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User Manual

PXI

High Density SPST, DPST & SPDT Relay Modules (Model Nos. 40-145/146/148)



Issue 5.4 August 2017

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

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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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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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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 PXI/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.	

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.

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SECTION 1 - TECHNICAL SPECIFICATION

40-145/146/148
High Density SPST, SPDT & DPST Relay Module

- SPST Choice of 50, 75 or 100 Relays Per Module
- DPST Choice of 25 or 50 Relays Per Module
- SPDT Choice of 32, 48 or 64 Relays Per Module
- SPST, Normally Closed, Choice of 50, 75 or 100 Relays Per Module
- Electro-mechanical High Density Relays
- Pin Compatible With Alternate 40-140A Reed Relay Modules
- Operating Speed 3ms Typical
- Switching up to 150V/1A/60W
- Single PCB Construction With Leaded Relays Allow Easy Maintenance
- VISA, IVI & Kernel Drivers Supplied for Windows
- Supported by PXI or LXI Chassis
- Supported by eBIRST
- 3 Year Warranty



The 40-145/146/148 range of high density switching modules are available in Normally Open (SPST & DPST), Changeover (SPDT) and Normally Closed (SPST) configurations. Connections are made via a front panel 200-pin female connector.

General purpose reed relays are suitable for the construction of small switching networks, I/O port switching, for slaving up to larger switches or for operating external devices (e.g. lamps, solenoids etc.).

Range Description:

40-145	50, 75 or 100 x SPST Relays (Normally Open or Normally Closed Versions).
40-146	25 or 50 x DPST Relays.
40-148	32, 48 or 64 x SPDT Relays.

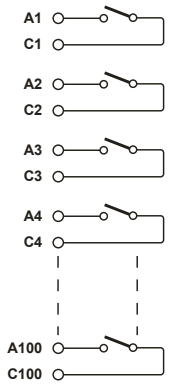
Choice of Signal Relay Types

40-145/146/148 series modules are fitted with **Electro-mechanical Relays** (Palladium-Ruthenium, Gold covered) offering good general purpose performance, switching times of 3ms and are lower cost than instrumentation grade reed relays. Overall they offer a good general purpose choice.

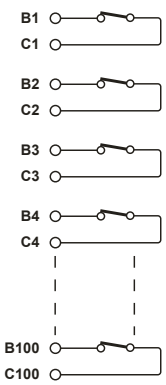
Reed Relays (Sputtered Ruthenium Type) which are designed solely for high-end instrumentation applications are used in series 40-140A/141/142/143 modules, they offer very long life up to 1000 million operations, fast operate time of 0.25ms and exceptional low level switching performance. Reed Relays are hermetically sealed so ensuring consistent and stable contact resistance with long life. All of the reed relays used in our PXI modules are manufactured by our sister company Pickering Electronics: (www.pickeringrelay.com).

Pin Compatibility. 40-140A & 40-145 series modules are 100% pin compatible (except shielded types) so allowing use of either module type in your Test System.

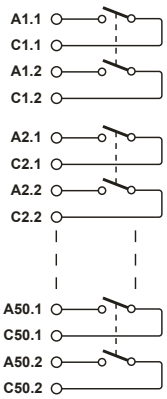
Exactly which type to select depends on your application, if in doubt please contact your nearest Pickering sales office.



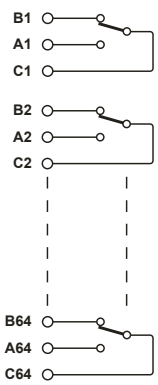
40-145-201 SPST Relay Module



40-145-201-NC SPST Normally Closed Relay Module



40-146-202 DPST Relay Module



40-148-201 SPDT Relay Module

Supported by eBIRST

This product is supported by eBIRST which tests the switching system using an external tool. eBIRST provides a graphical output of its tests which includes an image showing the location of any defective relay. For more information on eBIRST see 93-000D.pdf

High Density 200-pin Connector

Pickering Interfaces have a range of connector solutions for the 200-pin connector used on the 40-14X module. These include mating connectors, pre-made cable assemblies and also cable assemblies that break out the 200 pins to more manageable 50-pin transition connectors. Please refer to web site for latest details or the Interconnection Solutions Catalog.

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Relay Type & Maintenance

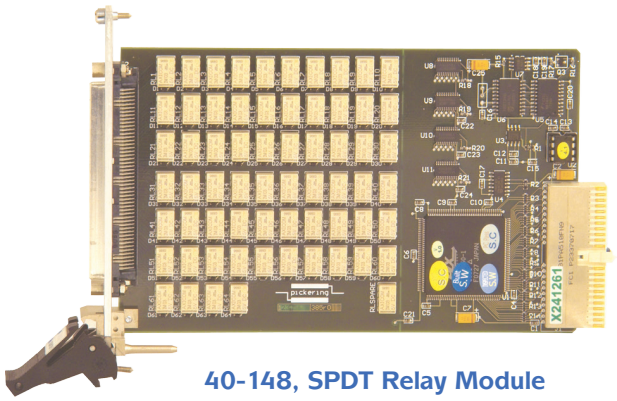
The 40-145/46/48 series modules are fitted with electro-mechanical signal relays, palladium-ruthenium, gold covered contacts. The module is of a single circuit board construction and uses leaded relays (not SMT relays) so in field maintenance is greatly simplified. In addition a **Spare Relay** is built onto the circuit board to facilitate easy maintenance with minimum downtime.

Switching Specification

Switch Type:	**Electro-mechanical**
Contact Type:	Palladium-ruthenium, Gold Covered Bifurcated contact
Max Switching Voltage:	150VDC/100VAC
Max Power: Max Switch Current: Max Carry Current:	60W/62.5VA 1A 1A
Initial On Path Resistance: Initial Off Path Resistance: Minimum Voltage: Thermal Offset:	<500mΩ typical $>10^9$Ω 100µV <10µV
Operate Time:	<3ms
Expected Life (operations) Very low power load: Low power load (2W): Med power load (30W): Full power load (60W):	 $>1x10^8$ $>1.5x10^7$ (0.1A, 20VDC) $>5x10^6$ (1A, 30VDC) $>1x10^5$ (1A, 60VDC)

Power Requirements

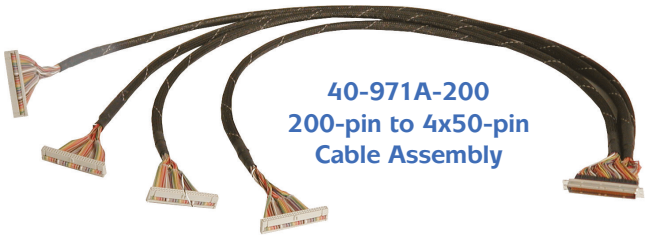
+3.3V	+5V	+12V	-12V
0	1440mA (typ 840mA)	0	0



40-148, SPDT Relay Module

40-961A-200
200-pin
Mating Connector





40-971A-200
200-pin to 4x50-pin
Cable Assembly

Mechanical Characteristics

Single slot 3U PXI (CompactPCI card).
Module weight: 200g (40-145-201)
125g (40-146-202)
180g (40-148-201)
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.
Signals via front panel 200-pin female LFH connector, for pin outs please refer to the operating manual.

Product Order Codes

50 x SPST Electro-mechanical Relays	**40-145-001**
75 x SPST Electro-mechanical Relays	**40-145-101**
100 x SPST Electro-mechanical Relays	**40-145-201**
50 x SPST Normally Closed Relays	**40-145-001-NC**
75 x SPST Normally Closed Relays	**40-145-101-NC**
100 x SPST Normally Closed Relays	**40-145-201-NC**
25 x DPST Electro-mechanical Relays	**40-146-002**
50 x DPST Electro-mechanical Relays	**40-146-202**
32 x SPDT Electro-mechanical Relays	**40-148-001**
48 x SPDT Electro-mechanical Relays	**40-148-101**
64 x SPDT Electro-mechanical Relays	**40-148-201**

Support Products

eBIRST Switching System Test Tool

This product is supported by the eBIRST test tools which simplify the identification of failed relays, the required eBIRST tools are below. For more information see **eBIRST**.

Product	Test Tool	Adaptor
All Types	**93-002-001**	**Not Required**

Spare Relay Kits

Kits of replacement relays are available for the majority of Pickering's PXI switching products, simplifying servicing and reducing down-time.

Product	Relay Kit
All Types	**91-100-001**

For further assistance, please contact your local Pickering sales office.

Mating Connectors & Cabling

For connection accessories for the 40-145 series please refer to the **90-002D** 200-pin LFH Connector Accessories data sheet where a complete list and documentation can be found for accessories, or refer to the Connection Solutions catalog.

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

Drivers for popular Linux distributions are available, other environments are also supported, please contact Pickering with specific enquiries.

Operating/Storage Conditions

Operating Conditions

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

Storage and Transport Conditions

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

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 33MHz 32-bit backplane interface.

Safety & CE Compliance

All modules are fully CE compliant and meet applicable EU directives: Low-voltage safety EN61010-1:2001, EMC Immunity EN61000-6-1:2001, Emissions EN55011:1998.

PXI & LXI Chassis Compatibility

Compatible with all chassis conforming to the 3U PXI and 3U cPCI specification. Compatible with Legacy and Hybrid peripheral slots in a 3U PXI Express chassis.
Compatible with Pickering Interfaces LXI Modular Chassis. For information on driving your switching solution in an LXI environment refer to the LXI Product Guide.



Latest Details

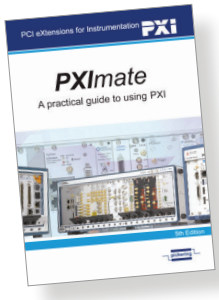
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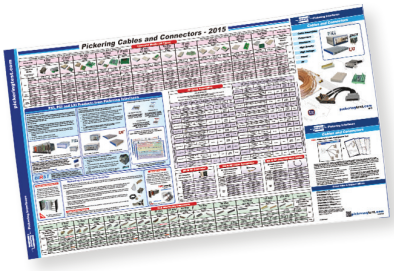
Please refer to the 200 page Pickering Interfaces "**Connection Solutions**" catalog for the full list of connector/cabling options, including drawings, photos and specifications. Available in either print or as a download.
Alternatively our web site has dynamically linked connector/cabling options, including pricing, for all Pickering PXI modules.



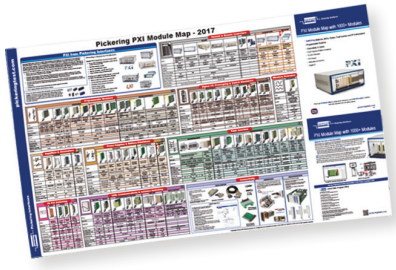
"**The Big PXI Catalog**" gives full details of Pickering's entire range of PXI switch modules, instrument modules and support products.
At over 500 pages, the Big PXI Catalog is available on request or can be downloaded from the Pickering website.



Ever wondered what PXI is all about?
Pickering Interfaces' "**PXImate**" explains the basics of PXI and provides useful data for engineers working on switch based test systems.
The PXImate is available free on request from the Pickering website.



The "**Cables & Connectors Map**" - outlines the cable and connector options available for all PXI Modules.



The "**PXI Module Map**" - a simple fold-out selection guide to all Pickering's 1000+ PXI Modules.

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SECTION 2 - TECHNICAL DESCRIPTION

FUNCTIONAL DESCRIPTION

A functional block diagram is provided in Figure 2.1. The High Density Relay 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 200-pin LFH type connector, J2. The module comprises a PCB populated with electro-mechanical relays. The relays are energised via control signals from relay drivers U8 to U14, which are addressed by PCI bridge U1, via the control logic, to output the required signal. Module configuration is determined by links and data stored in EEPROM U7. PCI Bridge U1 is configured by EEPROM U2.

