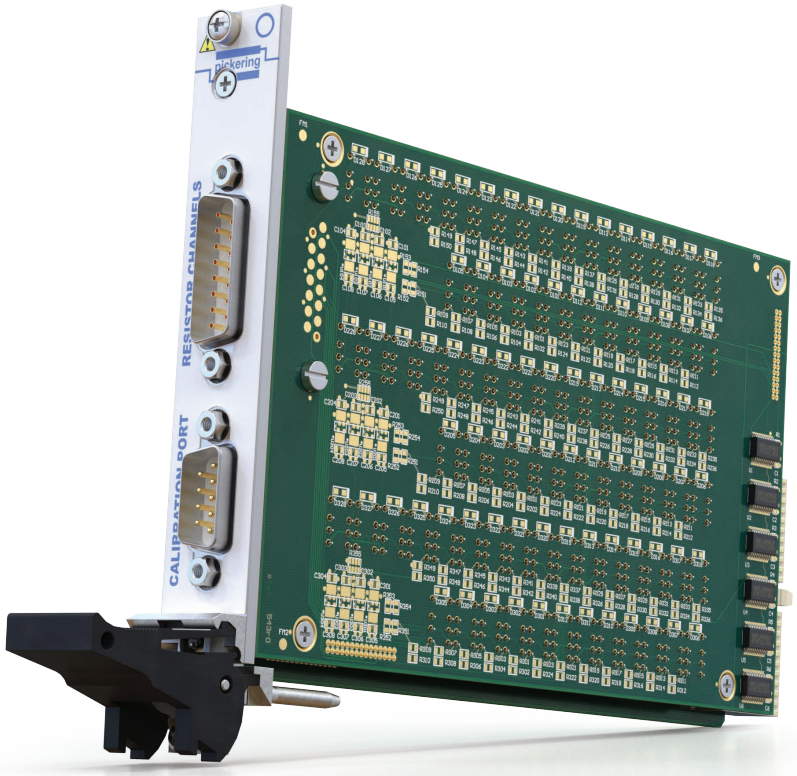
PXI Precision Programmable Resistor Module



PXI

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FM38792

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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.

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Pickering Interfaces strives to fulfill 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 endeavors 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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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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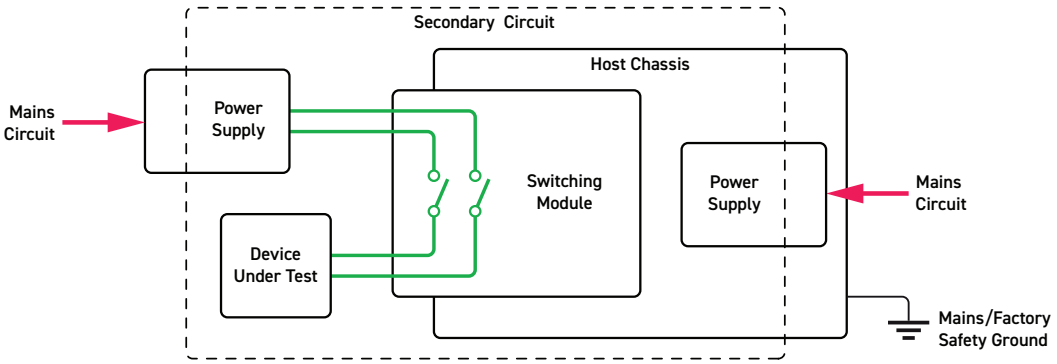
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Warnings & Cautions

WARNING - Hazardous Environments	Symbol
This product is not specifically designed for use in hazardous environments, for example in explosive atmospheres. If the product is to be used in hazardous environments we recommend that the user ensures suitable protective measures are taken.	

WARNING - Danger of Electric Shock	Symbol
This module may contain hazardous voltages. Before removing the module from the rack remove all supplies and disconnect user I/O signals. Unused slots in the PXI/PXIe/LXI chassis are populated with blanking plates to prevent access to user I/O signals that may be present. Blanking panels are available to order from Pickering in a variety of slot widths. If the product is not used in this manner for example by using an extender card then additional care must be taken to avoid contact with exposed signals. Not to be used in safety critical circuits, refer to the Pickering Interfaces' terms & conditions of sale. This module must not be used for the switching of Mains Circuits. For the switching of voltages up to the module's full specification, Secondary Circuit power supplies and the Device Under Test must be fully isolated from the Mains Circuit and the safety earth. The host chassis must be correctly installed and be connected to mains or factory safety ground, please refer to your chassis installation manual.  **Diagram Showing Separation Between The Mains Circuit and Secondary Circuit / DUT** For the purposes of this document, a Mains Circuit is an installation classified as Overvoltage Category II up to 300 V. Separation between the Secondary Circuit and Mains Circuit is achieved by a transformer in which the primary windings are separated from the secondary windings by reinforced insulation, double insulation, or a screen connected to the protective conductor terminal.	

CAUTION - Handling of Electrostatic-Sensitive Devices	Symbol
Certain semiconductor devices used in this equipment are liable to damage due to static voltage. Observe the following precautions when handling these devices in their unterminated state, or sub-assemblies containing these devices: • Persons removing sub-assemblies from equipment using these devices must be earthed by a wrist strap and a resistor at the point provided on the equipment. • Soldering irons used during the repair operations must be low voltage types with earthed tips and isolated from the mains voltage by a double insulated transformer. • Outer clothing worn must be unable to generate static charges. • Printed Circuit Boards (PCBs) fitted with these devices must be stored and transported in anti-static bags.	

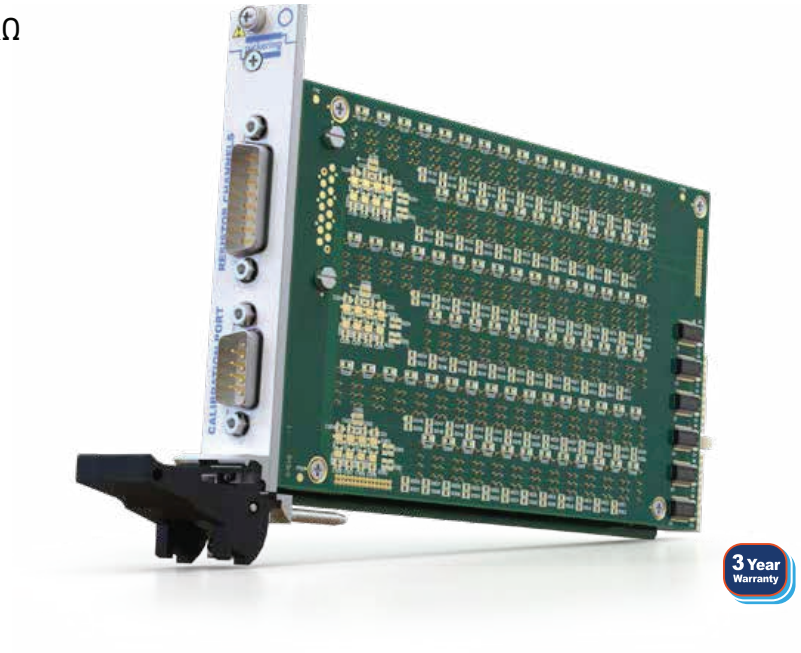
CAUTION - Product Documentation	Symbol
Suitably qualified & trained users should ensure that the accompanying documentation is fully read and understood before attempting to install or operate the product.	

Safety Instructions

Safety Instructions
All cleaning and servicing requires the equipment to be isolated and disconnected from the power source and user I/O signals (refer to the Maintenance Section). • Appropriate manual handling procedures should be followed as dictated by the weight of the individual module or the combined weight of the modules & chassis. • Should a fault occur with the module or chassis, immediately isolate and disconnect the incoming power to the chassis and the user I/O signals. • Ensure the equipment is installed, operated and maintained by trained and authorised personnel. • For suitably equipped products in the event of an emergency press the red "emergency stop" button situated on the front of the unit.

Section 1 - Technical Specification

- Precision Variable Resistance From 90 Ω to 8 kΩ
- 3 Channels Per Module
- Very High Accuracy and Stability
- Controlled by Simple Resistor Value Calls
- Fine Setting Resolution <10 mΩ
- Short and Open Circuit Simulation
- Low Thermo-Electric EMF
- Simple Calibration With External DMM
- Drivers Supplied for Windows & Linux, Plus Support for Real-time Systems
- Supported by PXI or LXI Chassis
- 3 Year Warranty



The 40-260 is the first in a new generation of PXI based precision programmable resistor modules. Through the use of innovative switching networks and software correction techniques, these modules feature high setting resolution with excellent stability and accuracy.

The module has three identical resistor channels that can be set to a range of values with a resolution better than 10 mΩ. This makes the 40-260 ideal for sensor simulation applications that require fine adjustment such as strain gauge and temperature dependent resistor emulation. The use of innovative technology ensures all resistance values can be set, there are no missing values caused by switch resistance or resistor tolerance. Additionally, each channel can be set as open or short circuit to simulate cabling faults.

