41/43-765 User Manual

PXI/PXIe Analog Output/Current Loop Simulator Module

Issue 2.0 February 2022

pickeringtest.com

ISO 9001
Reg No. FM38792

TECHNICAL SUPPORT

For Technical Support please contact Pickering Interfaces either by phone, the website or via e-mail.

WARRANTY

All products manufactured by Pickering Interfaces are warranted against defective materials and workmanship for a period of three years, excluding programmable power supplies, from the date of delivery to the original purchaser. Any product found to be defective within this period will, at the discretion of Pickering Interfaces be repaired or replaced.

Products serviced and repaired outside of the warranty period are warranted for ninety days.

Extended warranty and service are available. Please contact Pickering Interfaces by phone, the website or via e-mail.

ENVIRONMENTAL POLICY

Pickering Interfaces operates under an environmental management system similar to ISO 14001.

Pickering Interfaces strives to fulfil all relevant environmental laws and regulations and reduce wastes and releases to the environment. Pickering Interfaces aims to design and operate products in a way that protects the environment and the health and safety of its employees, customers and the public. Pickering Interfaces endeavours to develop and manufacture products that can be produced, distributed, used and recycled, or disposed of, in a safe and environmentally friendly manner.

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PRODUCT SAFETY

SAFETY SYMBOLS

The following safety symbols may be used on the product and throughout the product documentation.

MEANING / DESCRIPTION	SYMBOL
PROTECTIVE EARTH (GROUND) To identify any terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth (ground) electrode.	
DANGEROUS VOLTAGE To indicate hazards arising from dangerous voltages.	
WARNING / CAUTION An appropriate safety instruction should be followed or caution to a potential hazard exists. Refer to the relevant instructions detailed within the product manual.	
HEAVY If this product is heavy reference should be made to the safety instructions for provisions of lifting and moving.	
STATIC SENSITIVE To indicate that static sensitive devices are present and handling precautions should be followed.	

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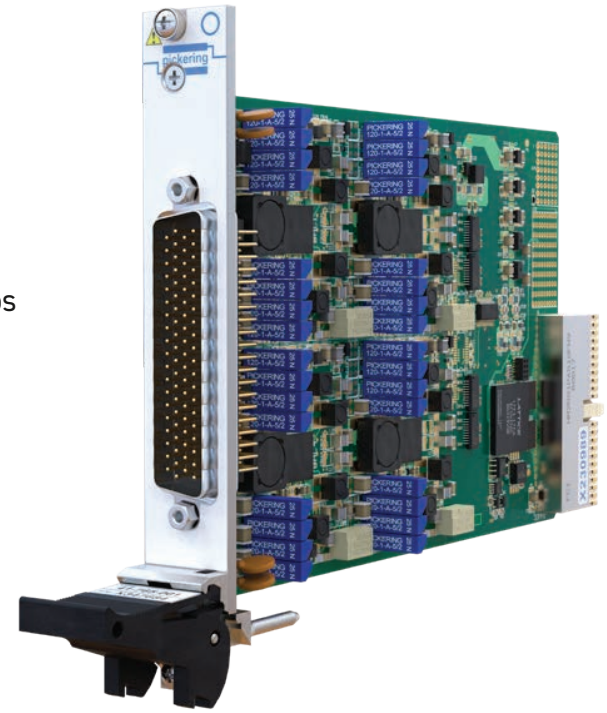
SECTION 1 - TECHNICAL SPECIFICATION

- Available as PXI or PXIe Modules
- Ideal for 4–20 mA Industrial Current Loop Simulation
- Multiple Modes of Operation: 4-20 mA, 0-24 mA, +/-24 mA, 0-5 V, +/-12 V & +/-5 V
- Self-powered with Sourcing or Sinking
- From 4 up to 16 Channels in One Slot Module
- Ability to Work in Full Isolation to Avoid Ground Loops
- Hardware Interlock Feature
- 16-bit Resolution – Output Control Within 1µA
- Accuracy of ±0.1 % FSR
- Programmable Slew Rate
- Short and Open Simulation
- PXI Versions Supported by PXI or LXI/USB Chassis
- Kernel and VISA Drivers
- 3 Year Warranty



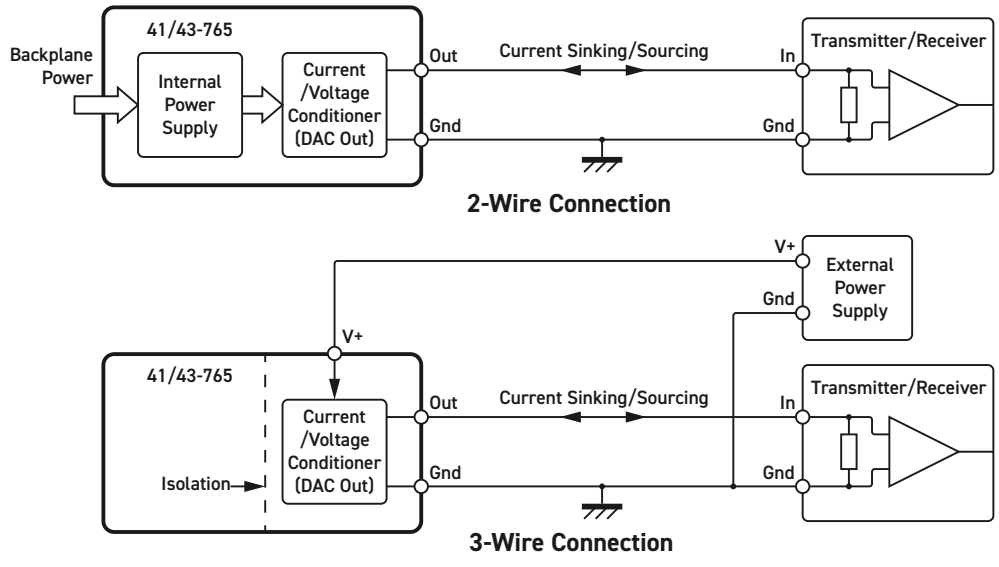
The 41-765 (PXI) and 43-765 (PXIe) are designed to meet the requirements of industrial control applications utilising current loops 4 – 20 mA. It consists of up to four 16-bit, digital-to-analogue converters (DAC), capable of creating four current outputs each. Output current within 0 - 4 mA and 20 mA - 24 mA,
give the ability to simulate error or extra signalling conditions. The ±24 mA mode gives the ability to simulate either sourcing or sinking sensor.

Typical applications of this module span across: 4 – 20 mA current loops, analogue output modules, programmable logic controllers (PLCs), industrial automation, sensor transmitters, process control.

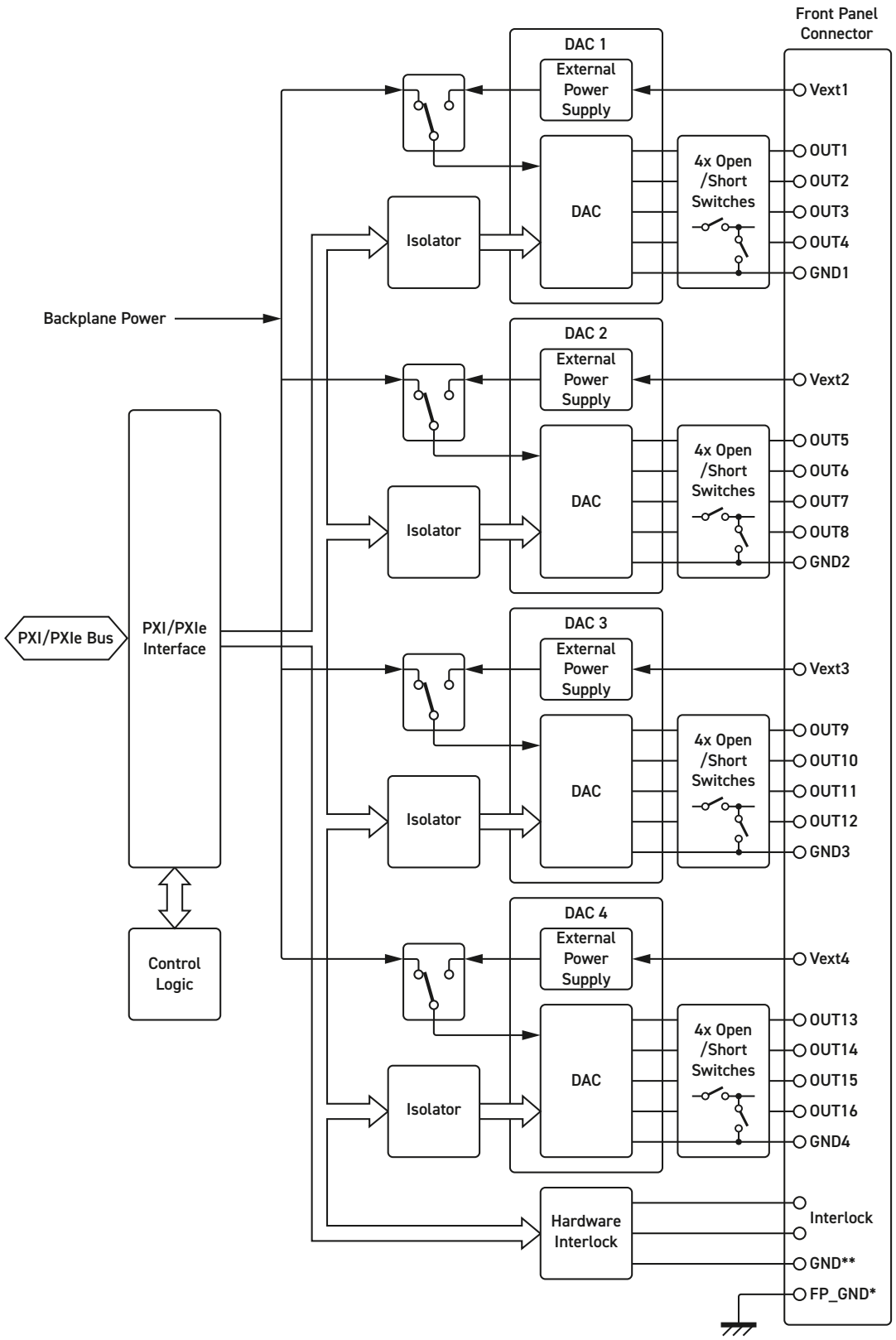
The outputs can work in one of several modes of operation: 4-20 mA, 0-24 mA or +/-24 mA. As well as low power voltage modes of operation: 0-5 V, +/-12 V or +/-5 V.

Each DAC of the module can be powered up independently, either from the chassis power supply or can work as fully isolated unit, being powered up from an external source. This approach removes issues of ground looping. The DAC is always actively sourcing or sinking, so no voltage source is required in a current loop, simplifying the test system.

Each channel of the 41/43-765 module is able to simulate the short and open circuit conditions that can be experienced in a system due to faulty wiring or sensors.



Block Diagram for 4-20 mA Current Loop Example



Functional Diagram for the 41/43-765 Analog Output Module

* Front panel ground (FP_GND) is internally connected to chassis GND, however the grounds of the consecutive DACs may become isolated and should not be externally connected to FP_GND.

** This pin (GND) is used for special interlock configurations only.

Specification

Number of Channels:	16, 12, 8 or 4
Output Current (each Channel):	4-20 mA, 0-24 mA, +/-24 mA, 0-5 V, +/-12 V or +/-5 V
Resolution:	16 bit – less than 1 uA per 1 LSB
Error (typical*):	±0.1 FSR Total Unadjusted Error
DNL	±1 LSB
Fault Simulation:	Open or Short Circuit
Channel Isolation:	Full isolation mode in banks of 4 channels (per DAC)
External PSU input:	16.5 VDC to 60 VDC, 500 mA

* The extreme top and bottom ends of ranges may reach ±0.2% of FSR ±Resolution.

Power Requirements - 41-765

+3.3 V	+5 V	+12 V	-12 V
0.25 A	0.55 A	0.8 A	0

Power Requirements - 43-765

+3.3 V	+12 V
0.5 A	1 A

Mechanical Characteristics

41-765 - Single slot 3 U PXI (CompactPCI card).
43-765 - Single slot 3 U PXIe, compatible with PXIe hybrid slot.
3D models for all versions in a variety of popular file formats are available on request.

Connectors

41-765 - PXI bus via 32-bit P1/J1 backplane connector.
43-765 - PXIe bus via XJ3 and XJ4 backplane connectors.
Signals via front panel 78-pin male D-type connector, for pin outs please refer to the operating manual.

Operating/Storage Conditions

Operating Conditions

Operating Temperature:	0 °C to +55 °C
Humidity:	Up to 90 % non-condensing
Altitude:	5000 m

Storage and Transport Conditions

Storage Temperature:	-20 °C to +75 °C
Humidity:	Up to 90 % non-condensing
Altitude:	15000 m

Safety & CE Compliance

All modules are fully CE compliant and meet applicable EU directives: Low-voltage safety EN61010-1:2010, EMC Immunity EN61326-1:2013, Emissions EN55011:2009+A1:2010.

Product Order Codes

PXI Analog Output / Current Loop Simulator Module	
16 Channel	**41-765-001**
12 Channel	**41-765-002**
8 Channel	**41-765-003**
4 Channel	**41-765-004**
PXIe Analog Output / Current Loop Simulator Module	
16 Channel	**43-765-001**
12 Channel	**43-765-002**
8 Channel	**43-765-003**
4 Channel	**43-765-004**

Product Customization

Pickering modules are designed and manufactured on our own flexible manufacturing lines, giving complete product control and enabling simple customization to meet very specific requirements.

All customized products are given a unique part number, fully documented and may be ordered at any time in the future. Please contact your local sales office to discuss.

Mating Connectors & Cabling

For other connection accessories for the 41/43-765 please refer to the 90-006D 78-pin D-type Connector Accessories data sheet where a complete list and documentation can be found for accessories, or refer to the Connection Solutions catalog.

Note: If acceptance of the HART signaling is required please contact the sales office.