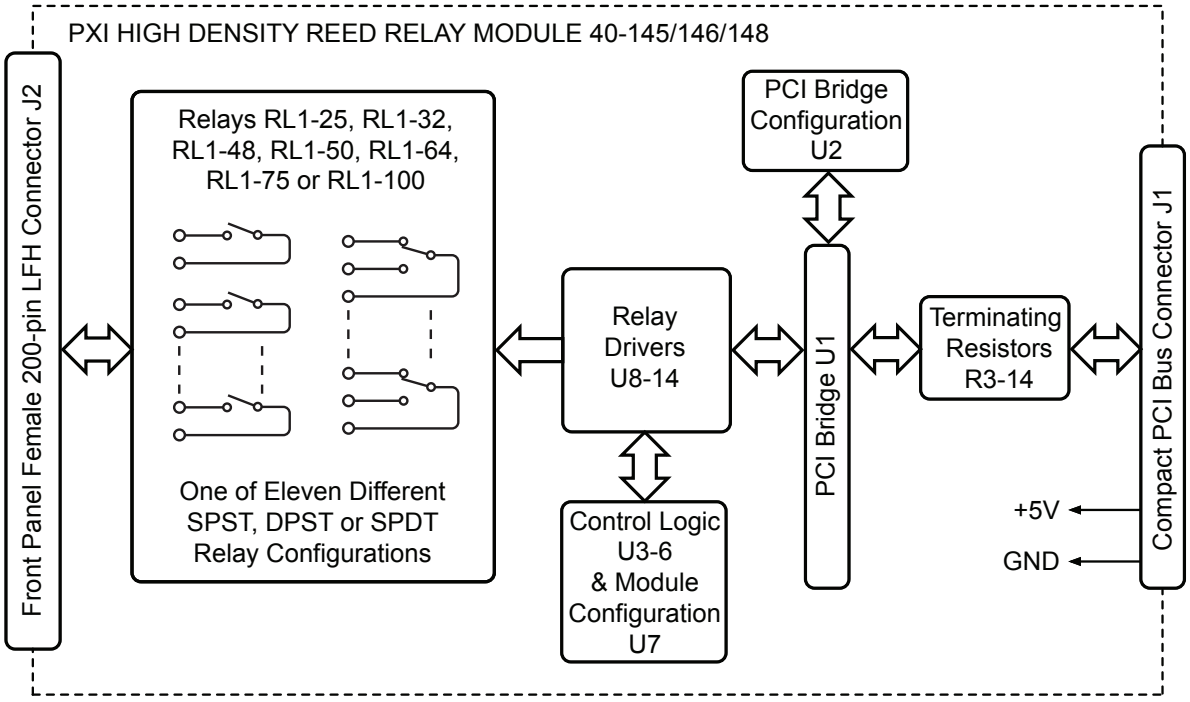


Figure 2.1 - High Density Relay Modules 40-145/146/148: Functional Block Diagram

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40-145 - GUIDANCE ON POWER HANDLING (PXI CHASSIS)

The PXI standard recommends that each slot consumes less than 25 Watts to ensure that the chassis does not overheat. Some chassis may be capable of handling more than 25W per slot.

For the 40-145 there are three main contributing factors to the power consumption of the module:

- Fixed power from the PXI interface and relay controllers
- Relay coil power
- Power loss from the signal being switched due to path resistance.

Applications vary considerably as to how many relays may be closed and what current each contact carries. Users should consider how much power the module is likely to dissipate from all sources.

For the 40-145 fitted with SPST normally open relays, Figure 2.1 below provides guidance. It assumes that all contacts carry the same current and that every path has the resistance value shown on the data sheet. If your application is likely to load large numbers of contacts with currents over 0.7 Amps you should consult the graph to find the number of closures we recommend. In most applications this is of no concern since many contacts may be unused or are relatively lightly loaded.

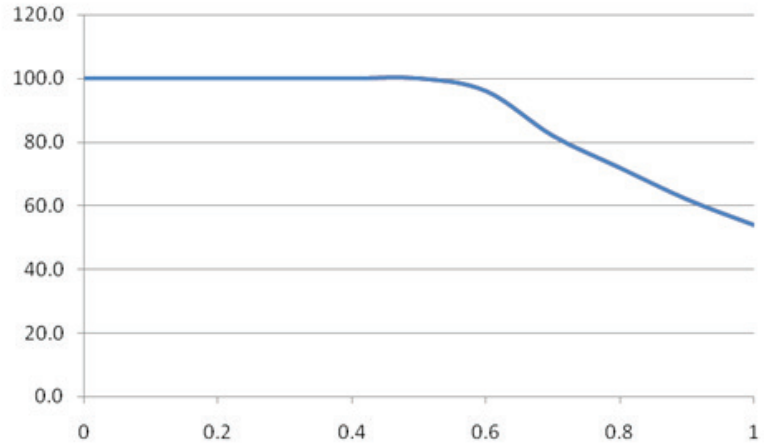


Figure 2.1 Plot of recommended number of closures of SPST (normally open) relays (vertical) versus carry current (horizontal, Amps). This assumes a contact resistance of 300mΩ and a chassis capable of supporting the minimum 25W per slot recommended in the PXI standard.

An example is shown in Figure 2.2 for the 40-145 fitted with SPST normally closed relays where the path resistance is also assumed to be 300mΩ in a chassis with 25W capacity per slot.

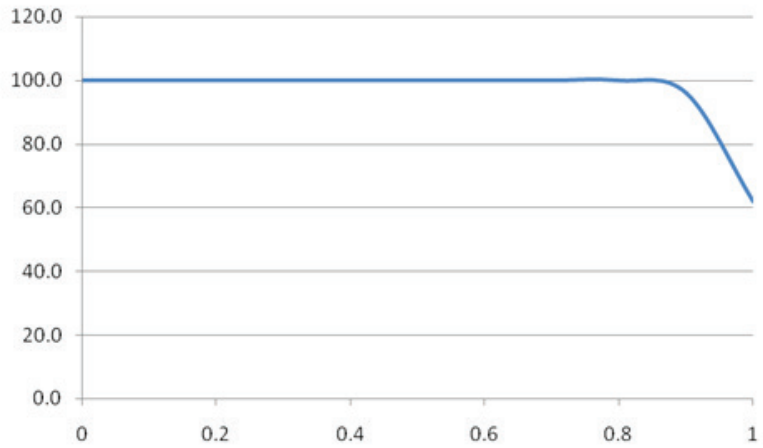


Figure 2.2 Plot of recommended number of closures of SPST (normally closed) relays (vertical) versus carry current (horizontal, Amps). This assumes an average contact resistance of 300mΩ and a chassis capable of supporting the minimum 25W per slot recommended in the PXI standard.

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The limitations described are thermal characteristics, and short term closure counts or current increases in excess of these numbers will not cause problems.

The closures noted refer to any setting which requires the relay state to be changed from it's default (unpowered) condition.

- For SPST switching, this refers to the number of relays energised with the stated current flowing in the contact.
- For SPDT and DPDT switching, it refers to the relay being in the energised state and the stated current flowing in the closed contact, In the un-energised state the thermal load will be lower.
- For DPDT switching where current is flowing in both closed contacts, the recommendations count each switch as two closures.

It should be noted that users with a Pickering Interfaces 40-908, 40-914 or 40-918 PXI chassis mounted in accordance with the user instructions ensuring free air flow, can expect a capacity of 40W per slot.

Use in LXI Chassis 60-102B & 60-103B

Users wishing to use the 40-145 in an LXI chassis should consult Pickering Interfaces for information on the maximum number of relay closures supported.

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SECTION 3 - INSTALLATION

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

Modular products require installation in a suitable PXI/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.

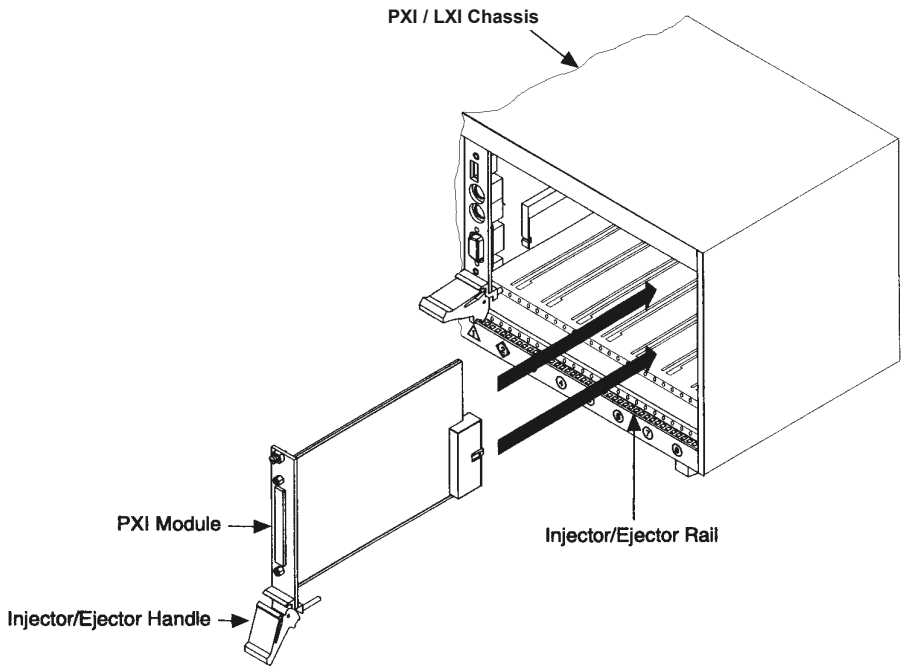


Figure 3.1 - Installing the Module into a PXI/cPCI/LXI Chassis

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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.

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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.

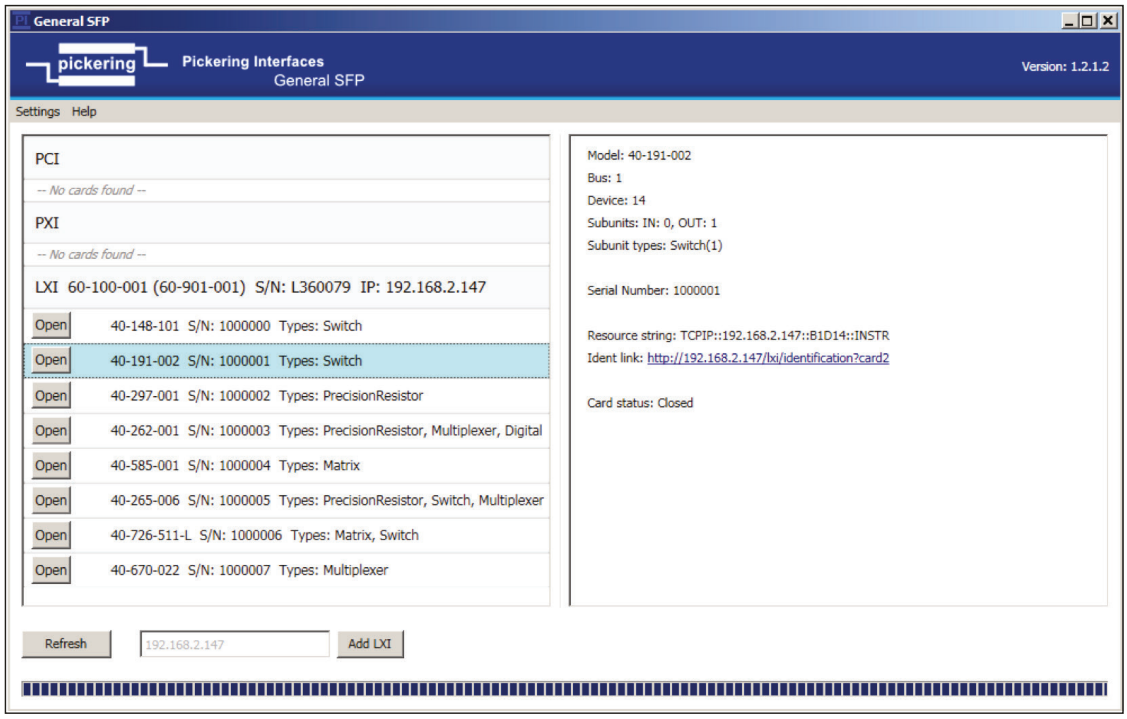


Figure 3.3 - General Soft Front Panel Selector

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 CARDS

Software drivers are supplied for Microsoft Windows operating systems, with specific support for the following development environments:

- Microsoft Visual Studio (VB, C++, C#)
- Borland C++
- National Instruments LabWindows/CVI
- National Instruments LabVIEW and LabVIEW RT

Windows drivers are supplied in the form of Dynamic Link Libraries, which should also be usable in any other development environment that supports them.

Some recent drivers developed for the LXI platform are capable of addressing both PXI and LXI domains. Such duality may be of help to users considering future migration from PXI based systems to LXI based systems, or indeed systems containing both PXI and LXI components.

Programming for PXI

A number of different Windows drivers are available to meet particular system requirements, and should none of these be suitable there is also the option of register-level programming. Drivers are generally ‘universal’, handling all models in the System 40, 45 and 50 ranges; however some models that are not compliant with the Ivi Swtch class cannot be used with the pi40iv IVI driver. The pipx40 and Pilpxi drivers are also applicable to certain models in the System 41 (PXI Instruments) range - see these drivers’ System 41 support list.

Please note that this documentation is available in its most up-to-date form as HTML help files, fully hyperlinked for easy access - both pipx40 and Pilpxi documents are included in the Pipx40vpp software installation.

IVI Driver for Windows - pi40iv

The pi40iv IVI (Interchangeable Virtual Instrument) driver supports all Pickering Interfaces PXI switch cards that are consistent with the Iviswtch class model - as are the great majority of cards in the System 40/45/50 ranges. It integrates well with LabWindows/CVI and LabVIEW, and is fully compatible with Switch Executive. It is also usable in general-purpose programming environments such as Visual C++ and Visual Basic.

