# CPCI-DIO1616/2

## CompactPCI® Digital I/O-Board

Manual

to Product I.2309.04



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## Notes

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This manual contains important information and instructions on safe and efficient handling of the CPCI-DIO1616/2. Carefully read this manual before commencing any work and follow the instructions.
The manual is a product component, please retain it for future use.

# Document Information

| | |
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**Document History**

The changes in the document listed below affect changes in the hardware as well as changes in the description of the facts, only.

| Rev. | Chapter | Changes versus previous version | Date |
|---|---|---|---|
| 1.0 | - | First version of English CPCI-DIO1616/2 manual. | 2024-03-15 |
| | | | |

Technical details are subject to change without further notice.

## Classification of Warning Messages and Safety Instructions

This manual contains noticeable descriptions, warning messages and safety instructions, which you must follow to avoid personal injuries or death and property damage.

This is the safety alert symbol.
It is used to alert you to potential personal injury hazards. Obey all safety messages and instructions that follow this symbol to avoid possible injury or death.

### DANGER, WARNING, CAUTION

Depending on the hazard level the signal words DANGER, WARNING or CAUTION are used to highlight safety instructions and warning messages. These messages may also include a warning relating to property damage.

**DANGER**
Danger statements indicate a hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING**.
Warning statements indicate a hazardous situation that, if not avoided, could result in death or serious injury.

**CAUTION**
Caution statements indicate a hazardous situation that, if not avoided, could result in minor or moderate injury.

### NOTICE

Notice statements are used to notify people on hazards that could result in things other than personal injury, like property damage.

**NOTICE**
This NOTICE statement indicates that the device contains components sensitive to electrostatic discharge.

**NOTICE**
This NOTICE statement contains the general mandatory sign and gives information that must be heeded and complied with for a safe use.

### INFORMATION

**INFORMATION**
Notes to point out something important or useful.

# Safety Instructions

- When working with the CPCI-DIO1616/2 follow the instructions below and read the manual carefully to protect yourself from injury and the CPCI-DIO1616/2 from damage.
- The device is a built-in component. It is essential to ensure that the device is mounted in a way that cannot lead to endangering or injury of persons or damage to objects.
- Do not use damaged or defective cables to connect the CPCI-DIO1616/2.
- In case of damages to the device, which might affect safety, appropriate and immediate measures must be taken, that exclude an endangerment of persons and domestic animals and property.
- The galvanic isolation of the CPCI-DIO1616/2 has only functional tasks and is not a protection against hazardous electrical voltage.
- The CPCI-DIO1616/2 may only be operated on supply circuits that provide sufficient protection against dangerous voltages.
- External circuits connected to the interfaces of the CPCI-DIO1616/2 must be sufficiently protected against dangerous voltage.
- The user is responsible for compliance with the applicable national safety regulations.

- The device must be securely installed in the control cabinet before commissioning.
- Protect the CPCI-DIO1616/2 from dust, moisture, and steam.
- Protect the CPCI-DIO1616/2 from shocks and vibrations.
- The CPCI-DIO1616/2 may become warm during normal use. Always allow adequate ventilation around the CPCI-DIO1616/2 and use care when handling.
- Do not operate the CPCI-DIO1616/2 adjacent to heat sources and do not expose it to unnecessary thermal radiation. Ensure an ambient temperature as specified in the technical data.

**DANGER**

Hazardous Voltage - **Risk of electric shock** due to unintentional contact with uninsulated live parts with high voltages inside of the system into which the CPCI-DIO1616/2 is to be integrated.

→ Disconnect all hazardous voltages (mains voltage) before opening the system.

→ Ensure the absence of voltage before starting any electrical work

**NOTICE**

**Electrostatic discharges may cause damage to electronic components.**

→ Take the appropriate precautions for handling electrostatic discharge sensitive devices.

→ Discharge the static electricity from your body before touching the CPCI-DIO1616/2.

→ Transport and store the CPCI-DIO1616/2 only in an electrostatically safe bag, as when delivered.

## Qualified Personnel

This documentation is directed exclusively towards personnel qualified in control and automation engineering. The installation and commissioning of the product may only be carried out by qualified personnel, which is authorized to put devices, systems, and electric circuits into operation according to the applicable national standards of safety engineering.

## Conformity

The CPCI-DIO1616/2 is an industrial product and meets the demands of the EU regulations and EMC standards printed in the conformity declaration at the end of this manual.

**Warning:** In a residential, commercial, or light industrial environment the CPCI-DIO1616/2 may cause radio interferences in which case the user may be required to take adequate measures.

The CPCI-DIO1616/2 is a sub-assembly intended for incorporation into an apparatus by a manufacturer and NOT by the end user. The manufacturer of the final system must decide whether additional EMC or EMI protection requirements are necessary.

## Intended Use

The intended use of the CPCI-DIO1616/2 is the operation as CompactPCI® Digital I/O-Board.
The guarantee given by esd does not cover damages which result from improper use, usage not in accordance with regulations or disregard of safety instructions and warnings.

- The CPCI-DIO1616/2 is intended for installation in a CompactPCI system
- The operation of the CPCI-DIO1616/2 in hazardous areas, or areas exposed to potentially explosive materials is not permitted.
- The operation of the CPCI-DIO1616/2 for medical purposes is prohibited.

## Service Note

The CPCI-DIO1616/2 does not contain any parts that require maintenance by the user. The CPCI-DIO1616/2 does not require any manual configuration of the hardware. Unauthorized intervention in the device voids warranty claims

## Disposal

Products marked with a crossed-out dustbin must not be disposed of with household waste. Devices which have become defective in the long run must be disposed in an appropriate way or must be returned to the manufacturer for proper disposal. Please, contribute to environmental protection.

---

### Typographical Conventions

Throughout this manual the following typographical conventions are used to distinguish technical terms.

| Convention | Example |
|---|---|
| File and path names | **`/dev/null`** or **`<stdio.h>`** |
| Function names | ***open()*** |
| Programming constants | `NULL` |
| Programming data types | `uint32_t` |
| Variable names | *Count* |

### Number Representation

All numbers in this document are base 10 unless designated otherwise. Hexadecimal numbers have a prefix of 0x, and binary numbers have a prefix of 0b. For example, 42 is represented as 0x2A in hexadecimal and 0b101010 in binary.

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# 1 Overview

## 1.1 About this Manual

This manual describes the hardware and the available driver software of the CPCI-DIO1616/2.

