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USER GUIDE

NI Camera Link I/O Extension Board (PCIe)

The NI Camera Link I/O Extension Board provides additional I/O capabilities for National Instruments PCI Express (PCIe) Camera Link image acquisition devices. This document describes how to install and configure the necessary components to begin using the I/O Extension Board.

The I/O Extension Board offers the following functionality:

- 8 TTL I/O. Refer to the *Configuring the TTL I/O Start Condition* section for more information.
- 3 optically isolated inputs.
- 3 optically isolated outputs.
- Quadrature encoder input.
- Camera power (+5 V and +12 V).

What You Need to Get Started

You need the following items to set up and use the I/O Extension Board:

- ❑ NI Camera Link I/O Extension Board
- ❑ National Instruments PCIe Camera Link image acquisition device
- ❑ 50-pin ribbon cable, included in kit
- ❑ Computer running Microsoft Windows Vista/XP/2000 with at least one available PCIe slot

Note Visit `ni.com/info` and enter `rdvisionvista` for more information about National Instruments device compatibility with Windows Vista.

- ❑ NI Vision Acquisition Software 8.2.0 or later, which includes the NI-IMAQ driver software

Optional Equipment

National Instruments offers a variety of products for use with the I/O Extension Board, including the following:

- ❑ Digital I/O cable and horizontal DIN rail terminal block (part number 778790-01)
- ❑ Digital I/O cable and vertical DIN rail terminal block (part number 778791-01)

Refer to the National Instruments catalog, visit `ni.com`, or call the National Instruments office nearest you for more specific information about these products.

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Related Documentation

The following documents contain additional information that you may find helpful:

- *NI Vision Acquisition Software Release Notes*—Contains information about new functionality, minimum system requirements, and installation instructions for the NI-IMAQ driver software.
- *Measurement & Automation Explorer Help for NI-IMAQ*—Describes how to configure the NI-IMAQ driver software, NI image acquisition devices, and cameras using Measurement & Automation Explorer (MAX).
- *NI-IMAQ Help*—Contains fundamental programming concepts for the NI-IMAQ driver software and terminology for using NI image acquisition devices.

Safety Information



Caution The following paragraphs contain important safety information you *must* follow when installing and operating the I/O Extension Board and all devices connecting to the I/O Extension Board.

Do *not* operate the device in a manner not specified in the documentation. Misuse of the device may result in a hazard and may compromise the safety protection built into the device. If the device is damaged, turn it off and do *not* use it until service-trained personnel can check its safety. If necessary, return the device to National Instruments for repair.

Keep away from live circuits. Do *not* remove equipment covers or shields unless you are trained to do so. If signal wires are connected to the device, hazardous voltages can exist even when the equipment is turned off. To avoid a shock hazard, do *not* perform procedures involving cover or shield removal unless you are qualified to do so. Disconnect all field power prior to removing covers or shields.

If the device is rated for use with hazardous voltages (>30 V_{rms}, 42.4 V_{pk}, or 60 V_{dc}), it may require a safety earth-ground connection wire. Refer to the device specifications for maximum voltage ratings.

Because of the danger of introducing additional hazards, do *not* install unauthorized parts or modify the device. Use the device only with the chassis, modules, accessories, and cables specified in the installation instructions. All covers and filler panels *must* be installed while operating the device.

Do *not* operate the device in an explosive atmosphere or where flammable gases or fumes may be present. Operate the device only at or below the pollution degree stated in the specifications. Pollution consists of any foreign matter—solid, liquid, or gas—that may reduce dielectric strength or surface resistivity. The following is a description of pollution degrees.

- Pollution Degree 1—No pollution or only dry, nonconductive pollution occurs. The pollution has no effect.
- Pollution Degree 2—Normally only nonconductive pollution occurs. Occasionally, nonconductive pollution becomes conductive because of condensation.
- Pollution Degree 3—Conductive pollution or dry, nonconductive pollution occurs. Nonconductive pollution becomes conductive because of condensation.

Clean the device and accessories by brushing off light dust with a soft, nonmetallic brush. Remove other contaminants with a stiff, nonmetallic brush. The unit *must* be completely dry and free from contaminants before returning it to service.

You *must* insulate signal connections for the maximum voltage for which the device is rated. Do *not* exceed the maximum ratings for the device. Remove power from signal lines before connection to or disconnection from the device.

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Caution National Instruments measurement products may be classified as either Measurement Category I or II. Operate products at or below the Measurement Category level specified in the hardware specifications.