Prior installation of the VISA and IviEngine from National Instruments are required for the correct installation and operation of this driver.

VISA Driver for Windows - pipx40

The pipx40 driver conforms to the VISA (Virtual Instrument Software Architecture) standard for programmable instrumentation. Instrument control environments such as LabVIEW and LabWindows/CVI are based on VISA, and pipx40 support libraries are provided for them.

Prior installation of VISA from National Instruments is required for the operation of this driver.

Where VISA is available, pipx40 can also be used in general-purpose programming environments such as Visual C++ and Visual Basic. When IVI is not a system requirement this driver will often yield faster operation than the pi40iv driver.

Direct I/O Driver for Windows - Pilpxi

The Pilpxi driver accesses cards directly, without using the VISA software layer, while offering similar overall functionality to pipx40. It is most commonly used in general-purpose programming environments such as Visual C++ and Visual Basic. Operating speed of the VISA and Direct I/O drivers is generally comparable.

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Register-level Programming

Where the supplied drivers are not suitable, register-level programming can be employed - for example:

- If the functionality of the supplied drivers does not meet the application requirements
- If security considerations demand full source-code for the application
- In development environments that have alternate mechanisms for accessing PCI bus
- For operating systems other than Windows

Programming for LXI

When Pickering PXI cards are inserted into an LXI Modular Chassis a different set of drivers is available.

IVI Driver for Windows - pi40iv

The pi40iv IVI also supports LXI inserted cards simply by changing the resource string to address string to the appropriate address.

Direct I/O Driver for Windows - Piplx

The piplx driver is based on the PXI Direct I/O driver pilpxi, but with added functionality to deal with the added need to address the chassis using an IP address. It integrates well with LabWindows/CVI and LabVIEW, and is fully compatible with Switch Executive. It is also usable in general-purpose programming environments such as Visual C++ and Visual Basic.

Please note that this driver may also be used in the PXI domain. If the addressed card is in the local computer PCI/PXI system, commands will be passed through to the PXI Direct I/O driver. This mechanism allows the piplx driver to be used for both PXI and LXI cards.

The LXI format offers additional interface options not available in PXI :

.NET

A .NET native driver is also available. Once again this may be used for both LXI and PXI card control.

SOAP

Pickering LXI products include a SOAP interface which is usable from a wide variety of platforms and languages.

SSH

Pickering LXI products include an SSH interface which allows remote command line access to control cards, or, using a suitable package, programmatic control.

The user is advised to visit the Pickering web site for further details of all the above drivers, where documentation, example programs, and further help with driver choice are available.

LabVIEW, LabWindows/CVI and Switch Executive are trademarks of National Instruments Corporation.

General Pickering Card Architecture

With most drivers, before programming a Pickering card it is important to understand the basic architecture of Pickering cards.

The switches on a Pickering card are organized into logical sub-units, each sub-unit containing a set of objects of similar type and use. These objects may be switches, digital outputs, digital inputs, resistors, power supplies etc, depending on the nature of the specific card.

For example a simple matrix card will usually contain a single sub-unit containing the switches arranged in a 2-dimensional array. However a similar card with additional isolating relays connected to the matrix will contain additional sub-units containing those isolation relays.

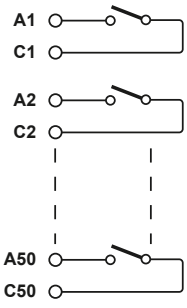
Low level drivers include functions to allow the programmer to query the card to ascertain the number of sub-units, and the size and type of each sub-unit.

For full details of the driver functions available the programmer should refer to the documentation provided.

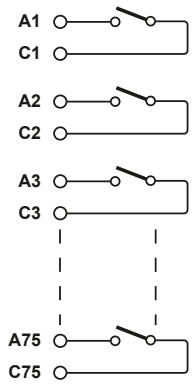
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MODULE ARCHITECTURE - 40-145 NORMALLY OPEN VERSIONS

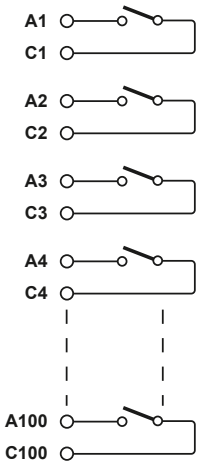
The 40-145-001/101/201 are arrays of 50, 75 or 100 uncommitted SPST relays. In the default state, all signal paths are open, energising a particular relay creates a signal path between the C and A terminals. The relay module's switching architectures are shown in their default state in the diagram below:



40-145-001 (50 x SPST)



40-145-101 (75 x SPST)



40-145-201 (100 x SPST)

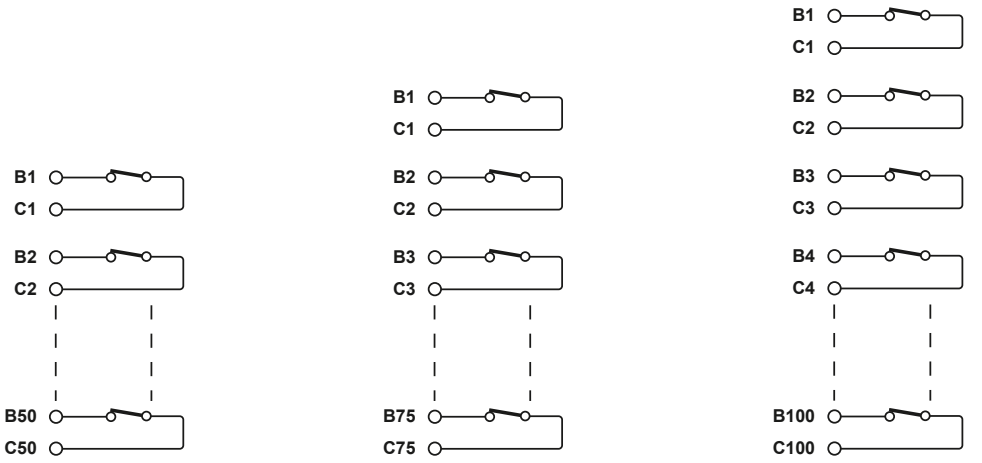
One sub-unit is used to control all the module's relays as shown below. Enabling a particular bit closes the C to A signal path.

Sub-Unit	Bit	40-145-001 Signal Path (with relay energised)	40-145-101 Signal Path (with relay energised)	40-145-201 Signal Path (with relay energised)
1	1	C1 to A1	C1 to A1	C1 to A1
1	2	C2 to A2	C2 to A2	C2 to A2
1	3	C3 to A3	C3 to A3	C3 to A3
1	4	C4 to A4	C4 to A4	C4 to A4
⋮	⋮	⋮	⋮	⋮
1	49	C49 to A49	C49 to A49	C49 to A49
1	50	C50 to A50	C50 to A50	C50 to A50
1	51	—	C51 to A51	C51 to A51
1	52	—	C52 to A52	C52 to A52
⋮	⋮	⋮	⋮	⋮
1	74	—	C74 to A74	C74 to A74
1	75	—	C75 to A75	C75 to A75
1	76	—	—	C76 to A76
1	77	—	—	C77 to A77
⋮	⋮	⋮	⋮	⋮
1	97	—	—	C97 to A97
1	98	—	—	C98 to A98
1	99	—	—	C99 to A99
1	100	—	—	C100 to A100

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MODULE ARCHITECTURE - 40-145 NORMALLY CLOSED VERSIONS

The 40-145-001/101/201-NC are arrays of 50, 75 or 100 uncommitted SPST relays. In the default state, all signal paths are connected between the C and the corresponding B terminals, energising a particular relay disconnects the signal path The relay module's switching architectures are shown in their default state in the diagram below:



40-145-001-NC (50 x SPST) | **40-145-101-NC (75 x SPST)** | **40-145-201-NC (100 x SPST)**

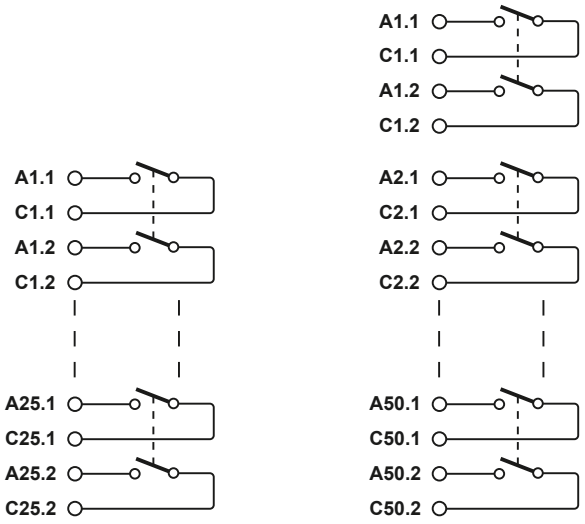
One sub-unit is used to control all the module's relays as shown below. Enabling a particular bit disconnects the C to B signal path.

Sub-Unit	Bit	40-145-001-NC Signal Path (with relay de-energised)	40-145-101-NC Signal Path (with relay de-energised)	40-145-201-NC Signal Path (with relay de-energised)
1	1	C1 to B1	C1 to B1	C1 to B1
1	2	C2 to B2	C2 to B2	C2 to B2
1	3	C3 to B3	C3 to B3	C3 to B3
1	4	C4 to B4	C4 to B4	C4 to B4
⋮	⋮	⋮	⋮	⋮
1	49	C49 to B49	C49 to B49	C49 to B49
1	50	C50 to B50	C50 to B50	C50 to B50
1	51	—	C51 to B51	C51 to B51
1	52	—	C52 to B52	C52 to B52
⋮	⋮	⋮	⋮	⋮
1	74	—	C74 to B74	C74 to B74
1	75	—	C75 to B75	C75 to B75
1	76	—	—	C76 to B76
1	77	—	—	C77 to B77
⋮	⋮	⋮	⋮	⋮
1	97	—	—	C97 to B97
1	98	—	—	C98 to B98
1	99	—	—	C99 to B99
1	100	—	—	C100 to B100

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MODULE ARCHITECTURE - 40-146

The 40-146 is an array of 25 or 50 uncommitted DPST relays. In the default state, all signal paths are open. Energising a particular relay creates a signal path between the C and A terminals of both poles of the corresponding channel. The relay module's switching architectures are shown in their default state in the diagram below:



40-146-002 (25 x DPST) **40-146-202 (50 x DPST)**

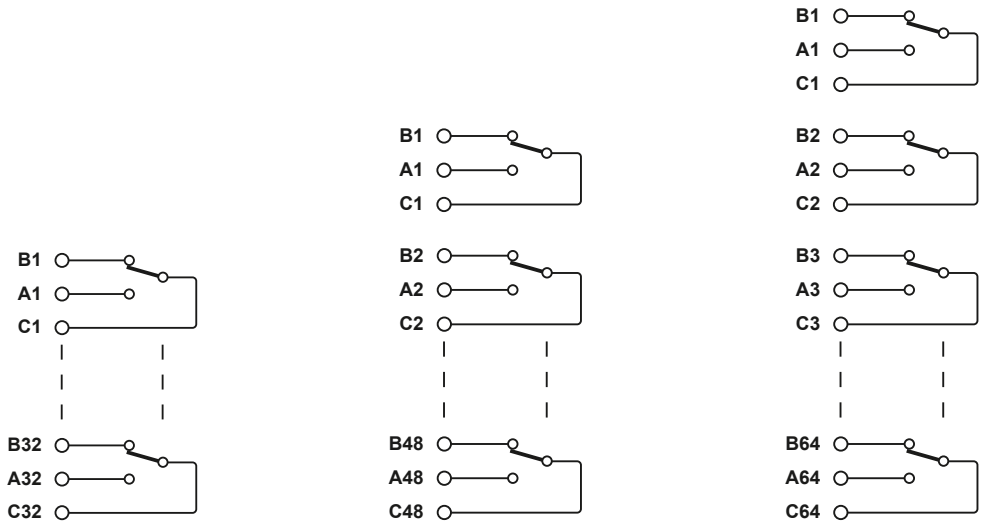
One sub-unit is used to control all the module's relays as shown below. Enabling a particular bit closes both C to A signal paths of the corresponding channel.

