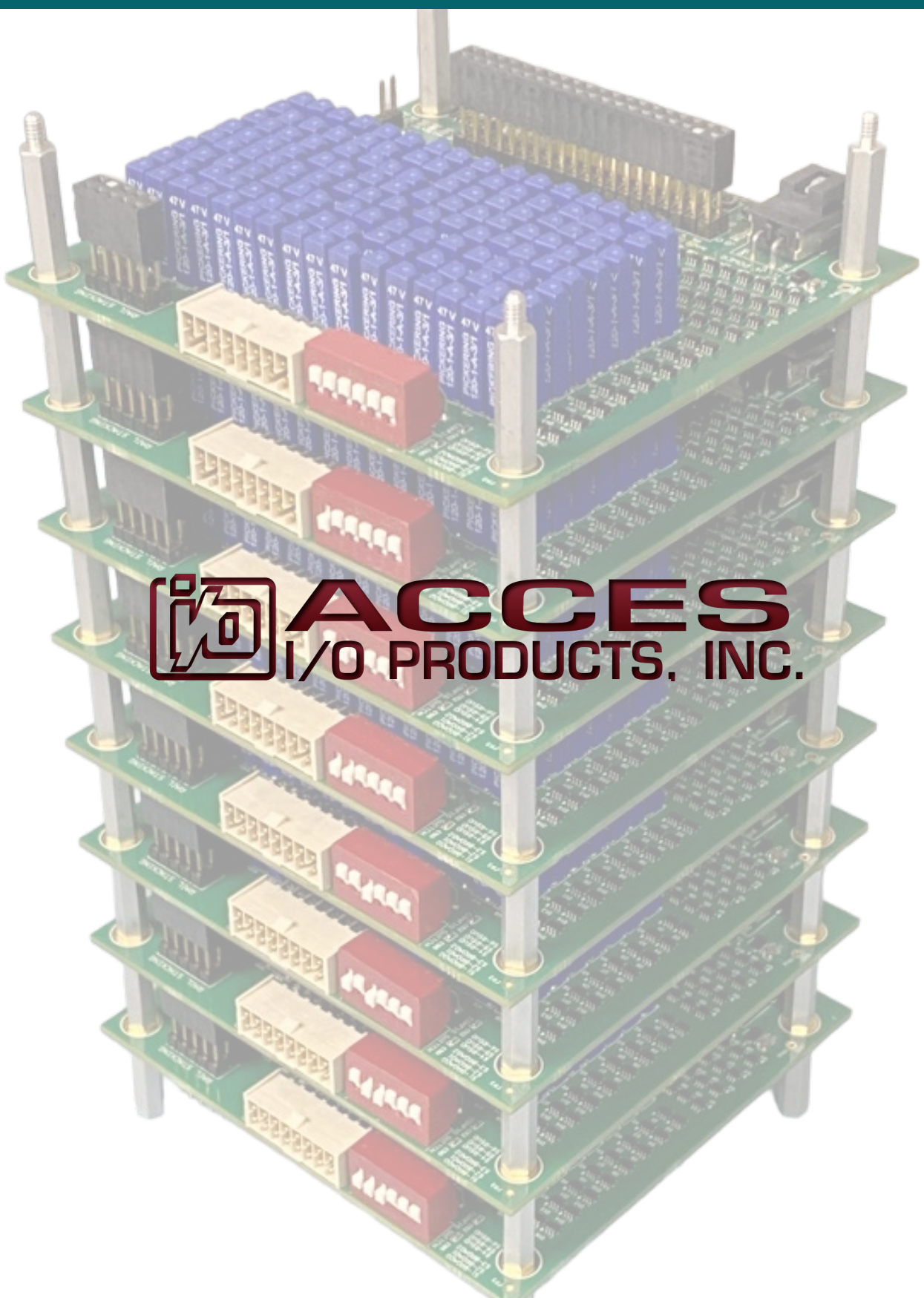
ROB-Matrix-8x128 Kit Hardware Manual

Models mPCIe-DIO-24SRL or M.2-DIO-24SRL with 8 × ROB-Matrix-8x16



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Manual Revision B1c
MADE IN THE USA

Chapter 1: Quick Start

It is recommended that you install the software package before installing the PCI Express Mini Card (mPCIe) in your computer.