Measurement Category[1]: Measurement circuits are subjected to working voltages[2] and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Measurement Category establishes standardized impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of Measurement (Installation[3]) Categories:

- Measurement Category I is for measurements performed on circuits *not* directly connected to the electrical distribution system referred to as MAINS[4] voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.
- Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (e.g., 115 V for U.S. or 230 V for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar products.
- Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.

Unpacking

The I/O Extension Board ships in an antistatic package to prevent electrostatic discharge from damaging device components. To avoid such damage in handling your device, take the following precautions:

1. Ground yourself using a grounding strap or by touching a grounded object, such as the computer chassis.
2. Touch the antistatic package to a metal part of the computer chassis before removing the device from the package.

Caution *Never* touch the exposed pins of connectors.

3. Remove the device from the package and inspect it for loose components or any other signs of damage. Notify National Instruments if the device appears damaged in any way. Do *not* install a damaged device in the computer.

Store the I/O Extension Board in the antistatic package when not in use.

[1] Measurement Categories as defined in electrical safety standard IEC 61010-1.

[2] Working voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

[3] Measurement Category is also referred to as Installation Category.

[4] MAINS is defined as the (hazardous live) electrical supply system to which equipment is designed to be connected for the purpose of powering the equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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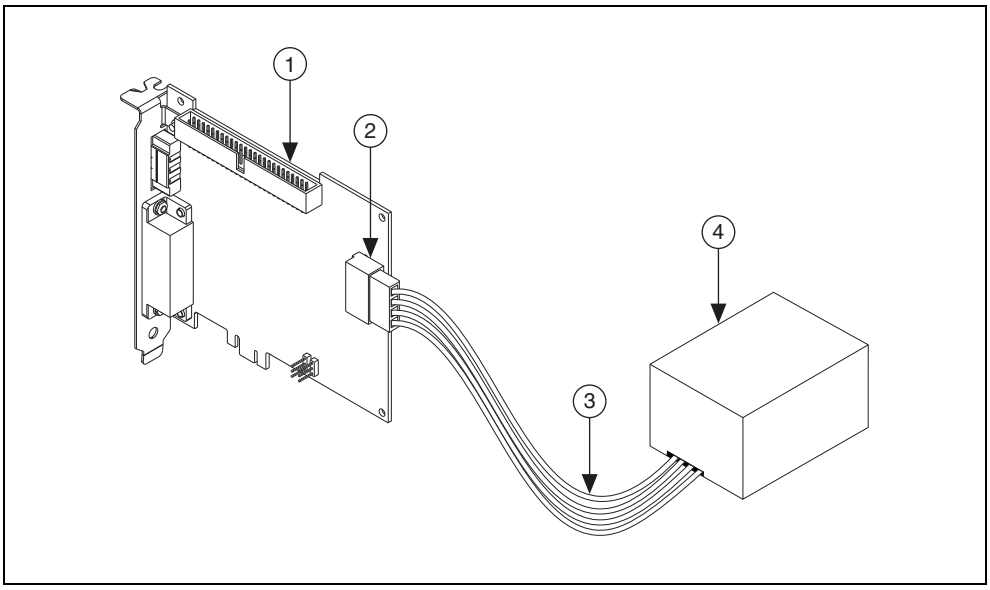
Installation

The following instructions are for general installation. Refer to the documentation provided by your computer manufacturer for specific instructions and warnings. Refer to the *Specifications* section for a list of the typical power requirements for the I/O Extension Board.

1. Install the NI Vision Acquisition Software before installing the I/O Extension Board. Refer to the *NI Vision Acquisition Software Release Notes* for specific installation instructions.
2. Power off and unplug the computer.

Caution To protect yourself and the computer from electrical hazards, the computer *must* remain unplugged until the installation is complete.

3. Remove the computer cover to expose the expansion slots.
4. Choose an unused PCIe slot, and remove the corresponding expansion slot cover on the back panel of the computer.
5. Touch a metal part on the computer case to discharge any static electricity that might be on your clothes or body. Static electricity can damage the device.
6. Remove the device from the antistatic package and gently rock the device into the slot. The connection may be tight, but do *not* force the device into place.
7. Secure the device mounting bracket to the back panel rail of the computer.
8. To provide power to your camera, connect an unused power connector from the ATX power supply on your computer to the camera power ATX connector on the I/O Extension Board. Figure 1 shows how to connect the power cable from your PC power supply to the ATX power supply connector on the I/O Extension Board.

