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40-290/291 User Manual

PXI Programmable Resistor Module



PXI

Issue 9.3 March 2021

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ISO 9001
Reg No. 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.

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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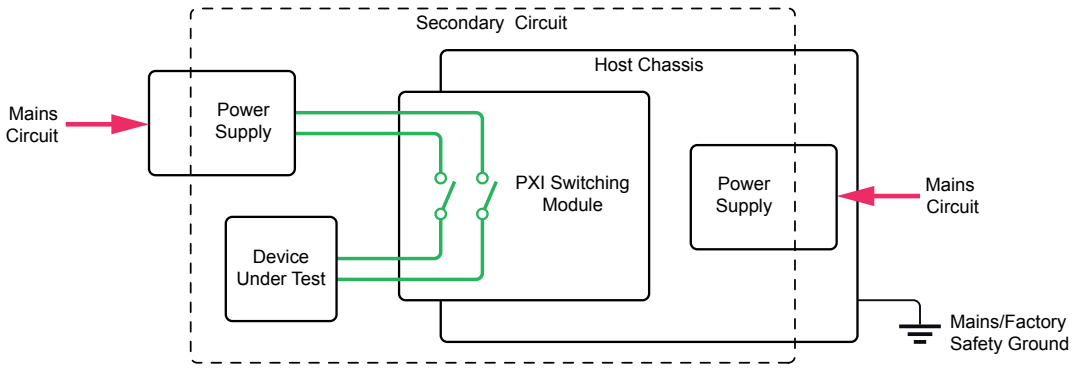
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WARNINGS AND CAUTIONS

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 host 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 300V. 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: 1. 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. 2. 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. 3. Outer clothing worn must be unable to generate static charges. 4. 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

- Dual 16-Bit or Quad 8-Bit Resolution Resistor Module
- Programmable From 0 Ω to 32767.5 Ω in 0.5 Ω Steps
- Built-In Non-Volatile Parametric Memory For Calibration Data
- Option To Include 16 SPDT Reed Relays
- Uses High Reliability Pickering Reed Relays For Maximum Performance
- Over 1000 Value Changes Per Second
- Special Versions Built To Order
- VISA, IVI & Kernel Drivers Supplied for Windows
- Supported by PXI or LXI Chassis
- 3 Year Warranty



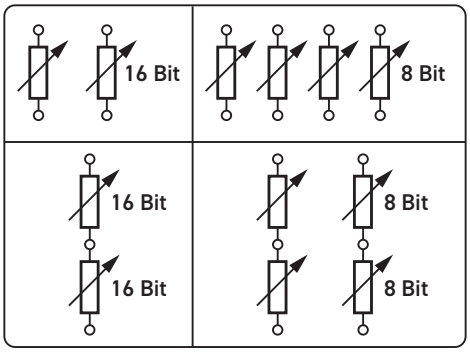
The 40-290 Programmable Resistor Module comprises a dual 16-bit resistor chain together with 16 optional SPDT Reed Relays (see diagram below). The 40-291 is configured as a quad 8-bit programmable resistor chain also with the option of 16 SPDT relays. Connections are made via a front panel 68-pin male connector.

Programmable resistors may be connected together either in series or in parallel to form many types of configuration. For example potentiometers (2 resistors in series) and more accurate resistors (connecting in parallel). Each programmable resistor has a position for a user inserted offset value.

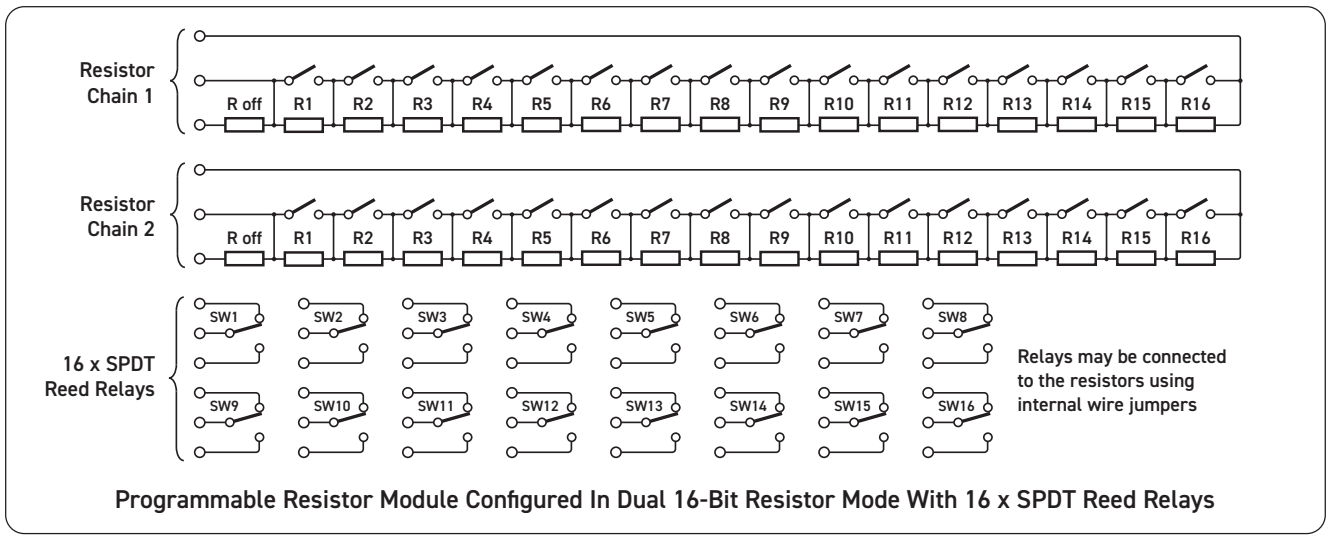
The 40-290 and 40-291 use Ruthenium Reed Relays for maximum switching accuracy and operating life.

To give maximum accuracy each resistor chain has on-board E²PROM, this allows accurate calibration data to be recorded for each resistor in the chain.

If versions are required with different resistor ranges than those shown, please contact the Sales Office for assistance.



Programmable Resistor Module Overview



Programmable Resistor Module Configured In Dual 16-Bit Resistor Mode With 16 x SPDT Reed Relays

Relay Type

The 40-290 & 40-291 are fitted with ruthenium sputtered reed relays offering very long life with good low level switching performance and excellent contact resistance stability. Spare reed relays are built onto the circuit board to allow easy maintenance with minimum downtime.

All reed relays are manufactured by our Relay Division: pickeringrelay.com

Programmable Resistor Specification

Max Switch Voltage:	100 V*
Resolution:	0.5 Ω
† Accuracy of Fitted Resistor:	0.5 %
Residual Resistance, typical (when chain is set to 0Ω):	1 Ω (8-bit) 2 Ω (16-bit)
Max Power: 0.5 to 10 Ω 10 to 100 Ω 100 Ω+	1 W 0.5 W 0.25 W
Operate Time: Release Time:	<0.5 ms <0.5 ms
Expected Life, Low power load: Expected Life, Full power load:	>1x10^8 operations >1x10^6 operations

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

† Overall accuracy of module is a combination of the fitted resistor accuracy and the relay/track resistance that makes up the residual path resistance.

Switching Specification (16 x SPDT Reed Relays)

Switch Type:	Ruthenium Reed
Max Standoff Voltage:	100 V*
Max Power: Max Switch Current: Max Carry Current:	3 W 0.25 A 0.5 A
Initial Path Resistance, On: Path Resistance, Off:	<400 mΩ >1x10^9 Ω
Operate Time: Release Time:	<0.5 ms <0.5 ms
Expected Life, Low power load: Expected Life, Full power load:	>1x10^8 operations >1x10^6 operations

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

Power Requirements

+3.3 V	+5 V	+12 V	-12 V
0	740 mA (typ 400 mA)	0	0

Mechanical Characteristics

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

Connectors

PXI bus via 32-bit P1/J1 backplane connector.
Resistor channel signals via front panel 68-pin female micro-D connector. Each resistor has 4 wire connections (Kelvin) so allowing elimination of wires and connectors in high accuracy measurements.

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

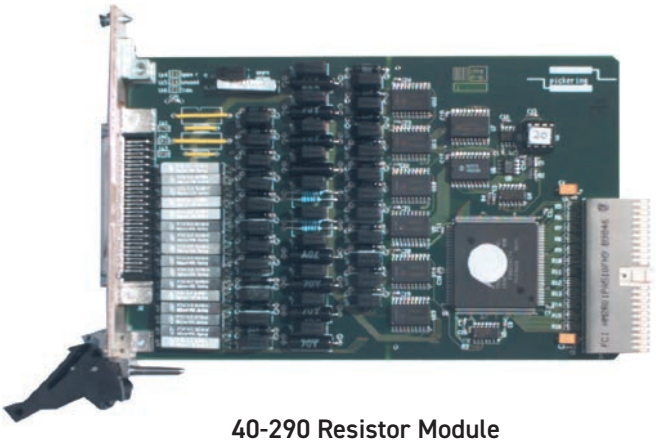
PXI & CompactPCI Compliance

The module is compliant with the PXI Specification 2.2. Local Bus, Trigger Bus & 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.



40-290 Resistor Module

Product Order Codes

Dual 16-Bit Resistor Module	**40-290-021**
(resistor value is 0 Ω to 32,767.5 Ω excluding residual resistance)	
Dual 16-Bit Resistor Module + 16 x SPDT Relays	**40-290-121**
(resistor value is 0 Ω to 32,767.5 Ω excluding residual resistance)	
Quad 8-Bit Resistor Module	**40-291-021**
(resistor value is 0 Ω to 127.5 Ω excluding residual resistance)	
Quad 8-Bit Resistor Module + 16 x SPDT Relays	**40-291-121**
(resistor value is 0 Ω to 127.5 Ω excluding residual resistance)	

Mating Connectors & Cabling

For connection accessories for the 40-290 series please refer to the 90-015D 68-pin micro-D Connector Accessories data sheet where a complete list and documentation can be found for accessories, or refer to the Connection Solutions catalog.

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.

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.

Chassis Compatibility

This PXI module must be used in a suitable chassis. It is 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

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

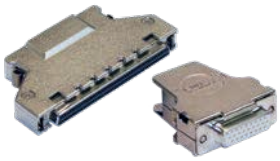


Pickering LXI or LXI/USB Modular Chassis—only accept our 1000+ PXI Switching & Simulation Modules:

- 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

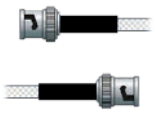
We provide a full range of supporting cable and connector solutions for all our switching products—20 connector families with 1200+ products. We offer everything from simple mating connectors to complex cables assemblies and terminal blocks. All assemblies are manufactured by Pickering and are guaranteed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



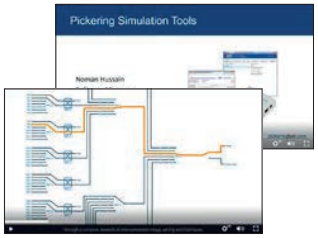
eBIRST Switching System Test Tools are designed specifically for our PXI, PCI or LXI products, these tools simplify switching system fault-finding by quickly testing the system and graphically identifying the faulty relay.
To learn more, please go to: pickeringtest.com/ebirst

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

A functional block diagram is provided in Figure 2.1. The Module is powered by a +5V input via Compact PCI connector J1. The interface to the user test equipment is via the front panel mounted 68-pin micro-D connector, J2. The module comprises a PCB populated with four resistor chains, thirty two single pole single throw relays (RL1 to RL32) and sixteen single pole double throw pole relays (RL33 to RL48). The relays are energised via control signals from relay driver U8. The relay driver is addressed by PCI bridge U1 to output the required signal. Module configuration is determined by hardwired links and data stored in EEPROM U7. PCI Bridge U1 is configured by EEPROM U2, which also stores resistor calibration data.

