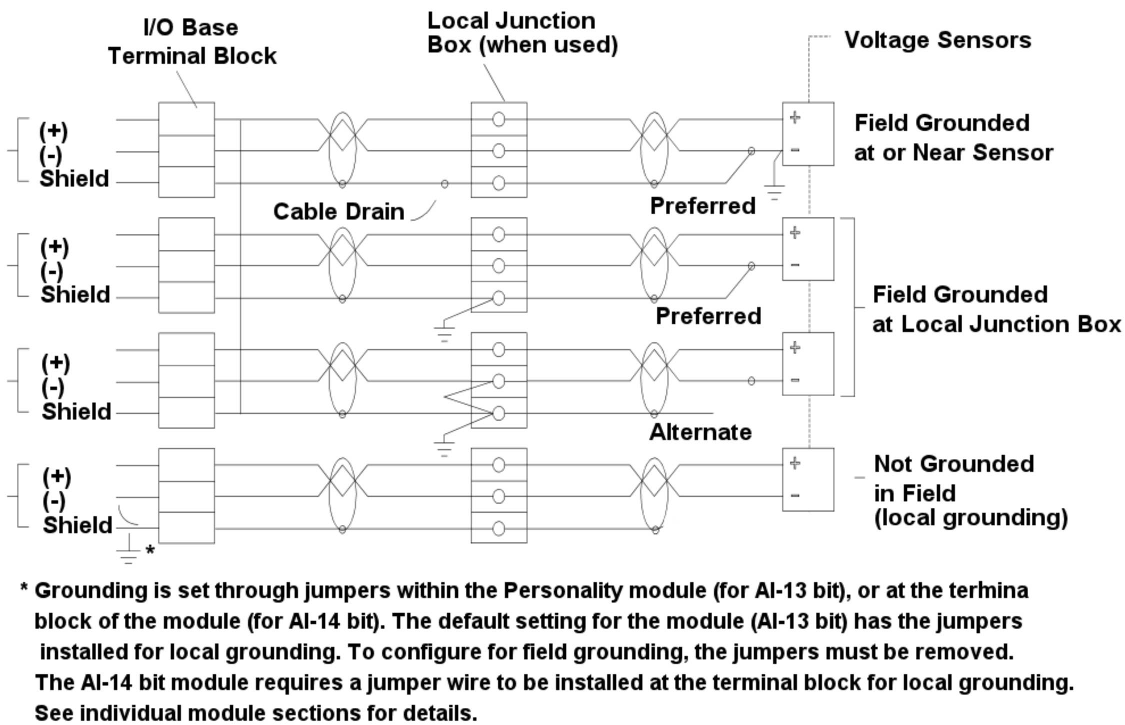


Figure 194: Typical Sensor Analog Signal Wiring by User

10.13 What are some Common Input Considerations?

4 to 20 mA Signal Considerations

When sufficient separation from noise sources exists, this standard class of control signal does not require shielded cables. However, it is strongly recommended for surge protection. Use of twisted-pair cables is recommended.

Digital Signal Considerations

The Ovation System's digital I/O circuits used in data transmission do not require individual twisted or shielded pair conductors. A multi-conductor cable, in which one conductor serves as a common return and with a single overall cable shield, is sufficient for most Ovation digital signal applications.

Contact Closure Signal Considerations

- Outputs (CCO) - These circuits usually require no shielding.
- Inputs (CCI) - These circuits require no shielding if the net current in the cable is zero.

CE Mark Considerations

For CE Mark certified systems, all field wiring must be braid-shielded and grounded at the entry point of the cabinet using the recommended hardware. (See *Planning Your Ovation System*.)

SECTION 11

Defining and addressing the I/O for the OCR161 and OCR400

IN THIS SECTION

11.1 What is the process for planning the I/O for your system?

The Ovation Distributed Control System provides modulating control, sequential control, and data acquisition for a variety of system applications. This system consists of a configurable mix of functional input/output (I/O) modules that communicate on the I/O bus to the Ovation Controller.

I/O modules provide an interface between the Ovation Controller and the processes in the plant. Ovation I/O modules are “plug-in” components with built-in fault tolerance and diagnostics. They are able to operate on a wide range of signals and perform a multitude of functions.

The Developers Studio I/O (input/output) Devices folder contains tools used to define the I/O modules for the Ovation system. The I/O Device folders contain Setup Wizards and dialog boxes that provide visual representation of the I/O devices for an Ovation system.

Before the I/O devices folder can be used to define the I/O hardware, you need to secure the I/O for your Ovation system.

After securing the plan, the information is entered into the I/O Devices portion of the system hierarchy to define the I/O for your Ovation system. I/O Devices are defined individually for each drop.

During configuration, the following elements are assigned point names by the system to identify the elements to the Ovation database:

- Each **remote node** is assigned a Node (RN) record type point name. The RN record type is used because it contains bits that are used to monitor the node power supply.
- Each **Ovation I/O module** is given a Module (RM) record type point name. The RM point is used to configure the I/O module and to provide status/alarm information about the I/O module. Points can then be assigned to each module by using the Hardware tab in the Points folder. Refer to the *Ovation Record Types Reference Manual* for additional information.

11.2 What are the Ovation I/O module base types?

Ovation I/O bases house the Ovation I/O modules and provide a mechanism for you to run field wiring and connect field signals to the Ovation I/O. Series of bases can be connected together to form a “branch” of Ovation I/O.

The Ovation system supports two different types of bases:

- Standard I/O base.
- Relay Output base.

Bases can be mixed within a given I/O branch and cabinet. There are restrictions as to how these bases can be mixed. (See *Planning Your Ovation System*.)

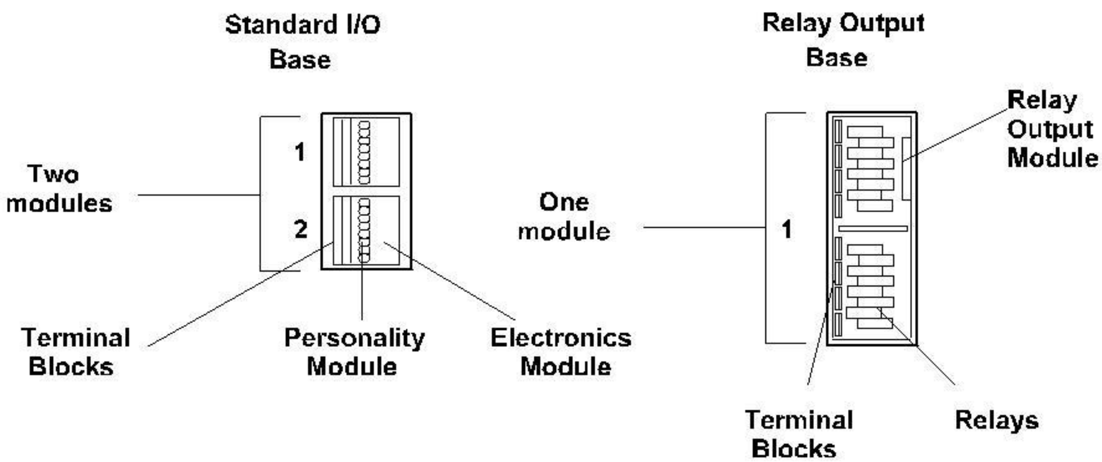


Figure 195: Standard I/O and relay output bases

11.2.1 What is a standard I/O module base?

A standard Ovation I/O base houses up to two standard Ovation I/O modules. Standard Ovation I/O modules are designed to fit securely into the standard I/O bases.

Each standard I/O module is assigned a logical address. Since each standard I/O base can house two Ovation I/O modules, a standard I/O base occupies **two** logical module addresses.

11.2.2 What is a relay output module base?

The relay output base houses one module and requires **one** I/O address. Although the relay output base only contains one module, it is **1.5 times longer** than the standard I/O module base to allow additional space to house the relays.

11.3 What is an Ovation I/O module address?

The System assigns an address to each Ovation module defined by the Ovation Developer Studio. This address is based on the logical location of the module with respect to the Ovation Controller and is used by the Ovation Developer Studio to configure the hardware information for a point.

A standard I/O base consists of two logical modules; and a relay output base has one logical module.

11.3.1 What are the guidelines for positioning I/O modules in cabinets?

When selecting module positions observe the following guidelines:

- The position of the module in the cabinet determines the address of the module.
- Placement of I/O modules are from **top to bottom** on the left side of a cabinet and from **bottom to top** on the right side of a cabinet.
- If Relay Output modules are mixed with standard I/O modules on the same branch, **always** start the standard I/O module base in an odd-numbered module position on the branch (positions 1/2, 3/4, 5/6, or 7/8).

  Relay Output modules can be placed in odd or even numbered positions. For example, modules can begin in 1, 2, 3, 4, 5, 6, 7, or 8 slots.

- Physical cabinet size and branch power requirements may limit the number of modules that can be configured in a branch.

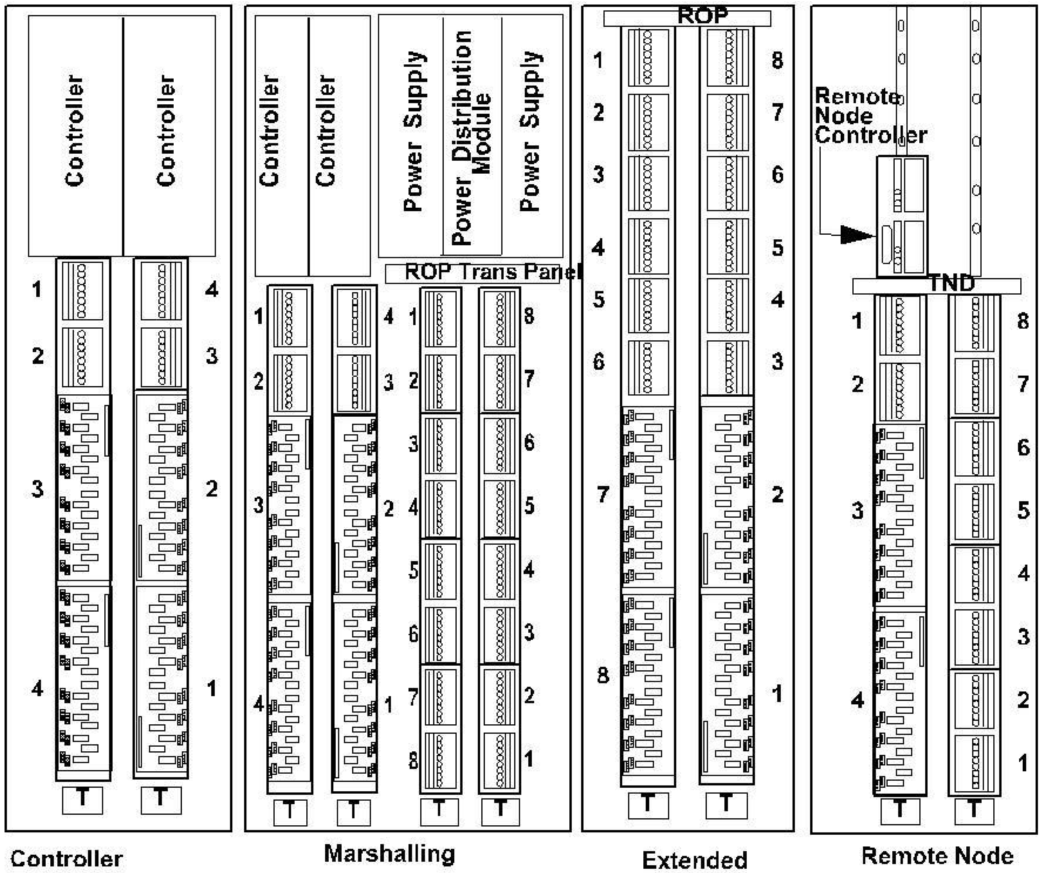


Figure 196: Examples of cabinets with standard I/O and relay modules

11.3.2 What is the addressing format for I/O modules?

The logical I/O address is composed of three numbers (four when remote I/O is used) separated by decimals and in the following format:

- **D.N.B.S where:**

  D = Device number assigned to the OCR1100 and OCR400 IOIC

  N = Node (only used in Remote I/O; 1 through 8).

  B = Branch (1 through 8).

  S = Slot where module is located (1 through 8 for Ovation I/O).
  (1 through 12 for Q-Line I/O).

- **Standard I/O base assemblies**

The I/O addressing for the Ovation database is determined from the positions of the bases installed in the cabinets. Installation of standard I/O bases requires at least two I/O module addresses on a branch. Their I/O module position must **always** start on odd positions.

I/O modules should be in the left-most branch of each side of a cabinet from the TOP down to the BOTTOM. I/O modules in the right-most branch of each side of a cabinet are addressed from the BOTTOM up to the TOP.

Emerson Process Management recommends that all bases (typically four) be installed in the right side of a cabinet, even if the bases are not all filled with I/O modules. This prevents disruption of the database if additional I/O modules are installed in the future.

- **Relay output base assemblies**

Relay Output bases can be located before or after standard I/O bases. Installation of relay output bases requires one I/O module address on a branch and can begin on an **odd** or **even** position.

Note: *Physical cabinet space may limit the Maximum number of bases in a given cabinet style.*

When a relay output base is used before a standard I/O base, an even number of relay output bases must be used so the I/O base starts at an odd position. If a standard I/O base follows an odd number of relay output bases, the configuration is incorrect and does **not** work (see the following figure for examples).

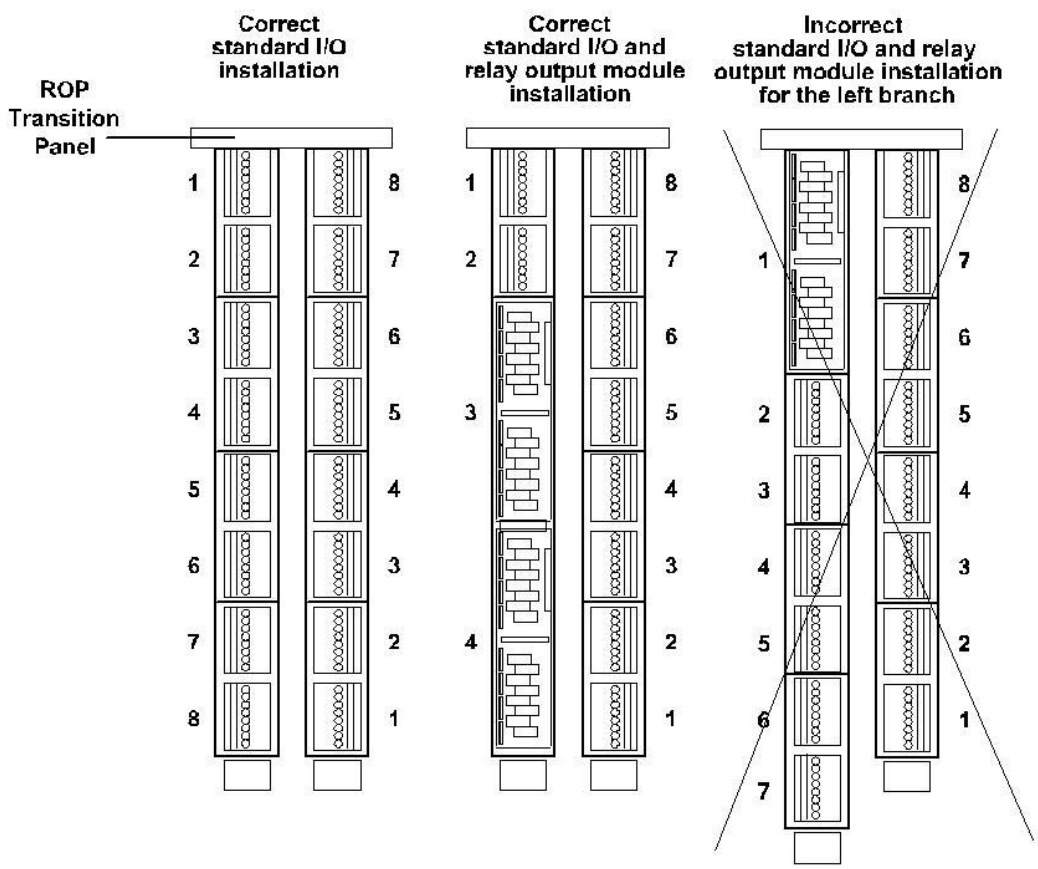


Figure 197: I/O and Relay Output module configuration examples

11.3.3 Examples of Controller cabinet I/O module addresses

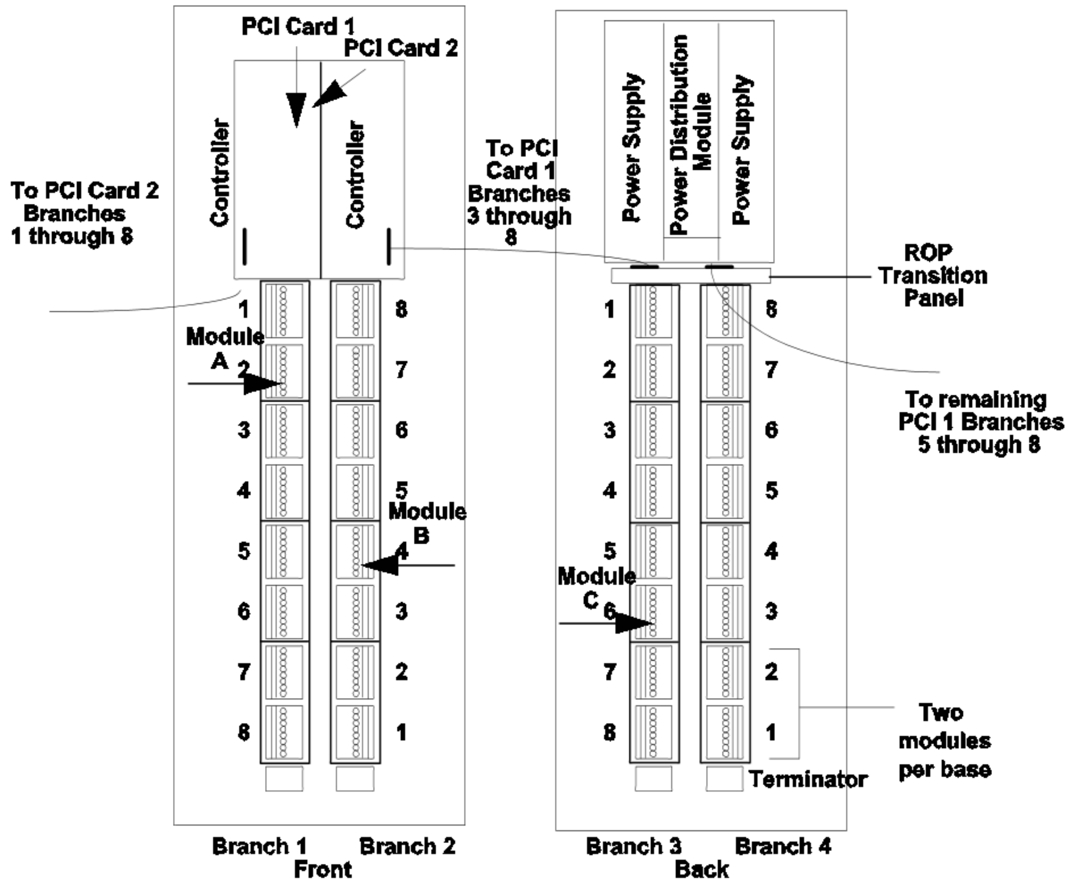


Figure 198: I/O Address examples, modules A, B, C (Controller cabinet)

Note: *PCI Cards 1 and 2 for the OCR161, IOIC module for the OCR400 and OCR1100.*

- Module A address = 1.1.2.
- Module B address = 1.2.4.
- Module C address = 1.3.6.

11.3.4 Examples of extended I/O cabinet module addresses

Note: *ROP transition panel is used when configuring cabinets (front of cabinet).*

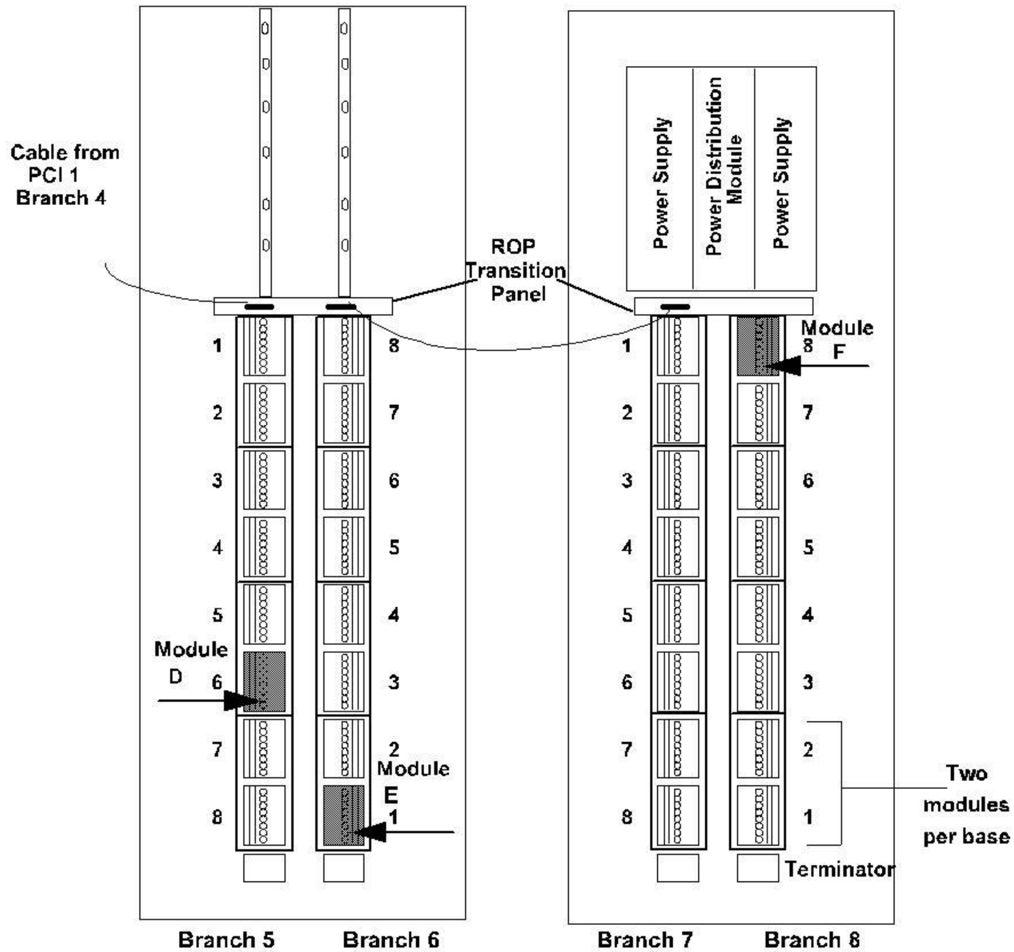
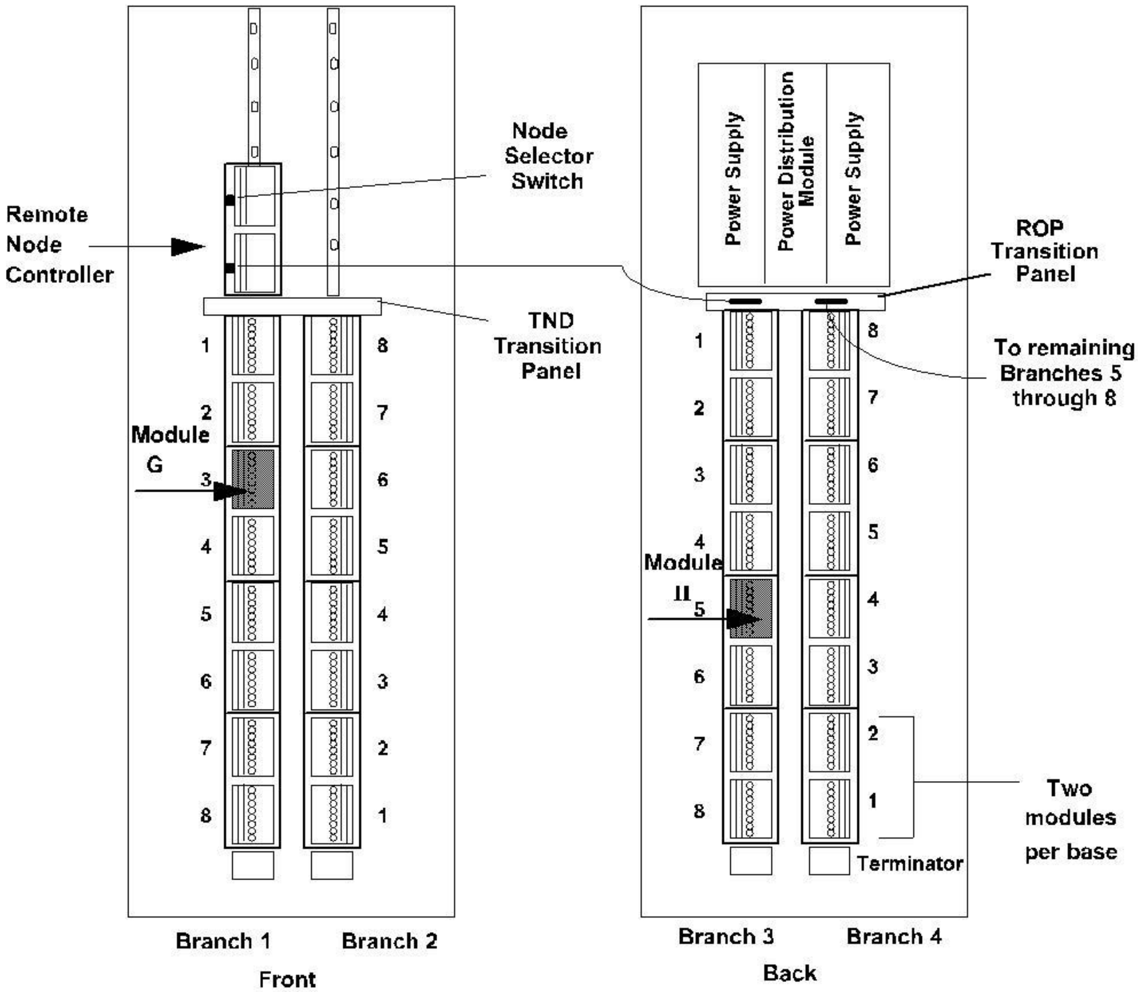


Figure 199: I/O Address examples, modules D, E, F (extended I/O cabinet)

Note: *IOIC module for the OCR400 and OCR1100.*

- Module D address = 1.5.6.
- Module E address = 1.6.1.
- Module F address = 1.8.8.