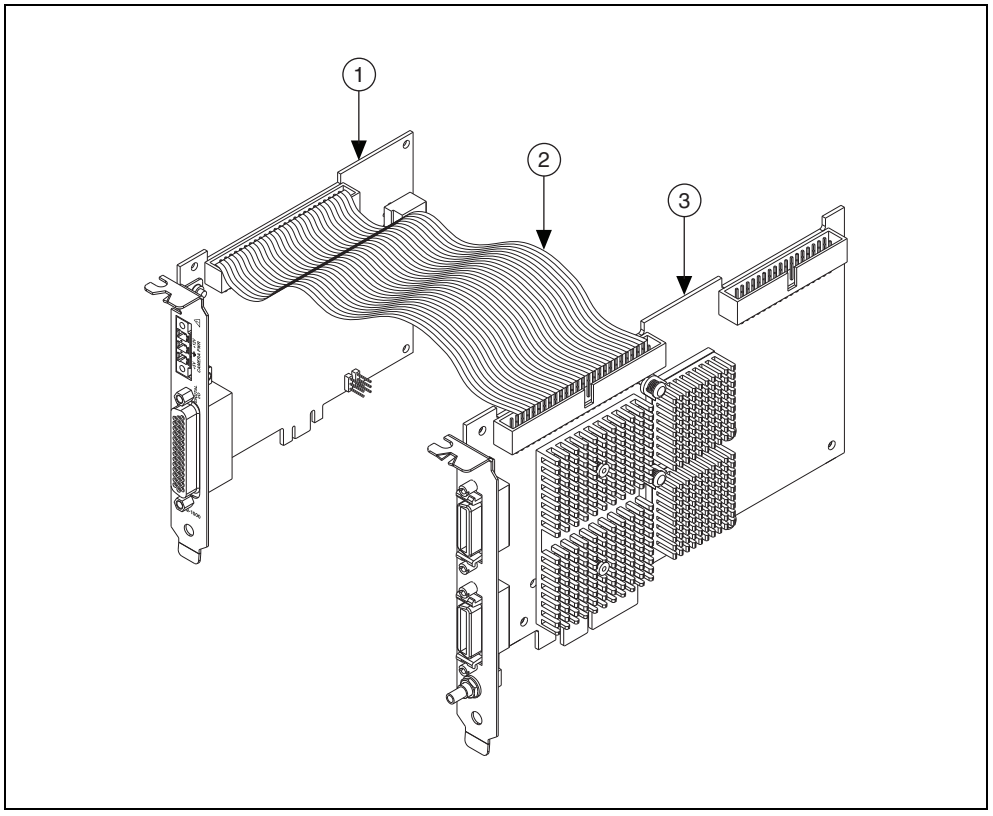


1	50-Pin I/O Connector	3	ATX Power Supply Cable
2	ATX Power Connector	4	Computer ATX Power Supply

Figure 1. Connecting the Power Supply

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9. Connect the 50-pin ribbon cable from the I/O Extension Board to your image acquisition device. Figure 2 shows how to connect the 50-pin ribbon cable from the I/O Extension Board to an image acquisition device that supports the I/O Extension Board.



1	I/O Extension Board	2	50-Pin Ribbon Cable	3	Image Acquisition Device

Figure 2. Connecting the I/O Extension Board to an Image Acquisition Device

10. Replace the computer cover.
11. Plug in and power on the computer.

The I/O Extension Board is now installed and connected to the image acquisition device.

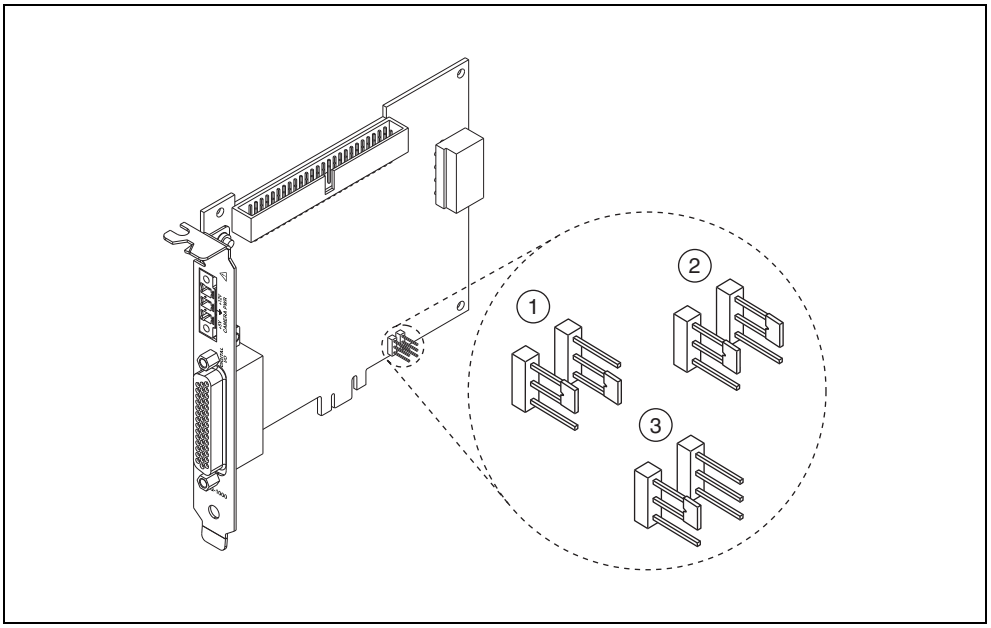
Configuring the TTL I/O Start Condition

The start condition for the TTL I/O is user-selectable. The TTL I/O can either be pulled high, pulled low, or tri-stated.

