# ISOLATED DIGITAL INPUT & OUTPUT
## BOARD FOR MINI PCI EXPRESS
## HARDWARE MANUAL

| MODEL | mPCIe-ISODIO-16 |
|---|---|

# CHAPTER 1: QUICK START

It is recommended that you install the software package before installing the PCI Express Mini Card (mPCIe) in your computer. You can install the software[1] using a stand-alone installer downloaded from the product page Manuals / Software tab on our website.

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

*Please note: during the installation you may be prompted regarding the installation of non-WHQL-certified drivers; please carefully confirm the digitally signed source of the drivers and accept the installation.*

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

Re-start your system. Once the computer finishes booting your new device should already be installed and ready for use; you can confirm this by launching Device Manager and looking under the "Data Acquisition" section. If, for any reason, the mPCIe displays a warning icon, right-click and select "Update Driver".

[1] *In Linux or OSX please refer to the instructions in those directories.*

# CHAPTER 2: INTRODUCTION
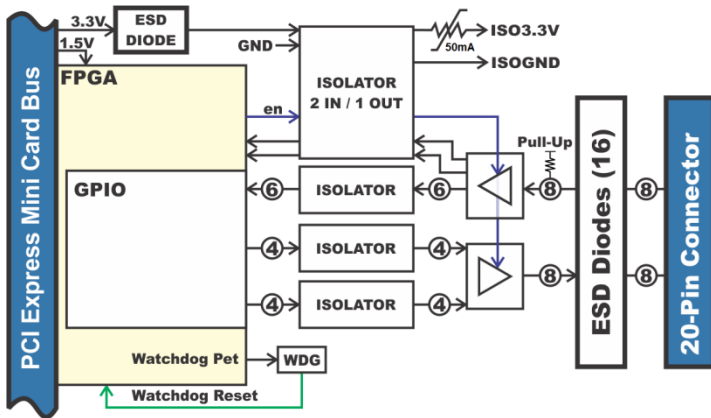


PCI Express Mini Card (mPCIe), a low-profile small-footprint bus standard originally intended for adding peripherals to notebook computers, has become the de-facto standard for high-performance, small form-factor devices in many applications.

## FEATURES

- PCI EXPRESS MINI CARD (mPCIE) TYPE F1, WITH LATCHING I/O CONNECTOR
- 8 ISOLATED INPUTS, 8 ISOLATED OUTPUTS, 3.3V SIGNALING
- USING THE LATEST ISOLATION TECHNOLOGY WITH 5000V ISOLATORS
- PER IPC-2221B: 1500V ISOLATION I/O-TO-COMPUTER ON ALL SIGNALS
- CHANGE-OF-STATE (CoS) DETECTION IRQ GENERATION
- 18KV ESD DIODE PROTECTION
- OPTIONAL 9" CABLE (228MM) TO PANEL MOUNTABLE DB25F
- AVAILABLE INDUSTRIAL TEMP (-40°C TO +85°C), ROHS STANDARD
- ON-BOARD 32-BIT TIMER WATCHDOG TO RESET BOARD TO DEFAULT POWER-UP VALUES

The mPCIe-ISODIO-16 card is well suited to complex environments, mitigating otherwise challenging ground-loops, high-common-mode, and transient voltage spikes common in electrically-noisy industrial or factory locations.

The mPCIe-ISODIO-16 provides 8 isolated digital inputs and 8 isolated digital outputs. Featuring Tru-Iso™ I/O-to-PC isolation this card provides a robust solution to common signal level and grounding issues when used in electrically noisy environments; at up to 1500V between I/O and the host computer, it's like data insurance.

Change of State (COS) detection and interrupt generation capabilities are designed to relieve software from polling routines that consume valuable processing time. Inputs can be programmed for detecting state changes on their lines, in which any changes of the bits (low-to-high or high-to-low) will generate an IRQ. An ISR (interrupt service routine) then determines which bit changed state and clears the interrupt.

# CHAPTER 3: HARDWARE

| This manual applies to model: |
|---|
| **mPCIe-ISODIO-16** 8 Isolated Inputs, 8 Isolated Outputs Card |

This card model is a full-length "F1" mPCIe device (30 × 50.95 mm). It is connected to a DB25F panel mounted connector via an available 9" (229mm) 20-conductor cable. The device is RoHS compliant.
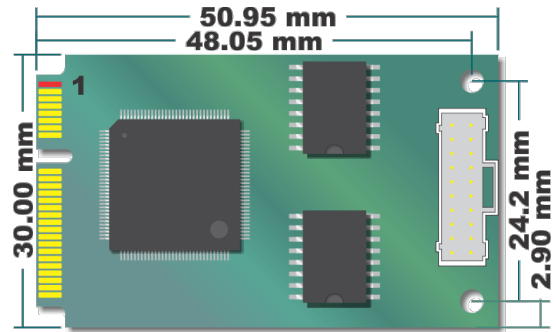


## INCLUDED IN YOUR PACKAGE

mPCIe-ISODIO-16 Isolated Digital I/O mPCIe card

| Available accessories include: | |
|---|---|
| **CAB-mPCIe-ISODIO** | Cable Assembly, 20 pin to DB25F, 9" |
| **ADAP25M** | 25 Pin Screw Terminal Accessory |
| **mPCIe-HDW-KIT2** | Mounting hardware for 2mm |
| **mPCIe-HDW-KIT2.5** | Mounting hardware for 2.5mm |

Contact the factory for information regarding additional accessories, options, and specials that may be available to best fit your specific application requirements, such as extended temperature, conformal coating, or alternate cable lengths, to name a few.