11.3.5 Examples of remote node I/O cabinet module addresses



The Node address (1 through 8) for Ovation remote I/O is determined by where the node is connected to the MAU Attachment Unit (located in the Controller cabinet). The Node Selector Switch in the Remote Node Cabinet is then set to match the connection position. See the Ovation I/O module addressing (see page 726) section in the *Ovation I/O Reference Manual* for details about addresses for remote nodes.

The Node is in MAU position 1 for the following examples:

- Module G address = 1.1.1.3.
- Module H address = 1.1.3.5.

11.3.6 Examples of Relay Output module addresses

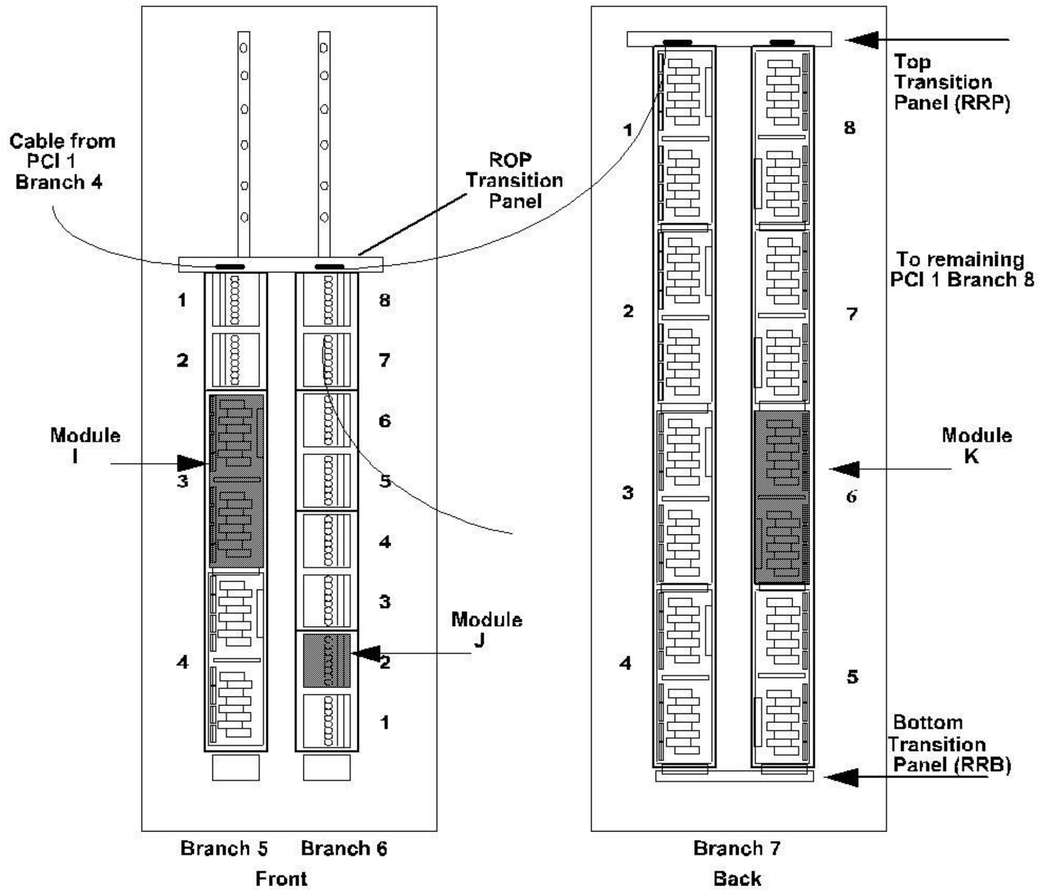


Figure 200: I/O address examples, modules I and J (Relay Output modules)

Note: *ROP transition panel is used when configuring cabinets (front of cabinet). Branch 7 (back of cabinet) is composed solely of relay panels using RRP and RRB transition panels. (See* Ovation I/O Reference Manual*.*

IOIC module for the OCR1100 and OCR400.

- Module I address = 1.5.3.
- Module J address = 1.6.2.
- Module K address = 1.7.6.

Note: *The back of the extended cabinet contains only one branch of Relay Output modules due to physical limitations.*

The Relay Output modules can also be used with the RRP and RRB transition panels (instead of the ROP or TND panel). Using the RRP and RRB transition panel allows one “branch” of up to eight relay bases to be housed in a single side of an Ovation ventilated extended cabinet in two columns of four bases.

11.3.7 Q-Line I/O module addressing

The address for Ovation modules is determined by the location of the module in the I/O cabinet. However, the address for a Q-Line card is determined by the jumper settings on the actual Q-Line card. A visual inspection of the card should be used to determine the jumper settings. (See *Q-Line Installation Manual*.)

Q-Line QBO modules are used to perform DIOB testing. The QBO card is addressed by entering it in hexadecimal format into a dialog box. The box appears when a Q-Line module is defined and configured through the Developer Studio.

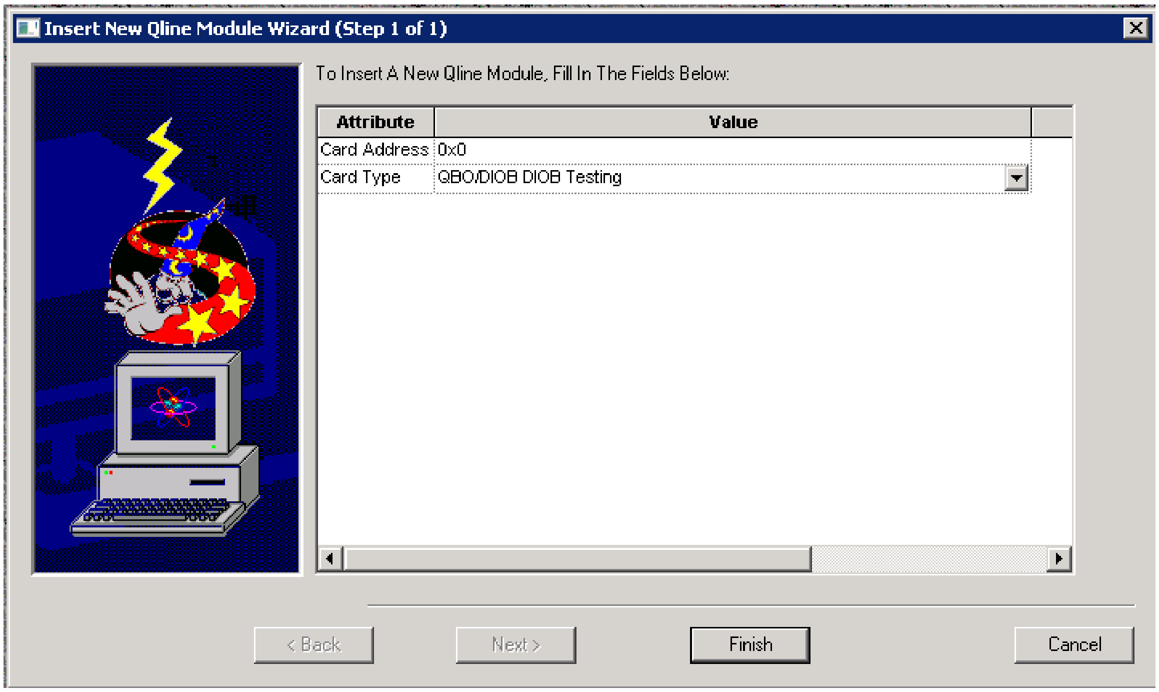


Figure 201: Insert New QLine Module Wizard

11.4 Controller interfaces, OCR400 and OCR161

11.4.1 What are the Ovation Controller I/O interfaces?

Ovation Controllers provide various types of interfaces to communicate with the system and other devices. These interfaces include:

- Ovation network.
- Dedicated backup.
- I/O devices.

Network interface ports

The Controller's processor module provides four network interface ports, labeled N1, N2, N3, and N4. These ports are located at the top of the module housing. Port N2 is typically used for single attached networking to the Ovation network. Port N3 provides an additional Ethernet interface for dual attached networking. N4 is the default Ethernet interface for dedicated control synchronization. Port N1 is an additional Ethernet interface for other uses, such as third-party links, if necessary.

Network Ports

PORT	SUPPORTS
N1	Third-party devices.
N2	Single attached network interface.
N3	Dual attached network interface or third-party device.
N4	Dedicated control synchronization or third-party device.

Note: *When using direct connection (Port N4 to N4) control synchronization, make sure both Controllers have control synchronization enabled and that the cable is attached before performing a download, reboot, and load.*

If a pair of redundant Controllers has been running with control synchronization enabled and control synchronization is then disabled, disconnect the dedicated cable from the Controllers before rebooting the Controllers with the new configuration.

Conversely, if a pair of redundant Controllers has been running with control synchronization disabled and control synchronization is then enabled, connect the dedicated cable between the Controllers after they have been running with the new configuration.

I/O interface ports

The Controller's I/O interface module supports up to 16 branches of local Ovation I/O, using ports L1 and L2, physically located on the Controller Base Assembly, below the Controller. The Controller also provides three RJ-45 interface ports to support additional local and remote I/O. These ports are located at the top of the module housing and are labeled Q5, R4, and R3. The port labeled Q5 supports up to four crates of local Q-Line I/O. Ports R3 and R4 are configured as a pair. They can support three different options:

- Remote Ovation (R3/R4).
- Remote Q-Line (R3/R4).
- Local Q-Line (R4 only).

When configured for Ovation I/O, up to four nodes of remote Ovation I/O can be supported on each port. Local Ovation I/O is not supported on either port. When ports R3/R4 are configured for remote Q-Line, each port can support up to four nodes each with four crates per node. When configured for local Q-Line, R4 can support up to four crates (1 node) of local Q-Line, but R3 must be unoccupied.

Note: *Ports R3 and R4 can be configured as a pair to support* either *Ovation I/O or Q-Line I/O, but not a mixture of the two. Port Q5 supports only local Q-Line I/O. Ports L1 and L2* only *support local Ovation I/O.*

The following list shows the configuration options:

- **Port L1** supports up to 8 local branches of local Ovation I/O.
- **Port L2** supports up to 8 local branches of local Ovation I/O.
- **Port Q5** supports up to 4 crates of local Q-Line I/O (1 node).
- **Port R3** supports one of the following:
  - ☐ up to 4 nodes of remote Ovation I/O.
  - ☐ up to 4 nodes of remote Q-Line I/O.
- **Port R4** supports one of the following:
  - ☐ up to 4 nodes of remote Ovation I/O.
  - ☐ up to 4 nodes of remote Q-Line I/O.
  - ☐ 1 node of local Q-Line I/O.

(See the *Q-Line Installation Manual* and the Q-Line card types (see page 783) section in the *Ovation I/O Reference Manual* for information about Q-Line modules.)

The following figure shows the physical locations of the interface ports and their uses:

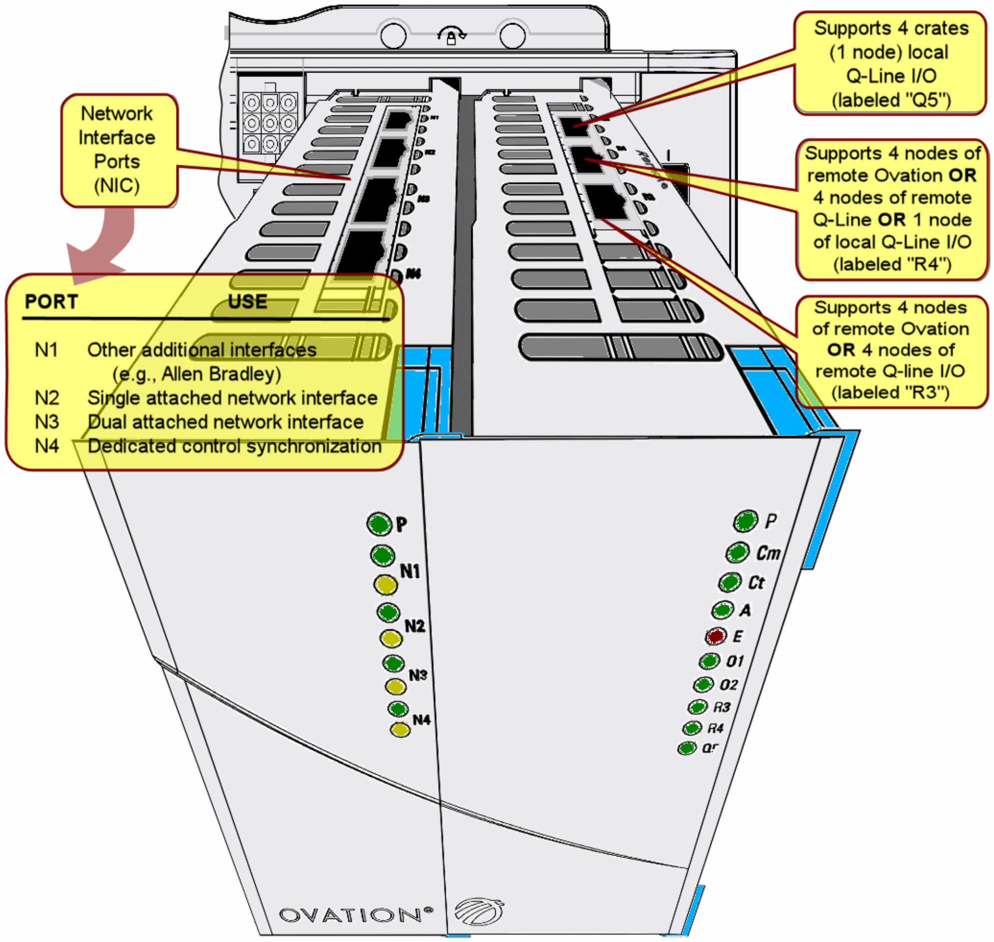
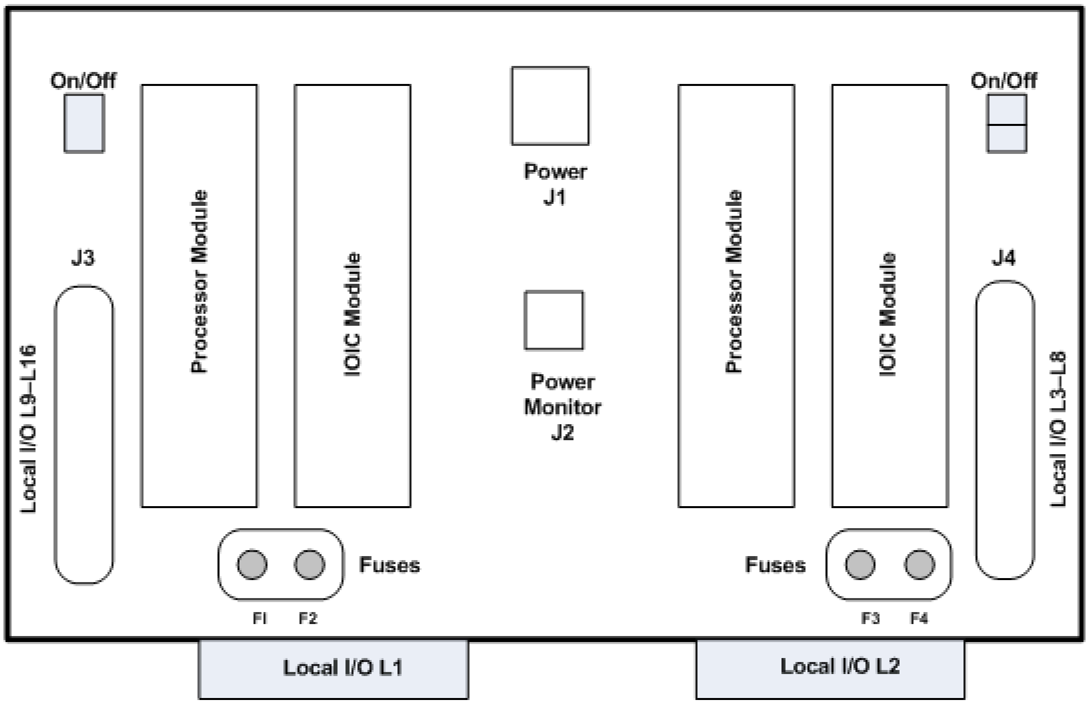


Figure 202: Interface port locations

11.4.2 Controller backplane (OCR400 Controller)



11.4.3 What are the OCR161 Controller cabinet components and interfaces

The Ovation local I/O subsystem has the following features:

- Maximum number of local I/O modules per PCRL: 64 (eight branches with eight modules each).
- Maximum number of Local I/O modules per Controller: **128** (two PCRLs)
- Modular, “plug-in” components.
- Quick installation and configuration of the modules.
- DIN Rail mounting of the I/O base units.
- Unique base unit interconnection scheme eliminates power and communications wiring.

Base unit common to all standard I/O modules and base units are available for Relay Output modules.

The Ovation I/O Controller cabinet contains the following:

- Redundant Ovation Controller Chassis (see page 739) - Housing two separate Controllers. Each Controller contains:
  - Pentium PC Processor Board - To perform I/O control.
  - Power Supply Board - Converts +24V to +5V and ±12V to power all components of the Controller chassis.
  - Network Interface Card - Provides the interface between the Ovation Controller and other network components of the system, FDDI/CDDI and Fast Ethernet versions are supported.
  - PCRL Board - **PCI** to local Ovation I/O interface board, used only if controlling local I/O modules (up to two PCRL cards per each Controller).

- ☐ PCQL Board - **PCI** to local Q-Line interface board, used only if controlling local Q-Line I/O boards (up to two PCQL cards per each Controller). Refer to the *Q-Line Installation Manual* for Q-Line I/O installation information.

- Power Supply - DIN Rail Mounted. Generates +24V to power the electronics in the I/O Controller Cabinet, as well as +24V auxiliary power. Two are required for redundancy. An optional separate +48V auxiliary power supply is also available.
- Power Distribution module (5X000489G01) - Provides connectors for cables used to distribute +24V to the Redundant Controller Chassis, and +24V and auxiliary power to branches of local I/O.
- Standard I/O modules and Bases (see page 740) - Standard Ovation I/O modules which interface to field devices.
- Relay Output module and Bases (see page 771) - Relay module base, 1.5 times larger than a standard I/O base unit, containing Electronics module and relays to control field devices (see page 771).
- I/O Dual Branch Transition Panel (see page 775) (ROP - 4D33922) - Connects to two branches of I/O, providing a point to bring in +24V redundant power, auxiliary power, and the local I/O communications bus.

  Connections are provided on the I/O Transition Panel to daisy-chain the local I/O communications bus from one ROP to the next (up to eight I/O branches **Maximum** may be daisy-chained together).
- I/O Branch Terminator **(1B30023)** - Connects to the A or B-side of a standard I/O base at the end of a branch having no Attachment Unit module to terminate the local I/O bus.

Note: *Refer to the* Planning Your Ovation System *manual for additional cabinet and cable information.*

CAUTION: The I/O addressing for the Ovation database is determined from the positions of the bases installed in the cabinets.

Emerson recommends that all possible bases be installed in the right-most branch of each side of a cabinet, even if they are not all filled with I/O modules. This prevents disruption of the database if additional I/O modules are installed in the future.

I/O modules should be installed in the right-most branch of each side of a cabinet from the BOTTOM UP. I/O modules should be installed in the left-most branch of each side of a cabinet from the TOP DOWN.

If Relay Output modules are mixed with Standard I/O modules on the same branch, the Standard I/O module base must always start in an odd-numbered position on the branch (positions 1/2, 3/4, 5/6, or 7/8).