Resistor chains 1 and 2 are linked via Link LK1, and resistor chains 3 and 4 are linked via Link LK3. Link 2 is not fitted. Relays RL1 to RL36 are used to switch resistors R17 to R52, respectively, in and out of the resistor chain. Relays RL37 to 48 are not dedicated to any function and are provided for customisation (see Figure 2.4).

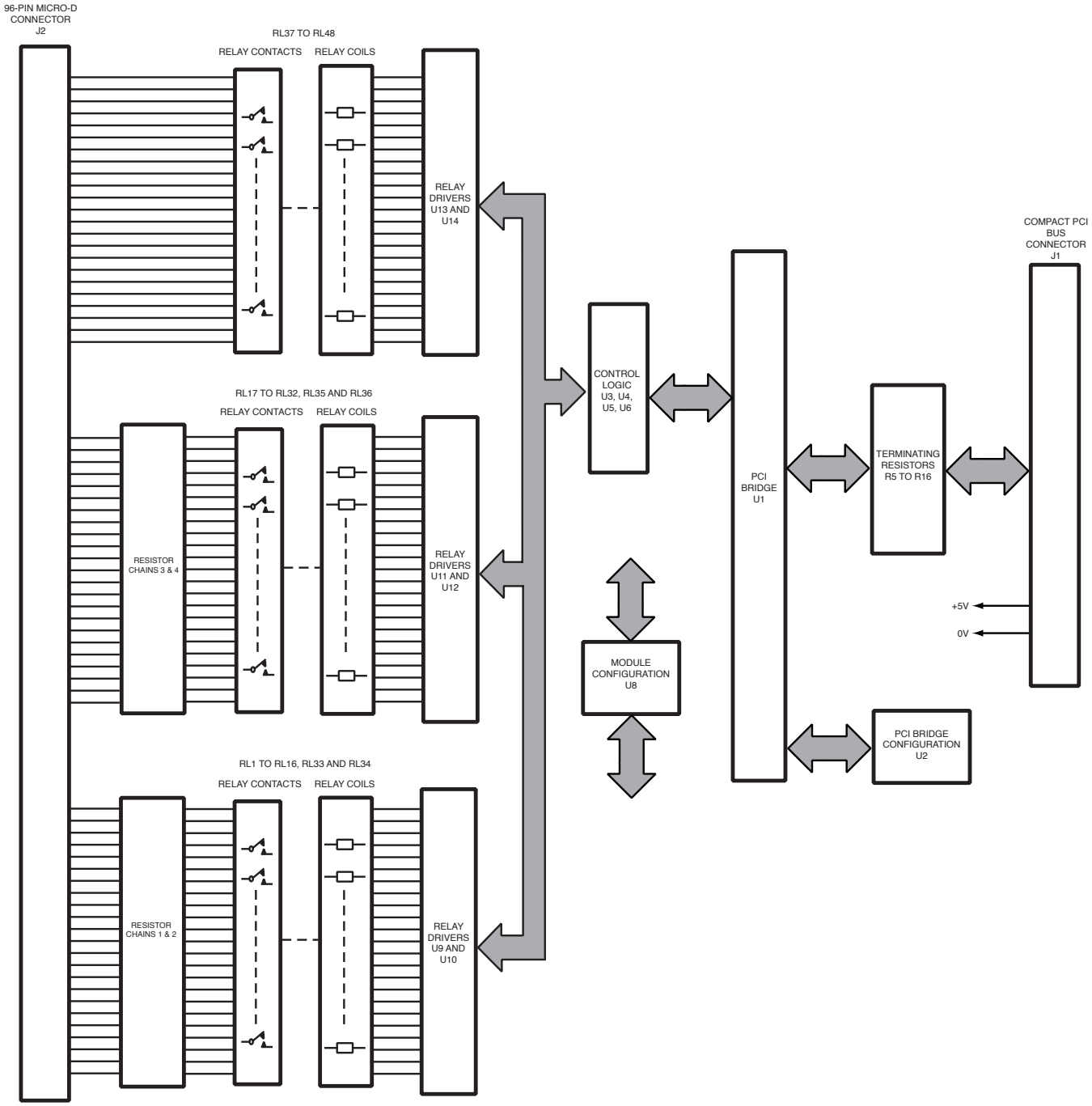


Figure 2.1 - Programmable Resistor Module (40-290/291): Functional Block Diagram

These cards support non-volatile storage of a 16-bit calibration value associated with every individual resistor in each resistor-chain. The Pickering software drivers provide functions allowing the storage and retrieval of these values, but their interpretation is left entirely to the user's program.

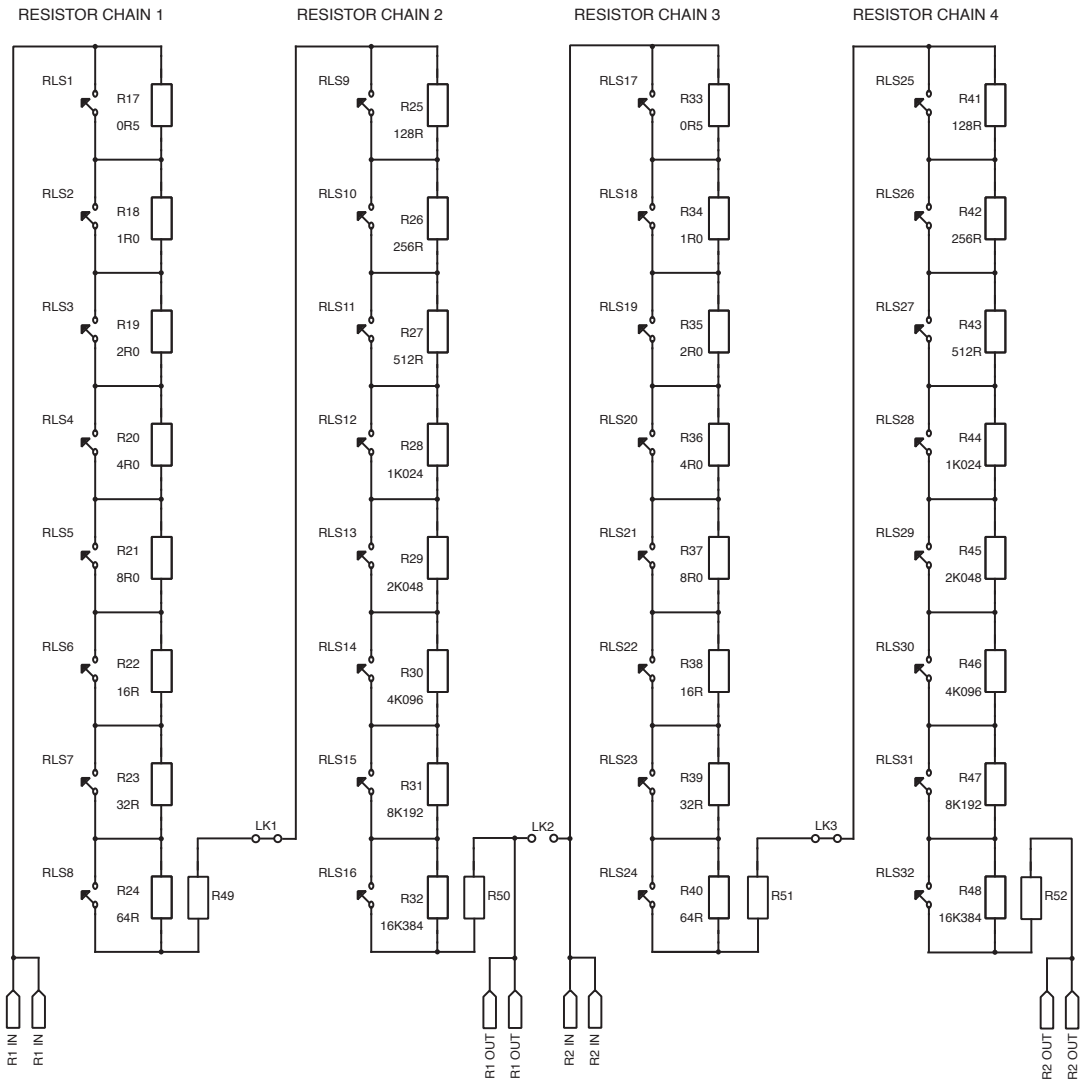
Pilpxi (Direct I/O) driver functions:

- PIL_WriteCal
- PIL_ReadCal

Pipx40 (VISA) driver functions:

- pipx40_writeCalibration
- pipx40_readCalibration

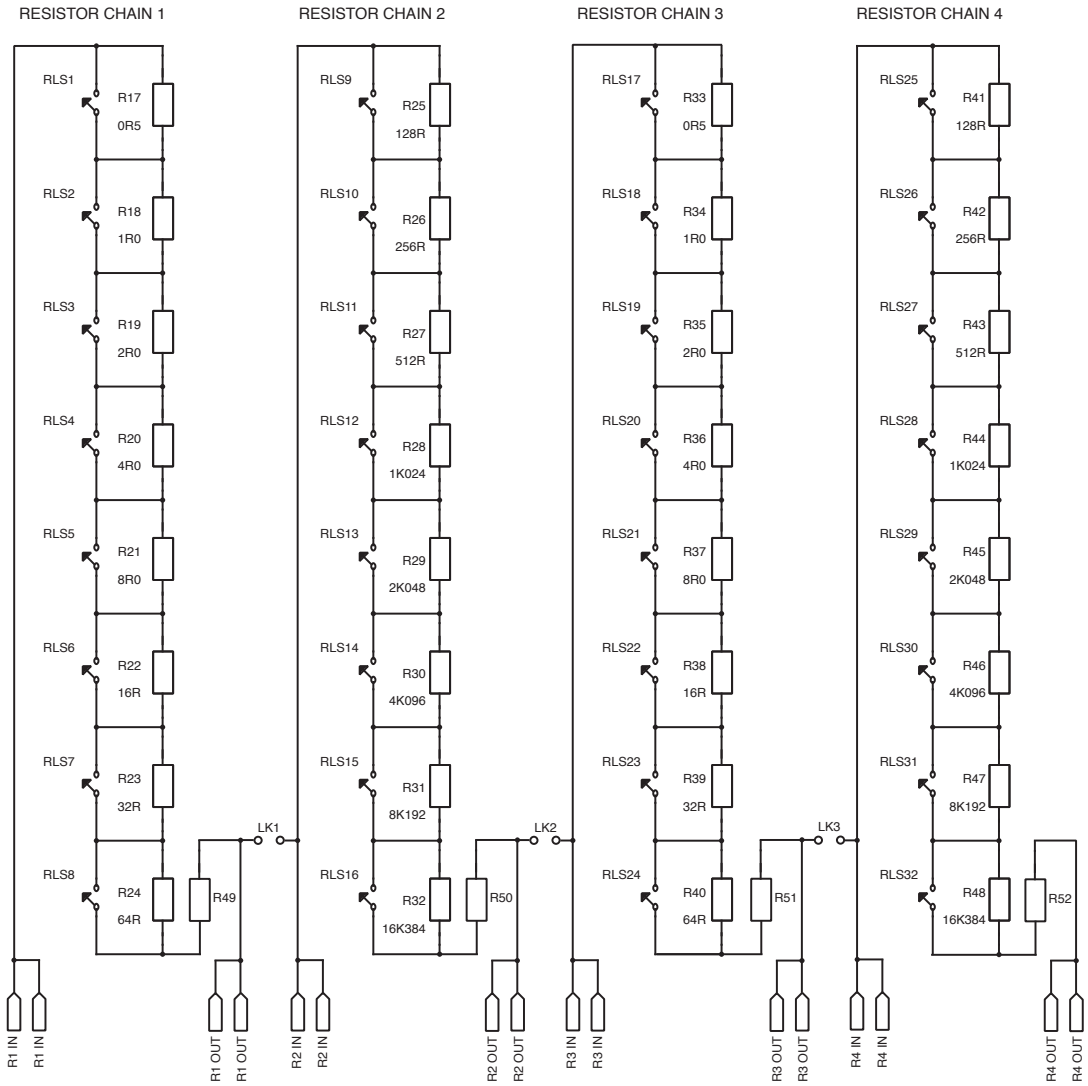
These functions are described in the Programming Manual and help files, with some further information in the Application Notes section on the Pickering Interfaces website www.pickeringtest.com.



THE 40-290 IS FITTED WITH LINKS 1 AND 3 FORMING 2 SEPARATE 16-BIT RESISTOR CHAINS.
THE RESISTOR VALUES SHOWN IN THE SCHEMATIC ARE STANDARD VALUES; THESE MAY BE CUSTOMISED.
RELAY RL1 SWITCHES R17, RL2 SWITCHES R18, ETC.
ADDRESS 1 COMPRISES RESISTOR CHAINS 1 AND 2. ADDRESS 2 COMPRISES RESISTOR CHAINS 3 AND 4.

THE STANDARD VALUE RESISTOR POWER RATINGS ARE PROVIDED IN THE PARTS LIST IN SECTION 4.

Figure 2.2 - Programmable Resistor Module 40-290: Resistor Chain Schematic



THE 40-291 IS NOT FITTED WITH LINKS 1, 2 OR 3 FORMING 4 SEPARATE 8-BIT RESISTOR CHAINS.
THE RESISTOR VALUES SHOWN IN THE SCHEMATIC ARE STANDARD VALUES; THESE MAY BE CUSTOMISED.
RELAY RL1 SWITCHES R17, RL2 SWITCHES R18, ETC.
ADDRESS 1 COMPRISES RESISTOR CHAIN 1. ADDRESS 2 COMPRISES RESISTOR CHAIN 2.
ADDRESS 3 COMPRISES RESISTOR CHAIN 3. ADDRESS 4 COMPRISES RESISTOR CHAIN 4

THE STANDARD VALUE RESISTOR POWER RATINGS ARE PROVIDED IN THE PARTS LIST IN SECTION 4.

Figure 2.3 - Programmable Resistor Module 40-291: Resistor Chain Schematic

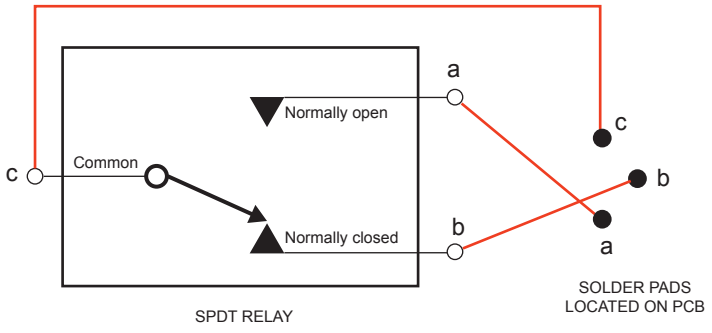


Figure 2.4 - Connecting to an SPDT Relay on the PCB

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.

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.

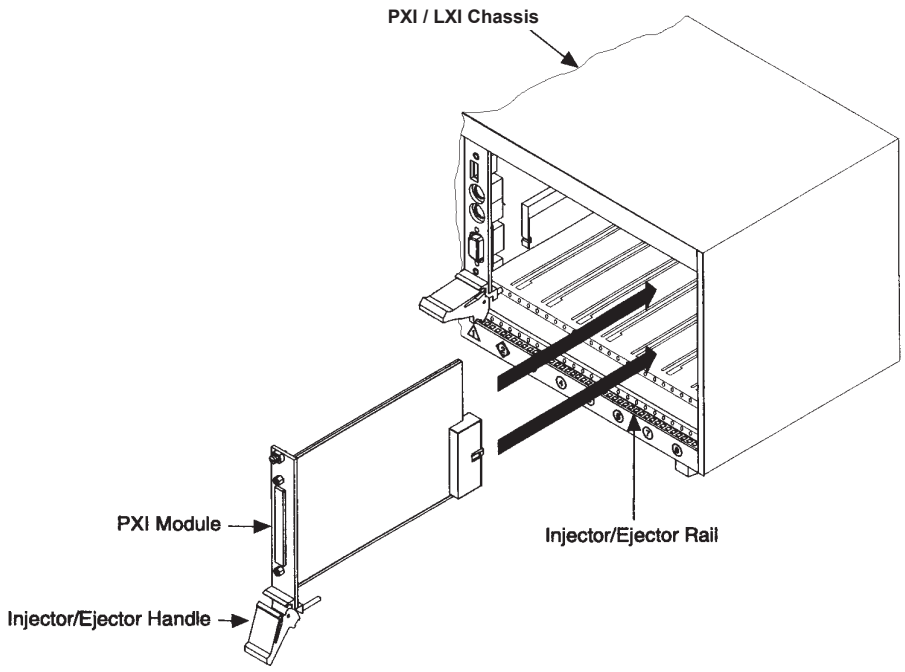


Figure 3.1 - Installing the Module into a PXI/cPCI/LXI Chassis

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.

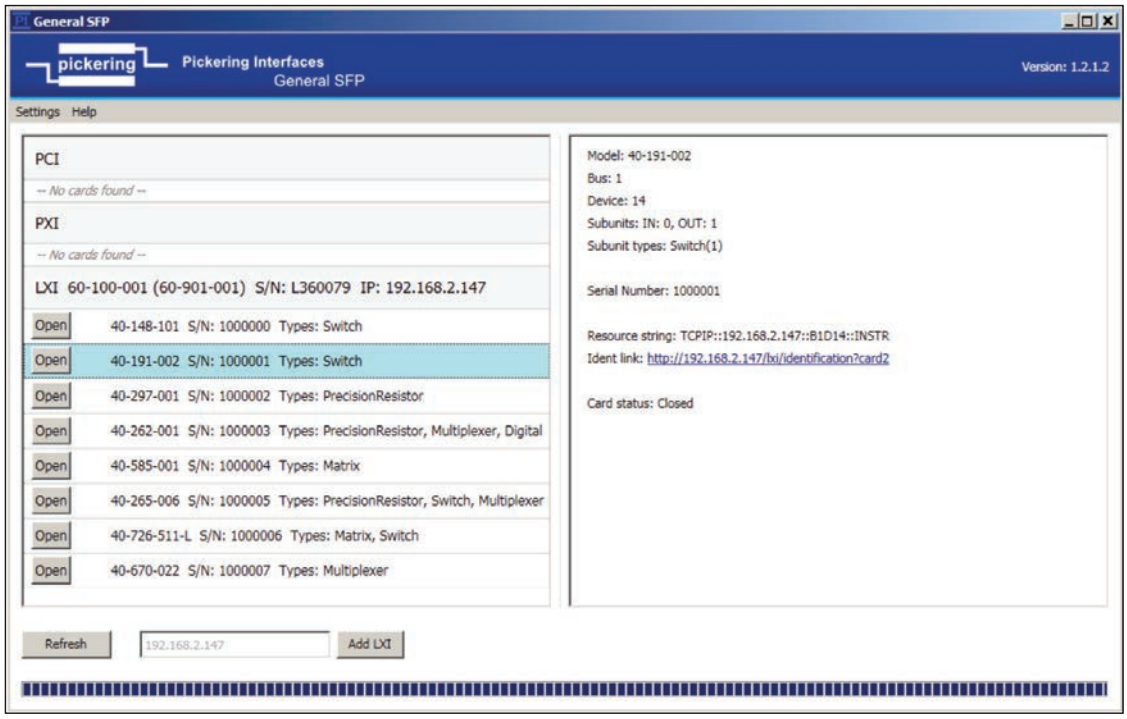


Figure 3.3 - General Soft Front Panel Selector

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 MODULES

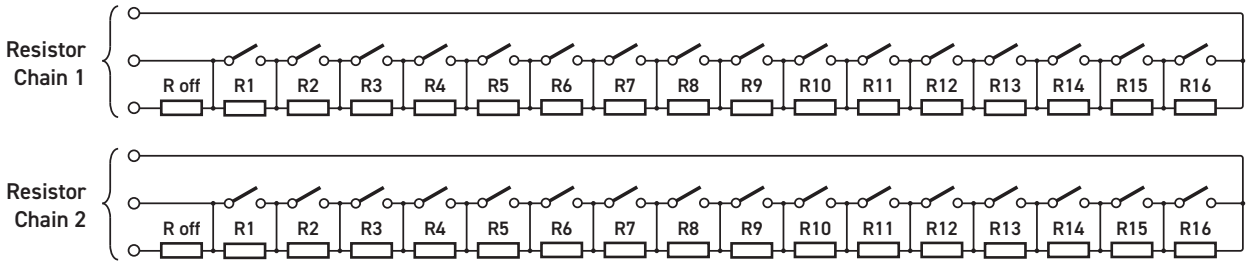
For information on the installation and use of drivers and the programming of Pickering's products in various software environments, please refer to the Software User Manual.