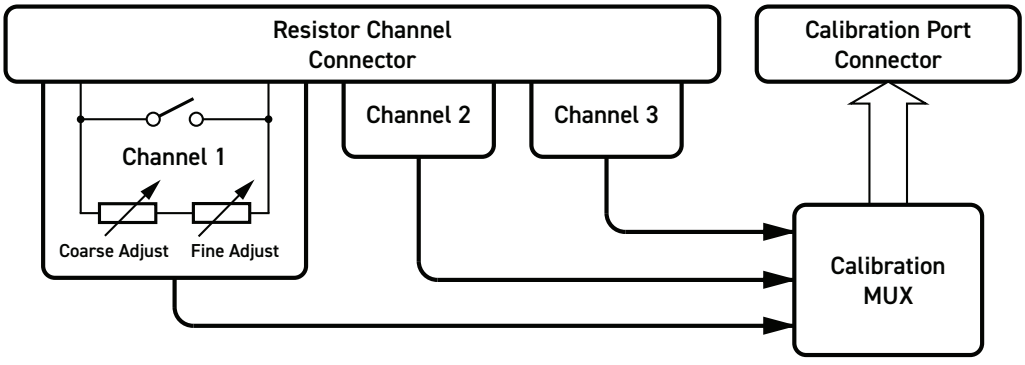
Each channel can operate with a differential input voltage range of greater than ±15 V relative to a defined common mode voltage. The common mode voltage can be set to 0 V, +12 V, -12 V or an external common mode source of up to ±50 V.

The 40-260 provides a convenient calibration system using an external DMM connected to the Calibration Port. The calibration system permits modules to be cascaded so one DMM can support the calibration of multiple channels and multiple modules. Calibration can be performed while the UUT is connected to the resistor channel.

Use of special switching techniques reduces measurement errors caused by thermo-electric EMFs to a minimum.

The 40-260 offers a stability, accuracy and setting resolution unmatched by any other PXI resistor module, minimizing the need for custom resistor modules and in use calibration.

The 40-260 can be supported in our LXI Modular Switching Chassis such as the 60-102B, 60-103B, 60-104 or 60-105.



Functional Diagram for the 40-260 Precision Programmable Resistor Module

Section 1 - Technical Specification

Specification

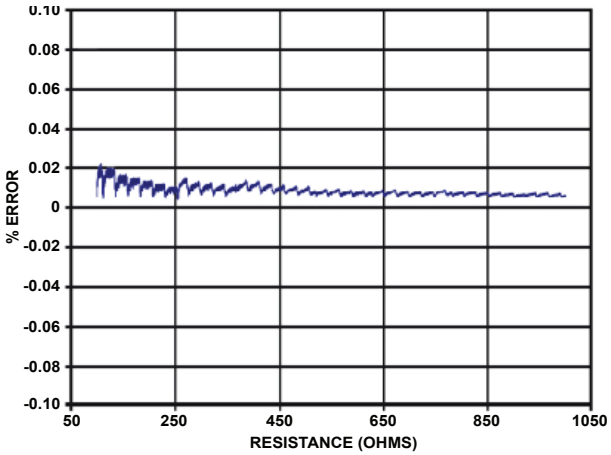
Resistor Channels	
Configuration:	3 resistor channels per module.
Resistance Range:	90 Ω to 8 kΩ and open circuit or short circuit.
Resistance resolution:	<10 mΩ, continuous resolution, no missing settings.
Accuracy:	0.1 % (can be improved with calibration).
Short Circuit Setting:	<0.3 Ω initial
Open Circuit Setting:	>10^9 Ω
Operating Voltage*	
Common Mode Voltage 0 V +12 V -12 V External	Input Voltage Range -15 V to +15 V -3 V to +27 V -27 V to +3 V External ±15 V
Common mode voltage can be selected by software control. Default value is 0 Volts. Damage level is a differential voltage level of ±18 V wrt common or the maximum power rating, whichever is lower.	
Ext common mode voltage:	±50 V*
Maximum power:	100 mW
Thermo-electric emf:	<2 µV 90 Ω to 260 Ω <5 µV 260 Ω to 8 kΩ
Resistance - power off:	Open circuit
Number of Operations:	100 million (10 mA)
Operating time:	3 ms typical

* For full voltage rating, signal sources must be fully isolated from mains supply and safety earth.

Calibration Channel	
Function:	Supports 4 terminal measurements of all the channels in the module. Modules can be cascaded together to permit single DMM to support multiple modules with resistor channel connected to UUT.

Power Requirements

+3.3 V	+5 V	+12 V	-12 V
0	0.2 A	10 mA	10 mA



Typical accuracy of 40-260 over the entire resistance range measured at 21˚C

Performance is measured in 10 mΩ increments by making a resistance call (in Ohms) to the module and then measuring the actual resistance with a DMM. Vertical axis shows the reading error as % of the requested value.

Mechanical Characteristics

Single slot 3U PXI (CompactPCI card).
Module weight: 280 g.
3D models for all versions in a variety of popular file formats are available on request.

Connectors

PCI Interface: 33 MHz, 32-bit address, 16 bit data.
Resistor Channel: 15-pin male D-Type connector.
Calibration Port: 9-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

PXI & CompactPCI Compliance

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

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

3 Channel Precision Resistor 90 Ω to 8 kΩ	40-260-001
Accessories:	
Calibration port to DMM lead (shrouded 4 mm bayonet plug):	
For a single module (1x9 pin D-type)	40-975-009-SL1
For two modules (2x9 pin D-types)	40-975-009-SL2
For three modules (3x9 pin D-types)	40-975-009-SL3
(calibration leads capable of supporting a greater number of modules are available, please contact sales office)	

Product Customization

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

Customization can include:

- Alternative resistance range
- Alternative resolution
- Different number of channels
- Different performance specifications

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.

Other Resistor Modules

Pickering Interfaces manufacture a range of variable resistor modules in the PXI format. If you have a requirement for a variable resistor module please contact your local sales office with the information below and we will advise you on the best solution for your application.

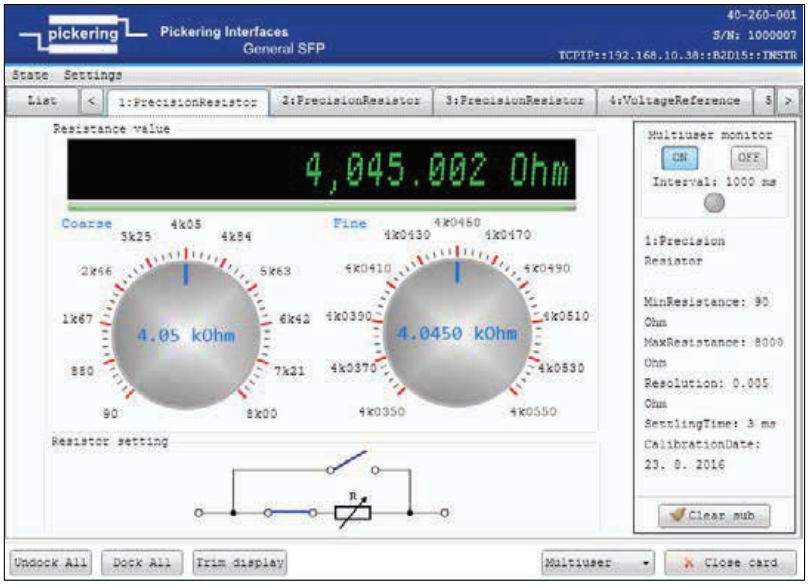
Lowest Resistance †	
Highest Resistance	
Resistance Resolution	
Overall Accuracy	
Maximum Power/Current	
Number of Channels (variable resistors)	

† Resistance is as measured across the user connector terminals, minimum resistance must have a non-zero value.

Mating Connectors & Cabling

For connection accessories for the 40-260 module please refer to the 90-010D 15-pin D-Type and 90-003D 9-pin D-Type Connector Accessories data sheets where a complete list and documentation can be found for accessories, or refer to the website.

The 40-260 uses innovative techniques which are the subject of protected Pickering Interfaces intellectual property rights.



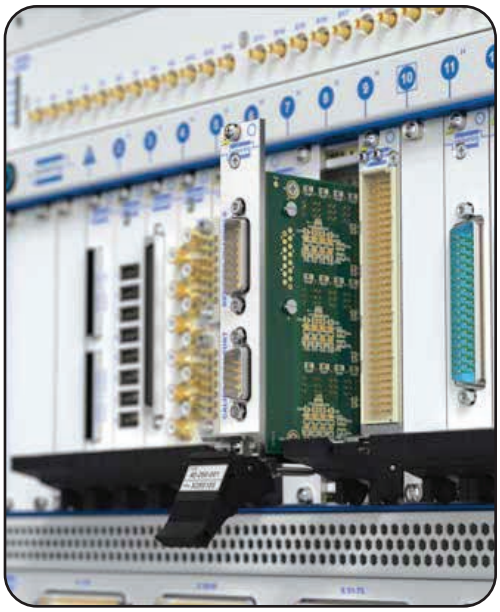
Soft Front Panel for the 40-260 Precision Resistor Module

Section 1 - Technical Specification

The 40-260 is part of a range of Precision Resistor Modules suitable for simulation applications.