PXI & CompactPCI Compliance - 41-765

The module is compliant with the PXI Specification 2.2. Local Bus, Trigger Bus & Star Trigger are not implemented. Uses a 33 MHz 32-bit backplane interface.

PXIe Compliance - 43-765

The module is compliant with the PXIe Specification 1.0. Local Bus, Trigger Bus & Star Trigger are not implemented.

43-765 Module in PXIe Format

Chassis Compatibility

The PXI versions of this module must be used in a suitable chassis. They are compatible with the following chassis types:

- All chassis conforming to the 3U PXI and 3U Compact PCI (cPCI) specification
- Legacy and Hybrid Peripheral slots in a 3U PXI Express (PXIe) chassis
- Pickering Interfaces LXI or LXI/USB Modular Chassis

The PXIe versions of this module are compatible with the following chassis types:

- All chassis conforming to the 3U PXIe specification
- PXIe and Hybrid Peripheral slots in a 3U PXI Express (PXIe) chassis

Chassis Selection Guide

Standard PXI or hybrid PXIe Chassis from any Vendor:

- Mix our 1000+ PXI switching & simulation modules with any vendor's PXI instrumentation
- Embedded or remote Windows PC control
- Real-time Operating System Support
- High data bandwidths, especially with PXI Express
- Integrated module timing and synchronization

Pickering LXI or LXI/USB Modular Chassis—only accept our 1000+ PXI Switching & Simulation Modules:

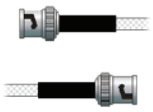
- Ethernet or USB control enables remote operation
- Low-cost control from practically any controller
- LXI provides manual control via Web browsers
- Driverless software support
- Power sequencing immunity
- Ethernet provides chassis/controller voltage isolation
- Independence from Windows operating system

Connectivity Solutions

We provide a full range of supporting cable and connector solutions for all our switching products—20 connector families with 1200+ products. We offer everything from simple mating connectors to complex cables assemblies and terminal blocks. All assemblies are manufactured by Pickering and are guaranteed to mechanically and electrically mate to our modules.

Connectors & Backshells

Multiway Cable Assemblies



RF Cable Assemblies

Connector Blocks

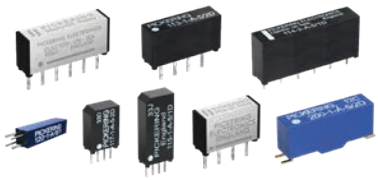
We also offer customized cabling and have a free online **Cable Design Tool** that can be used to create custom cable solutions for many applications. Visit: pickeringtest.com/cdt to start your design.

Mass Interconnect

We recommend the use of a mass interconnect solution when an Interchangeable Test Adapter (ITA) is required for a PXI or LXI based test system. Our modules are fully supported by both Virginia Panel and MacPanel.

Pickering Reed Relays

We are the only switch provider with in-house reed relay manufacturing capability via our Relay Division. These instrument grade reed relays feature ***SoftCenter™*** technology, ensuring long service life and repeatable contact performance. To learn more, please go to: pickeringrelay.com



Programming

Pickering provide kernel, IVI and VISA (NI & Keysight) drivers which are compatible with all Microsoft supported versions of Windows and popular older versions. For a list of all supporting operating systems, please see: pickeringtest.com/os

The VISA driver is also compatible with Real-Time Operating Systems such as LabVIEW RT. For other RTOS support contact Pickering. These drivers may be used with a variety of programming environments and applications including:

- **Pickering Interfaces Switch Path Manager**
- **National Instruments** products (LabVIEW, LabWindows/CVI, Switch Executive, MAX, TestStand, VeriStand, etc.)
- **Microsoft Visual Studio** products (Visual Basic, Visual C+)
- **Keysight** VEE and OpenTAP
- **Mathworks** Matlab
- **Marvin** ATEasy
- **MTQ Testsolutions** Tecap Test & Measurement Suite

Drivers for popular Linux distributions are available, other environments are also supported, please contact Pickering with specific enquiries. We provide Soft Front Panels (SFPs) for our products for familiarity and manual control, as well as comprehensive documentation and example programs to help you develop test routines with ease.
To learn more about software drivers and development environments, please go to: pickeringtest.com/software

Signal Routing Software

Our signal routing software, Switch Path Manager, automatically selects and energizes switch paths through Pickering switching systems. Signal routing is performed by simply defining test system endpoints to be connected together, greatly accelerating Test System software development. To learn more, please go to: pickeringtest.com/spm

Diagnostic Relay Test Tools

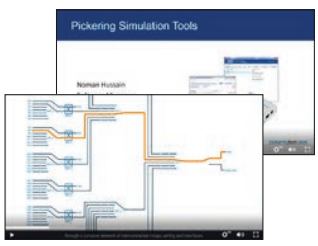
eBIRST Switching System Test Tools are designed specifically for our PXI, PCI or LXI products, these tools simplify switching system fault-finding by quickly testing the system and graphically identifying the faulty relay.
To learn more, please go to: pickeringtest.com/ebirst

Three Year Warranty & Guaranteed Long-Term Support

All standard products manufactured by Pickering Interfaces are warranted against defective materials and workmanship for a period of three years from the date of delivery to the original purchaser. Extended warranty and service agreements are available for all our modules and systems with various levels to suit your requirements. Although we offer a 3-year warranty as standard, we also include guaranteed long-term support—with a history of supporting our products for typically 15-20 years. To learn more, please go to: pickeringtest.com/support

Available Product Resources

We have a large library of product resources including success stories, product and support videos, articles and white papers as well as application specific product brochures to assist when looking for the switching, simulation and connection solutions you need. We have also published handy reference books on Switching Technology and for the PXI and LXI standards.



To view, download or request any of our product resources, please visit: pickeringtest.com/resources

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SECTION 2 - TECHNICAL DESCRIPTION

FUNCTIONAL DESCRIPTION

The 41/43-765 is designed to meet the requirements of industrial control applications utilising current loops 4 – 20mA. It is designed in the form of a typical PXI/PXIe module, supported by a PXI/PXIe, chassis or Pickering's LXI/USB chassis. The module is also designed to support PXIe communication but not as hybrid - please contact the Pickering sales office for details. A functional block diagram is provided in Figure 2.1.

The Analog Output/Current Loop Simulator Module is powered by +12V, +5V and +3.3V supplies via Compact PCI connector J1.

The interface to the user test equipment is via a front panel mounted 78-pin male D-type connector, J2. A pinout of the connector is shown in Section 5, for each population variant of the module.

The module comprises a PCB populated with up to 4 digital to analog converter (DAC) devices (U11 to U14), depending on module version. Each DAC provides 4 analog output channels that can be programmed to act as current sources, current sinks or low power voltage sources. These are controlled by the PCI interface (U30) and control logic via logic isolation devices (U7 to U10).

Each channel of the module can operate as a current loop transmitter, by sourcing current, or as a current loop receiver by sinking current. In the sourcing current scenario, the 0-24mA and 4-20mA modes are recommended as they deliver the best resolution, with the 0-24mA mode also delivering error and/or signalling ranges between 0-4mA and 20-24mA. In the sinking current scenario, the ±24mA mode in the negative range, can be utilised. The module can also deliver uni- and bi-polar low current voltage modes with precise resolution control.

For fault simulation purposes, the analog channels are routed to the front panel connector via isolation relays (RLI_11 to RLI_44) and short relays (RLS_11 to RLS_44). When the short relay is energised for a particular channel, the status of the corresponding isolation relay is irrelevant. To see how the relays are utilised for each channel, please refer to the Functional Diagram or Figures 4.1 to 4.4.

Each DAC is powered via its own power management circuit, this includes relays (RL_DAC1 to RL_DAC4) for the selection of the internal power supply or external power from the front panel connector. The internal power supply is derived from the PXI bus and is fixed at +12V. External power for each DAC is supplied via regulators (U151 to U154). The external supply can vary between +16.5V and +60V (regulated by the module to +15V). By default the internal supply is selected and is used during the module power up sequence. When the internal supply is selected, all the grounds are tied, including all channel grounds, to the controller and PXI chassis ground. When the external power supplies are selected, each DAC works in full isolation mode. This means all channels of a specific DAC have a common ground, isolated from the PXI chassis, controller ground and other DACs, which needs to be provided by the external PSU. This feature can be used to break potential ground loops when delivering power from the transmitter/receiver site. Each DAC can be used independently in this respect. Please see the 2- and 3-wire connection examples in Section 1 of this manual, also refer to the "Connectivity Notes" section.

Output isolation, output shorting and power selection relays are controlled by relay drivers (U6, U22 and U23).

In many simulation cases it may be desirable to change the speed of the level-to-level signal transition. Therefore, each channel has a programmable slew rate - this feature is disabled by default. The slew rate can be programmed in two ways: by modifying the clock rate and/or the step size. The range of the clock rate is between 3.3Hz and 258.065Hz. Each step size is a multiple of 2 with 8 settings ranging from 1 to 128. Please see Figure 4.6 for the slew rate programming concept. The time required for the output to slew over a given range may vary mode to mode and the step size will be a different value in mA or V. When the slew rate control feature is enabled, the output changes occur at the programmed slew rate. This configuration results in a staircase waveform at the output. If a hardware clear is invoked, the output slews to the zero value at the programmed slew rate. When new data is written to the DAC, the output starts slewing to the new value at the slew rate determined by the current settings.

The module consists of a safety hardware interlock feature which disables all the outputs if the front panel connector is not correctly wired, or will immediately disable all the outputs it the front panel connector is removed whilst the module is operating. Please see Section 5 – "Connector Information" for more details.

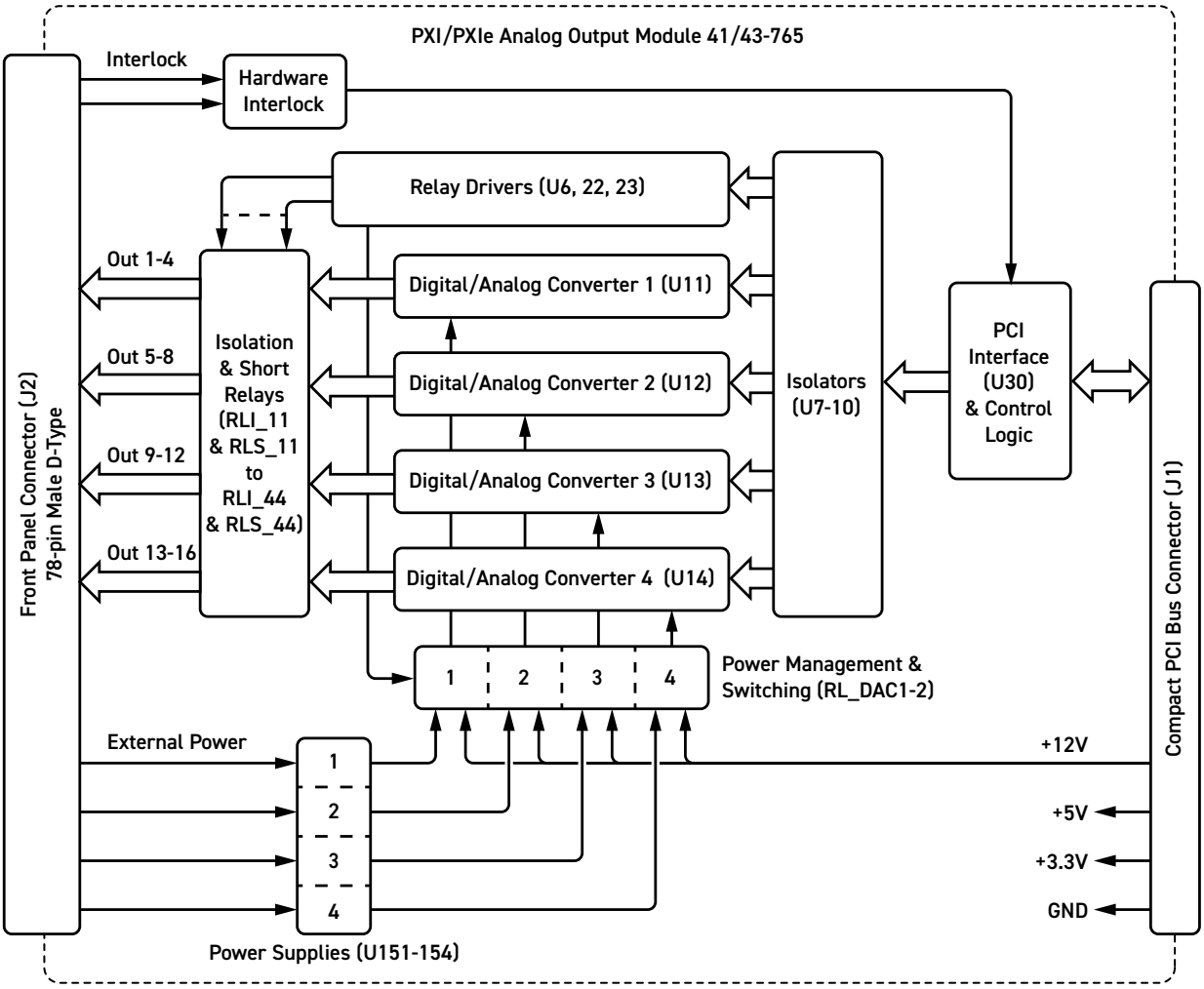

Figure 2.1 - Functional Block Diagram:
Analog Output/Current Loop Simulator Module 41/43-765

Connectivity Notes

The 41/43-765 module doesn't generally need an external PSU. The external PSU is only needed in cases where there are ground loops between the simulator module and DUT - this is a rare occurrence in majority of compact test systems, however, it can be a problem in systems spanning large distances. When an external PSU is required, it should be connected per bank of channels (one DAC), then the entire bank (4 channels) is isolated from the test system and can be powered from the same power points as the DUT, effectively bringing the DAC with its 4 channels "close" to the DUT (breaking the ground loop).