11.4.4 Controller backplane (CBO) for the OCR161

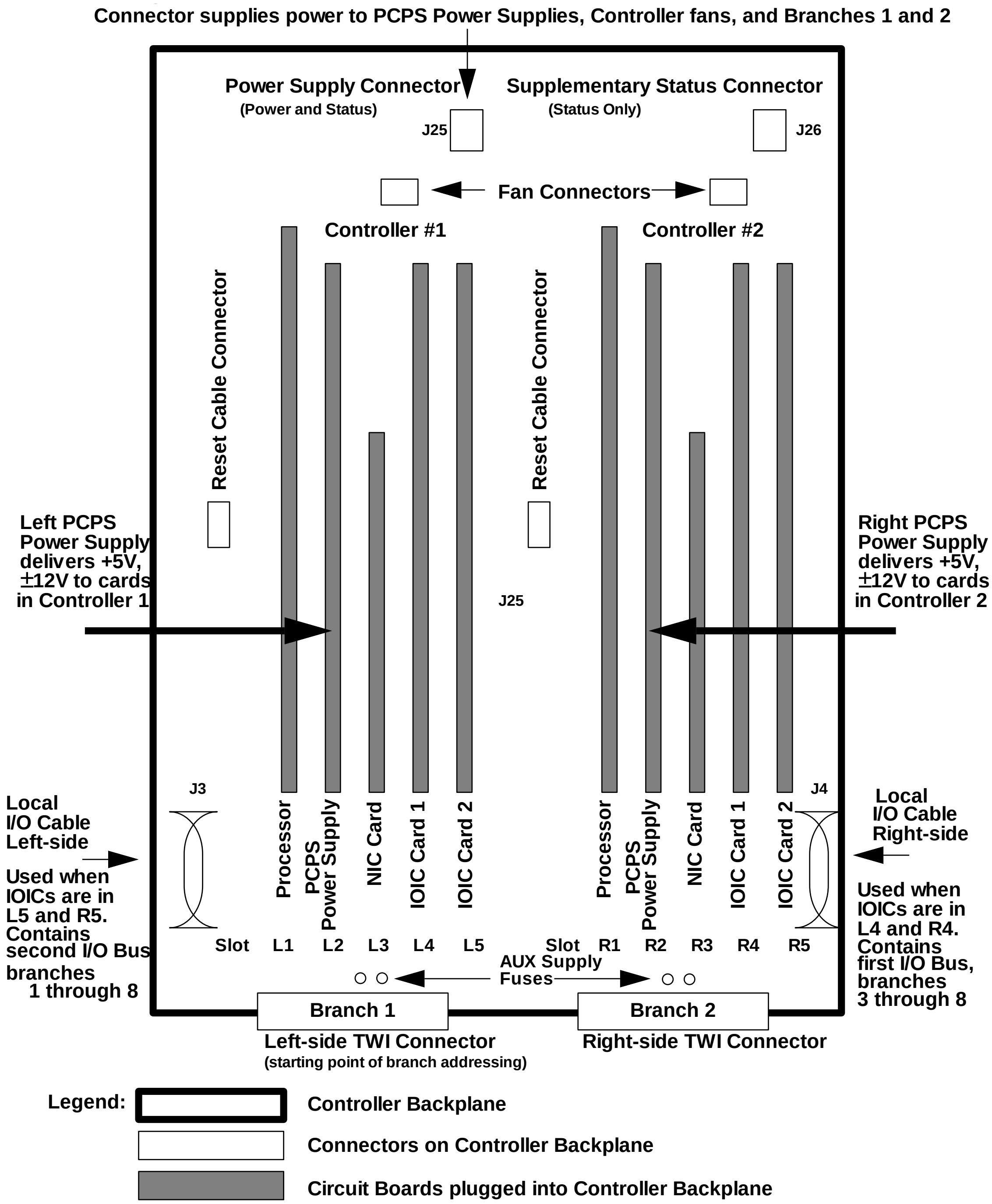


Figure 203: Controller Backplane (CBO)

11.5 Common cabinet components (Controller, remote node, and extended cabinet)

The following figures illustrate components that may be contained in both Controller cabinets, remote node cabinets and extended cabinets:

11.5.1 Ovation Power Distribution Module (PDM)

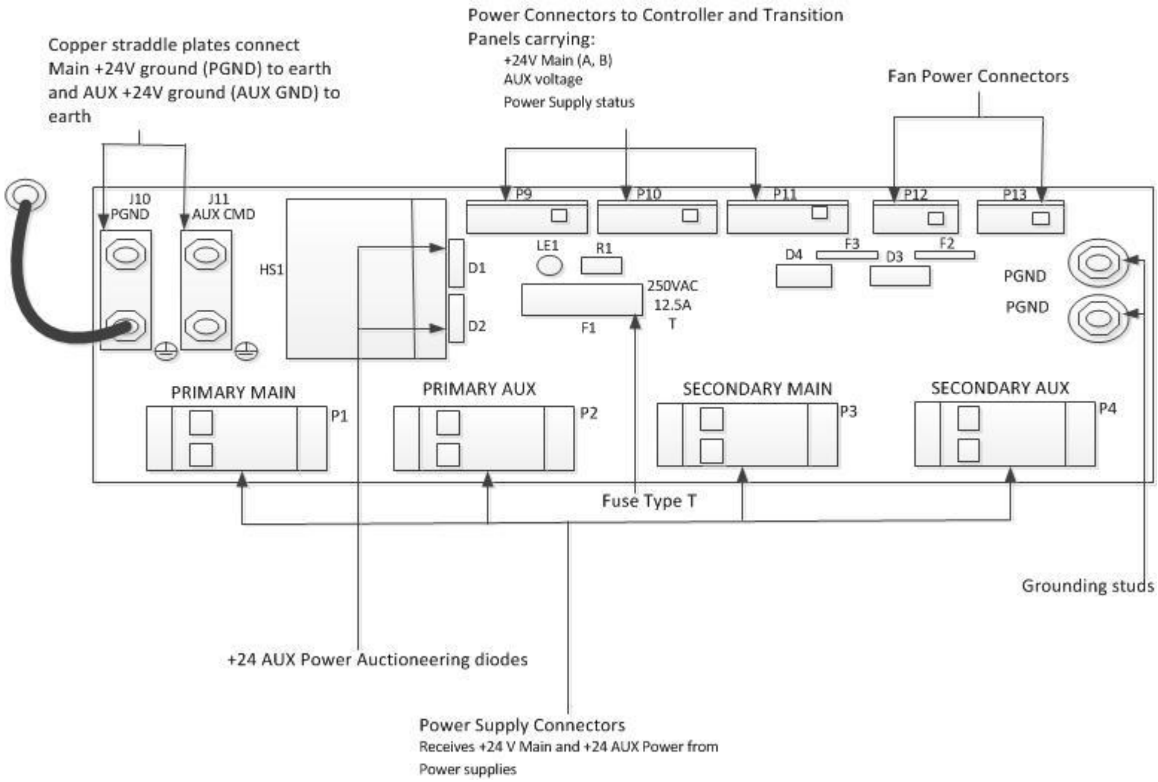


Figure 204: Ovation Power Distribution Module (PDM)

11.5.2 Ovation Standard I/O Modules and Base Units

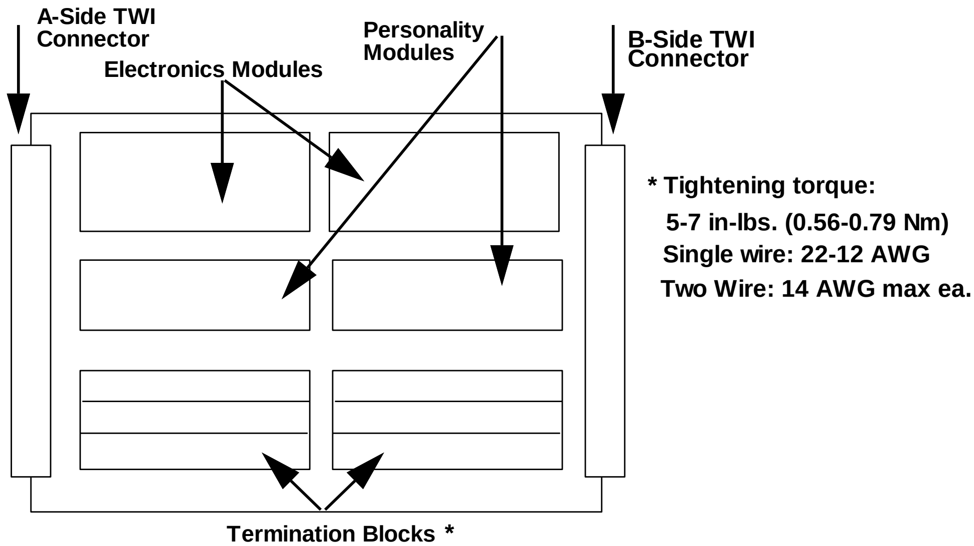


Figure 205: Ovation Standard I/O Modules and Base Units

11.5.3 Relay Output Modules and Bases

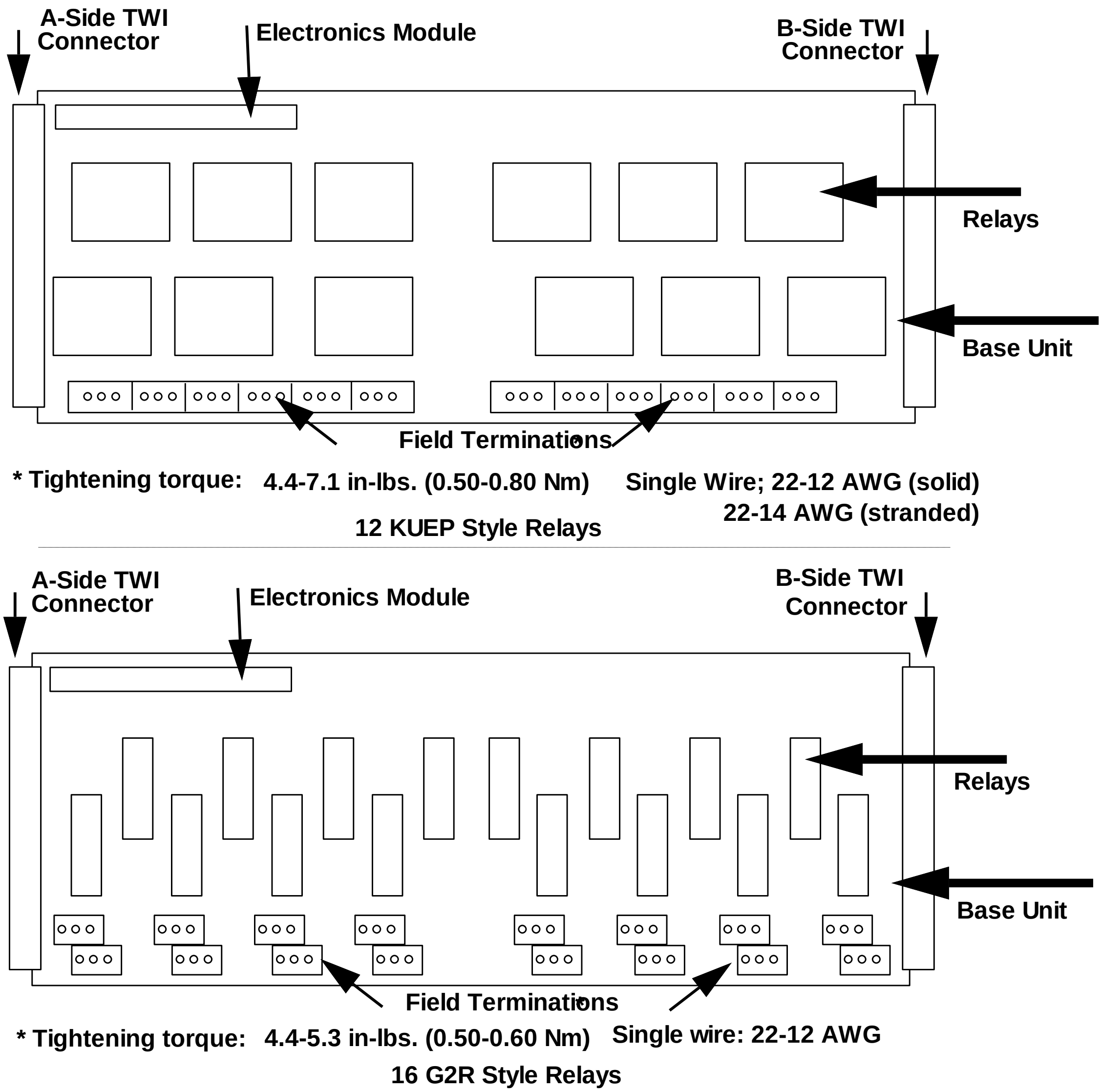


Figure 206: Relay Output Modules and Bases

11.5.4 I/O Dual Branch Transition Panel (ROP)

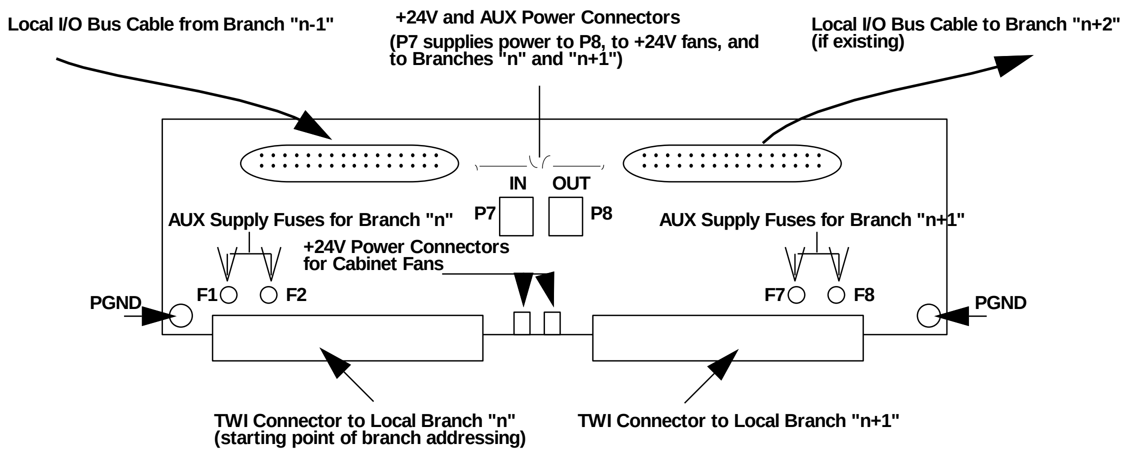
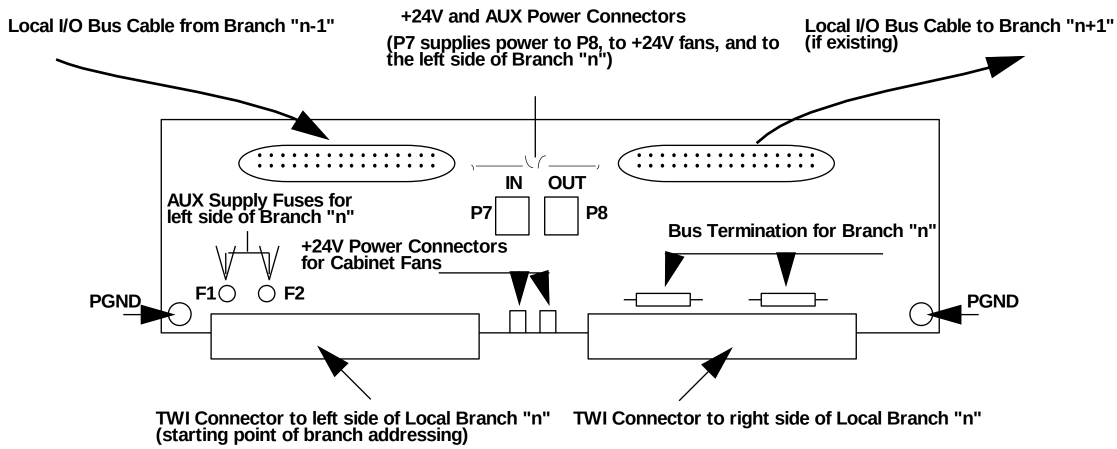


Figure 207: I/O Dual Branch Transition Panel (ROP)

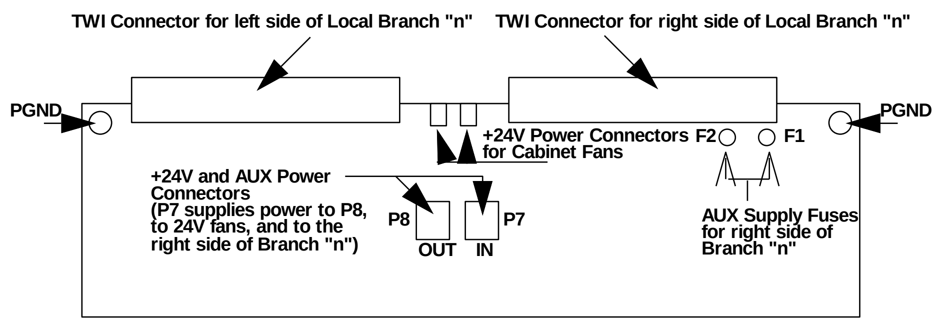
11.5.5 Ovation I/O Single Branch Transition Panels



Note

The RRP is typically used in conjunction with the RRB.

Transition Panel (RRP at top of branch)



Notes

1. **The RRP is typically used in conjunction with the RRB.**
2. **I/O module addresses continue from the left side TWI connector to the right side TWI connector.**

Transition Panel (RRB at bottom of branch)

Figure 208: Ovation I/O Single Branch Transition Panels

11.5.6 Remote Node Controller (RNC)

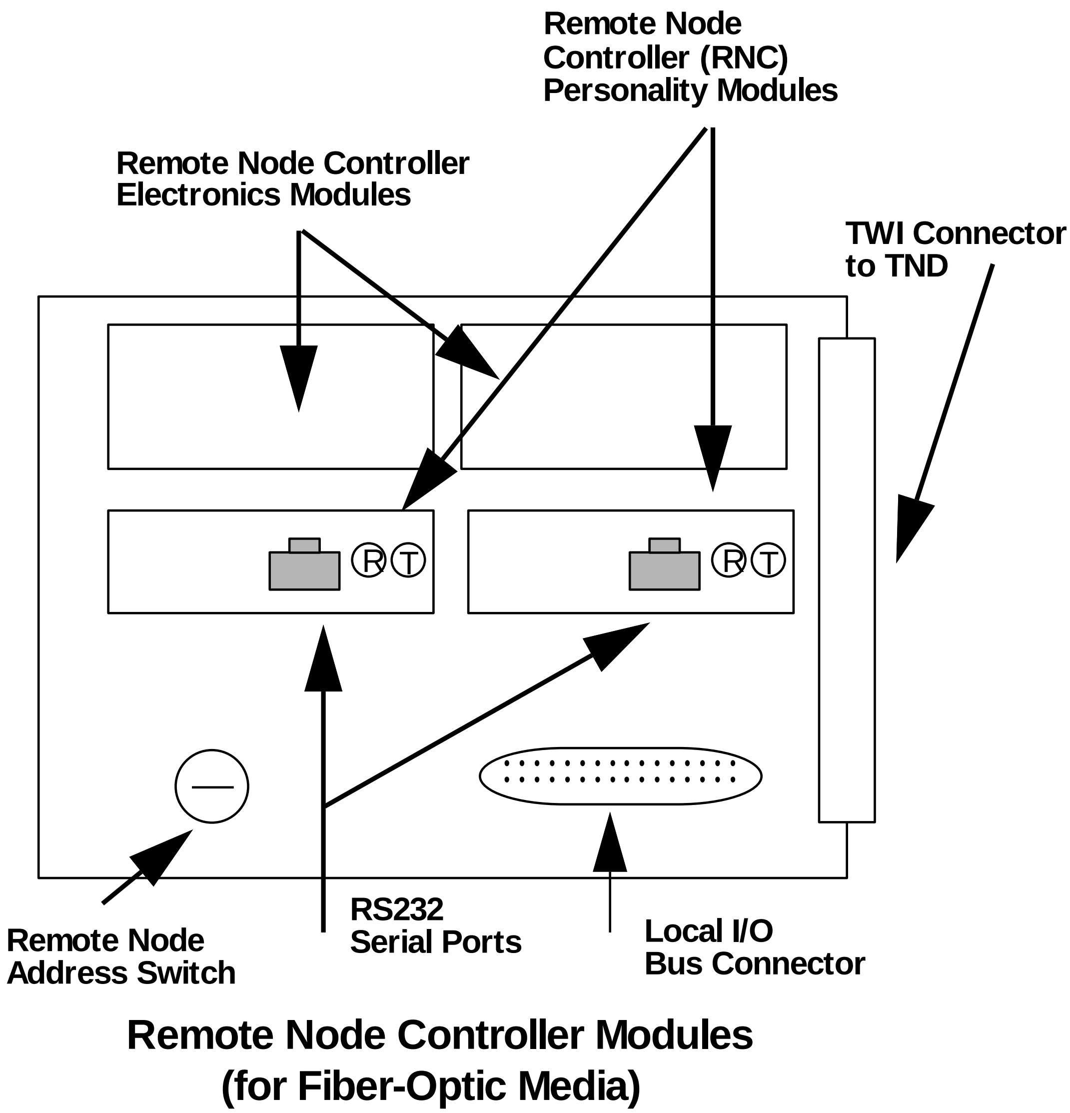


Figure 209: Remote Node Controller (RNC)

11.5.7 Remote Node Transition Panel (TND)

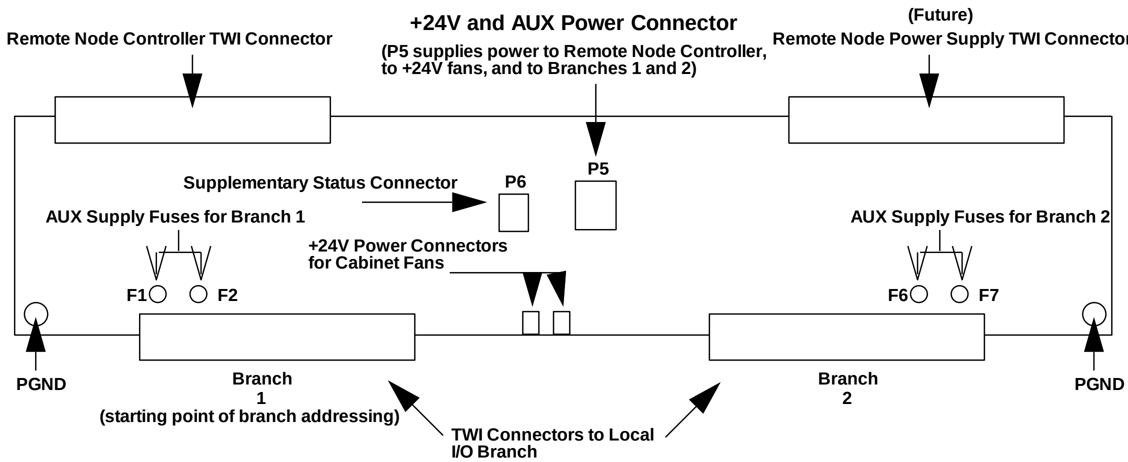


Figure 210: Remote Node Transition Panel (TND)

11.5.8 MAU with typical fiber-optic connector pairs (OCR400 Controller)

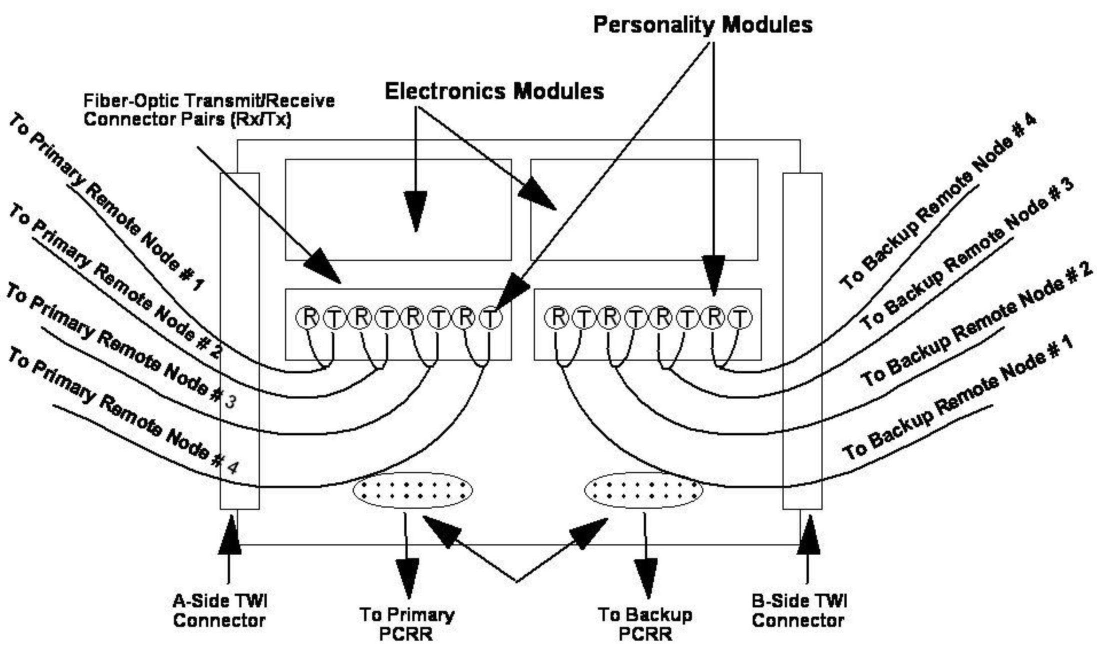


Figure 211: MAU with Typical Fiber-Optic Connector Pairs (OCR400 Controller)

11.5.9 MAU with typical fiber-optic connector pairs (OCR161 Controller)

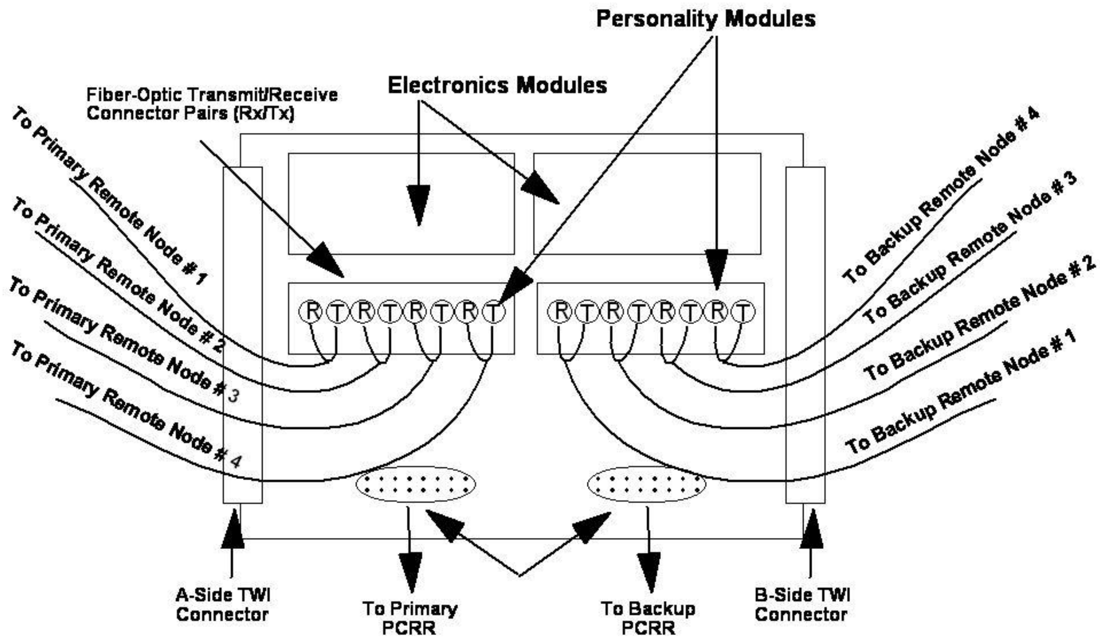


Figure 212: MAU with Typical Fiber-Optic Connector Pairs (OCR400 Controller)