For applications that do not require the precision or accuracy of our precision range, look to our PXI Standard Resistor range which includes models 40-280, 40-281, 40-282, 40-290, 40-291, 40-292, 40-293, 40-294, 40-295 and 40-296.

Pickering's Range of Precision Resistor Modules				
Resistor Type	Channels	Range	Resolution	Model No.
Precision	3	90 Ω to 8 kΩ	<10 mΩ	40-260
Precision	2	1.5 Ω to 2.9 kΩ or 10 Ω to 36 kΩ	<2 mΩ or <15 mΩ	40-261
RTD Simulator	18, 12 or 6	90 Ω to 250 Ω or 900 Ω to 2500 Ω	<8 mΩ or <90 mΩ	40-262
RTD Simulator	24, 20, 16, 12, 8 or 4	40 Ω to 900 Ω, 200 Ω to 4.5 kΩ or 400 Ω to 9 kΩ	<10 mΩ, <50 mΩ or <100 mΩ	40-263
Strain Gauge Simulator	6, 4 or 2	350 Ω, 1 kΩ, 1.5 kΩ, 2 kΩ or 3 kΩ	<2 mΩ, <10 mΩ, <12.5 mΩ, <20 mΩ or <25 mΩ	40-265
High Density Precision	18, 9, 6, 4 or 3	Up to 85.3 MΩ	0.125 Ω, 0.25 Ω, 0.5 Ω, 1 Ω, 2 Ω, 4 Ω or 8 Ω	40/42-297A
High Density Precision	18, 9, 6, 4 or 3	Up to 22.3 MΩ	0.125 Ω, 0.25 Ω, 0.5 Ω, 1 Ω or 2 Ω	40-298





Functional Description

A functional block diagram is provided in Figure 2.1. The Module is powered by the 5V supply via Compact PCI connector J1. The interface to the 3 programmable resistor channels is via a front panel mounted 15-pin D-type plug, connection to the Calibration Port is via a front panel mounted 9-pin D-type plug. The module comprises a mother and daughter PCB populated with precision resistor networks arranged as three separate channels switched by electro-mechanical relays. Also there is a multiplexer arrangement to allow a selected channel to be routed to the Calibration Port for connection to a DMM. The control coils of the electro-mechanical relays are enabled via control signals from relay drivers U1 to U6 on the module's daughter card. The relay drivers are addressed by the PLX device U1 to output the required signal.

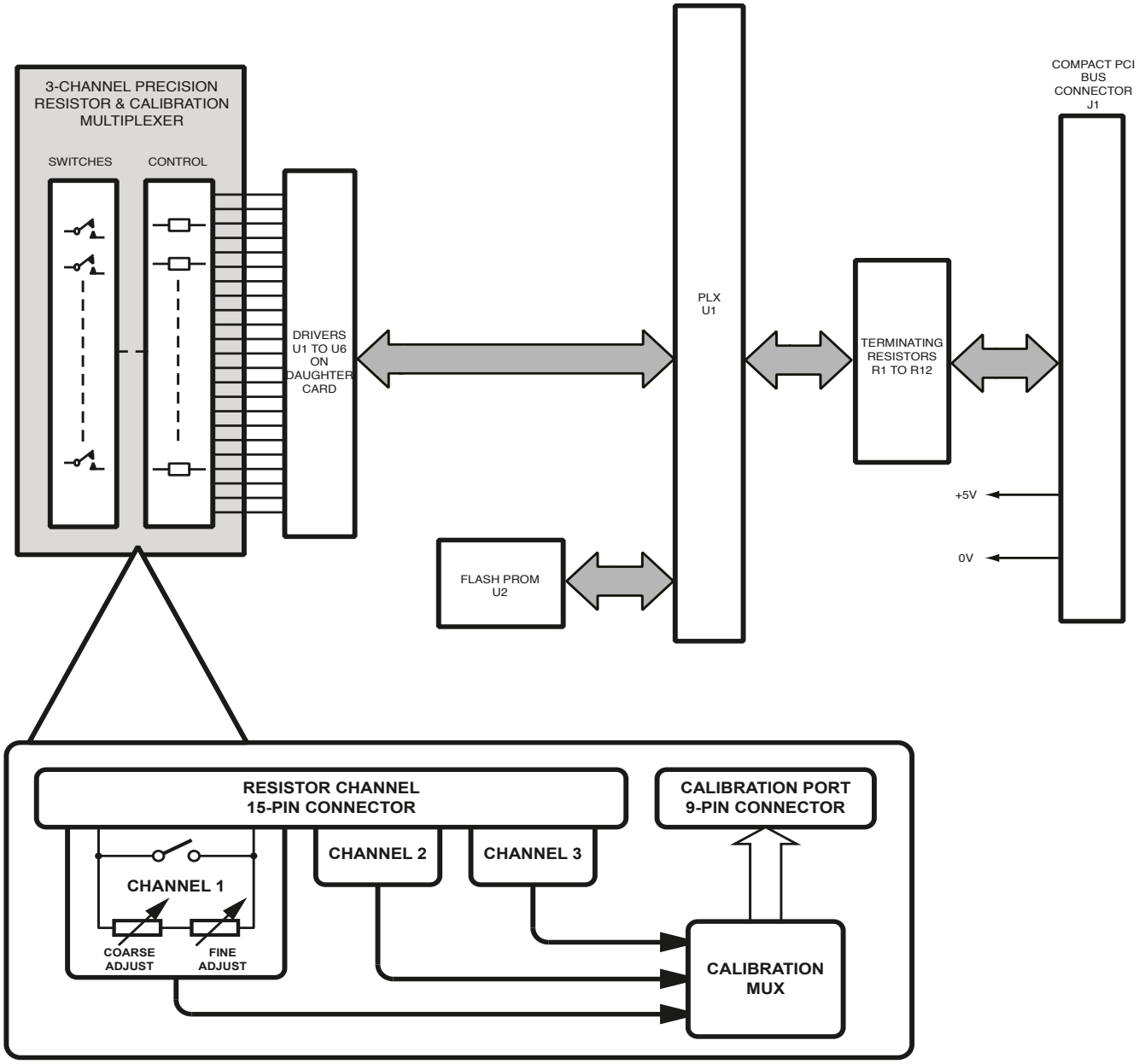


Figure 2.1 -Precision Programmable Resistor Module 40-260: Functional Block Diagram

Guidance on using the Module

The 40-260 behaves as a precise but adjustable in value resistor. The circuit elements in the design use switch resistors, some switched by relays and others by electronic switches. It can be used to simulate the type of variable resistor found in many control systems that indicate the value of a parameter, such as temperature, strain or pressure.

The 40-260 responds directly to a request for a particular value of resistance and is therefore very easy to use in a system. Applications programs are easily generated to convert, for example, temperature requests to resistance values for different types of RTD that are to be emulated.

Each resistor channel has two "input" connections and two "output" connections. There is no significance in the label "input" and "output" other than to identify them. The two contacts on each terminal make it easy to connect resistors together and to perform 4 terminal measurements on the channel as shown in Figure 2.2.

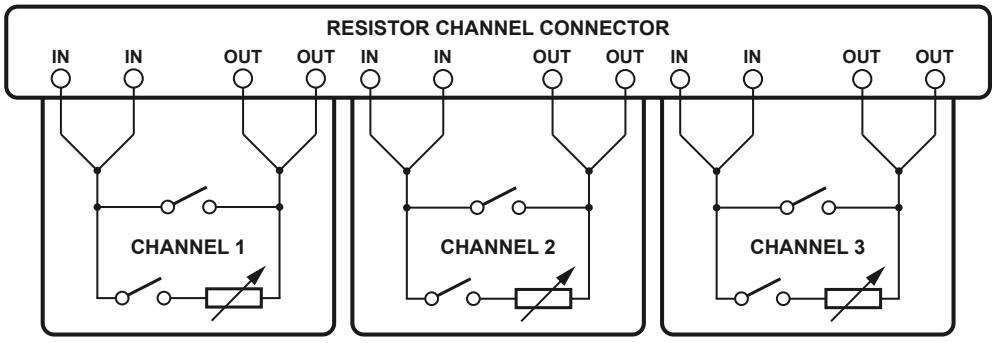


Figure 2.2 - Each resistor channel has two "input" and two "output" connections to simplify connecting it to a system and allow accurate 4 terminal measurements to be made.

Voltage Range

The applied voltage to each channel is limited because of the use of electronic switching systems. The input and output terminals should be within ±15 V of the voltage referred to as the common mode voltage. For most applications sensors operate within the voltage range ±15 V referenced to ground. In this case the common mode voltage should be ground, the default position.

Two other common voltages are provided internally, +12 V and -12 V, these allow the resistor chain to be used over the range -3 V to +27 V and -27 V and +3 V respectively. The former may be applicable for systems where, for example, the sensors are connected to a 12 V power supply system.