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

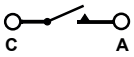
Also, it can be accessed from the DVD supplied with the product:
<DVD_DRIVE>\downloads\Documentation\Software-Manual.pdf

MODULE ARCHITECTURE 40-290-021

The 40-290-021 Module utilises 32 SPST relays. In the default state, all relay signal paths are open circuit and all resistors are linked in the chains. Energising a particular relay creates a signal path between the C and A terminals of the relay and short circuits the corresponding resistor. The relay module's switching architecture is shown in its default state in the diagram below:



40-290-021 (32 x SPST)



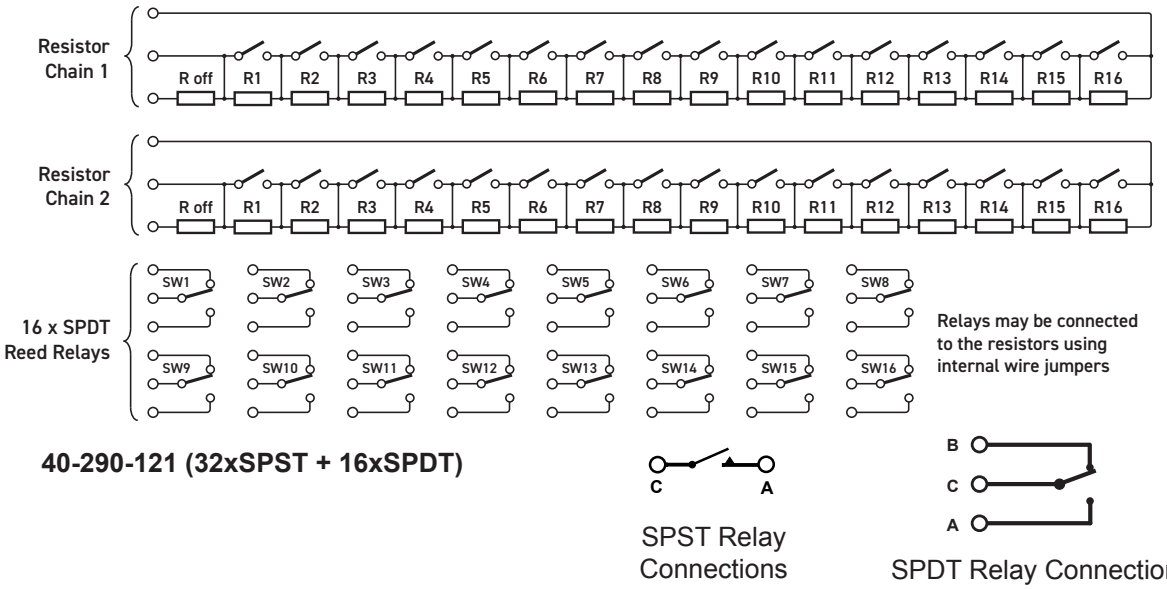
Relay Connections

Two sub-units (one for each Chain) are used to control the module's relays as shown below. Enabling a particular bit closes the C to A signal path of that relay.

Chain	Sub-Unit	Bit	40-290-021 Signal Path (with relay energised)	Associated Resistor	PCB Resistor
1	1	1	C1.1 to A1.1	R1	R17
	1	2	C2.1 to A2.1	R2	R18
	1	3	C3.1 to A3.1	R3	R19
	1	4	C4.1 to A4.1	R4	R20
	1	5	C5.1 to A5.1	R5	R21
	1	6	C6.1 to A6.1	R6	R22
	1	7	C7.1 to A7.1	R7	R23
	1	8	C8.1 to A8.1	R8	R24
	1	9	C9.1 to A9.1	R9	R25
	1	10	C10.1 to A10.1	R10	R26
	1	11	C11.1 to A11.1	R11	R27
	1	12	C12.1 to A12.1	R12	R28
	1	13	C13.1 to A13.1	R13	R29
	1	14	C14.1 to A14.1	R14	R30
	1	15	C15.1 to A15.1	R15	R31
	1	16	C16.1 to A16.1	R16	R32
2	2	1	C1.2 to A1.2	R1	R33
	2	2	C2.2 to A2.2	R2	R34
	2	3	C3.2 to A3.2	R3	R35
	2	4	C4.2 to A4.2	R4	R36
	2	5	C5.2 to A5.2	R5	R37
	2	6	C6.2 to A6.2	R6	R38
	2	7	C7.2 to A7.2	R7	R39
	2	8	C8.2 to A8.2	R8	R40
	2	9	C9.2 to A9.2	R9	R41
	2	10	C10.2 to A10.2	R10	R42
	2	11	C11.2 to A11.2	R11	R43
	2	12	C12.2 to A12.2	R12	R44
	2	13	C13.2 to A13.2	R13	R45
	2	14	C14.2 to A14.2	R14	R46
	2	15	C15.2 to A15.2	R15	R47
	2	16	C16.2 to A16.2	R16	R48

MODULE ARCHITECTURE 40-290-121

The 40-290-121 Module utilises 32 SPST relays, and 16 SPDT changeover relays. In the default state all signal paths are open circuit for the SPST relays with all resistors linked in the chains, and between the C and B terminals for the changeover relays. Energising any relay creates a signal path between the C and A terminals of that relay. As the SPST relays are energised the corresponding resistor is short circuited. The relay module's switching architecture is shown in its default state in the diagram below:



40-290-121 (32xSPST + 16xSPDT)

SPST Relay Connections

SPDT Relay Connections

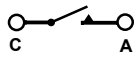
Three sub-units of 16 bits are used to control the module's relays as shown below. Enabling a particular bit closes the C to A signal path of that relay.

Chain	Sub-Unit	Bit	40-290-121 Signal Path (with relay energised)	Associated Resistor	PCB Resistor
1	1	1	C1.1 to A1.1	R1	R17
	1	2	C2.1 to A2.1	R2	R18
	1	3	C3.1 to A3.1	R3	R19
	1	4	C4.1 to A4.1	R4	R20
	1	5	C5.1 to A5.1	R5	R21
	1	6	C6.1 to A6.1	R6	R22
	1	7	C7.1 to A7.1	R7	R23
	1	8	C8.1 to A8.1	R8	R24
	1	9	C9.1 to A9.1	R9	R25
	1	10	C10.1 to A10.1	R10	R26
	1	11	C11.1 to A11.1	R11	R27
	1	12	C12.1 to A12.1	R12	R28
	1	13	C13.1 to A13.1	R13	R29
	1	14	C14.1 to A14.1	R14	R30
	1	15	C15.1 to A15.1	R15	R31
	1	16	C16.1 to A16.1	R16	R32
2	2	1	C1.2 to A1.2	R1	R33
	2	2	C2.2 to A2.2	R2	R34
	2	3	C3.2 to A3.2	R3	R35
	2	4	C4.2 to A4.2	R4	R36
	2	5	C5.2 to A5.2	R5	R37
	2	6	C6.2 to A6.2	R6	R38
	2	7	C7.2 to A7.2	R7	R39
	2	8	C8.2 to A8.2	R8	R40
	2	9	C9.2 to A9.2	R9	R41
	2	10	C10.2 to A10.2	R10	R42
	2	11	C11.2 to A11.2	R11	R43
	2	12	C12.2 to A12.2	R12	R44
	2	13	C13.2 to A13.2	R13	R45
	2	14	C14.2 to A14.2	R14	R46
	2	15	C15.2 to A15.2	R15	R47
	2	16	C16.2 to A16.2	R16	R48

Changeover Relays (SPDT)		
Sub-Unit	Bit	40-290-121 Signal Path (with relay energised)
3	1	C1.3 to A1.3
3	2	C2.3 to A2.3
3	3	C3.3 to A3.3
3	4	C4.3 to A4.3
3	5	C5.3 to A5.3
3	6	C6.3 to A6.3
3	7	C7.3 to A7.3
3	8	C8.3 to A8.3
3	9	C9.3 to A9.3
3	10	C10.3 to A10.3
3	11	C11.3 to A11.3
3	12	C12.3 to A12.3
3	13	C13.3 to A13.3
3	14	C14.3 to A14.3
3	15	C15.3 to A15.3
3	16	C16.3 to A16.3

MODULE ARCHITECTURE 40-291-021

The 40-291-021 Module utilises 32 SPST relays. In the default state, all relay signal paths are open circuit and all resistors are linked in the chains. Energising a particular relay creates a signal path between the C and A terminals of the relay and short circuits the corresponding resistor. The relay module's switching architecture is detailed in Figure 2.3. Relay connections are as shown below.



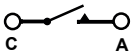
Relay Connections

Four sub-units (one for each Chain) are used to control the module's relays as shown below. Enabling a particular bit closes the C to A signal path of that relay.

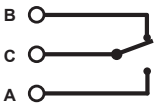
Chain	Sub-Unit	Bit	40-291-021 Signal Path (with relay energised)	Associated Resistor	PCB Resistor
1	1	1	C1.1 to A1.1	R1	R17
	1	2	C2.1 to A2.1	R2	R18
	1	3	C3.1 to A3.1	R3	R19
	1	4	C4.1 to A4.1	R4	R20
	1	5	C5.1 to A5.1	R5	R21
	1	6	C6.1 to A6.1	R6	R22
	1	7	C7.1 to A7.1	R7	R23
	1	8	C8.1 to A8.1	R8	R24
2	2	1	C1.2 to A1.2	R1	R25
	2	2	C2.2 to A2.2	R2	R26
	2	3	C3.2 to A3.2	R3	R27
	2	4	C4.2 to A4.2	R4	R28
	2	5	C5.2 to A5.2	R5	R29
	2	6	C6.2 to A6.2	R6	R30
	2	7	C7.2 to A7.2	R7	R31
	2	8	C8.2 to A8.2	R8	R32
3	3	1	C1.3 to A1.3	R1	R33
	3	2	C2.3 to A2.3	R2	R34
	3	3	C3.3 to A3.3	R3	R35
	3	4	C4.3 to A4.3	R4	R36
	3	5	C5.3 to A5.3	R5	R37
	3	6	C6.3 to A6.3	R6	R38
	3	7	C7.3 to A7.3	R7	R39
	3	8	C8.3 to A8.3	R8	R40
4	4	1	C1.4 to A1.4	R1	R41
	4	2	C2.4 to A2.4	R2	R42
	4	3	C3.4 to A3.4	R3	R43
	4	4	C4.4 to A4.4	R4	R44
	4	5	C5.4 to A5.4	R5	R45
	4	6	C6.4 to A6.4	R6	R46
	4	7	C7.4 to A7.4	R7	R47
	4	8	C8.4 to A8.4	R8	R48

MODULE ARCHITECTURE 40-291-121

The 40-291-121 Module utilises 32 SPST relays, and 16 changeover relays. In the default state all signal paths are open circuit for the SPST relays with all resistors linked in the chains, and between the C and B terminals for the changeover relays. Energising any relay creates a signal path between the C and A terminals of that relay. As the SPST relays are energised the corresponding resistor is short circuited. The relay module's switching architecture is detailed in Figure 2.3. Relay connections are as shown below.



SPST Relay Connections



DPST Relay Connections

Five sub-units are used to control the module's relays as shown below. Enabling a particular bit closes the C to A signal path of that relay.