Run the installer you downloaded and follow the prompts to install the software for your device.

Once the software has been installed, shut down your system and carefully install the M.2 or mPCIe card.

With the system off connect the 9” one-to-one 40-pin cable from the mPCIe-DIO-24SRL to the 40-pin header on *any* one of the eight ROB-Matrix-8x16 boards in the ROB-Matrix-8x128 stack.

Connect a 3.3V power cable to *any one* of the eight ROB-Matrix-8x16 boards’ 2-position Model 1723103202 power connectors.

Both power and serial data are passed through the stack.

Check that the Board ID dip switches are in the correct positions with unique addresses per board.

Power up everything and run the included C# sample program to see it all working.

Chapter 2: Introduction

The M.2- or mPCIe-DIO-24SRL, combined with eight ROB-Matrix-8x16 boards (stacked), creates a single 8×128 electromechanical reed relay cross matrix switch, all controlled over one serial interface and requiring only a single power cable. The 1A reed relays support 200 Volts (20 watts max) and all 1024 relays can be switched in a millisecond (Note: at most 20% of relays on any given ROB-Matrix-8x16 can be energized at the same time. Exceeding these limits may trip the resettable F1 polyfuse).

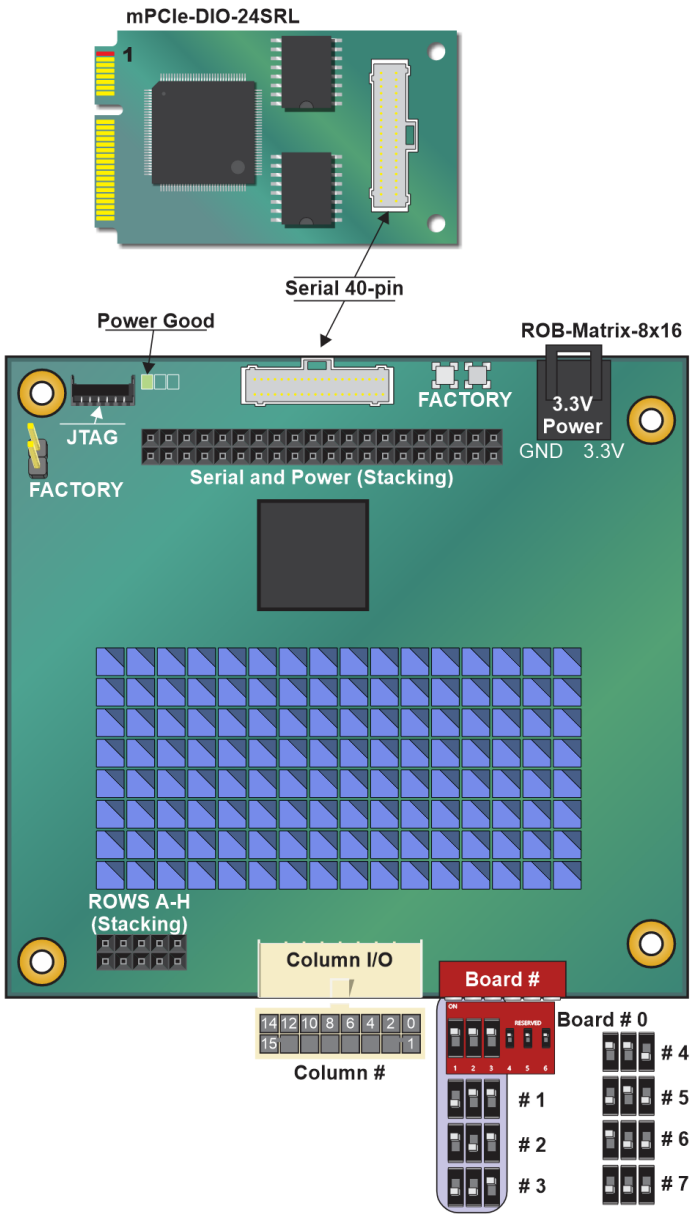
Chapter 3: Hardware

The mPCIe-DIO-24SRL is a full-length “F1” mPCIe device (30 × 50.95 mm). The M.2-DIO-24SRL is an M.2 2260/2280 M&B key card. Each ROB-Matrix-8x16 uses PC/104 mounting locations and PCB size, but needs 0.75” height, which exceeds the 0.6” height of actual PC/104. The unit is not a PC/104 device; there is no bus connector. Communication is by serial data. All units are RoHS compliant.