For applications where the common voltage needs to be different an external setting is provided. In this mode an external common voltage, for example 48 V, can be applied to the resistor channel connector that will be used as the reference value. When using an external common mode reference make sure the resistor channels are all left open circuit until the external common mode voltage is connected in order to avoid damage to the resistor channel.

Potentiometer Operation

The 40-260 can be used to simulate a potentiometer by using two channels connected in series. The user should decide on the value of the potentiometer to be simulated and program two channels so that the sum of their resistances is always the same. For example, if a 5 kΩ potentiometer is needed with a wiper position at 1 kΩ, set one channel to 1 kΩ and the other to 4 kΩ.

Calibration Port

The calibration port is a convenient way of measuring the resistance of a channel without having to use an external switching network to connect a DMM to each channel in turn. It is used when the module is calibrated in the factory for the purpose of generating a file of correction data that ensures each channel can be set to the requested value.

Users can use the Calibration Port for the same purpose. With a DMM connected to the calibration port, preferably with the optional cable assembly, the calibration port MUX can be switched to each channel in turn to allow the resistance to me measured using a 4 terminal measurement method. To measure the complete channel the UUT should be disconnected from the Resistor Channel connector.

In some very sensitive applications the user may want to verify the resistor channel values before commencing a test. The 40-260 accuracy is specified over a range of temperatures and is stable with time

During the measurement process the UUT can remain connected to the resistor channels since it is automatically isolated during the process.

The calibration port is designed so that it can be daisy chained with other resistor modules (for example multiple modules of 40-260). A cable assembly can be purchased as an accessory for this purpose or the user can make their own as shown in Figure 2.3.

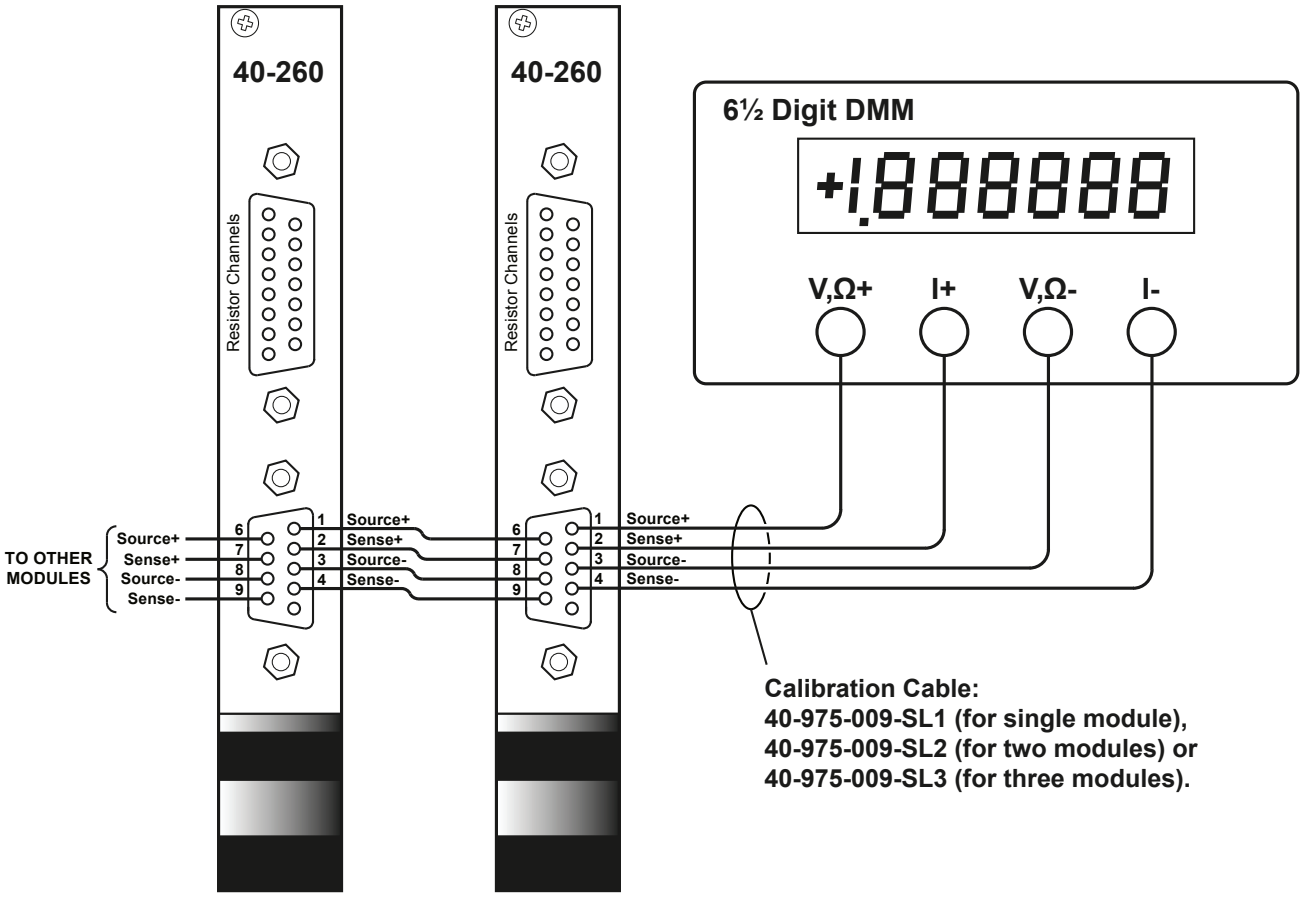


Figure 2.3 - The calibration port can be daisy chained between modules to allow one DMM to support multiple modules for calibration or measurement purposes.

This feature is particularly useful when in system monitoring or calibration is needed since one DMM can sequentially access all the channels in a system without any additional switching.

Calibration Data

The 40-260 contains a Factory Calibration data table which cannot be overwritten by the user. It is created when Pickering Interfaces manufacture the module.

Section 3 - Installation

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

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

Pre-operation 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.

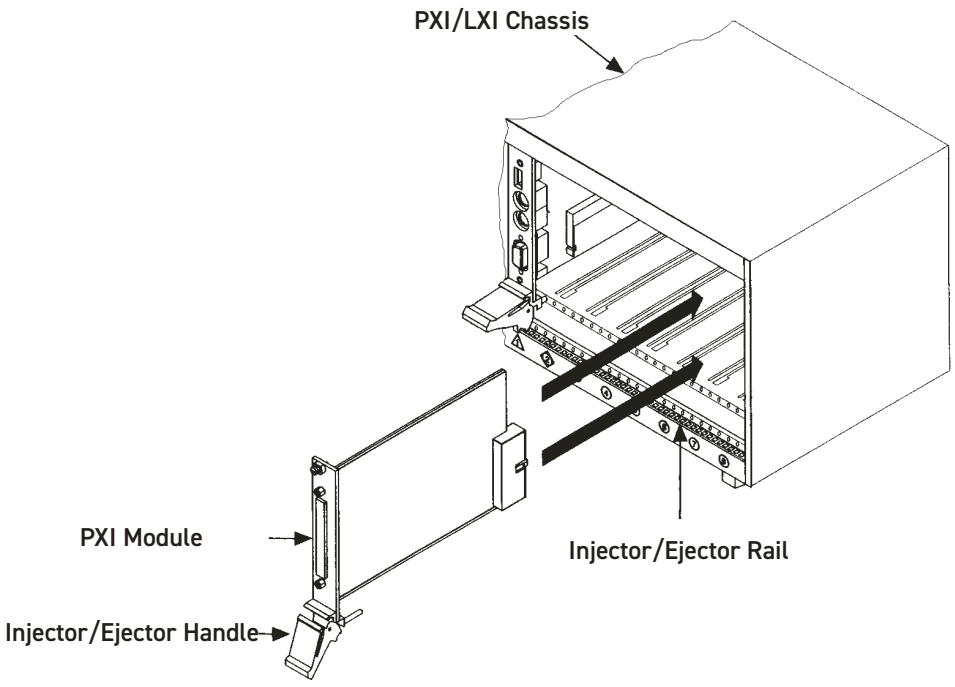


Figure 3.1 - Installing the Module into a PXI/cPCI/LXI Chassis

Hardware Installation Electrical Connection (Chassis)

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

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 vi.

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 Pickering switching and simulation PCI, PXI and PXIe products.

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.