Chain	Sub-Unit	Bit	40-291-121 Signal Path (with relay energised)	Associated Resistor	PCB Resistor
1	1	1	C1.1 to A1.1	R1	R17
	1	2	C2.1 to A2.1	R2	R18
	1	3	C3.1 to A3.1	R3	R19
	1	4	C4.1 to A4.1	R4	R20
	1	5	C5.1 to A5.1	R5	R21
	1	6	C6.1 to A6.1	R6	R22
	1	7	C7.1 to A7.1	R7	R23
	1	8	C8.1 to A8.1	R8	R24
2	2	1	C1.2 to A1.2	R1	R25
	2	2	C2.2 to A2.2	R2	R26
	2	3	C3.2 to A3.2	R3	R27
	2	4	C4.2 to A4.2	R4	R28
	2	5	C5.2 to A5.2	R5	R29
	2	6	C6.2 to A6.2	R6	R30
	2	7	C7.2 to A7.2	R7	R31
	2	8	C8.2 to A8.2	R8	R32
3	3	1	C1.3 to A1.3	R1	R33
	3	2	C2.3 to A2.3	R2	R34
	3	3	C3.3 to A3.3	R3	R35
	3	4	C4.3 to A4.3	R4	R36
	3	5	C5.3 to A5.3	R5	R37
	3	6	C6.3 to A6.3	R6	R38
	3	7	C7.3 to A7.3	R7	R39
	3	8	C8.3 to A8.3	R8	R40
4	4	1	C1.4 to A1.4	R1	R41
	4	2	C2.4 to A2.4	R2	R42
	4	3	C3.4 to A3.4	R3	R43
	4	4	C4.4 to A4.4	R4	R44
	4	5	C5.4 to A5.4	R5	R45
	4	6	C6.4 to A6.4	R6	R46
	4	7	C7.4 to A7.4	R7	R47
	4	8	C8.4 to A8.4	R8	R48

Changeover Relays (DPST)		
Sub-Unit	Bit	40-291-121 Signal Path (with relay energised)
5	1	C1.5 to A1.5
5	2	C2.5 to A2.5
5	3	C3.5 to A3.5
5	4	C4.5 to A4.5
5	5	C5.5 to A5.5
5	6	C6.5 to A6.5
5	7	C7.5 to A7.5
5	8	C8.5 to A8.5
5	9	C9.5 to A9.5
5	10	C10.5 to A10.5
5	11	C11.5 to A11.5
5	12	C12.5 to A12.5
5	13	C13.5 to A13.5
5	14	C14.5 to A14.5
5	15	C15.5 to A15.5
5	16	C16.5 to A16.5

PROGRAMMING THE MODULE

Here are examples of using the drivers with the 40-290-021 (32 x SPST) module. For further information please refer to the help information supplied with the software.

Using PILPXI

To operate a relay the user could use the simple OpBit command or the WriteSub commands

OpBit

```
DWORD sub_unit = 1;
PIL_OpBit( card_num, sub_unit, 1, 1);   // Operates the A1.1/C1.1 relay
PIL_OpBit( card_num, sub_unit, 1, 0);   // Releases the A1.1/C1.1 relay
PIL_OpBit( card_num, sub_unit, 6, 1);   // Operates the A6.1/C6.1 relay
```

WriteSub

```
// Sub-unit is 32 bits wide, so 1 DWORD is needed to hold the pattern
DWORD data[1];
data[0] = 1;            // Sets lowest bit to 1, A1.1/C1.1 relay
PIL_WriteSub( card_num, sub_unit, data);
data[0] = 0x20;         // Sets 6th bit, A6.1/C6.1 relay
                        // All other relays are set to off
PIL_WriteSub( card_num, sub_unit, data);
```

WriteCal and ReadCal These functions can be used to Write and Read calibration data.

Using PIPX40

setChannelState

```
ViUInt32 sub_unit = 1;
pipx40_setChannelState(vi, sub_unit, 1, VI_ON);     // Operates the A1.1/C1.1 relay
pipx40_setChannelState(vi, sub_unit, 1, VI_OFF);    // Releases the A1.1/C1.1 relay
pipx40_setChannelState(vi, sub_unit, 6, VI_ON);     // Operates the A6.1/C6.1 relay
```

setChannelPattern

```
// Sub-unit is 32 bits wide, so 1 ViUInt32 value is needed to hold the entire pattern
ViUInt32 data[1];
data[0] = 1;            // Sets lowest bit to 1, A1.1/C1.1 relay
pipx40_setChannelPattern( vi, sub_unit, data);
data[0] = 0x20;         // Sets 6th bit, A6.1/C6.1 relay
                        // All other relays are set to off
pipx40_setChannelPattern( vi, sub_unit, data);
```

writeCalibration and readCalibration These functions can be used to Write and Read calibration data.

Using pi40iv

The IVI driver has no special labelling for this card and treats the array of switches as a simple array, labelling the channels using the normal com./ch labelling tags.

```
pi40iv_Connect(vi, com1, ch1);      // Operates the A1.1/C1.1 relay
pi40iv_Disconnect(vi, com1, ch1);   // Releases the A1.1/C1.1 relay
pi40iv_Connect(vi, com6, ch6);      // Operates the A6.1/C6.1 relay
```

The IVI Swtch driver specification contains no bulk setting capabilities.

SECTION 5 - CONNECTOR INFORMATION

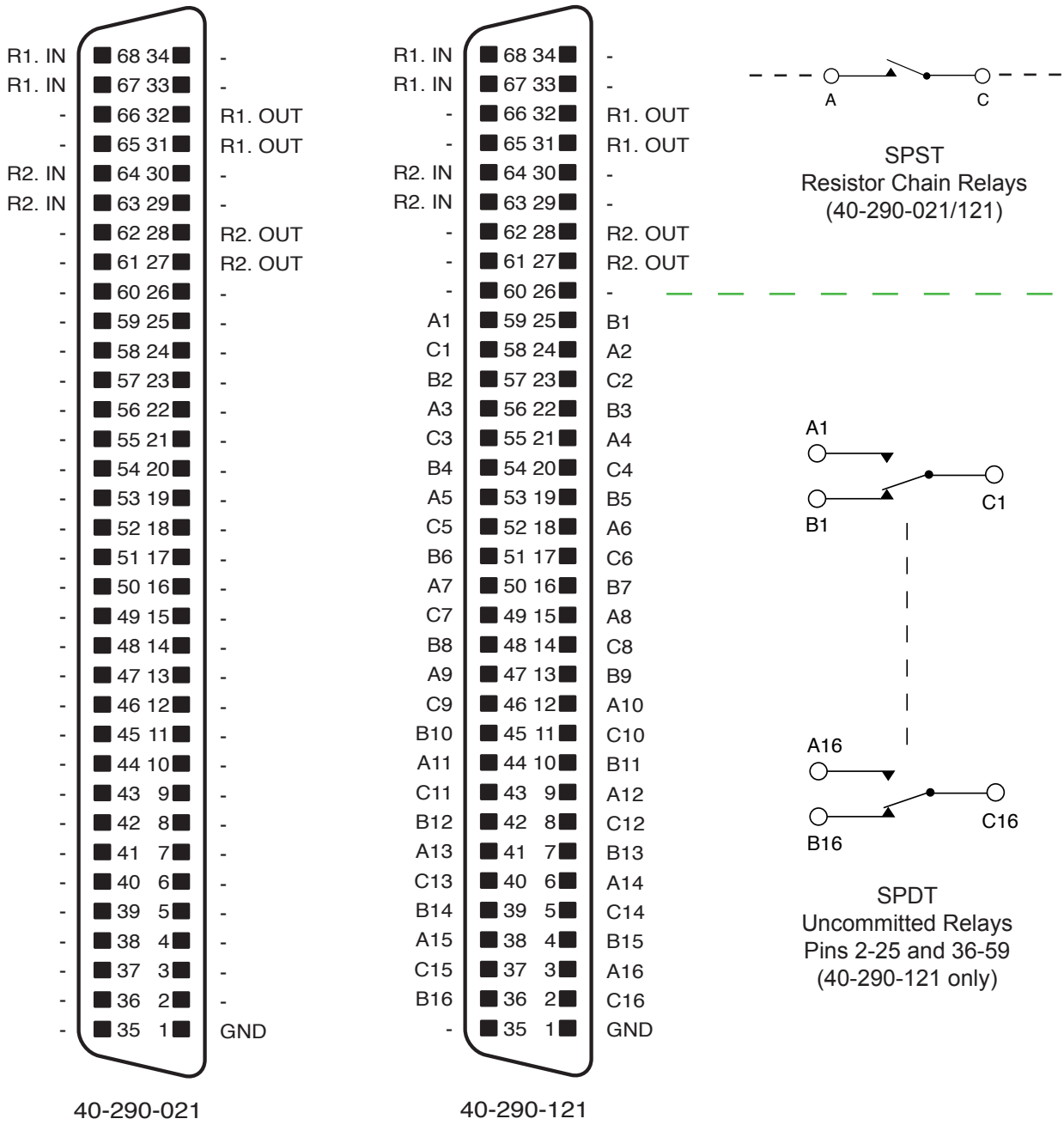


Figure 5.1 - Pinouts: 40-290-021/121
(68-pin female micro-D connector viewed from front of module)