Sub-Unit	Bit	40-146-002 Signal Path (with relay energised)	40-146-202 Signal Path (with relay energised)
1	1	C1.1 to A1.1 & C1.2 to A1.2	C1.1 to A1.1 & C1.2 to A1.2
1	2	C2.1 to A2.1 & C2.2 to A2.2	C2.1 to A2.1 & C2.2 to A2.2
1	3	C3.1 to A3.1 & C3.2 to A3.2	C3.1 to A3.1 & C3.2 to A3.2
1	4	C4.1 to A4.1 & C4.2 to A4.2	C4.1 to A4.1 & C4.2 to A4.2
⋮	⋮	⋮	⋮
1	24	C24.1 to A24.1 & C24.2 to A24.2	C24.1 to A24.1 & C24.2 to A24.2
1	25	C25.1 to A25.1 & C25.2 to A25.2	C25.1 to A25.1 & C25.2 to A25.2
1	26	—	C26.1 to A26.1 & C26.2 to A26.2
1	27	—	C27.1 to A27.1 & C27.2 to A27.2
⋮	⋮	⋮	⋮
1	47	—	C47.1 to A47.1 & C47.2 to A47.2
1	48	—	C48.1 to A48.1 & C48.2 to A48.2
1	49	—	C49.1 to A49.1 & C49.2 to A49.2
1	50	—	C50.1 to A50.1 & C50.2 to A50.2

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MODULE ARCHITECTURE - 40-148

The 40-148 is an array of 32, 48 or 64 uncommitted changeover relays. In the default state, all signal paths are between the C terminal and the corresponding B terminal. Energising a particular relay disconnects the B terminal and creates a signal path between the C and A terminals. The relay module's switching architectures are shown in their default state in the diagram below:



40-148-001 (32 x SPDT) **40-148-101 (48 x SPDT)** **40-148-201 (64 x SPDT)**

One sub-unit is used to control all the module's relays as shown below. Enabling a particular bit opens the C to B signal path and closes the C to A signal path.

Sub-Unit	Bit	40-148-001 Signal Path (with relay energised)	40-148-101 Signal Path (with relay energised)	40-148-201 Signal Path (with relay energised)
1	1	C1 to A1	C1 to A1	C1 to A1
1	2	C2 to A2	C2 to A2	C2 to A2
1	3	C3 to A3	C3 to A3	C3 to A3
1	4	C4 to A4	C4 to A4	C4 to A4
⋮	⋮	⋮	⋮	⋮
1	31	C31 to A31	C31 to A31	C31 to A31
1	32	C32 to A32	C32 to A32	C32 to A32
1	33	—	C33 to A33	C33 to A33
1	34	—	C34 to A34	C34 to A34
⋮	⋮	⋮	⋮	⋮
1	47	—	C47 to A47	C47 to A47
1	48	—	C48 to A48	C48 to A48
1	49	—	—	C49 to A49
1	50	—	—	C50 to A50
⋮	⋮	⋮	⋮	⋮
1	61	—	—	C61 to A61
1	62	—	—	C62 to A62
1	63	—	—	C63 to A63
1	64	—	—	C64 to A64

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PROGRAMMING THE MODULE

Here are examples of using the drivers with the 40-145-001 (50 x SPST) module. All other versions in the series operate in the same way but with different numbers of bits in the sub-unit.

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

WriteSub

```
// Sub-unit is 50 bits wide, so 2 DWORDs are needed to hold the pattern
DWORD data[2];
data[0] = 1;            // Sets lowest bit to 1, A1/C1 relay
data[1] = 0;
PIL_WriteSub( card_num, sub_unit, data);
data[0] = 0x20;         // Sets 6th bit, A6/C6 relay
data[1] = 0;            // All other relays are set to off
PIL_WriteSub( card_num, sub_unit, data);
```

Using PIPX40

setChannelState

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

setChannelPattern

```
// Sub-unit is 50 bits wide, so 2 ViUInt32 values are needed to hold the entire pattern
ViUInt32 data[2];
data[0] = 1;            // Sets lowest bit to 1, A1/C1 relay
data[1] = 0;
pipx40_setChannelPattern( vi, sub_unit, data);
data[0] = 0x20;         // Sets 6th bit, A6/C6 relay
data[1] = 0;            // All other relays are set to off
pipx40_setChannelPattern( vi, sub_unit, 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/C1 relay
pi40iv_Disconnect(vi, com1, ch1);   // Releases the A1/C1 relay
pi40iv_Connect(vi, com6, ch6);      // Operates the A6/C6 relay
```

The IVI Swtch driver specification contains no bulk setting capabilities.

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USING PICKERING DRIVERS IN LabVIEW

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

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

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

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

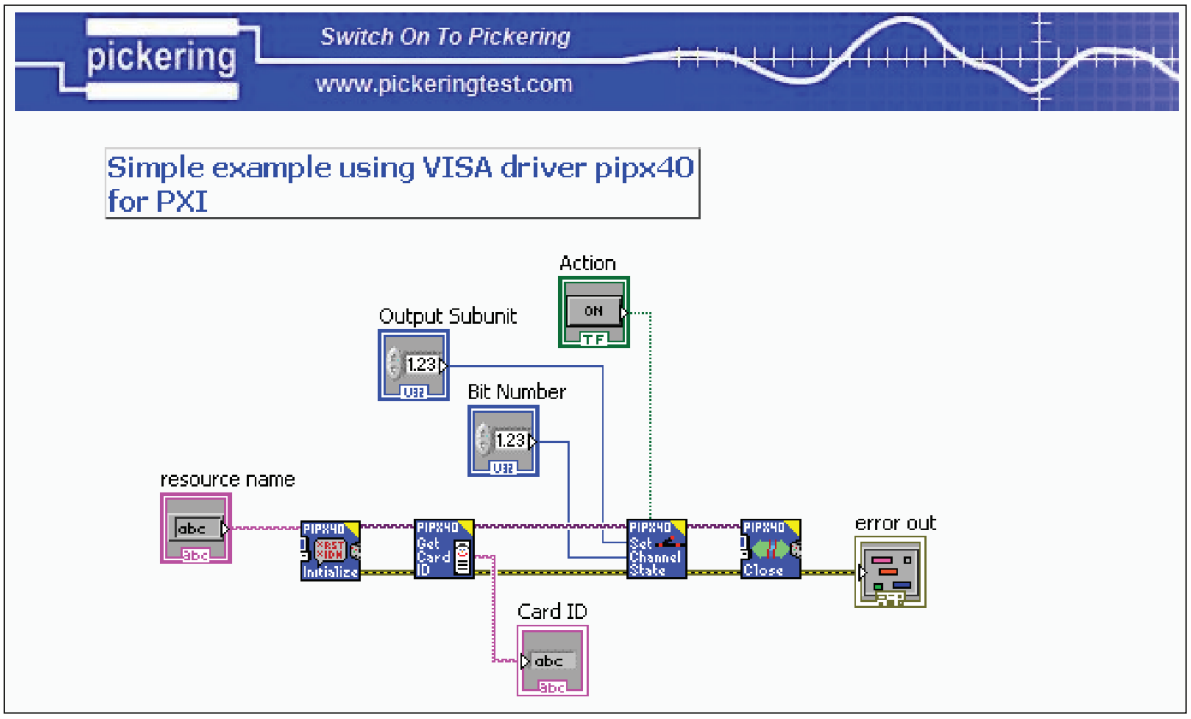


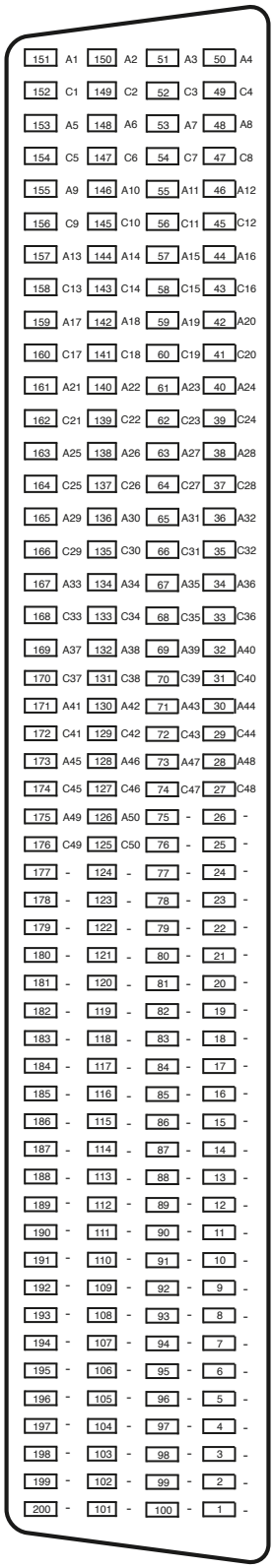
Figure 4.4 - Example Use of Pickering Drivers in LabVIEW

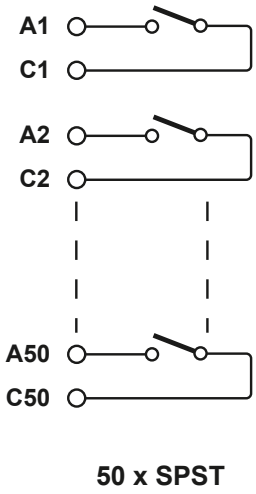
To download LabVIEW examples, please go to:

http://wiki.pickeringtest.net/Using+Pickering+Drivers+in+LabView

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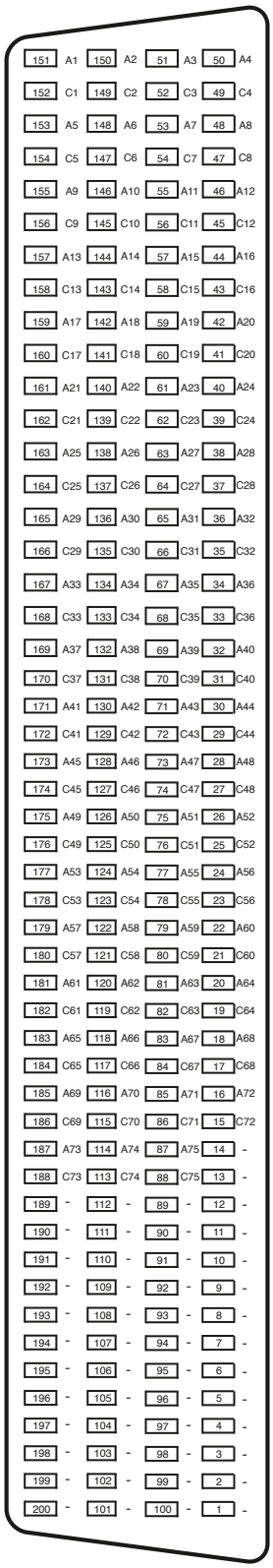
SECTION 5 - CONNECTOR INFORMATION

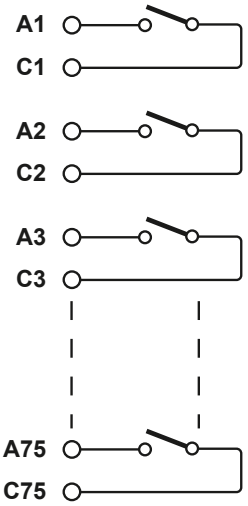




50 x SPST

Figure 5.1 - Pinouts: 50xSPST High Density Relay Module 40-145-001 (200-pin female LFH connector viewed from front of module)

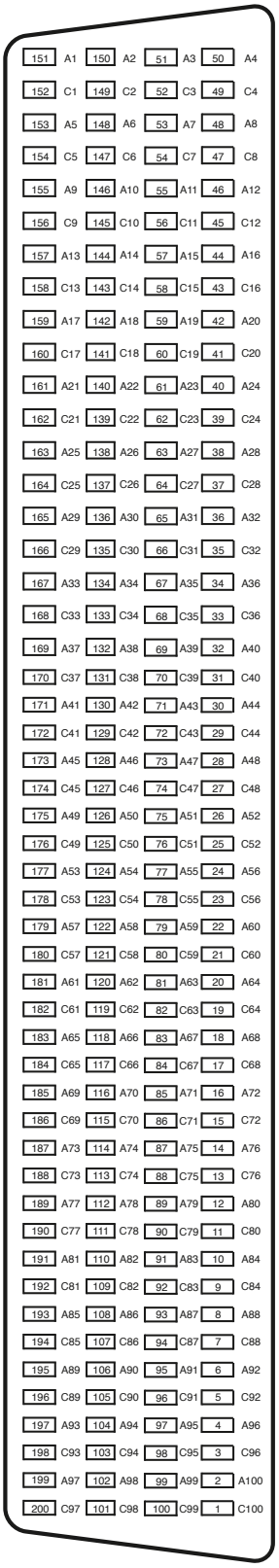


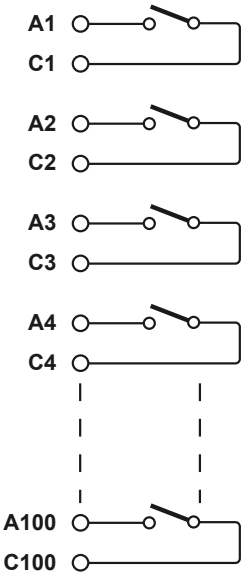


75 x SPST

Figure 5.2 - Pinouts: 75xSPST High Density Relay Module 40-145-101 (200-pin female LFH connector viewed from front of module)