## 1.2 Description of CPCI-DIO1616/2

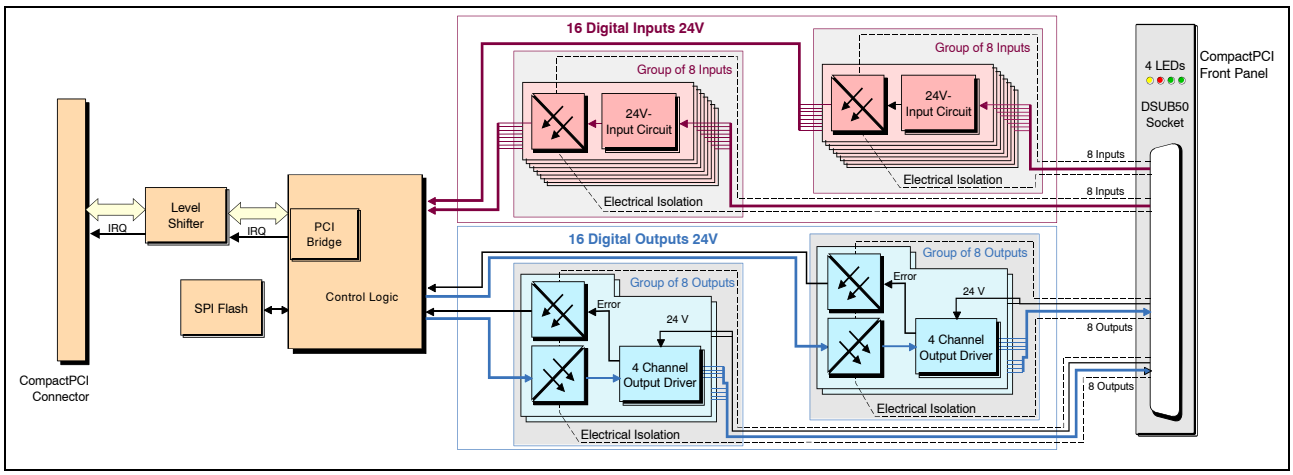



**Figure 1:** Block circuit diagram

The CPCI-DIO1616/2 is a CompactPCI board in Eurocard format.
It provides 16 digital inputs in accordance with IEC 61131-2 Type 3 and 16 digital outputs in accordance with IEC 61131-2 Type 1A via a 50-pin DSUB connector. The 16 inputs are designed for 24 V. All inputs and outputs are electrically isolated divided into groups of eight.
The CPCI-DIO1616/2 is designed as successor of the CPCI-DIO1616. The properties of the predecessor module are retained as far as possible.

Each digital input can be configured individually to generate interrupts triggered by rising or falling edge input signals.
The 16 digital outputs are designed as 24V high-side switches. They are protected against overtemperature and short circuit The error signals of the output drivers can be read. IRQs on errors can be activated.
For an easier connection of the inputs and outputs, a passive module can be connected to the DSUB50 connector via a ribbon cable.

Software drivers are available for QNX®. Drivers for other operating systems are available on request.

# 1.3 Glossary

## Abbreviations

| Abbreviation | Term |
|---|---|
| API | Application Programming Interface |
| CPU | Central Processing Unit |
| HW | Hardware |
| I/O | Input/Output |
| LSB | Least Significant Bit |
| MSB | Most Significant Bit |
| n.a. | not applicable |
| OS | Operating System |
| PLD | Programmable Logic Device |
| RTR | Remote Transmission Request |
| SDK | Software Development Kit |

# 1.4 References

(1) PCI Local Bus Specification, Revision 3.0, PCI_LB3.0-2-6-04.pdf; from 3. Feb. 2004
(2) CompactPCI Specification, Revision 3.0, „PICMG 2.0 R3.0“, October 1, 1999, Hardcopy

# 2 PCB View with Connectors

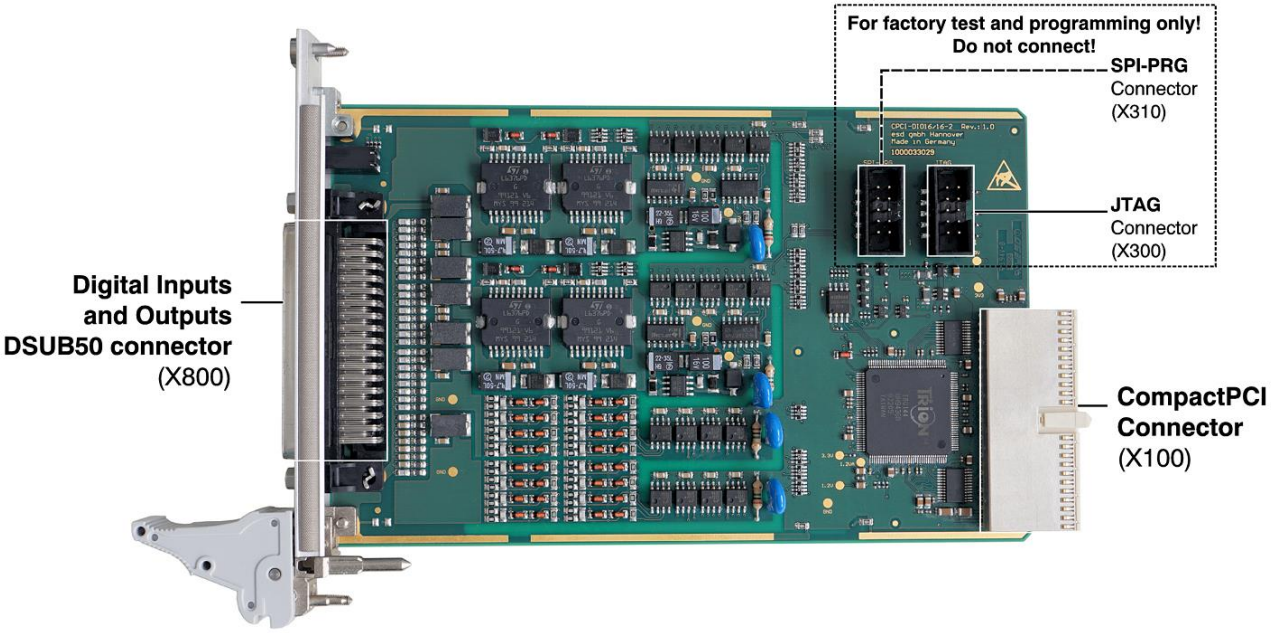


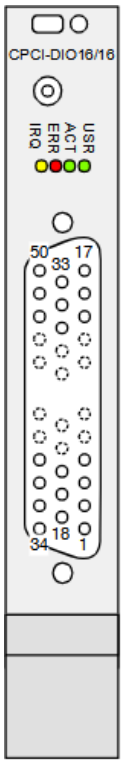

**Figure 2:** PCB top view

**NOTICE**
Read chapter “Installing and Uninstalling Hardware” on page 13, before you start with the installation of the hardware!

See also page 25 for signal assignment of the connectors.

# 3 LEDs

## 3.1 Front Panel View and Description of the LEDs




| LED | Function | Colour | Status | Meaning |
|---|---|---|---|---|
| USR | User-LED | Green | On | User-LED-bit = ‘1’ |
| | | | Off | User-LED-bit = ‘0’ |
| ACT | Activity | Green | On | Access to I/O register |
| | | | Off | No access to I/O register |
| ERR | Error | Red | On | Error of digital outputs (excess current, excess temperature or power supply of digital outputs too low) |
| | | | Off | No error |
| IRQ | Interrupt | Yellow | On | CPCI-DIO1616-board triggers an interrupt |
| | | | Off | No interrupt |

**Figure 3:** Connectors and LEDs

**Description**

USR — The User-LED can be freely set by the user.
It is controlled in the same way as the 16 digital outputs.