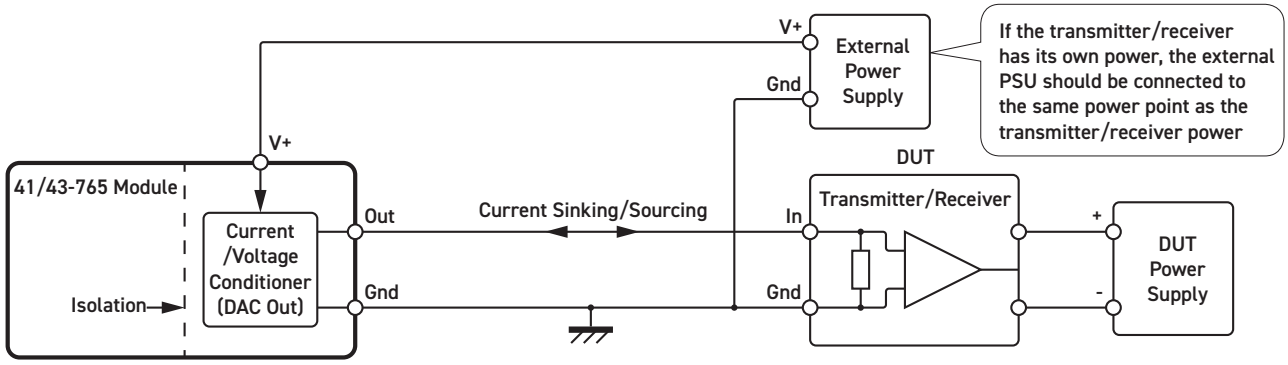

Figure 2.2 - Analog Output/Current Loop Simulator Module with 3-Wire Connection

When an external PSU is required, a single, sufficiently specified supply can be used for all four DACs and appropriate interconnecting wiring created (see "Connector Information" section). Bear in mind that, none of the isolated grounds of the DACs should be connect to the FP_GND or GND during normal operation.

When using an external PSU for a particular bank, it must be connected between the respective FP_Vccx pin and associated GNDx pin. Then the internal power selection relay needs to be enabled via software or using the SFP to connect the external supply to the required bank of 4 channels.

During the power up sequence of the test system, all the module's channels are always powered from the internal chassis source.

The external PSU mustn't be confused with a power source in a typical current loop. In normal use of the 41/43-765, current loops don't need the explicit "in-line" power source. The simulator is actively sourcing or sinking current. This means you need to connect the transmitter/receiver directly between a channel output pin and a ground pin designated for the corresponding bank of channels. Example: Out1 – Gnd1, Out2 – Gnd1, … , Out5 – Gnd2, Out6 – Gnd2, and so on.

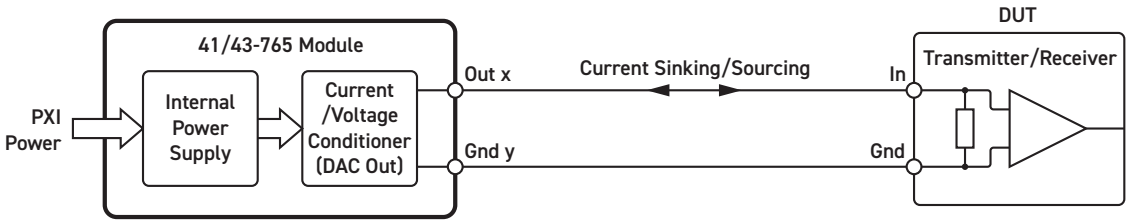

Figure 2.3 - Analog Output/Current Loop Simulator Module - Typical Connection of a DUT

If an external power source is inserted into the loop, it will "fight" the source/sink function of the channel, obeying Kirchhoff's laws, potentially damaging the DAC if pushed hard enough. In this scenario, the DAC would work to the best of it's capabilities but since it is an advanced device, conscious of power usage, it will only supply as much voltage as is needed to fulfill the required compliance voltage. It will eventually succumb to the external, in-line source, which is usually fixed.

The FP_GND pin shouldn't normally be used (as a power return for anything), it is provided as a chassis ground in accordance with the PXI standard. The GND pin (GND signal without a suffix number - pin 76) also mustn't be used as it serves only for certain configurations of the interlock system.

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SECTION 3 - INSTALLATION

Refer to the Warnings and Cautions at the front of this manual

Modular products require installation in a suitable PXI/PXIe/LXI chassis. The module is for indoor use only.

PREOPERATION CHECKS (UNPACKING)

1. Check the module for transport damage and report any damage immediately to Pickering Interfaces. Do not attempt to install the product if any damage is evident.
2. Position the chassis relative to any other equipment the module(s) will connect with. Ensure the chassis is not connected to the electrical supply.
3. Ensure that the designated area for the chassis containing the module is of flat and solid construction to withstand and support the combined weight of the module(s) and chassis.

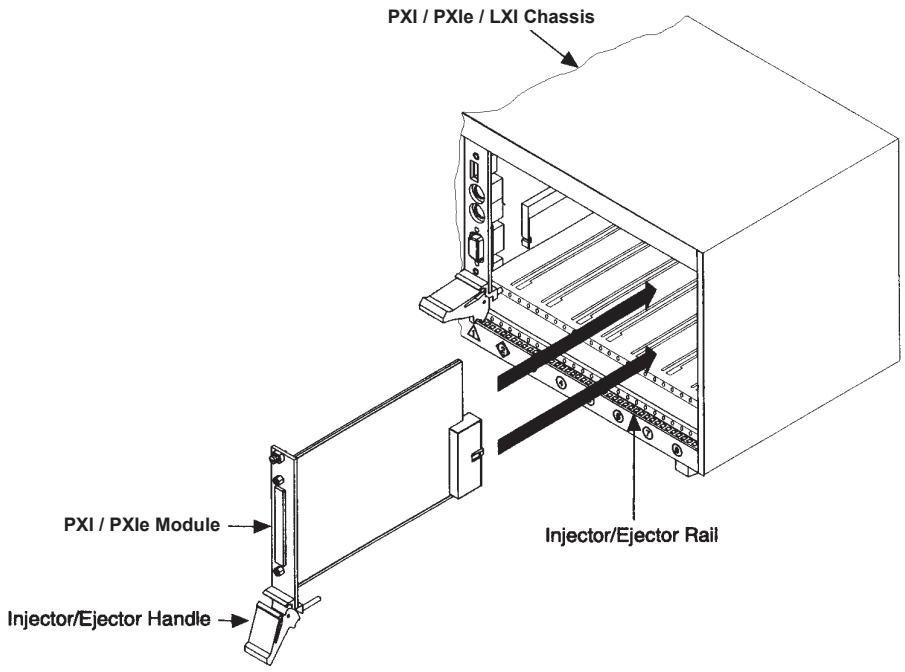

Figure 3.1 - Installing the Module into a PXI/PXIe/cPCI/LXI Chassis

HARDWARE INSTALLATION
ELECTRICAL CONNECTION (CHASSIS)

1. The chassis must be electrically installed in accordance with local regional electrical codes by a qualified engineer.
2. The chassis must be grounded.

Electrostatic discharge can damage the components on the module. To avoid such damage in handling the board refer to page VII.

Ensure that there is adequate ventilation.

The module should be installed in accordance with the following procedure:

1. Ensure that the system is turned OFF but still connected to mains so that it remains grounded.
2. Choose an appropriate slot in the rack.
3. Remove the blanking plate for the chosen slot.
4. Ensure that the injector/ejector handle is in its downward position. Align the module with the card guides on the top and bottom of the slot.

   Do not raise the injector/ejector handle whilst inserting the module as the module will not insert properly.
5. Hold the handle whilst slowly sliding the module into the card guides until the handle catches on the injector/ejector rail (refer to Figure 3.1).
6. Raise the injector/ejector handle until the module firmly seats into the backplane. The front panel of the module should be flush with the front panel of the chassis.
7. Secure the front panel of the module using both screws to the chassis front panel mounting rails.
8. In a system employing a remote control interface to connect an external controller to a PXI chassis or to link multiple chassis, power-up the system as follows:
   a. For a system comprising an external controller and one chassis, power up the chassis before powering up the external controller.
   b. For a system comprising more than one chassis, turn ON the last chassis in the system followed by the penultimate, etc, and finally turn ON the external controller or chassis containing the system controller.
9. For Pickering Interfaces modular LXI installation there is no requirement to use any particular power up sequence.

SOFTWARE INSTALLATION

First install the appropriate Pickering PXI switch card drivers by running the installer program Setup.exe (provided in a compressed zip file), either from the CD-ROM supplied, or by downloading the latest version from our website **pickeringtest.com** - the recommended method. Setup is accompanied by a ReadMe file containing additional installation information. A single installation covers all cards in the System 40, System 45 and System 50 ranges.

When installation completes, the installed drivers' ReadMe file is offered for display. It can also be displayed later using a shortcut on the Programs>>Pickering menu.

If you are not a LabVIEW user you should choose the "full" version, and once that has been installed run the LabVIEW Runtime Engine installer via the shortcut on the Programs>>Pickering menu. In the absence of LabVIEW the Runtime Engine is required to support the Pickering Test Panels application.

TESTING OPERATION

After installation of the hardware and Pickering PXI Driver software package start the General Soft Front Panel (GSFP) using the desktop icon or via the Start menu (***Start Menu-> Pickering Interfaces Ltd -> General Soft Front Panel***).

Figure 3.2 - General Soft Front Panel Icon

A selector panel will appear, listing all installed Pickering PCI, PXI or LXI switch cards and resistor cards. Click on the card you wish to control, and a graphical control panel is presented allowing operation of the card. Panels can be opened simultaneously for all the installed cards.

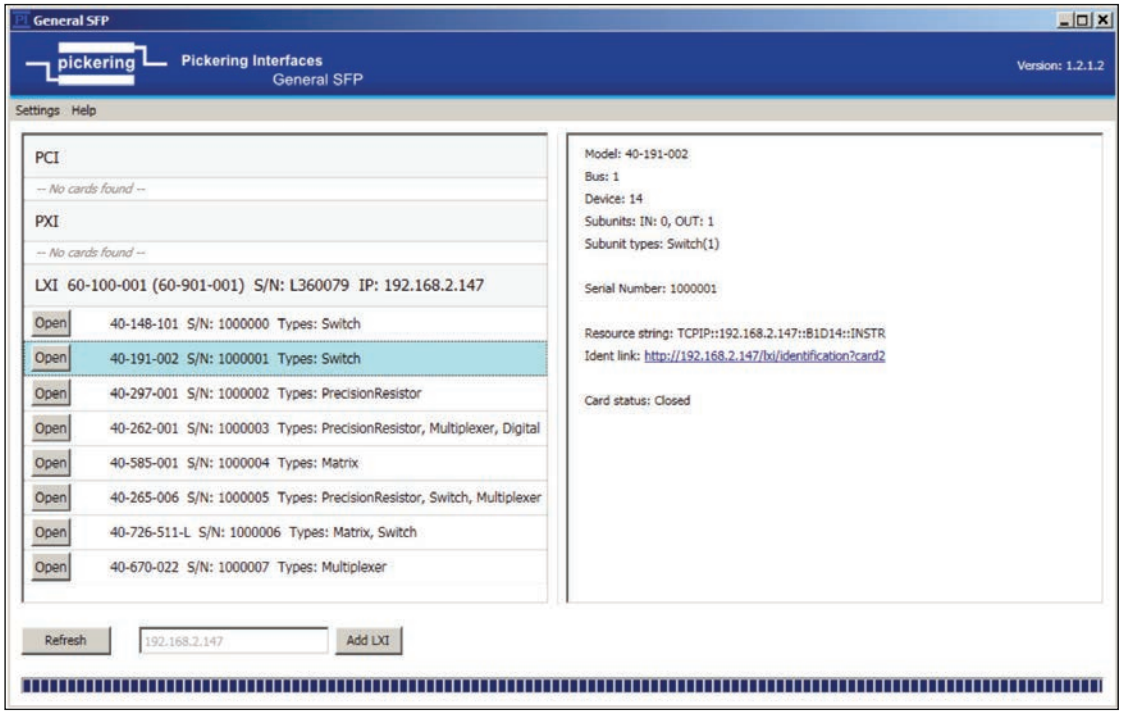

Figure 3.3 - General Soft Front Panel Selector

More details how to use the GSFP can be found in the manual, via menu ***Help\Manual***

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SECTION 4 - PROGRAMMING GUIDE

Programming Options for Pickering Interfaces PXI/PXIe Modules

For information on the installation and use of drivers and the programming of Pickering's products in various software environments, please refer to the Software User Manual.

This is available as a download from:
https://www.pickeringtest.com/support/software-drivers-and-downloads

Also, it can be accessed from the DVD supplied with the product:
<DVD_DRIVE>\downloads\Documentation\Software-Manual.pdf

PROGRAMMING THE MODULE

The 41/43-765 Analog Output/Current Loop Simulator module is available with 4,8,12 or 16 independent programmable voltage and current source channels. These can be set using the Set and Get attribute functions. The default mode is 4-20mA operation.

Modes of Operation

The following table illustrates 6 different modes of operation. These modes can be configured independently on every programmable source channel.

Table 4.1 – Summary of Modes of Operation

Mode	Description
1	4 to 20mA operation programmable with up to 1µA resolution. This mode is set by default
2	0 to 24mA operation programmable with up to 1µA resolution.
3	-24 to 24mA operation programmable with up to 1µA resolution.
4	0 to 5V operation programmable with up to 1µV resolution.
5	-12 to 12V operation programmable with up to 1µV resolution.
6	-5 to 5V operation programmable with up to 1µV resolution.

Programmable Slew Rate

The slew rate control feature allows the user to control the rate at which the output voltage or current changes. This feature is disabled by default and can be enabled for the selected channel by Set Attribute function.

With this feature enabled, the user needs to define the output steps digitally at a rate defined by a combination of Step Size and Update Clock Frequency. When calling the Set Attribute function with ATTR_SLEW_RATE, the value is defined as a BYTE with upper nibble <Step Size – 0 -0x7> lower nibble < Slew Clock Rate - 0x1-0xFF>. The following table describes the slew rate.