11.6 Common cabinet configurations

11.6.1 Controller cabinet components and cabling (local and remote I/O) (OCR400 Controller)

***Note**: For the new power distribution scheme, refer to the New power distribution scheme (see page 774) section.*

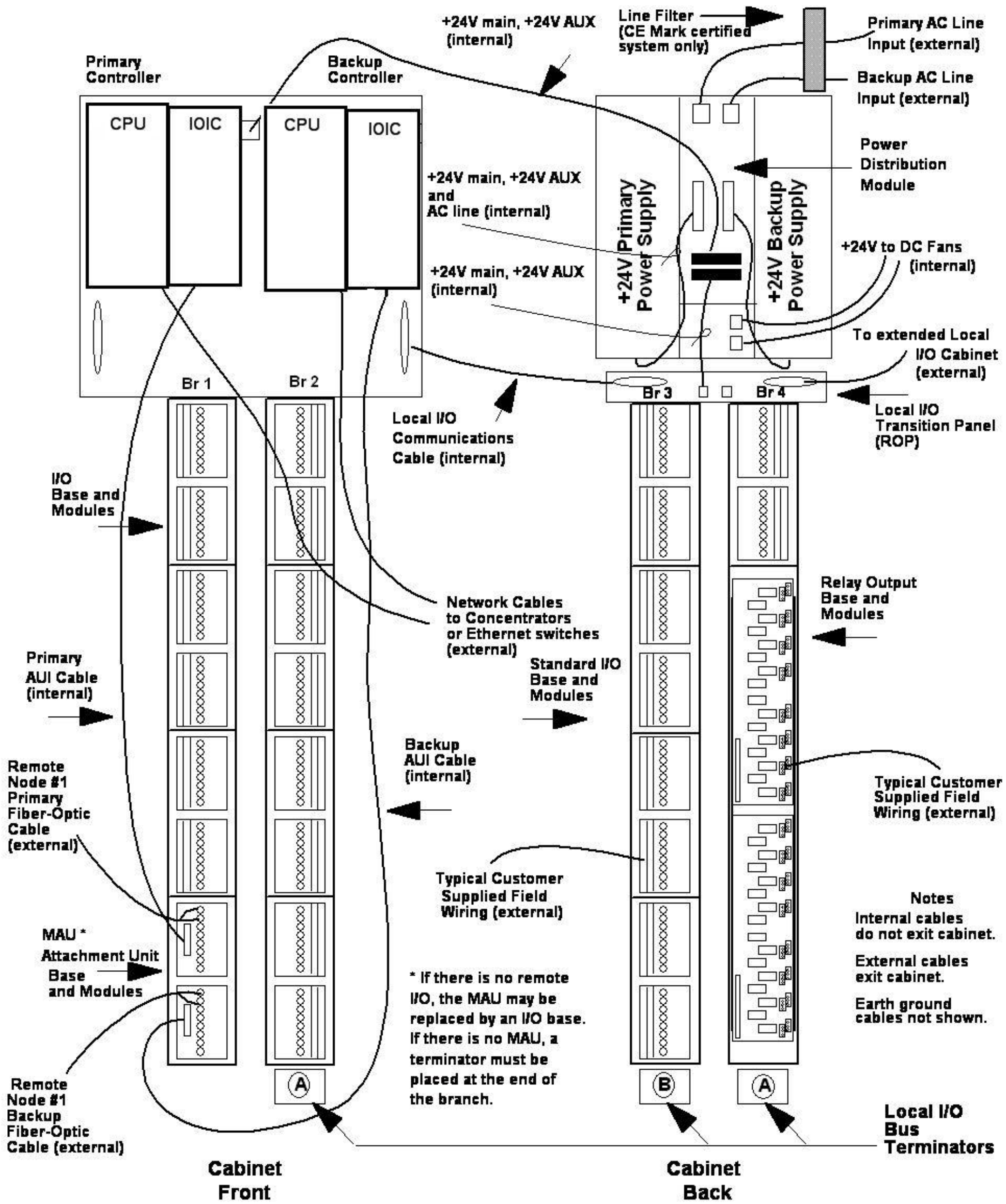


Figure 213: Controller Cabinet Components and Cabling (local and remote I/O) (OCR400 Controller)

11.6.2 Controller cabinet components and cabling (local and remote I/O) (OCR161 Controller)

Note: *For the new power distribution scheme, refer to the New power distribution scheme (see page 774) section.*

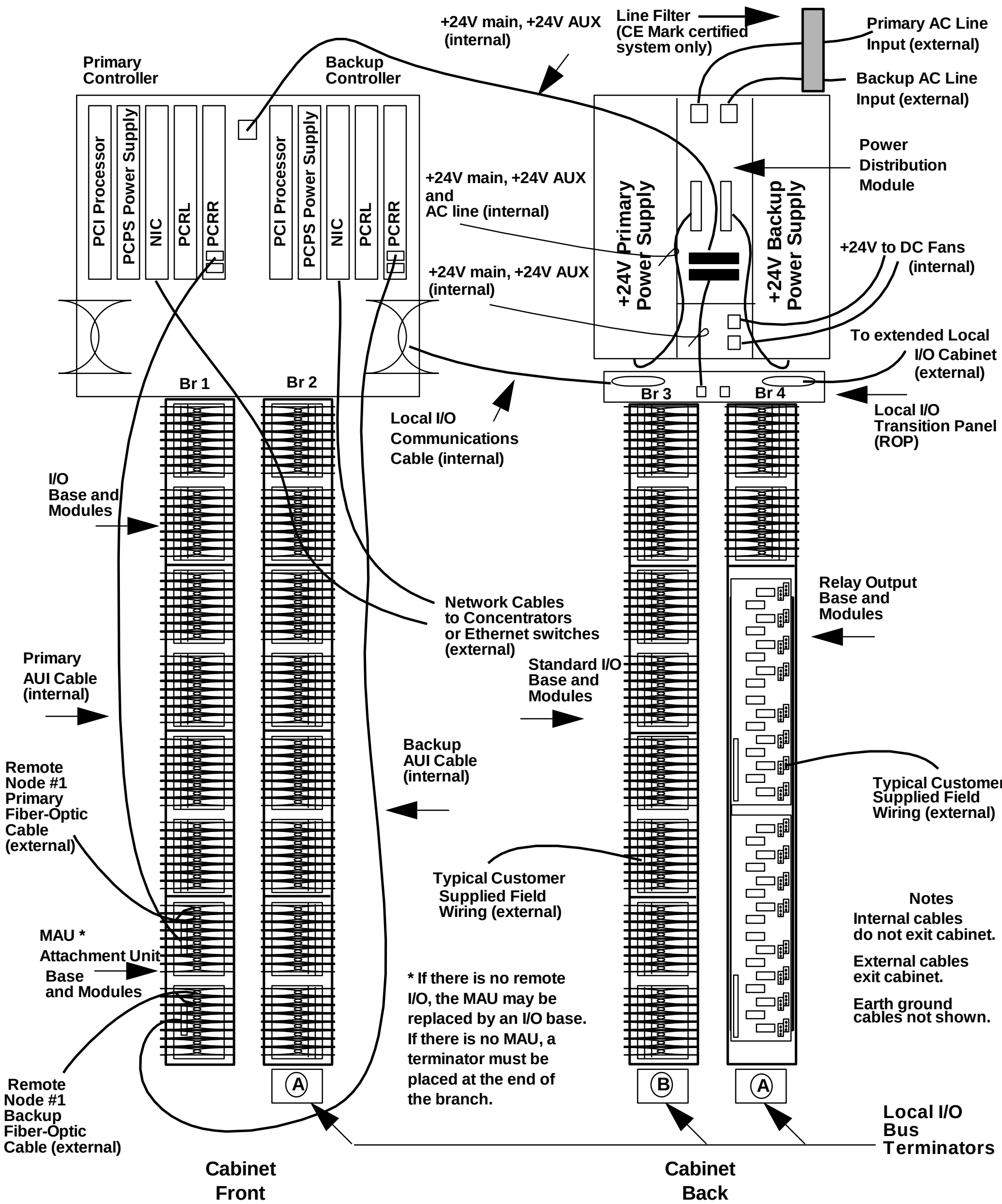


Figure 214: Controller Cabinet Components and Cabling (local and remote I/O) (OCR161 Controller)

11.7 Local I/O

The Ovation Distributed Control System provides modulating control, sequential control, and data acquisition for a variety of system applications. The local Ovation I/O consists of a mix of functional I/O units (modules) that communicate on the I/O bus to the Controller in the Controller's cabinet or in close proximity (9.1 meters (30 ft)).

Note: *Ovation local I/O is applicable for use in CE Mark certified systems except where noted.*

Ovation I/O (see page 752) also provides for remote I/O functions.

Typically, the Ovation local I/O subsystem contains:

- Controller cabinet with the redundant Ovation Controller, applicable IOIC (OCR400) or PCQL/PCRL (OCR161), power supplies, and I/O modules,
- Extended I/O cabinet with additional I/O modules and power supplies.
- Appropriate cable and connections (see page 771) between the cabinets (See *Planning Your Ovation System*.)
- Interface support of existing Q-Line I/O using the IOIC (OCR400) or a PCQL card (OCR161).

Note: *Optional Ovation Marshalling cabinet configurations are also available, which provide for halfshell wiring terminations. (See* Planning Your Ovation System*.)*

11.7.1 Local I/O system configuration for the OCR400

The OCR400 is a second generation Ovation Controller and uses an Ovation I/O Interface Card to communicate with Ovation I/O. Refer to the Ovation *Ovation Controller (OCR400) User Guide* for additional information on the OCR400 I/O configuration.

The Ovation OCR400 Controller contains one IOIC module. This module provides ports that connect to and support the following I/O module locations:

- **Local Ovation I/O** connects through ports L1 and L2.
- **Remote Ovation I/O** connects through IOIC ports R3 (nodes 0 through 3) and R4 (nodes 4 through 7).
- **Local Q-line I/O** connects through IOIC ports Q5 (DIOB 0) and R4 (DIOB 1).
- **Remote Q-line I/O** connects through IOIC ports R3 (nodes 0 through 3) and R4 (nodes 4 through 7).

One OCR400 Controller can support the following I/O modules in various combinations:

- Maximum of **128 local** Ovation I/O modules.
- Maximum of **512 remote** Ovation I/O modules.
- Maximum of **96 local** Q-line I/O cards.
- Maximum of **384 remote** Q-line I/O cards.

Observe the following combination rules:

- If you connect to remote Q-line I/O, you cannot connect to remote Ovation I/O. You can connect to local Q-line through port Q5 (DIOB 0).
- If you connect to remote Ovation I/O, you cannot connect to remote Q-line I/O. You can connect to local Q-line through port Q5 (DIOB 0).
- If you use both ports Q5 and R4 to connect to local Q-line I/O, you cannot connect to any remote I/O.

You can always connect to local Ovation I/O.

Refer to the following diagram for possible combinations:

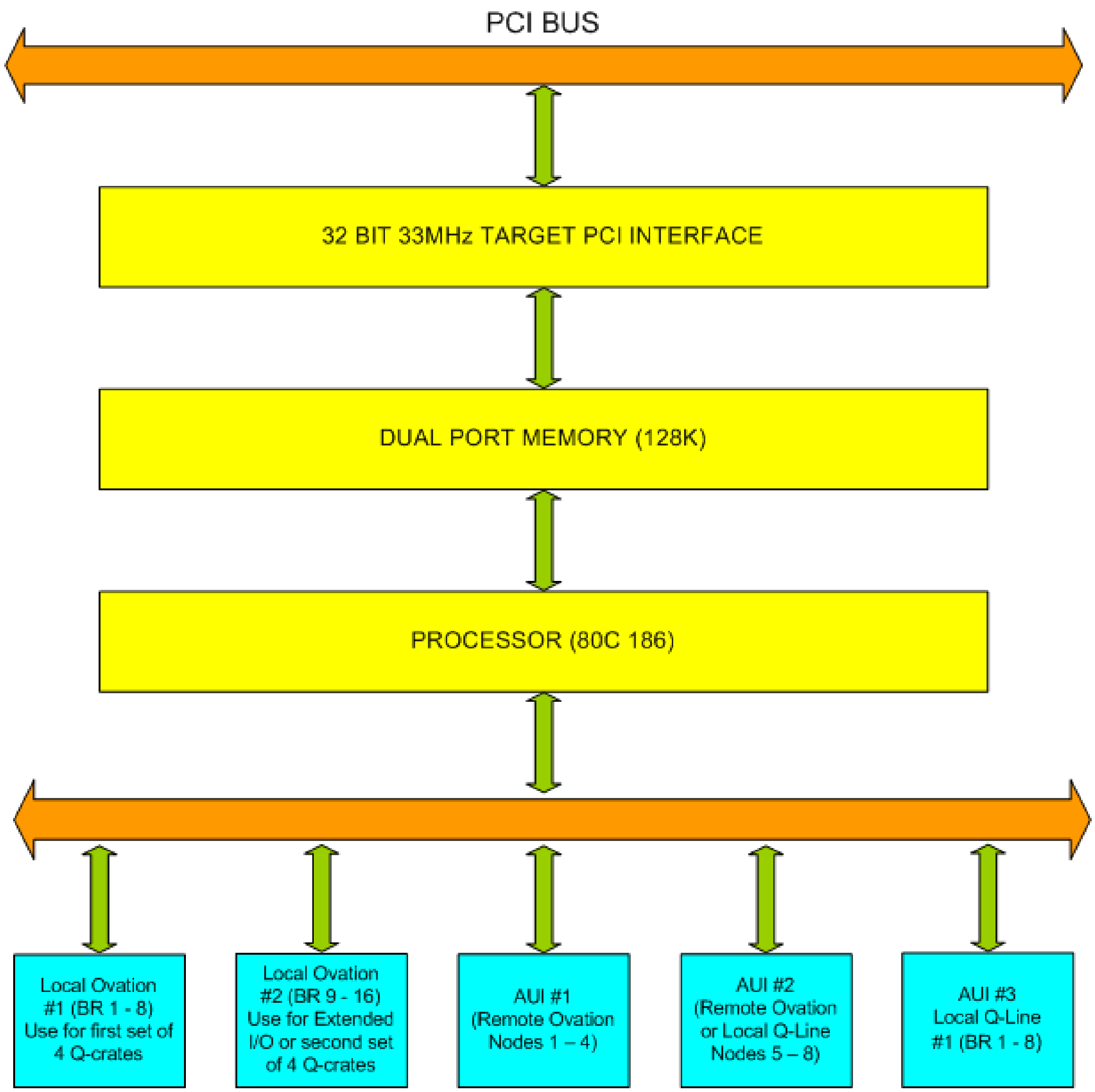


Figure 215: OCR400 I/O ports diagram

11.7.2 Local I/O system configuration for the OCR161

The Ovation local I/O subsystem has the following features:

- Maximum number of local I/O modules per PCRL: 64 (eight branches with eight modules each).
- Maximum number of Local I/O modules per Controller: **128** (two PCRLs)
- Modular, “plug-in” components.
- Quick installation and configuration of the modules.
- DIN Rail mounting of the I/O base units.
- Unique base unit interconnection scheme eliminates power and communications wiring.
- Base unit common to all standard I/O modules and base units are available for Relay Output modules.

11.8 Remote I/O

Note: *Ovation remote I/O is applicable for use in CE Mark certified systems except where noted.*

The Ovation Distributed Control System provides modulating control, sequential control, and data acquisition for a variety of system applications. Although using local I/O is typically the most practical control solution, a remote process might need to be controlled.

Remote I/O is typically used where a process requires that I/O modules be located near the process, even though the Controller is not. The remote I/O modules are connected to the Controller through long distance, serial media, such as fiber-optic cables.

Typically, the Ovation remote I/O subsystem contains:

- Controller cabinet (see page 757) containing the redundant Ovation Controller, applicable I/O Interface Controller (IOIC) or PCI cards, power supplies, and I/O modules.
- Remote Node cabinet(s) (see page 761) containing the redundant Remote Node Controller module, as well as I/O cards.
- Extended I/O cabinet (see page 759) containing additional I/O modules and power supplies.
- Appropriate cable and connections between cabinets (See *Planning Your Ovation System*.)

Note: *An optional Ovation Marshalling cabinet is also available. The rear of this 32 inch wide cabinet provides for halfshell wiring terminations, but has the same mechanical and electrical performance as the standard Ovation cabinet. (See* Planning Your Ovation System*.)*

11.8.1 Remote I/O features (OCR400 Controller)

The Ovation remote I/O subsystem has the following features:

- Maximum number of Remote Nodes: **8 nodes**, redundant Controller.
- Maximum number of I/O modules per remote node: **64**[1] (eight branches with eight modules for each branch).
- Maximum number of I/O modules per Controller: **512**[1].
- Remote I/O Bus configuration: 10 BASE-FL Ethernet physical layer with a proprietary protocol.
- Remote I/O cycle time: <**100** microseconds (no repeaters[2]), double byte word master/slave access as seen by the IOIC.
- Cyclic redundancy checking on all outbound and inbound messages. Retries on failed messages.
- Standard Remote communications media offered: **Fiber-optic**
- Maximum cable length (see page 757) for 850 nm fiber-optic media: **2 km**
- Maximum cable length (see page 757) for 1300 nm fiber-optic media: **4 km**
- Remote communication diagnostics can be performed in the Primary and Backup system without affecting I/O modules. The diagnostics available are:
    1. Simulation of all types of bus cycles (such as local I/O including statuses, bit corruption, message length faults, collision faults, and no response).
    2. Loopback of all messages from IOIC through the MAU.
    3. Connection check of AUI cable and remote node link.
- Status LEDs: Available on IOIC, MAU, and RNC modules.
- Interface support of existing Q-Line I/O using Q-Line QOR card.
- Redundancy provided through independent MAU and RNC modules as well as communication media. The primary Controller has sole access to the remote I/O. The backup can perform diagnostic tests of the backup remote I/O link and RNC.

[1] These numbers represent hardware capabilities. Controller software limitations are not implied.

[2] Repeaters are third-party Ethernet devices that must be endorsed by Emerson design engineers.

11.8.2 Controller cabinet components (Remote I/O) (OCR400 Controller)

The Ovation Remote I/O Controller cabinet (see page 749) contains the following:

- Redundant Controller Chassis - This rack in the Controller cabinet provides the backplane for two separate Controllers. For each Controller, the backplane interconnects the following components:
    - ☐ CPU module. Includes Fast Ethernet network interface.
    - ☐ IOIC module - I/O interface Controller module serving as the master of the remote I/O bus. Refer to the *Q-Line Installation Manual* for remote Q-Line I/O installation information (only 850 nm optics, with 2 km Maximum length, are available for remote Q-Line applications).

An IOIC module has two Attachment Unit Interface (AUI) ports each of which may connect to an Attachment Unit module using an AUI cable. Together, the two ports typically serve as the primary I/O bus master with another IOIC providing the redundant pair.

The IOIC module provides local power for itself and the CPU module.

- Power Supply - DIN Rail Mounted. Generates +24V to power the electronics in the I/O Controller Cabinet, as well as +24V auxiliary power. Two are required for redundancy. An optional separate +48V auxiliary power supply is also available.
- Power Distribution module (5X000489G01) - Provides connectors for cables used to distribute +24V to the Redundant Controller Chassis, and +24V and auxiliary power to branches of local I/O.
- Standard I/O modules and bases (see page 741) - Standard Ovation I/O modules which interface to field devices.
- Relay Output module and bases (see page 742) - Relay module base, 1.5 times larger than a standard I/O base unit, containing Electronics module and relays to control field devices).
- I/O Dual Branch Transition Panel (see page 743) (ROP - 4D33922) - Connects to two branches of I/O, providing a point to bring in +24V redundant power, auxiliary power, and the local I/O communications bus.

  Connections are provided on the I/O Transition Panel to daisy-chain the local I/O communications bus from one ROP to the next (up to eight I/O branches Maximum may be daisy-chained together).
- I/O Branch Terminator (see page 744) (1B30023) - Connects to the A or B-side of a standard I/O base at the end of a branch having no Attachment Unit module to terminate the local I/O bus.

CAUTION: The I/O addressing for the Ovation database is determined from the positions of the bases installed in the cabinets.

Emerson recommends that all possible bases (typically four) be installed in the right-most branch of each side of a cabinet, even if they are not all filled with I/O modules. This prevents disruption of the database if additional I/O modules are installed in the future.

I/O modules should be installed in the right-most branch of each side of a cabinet from the BOTTOM UP. I/O modules should be installed in the left-most branch of each side of a cabinet from the TOP DOWN.

If Relay Output modules are mixed with Standard I/O modules on the same branch, the Standard I/O module base must always start in an odd-numbered position on the branch (positions 1/2, 3/4, 5/6, or 7/8).

- Media Attachment Unit (see page 747) (**MAU**) - This module provides a point of attachment for fiber optic cables used to transfer messages over long distances between the IOIC and up to four remote nodes (see page 770). The module directs messages between the IOIC and one of the four remote nodes at a time as selected, converting signals readable by the IOIC to signals compatible with the fiber optic media and vice versa. The following components comprise the MAU:
  - Electronics module (1C31179) - Houses the Attachment Unit Logic Board (LAU) which provides power for the module and displays LED indication that the fiber optic cables are connected and the Remote Node Controller module has power.

- Personality module (1C31181) - Houses the Attachment Unit Personality Board (PAU) which translates signals between the PCRR and the fiber optic media and provides connectors for the fiber optic cables.

MAU Subsystem

Electronics Module	Personality Module	Length of Optical Link[1]	Channels	Optics
1C31179G01	1C31181G01	Up to 2 kilometers (6,560 ft)	2	850 nm
1C31179G02	1C31181G02	Up to 2 kilometers (6,560 ft)	4	850 nm
1C31179G01	1C31181G03	Up to 4 kilometers (13,120 ft)	2	1300 nm
1C31179G02	1C31181G04	Up to 4 kilometers (13,120 ft)	4	1300 nm

[1] In order not to be required to select extended IOIC time-out periods, it is recommended that you do NOT exceed an optical length of 3.7 km.

[2] An Ovation Controller cabinet MAU MUST use the same type of optics (850 nm or 1300 nm) for each of the remote nodes that it interfaces. An MAU cannot interface both 850 nm remote nodes (using 1C1204G01 Personality modules) and 1300 nm remote nodes (using 1C31204G03 Personality modules.)

- Media Attachment Unit Base **(1C31206)** - This base holds a Maximum of two modules and provides a connector for the AUI Cable which interconnects the IOIC and Attachment Unit module. The backplane routes +24V to the Attachment Unit modules for power. It also provides local I/O bus termination.

Therefore, I/O branch terminator boards are not required at the end of branches where Media Attachment Unit modules are placed.

11.8.3 Remote I/O features (OCR161 Controller)

The Ovation remote I/O subsystem has the following features:

- Maximum number of Remote Nodes: **16 nodes**, redundant controlled (eight nodes for each PCRR card).
- Maximum number of I/O modules per remote node: **64**[1] (eight branches with eight modules for each branch).
- Maximum number of I/O modules per PCRR card: **512**[1] (eight nodes, eight branches for each node, eight modules for each branch).
- Maximum number of I/O modules per Controller: **1024**[1].
- Remote I/O Bus configuration: 10 BASE-FL Ethernet physical layer with a proprietary protocol.
- Remote I/O cycle time: <**100** microseconds (typical), double byte word access as seen by PCRR.
- Standard Remote communications media offered: **Fiber-optic**
- Maximum cable length (see page 757) for 850 nm fiber-optic media: **2 km**
- Maximum cable length (see page 757) for 1300 nm fiber-optic media: **4 km**
- Remote communication diagnostics can be performed in the Primary and Backup system without affecting I/O modules. The diagnostics available are:
  1. Simulation of all types of bus cycles (such as local I/O including statuses, bit corruption, message length faults, collision faults, and no response).
  2. Loopback of all messages from PCRR through the MAU.
  3. Connection check of AUI cable and remote node link.
- Status LEDs: Available on PCRR, MAU, and RNC modules.
- Interface support of existing Q-Line I/O using Q-Line QOR card.

[1] These numbers represent hardware capabilities. Controller software limitations are not implied.