ERR — The LED lights up if there is an error condition for at least one of the 16 outputs. The error LED lights up in the event of overtemperature, overcurrent and insufficient power supply to the output drivers, i.e. even if no voltage is applied to the output drivers.

# 4 Installing and Uninstalling Hardware

**NOTICE**
**Read the safety instructions at the beginning of this document carefully before you start with the hardware installation/uninstallation!**

**WARNING**
Hazardous Voltage - **Risk of electric shock** due to unintentional contact with uninsulated live parts with high voltages inside of the system into which the CPCI-DIO1616/2 is to be integrated.

→ The CPCI-DIO1616/2 may only be operated on supply circuits that provide sufficient protection against dangerous voltages.
→ External circuits connected to the interfaces of the CPCI-DIO1616/2 must be sufficiently protected against dangerous voltage.
→ The user is responsible for compliance with the applicable national safety regulations.
→ Disconnect all hazardous voltages (mains voltage) before opening the system.
→ Never carry out work while power supply voltage is switched on!
→ Ensure the absence of voltage before starting any electrical work.

**NOTICE**
**Electrostatic discharges may cause damage to electronic components.**

→ Take the appropriate precautions for handling electrostatic discharge sensitive devices.
→ Discharge the static electricity from your body before touching the CPCI-DIO1616/2.
→ Transport and store the CPCI-DIO1616/2 only in an electrostatically safe bag, as when delivered.

## 4.1 Preparation

**Procedure:**

1. Switch off your system and all connected peripheral devices (monitor, printer, etc.).
2. Discharge your body.
3. Disconnect the system from the mains.
   Make sure that no risk arises from the system into which the CPCI-DIO1616/2 shall be inserted.
   Read the manual of the system used and follow the instructions of the system manufacturer.

   **WARNING**
   Hazardous Voltage
   **Risk of electric shock** due to unintentional contact with uninsulated live parts with high voltages.

   → Disconnect all hazardous voltages (mains voltage) before opening the system.
   → If the system does not have a flexible mains cable, but is directly connected to mains, disconnect the power supply via the safety fuse and make sure that the fuse cannot switch on again unintentionally (i.e., with caution label).
   → Ensure the absence of voltage before starting any electrical work.
   → Cover or block off adjacent live parts.

4. Open the case if necessary.

To install the CPCI-DIO1616/2 board, continue as described in chapter 4.2 ‘Installing the Hardware’. To uninstall the CPCI-DIO1616/2 board, continue as described in chapter 4.3 ‘Uninstalling the Hardware’.

## 4.2 Installing the Hardware

1. Read and follow the safety instructions at the beginning of chapter 4 and execute step 1 to 4 of the preparation procedure as described in chapter 4.1 if not already done.
2. Select a free CompactPCI slot and remove the slot cover in the rear panel of the PC.
3. Insert the CPCI-DIO1616/2 board into the selected CompactPCI slot.
   Carefully push the board until it snaps into place.
4. Fix the module.
5. Close the system's case again.
6. Connect the digital I/O via the DSUB50 connector in the front panel of the CPCI-DIO1616/2.
7. Connect the system to mains again (mains connector or safety fuse).
8. Before you switch on the supply voltage, check that all plug connectors are correctly seated. Switch on the system and the peripheral devices.
9. Set the interface properties in your operating system. Refer to the documentation of the operating system.

## 4.3 Uninstalling the Hardware

1. Read and follow the safety instructions at the beginning of chapter 4 and execute step 1 to 4 of the preparation procedure as described in chapter 4.1 if not already done.
2. Make sure that all connected interfaces and power supply are switched off.
3. Disconnect the CPCI-DIO1616/2 from the connected interfaces.
4. Loosen the fastening of the CPCI-DIO1616/2.
5. Carefully pull the CPCI-DIO1616/2 out of the slot.
6. If necessary, mount the slot cover again.