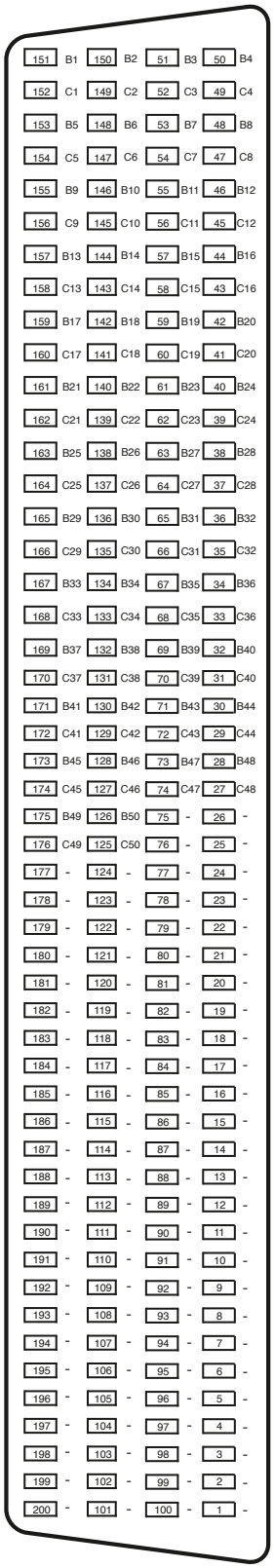
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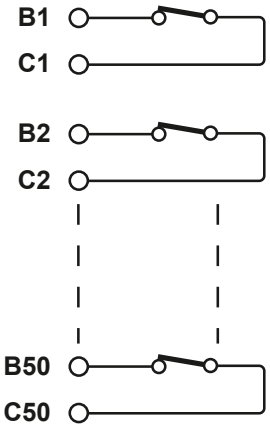




100 x SPST

Figure 5.3 - Pinouts: 100xSPST High Density Relay Module 40-145-201 (200-pin female LFH connector viewed from front of module)

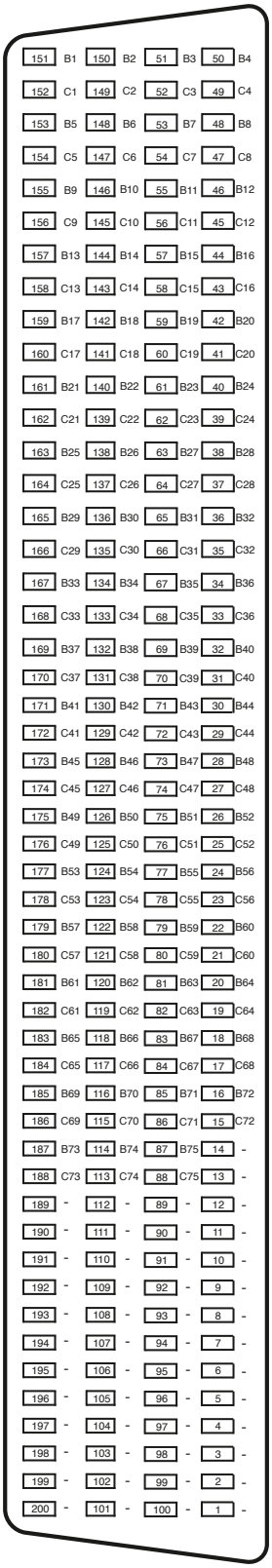


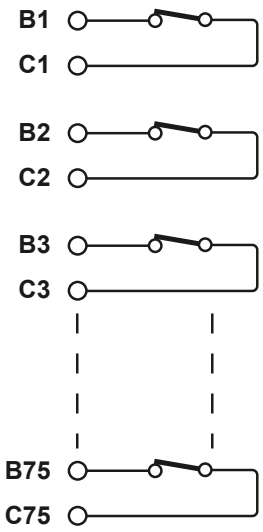


50 x SPST
Normally
Closed

Figure 5.4 - Pinouts: 50xSPST High Density Relay Module 40-145-001-NC (200-pin female LFH connector viewed from front of module)

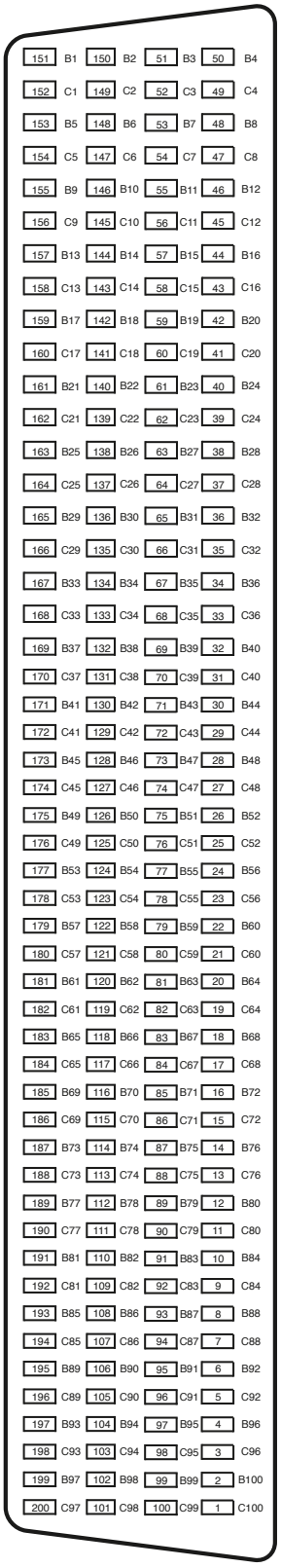
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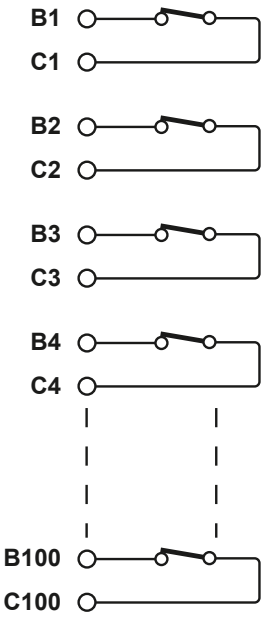




75 x SPST Normally Closed

Figure 5.5 - Pinouts: 75xSPST High Density Relay Module 40-145-101-NC (200-pin female LFH connector viewed from front of module)





100 x SPST Normally Closed

Figure 5.6 - Pinouts: 100xSPST High Density Relay Module 40-145-201-NC (200-pin female LFH connector viewed from front of module)

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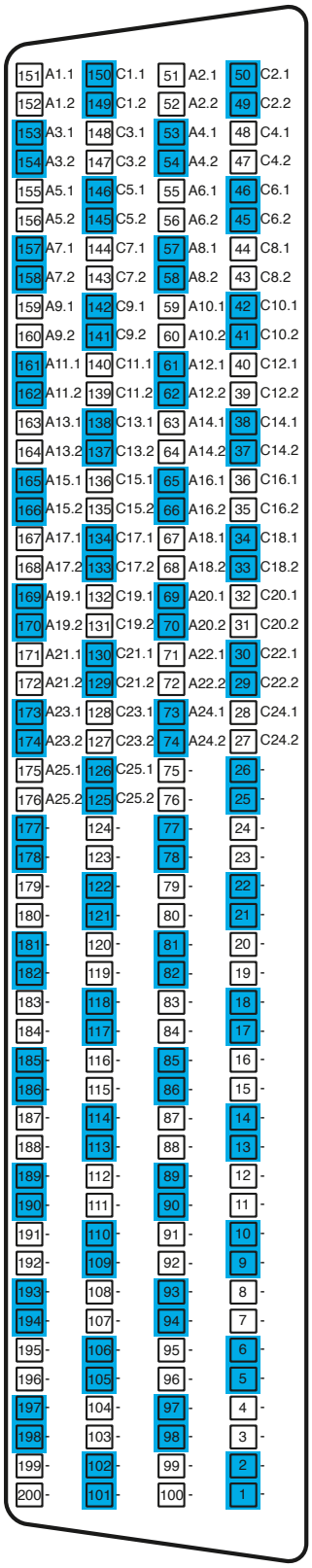


Figure 5.7 - Pinouts: 25xDPST High Density Relay Module 40-146-002 (200-pin female LFH connector viewed from front of module)

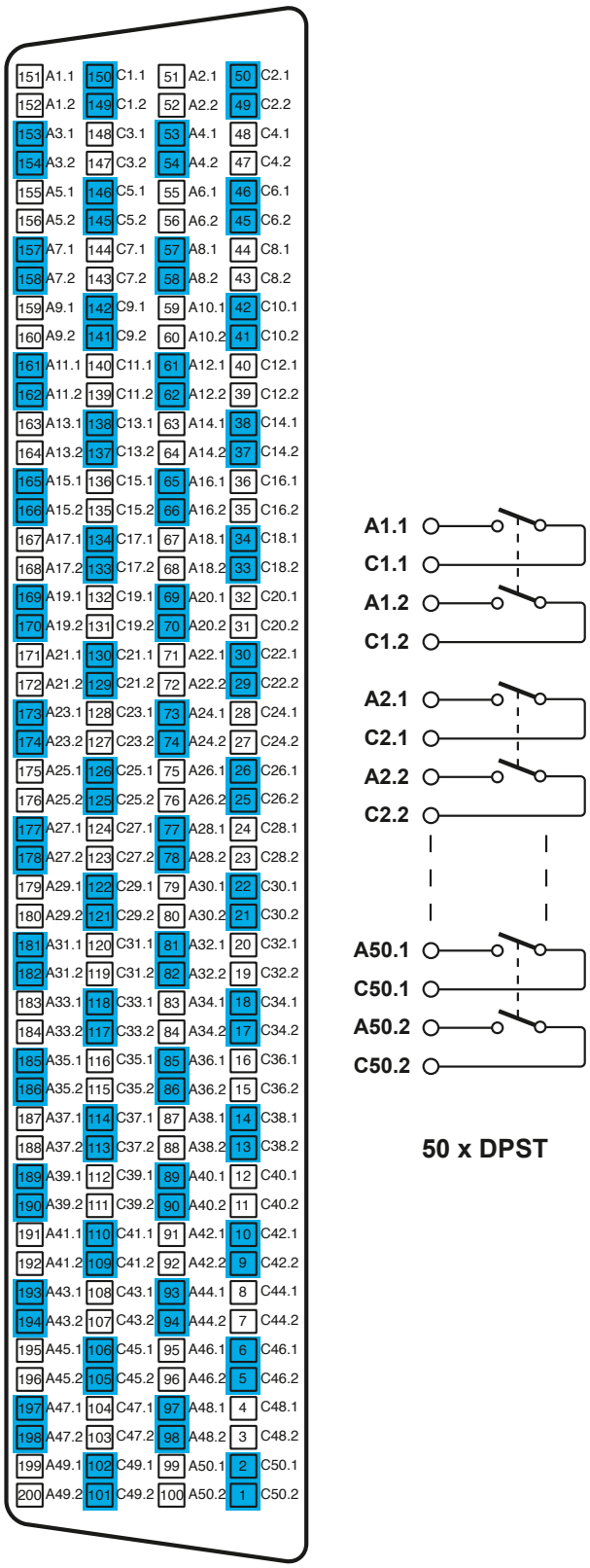


Figure 5.8 - Pinouts: 50xDPST High Density Relay Module 40-146-202 (200-pin female LFH connector viewed from front of module)

NOTE: The pairs of contacts show indicate a twisted pair connection inside the 200-pin connector flying lead

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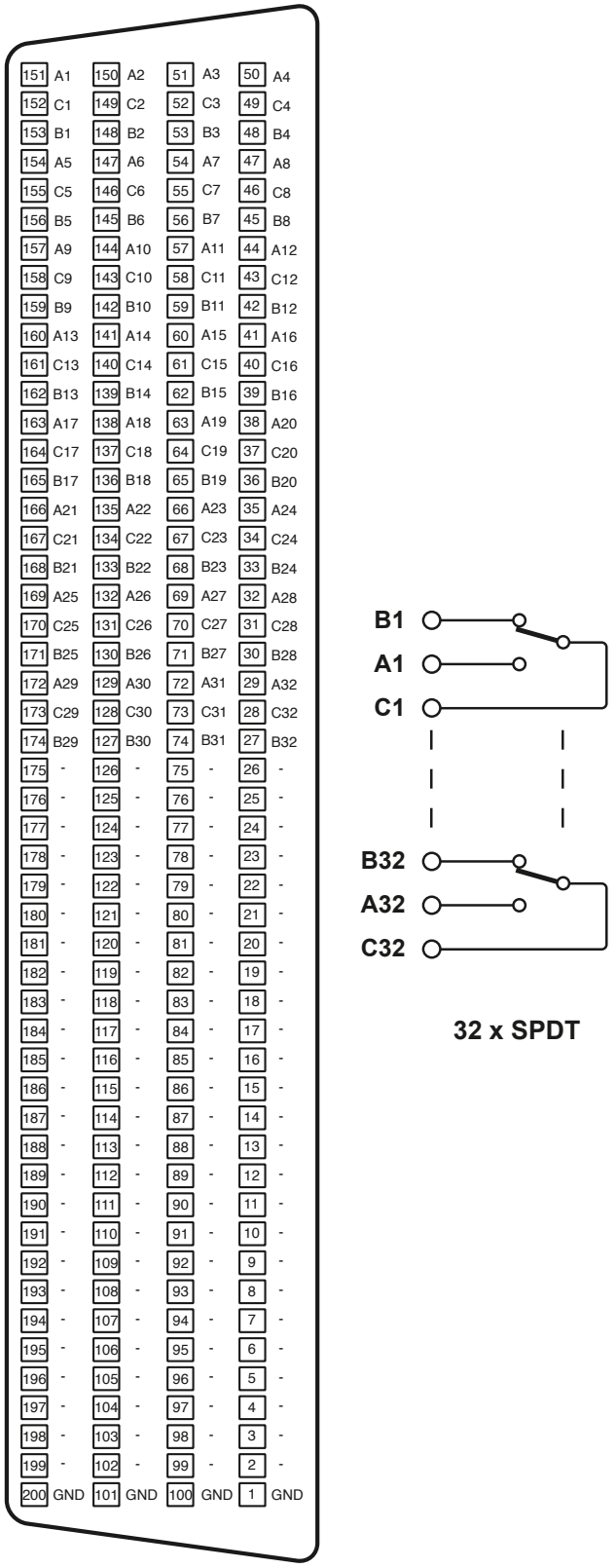