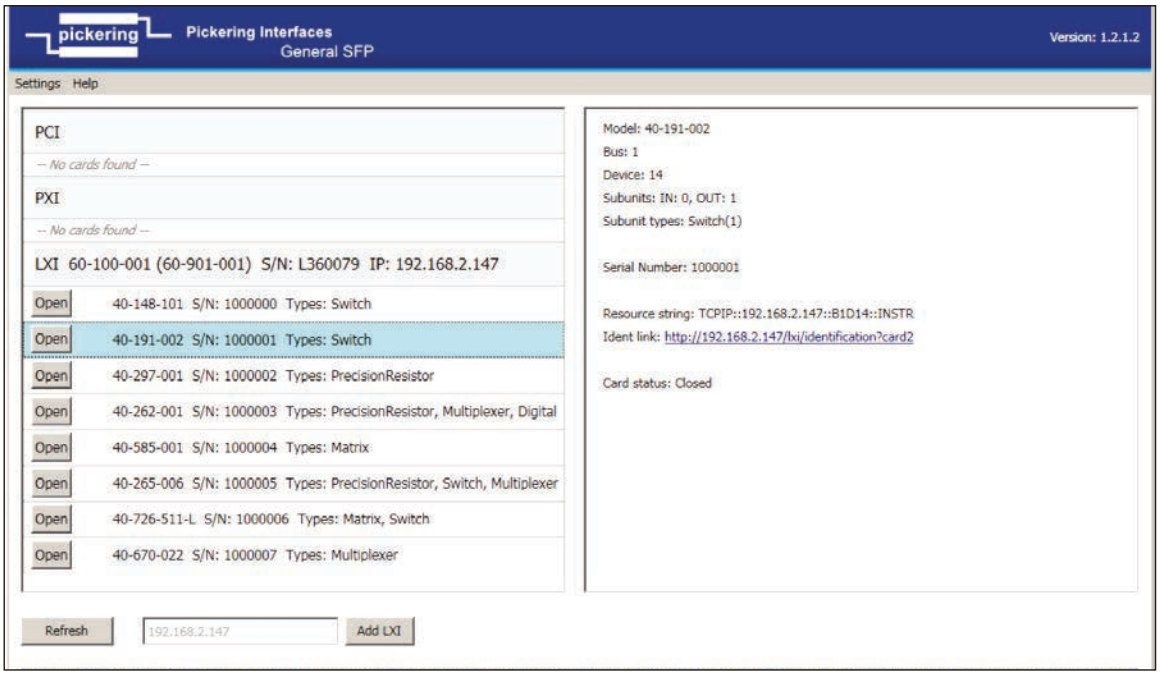


Figure 3.3 - General Soft Front Panel Selector

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

Section 4 - Programming

Programming options for Pickering Interfaces PXI 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:
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

Module Architecture

These 3 channel resistor modules expose a total of 5 sub-units as detailed below:

Sub-Unit	Type	Size	Use
1	Resistor	28	Resistor 1
2	Resistor	28	Resistor 2
3	Resistor	28	Resistor 3
4	MUX	4	Reference MUX
5	MUX	9	DMM MUX

Programming The Module

Resistance Control

Single sub-unit control

In practice the control of resistance is not performed by controlling of the sub-units directly but rather using the **`SetResistance()`** and **`GetResistance()`** functions provided in the driver.

To set a resistance value for a channel (sub-unit) use the below APIs:

Pickering Direct IO Driver (pilpxi) –

```
DWORD PIL_ResSetResistance(DWORD card, DWORD channel, DWORD Mode, double resistance)
```

Pickering VISA compliant Driver (pipx40) –

```
ViStatus pipx40_resSetResistance(ViSession vi, ViUint32 subUnit, ViUInt32 mode,
ViReal64 resistance)
```

To readback resistance value set on a channel (sub-unit) use the below API:

Pickering Direct IO Driver (pilpxi) –

```
DWORD PIL_ResGetResistance(DWORD CardNum, DWORD OutSub, double *Resistance)
```

Pickering VISA compliant Driver (pipx40) –

```
ViStatus pipx40_resGetResistance (ViSession vi, ViUInt32 subUnit, ViPReal64 resistance)
```

Multiple sub-unit control

Resistances can be set to multiple sub-units by using **`SetResistanceMulti()`** functions provided in the driver.

Pickering Direct IO Driver (pilpxi) –

```
DWORD PIL_ResSetResistanceMulti(DWORD CardNum, DWORD *OutSubList, DWORD Mode, double
*Resistances, DWORD Size)
```

Pickering VISA compliant Driver (pipx40) –

```
ViStatus pipx40_resSetResistanceMulti (ViSession vi, ViAUInt32 outSubList, ViUInt32
mode, ViAReal64 resistances, ViUInt32 size)
```

`OutSubList` is an array of sub-unit numbers and **`Resistances`** is a floating-point array of resistances to set for the corresponding sub-unit numbers. Size is the size of the arrays passed.

The size of the arrays passed to **`OutSubList`** and **`Resistances`** **must** be the same.

Error code **`ER_BAD_ARRAY (7)`** will be returned in the following conditions:

- If an entry in the **`OutSubList`** array exceeds the sub-units available.
- If the size argument exceeds the maximum sub-unit number.
- If any of the sub-units in the **`OutSubList`** array is not **`TYPE_RES`**.

The sub-unit's array can be in any order and does not need to have all of the resistance sub-units defined, to provide flexibility to this function.

For Example, If you pass the below arguments:

`OutSubList[3] = {2, 7, 1}, Resistances[3] = {1200, 751, 999}, Size = 3`

Sub-unit 2 will have resistance set to 1200Ω, sub-unit 7 will have resistance set to 751Ω , and sub-unit 1 will be set with 999Ω.

Both functions (single and multi-sub-unit control) accept floating-point values for the resistance and calculate the appropriate settings of the sub-units required to achieve that resistance.

To set short circuit (nominally zero ohms) use a floating-point value of 0.0, and to set open circuit use a floating-point value of "**`HUGE_VAL`**" (using C requires **`#include <math.h>`**, other languages should provide similar libraries).

Notes:

1. The resistor sub-units should NOT be controlled using driver functions intended for switch control if accurate resistance is required. Only the resistance setting functions should only be used for setting resistance.
2. The monitor port should not be left connected to external equipment during normal use and the DMM MUX should be reset if it has been used.
3. Multiple sub-unit control API functions are available only from Pickering PXI Driver v5.38.001 and LXI firmware version 6.5.4 onwards.

Reference MUX & DMM MUX

The Reference MUX sub-unit is used to set the common mode voltage for all three resistance channels, refer to the section "Guidance on Using The Module" for a explanation of this function. The sub-unit contains 4 bit positions as shown below:

Bit 1 – GND reference (default setting)

Bit 2 – -12 V internal reference

Bit 3 – +12 V internal reference

Bit 4 – Ext V external reference via front panel connector

The DMM MUX sub-unit is present for calibration purposes and is not required for normal use. It should be left in the default state or reset prior during normal use.

The DMM multiplexer sub-unit contains 3 bit positions for each resistor channel. These are organised as 3 bits per channel:

Bit 1 – monitor across entire resistor

Bit 2 – monitor coarse section

Bit 3 – monitor fine section

So, to monitor a particular resistor, the user should set the following DMM MUX sub-unit bits:

Resistor	Entire Resistor	Coarse Section	Fine Section
1	1	2	3
2	4	5	6
3	7	8	9

The Reference multiplexer and DMM multiplexer sub-units are controlled using the normal driver functions:

In pilpxi:

```
DWORD PIL_OpBit(DWORD card, DWORD sub-unit, DWORD bit_num, BOOL Action)
```

Or in pipx40:

```
ViStatus pipx40_setChannelState(ViSession vi, ViUInt32 subUnit, ViUInt32 channel, ViBoolean state);
```

The sub-unit is cleared using clear sub-unit functions in the library:

pilpxi: `DWORD PIL_ClearSub(DWORD CardNum, DWORD OutSub);`

pipx40: `ViStatus pipx40_clearSub(ViSession vi, ViUInt32 subUnit);`

Programming The Module In LabVIEW

The locations of the various functions relevant to programming a resistor card are shown in the following diagram.