# 5 Description of the Units

## 5.1 Input and Output Circuits

### 5.1.1 Digital Inputs

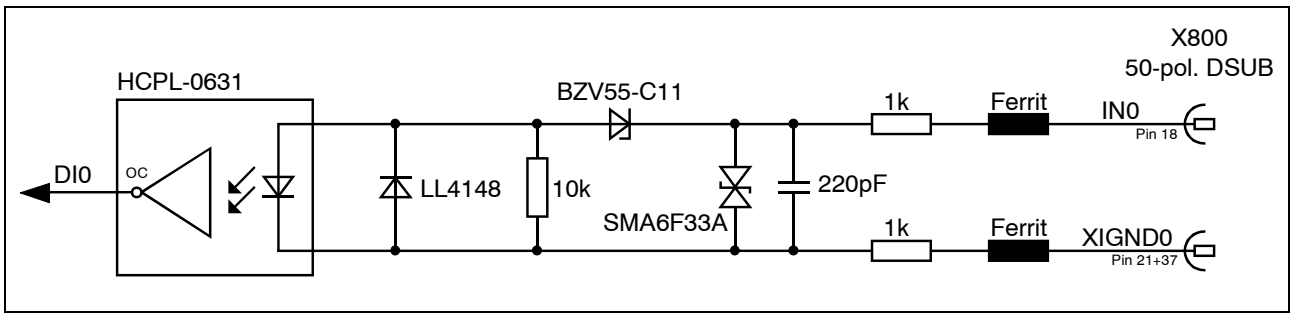



**Figure 4:** Digital Input circuit IN0 (Example)

### 5.1.2 Digital Outputs

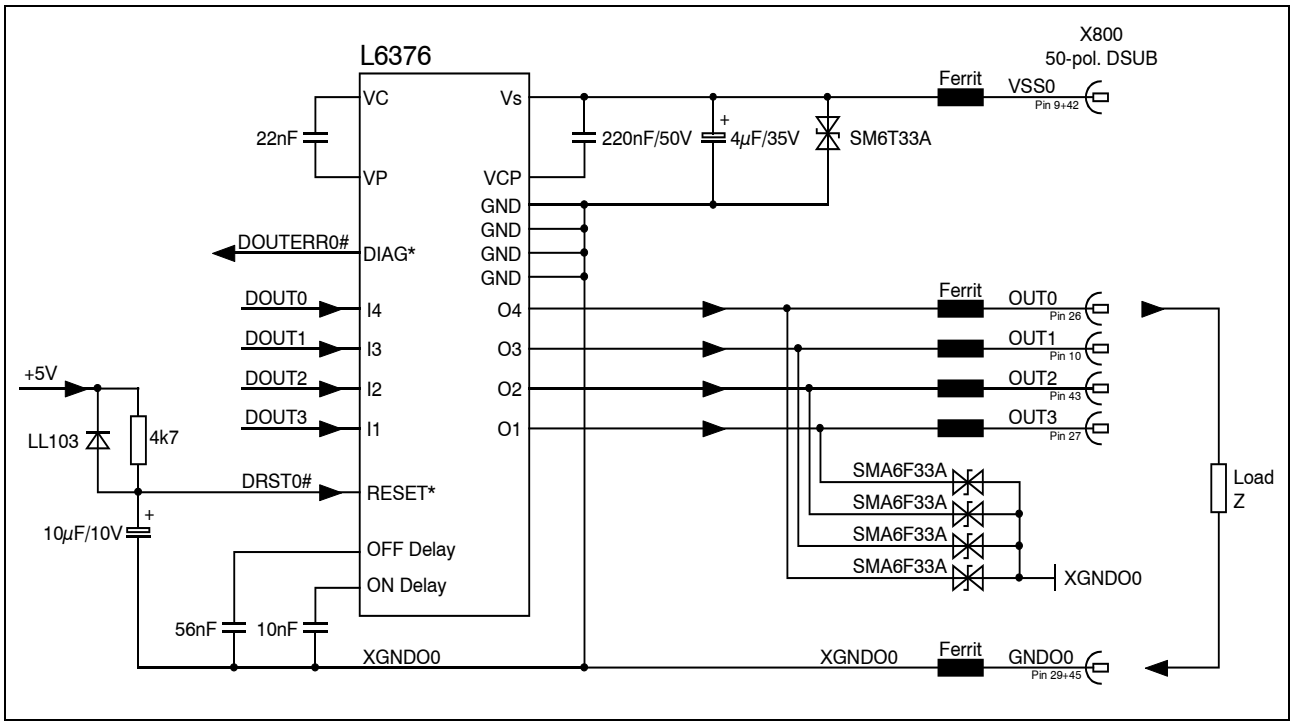



**Figure 5:** Digital output circuit OUT0-OUT3 (Example)

# 5.2 Register

As the CPCI-DIO1616/2 is the successor to the CPCI-DIO16/16, software development is essentially limited to the creation of the FPGA image. The existing operating system drivers were used largely unchanged. The necessary modifications are limited to adapting the PCI IDs.

An essential component of the FPGA image is an IP core, that contains the registers required to control the input and output functions.

## 5.2.1 PCI-IP Core in FPGA

| | |
|---|---|
| Specification | Based on PCI Specification 3.0 (1) |
| Bus width | 32 bit |
| Bus speed | 33 MHz |
| Bus Master Support | Target only |
| Interrupt Support | Yes – Support for Interrupt Line A |
| Device Registers | Accessible via PCI Config Space BAR0.<br>4 kByte memory mapped. See 5.2.2 |
| PCI-IDs | Vendor ID: 0x12FE<br>Device ID: 0x0121<br>Subsystem Vendor ID: 0x12FE<br>Subsystem Device ID: 0x0121 |

## 5.2.2 Register Overview

The following registers are available on the CPCI-DIO1616/2.
All registers are 32 bits wide.

| Offset to MM I/O Space Base Address | Register | |
|---|---|---|
| | Write Access | Read Access |
| +0x00 | Output register | Output register |
| +0x04 | ---- | Input register |
| +0x08 | IRQ-reset register | IRQ status register |
| +0x0C | IRQ-enable register LH edge | IRQ enable register LH edge |
| +0x10 | IRQ-enable register HL edge | IRQ enable register HL edge |
| +0x14 | ---- | FPGA version register |
| +0x18 – 0xFFF | reserved | reserved |

**Table 1:** Register Overview

## 5.2.3 Output Register

Address offset to base address: 0x00
Access: Write and read
Value after the reset: 0x0000
Function: Set the digital outputs and the User LED

| Bit | Assignment | Level Assignment |
|---|---|---|
| 31<br>:<br>17 | Reserved<br>:<br>Reserved | - |
| 16 | *User-LED-Bit* | '0' -> LED off<br>'1' -> LED on |
| 15<br>:<br>0 | *Output 15*<br>*:*<br>*Output 0* | '0' -> Output inactive<br>'1' -> Output driving |

## 5.2.4 Input Register

Address offset to base address: 0x04
Access: Read only
Value after the reset: Always corresponds to the input states.
Function: Reading the input states and the error status of the output drivers

| Bit | Assignment | Level Assignment |
|---|---|---|
| 31<br>:<br>20 | Reserved<br>:<br>Reserved | |
| 19<br>18<br>17<br>16 | *Error outputs 12 - 15*<br>*Error outputs 8 - 11*<br>*Error outputs 4 - 7*<br>*Error outputs 0 - 3* | ‘0’ -> No error<br>‘1’ -> Error |
| 15<br>:<br>0 | *Input 15*<br>*:*<br>*Input 0* | ‘1‘ -> Input voltage off<br>‘0‘ -> Input voltage on |

## 5.2.5 IRQ Status Register

Address offset to base address: 0x08
Access: Read only
Value after the reset: 0x0000
Function: Reading the interrupt source after an interrupt has been triggered

| Bit | Assignment | Level Assignment |
|---|---|---|
| 31<br>:<br>20 | Reserved<br>:<br>Reserved | |
| 19<br>18<br>17<br>16 | *IRQ error outputs 12 - 15*<br>*IRQ error outputs 8 - 11*<br>*IRQ error outputs 4 - 7*<br>*IRQ error outputs 0 - 3* | ‘0’ -> No IRQ<br>‘1’ -> IRQ has been triggered |
| 15<br>:<br>0 | *IRQ 15*<br>*:*<br>*IRQ 0* | ‘0’ -> No IRQ<br>‘1’ -> IRQ has been triggered |

## 5.2.6 IRQ Reset Register

Address offset to base address: 0x08
Access: Write only
Function: Resetting the IRQ-status register

| Bit | Assignment | Level Assignment |
|---|---|---|
| 31<br>:<br>20 | Reserved<br>:<br>Reserved | |
| 19<br>18<br>17<br>16 | IRQ error outputs 12 - 15<br>IRQ error outputs 8 - 11<br>IRQ error outputs 4 - 7<br>IRQ error outputs 0 - 3 | ‘0’ -> No action<br>‘1’ -> Reset IRQ |
| 15<br>:<br>0 | IRQ 15<br>:<br>IRQ 0 | ‘0’ -> No action<br>‘1’ -> Reset IRQ |

## 5.2.7 IRQ Enable Register LH (Rising Edge)

Address offset to base address: 0x0C
Access: Read and write
Value after the reset: 0x0000
Function: Activation of an interrupt during a transition from low to high of an input

| Bit | Assignment | Level Assignment |
|---|---|---|
| 31<br>:<br>20 | Reserved<br>:<br>Reserved | |
| 19<br>18<br>17<br>16 | IRQ error outputs 12 - 15<br>IRQ error outputs 8 - 11<br>IRQ error outputs 4 - 7<br>IRQ error outputs 0 - 3 | ‘0’ -> No IRQ<br>‘1’ -> IRQ at rising edge |
| 15<br>:<br>0 | IRQ 15<br>:<br>IRQ 0 | ‘0’ -> No IRQ<br>‘1’ -> IRQ at rising edge |