Included in your package:

- 1 × mPCIe-DIO-24SRL or 1 × M.2-DIO-24SRL
- 8 × ROB-Matrix-8x16 boards, stacked and configured (#0 on top)
- 1 × 9” 40-pin 1 to 1 cable for serial data
- 36 × 0.75” standoffs

Chapter 4: Configuration Settings



The only configuration available is the board address assigned to each board in the ROB-Matrix-8x128 stack. The stack ships with these dip switches already configured, with Board #0 on top of the stack incrementing down until Board #7 at the bottom.

Chapter 5: PC Interface

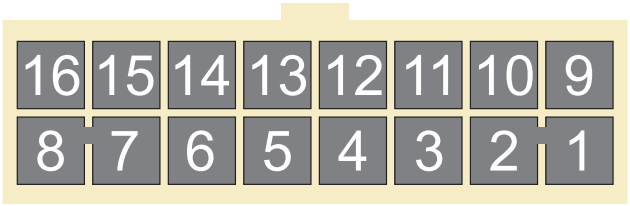
This product interfaces with a PC using either a PCI Express Mini Card (mPCIe) connection or an M.2 2260/2280 connection. These small-form-factor, high-performance, rugged peripheral interconnect technologies were first introduced for use in laptops and other portable or small form factor computers and SOC/SOM.

In the ROB-Matrix-8x128 this card implements an SPI serial interface to the stack of ROB-Matrix-8x16 boards; this SPI protocol includes a board address, a write/read bit, and 128 bits of relay state control bits. This allows 128 relays to be updated or read back in a single serial transaction, with at most five PCI Express register accesses to update or readback all 128 relays per board.

Chapter 6: I/O Interface

The Relay Matrix Switch Column data is available on a 16-pin Molex connector on each ROB-Matrix-8x16 board:

Column I/O Connector Pinout



Column signals table (bottom)			
Pin #	Pin Name / Description	Pin #	Pin Name / Description
1	Column #1	9	Column #0
2	Column #3	10	Column #2
3	Column #5	11	Column #4
4	Column #7	12	Column #6
5	Column #9	13	Column #8
6	Column #11	14	Column #10
7	Column #13	15	Column #12
8	Column #15	16	Column #14

The Rail/Row pins can be accessed at the top of the stack via a 10-pin IDC 0.1" female header:

Stacking Rail Connector Pinout



Row signal table			
Pin #	Pin Name / Description		
1	Rail #1	6	Rail #4
2	Rail #2	7	Rail #5
3	KEY	8	Rail #6
4	No Connect	9	Rail #7
5	Rail #3	10	Rail #8

Chapter 7: Software Interface

I/O Registers at BAR [2]	
Register [hex]	
+68	FPGA Version Code
+70	FLASH Control
+74	FLASH Data
+78	FLASH Erase
+100	SPI Bus Busy, Write/Read, Board #
+104	Relay Control Bits 0-31 (+128 × Board #)
+108	Relay Control Bits 32-63 (+128 × Board #)
+10C	Relay Control Bits 64-95 (+128 × Board #)
+110	Relay Control Bits 96-127 (+128 × Board #)
+1A0	SPI Busy at bit 0

Registers documented with a gray background, and any offset not documented above, are reserved for factory use and should not be accessed.

BAR[2]	D31	D7	D6	D5	D4	D3	D2	D1	D0
+100	BUSY	WRITE	unused				B2	B1	B0

Bit 31 BUSY reads 1 while the SPI bus is busy This bit is also available via the +1A0 SPI busy register at bit 0.

Set bit 7 WRITE to 1 to command the Relay Control Bits be written to the stack. Clear bit 7 to readback the relay states from the specified Board # in the stack.