Table 4.2 – Programmable Slew Rate Settings

Upper Nibble	Step Size	Lower Nibble	Slew Clock Rate
0x00h (default)	X1	0x00h (default)	258,065 Hz (default)
0x01h	X2	0x01h	200,000 Hz
0x02h	X4	0x02h	153,845 Hz
0x03h	X8	0x03h	131,145 Hz
0x04h	X16	0x04h	115,940 Hz
0x05h	X32	0x05h	69,565 Hz
0x06h	X64	0x06h	37,560 Hz
0x07h	X128	0x07h	25,805 Hz

For example, in Pilpxi in order to set a value of Step Size x2 and Slew Clock Rate of 20,150 Hz:
 	
`BYTE val = 0x18`
`p = &val`
 	
`PIL_SetAttribute(card,sub,out,`
`ATTR_SLEW_RATE, p);`
		0x08h	20,150 Hz

		0x09h	16,030 Hz
		0x0Ah	10,295 Hz
		0x0Bh	8,280 Hz
		0x0Ch	6,900 Hz
		0x0Dh	5,530 Hz
		0x0Eh	4,240 Hz
		0x0Fh	3,300 Hz

Sub-unit Structure

Table 4.3 – Summary of Sub-units

	Output Sub-Units			
Model Number	**Sub-unit Number**	**Sub-unit Type**	**Description**	
41/43-765-001	1...16	PSOURCE	PowerSouce sub-unit allows you to set Voltage and Current. Each channel can be control individually.	
41/43-765-002	1...12			
41/43-765-003	1...8			
41/43-765-004	1...4			
Applicable Functions		**LXI Driver**	**VISA Driver**	**Direct Driver**
		PIPLX_SetAttribute PIPLX_GetAttribute	pipx40_setAttribute pipx40_getAttribute	PIL_SetAttribute PIL_GetAttribute
Applicable Attributes		**Name**	**Description**	
		ATTR_MODE	The Mode functionality allows the user to choose between different ranges in Voltage and Current (see 'Modes of Operation').	
		ATTR_CURRENT_MA	Allows the user to set/get current in mA.	
		ATTR_CURRENT_V	Allows the user to set/get voltage in V.	
		ATTR_SLEW_RATE	Allows the user to set/get slew rate on specific channel.	
		ATTR_IS_SLEW	Queries the driver to check if the slewing functionality is on (this is Get only).	
Model Number	**Sub-unit Number**	**Sub-unit Type**	**Description**	
41/43-765-001	17	SWITCH	This sub-Unit allows the user to set isolation and shorting relays on individual channels.	
41/43-765-002	13			
41/43-765-003	9			
41/43-765-004	5			
Model Number	**Sub-unit Number**	**Sub-unit Type**	**Description**	
41/43-765-001	18	SWITCH	This sub-unit allows the user to choose between external and internal power source. Each switch switches 4 channels.	
41/43-765-002	14			
41/43-765-003	10			
41/43-765-004	6			
Applicable Functions		**LXI Driver**	**VISA Driver**	**Direct Driver**
		PIPLX_OpBit PIPLX_WriteSub PIPLX_ClearSub PIPLX_ViewBit PIPLX_ViewSub	pipx40_setChannelState pipx40_setChannelPattern pipx40_clearSub pipx40_getChannelState pipx40_getChannelPattern	PIL_OpBit PIL_WriteSub PIL_ClearSub PIL_ViewBit PIL_ViewSub

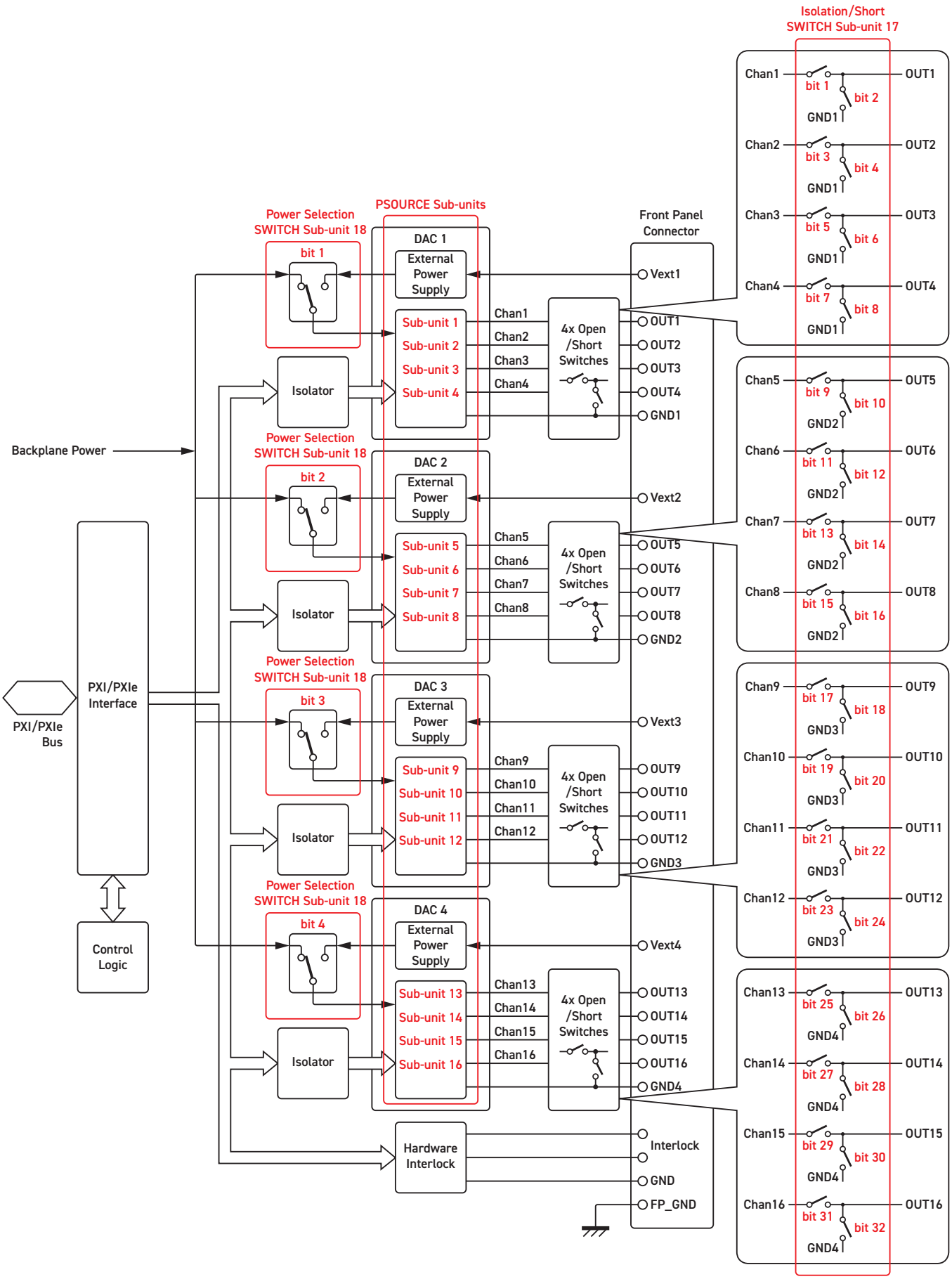

Figure 4.1 - Sub-unit/Bit Allocations:
41/43-765-001 16-Channel Analog Output/Current Loop Simulator Module

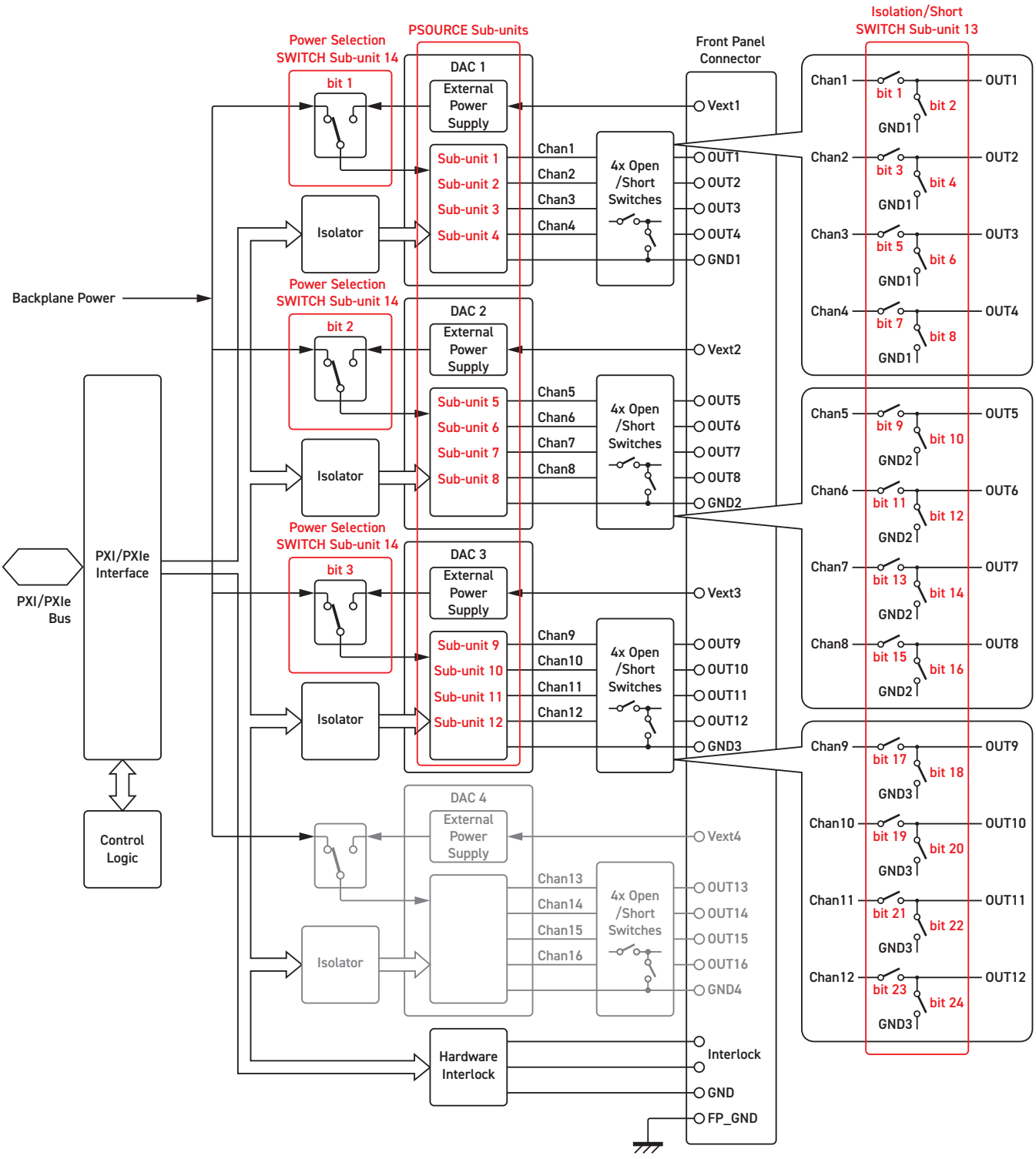

Figure 4.2 - Sub-unit/Bit Allocations:
41/43-765-002 12-Channel Analog Output/Current Loop Simulator Module

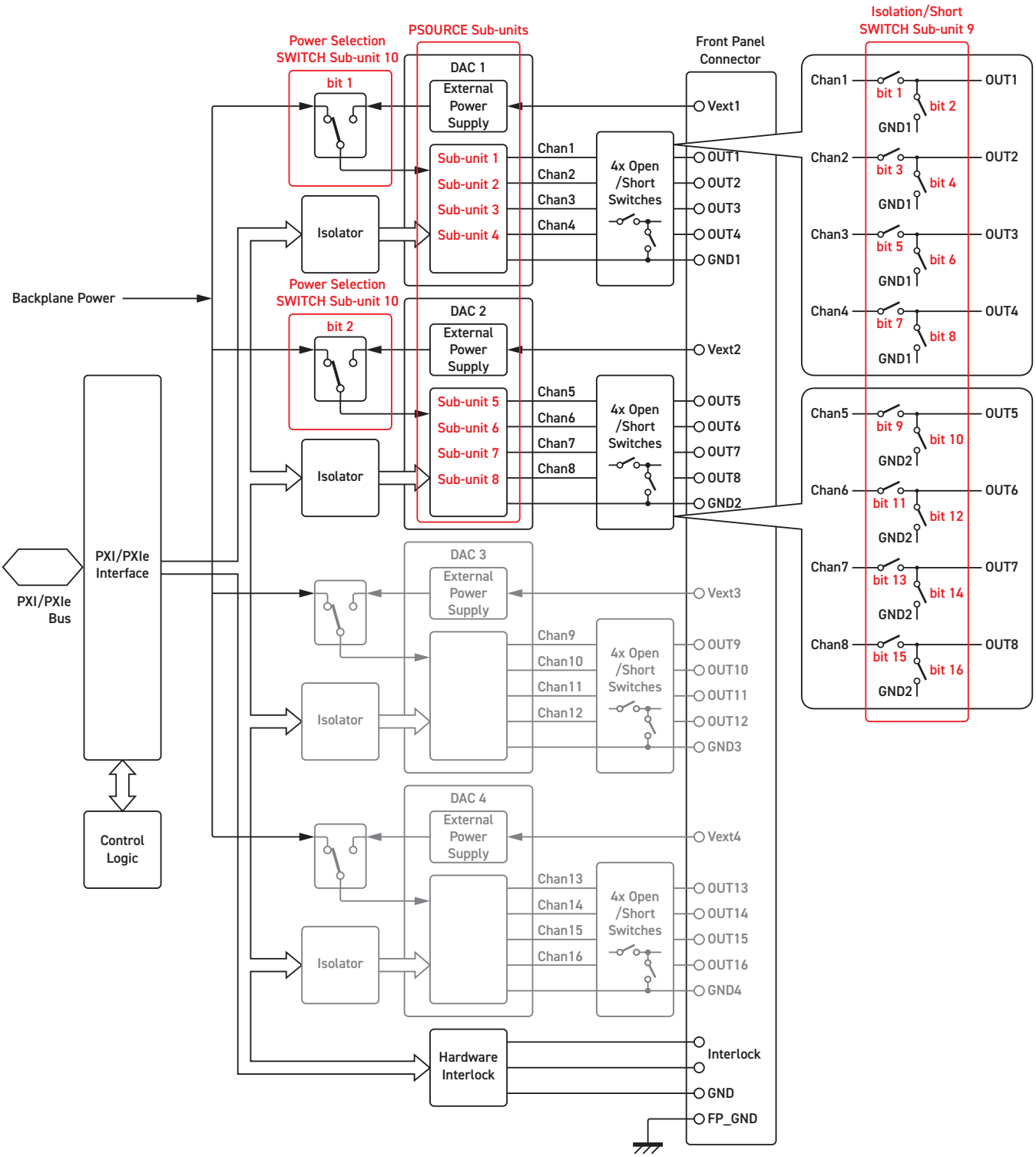

Figure 4.3 - Sub-unit/Bit Allocations:
41/43-765-003 8-Channel Analog Output/Current Loop Simulator Module