## 5.2.8 IRQ Enable Register HL (Falling Edge)

Address offset to base address: 0x10
Access: Read and write
Value after the reset: 0x0000
Function: Activation of an interrupt during a transition from high to low of an input

| Bit | Assignment | Level Assignment |
|---|---|---|
| 31<br>:<br>20 | Reserved<br>:<br>Reserved | |
| 19<br>18<br>17<br>16 | IRQ error outputs 12 - 15<br>IRQ error outputs 8 - 11<br>IRQ error outputs 4 - 7<br>IRQ error outputs 0 - 3 | ‘0’ -> No IRQ<br>‘1’ -> IRQ at falling edge |
| 15<br>:<br>0 | IRQ 15<br>:<br>IRQ 0 | ‘0’ -> No IRQ<br>‘1’ -> IRQ at falling edge |

## 5.2.9 FPGA Version Register

Address offset to base address: 0x14
Access: Read only
Value after the reset: FPGA Version (First version starting with 0x0001)
Function: Reading out the version of the VHDL implementation

| Bit | Assignment |
|---|---|
| 31<br>:<br>0 | MSB<br>:<br>LSB |

# 5.3 LED Control

| LED | Triggering | Function |
|---|---|---|
| USR | See 5.2.3 | Setting or resetting is determined by an output register.<br>‘0’ -> LED off<br>‘1’ -> LED on |
| ACT | By a read or write access to one of the registers described in 5.2.2. | When a register is accessed, a retriggerable "one-shot" timer is set, which guarantees a minimum LED lighting time of 200ms.<br>‘0’ -> LED off<br>‘1’ -> LED on |
| ERR | Is generated by linking the error signals.<br>FPGA load errors are also covered by using the NSTATUS output. | In the event of a fault, a retriggerable "one-shot" timer is set which guarantees a minimum LED illumination time of 200 ms.<br>‘0’ -> LED off<br>‘1’ -> LED on |
| IRQ | Is triggered when an interrupt request (sum of all interrupts) is present. | If there is an interrupt request, a retriggerable "one-shot" timer is set which guarantees a minimum LED lighting time of 200ms.<br>‘0’ -> LED off<br>‘1’ -> LED on |

# 6 Technical Data

## 6.1 General Technical Data

| | |
|---|---|
| Power supply voltage | 5 V DC (+5% / -3%) via the CPCI bus<br>3.3 V DC (+5% / -3%) via the CPCI bus<br>+12V, -12V and VIO are not used. |
| Current consumption | Maximum @ 3.3 V: $I_{MAX\_3.3V}$ = 100 mA |
| Temperature range | -40°C … +85°C ambient temperature |
| Humidity | Operation: max. 90%, non-condensing |
| Protection class | None |
| Form factor / Dimensions | According to CompactPCI Specification, Revision 3.0 (2),<br>160 mm x 100 mm (length x width) without front panel |
| Front panel | 3U/4HP |
| Weight | 180 g |

**Table 2:** General Data of the module

## 6.2 Connectors

| Name | Function, Interfaces | Type | Durability (e.g. grade, contact surface, mating cycles) | Name in schematic diagram |
|---|---|---|---|---|
| J1 | CPCI connector J1 | 110-pos. post right-angle receptacle, socket contacts,<br>e.g.: Erni 354142 or comparable | 250 mating cycles | X100 |
| I/O | Input/Output interface | DSUB50, socket contacts | 250 mating cycles | X800 |

**Table 3:** Connectors, accessible from outside

### 6.2.1 Connectors for esd internal Use

**NOTICE**
These connectors are intended for esd internal testing and programming purposes only.
Do not connect!

| Name | Function, Interfaces | Type | Durability (e.g. grade, contact surface, mating cycles) | Name in schematic diagram |
|---|---|---|---|---|
| JTAG | JTAG-Interface | 10-pos. IDC box header, pin-contacts,<br>e.g.: W&P 1371-10-00-HT-(PP)-ST | no requirements | X101 |
| Debug | Debug Console, TTL level | 10-pos. IDC box header, pin-contacts,<br>e.g.: W&P 1371-10-00-HT-(PP)-ST | no requirements | X103 |

**Table 4:** Connectors for internal use

# 6.3 CompactPCI Bus

| | |
|---|---|
| Number | 1 |
| Standard | CompactPCI Specification, Revision 3.0, (2) |
| PCI-data / address bus | 32 bit, 33 MHz |
| Signalling voltage | 3.3 V (5 V tolerant) |
| CPCI Coding | Universal board (without coding) |
| Interrupt signal | A |
| Connector | CPCI Connector J1, pinning according to CompactPCI Specification, Revision 3.0 |

**Table 5:** Data of the CompactPCI interface

# 6.4 Digital Outputs

| | |
|---|---|
| Number | 16, divided into 2 groups of 8 outputs |
| Max switching frequency | 25 kHz @ pulse / pause ratio 1:1 |
| Driver Topology | High Side switch |
| External voltage range | 9,5 V - 35 V, nominal 24 V |
| External power supply | Each group of 8 outputs shares one power supply. |
| Output current per output | 0.25 A nominal |
| Maximum output current per group of 8 | 2 A |
| Output impedance | ≈ 1000 mΩ ON resistance @ 25°C |
| Driver type | ST L6376D |
| Controller FPGA | Register set in FPGA – see 5.2 |
| Error signalling | Two status signals for every group of 8 outputs (one per driver IC) |
| Galvanic isolation | Yes - divided into 2 groups of 8 outputs (purely functional isolation) |
| Dielectric strength of the galvanic isolation | Output* <-> Output*: 500V DC @ 1s (I < 1 mA)<br>Output* <-> Input*: 500V DC @ 1s (I < 1 mA)<br>Output <-> System: 500V DC @ 1s (I < 1 mA)<br>Output <-> Shield: 500V DC @ 1s (I < 1 mA)<br><br>*Input and output here mean a group of 8 channels each. |
| Protective circuit | One TVS diode per channel (SMA 400W design) and one per power supply (SMB 600W design). |
| Output voltage resistance | 8kV contact discharge,<br>15kV air discharge |
| EMC filter | Series ferrite 100Ω@100MHz + capacitor 1nF against shield |
| Connector | X800 – Pin assignment, see 7.1 |