Figure 5.9 - Pinouts: 32xSPDT High Density Relay Module 40-148-001 (200-pin female LFH connector viewed from front of module)

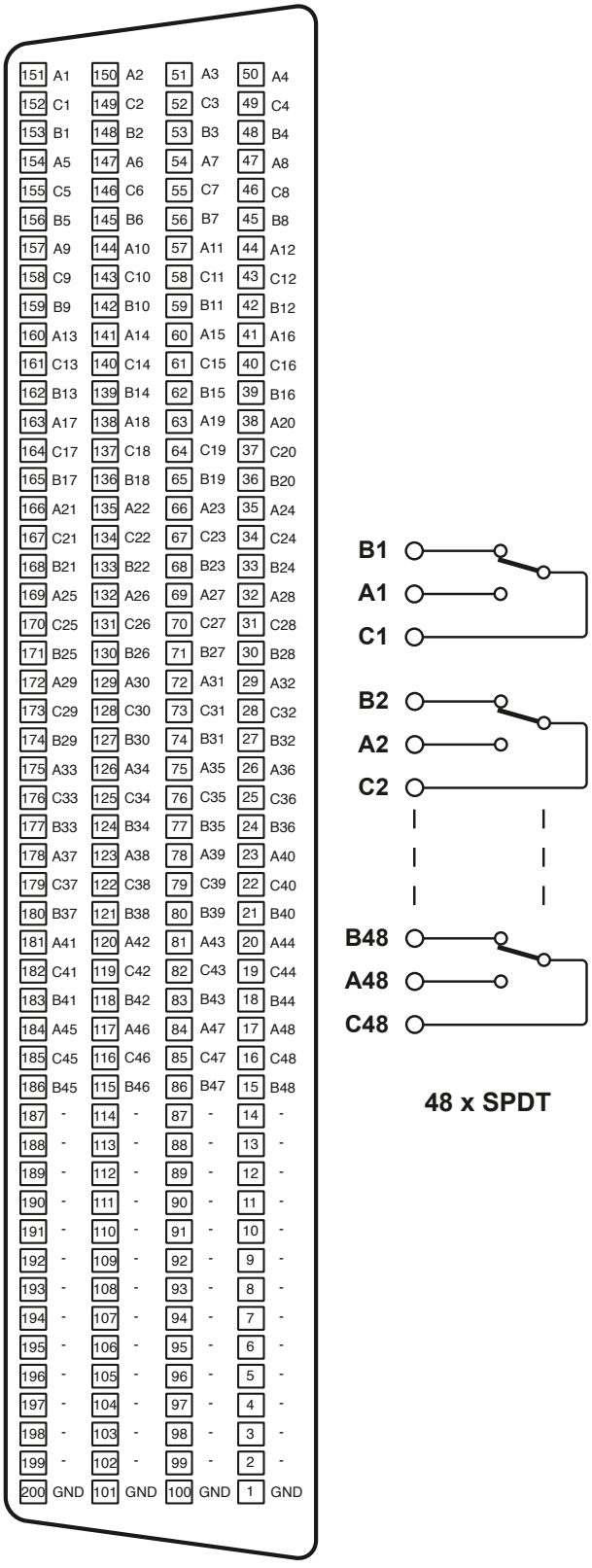
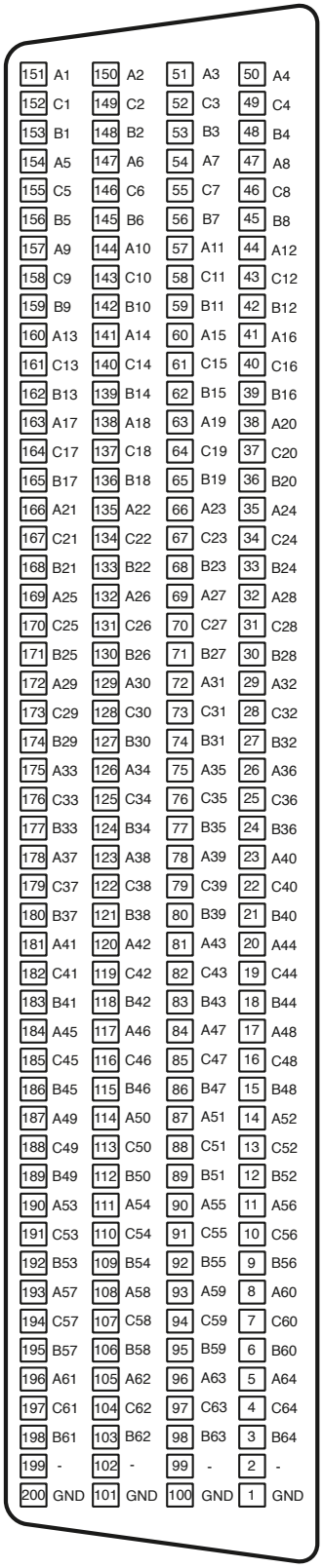


Figure 5.10 - Pinouts: 48xSPDT High Density Relay Module 40-148-101 (200-pin female LFH connector viewed from front of module)



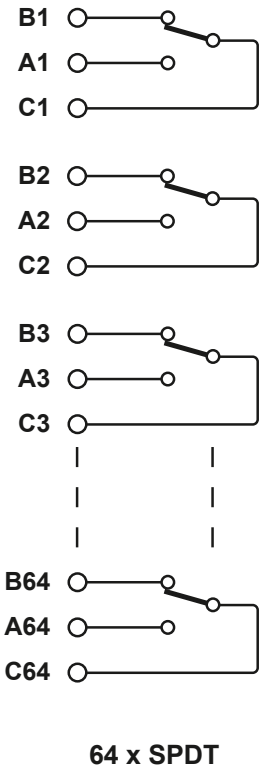


Figure 5.11 - Pinouts: 64xSPDT High Density Relay Module 40-148-201 (200-pin female LFH connector viewed from front of module)

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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.

SWITCHING SYSTEM TEST TOOLS

Please refer to Section 7 - Maintenance Information.

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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.

SWITCHING SYSTEM TEST TOOLS

We recommend the use of ***eBIRST*** to provide a check of the correct operation of relays and to identify the location of any faulty relay. For more information on ***eBIRST*** click here.

RELAY LOOK-UP TABLES

The following pages provide a cross reference between the signal paths of the product 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. Users of ***eBIRST*** switching system test tools do not need to use this information to locate faulty relays.

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TABLE 7.1 - High Density Relay Module 40-145-001/101/201 (normally open) Relay Numbering

Signal Path (with relay energised)	Relay No. 40-145-001	Relay No. 40-145-101	Relay No. 40-145-201	Signal Path (with relay energised)	Relay No. 40-145-001	Relay No. 40-145-101	Relay No. 40-145-201
A1 - C1	RL1	RL1	RL1	A51 - C51	NOT FITTED	RL51	RL51
A2 - C2	RL2	RL2	RL2	A52 - C52	NOT FITTED	RL52	RL52
A3 - C3	RL3	RL3	RL3	A53 - C53	NOT FITTED	RL53	RL53
A4 - C4	RL4	RL4	RL4	A54 - C54	NOT FITTED	RL54	RL54
A5 - C5	RL5	RL5	RL5	A55 - C55	NOT FITTED	RL55	RL55
A6 - C6	RL6	RL6	RL6	A56 - C56	NOT FITTED	RL56	RL56
A7 - C7	RL7	RL7	RL7	A57 - C57	NOT FITTED	RL57	RL57
A8 - C8	RL8	RL8	RL8	A58 - C58	NOT FITTED	RL58	RL58
A9 - C9	RL9	RL9	RL9	A59 - C59	NOT FITTED	RL59	RL59
A10 - C10	RL10	RL10	RL10	A60 - C60	NOT FITTED	RL60	RL60
A11 - C11	RL11	RL11	RL11	A61 - C61	NOT FITTED	RL61	RL61
A12 - C12	RL12	RL12	RL12	A62 - C62	NOT FITTED	RL62	RL62
A13 - C13	RL13	RL13	RL13	A63 - C63	NOT FITTED	RL63	RL63
A14 - C14	RL14	RL14	RL14	A64 - C64	NOT FITTED	RL64	RL64
A15 - C15	RL15	RL15	RL15	A65 - C65	NOT FITTED	RL65	RL65
A16 - C16	RL16	RL16	RL16	A66 - C66	NOT FITTED	RL66	RL66
A17 - C17	RL17	RL17	RL17	A67 - C67	NOT FITTED	RL67	RL67
A18 - C18	RL18	RL18	RL18	A68 - C68	NOT FITTED	RL68	RL68
A19 - C19	RL19	RL19	RL19	A69 - C69	NOT FITTED	RL69	RL69
A20 - C20	RL20	RL20	RL20	A70 - C70	NOT FITTED	RL70	RL70
A21 - C21	RL21	RL21	RL21	A71 - C71	NOT FITTED	RL71	RL71
A22 - C22	RL22	RL22	RL22	A72 - C72	NOT FITTED	RL72	RL72
A23 - C23	RL23	RL23	RL23	A73 - C73	NOT FITTED	RL73	RL73
A24 - C24	RL24	RL24	RL24	A74 - C74	NOT FITTED	RL74	RL74
A25 - C25	RL25	RL25	RL25	A75 - C75	NOT FITTED	RL75	RL75
A26 - C26	RL26	RL26	RL26	A76 - C76	NOT FITTED	NOT FITTED	RL76
A27 - C27	RL27	RL27	RL27	A77 - C77	NOT FITTED	NOT FITTED	RL77
A28 - C28	RL28	RL28	RL28	A78 - C78	NOT FITTED	NOT FITTED	RL78
A29 - C29	RL29	RL29	RL29	A79 - C79	NOT FITTED	NOT FITTED	RL79
A30 - C30	RL30	RL30	RL30	A80 - C80	NOT FITTED	NOT FITTED	RL80
A31 - C31	RL31	RL31	RL31	A81 - C81	NOT FITTED	NOT FITTED	RL81
A32 - C32	RL32	RL32	RL32	A82 - C82	NOT FITTED	NOT FITTED	RL82
A33 - C33	RL33	RL33	RL33	A83 - C83	NOT FITTED	NOT FITTED	RL83
A34 - C34	RL34	RL34	RL34	A84 - C84	NOT FITTED	NOT FITTED	RL84
A35 - C35	RL35	RL35	RL35	A85 - C85	NOT FITTED	NOT FITTED	RL85
A36 - C36	RL36	RL36	RL36	A86 - C86	NOT FITTED	NOT FITTED	RL86
A37 - C37	RL37	RL37	RL37	A87 - C87	NOT FITTED	NOT FITTED	RL87
A38 - C38	RL38	RL38	RL38	A88 - C88	NOT FITTED	NOT FITTED	RL88
A39 - C39	RL39	RL39	RL39	A89 - C89	NOT FITTED	NOT FITTED	RL89
A40 - C40	RL40	RL40	RL40	A90 - C90	NOT FITTED	NOT FITTED	RL90
A41 - C41	RL41	RL41	RL41	A91 - C91	NOT FITTED	NOT FITTED	RL91
A42 - C42	RL42	RL42	RL42	A92 - C92	NOT FITTED	NOT FITTED	RL92
A43 - C43	RL43	RL43	RL43	A93 - C93	NOT FITTED	NOT FITTED	RL93
A44 - C44	RL44	RL44	RL44	A94 - C94	NOT FITTED	NOT FITTED	RL94
A45 - C45	RL45	RL45	RL45	A95 - C95	NOT FITTED	NOT FITTED	RL95
A46 - C46	RL46	RL46	RL46	A96 - C96	NOT FITTED	NOT FITTED	RL96
A47 - C47	RL47	RL47	RL47	A97 - C97	NOT FITTED	NOT FITTED	RL97
A48 - C48	RL48	RL48	RL48	A98 - C98	NOT FITTED	NOT FITTED	RL98
A49 - C49	RL49	RL49	RL49	A99 - C99	NOT FITTED	NOT FITTED	RL99
A50 - C50	RL50	RL50	RL50	A100 - C100	NOT FITTED	NOT FITTED	RL100