11.8.4 Controller cabinet components (Remote I/O) (OCR161 Controller)

The Ovation Remote I/O Controller cabinet (see page 749) contains the following:

- Redundant Controller Chassis - This rack in the Controller cabinet provides the backplane for two separate Controllers. For each Controller, the backplane interconnects the following components:
  - ☐ Pentium PC Processor Board - Third-party functional processor for the Controller.
  - ☐ Power Supply Board Kit - Contains a PCPS power supply converting +24V to +5V and ±12V to power all components in the Controller chassis.
  - ☐ Network Interface Card (NIC) - Provides the interface between the Ovation Controller, and the other network components of the system. FDDI/CDDI and Fast Ethernet versions are supported.
  - ☐ PCRR Board - **IOIC** (**PCI)** to remote Ovation or Q-Line I/O interface board, serving as the master of the remote I/O bus. Refer to the *Q-Line Installation Manual* for remote Q-Line I/O installation information (only 850 nm optics, with 2 km Maximum length, are available for remote Q-Line applications).

A PCRR board has two Attachment Unit Interface (AUI) ports each of which may connect to an Attachment Unit module using an AUI cable. Together, the two ports typically serve as the primary I/O bus master with another PCRR card providing the redundant pair (up to two PCRR cards per each Controller).

- Power Supply - DIN Rail Mounted. Generates +24V to power the electronics in the I/O Controller Cabinet, as well as +24V auxiliary power. Two are required for redundancy. An optional separate +48V auxiliary power supply is also available.
- Power Distribution module (5X000489G01) - Provides connectors for cables used to distribute +24V to the Redundant Controller Chassis, and +24V and auxiliary power to branches of local I/O.
- Standard I/O modules and bases (see page 741) - Standard Ovation I/O modules which interface to field devices.
- Relay Output module and bases (see page 742) - Relay module base, 1.5 times larger than a standard I/O base unit, containing Electronics module and relays to control field devices).
- I/O Dual Branch Transition Panel (see page 743) (ROP - 4D33922) - Connects to two branches of I/O, providing a point to bring in +24V redundant power, auxiliary power, and the local I/O communications bus.

  Connections are provided on the I/O Transition Panel to daisy-chain the local I/O communications bus from one ROP to the next (up to eight I/O branches Maximum may be daisy-chained together).
- I/O Branch Terminator (see page 744) (1B30023) - Connects to the A or B-side of a standard I/O base at the end of a branch having no Attachment Unit module to terminate the local I/O bus.

> **CAUTION**: The I/O addressing for the Ovation database is determined from the positions of the bases installed in the cabinets.
>
> We recommend that all possible bases (typically four) be installed in the right-most branch of each side of a cabinet, even if they are not all filled with I/O modules. This prevents disruption of the database if additional I/O modules are installed in the future.
>
> I/O modules should be installed in the right-most branch of each side of a cabinet from the BOTTOM UP. I/O modules should be installed in the left-most branch of each side of a cabinet from the TOP DOWN.
>
> If Relay Output modules are mixed with Standard I/O modules on the same branch, the Standard I/O module base must always start in an odd-numbered position on the branch (positions 1/2, 3/4, 5/6, or 7/8).

- Media Attachment Unit (see page 747) (**MAU**) - This module provides a point of attachment for fiber optic cables used to transfer messages over long distances between the PCRR and up to four remote nodes (see page 770). The module directs messages between the PCRR and one of the four remote nodes at a time as selected, converting signals readable by the PCRR to signals compatible with the fiber optic media and vice versa. The following components comprise the MAU:
  - Electronics module (1C31179) - Houses the Attachment Unit Logic Board (LAU) which provides power for the module and displays LED indication that the fiber optic cables are connected and the Remote Node Controller module has power.
  - Personality module (1C31181) - Houses the Attachment Unit Personality Board (PAU) which translates signals between the PCRR and the fiber optic media and provides connectors for the fiber optic cables.

MAU Subsystem

Electronics Module	Personality Module	Length of Optical Link[1]	Channels	Optics
1C31179G01	1C31181G01	Up to 2 kilometers (6,560 ft)	2	850 nm
1C31179G02	1C31181G02	Up to 2 kilometers (6,560 ft)	4	850 nm
1C31179G01	1C31181G03	Up to 4 kilometers (13,120 ft)	2	1300 nm
1C31179G02	1C31181G04	Up to 4 kilometers (13,120 ft)	4	1300 nm
[1] In order not to be required to select extended PCRR time-out periods, it is recommended that you do NOT exceed an optical length of 3.7 km. [2] An Ovation Controller cabinet MAU MUST use the same type of optics (850 nm or 1300 nm) for each of the remote nodes that it interfaces. An MAU cannot interface both 850 nm remote nodes (using 1C1204G01 Personality modules) and 1300 nm remote nodes (using 1C31204G03 Personality modules.)				

- Media Attachment Unit Base **(1C31206)** - This base holds a Maximum of two modules and provides a connector for the AUI Cable which interconnects the PCRR and Attachment Unit module. The backplane routes +24V to the Attachment Unit modules for power. It also provides local I/O bus termination.

Therefore, I/O branch terminator boards are not required at the end of branches where Media Attachment Unit modules are placed.

11.9 Extended I/O cabinet components

The Ovation I/O Extended cabinet contains the following:

Note: *Refer to the* Planning Your Ovation System *manual for additional cabinet and cable information.*

- Power Supply - DIN Rail Mounted. Generates +24V to power the electronics in the I/O Controller Cabinet, as well as +24V auxiliary power. Two are required for redundancy.
- Power Distribution module (5X000489G01) - Provides connectors for cables used to distribute +24V to branches of local I/O, and in the Redundant RNC in remote cabinets.
- Standard I/O modules and Base (see page 741) - Standard Ovation I/O modules which interface to field devices.
- Relay Output module and Base (see page 742) - Relay module base, 1.5 times larger than a standard I/O base unit, containing Electronics module and relays to control field devices.
- I/O Dual Branch Transition Panel (see page 743) (ROP - 4D33922) - Connects to two branches of I/O, providing a point to bring in +24V redundant power, auxiliary supplies, and the local I/O communications bus.

  Connections are provided on the I/O Transition Panel to daisy-chain the local I/O communications bus from one ROP to the next (up to eight I/O branches Maximum may be daisy-chained together).
- I/O Single Branch Transition Panels (see page 744) (Top - RRP 3A99252; Bottom - RRB 3A99253) - Used with Relay Output modules for a single I/O branch of up to eight relay bases.

  Supplies +24V redundant power, auxiliary power, and local communications bus to the branch. Mounted at the top/bottom of the extended cabinet. Only one I/O branch is used and remaining branches are passed on.

***Note**: For the new power distribution scheme, refer to the New power distribution scheme (see page 774) section.*

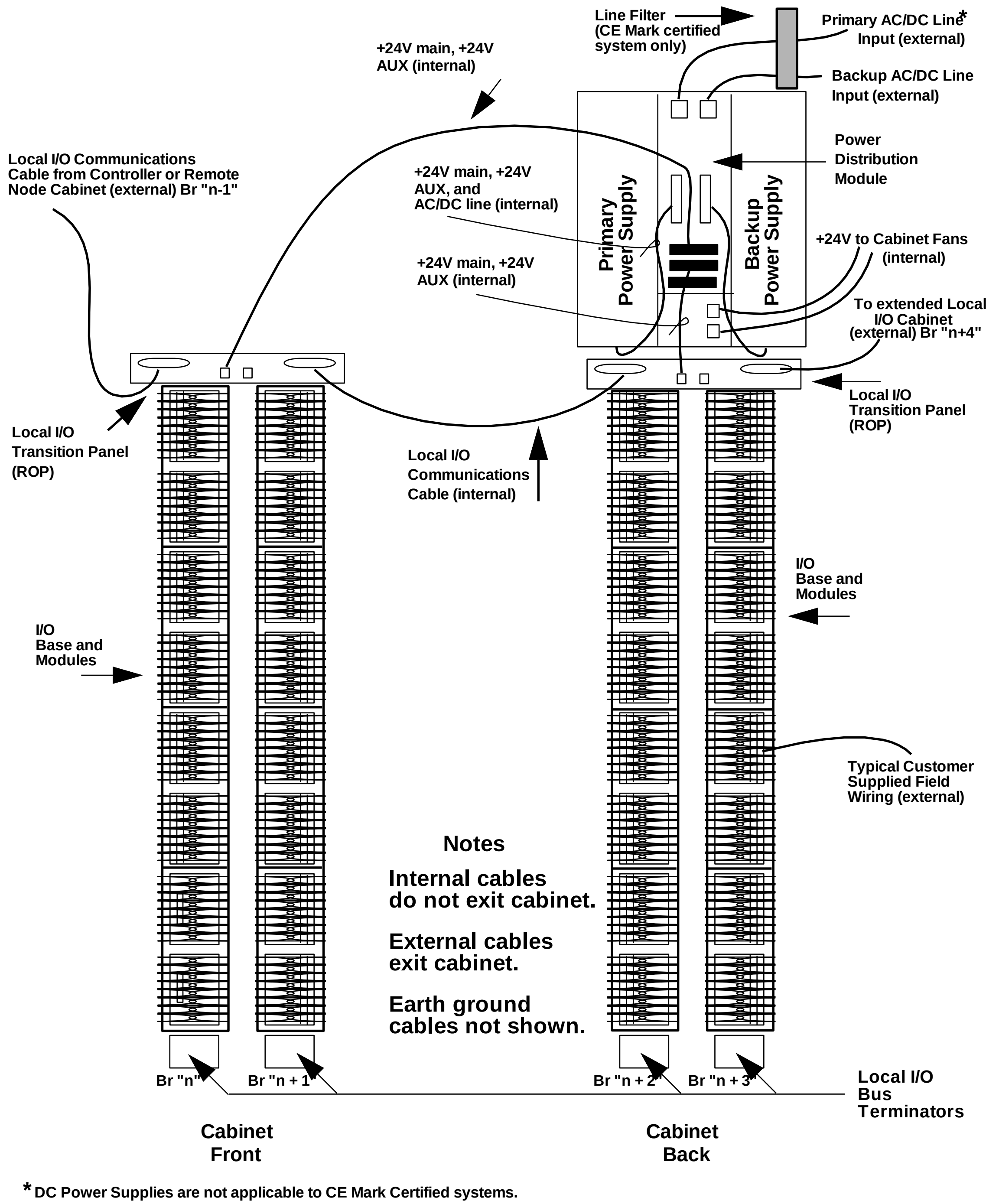


Figure 216: Ovation Extended I/O Cabinet (illustrating cables and Standard I/O)

11.10 Remote node cabinet components

The Ovation Remote Node (see page 763) cabinet, located remotely from the Controller cabinet contains the following:

- Power Supply - DIN Rail Mounted. Generates +24V to power the electronics in the Remote Node Cabinet, as well as +24V auxiliary power. Two are required for redundancy.
- Remote Node Controller (RNC) module (see page 745) - Provides a point of attachment for remote I/O media used to transfer messages between the remote node and the MAU. There are only two Remote Node Controller modules per remote node (one primary, one backup), regardless of the number of cabinets at the node. The module translates messages from the remote I/O bus into local I/O bus cycles that can be directed to as many as eight branches of local I/O modules.

  The following components comprise the Remote Node Controller module:

  - Remote Node Electronics module **(1C31203)** - Prepares messages received from the remote I/O Controller for the local I/O modules at the remote node. When an I/O module responds to the message, the module prepares the response to be sent back to the Controller over the fiber-optic media.
  - Remote Node Personality module **(1C31204G01 for 850 nm optics/1C31204G03 for 1300 nm optics)** - Houses the Remote Node Personality Board (PAU) which provides connectors for the media used to transmit and receive remote messages between the Controller and remote node. Group 1 modules provide fiber-optic connections; (future plans are that group 2 modules provide an AUI port used to connect to third-party transceivers). Power supply monitoring circuitry of the +24V redundant supplies is located on this module and is reported back to the Electronics module to flag failure of the primary or backup supply.
  - Remote Node Controller Base **(1C31205)** - This unique base holds a Maximum of two Remote Node modules and interfaces directly to two I/O branches. It provides a rotary switch for node addressing and a D-connector for interfacing to as many as six additional I/O branches using a local I/O communications cable. The RNC base unit is connected to the Remote Node Transition Panel described below.

- Remote Node Transition Panel **(see page 746) (TND - 4D33924)** - Interconnects the RNC base, Remote Power Supply module (if used), and the branches of local I/O in a single Remote Node cabinet. The Remote Node Transition Panel (TND) also provides connectors for DIN Rail Mounted +24V Supplies or auxiliary supplies to be wired into the remote node.
- Power Distribution module **(PDM - 5A26304)** - Provides connectors for cables used to distribute +24V to the Redundant RNC, and +24V and auxiliary power to the branches of I/O.
- Standard I/O modules and Base (see page 741) - Standard Ovation I/O modules which interface to remote field devices when placed in the Remote Node cabinet.
- Relay Output module and Base (see page 742) - Relay Output I/O modules which interface to remote field devices when placed in the Remote Node cabinet.
- I/O Dual Branch Transition Panel (see page 743) (ROP - 4D33922) - Connects to two branches of I/O, providing a point to bring in +24V redundant power, auxiliary power, and the local I/O communications bus.

  Connections are provided on the I/O Transition Panel to daisy-chain the local I/O communications bus from one ROP to the next (up to eight I/O branches **Maximum** may be daisy-chained (see page 766) together.

- I/O Single Branch Transition Panels (see page 744) **(Top - RRP 3A99252; Bottom - RRB 3A99253) -** Used with Relay Output modules for a single I/O branch of up to eight relay bases.

  Supplies +24V redundant power, auxiliary power, and local communications bus to the branch. Mounted at the top/bottom of the extended cabinet (see page 744). Only one I/O branch is used and branches 2 through 8 are passed on.

- I/O Branch Terminator Board A or B **(1B30023) -** Connects to the A/B-side of a standard I/O base (see page 763) at the end of a branch to terminate the I/O bus.

11.10.1 Typical Remote Node Cabinet

***Note**: For the new power distribution scheme, refer to the New power distribution scheme (see page 774) section.*

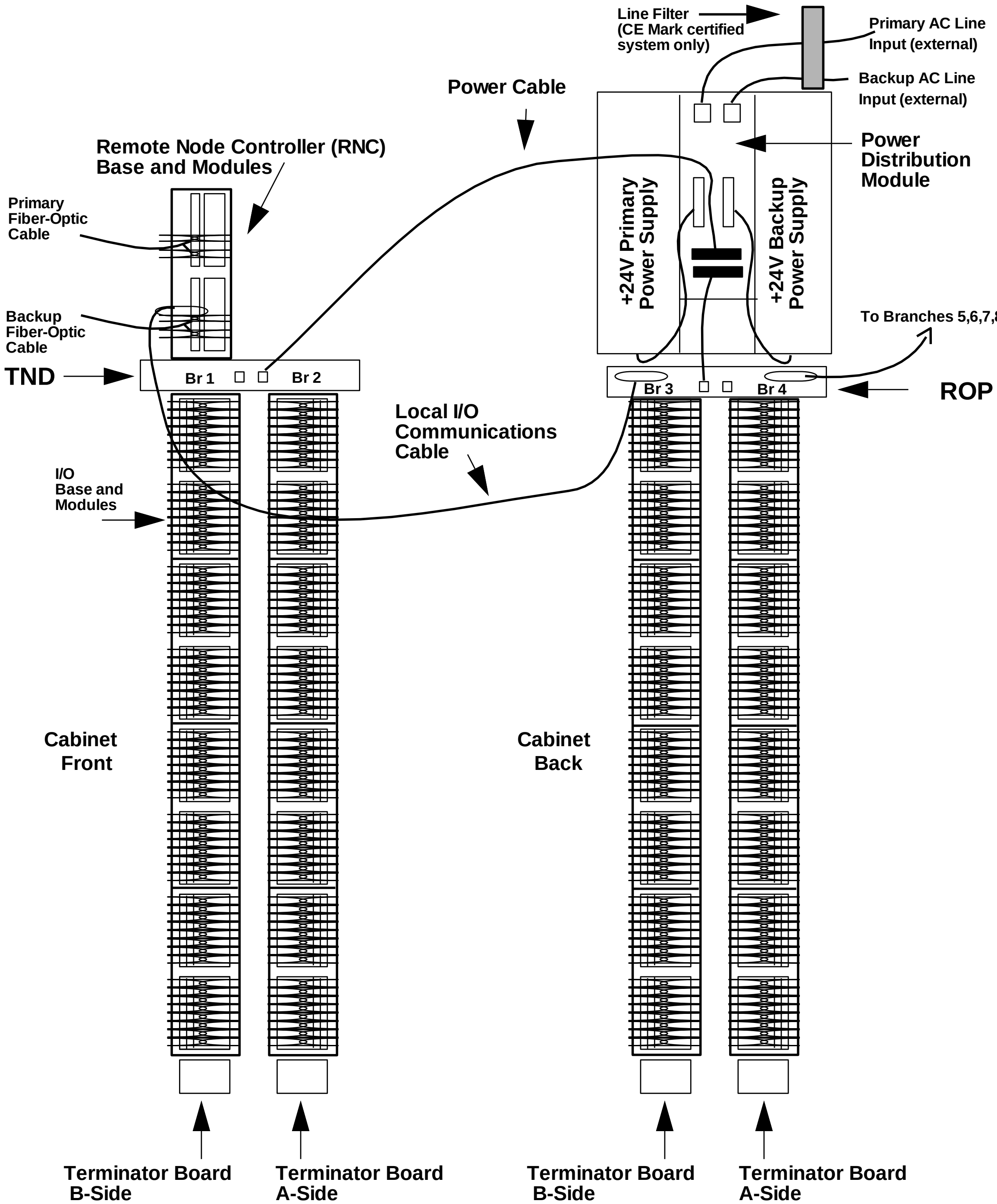


Figure 217: Typical Remote Node Cabinet

11.10.2 Placing the MAU module

The MAU module is located in an Ovation Controller cabinet or in a migrated WDPF DPU cabinet. The MAU plugs into a special base unit which can accommodate up to two modules per base. The base unit clamps onto the DIN rail, like standard I/O module bases.

MAU 1 and MAU 2 are two separate MAU modules which may be located anywhere in the Controller cabinet. One AUI cable connects (see page 765) MAU 1 to P1 on the PCRR, and a second AUI cable connects MAU 2 to P2 on the PCRR.

Note: *If you migrate a WDPF Q-Line remote I/O system to Ovation, a QOR card replaces the QRC card in the WDPF Remote Node. Be sure to connect the MAU* ***TX*** *ports to the QOR* ***RX*** *ports, and connect the MAU* ***RX*** *ports to the QOR* ***TX*** *ports.*

Refer to the applicable Remote Q-Line Installation Manual *for your system for information on remote Q-Line and the QOR card (only 850 nm optics, with 2 km Maximum length, are available for remote Q-Line applications).*

The A-side and B-side of the MAU base unit terminates the local I/O bus, so the base must always be at the end of a branch when local I/O modules are located on the same branch.

The B-side of the MAU base also initiates base addressing for a branch of local I/O. If desired, multiple MAU base units may be connected together on a single branch. Since the MAU base unit terminates the local I/O bus, I/O Bus Termination cards are not required on the end of a branch that has an MAU.

Duplex fiber optic cables (see page 766) must be hooked between the MAU channels and their corresponding remote nodes with specific switch settings.

11.10.3 Connecting the AUI Cable

The Attachment Unit Interface (AUI) cable in the Controller cabinet is used to connect **P1** and **P2** on the PCRR card to an MAU transceiver. This transceiver translates signals between the PCRR and the fiber-optic media that is used to connect remote nodes to the Controller.

P1 is the 15-pin D-connector on the PCRR closest to the front edge of the card where the LEDs are displayed. Controls and communication signals for nodes 1-4 are accessible through P1 on the PCRR.

P2 is the 15-pin D-connector closest to the back edge of the card. Control and communication signals for nodes 5-8 are accessible through P2 on the PCRR.

One PCRR provides two ports for AUI cables. The AUI cable connects the PCRR to the MAU which provides the reception and transmission for the fiber-optic cables. Both AUI ports are used on a single PCRR if the PCRR is to control more than four remote nodes. This configuration requires two AUI cables per PCRR card.

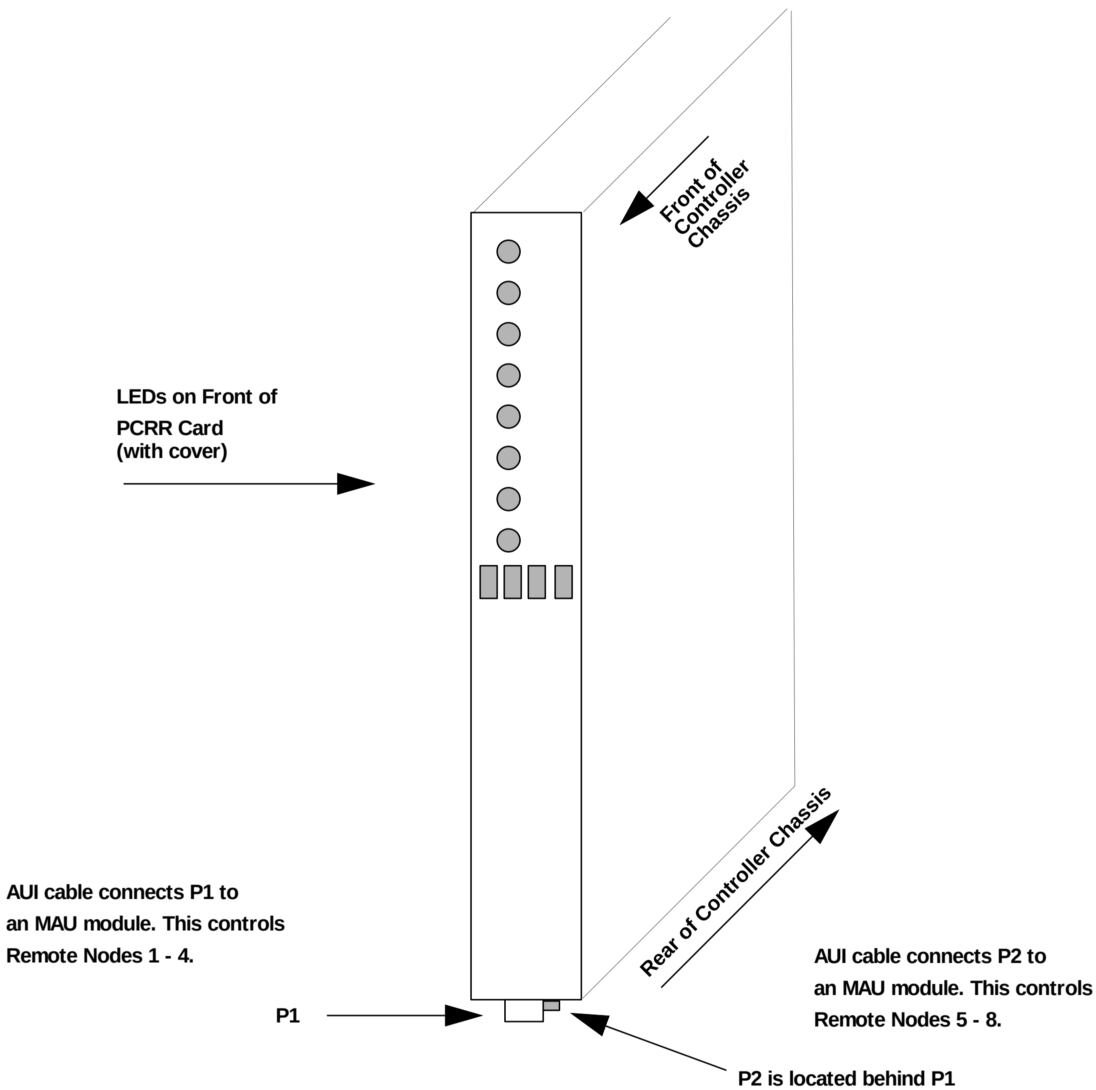


Figure 218: MAU Connections on PCRR Card

11.10.4 Remote node addressing switch

A Controller PCRR card can control up to eight remote nodes. A 10-position rotary switch (located on an RNC backplane or on a QOR card) is used to assign a node address to the remote node.

Note: *Each remote Q-Line node is assigned all 244 possible DIOB addresses (08H through FBH).*

Positions 0-7 on the switch assign the lowest-to-highest order remote node from an addressing standpoint. Selecting position 8 or 9 on the switch is the same as assigning position 0 or 1, respectively, to a remote node.

The remote node must be connected to a specific channel of the Controller cabinet's MAU so that the PCRR communication signals can be directed to the proper node. Similarly, the AUI cable connecting the MAU to the PCRR must be connected to a specific port on the PCRR. The following table lists the control path for a PCRR controlling eight remote nodes through two MAUs.