# CHAPTER 4: CONFIGURATION SETTINGS

There are no configuration settings on the mPCIe-ISODIO-16.

# CHAPTER 5: PC INTERFACE

This product interfaces with a PC using a PCI Express Mini Card (mPCIe) connection; a small-form-factor, high-performance, rugged peripheral interconnect technology first introduced for use in laptops and other portable computers.

mPCIe's small size and powerful performance, combined with perfect software compatibility with PCI and PCIe peripheral designs, have led to its recent adoption as a go-to standard for embedded Data Acquisition and Control, and many other applications.

Although mPCIe is a broadly-adopted industry standard, the actual connection to the computer shares a specification with mSATA: both mSATA and mPCIe use the same edge-connector. In fact, well-designed PCs can automatically detect and configure their onboard connectors to work with either mPCIe or mSATA devices – and, according to the standards for mPCIe and mSATA they are *supposed* to do so! However, some PC manufacturers ship computers that *only* support mSATA devices. Please confirm in your PC documentation that your edge-connector is *actually* PCI Express Mini Card compliant before installing this, or any, mPCIe card. Damage might occur if you install an mPCIe device into a computer that only supports mSATA.

mPCIe defines mounting holes for securing the otherwise loose end of the card, so it is impossible for these cards to wiggle or flap themselves loose (which was a recurring problem with the older PCI Mini devices). Eliminating this concern for PCI Express Mini Cards is a major reason this standard has seen rapid adoption by the Data Acquisition and Control industry.

The mPCIe standard, like its PCI Mini Card predecessor, was designed assuming use primarily in Laptop or Notebook and similar devices, where physical dimension is often the paramount design constraint. In Data Acquisition and Control applications low-weight combined with vibration tolerance tend to be of more concern.

# CHAPTER 6: I/O INTERFACE
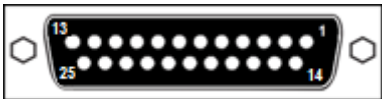


DB25F Pinouts on CAB-mPCIe-ISODIO cable assembly

| Signal Definitions | |
|---|---|
| Signal | Meanings |
| IN | Isolated Input |
| OUT | Isolated Output |
| ISOGND | Isolated Ground |
| VCCIO | Fused Isolated +3.3VDC @ 0.05A* |
| N/C | No Connection |

*Keep cumulative power draw from I/O sourcing and VCCIO <50mA

| DB-25 Female Pinout | | | |
|---|---|---|---|
| 1 | IN 0 | 14 | OUT 0 |
| 2 | IN 1 | 15 | OUT 1 |
| 3 | IN 2 | 16 | OUT 2 |
| 4 | IN 3 | 17 | OUT 3 |
| 5 | IN 4 | 18 | OUT 4 |
| 6 | IN 5 | 19 | OUT 5 |
| 7 | IN 6 | 20 | OUT 6 |
| 8 | IN 7 | 21 | OUT 7 |
| 9 | N/C | 22 | N/C |
| 10 | N/C | 23 | N/C |
| 11 | ISOGND | 24 | N/C |
| 12 | ISOGND | 25 | VCCIO |
| 13 | ISOGND | | |

Custom hardware interfaces can be produced to fit your specific application requirement.

# CHAPTER 7: SOFTWARE INTERFACE

The simplest way to program for the device is using legacy-compatibility mode: the device boots into this mode. In this mode, the unit provides I/O-mapped registers: 2 DIO registers, enable register and a 32-bit register for the Watchdog Timer.

| I/O Registers at BAR [2] | | |
|---|---|---|
| Register offset (hex) | Write Operation | Read Operation |
| Isolated Outputs [ + 0 ] | 0-7 output | Output 0-7 read-back |
| Isolated Inputs [ + 1 ] | *unused* | Input 0-7 input |
| Buffer Enable [ + A ] | Control DIO Buffer Enable | DIO Buffer Enable Read-back |
| Cos Mask [ + B ] | Change-of-State Enable | Change-of-State Enable Read-back |
| IRQ Clear [ + F ] | Clear IRQ | *unused* |
| IRQ Clear/Status [ + 29 ] | Clear IRQ | IRQ Status |
| Watchdog Timer [+30..+33 ] | 32-bit Watchdog Timeout Duration Divisor | Read-back of Watchdog Timeout Duration Divisor |