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TABLE 7.2 - High Density Relay Module 40-145-001/101/201-NC (normally closed) Relay Numbering

Signal Path (with relay de-energised)	Relay No. 40-145-001 -NC	Relay No. 40-145-101 -NC	Relay No. 40-145-201 -NC	Signal Path (with relay de-energised)	Relay No. 40-145-001 -NC	Relay No. 40-145-101 -NC	Relay No. 40-145-201 -NC
B1 - C1	RL1	RL1	RL1	B51 - C51	NOT FITTED	RL51	RL51
B2 - C2	RL2	RL2	RL2	B52 - C52	NOT FITTED	RL52	RL52
B3 - C3	RL3	RL3	RL3	B53 - C53	NOT FITTED	RL53	RL53
B4 - C4	RL4	RL4	RL4	B54 - C54	NOT FITTED	RL54	RL54
B5 - C5	RL5	RL5	RL5	B55 - C55	NOT FITTED	RL55	RL55
B6 - C6	RL6	RL6	RL6	B56 - C56	NOT FITTED	RL56	RL56
B7 - C7	RL7	RL7	RL7	B57 - C57	NOT FITTED	RL57	RL57
B8 - C8	RL8	RL8	RL8	B58 - C58	NOT FITTED	RL58	RL58
B9 - C9	RL9	RL9	RL9	B59 - C59	NOT FITTED	RL59	RL59
B10 - C10	RL10	RL10	RL10	B60 - C60	NOT FITTED	RL60	RL60
B11 - C11	RL11	RL11	RL11	B61 - C61	NOT FITTED	RL61	RL61
B12 - C12	RL12	RL12	RL12	B62 - C62	NOT FITTED	RL62	RL62
B13 - C13	RL13	RL13	RL13	B63 - C63	NOT FITTED	RL63	RL63
B14 - C14	RL14	RL14	RL14	B64 - C64	NOT FITTED	RL64	RL64
B15 - C15	RL15	RL15	RL15	B65 - C65	NOT FITTED	RL65	RL65
B16 - C16	RL16	RL16	RL16	B66 - C66	NOT FITTED	RL66	RL66
B17 - C17	RL17	RL17	RL17	B67 - C67	NOT FITTED	RL67	RL67
B18 - C18	RL18	RL18	RL18	B68 - C68	NOT FITTED	RL68	RL68
B19 - C19	RL19	RL19	RL19	B69 - C69	NOT FITTED	RL69	RL69
B20 - C20	RL20	RL20	RL20	B70 - C70	NOT FITTED	RL70	RL70
B21 - C21	RL21	RL21	RL21	B71 - C71	NOT FITTED	RL71	RL71
B22 - C22	RL22	RL22	RL22	B72 - C72	NOT FITTED	RL72	RL72
B23 - C23	RL23	RL23	RL23	B73 - C73	NOT FITTED	RL73	RL73
B24 - C24	RL24	RL24	RL24	B74 - C74	NOT FITTED	RL74	RL74
B25 - C25	RL25	RL25	RL25	B75 - C75	NOT FITTED	RL75	RL75
B26 - C26	RL26	RL26	RL26	B76 - C76	NOT FITTED	NOT FITTED	RL76
B27 - C27	RL27	RL27	RL27	B77 - C77	NOT FITTED	NOT FITTED	RL77
B28 - C28	RL28	RL28	RL28	B78 - C78	NOT FITTED	NOT FITTED	RL78
B29 - C29	RL29	RL29	RL29	B79 - C79	NOT FITTED	NOT FITTED	RL79
B30 - C30	RL30	RL30	RL30	B80 - C80	NOT FITTED	NOT FITTED	RL80
B31 - C31	RL31	RL31	RL31	B81 - C81	NOT FITTED	NOT FITTED	RL81
B32 - C32	RL32	RL32	RL32	B82 - C82	NOT FITTED	NOT FITTED	RL82
B33 - C33	RL33	RL33	RL33	B83 - C83	NOT FITTED	NOT FITTED	RL83
B34 - C34	RL34	RL34	RL34	B84 - C84	NOT FITTED	NOT FITTED	RL84
B35 - C35	RL35	RL35	RL35	B85 - C85	NOT FITTED	NOT FITTED	RL85
B36 - C36	RL36	RL36	RL36	B86 - C86	NOT FITTED	NOT FITTED	RL86
B37 - C37	RL37	RL37	RL37	B87 - C87	NOT FITTED	NOT FITTED	RL87
B38 - C38	RL38	RL38	RL38	B88 - C88	NOT FITTED	NOT FITTED	RL88
B39 - C39	RL39	RL39	RL39	B89 - C89	NOT FITTED	NOT FITTED	RL89
B40 - C40	RL40	RL40	RL40	B90 - C90	NOT FITTED	NOT FITTED	RL90
B41 - C41	RL41	RL41	RL41	B91 - C91	NOT FITTED	NOT FITTED	RL91
B42 - C42	RL42	RL42	RL42	B92 - C92	NOT FITTED	NOT FITTED	RL92
B43 - C43	RL43	RL43	RL43	B93 - C93	NOT FITTED	NOT FITTED	RL93
B44 - C44	RL44	RL44	RL44	B94 - C94	NOT FITTED	NOT FITTED	RL94
B45 - C45	RL45	RL45	RL45	B95 - C95	NOT FITTED	NOT FITTED	RL95
B46 - C46	RL46	RL46	RL46	B96 - C96	NOT FITTED	NOT FITTED	RL96
B47 - C47	RL47	RL47	RL47	B97 - C97	NOT FITTED	NOT FITTED	RL97
B48 - C48	RL48	RL48	RL48	B98 - C98	NOT FITTED	NOT FITTED	RL98
B49 - C49	RL49	RL49	RL49	B99 - C99	NOT FITTED	NOT FITTED	RL99
B50 - C50	RL50	RL50	RL50	B100 - C100	NOT FITTED	NOT FITTED	RL100

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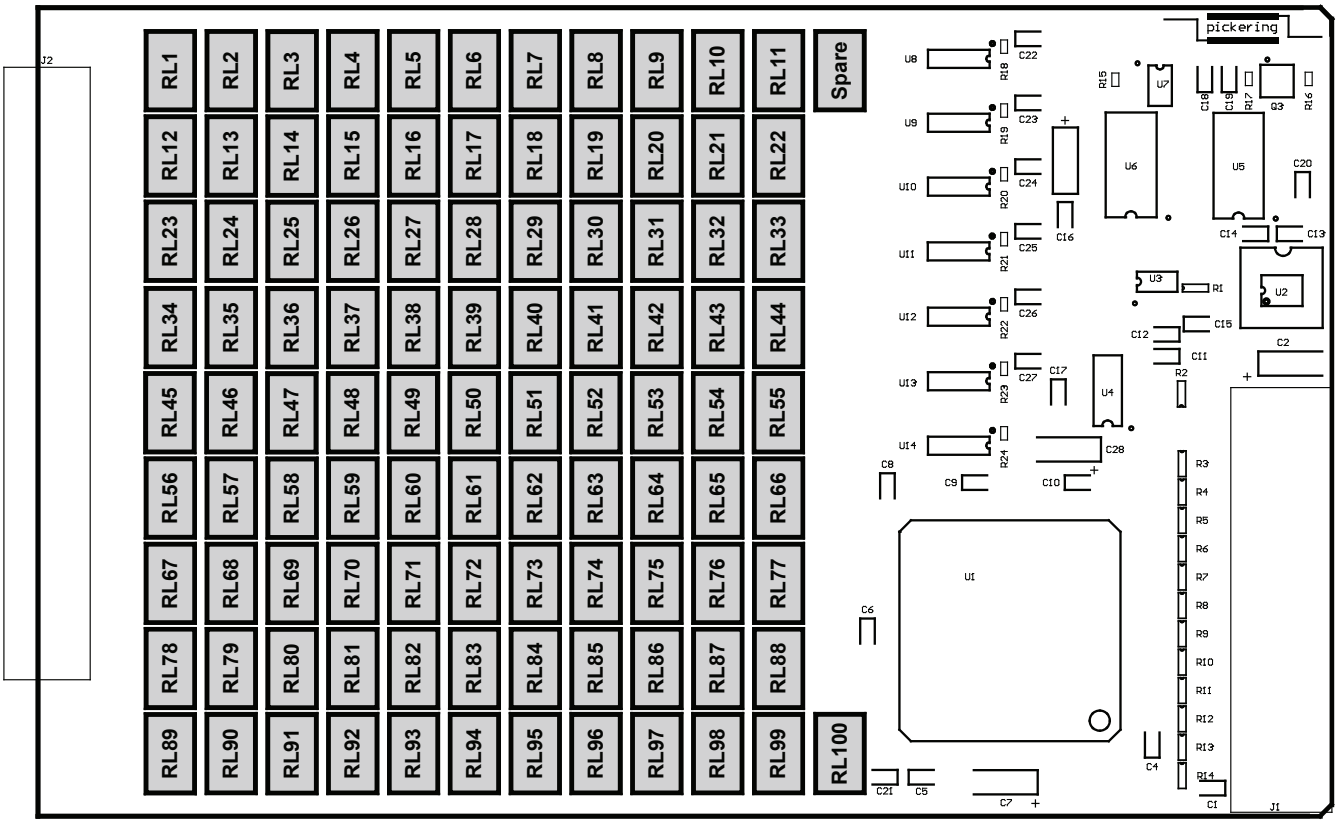


Figure 7.1 - 40-145 High Density Relay Module Component Layout

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TABLE 7.3 - High Density Relay Module 40-146-002/202 Relay Numbering

Signal Path (with relay energised)	Relay No. 40-146-002	Relay No. 40-146-202
C1.1 to A1.1 & C1.2 to A1.2	RL1	RL1
C2.1 to A2.1 & C2.2 to A2.2	RL2	RL2
C3.1 to A3.1 & C3.2 to A3.2	RL3	RL3
C4.1 to A4.1 & C4.2 to A4.2	RL4	RL4
C5.1 to A5.1 & C5.2 to A5.2	RL5	RL5
C6.1 to A6.1 & C6.2 to A6.2	RL6	RL6
C7.1 to A7.1 & C7.2 to A7.2	RL7	RL7
C8.1 to A8.1 & C8.2 to A8.2	RL8	RL8
C9.1 to A9.1 & C9.2 to A9.2	RL9	RL9
C10.1 to A10.1 & C10.2 to A10.2	RL10	RL10
C11.1 to A11.1 & C11.2 to A11.2	RL11	RL11
C12.1 to A12.1 & C12.2 to A12.2	RL12	RL12
C13.1 to A13.1 & C13.2 to A13.2	RL13	RL13
C14.1 to A14.1 & C14.2 to A14.2	RL14	RL14
C15.1 to A15.1 & C15.2 to A15.2	RL15	RL15
C16.1 to A16.1 & C16.2 to A16.2	RL16	RL16
C17.1 to A17.1 & C17.2 to A17.2	RL17	RL17
C18.1 to A18.1 & C18.2 to A18.2	RL18	RL18
C19.1 to A19.1 & C19.2 to A19.2	RL19	RL19
C20.1 to A20.1 & C20.2 to A20.2	RL20	RL20
C21.1 to A21.1 & C21.2 to A21.2	RL21	RL21
C22.1 to A22.1 & C22.2 to A22.2	RL22	RL22
C23.1 to A23.1 & C23.2 to A23.2	RL23	RL23
C24.1 to A24.1 & C24.2 to A24.2	RL24	RL24
C25.1 to A25.1 & C25.2 to A25.2	RL25	RL25
C26.1 to A26.1 & C26.2 to A26.2	NOT FITTED	RL26
C27.1 to A27.1 & C27.2 to A27.2	NOT FITTED	RL27
C28.1 to A28.1 & C28.2 to A28.2	NOT FITTED	RL28
C29.1 to A29.1 & C29.2 to A29.2	NOT FITTED	RL29
C30.1 to A30.1 & C30.2 to A30.2	NOT FITTED	RL30
C31.1 to A31.1 & C31.2 to A31.2	NOT FITTED	RL31
C32.1 to A32.1 & C32.2 to A32.2	NOT FITTED	RL32
C33.1 to A33.1 & C33.2 to A33.2	NOT FITTED	RL33
C34.1 to A34.1 & C34.2 to A34.2	NOT FITTED	RL34
C35.1 to A35.1 & C35.2 to A35.2	NOT FITTED	RL35
C36.1 to A36.1 & C36.2 to A36.2	NOT FITTED	RL36
C37.1 to A37.1 & C37.2 to A37.2	NOT FITTED	RL37
C38.1 to A38.1 & C38.2 to A38.2	NOT FITTED	RL38
C39.1 to A39.1 & C39.2 to A39.2	NOT FITTED	RL39
C40.1 to A40.1 & C40.2 to A40.2	NOT FITTED	RL40
C41.1 to A41.1 & C41.2 to A41.2	NOT FITTED	RL41
C42.1 to A42.1 & C42.2 to A42.2	NOT FITTED	RL42
C43.1 to A43.1 & C43.2 to A43.2	NOT FITTED	RL43
C44.1 to A44.1 & C44.2 to A44.2	NOT FITTED	RL44
C45.1 to A45.1 & C45.2 to A45.2	NOT FITTED	RL45
C46.1 to A46.1 & C46.2 to A46.2	NOT FITTED	RL46
C47.1 to A47.1 & C47.2 to A47.2	NOT FITTED	RL47
C48.1 to A48.1 & C48.2 to A48.2	NOT FITTED	RL48
C49.1 to A49.1 & C49.2 to A49.2	NOT FITTED	RL49
C50.1 to A50.1 & C50.2 to A50.2	NOT FITTED	RL50