Remote Node Addressing Switch

REMOTE NODE	PCRR PORT FOR AUI CABLE	MAU CHANNEL	REMOTE NODE'S ROTARY SWITCH SETTING
1	P1	MAU 1 - channel 1	0
2	P1	MAU 1 - channel 2	1
3	P1	MAU 1 - channel 3	2
4	P1	MAU 1 - channel 4	3
5 [1]	P2	MAU 2 - channel 1	4
6[1]	P2	MAU 2 - channel 2	5
7[1]	P2	MAU 2 - channel 3	6
8[1]	P2	MAU 2 - channel 4	7
Do not use.			8 or 9
[1] Optional for migration projects.			

11.10.5 Daisy-Chain Control of I/O Branches

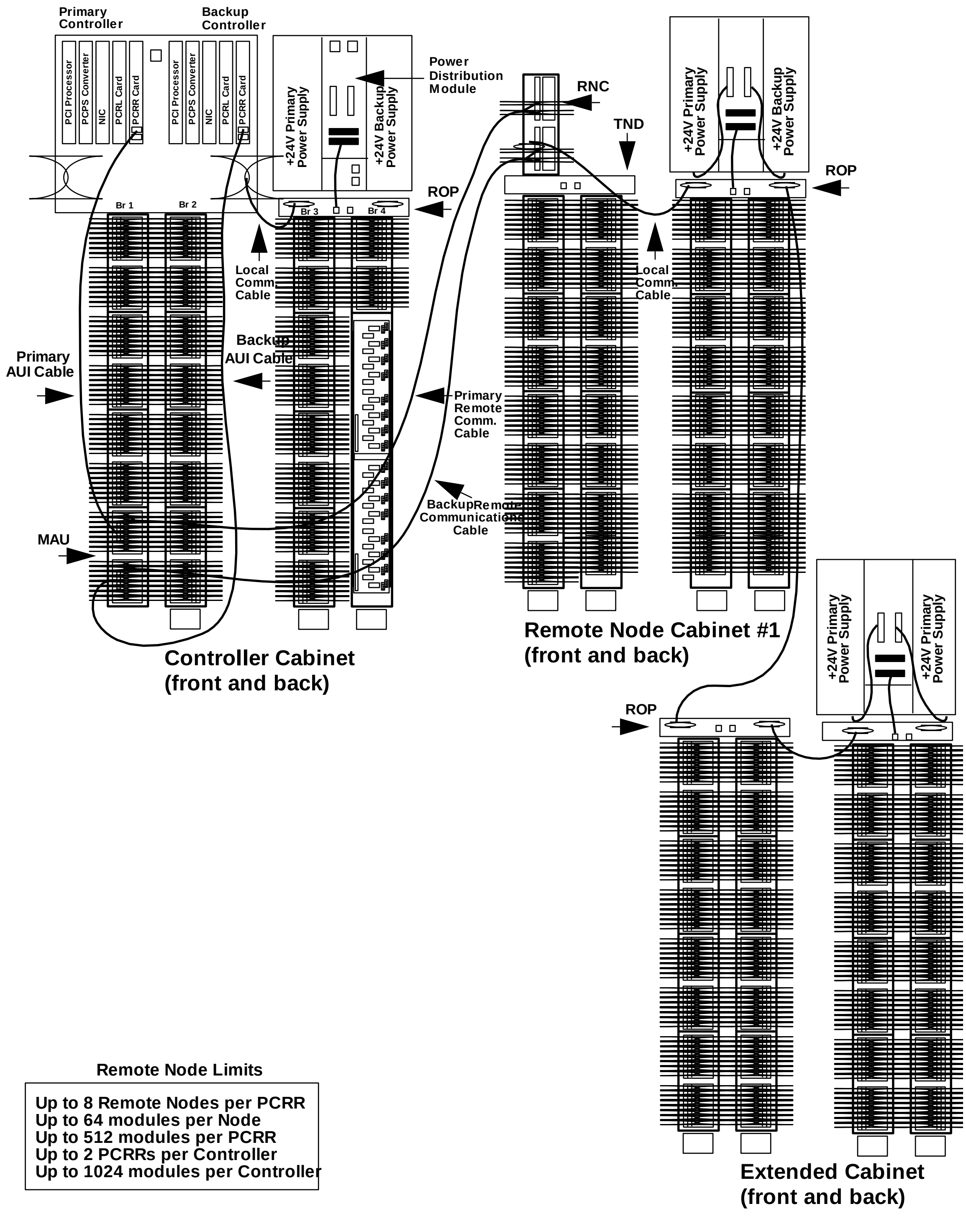
Only one cabinet at a remote node contains redundant RNC modules which connect to two branches of I/O through the TND.

To control additional branches of I/O (up to six more branches), the local I/O bus (beginning at the RNC transition panel) is daisy chained to up to three ROPs. The ROPs may or may not be located in the same cabinet as the RNC. Note that each branch of I/O must be terminated with the proper I/O Branch Terminator Board (A or B). See Power Supply (see page 767) for a typical configuration of a remote node cabinet using daisy-chain control.

11.10.6 Power Supply

A +24V Power Supply is used to supply power to the Remote Node cabinet. The Power Supply is mounted on DIN Rails in the Remote Node cabinet. It is wired to the TND to provide power to the RNC and to the local I/O branches that are connected to the TND.

***Note**: For the new power distribution scheme, refer to the New power distribution scheme (see page 774) section.*



Remote Node Limits

Up to 8 Remote Nodes per PCRR
Up to 64 modules per Node
Up to 512 modules per PCRR
Up to 2 PCRRs per Controller
Up to 1024 modules per Controller

Figure 219: Example of Remote I/O Daisy-Chain Connections

11.10.7 Example of typical MAU cable connections to Remote Nodes (OCR400 Controller)

***Note**: For the new power distribution scheme, refer to the New power distribution scheme (see page 774) section.*

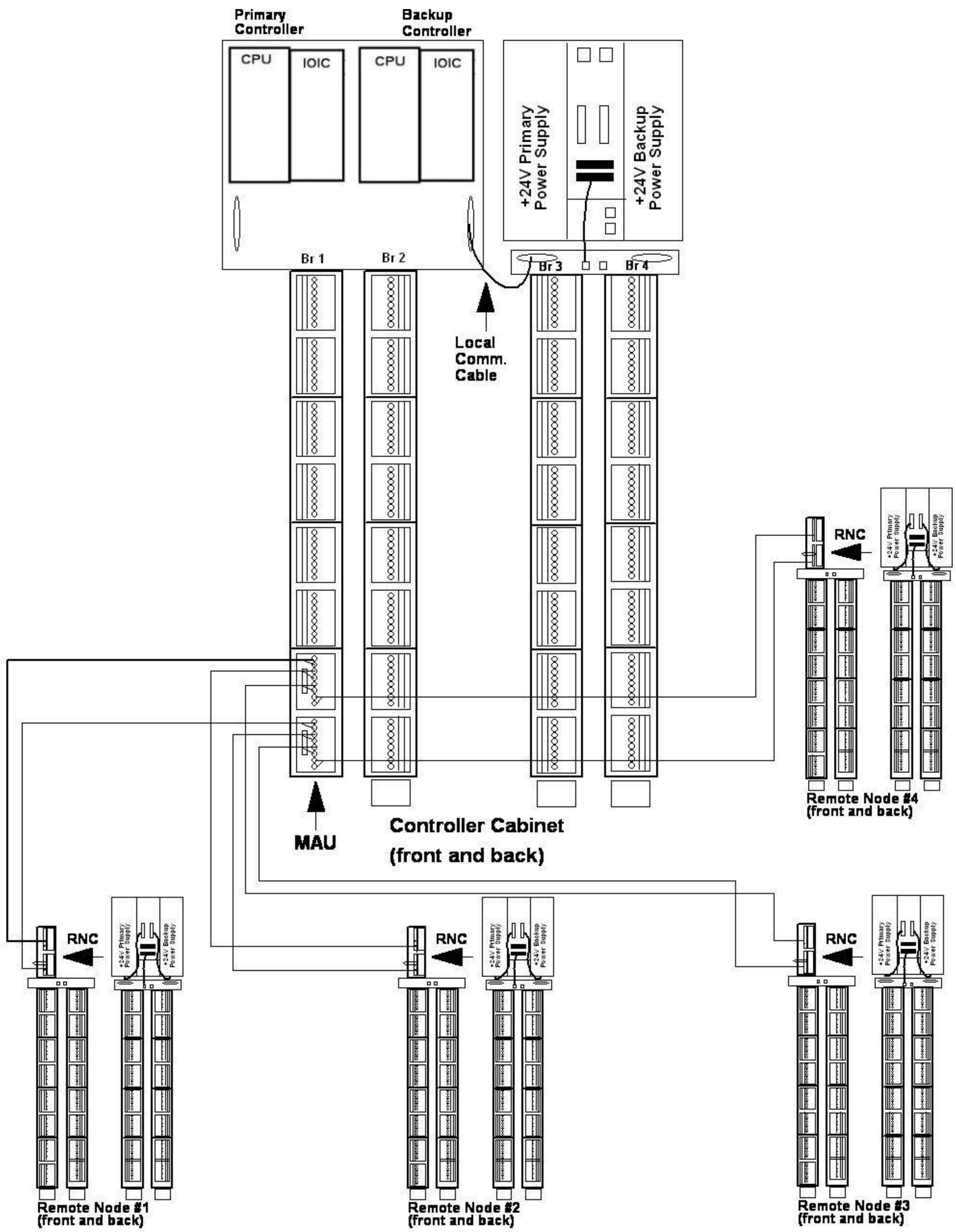


Figure 220: Example of Typical MAU Cable Connections to Remote Nodes (OCR400 Controller)

11.10.8 Example of typical MAU cable connections to Remote Nodes (OCR161 Controller)

Note*: For the new power distribution scheme, refer to the New power distribution scheme (see page 774) section.*

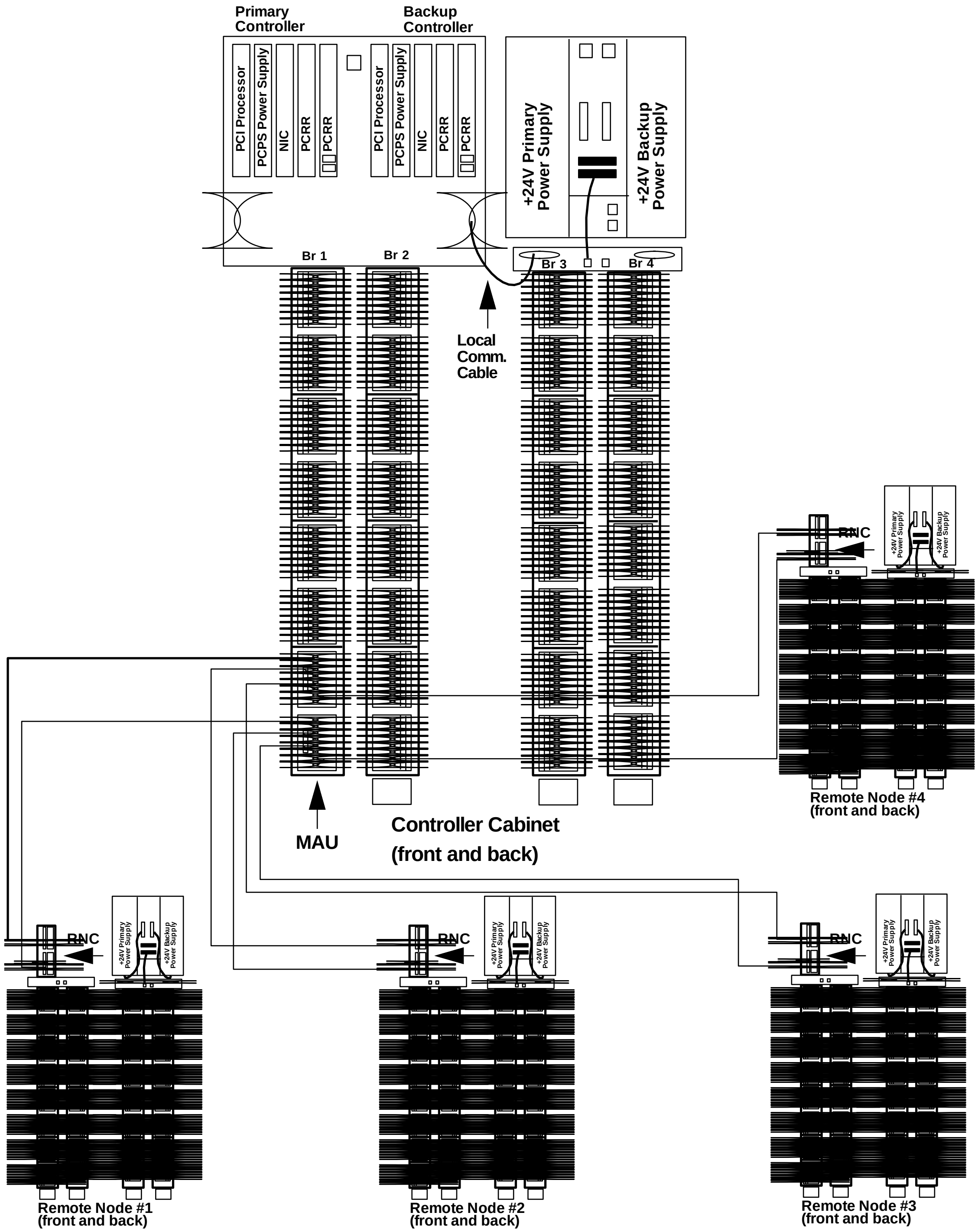


Figure 221: Example of Typical MAU Cable Connections to Remote Nodes

11.11 Selecting the I/O interface cards

1. For the OCR400, the IOIC module handles interface for all of the I/O cards (see What are the OCR400 Controller I/O interfaces? (see page 734)).
2. For the OCR161 there are two slots available for I/O interface cards for each functional processor in the redundant Controller cabinet (see page 737). The following interface must be used:

- Use a **PCRL** card for local Ovation I/O.

  Up to eight branches of Ovation modules can be supported by one PCRL. Use a second PCRL in the Controller if more branches are used.
- Use a **PCQL** card for local Q-Line I/O.

  One PCQL card supports one DIOB. Use a second PCQL card in the Controller if a second DIOB is used.

11.12 What changes can you make to an I/O device?

After an I/O device has been created and loaded to the target drop, it may be necessary to make changes.

You can make changes to the following:

- I/O devices (see page 771).
- External network devices (see page 771).

11.12.1 To modify an I/O device

After an I/O device has been created and loaded to the target drop, it may be necessary to make changes.

1. Launch the Ovation Developer Studio.
2. Use the system tree to navigate to the **I/O Devices** folder:
   Systems
   Networks
   Units
   Drops
   I/O Devices
3. Right-click the appropriate item.
4. Select **Open**.
5. Make necessary changes in the dialog box and select **Ok** or **Apply**.

11.12.2 To modify an external Ovation networks device

For external networks modification information, see *Ovation Multiple Networks User Guide*.

11.13 General requirements for I/O cable

The following cables are used for various I/O cable requirements:

11.13.1 I/O communications cable (5A26141)

This cable allows you to expand local I/O to additional branches by daisy-chaining connections between either the Controller backplane or Remote Node Controller Transition panel and additional local I/O Transition panels.

Length: 9.1 meters Maximum (30 ft).

11.13.2 AUI Cable (5A26147)

The PCRR and Media Attachment module are connected via an AUI cable. This cable meets the electrical specifications stated in the ANSI/IEEE 802.3 standard for local area networks. The cable should be long enough to reach the length of the cabinet.

Length: Approximately 1.5 meters (5 ft).

11.13.3 Fiber-Optic Cable (3A98763 - Green) (3A98764 - Yellow)

The standard configuration of the Ovation Remote I/O Subsystem requires fiber-optic cables (with ST connectors) to connect the MAU to a remote node.

For 850 nm optics, distances of up to 2 km are supported between the remote node and the Controller.

For 1300 nm optics, distances of up to 4 km are supported between the remote node and the Controller.

11.14 Adding OCR400 Controllers to WDPF Q-Line I/O

When OCR400 Controllers are added to a WDPF control system using Q-Line I/O, two QOL cards, one connected to each Controller are necessary to provide the connections previously done by the QBE or the QOR card. QOLs typically occupy the QBE slot or the 13th slot in the upper and lower Q-crates in a WDPF A or extended A cabinet.

QOL cards are typically used when OCR400 Controllers are installed and utilize Q-line I/O. Refer to drawing number 5X00252 for additional information.

The OCR400 treats local Q-Line as if it were remote Q-Line without the conversion to fiber-optic media. The 13V power supply voltages are not directly connected to the OCR400 Controller. QOL cards replace the first and last QBE cards in the Q-Crates.

The QOL monitors the 13V power supplies and provides a status bit to the Controller. This is similar to the way Remote Q-Line and the QOR card provide status for remote Q-Line. Both provide status bits in board registers which are read by the Controller.

Remember that the QOL is really making local Q-Line into remote Q-Line but only providing a short distance copper connection instead of fiber optic so the Controller does not notice this minor difference.

The migration kit wiring diagram 4D33960 shows a 2-connector cable connected to the PCQL module which was where the 13V power was monitored and status provided for the Controller. The I/O interface on the OCR400 Controller does not have this 13V connection capability so instead the status is read from the QOL.

Two QOL cards 5X00230 are used for local Q Line I/O.

- QOL combines MAU and QOR functionality while eliminating the FO cable that is “Local Remote” Q-Line.
- Replaces QBEs in Q1 and Q4 Q-Crate 13th slots.
- For single Q-crate applications, both QOL's are housed in the same Q-crate.

11.15 New power distribution scheme

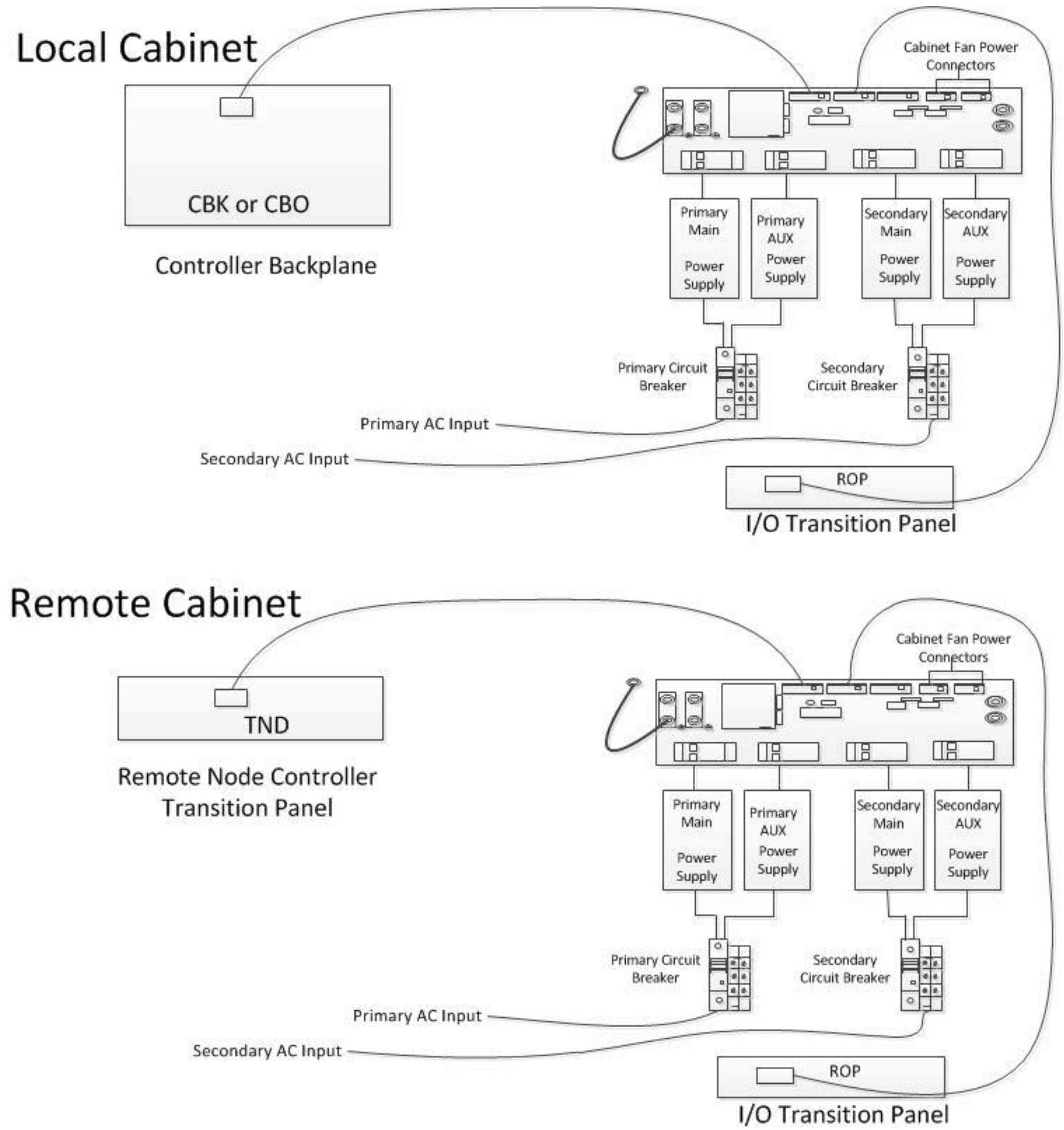


Figure 222: New Power Distribution Scheme

S E C T I O N 1 2

I/O system status and diagnostic LEDs

In This Section

12.1 What do the OCR161 PCQL card status LEDs indicate?

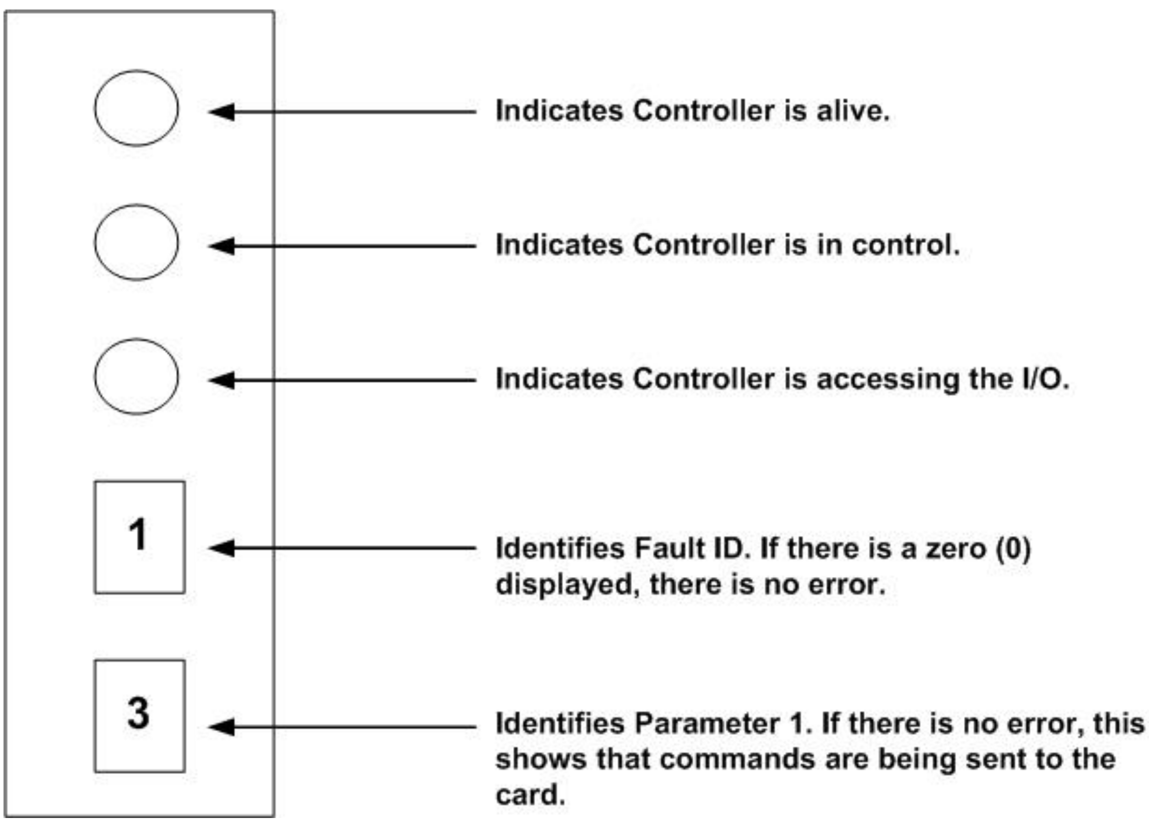


Figure 223: PCQL card used with Q-Line I/O

The following PCQL card LED's illuminate and indicate the following:

- **POWER** and **ALIVE** indicates that the Controller is on.
- **CTL** indicates that the Controller is in control.