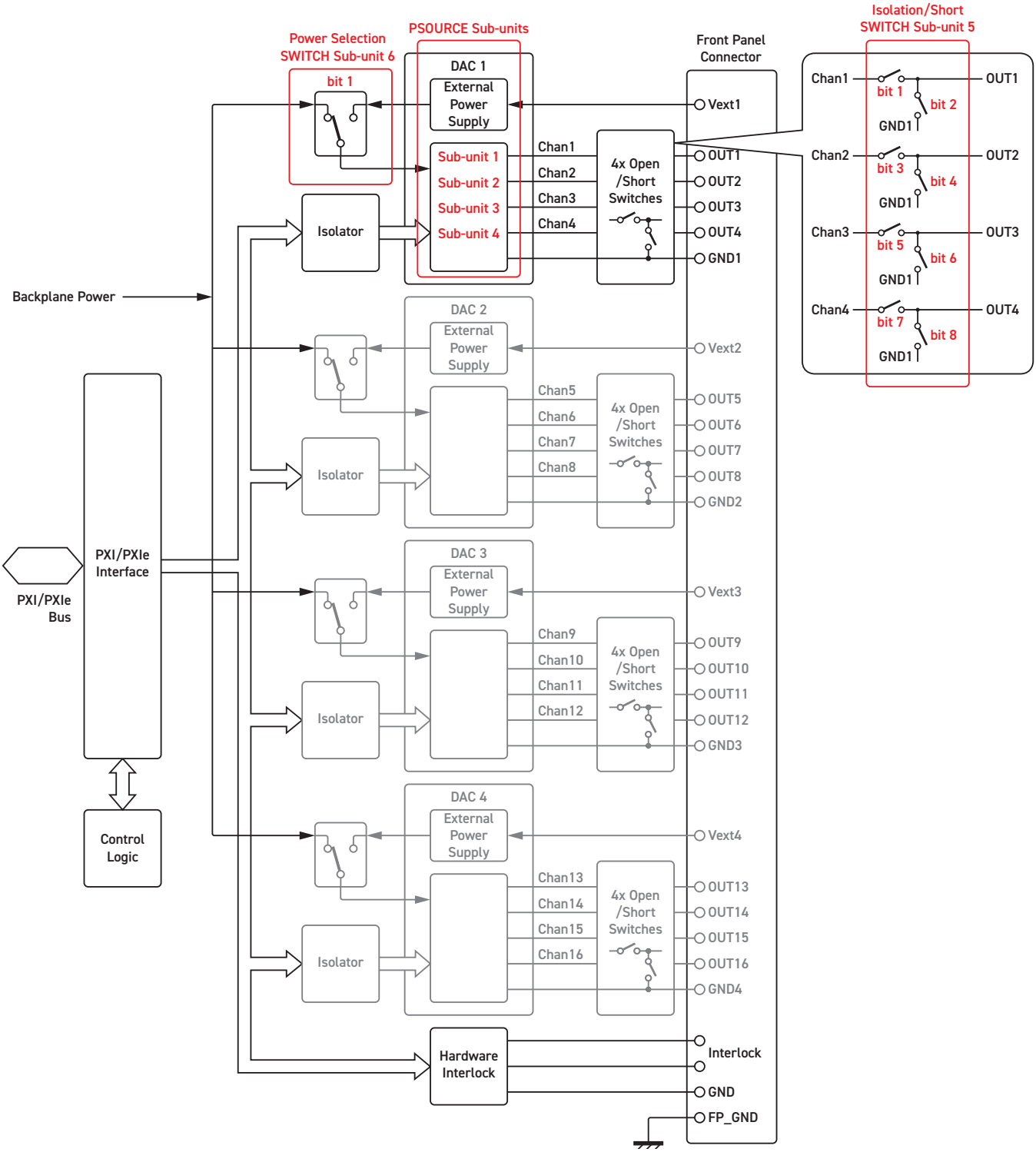

Figure 4.4 - Sub-unit/Bit Allocations:
41/43-765-004 4-Channel Analog Output/Current Loop Simulator Module

PROGRAMMING CONTROL – C++ FUNCTIONS

Set Mode Function

The Set Mode function allows you to choose between different modes of operation (see 'Modes of Operation').

```
DWORD setMode = 2; // Set Mode 0-24mA
DWORD sub = 1; // Channel 1
void* p = NULL;

p = &setMode;
ErrCheck(PIL_SetAttribute(card, sub, outSub, ATTR_MODE, p));
```

Set Current Value (mA)

The Current value is set to 6.55mA.

```
double current = 6.55; // Set current to 6.55mA
p = &current;
ErrCheck(PIL_SetAttribute(card, sub, outSub, ATTR_CURRENT_MA, p));
```

Set Mode Function

Using Set mode to set Voltage (see 'Modes of Operation').

```
DWORD setMode = 4; // Set Mode 0-5V
DWORD sub = 1; // Channel 1
void* p = NULL;

p = &setMode;
ErrCheck(PIL_SetAttribute(card, sub, outSub, ATTR_MODE, p));
```

Set Voltage Value (V)

The Voltage is set to 2.25V

```
double current = 2.25; // Set voltage to 2.25V
p = &current;
ErrCheck(PIL_SetAttribute(card, sub, outSub, ATTR_VOLTAGE_V, p));
```

Set Slew Rate

The Slew rate is set to Step Size of x2 and Slew clock rate of 20,150Hz (see 'Slew Rate').

```
BYTE setSlew = 0x18; //Sets Step to 100
p = &setInputAtten;

ErrCheck(PIL_SetAttribute(card, sub, outSub, ATTR_SLEW_RATE, p));
```

HARDWARE INTERLOCK API FUNCTIONS

Get the Status of Interlock

Use the attribute "ATTR_INTERLOCK_STATUS", to the get the status of the interlock.

```
BOOL interlock = 0x0;   // Interlock Status of the card.

// Getting the Interlock status of the card
ErrCheck(PIL_GetAttribute(card, subunit, TRUE, ATTR_INTERLOCK_STATUS,
((BOOL*)&interlock)));

if (interlock == (BOOL)FALSE)
{
    printf(" Front Panel Interlock pins are not connected. Card is disabled \n");
}
else
{
    printf(" Front Panel Interlock pins are connected. Card is active \n");
}
```

Reset the Interlock

Use the `ClearCard()` function to reset the interlock

After the front panel pins for the interlock are inter connected, the function ClearCard() should be called so the Interlock pin connection is registered and card to be active for user.

```
// Resetting the Interlock status of the card
ErrCheck(PIL_ClearCard(card));
```

Note: It's a good practice to have the `ClearCard()` function called as soon as the card is open for use in an application.

GENERAL SOFT FRONT PANEL

We provide General Soft Front Panels for all our PXI/PCI and LXI products to familiarize the user with the functionality and operation of our products. Similar to our drivers, our soft front panels cover all our cards and dedicated displays are provided for some of our products as shown in the following images.

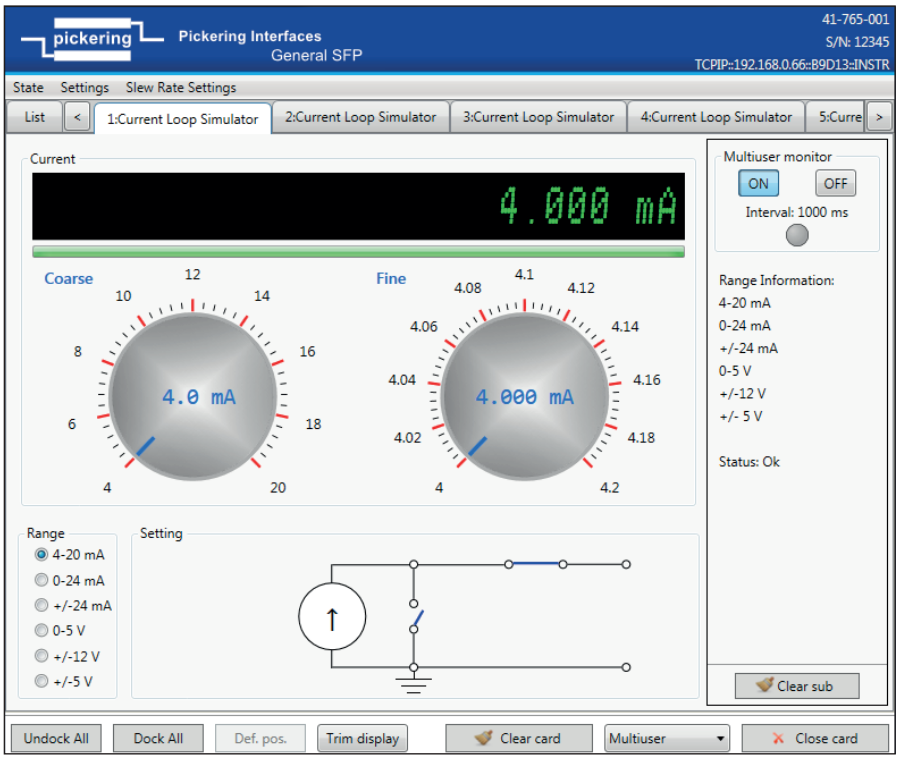

Figure 4.5 - Soft Front Panel For The 41/43-765 Module

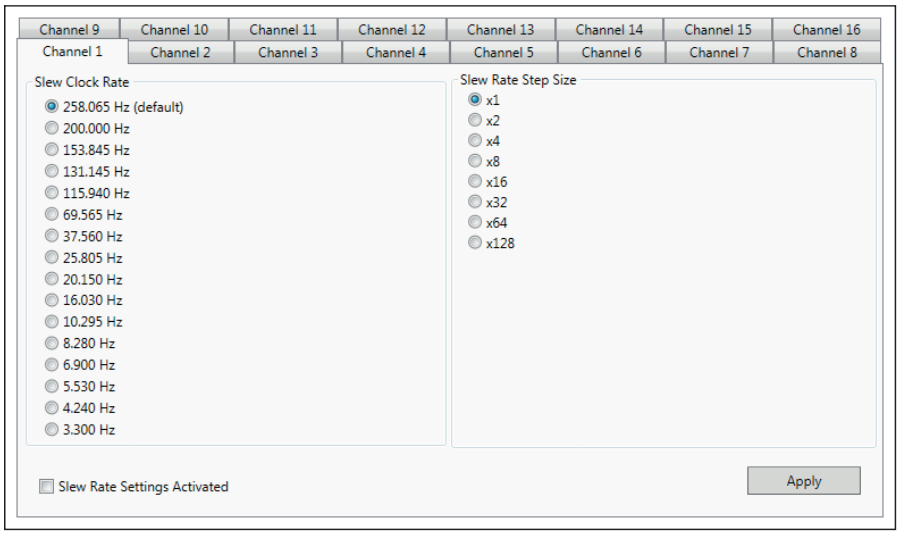

Figure 4.6 - Slew Rate Control Panel For The 41/43-765 Module

USING PICKERING DRIVERS IN LabVIEW

Most Pickering drivers include a LabVIEW wrapper to permit full operation of the Pickering product from the LabVIEW environment. These wrappers are normally installed to the current LabVIEW folder system during installation of the Pickering driver.