**Table 6:** Data of the digital outputs

# 6.5 Digital Inputs

| | |
|---|---|
| Number | 16, divided into 2 groups of 8 inputs |
| Input switching frequency | Max. 60 kHz @ pulse/pause ratio 1:1 |
| Switching thresholds | '0': $U_{IN}$ < 9V<br>'1': $U_{IN}$ >16,5V |
| External voltage range | -20 V ≤ $U_{IN}$ ≤ 33V, nominal 24 V |
| Input impedance | ≈ 12 kOhm |
| Input circuit | Z diodes, series resistors, optocouplers |
| Controller | Register set in FPGA – see 5.2 |
| Interrupts | Can be set to rising or falling or both edges. |
| Galvanic isolation | Yes - divided into 2 x 8 inputs<br>(purely functional isolation) |
| Dielectric strength of the galvanic isolation | Input* <-> Input*: 500V DC @ 1s (I < 1 mA)<br>Input* <-> Output*: 500V DC @ 1s (I < 1 mA)<br>Input* <-> System: 500V DC @ 1s (I < 1 mA)<br>Input* <-> Shield: 500V DC @ 1s (I < 1 mA)<br><br>*Input and output here mean a group of 8 channels each |
| Protective circuit | One TVS diode per channel (SMA 400W design). |
| Input voltage resistance | 8kV contact discharge,<br>15kV air discharge |
| EMC filter | Series ferrite (100Ω@100MHz) and capacitor (1nF) against shield |
| Connector | X800 – Pin assignment see 7.1 |

# 6.6 Software Support

Drivers are available for real-time operating system QNX® as object codes. They offer functions for reading the inputs and outputs. Drivers for other operating systems are available on request.
For detailed information about the driver availability for your operating system, please contact our sales team: (sales@esd.eu)

# 7 Connector Assignments

## 7.1 DSUB50, X800

**Device connector:** 50-pin DSUB connector, pin contacts

| Pin No.: | | | Signal | Description |
|---|---|---|---|---|
| 1 | | | --- | Reserved |
| | | 34 | --- | |
| | 18 | | IN0 | Input 0 |
| 2 | | | IN1 | Input 1 |
| | | 35 | IN2 | Input 2 |
| | 19 | | IN3 | Input 3 |
| 3 | | | IN4 | Input 4 |
| | | 36 | IN5 | Input 5 |
| | 20 | | IN6 | Input 6 |
| 4 | | | IN7 | Input 7 |
| | | 37 | XIGND0 | Reference potential Input group 0 - 7 |
| | 21 | | XIGND0 | |
| 5 | | | --- | Reserved |
| | | 38 | --- | |
| | 22 | | IN8 | Input 8 |
| 6 | | | IN9 | Input 9 |
| | | 39 | IN10 | Input 10 |
| | 23 | | IN11 | Input 11 |
| 7 | | | IN12 | Input 12 |
| | | 40 | IN13 | Input 13 |
| | 24 | | IN14 | Input 14 |
| 8 | | | IN15 | Input 15 |
| | | 41 | XIGND1 | Reference potential Input group 8 - 15 |
| | 25 | | XIGND1 | |
| 9 | | | VSSO0 | Power supply Output group 0 - 7 |
| | | 42 | VSSO0 | |
| | 26 | | OUT0 | Output 0 |
| 10 | | | OUT1 | Output 1 |
| | | 43 | OUT2 | Output 2 |
| | 27 | | OUT3 | Output 3 |
| 11 | | | OUT4 | Output 4 |
| | | 44 | OUT5 | Output 5 |
| | 28 | | OUT6 | Output 6 |
| 12 | | | OUT7 | Output 7 |
| | | 45 | GNDO0 | Reference potential Output group 0 - 7 |
| | 29 | | GNDO0 | |
| 13 | | | VSSO2 | Power supply Output group 8 - 15 |
| | | 46 | VSSO2 | |
| | 30 | | OUT8 | Output 8 |
| 14 | | | OUT9 | Output 9 |
| | | 47 | OUT10 | Output 10 |
| | 31 | | OUT11 | Output 11 |
| 15 | | | OUT12 | Output 12 |
| | | 48 | OUT13 | Output 13 |
| | 32 | | OUT14 | Output 14 |
| 16 | | | OUT15 | Output 15 |
| | | 49 | GNDO2 | Reference potential Input group 8 - 15 |
| | 33 | | GNDO2 | |
| 17 | | | VSSO3 | Additional power supply Output group 8 - 15 |
| | | 50 | VSSO3 | |

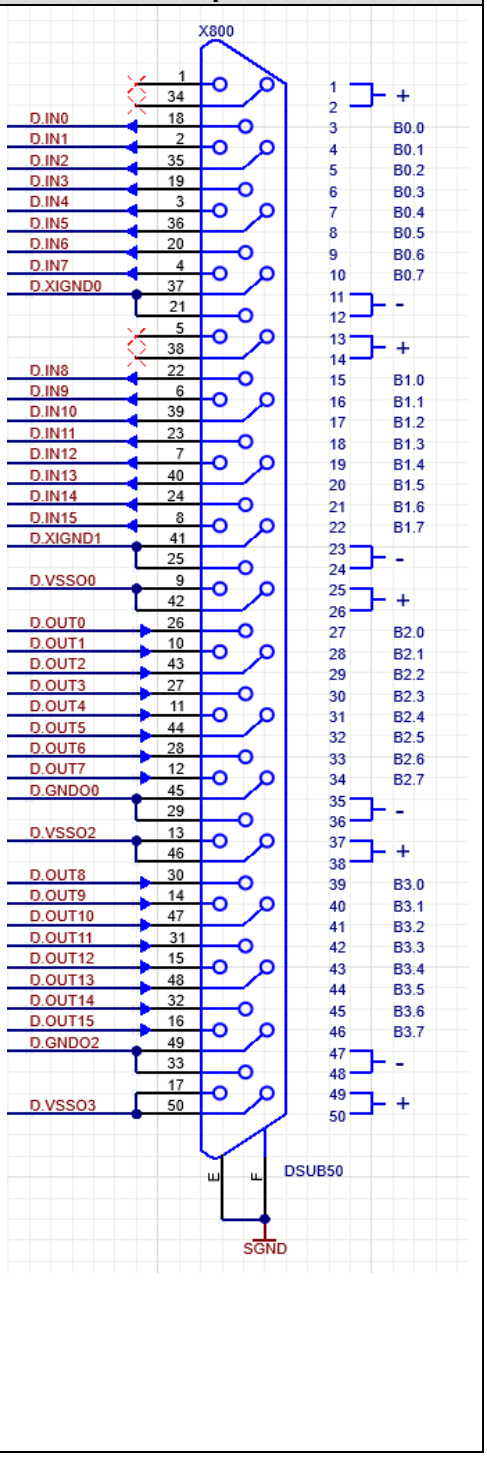



**Table 7:** I/O connector pinning

**NOTICE**
esd guarantees the EC conformity of the product if a shielded cable is used for the wiring or an unshielded cable with a maximum length of 3m.

# 7.2 Assignment of a Phoenix Transition Module

The pin assignment of the 50-pole DSUB-connector has been chosen in such a way that you have a clear terminal assignment when connecting a PHOENIX-transition module via flat-ribbon cable.