Set bits 2:0 B2:B0 to a number from 0->7 to address the specified Board # in the stack.

To set relays on or off write to the four data registers at 0x104 … 0x110, wait for SPI Busy to be clear, then write to 0x100 with bit 7 set.

To readback the current relay state, wait for SPI Busy to be clear, write to 0x100 with bit 7 clear, wait for SPI Busy to be clear, then read the registers at 0x104 … 0x110.

All of these registers can be operated from any operating system using any programming language, using either no driver at all (kernel mode, Linux ioperm(3), DOS, etc.) or using one of the ACCES provided drivers (AIOWDM [for Windows], APCI [for Linux & OSX]), or using any 3rd party APIs such as provided with Real-Time OSes.

In Windows[1], please consult the various samples (C#, C++) to explore how to program the device. The Software Reference Manual.pdf provides reference material covering all AIOWDM driver APIs, and tips for simplifying tasks such as Plug-and-Play card detection. Please note that the Software Reference Manual.pdf will include numerous functions that don't apply to this device. An overview of useful some functions is below:

AIOWDM API Quick Reference, DIO w/CoS IRQs	
Function name	Function Purpose
`RelOutPortL()`	Write 32-bits of data
`GetNumCards()`	Determine how many cards AIOWDM has detected in the system

Under certain circumstances the following information might prove useful:

PCI Express Mini Card Plug-and-Play Data	
Vendor / Device ID	Card Type
0x494F / 0x0180	mPCIe-DIO-24SRL or M.2-DIO-24SRL

A NOTE ABOUT PERFORMANCE

[1] *In Linux or OSX please refer to the documentation at github.com/accesio/apci*

The PCI Express bus and the PCI Express Mini Card standard are capable of very high bandwidth, but the latency per-transaction is roughly the same as all the other busses – it hasn't improved in decades. This means you can expect to usually see a not-less-than 1MHz transaction rate. Typical rates exceed 3MHz [0.3µs].

Unfortunately, modern Operating Systems have introduced a new source of latency, the kernel / userland division. Application code runs in userland, which must transition to the kernel in order to perform any hardware operation. This transition adds quite a lot of latency, which varies between different OSes, motherboards and revisions thereof, etcetera. A Windows system can experience an additional 7µs per transaction; a modern computer might see 3µs or less. Any transaction from the kernel itself, however, avoids this additional overhead.

Real-time operating systems will enable the highest transaction rates possible, all the way up to the hardware limits.

The latest information can always be found on the product page on the website. Here are some useful links:

Links to useful downloads	
ACCES web site	https://accesio.com
Linux / OSX	github.com/accesio/apci

Chapter 8: Specifications

PC Interface

PCI Express Mini Card	Type F1 "Full Length" V1.2

mPCIe-DIO-24SRL Specifications

SPI Bus Specs

SPI Busses	Number	8
	Frequency	1 MHz
Inputs	Logic High	2.0 V to VCCIO (3.3 VDC, 5 VDC tolerant)
	Logic Low	0 V to 0.8 V
Outputs	Logic High	2.0 VDC, min, 24 mA source
	Logic Low	0.55 VDC, max, 24 mA sink

Environmental

Temperature	Operating	-20° to 85°C
	Storage	-65°C to 150°C
Humidity		5% to 95%, non-condensing
Power required		+3.3VDC @ 330mA (typical)

Physical

Weight		6.2 grams (+ 12.8g for the cable)
Size	Length	50.95mm (2.006")
	Width	30.00mm (1.181")
I/O connector	On-card	Molex 501190-4017 40-pin latching
	mating	Molex 501189-4010

ROB-Matrix-8x16 Specifications

Relays

Number	128 (26, max energized at a time)
Type	SPST 1-A Dry Reed
Voltage	200V, max, ≤ 1.25MHz frequency, 20W, max
Switching Current	1.0 A, max
Carrying Current	1.2 A, max
Contact Resistance	0.18 Ω, max initial
Insulation resistance	10^{12} Ω, min @ 25°C
Capacitance	2.9 pF Closed switch to coil 0.14 pF Across open switch
Contact Life	10^{9}, min, 10V @ 10mA, 10^{7}, min, max load, resistive