In the following bit-level register descriptions the column labeled "Dir" indicates read or write operation, with the following notation:

R: Read function, and W: Write function. RW indicates both.
r: read, and w: write, but less-commonly useful than R or W

| + 0 | Dir | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|
| Out # | rW | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Writing one byte to +0 will control all 8 isolated outputs. Setting a bit to 1 sets the corresponding isolated output, while clearing a bit to 0 turns it off. Reading a byte will provide the currently commanded output state (read-back).

| + 1 | Dir | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|
| In # | R | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

Reading from +1 returns 8 bits. Each bit indicates the level that was detected at the corresponding isolated input.

| + A | Dir | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|
| ENABLE | RW | | | | | | | | EN |

Setting a bit to 1 at D0 at this register disables the DIO buffer, while clearing the bit to 0 enables it.

| + B | Dir | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|
| ENABLE | RW | | | | | | | | CoS |

Setting a bit to 1 at D0 at this register masks the Change-of-State for the inputs, while clearing the bit to 0 enables it.

| + F | Dir | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|
| Clear | W | | | | | | | | 0 |

Writing any value to +F clears all pending IRQ source latches.

| + 29 | Dir | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|
| IRQ Clr | W | Write 0xFF to clear pending IRQs | | | | | | | |
| IRQ Stat | R | | | | | | | | INT |

Write "1" to clear the pending IRQ. Bits D1 through D7 are reserved, for best results write "1" to all bits (0xFF).

Reading will give the current IRQ latch state. Bit D0 "1" means "an IRQ was generated".

| + 30...+33 | Dir | D31...D0 |
|---|---|---|
| WDG | rW | 32-Bit Timer Value |

Upon power-up the FPGA will continuously "pet" the external TPS3820 watchdog chip's WDI input with an FPGA-generated pulse-train.

A DWORD write to register base+30h will use the value written as the timeout value for the watchdog and will begin the countdown process. Note: Byte/Word writes are ignored, must be 32-bit. This value is the desired Watchdog Timeout duration as a number of 8ns "ticks". (Divide 125000000 by the desired timeout, in nanoseconds, to calculate the desired register (divisor) load value.)

If the count value decrements to 0 the FPGA will stop "petting" the TPS3820 and it will (after the ~200ms time out period) "bark" (for ~25ms), resetting the FPGA.

Any write or read of any valid mPCIe-ISODIO-16 register will reload the initial (or new, if it was a write to +30h) 32-bit divisor value and the countdown process resumes.

After the TPS3820 "barks" the FPGA resets to its default values and will behave in the same way as at power-up.

| PCI Express Mini Card Plug-and-Play Data | |
|---|---|
| Vendor / Device ID | Card Type |
| 0x494F / 0x0DC9 | mPCIe-ISODIO-16 |

## Available Downloads

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

| Links and useful downloads | |
|---|---|
| Main site | http://acces.io |
| Product's page | acces.io/mPCIe-ISODIO-16 |
| This manual | acces.io/MANUALS/mPCIe-ISODIO-16.pdf |
| Windows Software | acces.io/files/packages/mPCIe-ISODIO-16 |
| Install Package | Install.exe |

## PC Interface

| PCI Express Mini Card | Type F1 "Full Length" |
|---|---|

## Isolated Inputs

| Number | 8 | |
|---|---|---|
| Voltage | Logic High | 2.0V to 5V |
| | Logic Low | 0V to 0.8V |

## Isolated Outputs

| Number | 8 | |
|---|---|---|
| Voltage | Logic High | 2.0V (min), source 32mA |
| | Logic Low | 0.55V (max), sink 64mA |
| | Power Output | +3.3VDC via 50mA polyfuse (resetting) |

## Environmental

| Temperature | Operating | 0°C to +70°C |
|---|---|---|
| | | -40°C to +85°C (-T option) |
| | Storage | -65°C to +150°C |
| Humidity | | 5% to 95% RH, non-condensing |
| Power Required | +3.3VDC | 500mA |
| | +1.5VDC | 415mA |

## Physical

| Weight | 7.2g | |
|---|---|---|
| Size | Length: | 50.95mm (2.006") |
| | Width: | 30.00mm (1.181") |
| I/O connectors | On-card: | Molex 501190-2017 20-pin latching |
| | Mating | Molex 501189-2010 |
| | On-cable | Female, D-Sub Miniature, 25-pin |
| | Mating | Male, D-Sub Miniature, 25-pin |

## Isolation

| Tru-Iso | IPC-2221B |
|---|---|
| I/O to PC | 1500 V peak (AC or DC) |
| | UL-1577 |
| | UL recognition (pending): 5000 V rms for 1 minute |

*Careful attention has been paid to isolation design, including extensive keep-out zones and hand-routed circuit paths, as well as component and material selection.*

# 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.

### UL & TUV

No AC or DC voltages above 31V are consumed or produced during normal operation of this device. This product is therefore exempt from any related safety standards. Use it with confidence!

### 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.

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