- **ACT** indicates that the Controller is accessing the I/O database.
- The Hexadecimal displays show the status and error codes. (Refer to the Ovation fault information tool on the Emerson user site for more information.) Currently, they cycle through the hexadecimal characters.

12.2 What do the OCR161 PCRL card status LEDs indicate?

The following PCRL card LED's illuminate and indicate the following:

- **POWER** indicates that the Controller is on.
- The eight lights indicate the status of the I/O branches.
- The Hexadecimal displays show status and error codes. (Refer to the Ovation fault information tool on the Emerson user site for more information.)

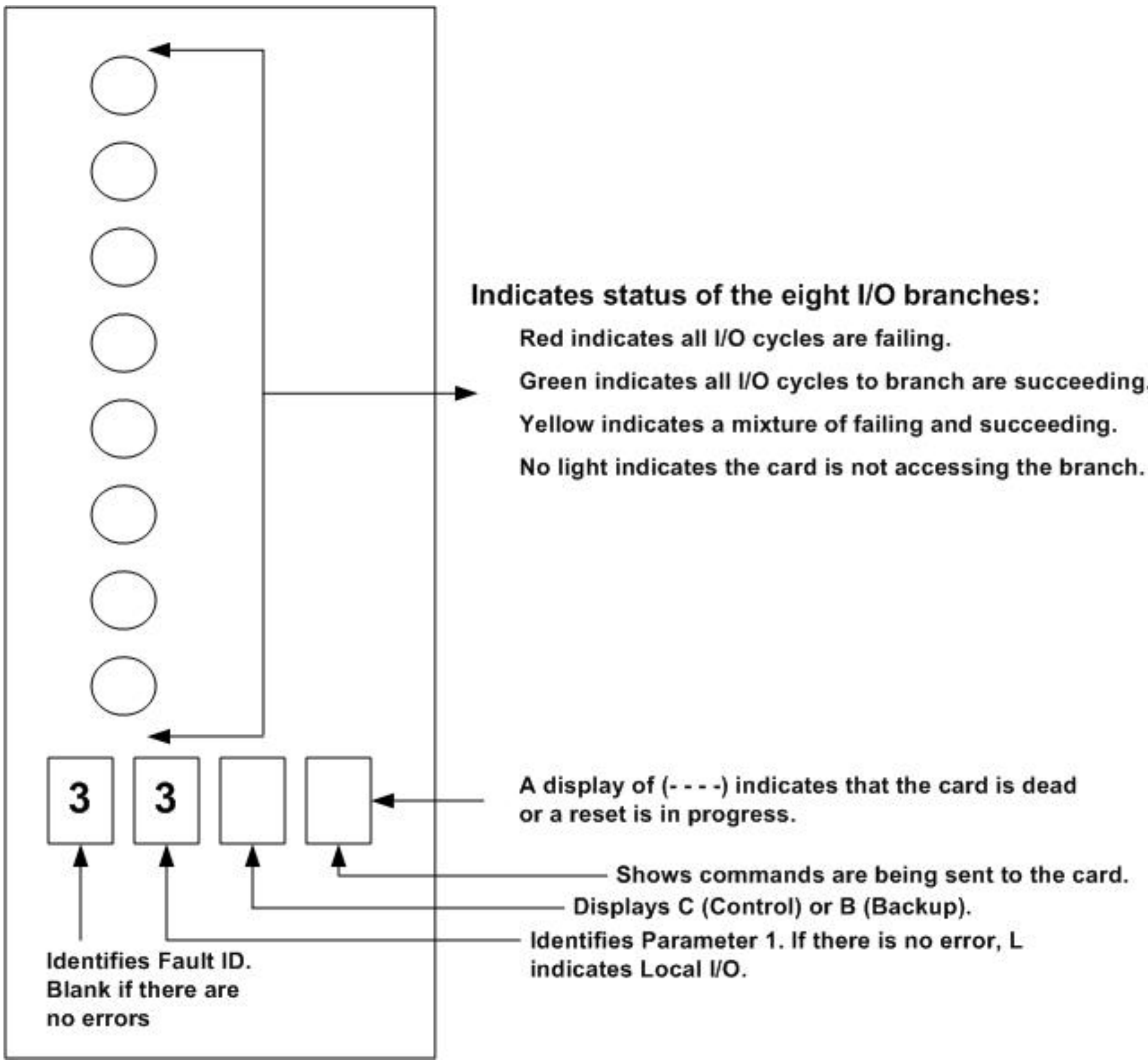


Figure 224: PCRL Card used with Ovation Local I/O

12.3 What do the OCR161 PCRR card status LEDs indicate?

The following PCRR card LED's illuminate and indicate the following:

- **POWER** indicates that the Controller is on.
- The eight lights indicate the status of the eight nodes of the Controller Remote I/O.
- The Hexadecimal displays show status and error codes. (Refer to the Ovation fault information tool on the Emerson user site for more information.)

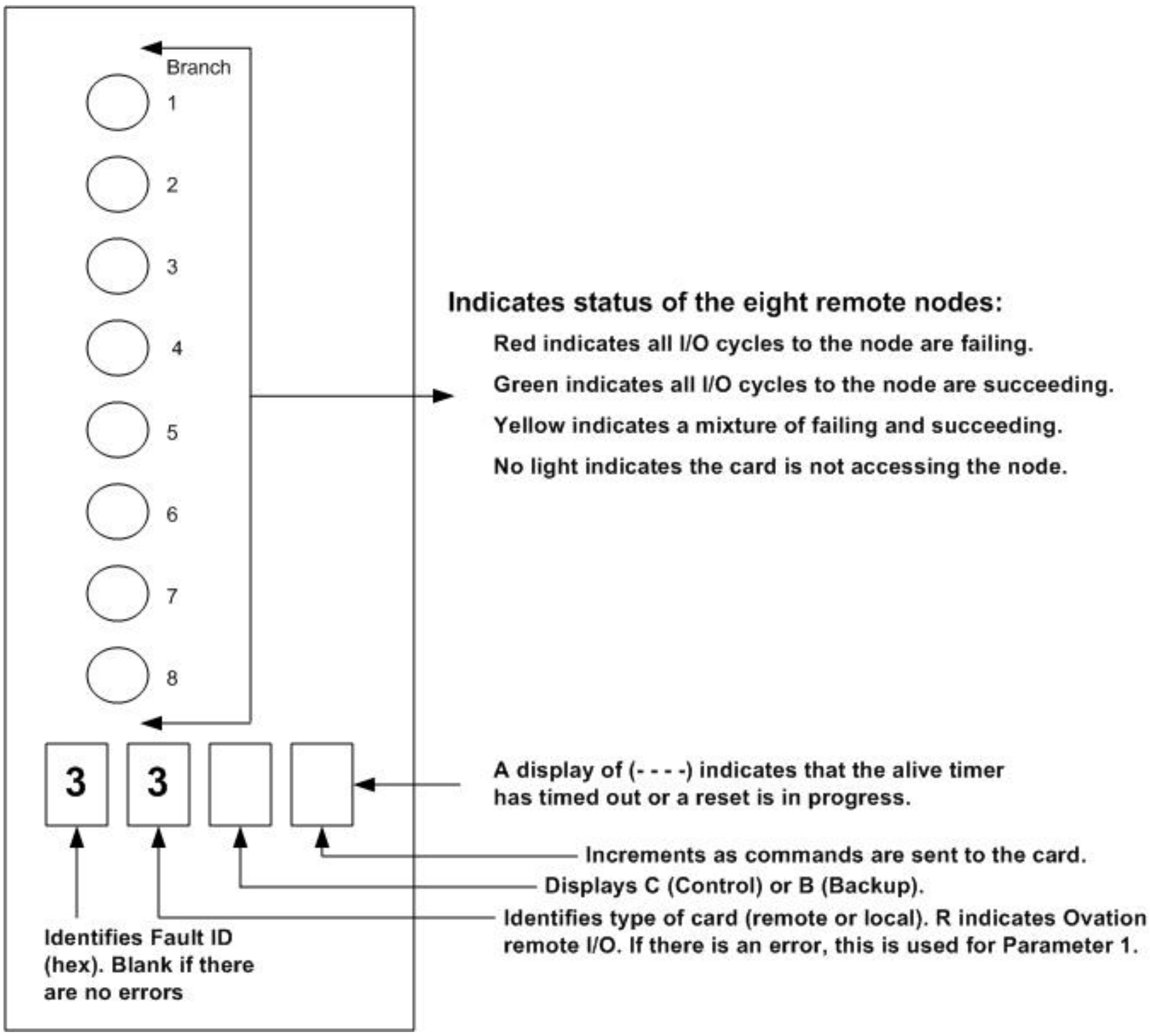


Figure 225: PCRR card for Ovation or Q-Line remote I/O

12.4 What are the processor module status LEDs for the OCR400 and OCR1100 Controllers?

The Controller processor module provides nine indicator LEDs that display status information about the interface between the Controller and the Ovation network.

There is a green power indicator (labeled P) and a pair of green and amber LEDs for each Ethernet port (labeled N1, N2, N3, and N4). The green power indicator lights when the Processor module is powered. Each Ethernet network port has two indicator LEDs (green and amber). The green indicator is the Link Integrity/Power LED. It lights when the port is receiving power and flashes slowly when the module is linked with the network through that port. The amber indicator displays Link Activity status and flashes when the module is receiving or transmitting data on that port.

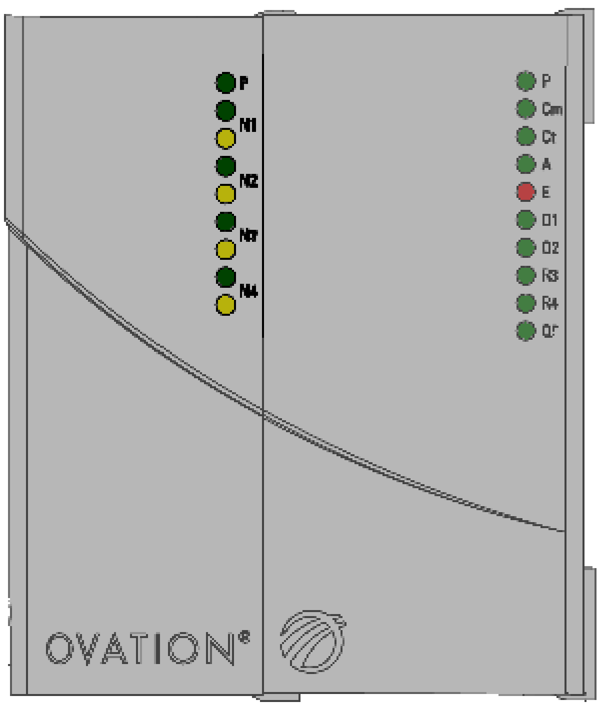


Figure 226: Processor module status LEDs

Processor module status LEDs

LED	MEANING	ON	OFF	BLINKING
P	Power	Lights green when module is powered	Unlit when module is not powered	N/A
N1	Ethernet port **green** LED (Link Integrity/Power LED)	Port is receiving power	Port is not receiving power	Module is linked to network through the port
	Ethernet port **amber** LED (Link activity status)	N/A	N/A	Module is receiving or transmitting data on the port

LED	Meaning	On	Off	Blinking
N2	Ethernet port **green** LED (Link Integrity/Power LED)	Port is receiving power	Port is not receiving power	Module is linked to network through the port
	Ethernet port **amber** LED (Link activity status)	N/A	N/A	Module is receiving or transmitting data on the port
N3	Ethernet port **green** LED (Link Integrity/Power LED)	Port is receiving power	Port is not receiving power	Module is linked to network through the port
	Ethernet port **amber** LED (Link activity status)	N/A	N/A	Module is receiving or transmitting data on the port
N4	Ethernet port **green** LED (Link Integrity/Power LED)	Port is receiving power	Port is not receiving power	Module is linked to network through the port
	Ethernet port **amber** LED (Link activity status)	N/A	N/A	Module is receiving or transmitting data on the port

12.5 Diagnostic LEDs

Three Controller modules used in the Ovation Remote I/O subsystem are equipped with LEDs that provide diagnostic displays. The modules are the PCRR, MAU, and the RNC.

12.6 MAU Module

The MAU Electronics Module front panel has LEDs to display the status of the MAU on-board power supply and the fiber-optic links between the MAU and each remote node.

The four LINK OK LEDs correspond with the four remote nodes connected to the MAU.

Note: *G01 MAU contains only two remote node connections and does have Link 3 and Link 4 LEDs.*

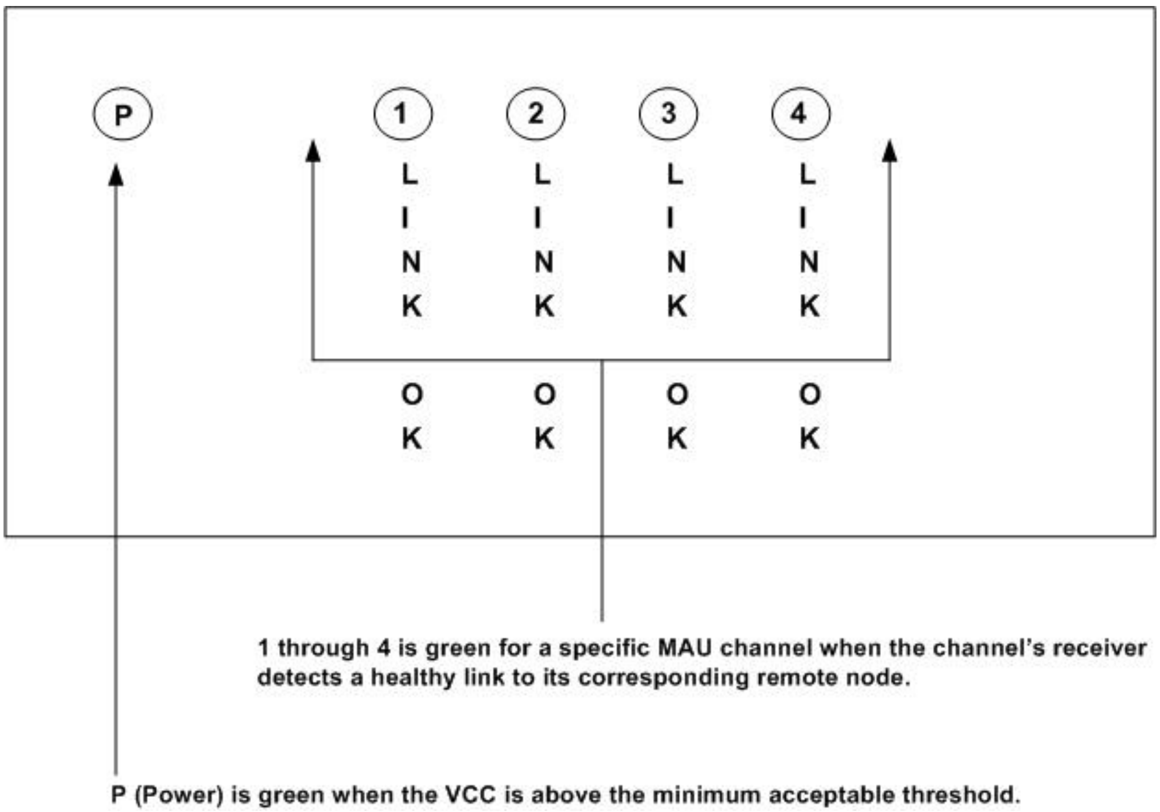


Figure 227: MAU LED Indicators

A healthy link between an MAU channel and a remote node is established when the transmitter of a powered-up remote node Controller is connected through a fiber-optic link to the receiver of its corresponding channel on the MAU. The transmitted signal received by the MAU must be strong enough to overcome low-light conditions to be seen as healthy by the MAU.

12.7 RNC Module

The RNC Electronics Module front panel has four LEDs to display statuses specific to the RNC and 16 LEDs to display statuses specific to the eight branches controlled by the RNC.

The LED states are defined in the following figure and table.

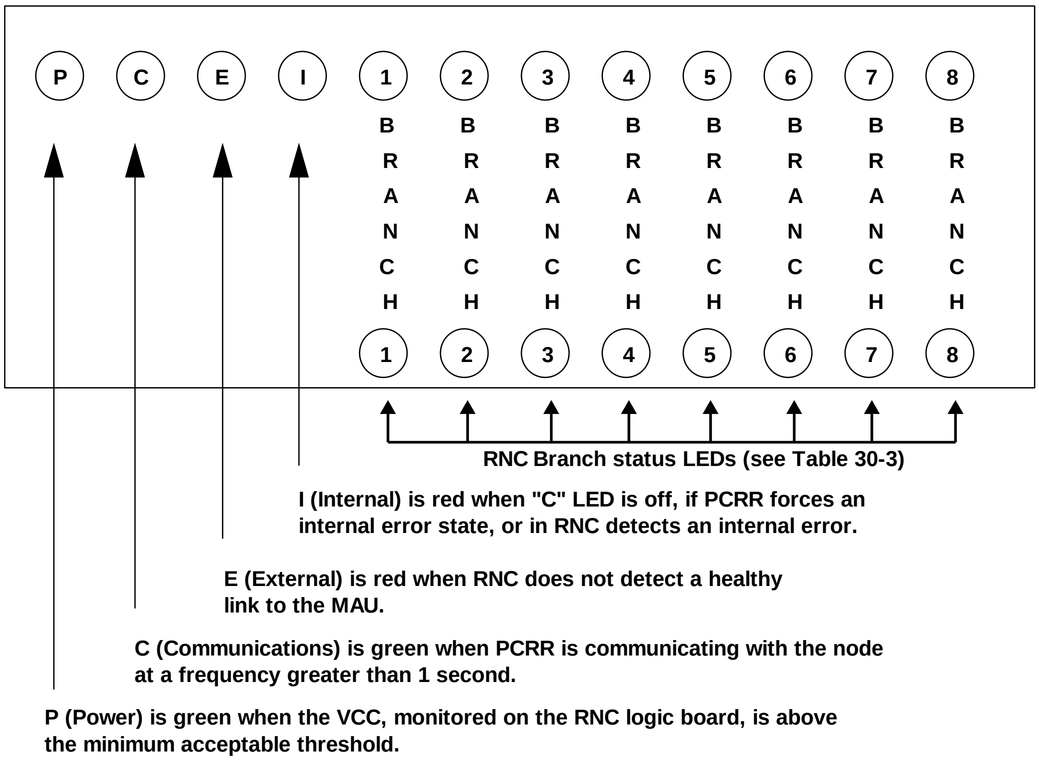


Figure 228: RNC LED Indicators

RNC Branch Status LED States

Green LED	Red LED	Remote Node Branch Status
On	Off	All I/O cycles to the branch are succeeding.
On	On	Mixture of failing and succeeding I/O cycles to the branch.
Off	On	All I/O cycles to the branch are failing.
Off	Off	Branch is not being accessed.

S E C T I O N 1 3

Q-Line card types

IN THIS SECTION

13.1 Analog card types

Analog Data Types

DATA TYPE	DESCRIPTION
0	Not applicable
1	Not applicable
2	Not applicable
3	16 bit signed analog input card, card status =15, confide = 14, sign = 13, signed over range = 12, value = 11 to 0
4	16 bit unsigned analog input card, card status =15, unsigned over range = 13, value = 12 to 0
5	16 bit unsigned analog input card, value = 15 to 0
6	16 bit signed analog input card, card status = 0, sign = 15, unsigned over range = 1, value = 13 to 3
7	16 bit unsigned analog input card, card status =15 and 0, unsigned over range = 1, value = 13 to 3
8	16 bit unsigned analog input card, card status = 15, value = 11 to 0
9	16 bit unsigned analog output card, value = 15 to 0
10	16 bit signed analog output card, sign = 15, value = 14 to 4
11	16 bit unsigned analog output card, value = 15 to 4
12	16 bit unsigned analog output card, clamped at 16, value = 15 to 4
13	16 bit unsigned analog output card, scaled by.6 and biases + 800, value = 15 to 4
22	16 bit unsigned analog input card, card status = 15, value = 14 to 0

Analog Card Types

Card	Group	WDPF II Card Type	Range	Data Type
QAA	G01	NA	-16 to +16mA (Position) +4 to +20 mA (Velocity)	0
QAA	G02	NA	+4 to +20 mA (Velocity) -10 to +10 VDC (Voltage) Optional	0
QAH	G01	17	-10.24 to +10.235 V	6
QAH	G02	18	-5.12 to + 5.117 V	6
QAH	G03	19	0 to +10.237 V	7
QAH	G04	20	0 to 5.119 V	7
QAI	G01	1	-20 to +20 mV	3
QAI	G02	2	-50 to +50 mV	3
QAI	G03	3	-100 to +100 mV	3
QAI	G04	4	-500 to +500 mV	3
QAI	G05	5	-1 to +1 V	3
QAI	G06	6	-10 to + 10 V	3
QAI	G07	7 or 9	0 to 20 mA	3
QAI	G07A	NA	4 to 20 mA	3
QAI	G08	8	-50 to +50 mV	3
QAM	G01	31	0 to 10 VDC (Output)	0
QAM	G02	31	0 to 10 mA, 0 to +5 VDC (Output)	0
QAO	G01	21	0 to + 20.475 mA	12
QAO	G01A	29	4.00 to + 20.475 mA	13
QAO	G02	22	-0 to +10.2375 V	11
QAO	G03	23	-10.24 to +10.235 V	10
QAO	G04	24	0 to +5.1187 V	11
QAO	G05	25	-5.12 1 to +5.1175 V	10
QAO	G06	26	-10.24 to + 10.235 V	10
QAO	G07	27	0 to + 20.475 mA	12
QAO	G07A	NA	+4 to +20 mA	12
QAO	G08	28	-10.24 to + 10.235 V	10
QUA	G01	1 or 54	-20 to +20 mV	3
QUA	G02	2 or 55	-50 to +50 mV	3
QUA	G03	3 or 56	-100 to +100 mV	3
QUA	G04	2	-50 to +50 mV	3
QUA	G05	3	-100 to +100 mV	3
QUA	G06	NA	-50 to +50 mV	3
QUA	G07	NA	-20 to +20 mV (with temperature compensation)	3

Card	Group	WDPF II Card Type	Range	Data Type
QUA	G08	NA	-50 to +50 mV (with temperature compensation)	3
QUA	G09	NA	-100 to +100 mV (with temperature compensation)	3
QUA	G01	13 or 34	0 to +1 V	3
QUA	G02	14 or 35	0 to +5 V	3
QUA	G03	15	0 to +10 V	3
QUA	G04	16	0 to +20 mA	3
QUA	G04A	NA	+4 to +20 mA	3
QUA	G05	NA	0 to +20 mA (self-powered)	3
QUA	G05A	16	+4 to +20 mA	3
QUA	G06	32	0 to +50 mA	3
QUA	G06A	NA	+4 to +50 mA	3
QAX	G01	68 or 71	-20 to +20 mV	3
QAX	G02	69 or 72	-50 to +50 mV	3
QAX	G03	70 or 71	-100 to +100 mV	3
QAX	G04	74	0 to +1 V	3
QAX	G05	75	0 to +5 V	3
QAX	G06	76	0 to +10 V	3
QFD	G01	88	-118.75 to +5000.625 mA	4
QLI	G01	51	0 to 10VDC (Analog Input/Output)	3
QLI	G02	52	0 to 5 VDC (Analog Input) 0 to 10 VDC (Analog Output)	3
QLI	G03	53	0 to 20mA (Analog Input) 4 to 20 mA (Analog Output)	3
QPA	G01	36	Pulses	5
QPA	G02	36	Pulses	5
QPA	G03	36	Pulses	5
QPA	G04	36	Pulses	5
QRT	G01	NA	0 to + 10 mV	3
QRT	G02	NA	0 to + 33 1/3 mV	3
QSD	G01	NA	Input: 20 V peak-to-peak, 1 KHz sine wave (LVDT) Output: +/- 24 mA	0
QSR	G01	NA	0 to 100	8
QSR	G02	NA	NA	8
QSR	G03	NA	NA	8
QSR	G04	NA	NA	8
QSS	G01	66	1.5, 1.8, 3.0, 3.6, 6.0, or 7.2 KHz	22

13.2 Digital card types

Digital data types

Data Type	Description	Data Type	Description
1	Standard digital input card	8	Not applicable
2	Standard digital output card	9	Not applicable
3	Not applicable	10	Not applicable
4	Not applicable	11	Not applicable
5	Not applicable	12	Not applicable
6	Not applicable	13	Not applicable
7	Not applicable	NA	Not applicable

Digital card types

Card	Group	Data Type
QBI	G01	1
QBI	G02	1
QBI	G03	1
QBI	G04	1
QBI	G05	1
QBI	G06	1
QBI	G07	1
QBI	G08	1
QBI	G09	1
QBI	G10	1
QBI	G11	1
QBO	G01	2
QBO	G02	2
QBO	G03	2
QBO	G04	2
QBO	G05	2
QCI	G02	1
QDI	G01	1
QDI	G02	1
QDI	G03	1
QDI	G04	1
QDI	G05	1
QDI	G06	1

Card	Group	Data Type
QDI	G07	1
QDI	G08	1
QDI	G09	1
QDI	G10	1
QDI	G11	1
QID	G01	1
QID	G02 (Low)	1
QID	G02H (High)	1
QID	G03	1
QID	G04 (Low)	1
QID	G04H (High)	1
QID	G05	1
QID	G06 (Low)	1
QID	G06H (High)	1
QID	G07	1
QID	G08	1
QID	G09	1
QID	G10	1
QID	G11 (Low)	1
QID	G11H (High)	1
QID	G12	1
QID	G13 (Low)	1
QID	G13H (High)	1
QID	G14	1
QID	G15 (Low)	1
QID	G15H (High)	1
QID	G16	1
QID	G17	1
QSE	G01	1
QSE	G02	1
QRO	G01 (Low)	2
QRO	G01H (High)	2
QRO	G02 (Low)	2
QRO	G02H (High)	2
QRO	G03 (Low)	2
QRO	G03H (High)	2

Card	Group	Data Type
QRO	G04 (Low)	2
QRO	G04H (High)	2

13.3 Packed point card types

Packed Data Types

Data Type	Description
1	Standard 16 bit digital input card
2	Standard 16 bit digital output card
3	Not applicable
4	Not applicable
5	Not applicable
6	Not applicable
7	Not applicable
8	Not applicable
9	Not applicable
10	Not applicable
11	Not applicable
12	Not applicable
13	Not applicable

Digital Card Types

Card	Group	Data Type
QBI	G01	1
	G02	1
	G03	1
	G04	1
	G05	1
	G06	1
	G07	1
	G08	1
	G09	1
	G10	1
	G11	1

CARD	GROUP	DATA TYPE
QBO	G01	2
	G02	2
	G03	2
	G04	2
	G05	2
QDI	G01	1
	G02	1
	G03	1
	G04	1
	G05	1
	G06	1
	G07	1
	G08	1
	G09	1
	G10	1
	G11	1
QID	G01	1
	G02	1
	G03	1
	G04	1
	G05	1
	G06	1
	G07	1
	G08	1
	G09	1
	G10	1
	G11	1
	G12	1
	G13	1
	G14	1
	G15	1
	G16	1
	G17	1
QSE	G01	1
	G02	1

SECTION 14

CE Mark specifications

IN THIS SECTION

14.1 What is a CE Mark Certified system?

CE Mark certification on a product is a manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety, and environmental protection legislation. CE Mark on a product indicates to governmental officials that the product may be legally placed on the market in their country and ensures the free movement of the product within the European Free Trade Association (EFTA) & European Union (EU) single market (total of 28 countries).