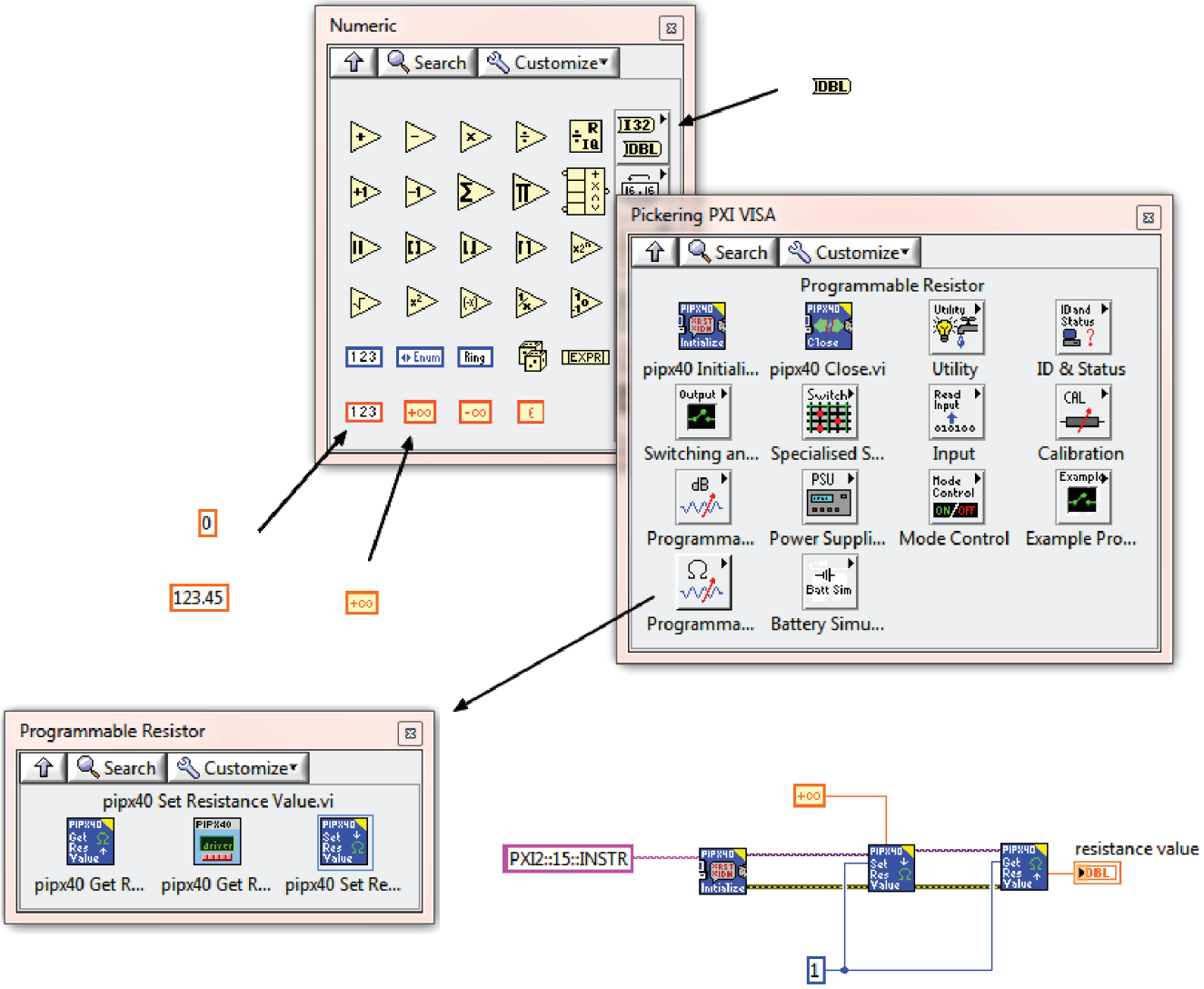


Figure 4.1 - Functions Used For Programming The Precision Resistor in LabVIEW

Setting a Resistance

Pass a double precision floating point value to the SetResistance function. If the initial value generated is an integer, then use of the conversion function DBL will ensure the value is converted to the right format, however this will not normally be required, the value should be automatically promoted.

Setting Short Circuit

Setting a resistor to short circuit is achieved by setting to 0.0 Ohms; the driver recognises 0.0 as a special value and will operate the relay bypassing the resistor chain.

Note however that a value of 0.0 is not achievable due to residual resistance in the relays and tracks on the card. The actual resistance achieved is however the lowest value that can be achieved by the resistor.

Setting open circuit

Open circuit is achieved by setting infinite resistance. The standard representation of double precision values has a defined means of representing infinity which can be found by checking the library of the programming language being used. In the case of LabVIEW, it is represented by the  icon in the Numeric Palette.

Querying the actual resistance

In many cases an algorithm may be improved if the actual achieved resistance is known, this is particularly relevant on those resistor cards with course setting resolution such as the 40-297 series of cards.

After setting a resistance, the GetResistance function may be used to obtain the actual value set, calculated from the stored calibration values, thus permitting the possibility of modifying a procedure to eliminate the uncertainty caused by the resistor resolution, leaving only the calibration uncertainty.

Using The Soft Front Panel

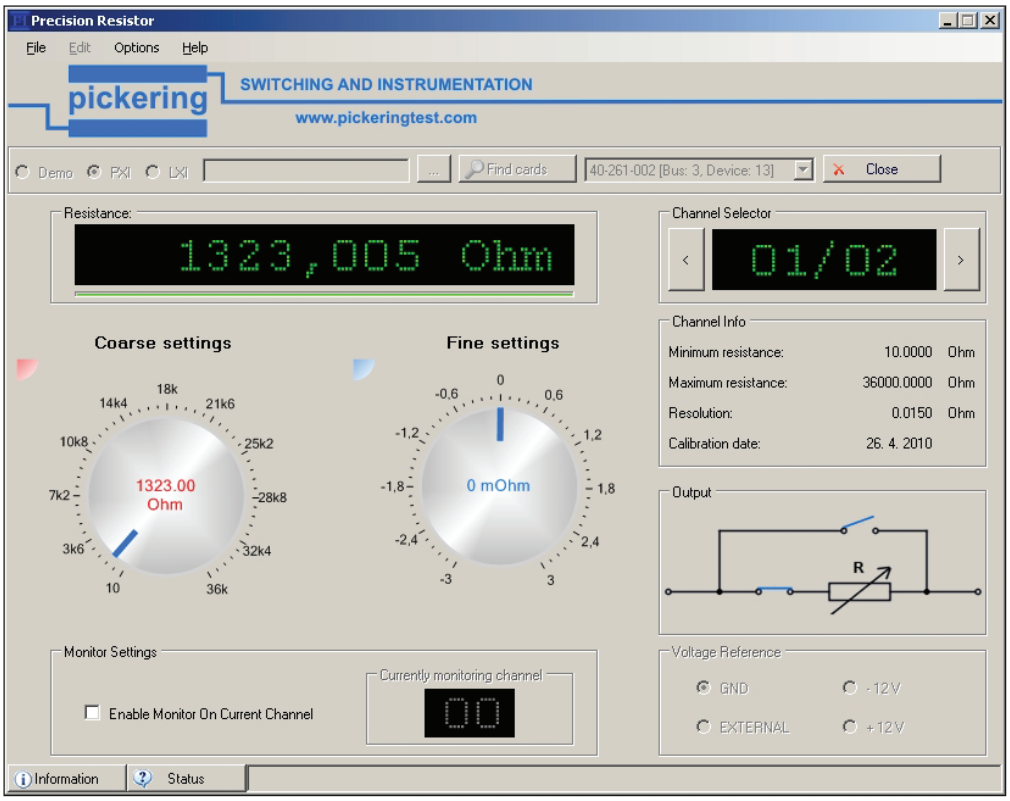


Figure 4.2 - Soft Front Panel Supplied With Precision Resistor Modules

Starting The SFP

To start the Soft Front Panel, double-click the icon in the applications folder.

Next, select Demo, PXI or LXI from the buttons in the top left of the window depending on which mode is required.

Demo Mode

The combo box displaying the available cards for simulation is now enabled as well as the "Open" button. Select a card from the list and click the "Open" button to start simulating the specified card. The application will enable the controls needed according to the simulated card's specification.

PXI Mode

The "Find cards" button is now enabled. Click this button to find all the available Precision Resistor cards in the connected PXI device. If there are suitable cards, they will be listed in the combo box. Here you can select the one you want to control (similar to Demo mode) and click the "Open" button. The application will open the card and enable the appropriate controls.

LXI Mode

The empty text field and the button with three dots are now enabled. You can type the IP address of the LXI device directly into text field, or you can use the discovery mechanism by clicking the button with three dots to find the devices. When you click the button with three dots it opens a new window and automatically tries to discover all available LXI devices. Depending on your operating system, you may see the Windows Security Alert window; click the "Unblock" button to allow the Soft Front Panel access to the network (Windows XP), or select the networks you want the Soft Front Panel to access and click the "Allow access" button (Windows 7). All located devices are then listed in the table. You can select the appropriate device from the table and click the "OK" button, or simply double-click on the device you want to use. You can also refresh the table by clicking the "Discover" button at the bottom of the window.

After selection of the device, the "Find cards" button is enabled. Click this button to find available Precision Resistor cards in the connected LXI device. If there are suitable cards, they will be listed in the combo box. There you can select the one you want to control (similar to Demo mode) and click the "Open" button. The application will open the card and enable the appropriate controls.

Controlling a Resistor Channel

The "Channel Selector" on the Soft Front Panel can be used to select a resistance channel to control by clicking on the left and right buttons either side of the channel number display.

The knob controls can be used to control the channel. The knob marked "Coarse" has a small resolution but covers the full resistance range of the channel, the knob marked "Fine" has high resolution and has a small resistance range within the setting of the Coarse knob.

You can also use the arrow keys and Page Up / Page Down keys to control the enabled knob.

- Arrow keys will increase/decrease enabled knob by 10 x smallest step
- Page Up / Page Down keys increase/decrease enabled knob by 100 x smallest step

Note: The coloured mark in the upper left corner of the knob control indicates that it is enabled. By clicking on the mark, it changes colour (red means enabled, blue means disabled) the same as the label inside the knob.

Important note: There's a progress bar just under the resistance display which indicates the time between a resistance command being sent and the resistance value being physically set on the channel.

You can also use a keyboard to manually set the resistance. Double-clicking on the resistance display enables keyboard input.

There are different ways to manually set resistance:

- Type the resistance in Ohms, for example 123,5 (You must use your system's default decimal separator).
- Type a resistance in milli, kilo, mega, giga or tera Ohms. For example 10 m, 11k, 12M, 13G, 14T. You can also type decimal numbers like 11,5k.
- Type a combined value, like 1k2 (corresponding to 1200 Ohm).
- Type a lower value than minimum to make a "short" connection or type a value higher than maximum to make an "open" connection.