**Figure 6:** PHOENIX-transition module UM45-FLK50/LA/PLC

The following table shows the assignments of transition modules UM45-FLK50/PLC and UM45-FLK50/LA/PLC (like UM45-FLK50/PLC but with LEDs):

| Pin | Signal |
|---|---|
| - | - |
| 0.1 | IN1 |
| 0.3 | IN3 |
| 0.5 | IN5 |
| 0.7 | IN7 |
| 0.- | XIGND0 |
| 1.1 | IN9 |
| 1.3 | IN11 |
| 1.5 | IN13 |
| 1.7 | IN15 |
| 1.- | XIGND1 |
| 2.1 | OUT1 |
| 2.3 | OUT3 |
| 2.5 | OUT5 |
| 2.7 | OUT7 |
| 2.- | GNDO0 |
| 3.1 | OUT9 |
| 3.3 | OUT11 |
| 3.5 | OUT13 |
| 3.7 | OUT15 |
| 3.- | GNDO2 |

| Pin | Signal |
|---|---|
| 0.0 | IN0 |
| 0.2 | IN2 |
| 0.4 | IN4 |
| 0.6 | IN6 |
| 0.+ | - |
| 1.0 | IN8 |
| 1.2 | IN10 |
| 1.4 | IN12 |
| 1.6 | IN14 |
| 1.+ | - |
| 2.0 | OUT0 |
| 2.2 | OUT2 |
| 2.4 | OUT4 |
| 2.6 | OUT6 |
| 2.+ | VSSO0 |
| 3.0 | OUT8 |
| 3.2 | OUT10 |
| 3.4 | OUT12 |
| 3.6 | OUT14 |
| 3.+ | VSSO2/VSSO3 |
| - | - |

**Signal Description of I/O-Connector X800 and Transition Module**

| | |
|---|---|
| IN0 ... IN15 | Digital inputs |
| XIGND0, XIGND1 | Reference potential of digital inputs |
| OUT0 ... OUT15 | Digital outputs |
| VSS0 | Power supply of drivers of digital outputs OUT0...OUT7 |
| VSS2, VSS3 | Power supply of drivers of digital outputs OUT8...OUT15 and optocouplers of output circuits of all channels |
| GNDO0, GNDO2 | Reference potential of digital outputs |

# 8 Software

This chapter describes the driver software of the CPCI-DIO1616/2 for the operating systems QNX6 and QNX7.

## 8.1 Installation of the QNX6/QNX7 Device Driver

To start the driver, you have to enter: `devio-cpcidio16`

**INFORMATION**
The driver can only be started with root rights!

## 8.2 Using the QNX6/QNX7 Device Driver

`devctl()` is used to access the driver.

The interface header `devio.h` contains the commands and parameters.

Example source, accessing the digital IOs, is part of the release archive.

# 8.3 Functions

## 8.3.1 Structures

The commands described below in chapter 8.3 use the following structures for their parameters:

```
typedef struct
{
       uint32_t data;
       uint32_t mask;
       int32_t err;
} DIODATA;


typedef struct
{
       int32_t data;
       int32_t err;

} AIODATA;


typedef struct
{
       int32_t counter;
       int32_t freq;
       int32_t pulseWidth;
       int32_t pulsePeriod;
       int32_t err;
} CIODATA;


typedef struct
{
       uint32_t index;
       union {
              DIODATA d;
              AIODATA a;
              CIODATA c;
       } u;
       uint64_t time;
} IODATA;

typedef struct
{
   uint32_t edgeRising;
   uint32_t edgeFalling;
} DIOIRQ;

typedef struct
{
    int32_t count; /* != 0 => IRQ on ADC sample */
} AIOIRQ;

typedef struct
{
       uint32_t index;
       union {
              DIOIRQ d;
              AIOIRQ a;
       } u;
} IOCFG;
```

### 8.3.2 Overview of Commands

| Command | Function |
|---|---|
| DCMD_IO_SEND | Setting the digital outputs and the user LED |
| DCMD_IO_RECEIVE_OUTPUT | Get the state of the digital output pins |
| DCMD_IO_RECEIVE | Reading the digital inputs and the error messages of the outputs |
| DCMD_IO_TIMERES | Determining the resolution (Ticks/Sec) of the time base returned by DCMD_IO_TIME |
| DCMD_IO_IRQSET | Initializing the interrupts |
| DCMD_IO_RECIRQ | Reading the interrupt source |
| DCMD_IO_RECIRQ_FLUSH | Flush the digital input event queue |
| DCMD_IO_TIME | Actual time in clock cycles (Ticks) of the board since switching on, 64-bit value, the time resolution is defined via DCMD_IO_TIMERES |

**Table 8:** Overview of the implemented commands

### 8.3.3 DCMD_IO_SEND - Setting the Digital Outputs and the User LED

| | | |
|---|---|---|
| **Command:** | **DCMD_IO_SEND** | |
| **Argument type:** | IODATA *io | |
| **Input:** | *io->index:* | Always ‘0’ |
| | *io->u.d.mask:* | Bit(x)=1 => output x to send<br>- Masks the output bits which are to be set |
| | *io->u.d.data:* | Output state for bits matched in mask<br>- Sets the outputs to ‘0’ or ‘1’. |
| **Output:** | None | |
| **Description:** | Use this command to set the outputs.<br>Outputs that are to be changed must be masked with *io->u.d.mask* first.<br>After reset or system boot all outputs are switched off.<br>The bit positions match the output register (see chapter 5.2.3).<br>Bit 0 - 15: Digital outputs *(Output 0 … Output 15*)<br>Bit 16: *User-LED* | |

## 8.3.4 DCMD_IO_RECEIVE_OUTPUT - Reading the Digital Outputs

| | | |
|---|---|---|
| **Command:** | **DCMD_IO_RECEIVE_OUTPUT** | |
| **Argument type:** | IODATA *io | |
| **Input:** | *io->index:* | Always ‘0’ |
| | *io->u.d.mask:* | Bit(x)=1 => output x to receive<br>- Masks the output bits which are to be received |
| **Output:** | *io->u.d.mask:* | Echo of input mask<br>- Echoed value of input mask |
| | *io->u.d.data:* | Output state for bits matched in mask; unmatched bits are set to ‘0’<br>- Status of received output bits, matched in mask. |
| **Description:** | This command is developed to read the digital outputs.<br>The bits whose levels are to be received are selected via a mask. The value of the mask is echoed.<br>The status of the output bits can be read in *io->u.d.data:*<br>The status of the non-masked bits is always set to ‘0’. | |

## 8.3.5 DCMD_IO_RECEIVE - Receiving the Digital Inputs

| | | |
|---|---|---|
| **Command:** | **DCMD_IO_RECEIVE** | |
| **Argument type:** | IODATA *io | |
| **Input:** | *io->index* | Always ‘0’ |
| | *io->u.d.mask:* | Bit(x)=1 => input x to receive<br>- Masks the input bits which are to be received |
| **Output:** | *io->u.d.mask:* | Echo of input mask<br>- Echoed value of input mask |
| | *io->u.d.data:* | Input state for bits matched in mask; unmatched bits are set to ‘0’<br>- Status of received input bits or error messages of the output drivers |