Environmental

Temperature	Operating	-20° to 85°C
	Storage	-35°C to +100°C
Humidity		5% to 95%, non-condensing
Power required		+3.3VDC @ 60 mA (typical) (490mA max — 16.5mA per relay energized)

Physical

Weight		113.9g
Size	Length	3.50"
	Width	3.775"
Column I/O connector	On-card	Samtec IPL1-108-01-L-D-RA-K
	Mating	Samtec MMSD-08-20-L-08.00-D-K-LUS
Power Connector	On-card	Molex 1723103202
	Mating	Molex 1722563102
Rail stacking connector	On-card	ASP-229295-01

Chapter 9: Certifications

CE & FCC

These devices are designed to meet all applicable EM interference and emission standards. However, as they are intended for use installed on motherboards, and inside the chassis of industrial PCs, important care in the selection of PC and chassis is important to achieve compliance for the computer as a whole.

ROHS / LEAD-FREE STATEMENT

All models are produced in compliance with RoHS and various other lead-free initiatives.

WARNING

A SINGLE STATIC DISCHARGE CAN DAMAGE YOUR CARD AND CAUSE PREMATURE FAILURE! PLEASE FOLLOW ALL REASONABLE PRECAUTIONS TO PREVENT A STATIC DISCHARGE SUCH AS GROUNDING YOURSELF BY TOUCHING ANY GROUNDED SURFACE PRIOR TO TOUCHING THE CARD.

ALWAYS CONNECT AND DISCONNECT YOUR FIELD CABLING WITH THE COMPUTER POWER OFF. ALWAYS TURN COMPUTER POWER OFF BEFORE INSTALLING A CARD. CONNECTING AND DISCONNECTING CABLES, OR INSTALLING CARDS, INTO A SYSTEM WITH THE COMPUTER OR FIELD POWER ON MAY CAUSE DAMAGE TO THE I/O CARD AND WILL VOID ALL WARRANTIES, IMPLIED OR EXPRESSED.

WARRANTY

Prior to shipment, ACCES equipment is thoroughly inspected and tested to applicable specifications. However, should equipment failure occur, ACCES assures its customers that prompt service and support will be available. All equipment originally manufactured by ACCES which is found to be defective will be repaired or replaced subject to the following considerations:

GENERAL

Under this Warranty, liability of ACCES is limited to replacing, repairing or issuing credit (at ACCES discretion) for any products which are proved to be defective during the warranty period. In no case is ACCES liable for consequential or special damage arriving from use or misuse of our product. The customer is responsible for all charges caused by modifications or additions to ACCES equipment not approved in writing by ACCES or, if in ACCES opinion the equipment has been subjected to abnormal use. "Abnormal use" for purposes of this warranty is defined as any use to which the equipment is exposed other than that use specified or intended as evidenced by purchase or sales representation. Other than the above, no other warranty, expressed or implied, shall apply to any and all such equipment furnished or sold by ACCES.

TERMS AND CONDITIONS

If a unit is suspected of failure, contact ACCES' Customer Service department. Be prepared to give the unit model number, serial number, and a description of the failure symptom(s). We may suggest some simple tests to confirm the failure. We will assign a Return Material Authorization (RMA) number which must appear on the outer label of the return package. All units/components should be properly packed for handling and returned with freight prepaid to the ACCES designated Service Center and will be returned to the customer's/user's site freight prepaid and invoiced.

COVERAGE

FIRST THREE YEARS: Returned unit/part will be repaired and/or replaced at ACCES option with no charge for labor or parts not excluded by warranty. Warranty commences with equipment shipment.

FOLLOWING YEARS: Throughout your equipment's lifetime, ACCES stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry.

EQUIPMENT NOT MANUFACTURED BY ACCES

Equipment provided but not manufactured by ACCES is warranted and will be repaired according to the terms and conditions of the respective equipment manufacturer's warranty.

DISCLAIMER

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PCI EXPRESS MINI CARD STANDARD NOTICE AND EXCEPTION

The mPCI-DIO-24SRL family of devices are fully compliant with PCI Express Mini Card v1.2.