The process of controlling a Pickering product normally consists of the following steps:

1. Open a control session on the product
2. Use functions in the library to operate the product
3. Close the control session

Following is a simple example of the use of the most common Pickering drivers:

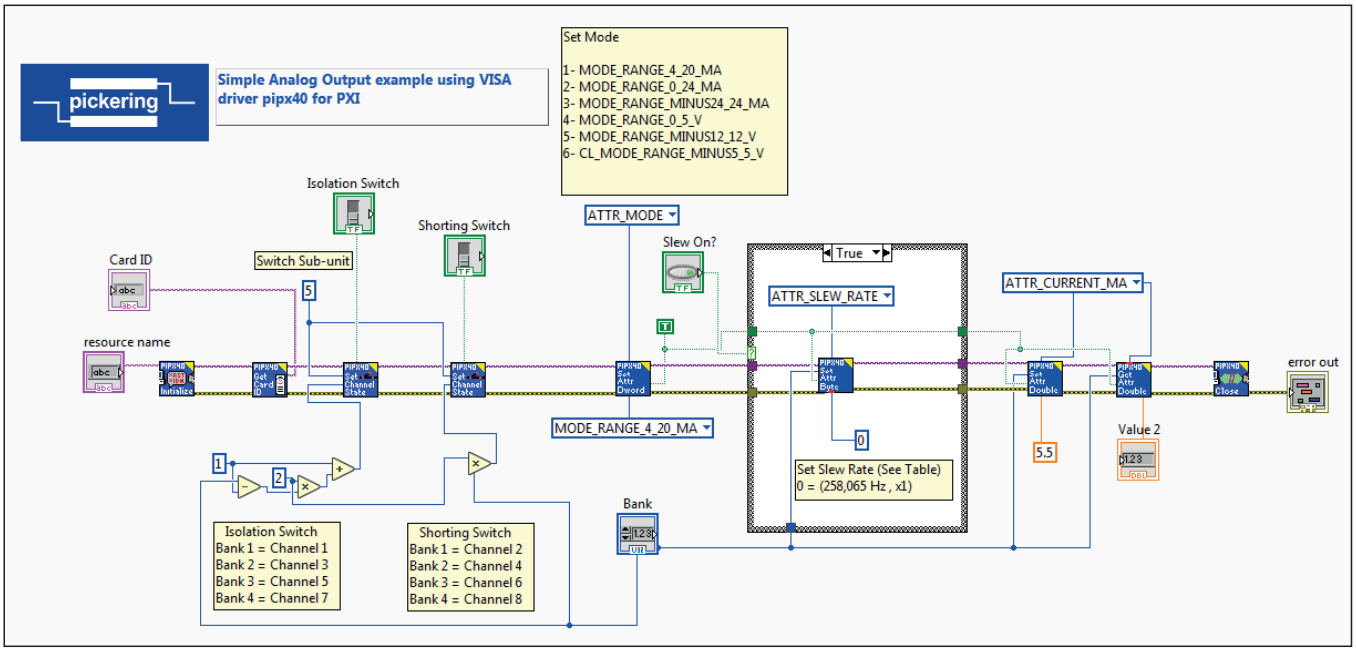

Figure 4.7 - Example Use of Pickering Drivers in LabVIEW for the 41/43-765 Module

To download LabVIEW examples, please go to:

http://downloads.pickeringtest.info/downloads/example_software/

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SECTION 5 - CONNECTOR INFORMATION

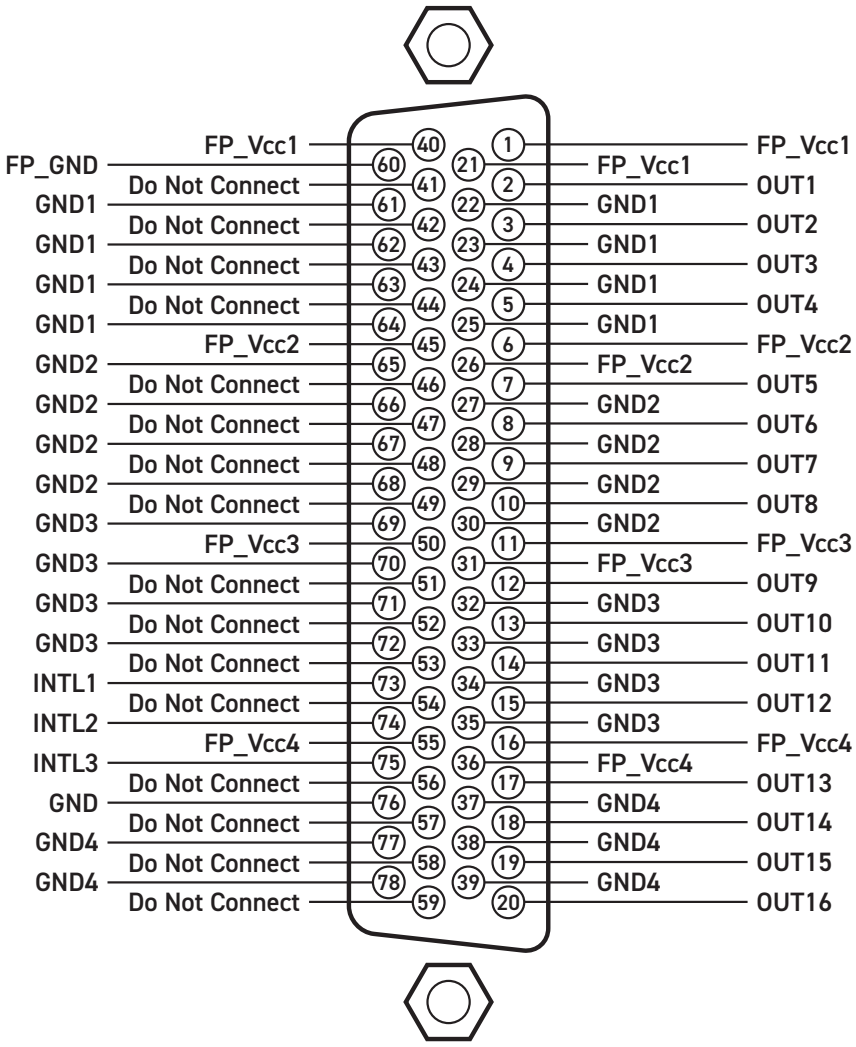

Figure 5.1 - Pinouts: 16-Channel Analog Output /Current Loop Simulator Module 41/43-765-001
(78-pin Male D-Type Connector Viewed From Front of Module)

NOTE: In order for the module's channels to be enabled, the external mating connector must have a link between interlock pins 73 (INTL1) and 74 (INTL2).

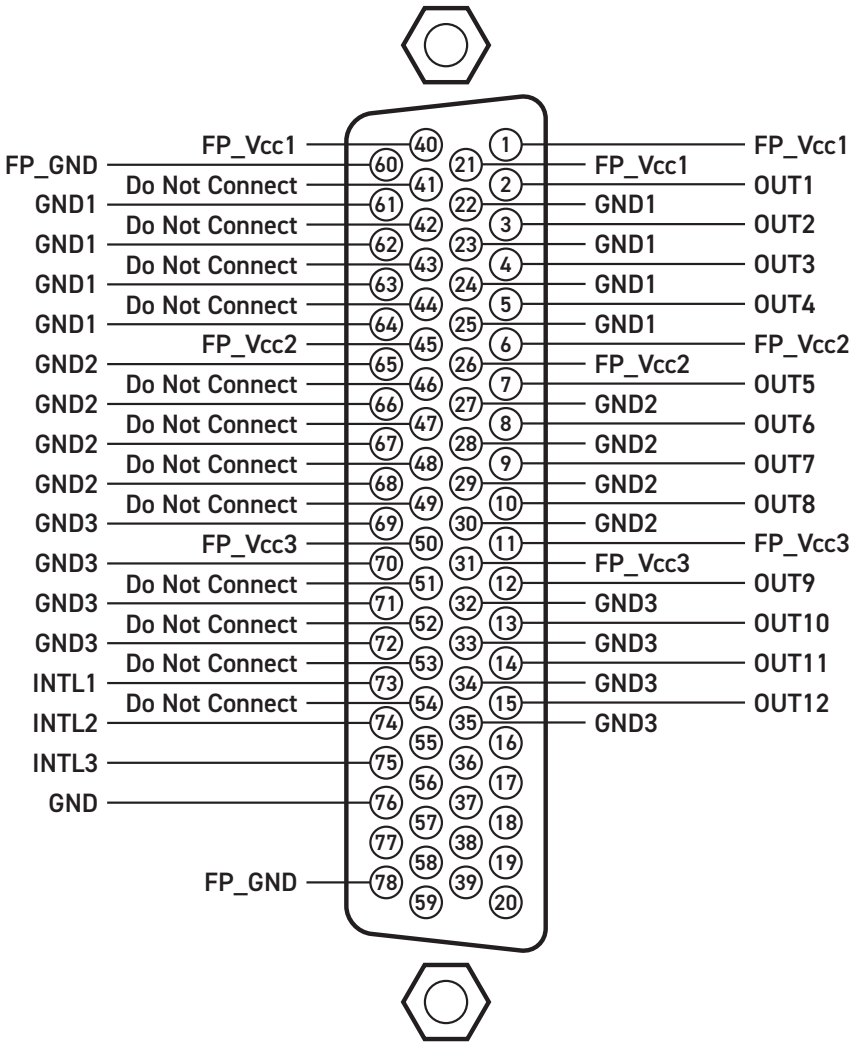

Figure 5.2 - Pinouts: 12-Channel Analog Output /Current Loop Simulator Module 41/43-765-002 (78-pin Male D-Type Connector Viewed From Front of Module)

NOTE: In order for the module's channels to be enabled, the external mating connector must have a link between interlock pins 73 (INTL1) and 74 (INTL2).

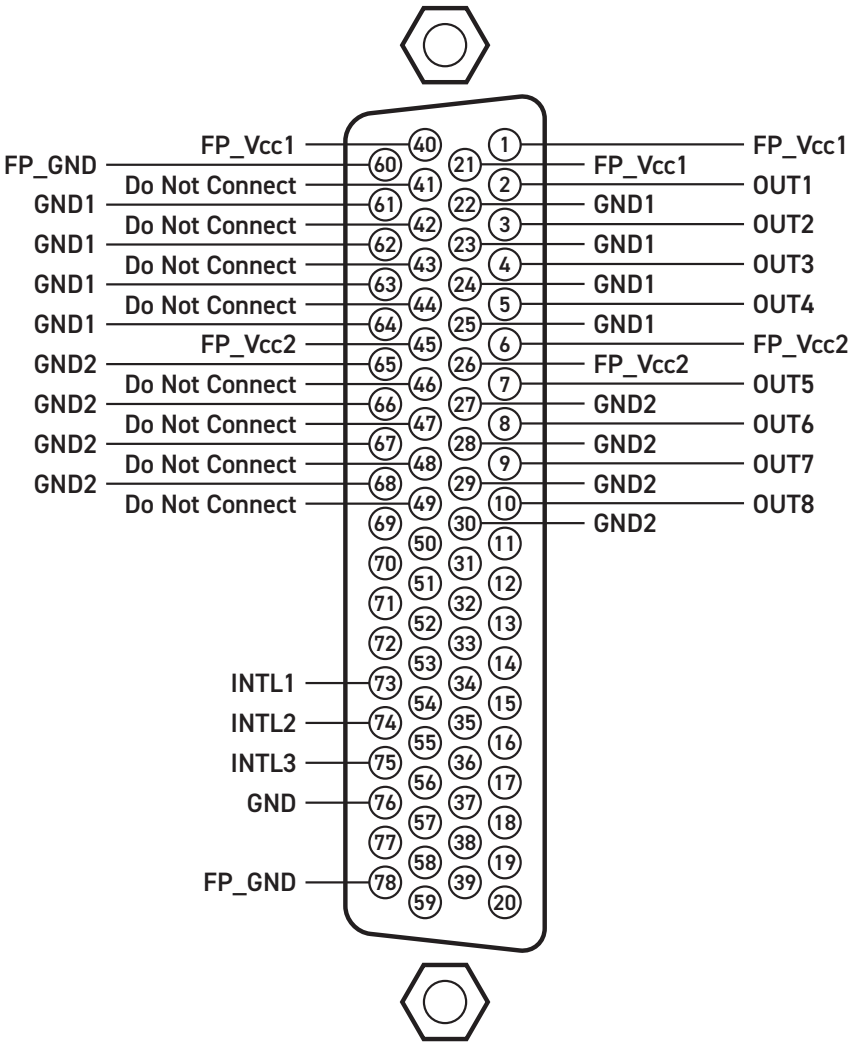

Figure 5.3 - Pinouts: 8-Channel Analog Output /Current Loop Simulator Module 41/43-765-003
(78-pin Male D-Type Connector Viewed From Front of Module)

NOTE: In order for the module's channels to be enabled, the external mating connector must have a link between interlock pins 73 (INTL1) and 74 (INTL2).

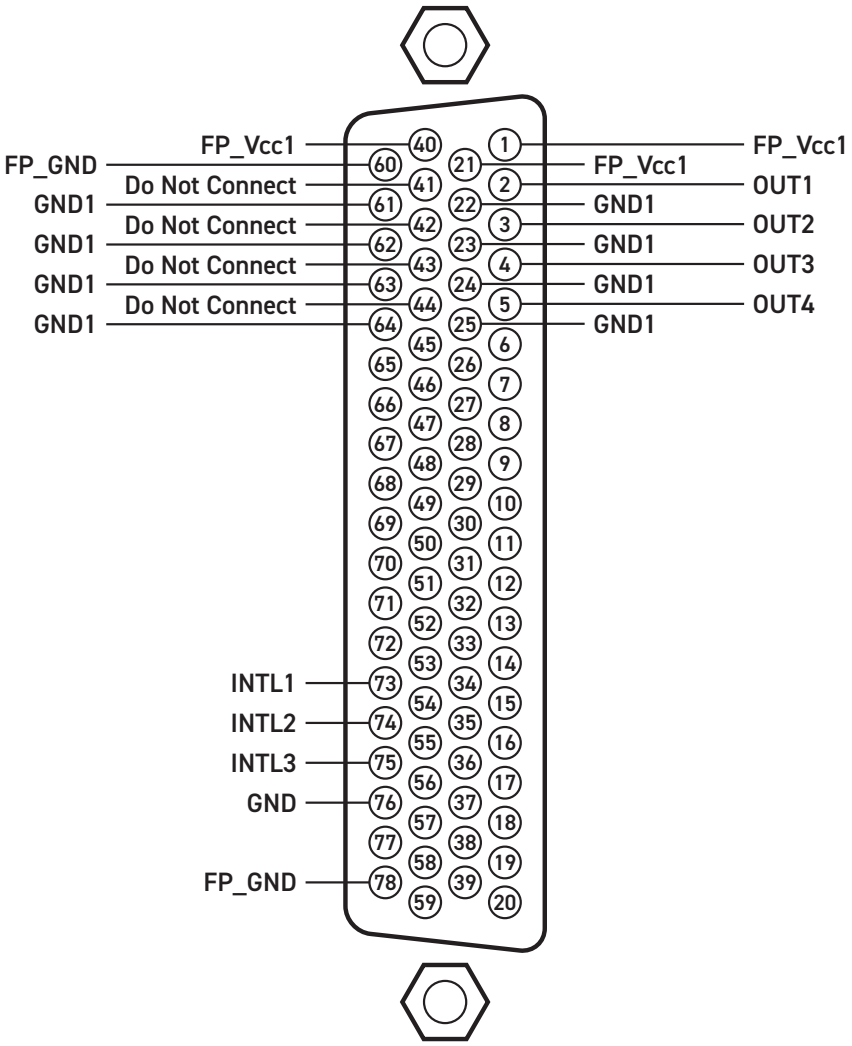

Figure 5.4 - Pinouts: 4-Channel Analog Output /Current Loop Simulator Module 41/43-765-004 (78-pin Male D-Type Connector Viewed From Front of Module)

NOTE: In order for the module's channels to be enabled, the external mating connector must have a link between interlock pins 73 (INTL1) and 74 (INTL2).