**Description:**

Use this command to read the digital inputs.
Inputs to be read must be masked with *io->u.d.mask* first.
The value of the mask is echoed.
The status of the input bits can be read under *io->u.d.data*.
The status of the non-masked bits is always set to ‘0’.
The bit positions match the input register (see chapter 5.2.4).
Bit 0 - 15: Digital inputs (Input0 … Input 15)
Bit16 - 19: Error states of the four output groups

### 8.3.6 DCMD_IO_TIMERES - Determining the Time Resolution

| | | |
|---|---|---|
| **Command:** | **DCMD_IO_TIMERES** | |
| **Argument type:** | uint64_t *frequency | |
| **Input:** | None | |
| **Output:** | **frequency:* | Timestamp frequency<br>- Number of clock cycles per second |
| **Description:** | Via this command the frequency of the timestamp clock can be determined for reasonable timestamp evaluation. | |

### 8.3.7 DCMD_IO_IRQSET - Initializing the Interrupts

| | | | |
|---|---|---|---|
| **Command:** | **DCMD_IO_IRQSET** | | |
| **Argument type:** | IOCFG *cfg | | |
| **Input:** | *cfg-> index* | Always ‘0’ | |
| | *cfg-> u.d.edgeRising:* | bit(x) = 1 => | interrupt enable for rising edge on input x |
| | | bit(x) = 0 => | interrupt disable for rising edge on input x |
| | *cfg-> u.d.edgeFalling:* | bit(x) = 1 => | interrupt enable for falling edge on input x |
| | | bit(x) = 0 => | interrupt disable for falling edge on input x |
| **Output:** | None | | |
| **Description:** | Via this command the interrupts for falling and/or rising edges on input x are enabled or disabled. After starting up, all interrupts are disabled. | | |

## 8.3.8 DCMD_IO_RECIRQ - Receiving Interrupt Source

| | | |
|---|---|---|
| **Command:** | **DCMD_IO_RECIRQ** | |
| **Argument type:** | IODATA *io | |
| **Input:** | *io->index* | Always ‘0’ |
| **Output:** | *io->u.d.mask:* | Bit(x) = 1 => edge for input x detected<br>- Masks input and error bits for interrupt evaluation |
| | *io->u.d.data:* | Input state for bits matched in mask; unmatched bits set to zero.<br>- Input or error bit which triggered interrupt |
| | *io->time:* | Timestamp of detected edge(s)<br>- The TIME resolution can be determined via DCMD_IO_TIMRES (see 8.3.6).<br>- The actual TIME can be determined by DCMD_IO_TIME (see 8.3.10). |
| **Description:** | Use this command to determine the input bits or error bits that have triggered an interrupt.<br>The timestamp of the interrupt can be read from *io->time:*.<br>The call is blocked until the desired edge(s) appear(s). | |

## 8.3.9 DCMD_IO_RECIRQ_Flush – Flush the Input Event Queue

| | |
|---|---|
| **Command:** | **DCMD_IO_RECIRQ_Flush** |
| **Argument type:** | None |
| **Input:** | None |
| **Output:** | None |
| **Description:** | This command deletes the interrupt events of the current handle.<br>An opened handle can buffer up to 256 events. |

## 8.3.10 DCMD_IO_TIME - Time Value

| | | |
|---|---|---|
| **Command:** | **DCMD_IO_TIME** | |
| **Argument type:** | uint64_t *time | |
| **Input** | None | |
| **Output:** | **time:* | Number of clock cycles counted since power on of the module<br>- Number of clock cycles, 64-bit value |
| **Description:** | This command reads the actual number of clock cycles of the PCI IP-Core in the FPGA, counted since power on. | |

# 9 Declaration of Conformity

## EU-KONFORMITÄTSERKLÄRUNG
## *EU DECLARATION OF CONFORMITY*

Adresse / *Address*
**esd electronics gmbh**
**Vahrenwalder Str. 207**
**30165 Hannover**
**Germany**

esd erklärt, dass das Produkt
*esd declares, that the product*
**CPCI-DIO1616/2**

Typ, Modell, Artikel-Nr.
*Type, Model, Article No.*
**I.2309.04**

die Anforderungen der Normen
*fulfills the requirements of the standards*
**EN 61000-6-2:2005,**
**EN 61000-6-4:2007/A1:2011**

gemäß folgendem Prüfbericht erfüllt.
*according to test certificate.*
**EMVP No.: 0228-202306**

Das Produkt entspricht damit der EU-Richtlinie „EMV"
*Therefore the product conforms to the EU Directive 'EMC'*
**2014/30/EU**

Das Produkt entspricht den EU-Richtlinien „RoHS"
*The product conforms to the EU Directives 'RoHS'*
**2011/65/EU, 2015/863/EU**

Diese Erklärung verliert ihre Gültigkeit, wenn das Produkt nicht den Herstellerunterlagen entsprechend eingesetzt und betrieben wird, oder das Produkt abweichend modifiziert wird.
*This declaration loses its validity if the product is not used or run according to the manufacturer's documentation or if non-compliant modifications are made.*

Name / *Name* T. Bielert
Funktion / *Title* QM-Beauftragter / *QM Representative*
Datum / *Date* Hannover, 2024-01-18

Rechtsgültige Unterschrift / *authorized signature*

I:\Texte\Doku\MANUALS\CPCI\CPCI-DIO1616-2\Konformitaetserklaerung\CPCI-DIO1616-2_EU_Declaration_of_Conformity_2024-01-18.docx

# 10 Order Information

## 10.1 Hardware

| Type | Properties | Order No. |
|---|---|---|
| CPCI-DIO1616/2 | CPCI-DIO1616/2 CompactPCI interface card,<br>16 electrically isolated outputs 24V/0.5A,<br>16 electrically isolated inputs 24V,<br>Drivers for various operating systems to be ordered separately | I.2309.04 |

**Table 9:** Order information hardware

## 10.2 Software for CPCI-DIO1616/2

| Type | | Order No. |
|---|---|---|
| CPCI-DIO1616-QNX Object Licence | CPCI-DIO1616-QNX driver (object) incl. documentation for QNX6 and QNX7 | I.2309.32 |
| For detailed information about the driver availability for your special operating system, please contact our sales team. | | |

**Table 10:** Order information software for CPCI-DIO1616/2

## 10.3 Manuals

**PDF Manuals**
For the availability of the manuals see table below.
Please download the manuals as PDF documents from our esd website https://www.esd.eu for free.

| Manuals | | Order No. |
|---|---|---|
| CPCI-DIO1616/2-ME | Hardware manual in English | I.2309.23 |

**Table 11:** Available Manuals

**Printed Manuals**
If you need a printout of the manual additionally, please contact our sales team (sales@esd.eu) for a quotation. Printed manuals may be ordered for a fee.