Ovation has two methods of achieving a CE Mark system:

- EMC cabinet.
- Non-EMC cabinet.

EMC cabinet approach

A CE Mark Certified Ovation system can use special EMC cabinets, supplementary internal filtering, and exacting requirements on field wiring and grounding to ensure compliance with the specific European Electromagnetic Emissions/Immunity and low voltage safety.

The CE Mark Certified Ovation Controller cabinet assembly, Extended I/O cabinet assembly, and Remote I/O cabinet assembly are certified for operation in the Industrial Environment as documented in the EMC Technical Construction File for Ovation (5A26444) and the Low Voltage Safety Technical File for Ovation (5A26443).

The CE Mark Certified Controller cabinet assembly drawing for the OCR400 Controller is 5X00293.

The CE Mark Certified Controller cabinet assembly drawing for the OCR161 Controller is 4D33953.

The specific requirements for the CE Mark Certified Systems are discussed throughout this document and also in the following:

- **Drawing 5A26418** - This drawing contains a baseline listing of all components applicable for the CE Mark Certified System.
- **Drawing 5A26370** - This drawing contains a baseline listing of workstation and peripheral components applicable for the CE Mark Certified System.

Non-EMC cabinet approach

A CE Mark Certified system can also use non-EMC cabinets. This is accomplished by utilizing a Non-EMC cabinet approach in which baseline testing was performed on the standard Ovation cabinet style 5X00127H02.

This approach utilizes requirements on field wiring shield termination and internal cabinet cable ferrites in specific locations to ensure compliance with the specific European Electromagnetic Emissions/Immunity and low voltage safety.

The baseline cabinet assemblies utilized for the Non EMC Cabinet approach testing are 5X00127H02 (ventilated cabinet assembly) or 5X00046H03 (sealed cabinet assembly). Alternate models shall be considered ongoing based upon equivalency and may include criteria such as welded steel frame construction, gauge of metal side panels, overlapping door seams, internal ground straps connecting all panels to the mounting plate, and a grounding stud for tying the EMC ground.

The specific requirements for the Non EMC Cabinet CE Mark approach are discussed throughout this document and are also in the following:

- **Drawing 5X00424** – This drawing contains a baseline listing of all components applicable for the Non EMC Cabinet CE Mark Certified System approach.
- **Drawing 5A26370** – This drawing contains a baseline listing of workstation and peripheral components applicable for the CE Mark Certified System.

14.2 CE Mark accuracy considerations

EMC Technical Construction Files 5A26444 and 5X00423 reference various temporary electromagnetic interferences that the Ovation system must operate through. During these conditions, the accuracy of all Ovation analog points shall be derated to ±2.5%.

SECTION 15

Replacing power supplies

IN THIS SECTION

15.1 Power supply replacement cautions

CAUTION! It is recommended that a certified electrical technician perform the replacement procedure when you are replacing power supplies while your system is powered and on-line.

When replacing both primary and secondary power supply units, begin by replacing the secondary power supplies first. After the secondary unit is re-installed and turned ON, indicator lights illuminate indicating that you have power on the secondary power supplies. Make sure the secondary power supply units are on-line before removal of the primary units.

Proceed by turning the power OFF of the primary power supplies. The primary power supplies fail over to the secondary power supplies allowing replacement of both power supplies to be accomplished without taking the system off-line. Install the replacement power supplies and reapply power to the primary power supply unit.

Both primary and secondary power supply units can be replaced by using the following procedure.

15.1.1 To replace redundant power supplies

1. Turn the power OFF at the power supply by switching the circuit breaker on the DIN rail to the **OFF** position.
2. Remove the power cable from the bottom of the power supply by releasing the terminal block levers, then pull the cable downward from the power supply terminal block. Repeat this Step for the output cable.
3. Loosen the power supply locking mechanism which is located at the bottom of the power supply (see Power Supply Locking Mechanism (see page 798)).

Note: *A medium size slotted head screwdriver is necessary to loosen the locking mechanism.*

4. After the locking mechanism has been loosened, lift the power supply from the rail assembly.
5. Install the replacement power supply on the power supply DIN rail.
6. Make sure the replacement power supply is fitted securely on the DIN rail assembly by checking that the locking mechanism is engaged.

7. Make sure the circuit breaker is in the **OFF** position before attaching power cabling to the power supply.
8. Re-attach the power cables by inserting the power supply cables into the connector terminals of the power supply.

Note: *Ensure that the color coding is maintained on the power supplies. Refer to the redundant power supplies for the color coding.*

9. Make sure that the cable connector secures the cables from falling out of the terminals. Also, make sure that lever arms are engaged.
10. If all wires are tight, you can re-apply power by switching the circuit breaker of the power supply to the **ON** position. This completes the power supply replacement process.

15.2 Power supply front view

The following figure illustrates the front view of the power supply:

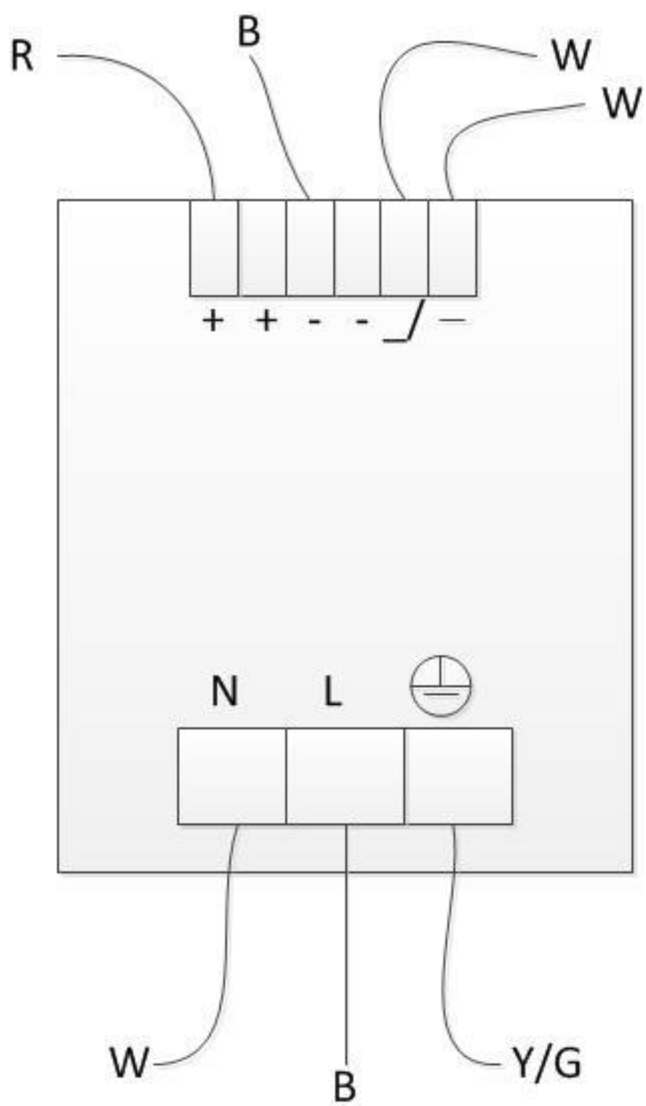
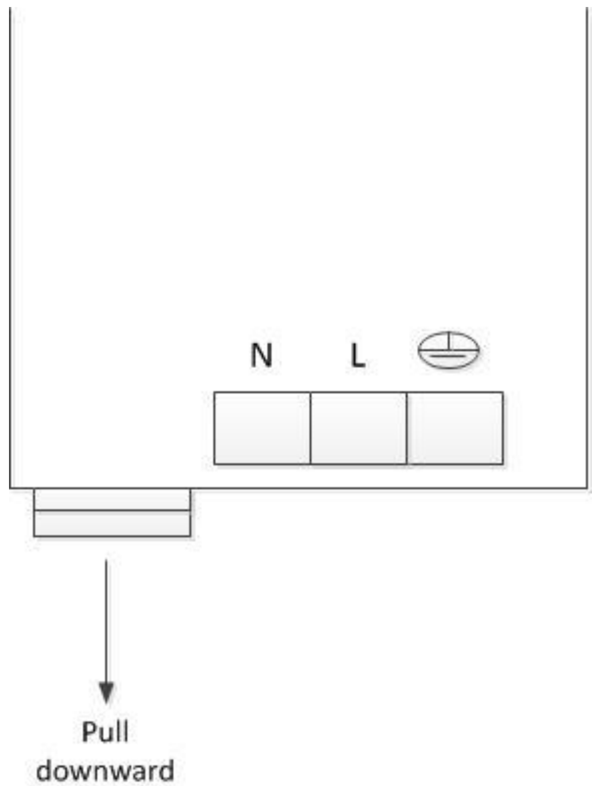


Figure 229: Power Supply Front View

15.3 Power supply locking mechanism

A locking mechanism, located at the bottom on the power supply, holds the power supply firmly to the DIN rail. Using a slotted head screwdriver to pull down the lever arm to release the power supply from the rail assembly. Lift the unit from the rail assembly while the lever arm is pulled down.

To re-attach the power supply, engage the top the power supply to the rail and push the bottom of the power supply onto the rail.



SECTION 16

Using an external power supply

IN THIS SECTION

16.1 What is an external supply?

Some Ovation I/O modules require an auxiliary power supply. Auxiliary power may be obtained either from the internal auxiliary power supply (backplane), or from an external power supply.

The auxiliary power is bussed along an entire branch of I/O modules. All I/O modules within a branch **MUST** use the same auxiliary power voltage for proper operation. External auxiliary power can be applied to each branch individually.

If an Ovation I/O module is to be connected to an external power supply, perform the following procedure **BEFORE** connecting the power supply to the Ovation module and powering it up.

Note: *Using external auxiliary power with the Relay Output module is not recommend. Instead, use the Ovation internal auxiliary supply for relay coil power.*

16.2 To prepare for connecting an external power supply

CAUTION! Using an external power supply may introduce dangerous voltages to an I/O cabinet. Do NOT apply external power to a cabinet until the appropriate internal auxiliary power supply fuses have been removed and the required fuse covers have been installed.

1. Identify the specific I/O branch to which the Ovation I/O module is assigned and the back panel (CBO) or transition panel (ROP or TND) associated with the I/O branch (see the following figures for panel locations).

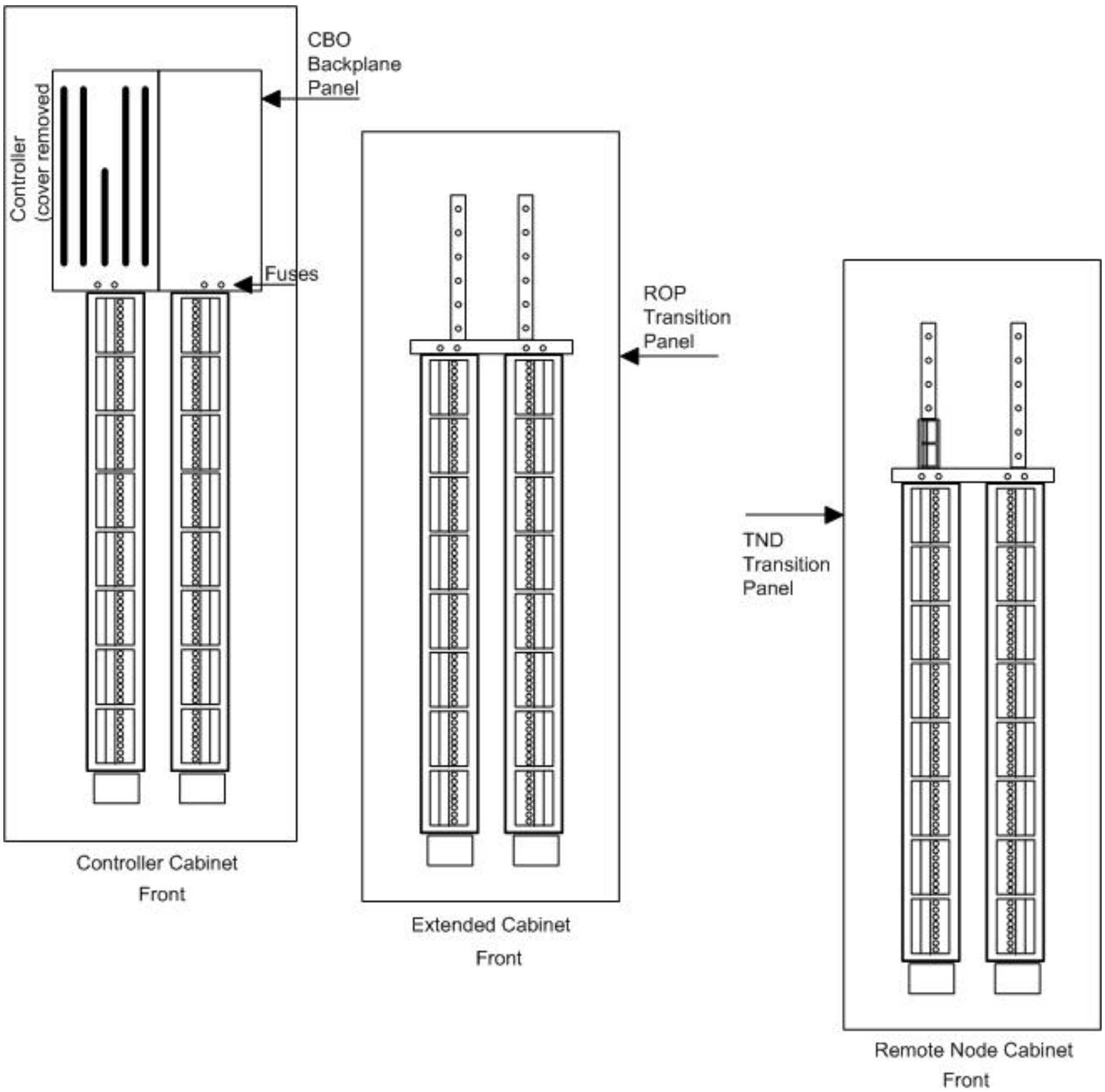


Figure 230: Locations of CBO, ROP, and TND Cabinet Panels

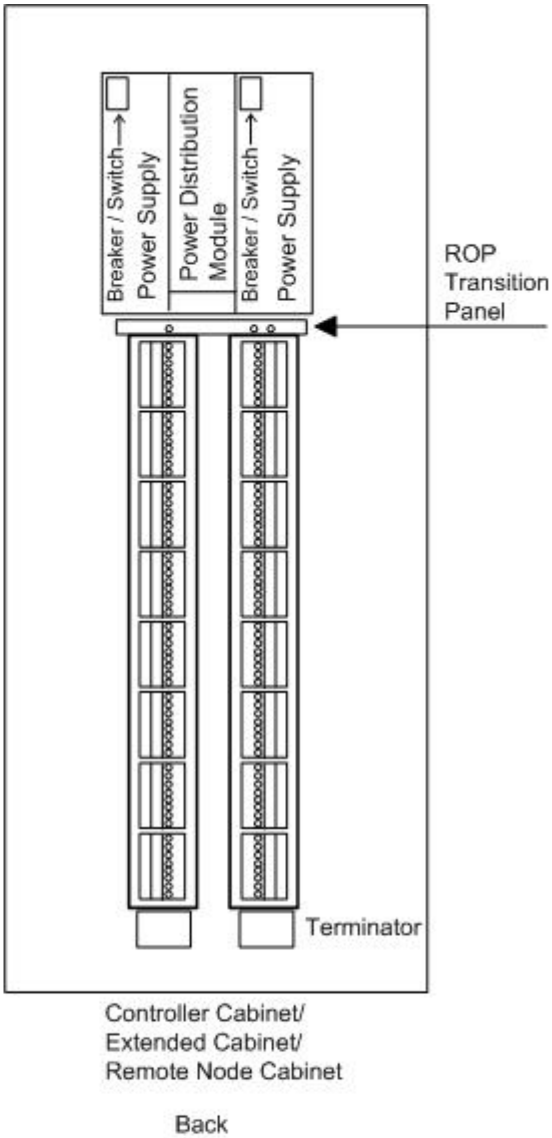


Figure 231: Location of ROP Panel in Cabinet Backs

1. If the I/O branch is associated with a transition panel, perform the following:
   a) If the transition panel has a cover, remove it in order to expose the fuses.
   b) Remove the pair of round plug-in fuses located nearest the I/O branch that you identified in Step 1.
   c) Replace the transition panel cover (where applicable) after the fuses are removed. A fuse cover kit is not required for transition panels that have a cover. However, if the transition panel does not have a cover, then fuse cover caps (5A26371H20) are required.

Note: *Fuse cover caps are required* ***only*** *if the external power supply output voltage is greater than 60 VDC, 42 VAC peak or 30 VAC rms.*

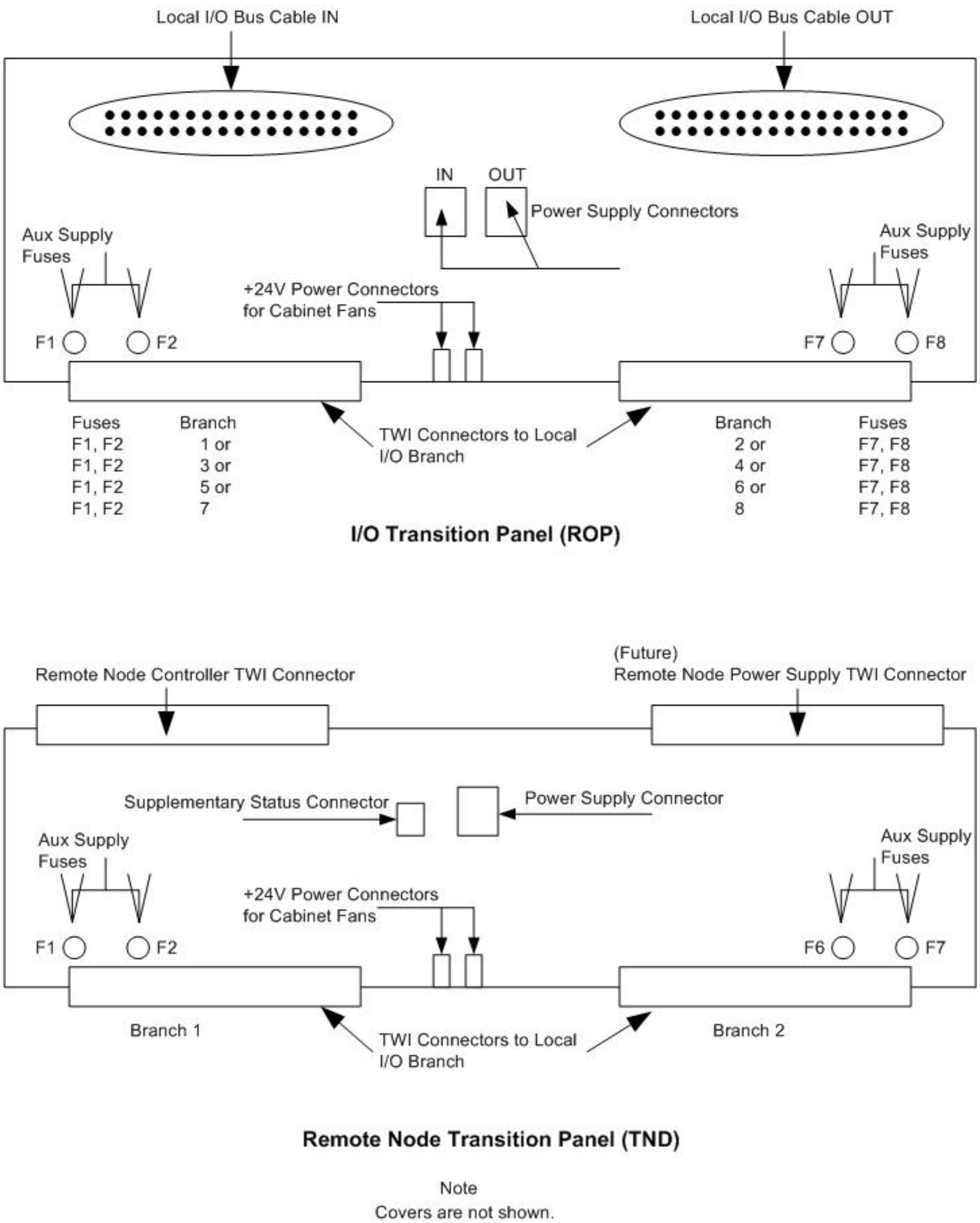


Figure 232: Auxiliary Power Supply Fuse Locations for ROP and TND Panels

2. If the I/O branch is associated with a back-plane (CBO), perform the following:
   a) Identify the artwork level of the backplane.

b) Determine what fuse cover kit is needed for the backplane:

- ☐ 1C31213G01 for artwork level 3CBO and earlier.
- ☐ 1C31213G02 for artwork level 5CBO and later.

a) Remove the pair of round plug-in fuses located nearest the I/O branch that you identified in Step 1.

b) Install the appropriate fuse cover kit over the fuse sockets from where the fuses were removed.

Note: *The fuse cover kit is required* ***only*** *if the external power supply output voltage is greater than 60 VDC, 42 VAC peak or 30 VAC rms.*

---

3. After the fuse covers are securely installed, connect the external voltage power supply positive (+) and negative (-) outputs to the Ovation I/O module base unit terminal block PS+ (A17 or B17) and PS- (A18) terminals. Once the external power supply is connected to the base unit terminal block and is powered up, the entire I/O branch has access to the external power supply voltage.

Note: *Base unit terminal block locations A17 (PS+) and B17 (PS+) are connected to the same potential within the base unit.*

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