Clicking "Enter" will submit the value and the Soft Front Panel will set it on the resistance channel. You can also use "Backspace" to delete typed text or "Escape" key to cancel typing.

To control the Precision Resistor channel's output you can also use the Output diagram control at the bottom right of the Soft Front Panel. Simply click on the switches in the diagram to select short circuit or open circuit for the resistance channel.

Setting the Common Mode Voltage

You can change the common mode voltage for all the resistor channels by clicking on one of the radio buttons inside the Voltage Reference group box. The default is GND.

Monitor Function

The Precision Resistor card has a calibration port providing a convenient way of measuring the resistance of a channel without having to use an external switching network to connect a DMM to each channel in turn. Click on the "Enable Monitor On Current Channel" check box to route the current resistor channel to the Calibration Port connector on the front of the card. Unchecking the Enable Monitor On Current Channel disables the Calibration Port connector. The digital display to the right of the control group shows the currently monitored channel.

Information & Status

At the bottom of the control window, there are two addition buttons: Information and Status. Click on "Information" to obtain information about the card currently being controlled. Next to the Status button is a display of the current status of the card, click on "Status" to update this display.

Load & Save

You can save the current state of the Soft Front Panel by selecting “Save” or “Save as...” from the “File” menu. You can also load the previously saved state of the Soft Front Panel by selecting “Load” from the “File” menu.

Settings

You can change settings of the Soft Front Panel by clicking on “Settings” from the menu “Options”. Here you can change the Broadcast Echo port, Broadcast Echo time out, Direct Echo port, etc.

Important note: The standard broadcast address is 255.255.255.255, but in some cases it can cause problems. For example, if you have more than one network interface (physical or virtual), you must specify the broadcast address of the specified sub net where you want to discover LXI devices.

Example: We want to discover LXI devices connected to a class C network where there is a computer with the IP address 192.168.10.13 and the network’s sub mask is 255.255.255.0, then the correct broadcast address is 192.168.10.255.

Help

From this menu you can open the Help document by clicking on “Contents” or you can obtain the information about the application by clicking on “About“. The About window displays the cards supported by the Soft Front Panel and also the required assemblies. You can also get System information by clicking on the “System Info” button. Alternately, F1 displays the help file, for more help please contact support@pickeringtest.com.

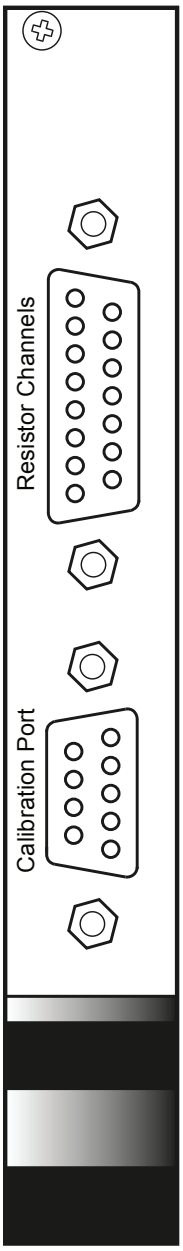
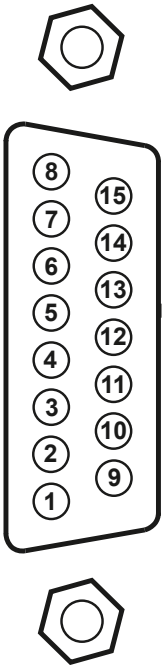
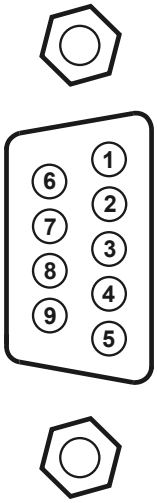


Figure 5.1 - Precision Programmable Resistor Module 40-260: Connector Positions



15-pin D-Type Plug				
Pin No.	Signal Name		Pin No.	Signal Name
1	FP_GND		9	Ext Voltage
2	NC		10	CH3_OUT
3	CH3_IN		11	CH3_OUT
4	CH3_IN		12	CH2_OUT
5	CH2_IN		13	CH2_OUT
6	CH2_IN		14	CH1_OUT
7	CH1_IN		15	CH1_OUT
8	CH1_IN			

Figure 5.2 - Resistor Channel Connector Pinouts
(15-pin male D-type viewed from front of module)



9-pin D-Type Plug				
Pin No.	Signal Name		Pin No.	Signal Name
1	V,Ω+, Source+		6	V,Ω+, Source+
2	I+, Sense+		7	I+, Sense+
3	V,Ω-, Source-		8	V,Ω-, Source-
4	I-, Sense-		9	I-, Sense-
5	Do Not Connect			

Figure 5.3 - Calibration Port Connector Pinouts
(9-pin male D-type viewed from front of module)

Section 6 - Troubleshooting

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.

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 40-260 is performing to specification and guidance on adjustment.

In normal use the 40-260 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.

If the module is used in a system which uses a DMM connected to the Calibration Port to periodically verify the resistor channels are within specification, then we recommend that no other verification tests are performed since traceability is provided by the DMM calibration.

Verification

Depending on the customer's requirements a verification check can be made periodically by connecting to the standard "Resistor Channels" port to check the module is within specification. The module has an internal date counter that shows a message in the diagnostics after this time but will not effect the cards operation. The customer has the option to read and reset the verification/calibration date as required via the following programming functions:

PIL_ReadCalDate

PIL_WriteCalDate

The module also has two internal calibration stores User_Store & Factory_Store which contain the same calibration information when leaving the factory. Resistance calls are made using the calibration values in the User_Store, in nearly all cases no changes to either store will be required, if the User_Store is accidently modified the Factory_Store can be copied to the User_Store to recover the factory calibration.

Verification Procedure

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

The following equipment is required to perform the test

- A DMM with 4 terminal resistance capability and a performance at least equivalent to a 6.5 digit model. Example: Agilent 34410A or 34411A
- A cable assembly to connect the DMM to the 40-260. This can be constructed by the user or the user can purchase a ready made cable from Pickering Interfaces suitable for connecting to the Calibration Port connector.

There are two ways of connecting to the module to conduct the test.

Calibration Port method (recommended)

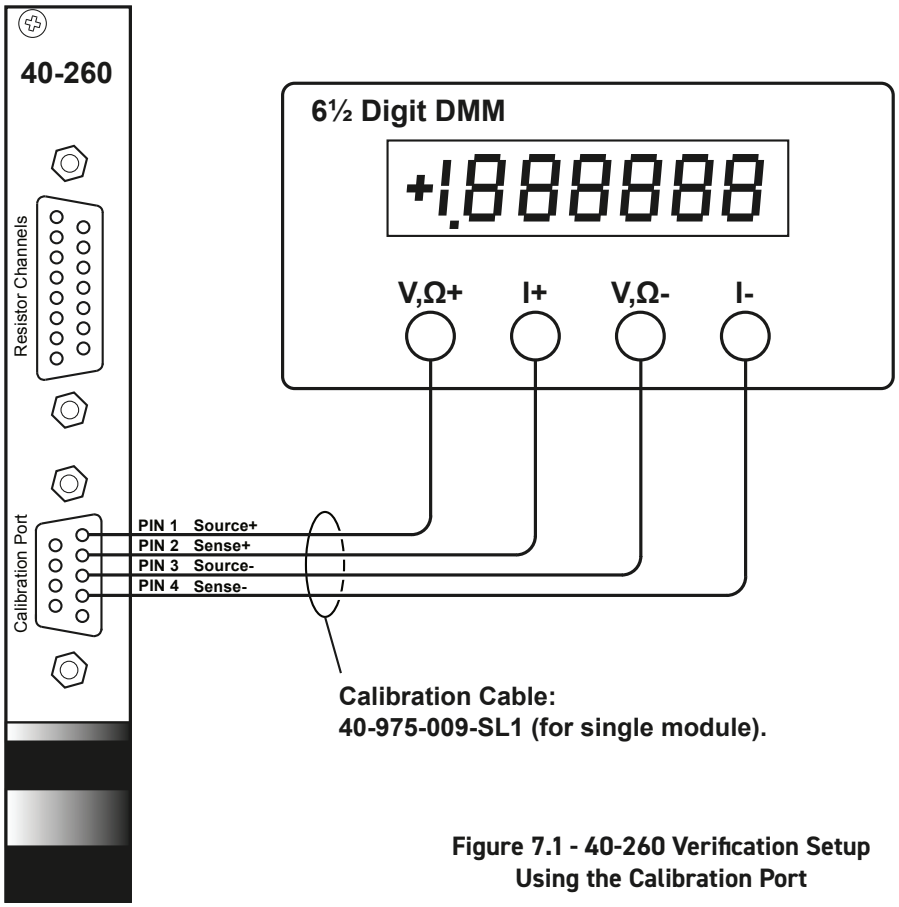


Figure 7.1 - 40-260 Verification Setup Using the Calibration Port

In this case the DMM is connected to the Calibration Port. A Pickering Interfaces cable assembly can be used for this purpose. Using this method the user can measure each of the channels in turn without changing the connection to the 40-260. The calibration MUX in the 40-260 will provide the switching function. The calibration MUX can be controlled through the SFP Monitor Port tab.