SECTION 6 - TROUBLE SHOOTING

Refer to the Warnings and Cautions at the front of this manual 

INSTALLATION PROBLEMS

The Plug & Play functionality of Pickering switch cards generally ensures trouble-free installation.

If you do experience any installation problems you should first ensure that all cards are properly seated in their slots. Improperly mated cards may go undetected by the operating system, or may be detected as a card of an unknown type. They can also cause the computer to freeze at various stages in the boot sequence.

If your system employs a remote control interface you should check the integrity of all remote control interface links. When the system is powered up, and during Windows start-up, you should expect to see periodic activity on the remote control interface RX/TX (yellow) indicators, clearing to leave only the PWR/LNK (green) LEDs illuminated. The RX/TX indicators should show activity when you attempt to access a card.

DIAGNOSTIC UTILITY

The Pickering Diagnostic Utility (accessible through the Programs>>Pickering>>PXI Utilities menu) generates a diagnostic report of the system's PCI configuration, highlighting any potential configuration problems. Specific details of all installed Pickering switch cards are included. All the installed Pickering switch cards should be listed in the "Pilpxi information" section - if one or more cards is missing it may be possible to determine the reason by referring to the PCI configuration dump contained in the report, but interpretation of this information is far from straightforward, and the best course is to contact Pickering support: support@pickeringtest.com, if possible including a copy of the diagnostic report.

In the "VISA information" section, if VISA is not installed its absence will be reported. This does not affect operation using the Direct I/O driver, and is not a problem unless you wish to use VISA. VISA is a component of National Instruments LabWindows/CVI and LabVIEW, or is available as a standalone environment.

If VISA is present and is of a sufficiently recent version, the section "Pipx40 information" should present a listing similar to "Pilpxi information".

Please note that the Diagnostic Utility cannot access cards if they are currently opened by some other application, such as the Test Panels or Terminal Monitor.

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SECTION 7 - MAINTENANCE INFORMATION

Refer to the Warnings and Cautions at the front of this manual 

PERIODIC MAINTENANCE

This product and its corresponding chassis do not require any periodic maintenance.

GENERAL CLEANING

- Isolate the electrical power from the chassis and ensure that no user I/O signals are being applied.
- Wipe the product & chassis surfaces with a clean dry anti-static cloth only.

SOFTWARE UPDATE

For PXI modules operating in a PXI chassis, no module software updates are required. For the latest version of the driver please refer to our web site **pickeringtest.com** where links to our Software Download page will provide the latest version of the driver software for the various programming environments encountered.

For PXI modules which are supported in one of Pickering Interfaces' Modular LXI Chassis (such as the 60-102B and 60-103B) no module software update is required. If the module was introduced after the LXI chassis was manufactured the module may not be recognized, in this case the chassis firmware may need upgrading. This is a simple process which is described in the manual for the Modular LXI Chassis.

VERIFICATION & ADJUSTMENT PROCEDURE

This section provides a procedure for verifying that the 41/43-765 is performing to specification and guidance on adjustment.

In normal use the 41/43-765 does not require regular adjustment. Where procedures require regular verification checks of instrumentation in a system Pickering Interfaces recommend a 1 year interval between tests.

Verification Procedure

The verification procedure describes a set of measurements that are adequate to check that the module is performing to specification.

The following equipment is required to perform the test

- A DMM with performance at least equivalent to a 6.5 digit model. Example: Keysight 34410A or 34411A
- A cable assembly to connect the DMM to the 41/43-765. This can be constructed by the user or the user can purchase a ready made cable from Pickering Interfaces suitable for connecting to the front panel connector.

Connecting to the Voltage Channels:

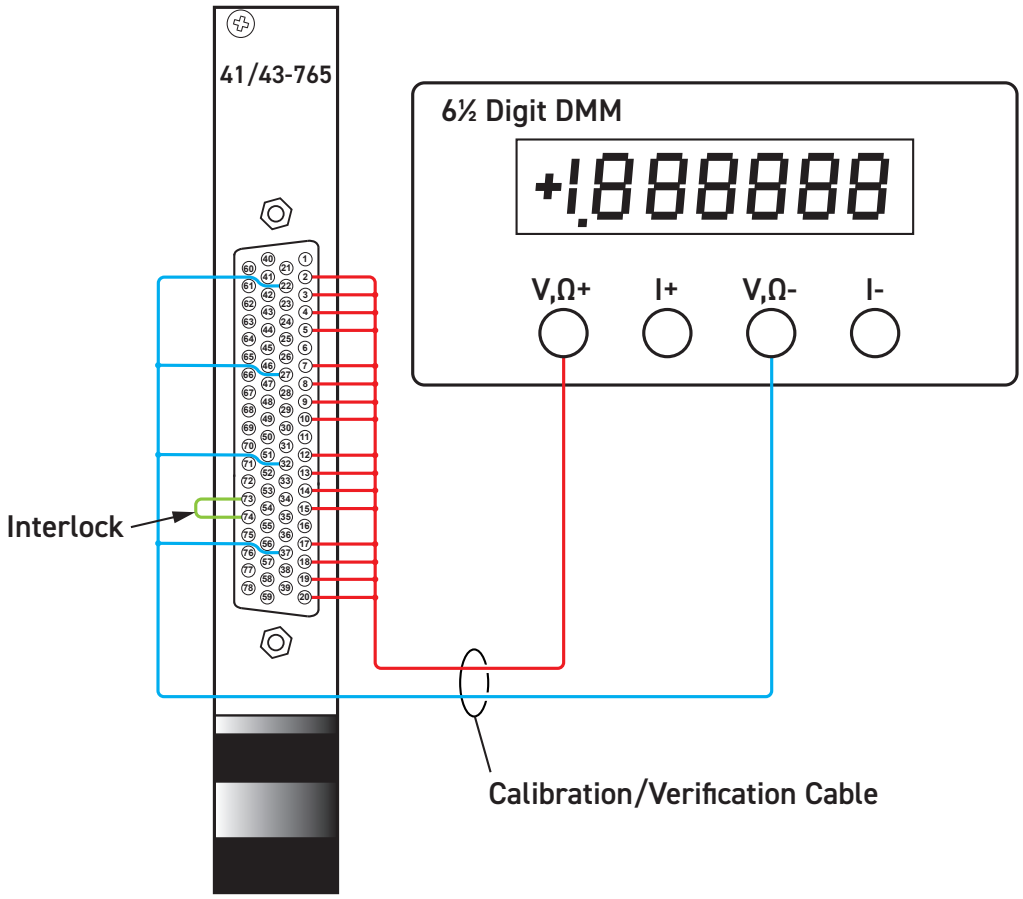

Figure 7.1 - 41/43-765 Voltage Verification Setup

Connecting to the Current Channels:

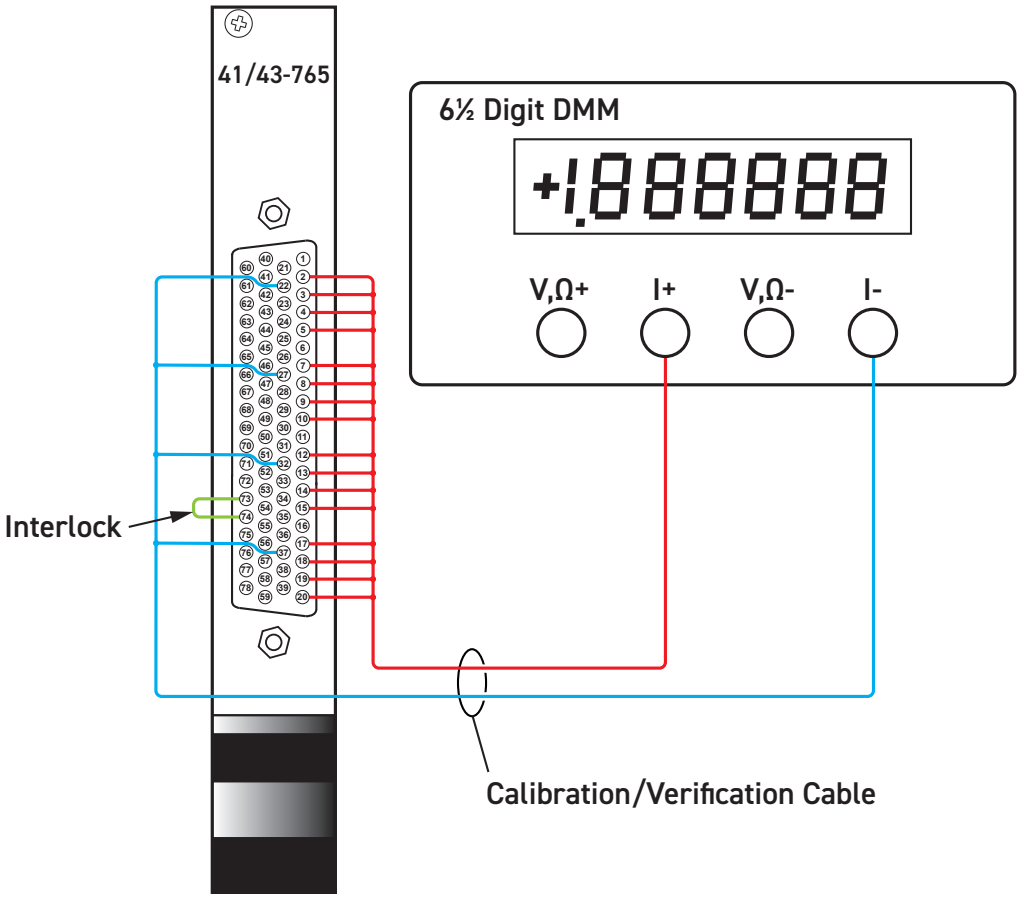

Figure 7.2 - 41/43-765 Current Verification Setup

Each channel can be independently verified using the following steps. Results from this verification can be recorded in the tables on the following pages. This procedure and cable configuration can only be used in the verification process utilizing the internal power source for all the DACs.

- All channels can be connected in parallel as shown in Figure 7.1 (for voltage verification) or Figure 7.2 (for current verification). This is achieved by connecting all OUT connections and a GND connections for each bank, providing a single 2-wire connection to the DMM.
- Select a voltage or current mode to be verified by using GSFP or a user application..
- Double check that all short and isolation relays are open for the channels not being verified, and only the isolation relay is operated for the channel under verification.
- Once a voltage or current (mode dependent) is set on the module, a high quality DMM can be used to measure the result. The measurement value should be within the range specified in the corresponding table entry for the set voltage in tables 7.2 to 7.4, observing the associated foot notes.

- If the full functionality of the module is to be checked, all remaining modes should be checked in turn, as defined in table 7.1.
- After a given channel is tested it is recommended that the clear card function is used to ensure each channel is left in the default state, ensuring it does not affect subsequent channel testing.
- Repeat across all channels as required.

Table 7.1 – Verification Settings For Each Mode

Mode					
4-20mA	**0-24mA**	**+/-24mA**	**0-5V**	**+/-12V**	**+/-5V**
4mA	0	-24mA	0	-12V	-5V
4.8mA	1.2mA	-21.6mA	0.25V	-10.8V	-4.5V
5.6mA	2.4mA	-19.2mA	0.5V	-9.6V	-4V
6.4mA	3.6mA	-16.8mA	0.75V	-8.4V	-3.5V
7.2mA	4.8mA	-14.4mA	1V	-7.2V	-3V
8mA	6mA	-12mA	1.25V	-6V	-2.5V
8.8mA	7.2mA	-9.6mA	1.5V	-4.8V	-2V
9.6mA	8.4mA	-7.2mA	1.75V	-3.6V	-1.5V
10.4mA	9.6mA	-4.8mA	2V	-2.4V	-1V
11.2mA	10.8mA	-2.4mA	2.25V	-1.2V	-0.5V
12mA	12mA	0	2.5V	0	0
12.8mA	13.2mA	2.4mA	2.75V	1.2V	0.5V
13.6mA	14.4mA	4.8mA	3V	2.4V	1V
14.4mA	15.6mA	7.2mA	3.25V	3.6V	1.5V
15.2mA	16.8mA	9.6mA	3.5V	4.8V	2V
16mA	18mA	12mA	3.75V	6V	2.5V
16.8mA	19.2mA	14.4mA	4V	7.2V	3V
17.6mA	20.4mA	16.8mA	4.25V	8.4V	3.5V
18.4mA	21.6mA	19.2mA	4.5V	9.6V	4V
19.2mA	22.8mA	21.6mA	4.75V	10.8V	4.5V
20mA	24mA	24mA	5V	12V	5V

Adjustment Procedure

In the unlikely event that adjustment of the 41/43-765 is required we recommend returning it to Pickering Interfaces. Adjustment of the 41/43-765 requires the use of a high performance DMM and an automated program in order to maintain its accuracy in the event of an adjustment being required to improve performance.

VERIFICATION TEST RESULTS

For convenience, Tables 7.2 to 7.7 on the following pages are provided for a means of recording results for one channel of each mode.