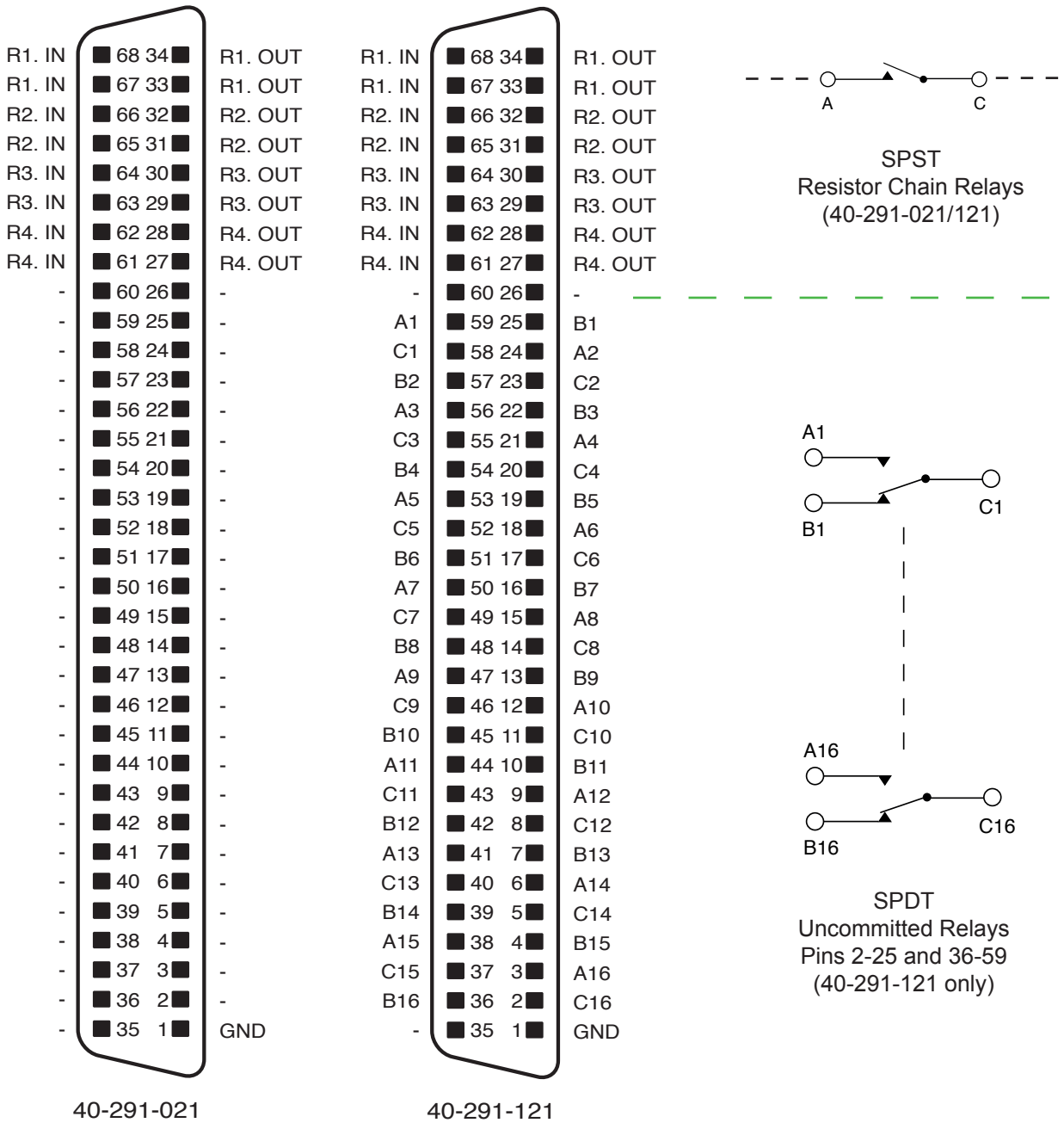


Figure 5.2 - Pinouts: 40-291-021/121
(68-pin female micro-D connector viewed from front of module)

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.

CALIBRATION

The 40-290 and 40-291 have no user adjustable components. In most applications regular calibration is not required; however for applications where a routine calibration is required for a system we suggest the following functional test for the module.

The 40-290/291 should be tested with a 6.5 digit DMM or better. The user must use 4 terminal resistance measurement to avoid the introduction of errors due to leads.

For each channel of the 40-290/291 connect the 4 wires to the connector as shown in Figure 7.1. For automated systems a multiplexer can be used provided the 4 wire measurement system is maintained.

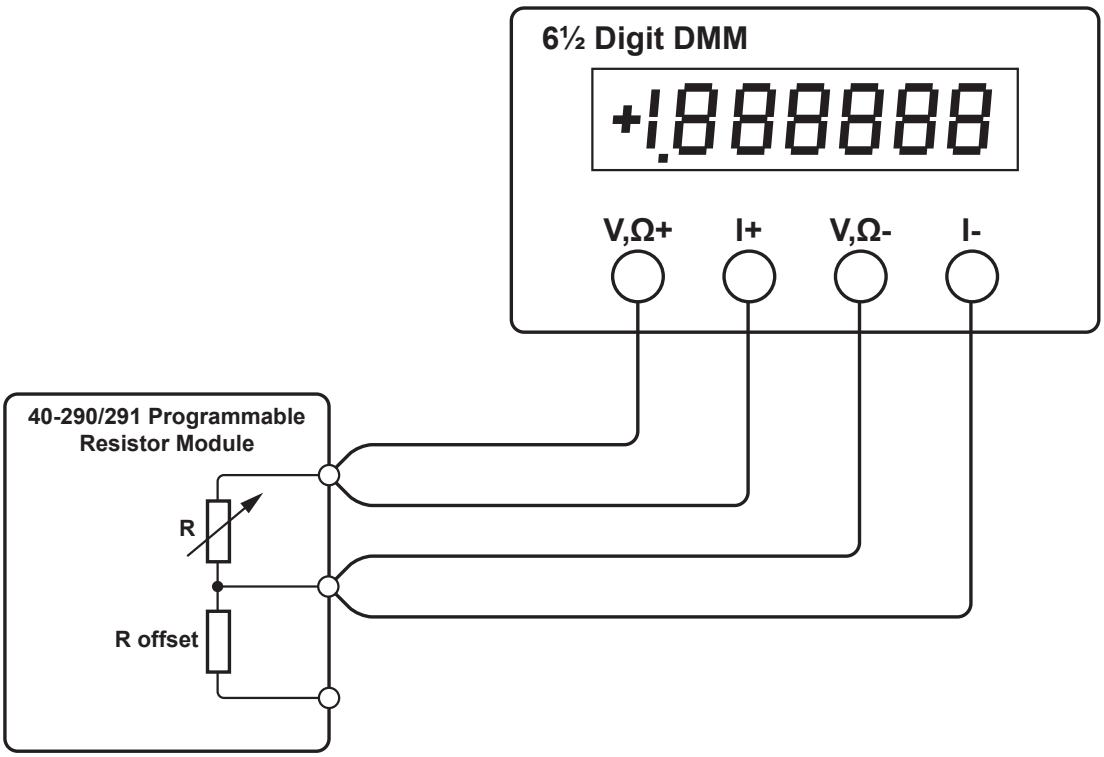


Figure 7.1 - Calibration of the 40-290/291 using a DMM with 4-wire resistance measurement

The test principals for the 40-291 are the same as for 40-290, from this point the procedure just refers to 40-290 models.

The procedure is given for the standard modules only; custom modules use the same procedure but must apply individual limits that reflect the accuracy of the resistors fitted and the resolution.

To test the module, launch the module soft front panel.

Close all the relays in the selected channel and measure the residual path resistance, note the result (from now referred to as PATH).

With the channel still set to the minimum resistance use the DMM offset facility to set the reading to ZERO.

For each resistor in the chain close all the relays except for the resistor to be measured

> **Example:** For R1 close all except the relay in parallel with R1, for R2 close all the relays except the relay in parallel with R2

Record each result for each resistor in the channel. For the tables the results are identified by the resistor number in each channel

> **Example:** For 8 bit channels each channel will have 9 measurement results consisting of one PATH result and 8 resistors numbered R1 to R8.

Accuracy limits are dependent on the tolerance of the resistor fitted and the changes in path resistance. For the 40-290 the measured value is:

(PATH -.05 to -0.2Ω)+ (Nominal resistance ± tolerance)

To eliminate the variability of the PATH result the DMM has been nulled to remove it from the subsequent measurements. The PATH resistance uncertainty assumes the reed relay path used to switch the resistors has a minimum contact resistance of 0.05Ω and a maximum of 0.2Ω. A typical value is 0.1Ω.

Table 7.1 shows the generic limits for standard modules.

Table 7.1 - Test Result Limits For 40-290/291

Resistor	Nominal Value	Maximum Value	Minimum Value
PATH	0Ω	See Note1	See Note1
R1	0.5Ω	0.453Ω	0.298Ω
R2	1Ω	0.955Ω	0.795Ω
R3	2Ω	1.96Ω	1.79Ω
R4	4Ω	3.97Ω	3.78Ω
R5	8Ω	7.99Ω	7.76Ω
R6	16Ω	16.03Ω	15.72Ω
R7	32Ω	32.11Ω	31.64Ω
R8	64Ω	64.3Ω	63.5Ω
R9	128Ω	128.6Ω	127.2Ω
R10	256Ω	257.2Ω	254.5Ω
R11	512Ω	514.5Ω	509.2Ω
R12	1024Ω	1029.1Ω	1018.7Ω
R13	2048Ω	2058Ω	2038Ω
R14	4096Ω	4116Ω	4075Ω
R15	8192Ω	8233Ω	8151Ω
R16	16384Ω	16466Ω	16302Ω

Note 1: PATH resistance limits are 0.5 ohm to 2 ohm for 8 bit modules, 1ohm to 4ohm for 16 bit channels.

Note 2: All results in red are taken with the DMM offset to remove the PATH result form the answer

The test should be repeated for each channel of the module.

To aid users to establish test limits the following generic tables should be used for the standard modules. The tables can be copied to record the results for each channel.

Similar principles can be applied to custom modules, if guidance is needed please consult your Pickering Interfaces representative.

Table 7.2 - Calibration Test Results For 40-290 (Dual 16-Bit)

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

Resistance Setting	Nominal Value	Measured Value	Maximum Value	Minimum Value	Result (delete as appropriate)
PATH	0Ω		See Note1	See Note1	Pass / Fail
R1	0.5Ω		0.453Ω	0.298Ω	Pass / Fail
R2	1Ω		0.955Ω	0.795Ω	Pass / Fail
R3	2Ω		1.96Ω	1.79Ω	Pass / Fail
R4	4Ω		3.97Ω	3.78Ω	Pass / Fail
R5	8Ω		7.99Ω	7.76Ω	Pass / Fail
R6	16Ω		16.03Ω	15.72Ω	Pass / Fail
R7	32Ω		32.11Ω	31.64Ω	Pass / Fail
R8	64Ω		64.3Ω	63.5Ω	Pass / Fail
R9	128Ω		128.6Ω	127.2Ω	Pass / Fail
R10	256Ω		257.2Ω	254.5Ω	Pass / Fail
R11	512Ω		514.5Ω	509.2Ω	Pass / Fail
R12	1024Ω		1029.1Ω	1018.7Ω	Pass / Fail
R13	2048Ω		2058Ω	2038Ω	Pass / Fail
R14	4096Ω		4116Ω	4075Ω	Pass / Fail
R15	8192Ω		8233Ω	8151Ω	Pass / Fail
R16	16384Ω		16466Ω	16302Ω	Pass / Fail

Note 1: PATH resistance limits are 1Ω to 4Ω.

Note 2: All results in colour are taken with the DMM offset to remove the PATH result form the answer.

Table 7.3 - Calibration Test Results For 40-291 (Quad 8-Bit)

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

Resistance Setting	Nominal Value	Measured Value	Maximum Value	Minimum Value	Result (delete as appropriate)
PATH	0Ω		See Note1	See Note1	Pass / Fail
R1	0.5Ω		0.453Ω	0.298Ω	Pass / Fail
R2	1Ω		0.955Ω	0.795Ω	Pass / Fail
R3	2Ω		1.96Ω	1.79Ω	Pass / Fail
R4	4Ω		3.97Ω	3.78Ω	Pass / Fail
R5	8Ω		7.99Ω	7.76Ω	Pass / Fail
R6	16Ω		16.03Ω	15.72Ω	Pass / Fail
R7	32Ω		32.11Ω	31.64Ω	Pass / Fail
R8	64Ω		64.3Ω	63.5Ω	Pass / Fail

Note 1: PATH resistance limits are 0.5Ω to 2Ω.

Note 2: All results in colour are taken with the DMM offset to remove the PATH result form the answer.