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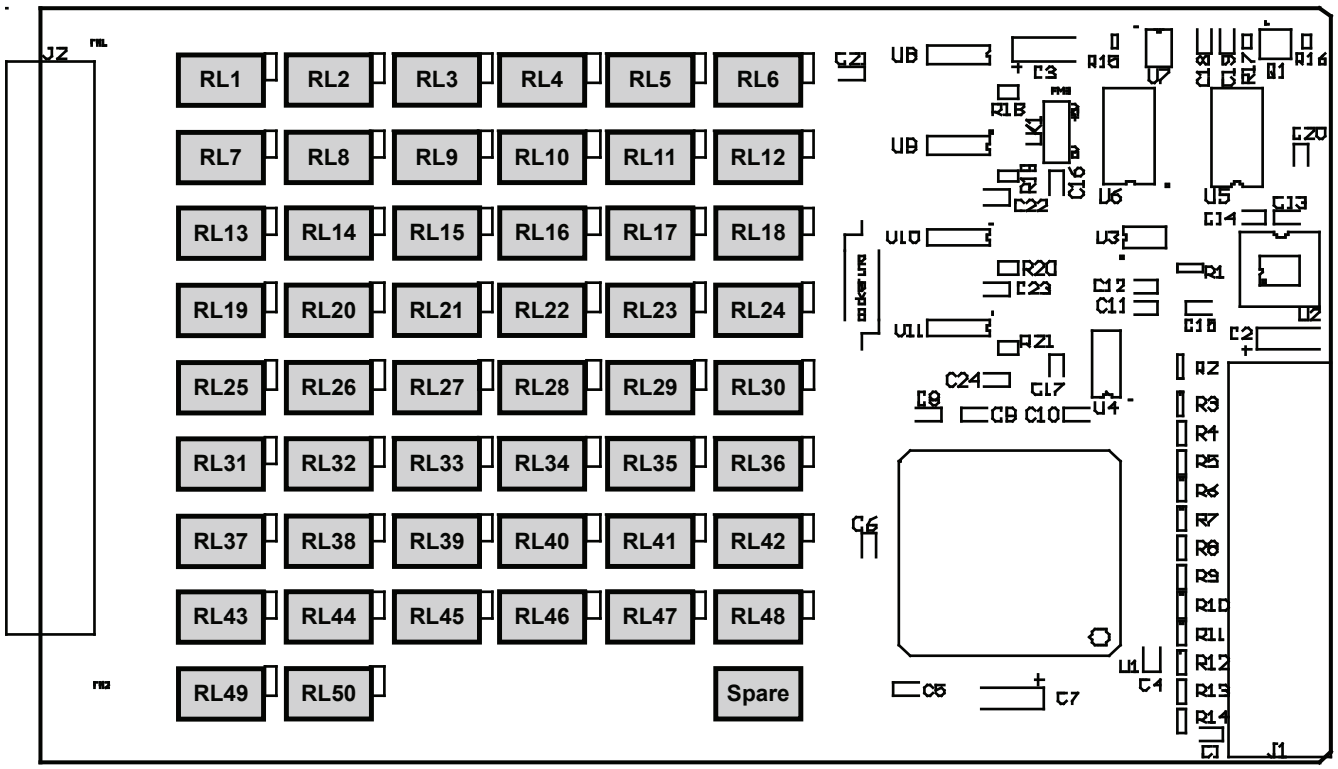


Figure 7.2 - 40-146 High Density Relay Module Component Layout

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TABLE 7.4 - High Density Relay Module 40-148-001/101/201 Relay Numbering

Signal Path (with relay energised)	Signal Path (with relay de-energised)	Relay No. 40-148-001	Relay No. 40-148-101	Relay No. 40-148-201
C1 to A1	C1 to B1	RL1	RL1	RL1
C2 to A2	C2 to B2	RL2	RL2	RL2
C3 to A3	C3 to B3	RL3	RL3	RL3
C4 to A4	C4 to B4	RL4	RL4	RL4
C5 to A5	C5 to B5	RL5	RL5	RL5
C6 to A6	C6 to B6	RL6	RL6	RL6
C7 to A7	C7 to B7	RL7	RL7	RL7
C8 to A8	C8 to B8	RL8	RL8	RL8
C9 to A9	C9 to B9	RL9	RL9	RL9
C10 to A10	C10 to B10	RL10	RL10	RL10
C11 to A11	C11 to B11	RL11	RL11	RL11
C12 to A12	C12 to B12	RL12	RL12	RL12
C13 to A13	C13 to B13	RL13	RL13	RL13
C14 to A14	C14 to B14	RL14	RL14	RL14
C15 to A15	C15 to B15	RL15	RL15	RL15
C16 to A16	C16 to B16	RL16	RL16	RL16
C17 to A17	C17 to B17	RL17	RL17	RL17
C18 to A18	C18 to B18	RL18	RL18	RL18
C19 to A19	C19 to B19	RL19	RL19	RL19
C20 to A20	C20 to B20	RL20	RL20	RL20
C21 to A21	C21 to B21	RL21	RL21	RL21
C22 to A22	C22 to B22	RL22	RL22	RL22
C23 to A23	C23 to B23	RL23	RL23	RL23
C24 to A24	C24 to B24	RL24	RL24	RL24
C25 to A25	C25 to B25	RL25	RL25	RL25
C26 to A26	C26 to B26	RL26	RL26	RL26
C27 to A27	C27 to B27	RL27	RL27	RL27
C28 to A28	C28 to B28	RL28	RL28	RL28
C29 to A29	C29 to B29	RL29	RL29	RL29
C30 to A30	C30 to B30	RL30	RL30	RL30
C31 to A31	C31 to B31	RL31	RL31	RL31
C32 to A32	C32 to B32	RL32	RL32	RL32
C33 to A33	C33 to B33	NOT FITTED	RL33	RL33
C34 to A34	C34 to B34	NOT FITTED	RL34	RL34
C35 to A35	C35 to B35	NOT FITTED	RL35	RL35
C36 to A36	C36 to B36	NOT FITTED	RL36	RL36
C37 to A37	C37 to B37	NOT FITTED	RL37	RL37
C38 to A38	C38 to B38	NOT FITTED	RL38	RL38
C39 to A39	C39 to B39	NOT FITTED	RL39	RL39
C40 to A40	C40 to B40	NOT FITTED	RL40	RL40
C41 to A41	C41 to B41	NOT FITTED	RL41	RL41
C42 to A42	C42 to B42	NOT FITTED	RL42	RL42
C43 to A43	C43 to B43	NOT FITTED	RL43	RL43
C44 to A44	C44 to B44	NOT FITTED	RL44	RL44
C45 to A45	C45 to B45	NOT FITTED	RL45	RL45
C46 to A46	C46 to B46	NOT FITTED	RL46	RL46
C47 to A47	C47 to B47	NOT FITTED	RL47	RL47
C48 to A48	C48 to B48	NOT FITTED	RL48	RL48
C49 to A49	C49 to B49	NOT FITTED	NOT FITTED	RL49
C50 to A50	C50 to B50	NOT FITTED	NOT FITTED	RL50
C51 to A51	C51 to B51	NOT FITTED	NOT FITTED	RL51
C52 to A52	C52 to B52	NOT FITTED	NOT FITTED	RL52
C53 to A53	C53 to B53	NOT FITTED	NOT FITTED	RL53
C54 to A54	C54 to B54	NOT FITTED	NOT FITTED	RL54
C55 to A55	C55 to B55	NOT FITTED	NOT FITTED	RL55
C56 to A56	C56 to B56	NOT FITTED	NOT FITTED	RL56
C57 to A57	C57 to B57	NOT FITTED	NOT FITTED	RL57
C58 to A58	C58 to B58	NOT FITTED	NOT FITTED	RL58
C59 to A59	C59 to B59	NOT FITTED	NOT FITTED	RL59
C60 to A60	C60 to B60	NOT FITTED	NOT FITTED	RL60
C61 to A61	C61 to B61	NOT FITTED	NOT FITTED	RL61
C62 to A62	C62 to B62	NOT FITTED	NOT FITTED	RL62
C63 to A63	C63 to B63	NOT FITTED	NOT FITTED	RL63
C64 to A64	C64 to B64	NOT FITTED	NOT FITTED	RL64

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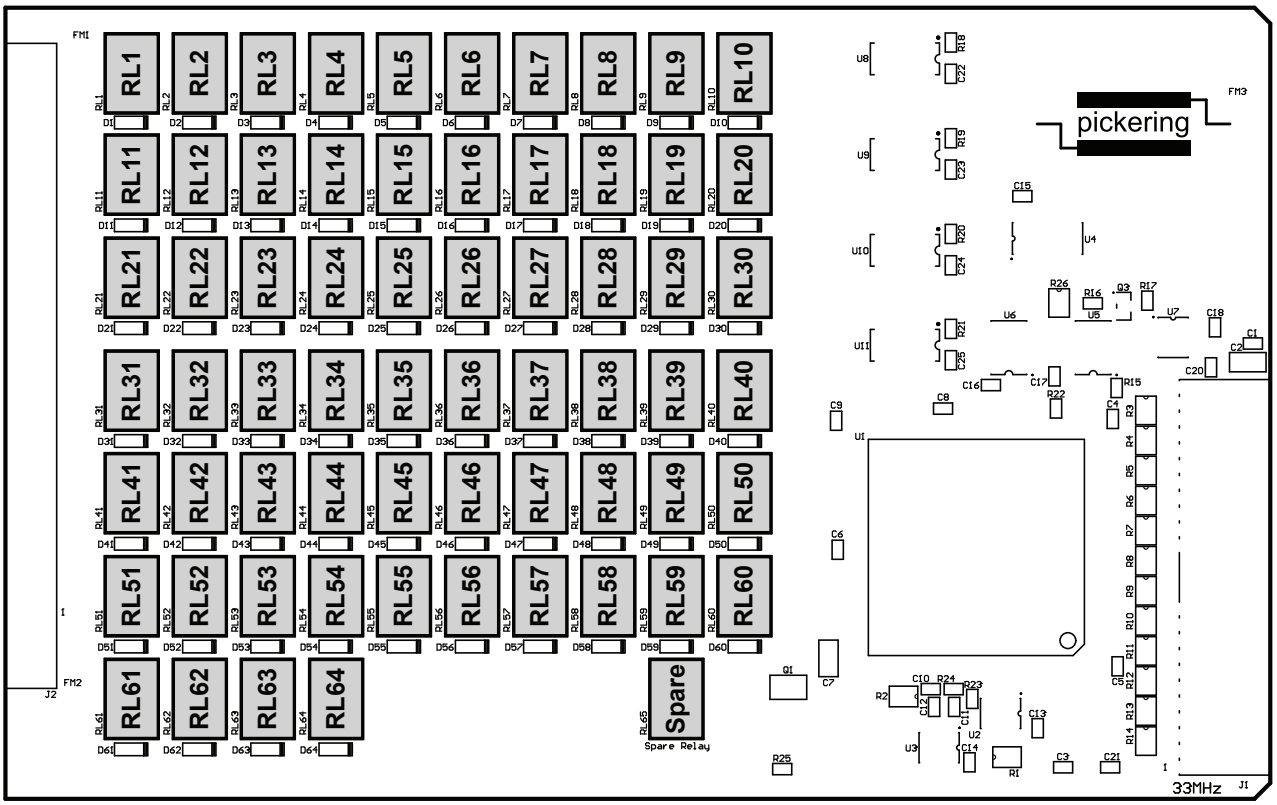


Figure 7.3 - 40-148 High Density Relay Module Component Layout

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