Table 7.2 - Verification Test Results For 4-20mA Mode

Serial Number:	
Channel Number:	
Date of Test:	
Operator's Name:	
Test Equipment Used:	

Current (mA)	Measured Value	Maximum (mA)	Minimum (mA)	Result (delete as appropriate)
4		4.032	3.968	Pass / Fail
4.8		4.816	4.784	Pass / Fail
5.6		5.616	5.584	Pass / Fail
6.4		6.416	6.384	Pass / Fail
7.2		7.216	7.184	Pass / Fail
8		8.016	7.984	Pass / Fail
8.8		8.816	8.784	Pass / Fail
9.6		9.616	9.584	Pass / Fail
10.4		10.416	10.384	Pass / Fail
11.2		11.216	11.184	Pass / Fail
12		12.016	11.984	Pass / Fail
12.8		12.816	12.784	Pass / Fail
13.6		13.616	13.584	Pass / Fail
14.4		14.416	14.384	Pass / Fail
15.2		15.216	15.184	Pass / Fail
16		16.016	15.984	Pass / Fail
16.8		16.816	16.784	Pass / Fail
17.6		17.616	17.584	Pass / Fail
18.4		18.416	18.384	Pass / Fail
19.2		19.216	19.184	Pass / Fail
20		20.032	19.968	Pass / Fail

Note: The maximum and minimum values listed do not take into account test equipment uncertainty, values are provided for convenience only. Only a high performance measuring device should be used to minimize the additional uncertainty.

Table 7.3 - Verification Test Results For 0-24mA Mode

Serial Number:	
Channel Number:	
Date of Test:	
Operator's Name:	
Test Equipment Used:	

Current (mA)	Measured Value	Maximum (mA)	Minimum (mA)	Result (delete as appropriate)
0		0.048	-0.048	Pass / Fail
1.2		1.224	1.176	Pass / Fail
2.4		2.424	2.376	Pass / Fail
3.6		3.624	3.576	Pass / Fail
4.8		4.824	4.776	Pass / Fail
6		6.024	5.976	Pass / Fail
7.2		7.224	7.176	Pass / Fail
8.4		8.424	8.376	Pass / Fail
9.6		9.624	9.576	Pass / Fail
10.8		10.824	10.776	Pass / Fail
12		12.024	11.976	Pass / Fail
13.2		13.224	13.176	Pass / Fail
14.4		14.424	14.376	Pass / Fail
15.6		15.624	15.576	Pass / Fail
16.8		16.824	16.776	Pass / Fail
18		18.024	17.976	Pass / Fail
19.2		19.224	19.176	Pass / Fail
20.4		20.424	20.376	Pass / Fail
21.6		21.624	21.576	Pass / Fail
22.8		22.824	22.776	Pass / Fail
24		24.048	23.952	Pass / Fail

Note: The maximum and minimum values listed do not take into account test equipment uncertainty, values are provided for convenience only. Only a high performance measuring device should be used to minimize the additional uncertainty.

Table 7.4 - Verification Test Results For +/-24mA Mode

Serial Number:	
Channel Number:	
Date of Test:	
Operator's Name:	
Test Equipment Used:	

Current (mA)	Measured Value	Maximum (mA)	Minimum (mA)	Result (delete as appropriate)
-24		-23.952	-24.048	Pass / Fail
-21.6		-21.552	-21.648	Pass / Fail
-19.2		-19.152	-19.248	Pass / Fail
-16.8		-16.752	-16.848	Pass / Fail
-14.4		-14.352	-14.448	Pass / Fail
-12		-11.952	-12.048	Pass / Fail
-9.6		-9.552	-9.648	Pass / Fail
-7.2		-7.152	-7.248	Pass / Fail
-4.8		-4.752	-4.848	Pass / Fail
-2.4		-2.352	-2.448	Pass / Fail
0		0.048	-0.048	Pass / Fail
2.4		2.448	2.352	Pass / Fail
4.8		4.848	4.752	Pass / Fail
7.2		7.248	7.152	Pass / Fail
9.6		9.648	9.552	Pass / Fail
12		12.048	11.952	Pass / Fail
14.4		14.448	14.352	Pass / Fail
16.8		16.848	16.752	Pass / Fail
19.2		19.248	19.152	Pass / Fail
21.6		21.648	21.552	Pass / Fail
24		24.048	23.952	Pass / Fail

Note: The maximum and minimum values listed do not take into account test equipment uncertainty, values are provided for convenience only. Only a high performance measuring device should be used to minimize the additional uncertainty.

Table 7.5 - Verification Test Results For 0-5V Mode

Serial Number:	
Channel Number:	
Date of Test:	
Operator's Name:	
Test Equipment Used:	

Voltage (V)	Measured Value	Maximum (V)	Minimum (V)	Result (delete as appropriate)
0		0.01	-0.01	Pass / Fail
0.25		0.255	0.245	Pass / Fail
0.5		0.505	0.495	Pass / Fail
0.75		0.755	0.745	Pass / Fail
1		1.005	0.995	Pass / Fail
1.25		1.255	1.245	Pass / Fail
1.5		1.505	1.495	Pass / Fail
1.75		1.755	1.745	Pass / Fail
2		2.005	1.995	Pass / Fail
2.25		2.255	2.245	Pass / Fail
2.5		2.505	2.495	Pass / Fail
2.75		2.755	2.745	Pass / Fail
3		3.005	2.995	Pass / Fail
3.25		3.255	3.245	Pass / Fail
3.5		3.505	3.495	Pass / Fail
3.75		3.755	3.745	Pass / Fail
4		4.005	3.995	Pass / Fail
4.25		4.255	4.245	Pass / Fail
4.5		4.505	4.495	Pass / Fail
4.75		4.755	4.745	Pass / Fail
5		5.01	4.99	Pass / Fail

Note: The maximum and minimum values listed do not take into account test equipment uncertainty, values are provided for convenience only. Only a high performance measuring device should be used to minimize the additional uncertainty.

Table 7.6 - Verification Test Results For +/-12V Mode

Serial Number:	
Channel Number:	
Date of Test:	
Operator's Name:	
Test Equipment Used:	

Voltage (V)	Measured Value	Maximum (V)	Minimum (V)	Result (delete as appropriate)
-12		-11.976	-12.024	Pass / Fail
-10.8		-10.776	-10.824	Pass / Fail
-9.6		-9.576	-9.624	Pass / Fail
-8.4		-8.376	-8.424	Pass / Fail
-7.2		-7.176	-7.224	Pass / Fail
-6		-5.976	-6.024	Pass / Fail
-4.8		-4.776	-4.824	Pass / Fail
-3.6		-3.576	-3.624	Pass / Fail
-2.4		-2.376	-2.424	Pass / Fail
-1.2		-1.176	-1.224	Pass / Fail
0		0.024	-0.024	Pass / Fail
1.2		1.224	1.176	Pass / Fail
2.4		2.424	2.376	Pass / Fail
3.6		3.624	3.576	Pass / Fail
4.8		4.824	4.776	Pass / Fail
6		6.024	5.976	Pass / Fail
7.2		7.224	7.176	Pass / Fail
8.4		8.424	8.376	Pass / Fail
9.6		9.624	9.576	Pass / Fail
10.8		10.824	10.776	Pass / Fail
12		12.024	11.976	Pass / Fail

Note: The maximum and minimum values listed do not take into account test equipment uncertainty, values are provided for convenience only. Only a high performance measuring device should be used to minimize the additional uncertainty.

Table 7.7 - Verification Test Results For +/-5V Mode

Serial Number:	
Channel Number:	
Date of Test:	
Operator's Name:	
Test Equipment Used:	

Voltage (V)	Measured Value	Maximum (V)	Minimum (V)	Result (delete as appropriate)
-5		-4.99	-5.01	Pass / Fail
-4.5		-4.49	-4.51	Pass / Fail
-4		-3.99	-4.01	Pass / Fail
-3.5		-3.49	-3.51	Pass / Fail
-3		-2.99	-3.01	Pass / Fail
-2.5		-2.49	-2.51	Pass / Fail
-2		-1.99	-2.01	Pass / Fail
-1.5		-1.49	-1.51	Pass / Fail
-1		-0.99	-1.01	Pass / Fail
-0.5		-0.49	-0.51	Pass / Fail
0		0.01	-0.01	Pass / Fail
0.5		0.51	0.49	Pass / Fail
1		1.01	0.99	Pass / Fail
1.5		1.51	1.49	Pass / Fail
2		2.01	1.99	Pass / Fail
2.5		2.51	2.49	Pass / Fail
3		3.01	2.99	Pass / Fail
3.5		3.51	3.49	Pass / Fail
4		4.01	3.99	Pass / Fail
4.5		4.51	4.49	Pass / Fail
5		5.01	4.99	Pass / Fail

Note: The maximum and minimum values listed do not take into account test equipment uncertainty, values are provided for convenience only. Only a high performance measuring device should be used to minimize the additional uncertainty.

RELAY LOOK-UP TABLE

The following table shows the relationship between the channel switches and the corresponding relay number on the circuit board. This can be used in conjunction with the PCB layout diagram in Figure 7.3 for locating faulty relays.

Table 7.8 Relay Look-up Table for the 41/43-765 Analog Output Module

Channel	Switch Function	Relay Number
1	Channel Short	RLS-11
	Channel Isolation	RLI-11
2	Channel Short	RLS-21
	Channel Isolation	RLI-21
3	Channel Short	RLS-31
	Channel Isolation	RLI-31
4	Channel Short	RLS-41
	Channel Isolation	RLI-41
1-4	DAC1 Power Switching	RL-DAC1
5	Channel Short	RLS-12
	Channel Isolation	RLI-12
6	Channel Short	RLS-22
	Channel Isolation	RLI-22
7	Channel Short	RLS-32
	Channel Isolation	RLI-32
8	Channel Short	RLS-42
	Channel Isolation	RLI-42
5-8	DAC2 Power Switching	RL-DAC2
9	Channel Short	RLS-13
	Channel Isolation	RLI-13
10	Channel Short	RLS-23
	Channel Isolation	RLI-23
11	Channel Short	RLS-33
	Channel Isolation	RLI-33
12	Channel Short	RLS-43
	Channel Isolation	RLI-43
9-12	DAC3 Power Switching	RL-DAC3
13	Channel Short	RLS-14
	Channel Isolation	RLI-14
14	Channel Short	RLS-24
	Channel Isolation	RLI-24
15	Channel Short	RLS-34
	Channel Isolation	RLI-34
16	Channel Short	RLS-44
	Channel Isolation	RLI-44
13-16	DAC4 Power Switching	RL-DAC4

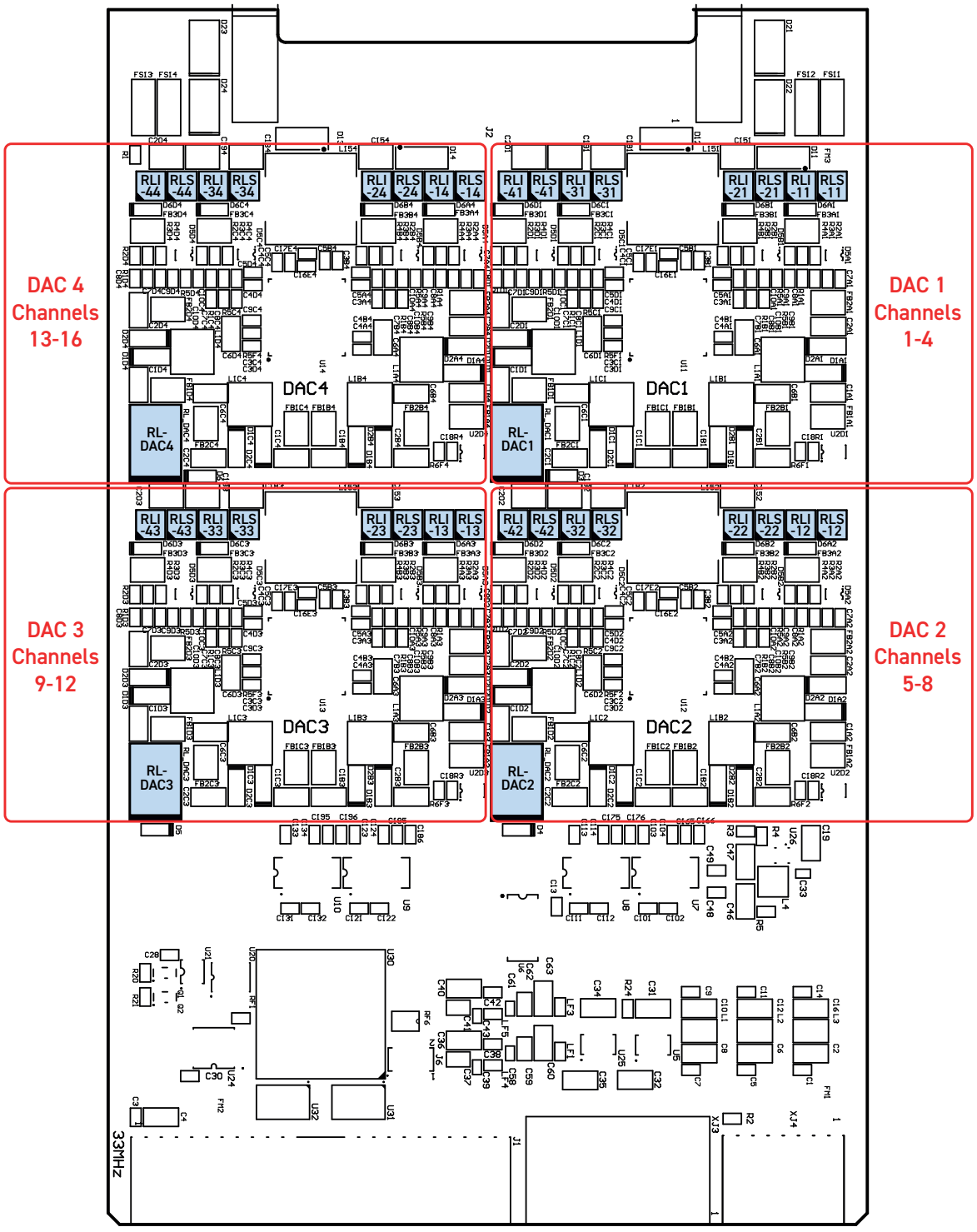

Figure 7.3 - 41/43-765 Analog Output Module - Relay Locations

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