RELAY LOOK-UP TABLES

The following pages provide a cross reference between the signal paths of the Programmable Resistor Module and the physical relays on the PCB. The tables can be used in the fault finding process and should be used in conjunction with the corresponding PCB layout diagrams to identify the position of faulty relays.

TABLE 7.4 - Dual 16-Bit Programmable Resistor Module 40-290-021: Relay Numbering

Programmable Resistor Module (40-290-021)							
Res Chain	Use	Relay	Res	Res Chain	Use	Relay	Res
1	Bit 1	RL1	R17	2	Bit 1	RL17	R33
1	Bit 2	RL2	R18	2	Bit 2	RL18	R34
1	Bit 3	RL3	R19	2	Bit 3	RL19	R35
1	Bit 4	RL4	R20	2	Bit 4	RL20	R36
1	Bit 5	RL5	R21	2	Bit 5	RL21	R37
1	Bit 6	RL6	R22	2	Bit 6	RL22	R38
1	Bit 7	RL7	R23	2	Bit 7	RL23	R39
1	Bit 8	RL8	R24	2	Bit 8	RL24	R40
1	Bit 9	RL9	R25	2	Bit 9	RL25	R41
1	Bit 10	RL10	R26	2	Bit 10	RL26	R42
1	Bit 11	RL11	R27	2	Bit 11	RL27	R43
1	Bit 12	RL12	R28	2	Bit 12	RL28	R44
1	Bit 13	RL13	R29	2	Bit 13	RL29	R45
1	Bit 14	RL14	R30	2	Bit 14	RL30	R46
1	Bit 15	RL15	R31	2	Bit 15	RL31	R47
1	Bit 16	RL16	R32	2	Bit 16	RL32	R48

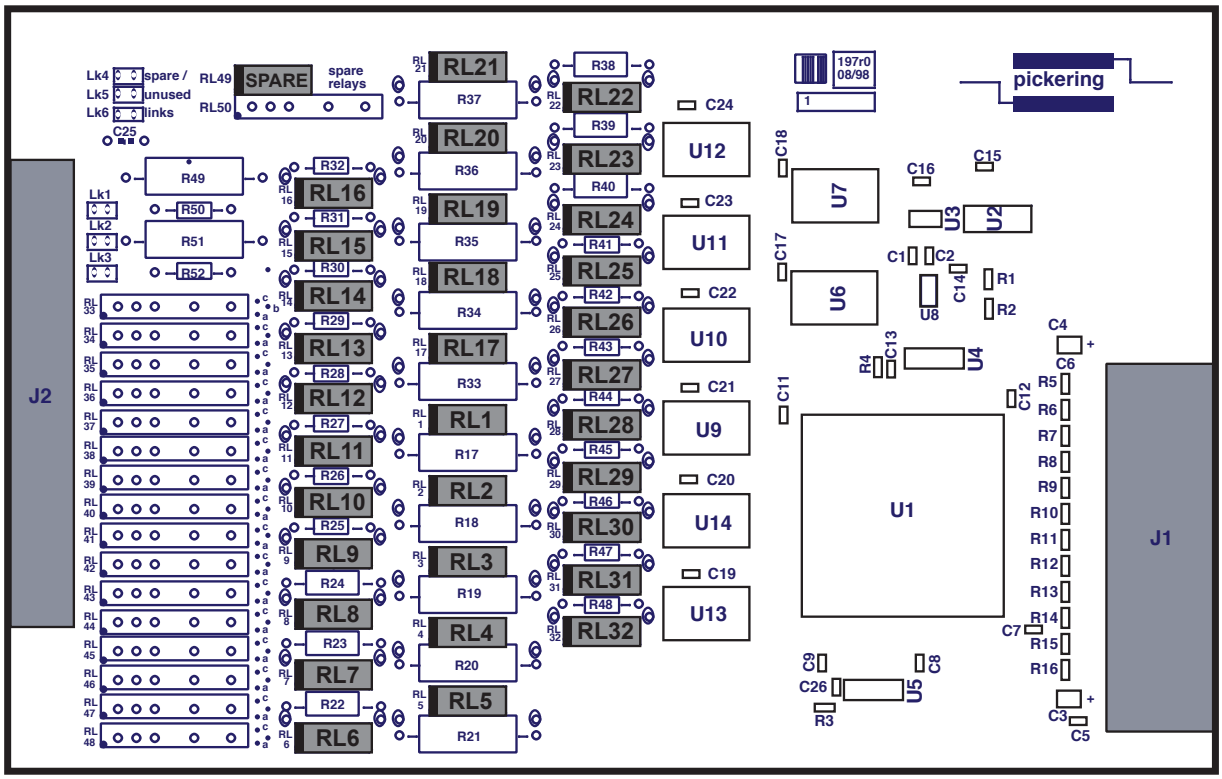


Figure 7.2 - Programmable Resistor Module 40-290-021: Component Layout

TABLE 7.5 - Dual 16-Bit Programmable Resistor Module 40-290-121: Relay Numbering

Programmable Resistor Module (40-290-121)								
Res Chain	Use	Relay	Res	Res Chain	Use	Relay	Res	Uncommitted Relays
1	Bit 1	RL1	R17	2	Bit 1	RL17	R33	RL33
1	Bit 2	RL2	R18	2	Bit 2	RL18	R34	RL34
1	Bit 3	RL3	R19	2	Bit 3	RL19	R35	RL35
1	Bit 4	RL4	R20	2	Bit 4	RL20	R36	RL36
1	Bit 5	RL5	R21	2	Bit 5	RL21	R37	RL37
1	Bit 6	RL6	R22	2	Bit 6	RL22	R38	RL38
1	Bit 7	RL7	R23	2	Bit 7	RL23	R39	RL39
1	Bit 8	RL8	R24	2	Bit 8	RL24	R40	RL40
1	Bit 9	RL9	R25	2	Bit 9	RL25	R41	RL41
1	Bit 10	RL10	R26	2	Bit 10	RL26	R42	RL42
1	Bit 11	RL11	R27	2	Bit 11	RL27	R43	RL43
1	Bit 12	RL12	R28	2	Bit 12	RL28	R44	RL44
1	Bit 13	RL13	R29	2	Bit 13	RL29	R45	RL45
1	Bit 14	RL14	R30	2	Bit 14	RL30	R46	RL46
1	Bit 15	RL15	R31	2	Bit 15	RL31	R47	RL47
1	Bit 16	RL16	R32	2	Bit 16	RL32	R48	RL48

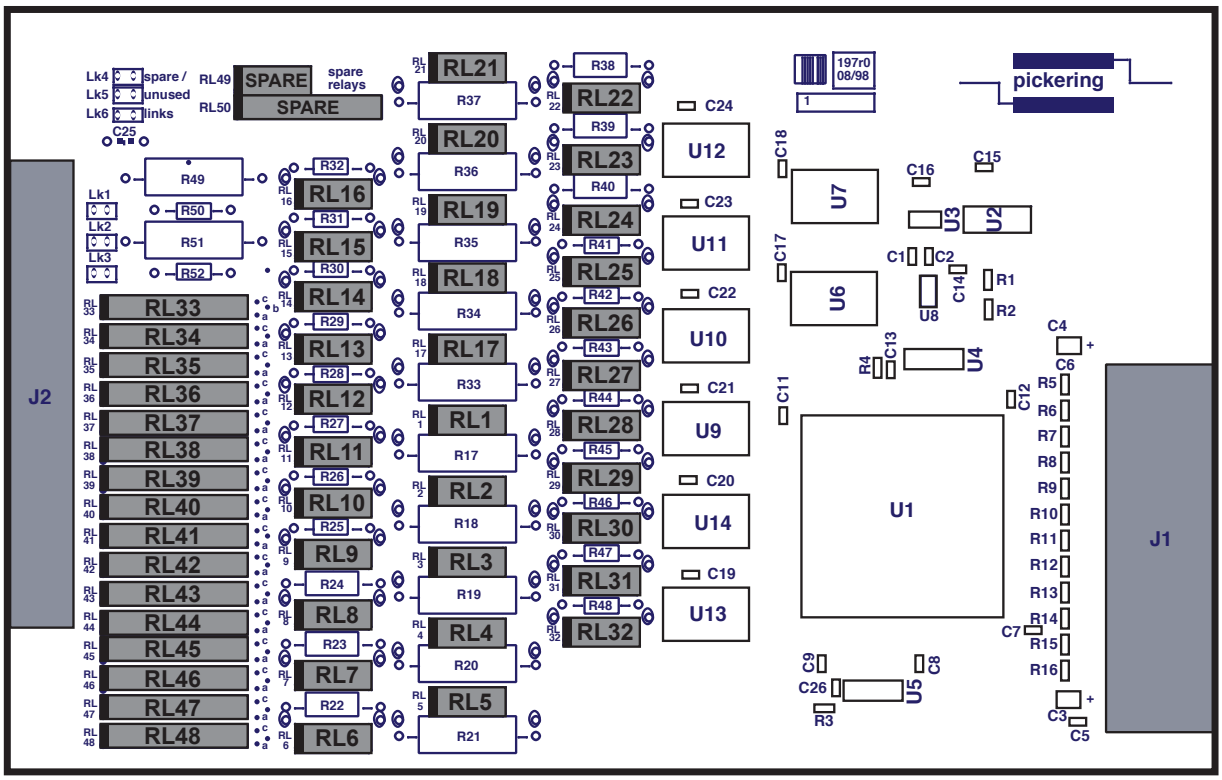


Figure 7.3 - Programmable Resistor Module 40-290-121: Component Layout

TABLE 7.6 - Quad 8-Bit Programmable Resistor Module 40-291-021: Relay Numbering

Programmable Resistor Module (40-291-021)							
Res Chain	Use	Relay	Res	Res Chain	Use	Relay	Res
1	Bit 1	RL1	R17	3	Bit 1	RL17	R33
1	Bit 2	RL2	R18	3	Bit 2	RL18	R34
1	Bit 3	RL3	R19	3	Bit 3	RL19	R35
1	Bit 4	RL4	R20	3	Bit 4	RL20	R36
1	Bit 5	RL5	R21	3	Bit 5	RL21	R37
1	Bit 6	RL6	R22	3	Bit 6	RL22	R38
1	Bit 7	RL7	R23	3	Bit 7	RL23	R39
1	Bit 8	RL8	R24	3	Bit 8	RL24	R40
2	Bit 1	RL9	R25	4	Bit 1	RL25	R41
2	Bit 2	RL10	R26	4	Bit 2	RL26	R42
2	Bit 3	RL11	R27	4	Bit 3	RL27	R43
2	Bit 4	RL12	R28	4	Bit 4	RL28	R44
2	Bit 5	RL13	R29	4	Bit 5	RL29	R45
2	Bit 6	RL14	R30	4	Bit 6	RL30	R46
2	Bit 7	RL15	R31	4	Bit 7	RL31	R47
2	Bit 8	RL16	R32	4	Bit 8	RL32	R48