Connecting to the Resistor Channel connector

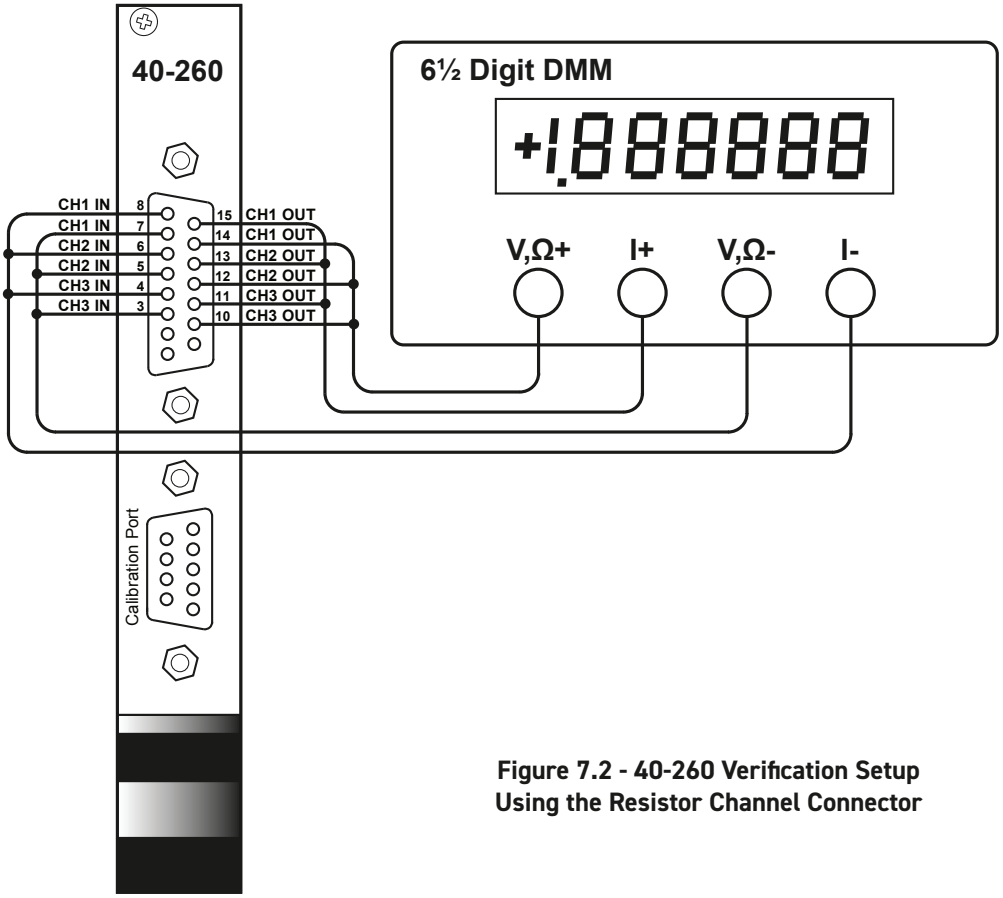


Figure 7.2 - 40-260 Verification Setup Using the Resistor Channel Connector

In this case the DMM is connected to the resistor through the normally used connector. All three channels are wired in parallel as a complete 4 terminal system.

When testing the channels not being used are set to the open circuit condition so that each of the channels can be tested in turn without having to change the connection.

Whichever method of connection is used the procedure is the same. A set of 4 terminal resistance measurements is made using the DMM.

Table 7.1 on the following two pages tabulate the measurements that need to be performed. The Soft Front Panel is used to set the required resistance, the DMM is used to measure the result and it is recorded in the following tables.

The tables include the specification limits (maximum and minimum resistance) for each of the settings of the 40-260, but the limit takes no account of DMM accuracy.

These pages can be printed out and used to provide paper or scanned records of the performance of the 40-260 when verifications tests are performed.

Adjustment Procedure

In the unlikely event that adjustment of the 40-260 is required we recommend returning it to Pickering Interfaces. Adjustment of the 40-265 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

Table 7.1 - Calibration Test Results For 40-260-001

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

Resistance Setting	Measured Value	Maximum	Minimum	Result (delete as appropriate)
90 Ω		89.91 Ω	90.09 Ω	Pass / Fail
90.01 Ω		89.91999 Ω	90.10001 Ω	Pass / Fail
90.02 Ω		89.92998 Ω	90.11002 Ω	Pass / Fail
90.03 Ω		89.93997 Ω	90.12003 Ω	Pass / Fail
90.04 Ω		89.94996 Ω	90.13004 Ω	Pass / Fail
90.05 Ω		89.95995 Ω	90.14005 Ω	Pass / Fail
90.06 Ω		89.96994 Ω	90.15006 Ω	Pass / Fail
90.07 Ω		89.97993 Ω	90.16007 Ω	Pass / Fail
90.08 Ω		89.98992 Ω	90.17008 Ω	Pass / Fail
90.09 Ω		89.99991 Ω	90.18009 Ω	Pass / Fail
90.1 Ω		90.0099 Ω	90.1901 Ω	Pass / Fail
90.2 Ω		90.1098 Ω	90.2902 Ω	Pass / Fail
90.3 Ω		90.2097 Ω	90.3903 Ω	Pass / Fail
90.4 Ω		90.3096 Ω	90.4904 Ω	Pass / Fail
90.5 Ω		90.4095 Ω	90.5905 Ω	Pass / Fail
90.6 Ω		90.5094 Ω	90.6906 Ω	Pass / Fail
90.7 Ω		90.6093 Ω	90.7907 Ω	Pass / Fail
90.8 Ω		90.7092 Ω	90.8908 Ω	Pass / Fail
90.9 Ω		90.8091 Ω	90.9909 Ω	Pass / Fail
91 Ω		90.909 Ω	91.091 Ω	Pass / Fail
91.5 Ω		91.4085 Ω	91.5915 Ω	Pass / Fail
92 Ω		91.908 Ω	92.092 Ω	Pass / Fail
92.5 Ω		92.4075 Ω	92.5925 Ω	Pass / Fail
93 Ω		92.907 Ω	93.093 Ω	Pass / Fail
93.5 Ω		93.4065 Ω	93.5935 Ω	Pass / Fail
94 Ω		93.906 Ω	94.094 Ω	Pass / Fail
94.5 Ω		94.4055 Ω	94.5945 Ω	Pass / Fail
95 Ω		94.905 Ω	95.095 Ω	Pass / Fail
96 Ω		95.904 Ω	96.096 Ω	Pass / Fail

Table 7.1 (Continued) - Calibration Test Results For 40-260-001

Resistance Setting	Measured Value	Maximum	Minimum	Result (delete as appropriate)
97 Ω		96.903 Ω	97.097 Ω	Pass / Fail
98 Ω		97.902 Ω	98.098 Ω	Pass / Fail
99 Ω		98.901 Ω	99.099 Ω	Pass / Fail
100 Ω		99.9 Ω	100.1 Ω	Pass / Fail
104 Ω		103.896 Ω	104.104 Ω	Pass / Fail
108 Ω		107.892 Ω	108.108 Ω	Pass / Fail
112 Ω		111.888 Ω	112.112 Ω	Pass / Fail
116 Ω		115.884 Ω	116.116 Ω	Pass / Fail
120 Ω		119.88 Ω	120.12 Ω	Pass / Fail
130 Ω		129.87 Ω	130.13 Ω	Pass / Fail
140 Ω		139.86 Ω	140.14 Ω	Pass / Fail
150 Ω		149.85 Ω	150.15 Ω	Pass / Fail
160 Ω		159.84 Ω	160.16 Ω	Pass / Fail
170 Ω		169.83 Ω	170.17 Ω	Pass / Fail
180 Ω		179.82 Ω	180.18 Ω	Pass / Fail
200 Ω		199.8 Ω	200.2 Ω	Pass / Fail
220 Ω		219.78 Ω	220.22 Ω	Pass / Fail
240 Ω		239.76 Ω	240.24 Ω	Pass / Fail
260 Ω		259.74 Ω	260.26 Ω	Pass / Fail
310 Ω		309.69 Ω	310.31 Ω	Pass / Fail
400 Ω		399.6 Ω	400.4 Ω	Pass / Fail
600 Ω		599.4 Ω	600.6 Ω	Pass / Fail
800 Ω		799.2 Ω	800.8 Ω	Pass / Fail
1000 Ω		999 Ω	1001 Ω	Pass / Fail
1500 Ω		1498.5 Ω	1501.5 Ω	Pass / Fail
2000 Ω		1998 Ω	2002 Ω	Pass / Fail
3000 Ω		2997 Ω	3003 Ω	Pass / Fail
5000 Ω		4995 Ω	5005 Ω	Pass / Fail
8000 Ω		7992 Ω	8008 Ω	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.