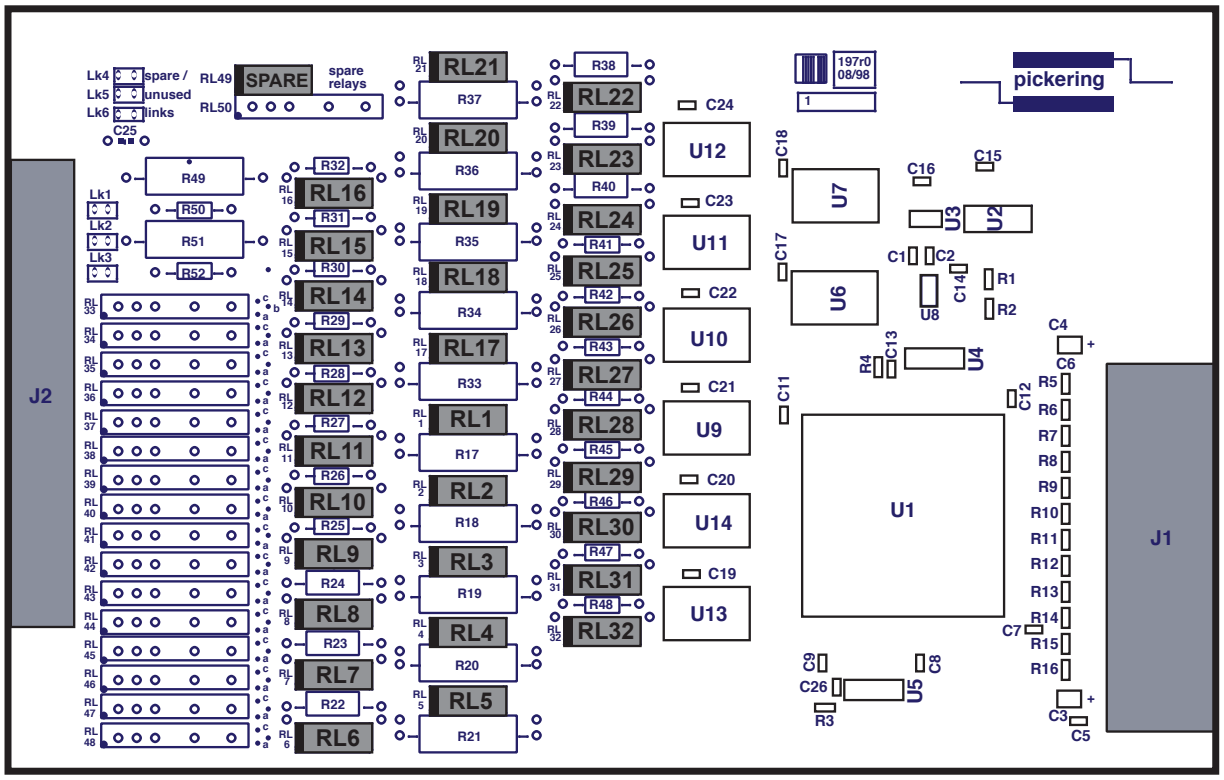


Figure 7.4 - Programmable Resistor Module 40-291-021: Component Layout

TABLE 7.7 - Quad 8-Bit Programmable Resistor Module 40-291-121: Relay Numbering

Programmable Resistor Module (40-291-121)								
Res Chain	Use	Relay	Res	Res Chain	Use	Relay	Res	Uncommitted Relays
1	Bit 1	RL1	R17	3	Bit 1	RL17	R33	RL33
1	Bit 2	RL2	R18	3	Bit 2	RL18	R34	RL34
1	Bit 3	RL3	R19	3	Bit 3	RL19	R35	RL35
1	Bit 4	RL4	R20	3	Bit 4	RL20	R36	RL36
1	Bit 5	RL5	R21	3	Bit 5	RL21	R37	RL37
1	Bit 6	RL6	R22	3	Bit 6	RL22	R38	RL38
1	Bit 7	RL7	R23	3	Bit 7	RL23	R39	RL39
1	Bit 8	RL8	R24	3	Bit 8	RL24	R40	RL40
2	Bit 1	RL9	R25	4	Bit 1	RL25	R41	RL41
2	Bit 2	RL10	R26	4	Bit 2	RL26	R42	RL42
2	Bit 3	RL11	R27	4	Bit 3	RL27	R43	RL43
2	Bit 4	RL12	R28	4	Bit 4	RL28	R44	RL44
2	Bit 5	RL13	R29	4	Bit 5	RL29	R45	RL45
2	Bit 6	RL14	R30	4	Bit 6	RL30	R46	RL46
2	Bit 7	RL15	R31	4	Bit 7	RL31	R47	RL47
2	Bit 8	RL16	R32	4	Bit 8	RL32	R48	RL48

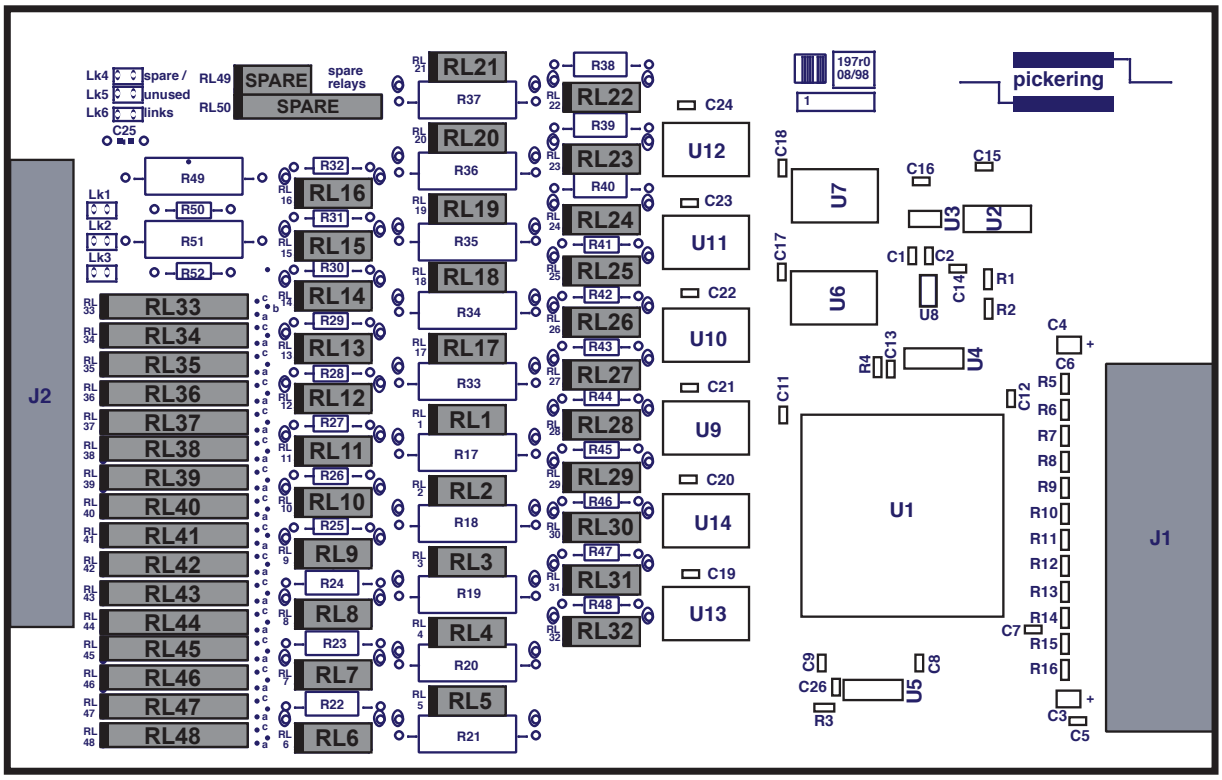


Figure 7.5 - Programmable Resistor Module 40-291-121: Component Layout

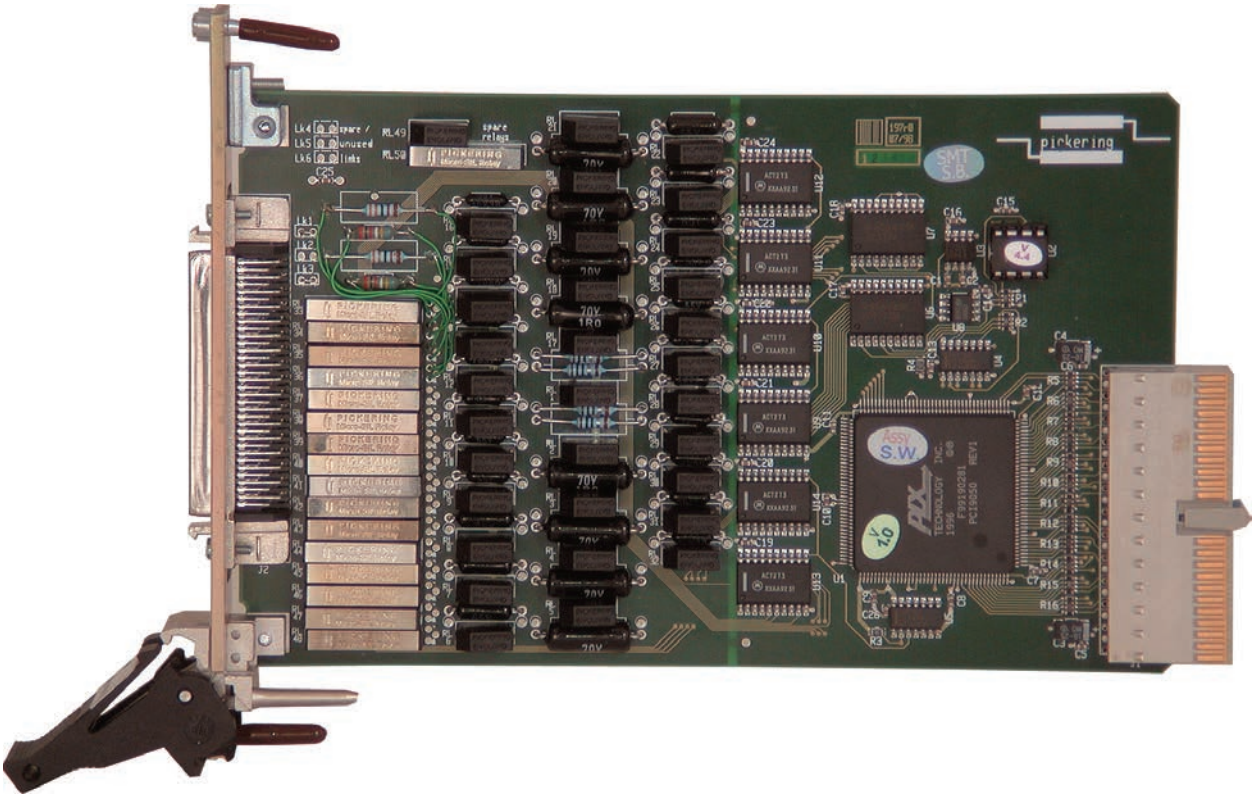


Figure 7.6 - Programmable Resistor Module 40-290-121

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