- To pull the TTL I/O lines high, connect the jumper to `TTL PULL` and `+5V`.
- To pull the TTL I/O lines low, connect the jumper to `TTL PULL` and `GND`.
- To tri-state the TTL I/O lines, remove the jumper.

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Figure 3 shows how to use the jumper setting to connect the start condition for the TTL I/O to be pulled high, pulled low, or tri-stated.



1	Pulled High Jumper Setting	2	Pulled Low Jumper Setting	3	Tri-Stated Jumper Setting

Figure 3. Configuring the TTL I/O

Signal Connections

The following sections describe the signal connections for the I/O Extension Board.

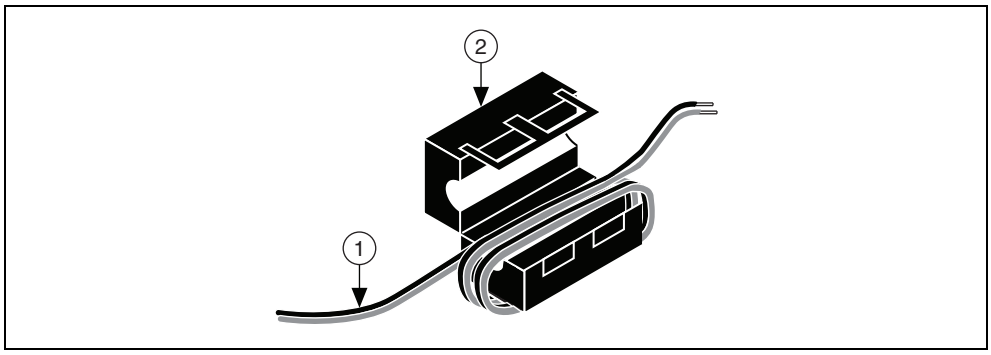
Wiring Recommendations

Caution Failure to follow these precautions may result in system instability and may cause permanent damage to system components.

National Instruments recommends the following guidelines for connecting to the I/O Extension Board.

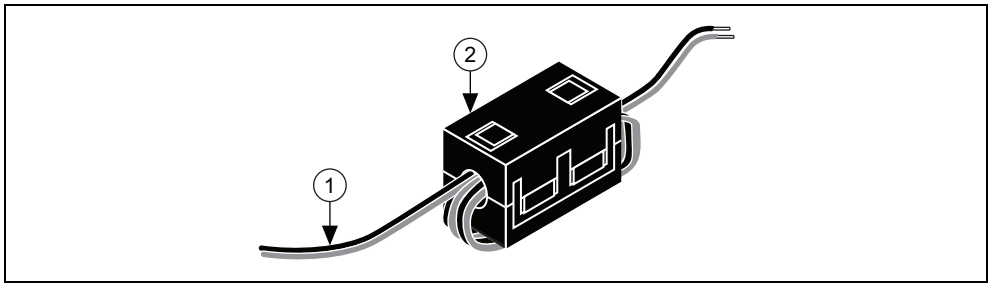
- Keep high-voltage lines, such as AC power cables, away from low-level signals, such as encoders.
- Use twisted pair cable for differential signals, such as encoders.
- Ensure that all cables connected to the I/O Extension Board include a braided shield.
- Use hoods with internal metallic shielding for D-SUB connectors.
- Ensure that all power supplies in the system are powered down when connecting them to the I/O Extension Board.
- To suppress electromagnetic interference, install a ferrite on the camera power cable as close to the connection to the I/O Extension Board as possible. Wrap the camera power cable around the ferrite two times, as shown in Figures 4 and 5.

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1	Power Supply Output Cable	2	Ferrite

Figure 4. Installing a Ferrite Connector on the Camera Power Cable



1	Power Supply Output Cable	2	Ferrite

Figure 5. Closed Ferrite on the Camera Power Cable

44-Pin D-SUB Connections

Figure 6 shows the pinout of the 44-pin D-SUB connector on the front panel of the I/O Extension Board.

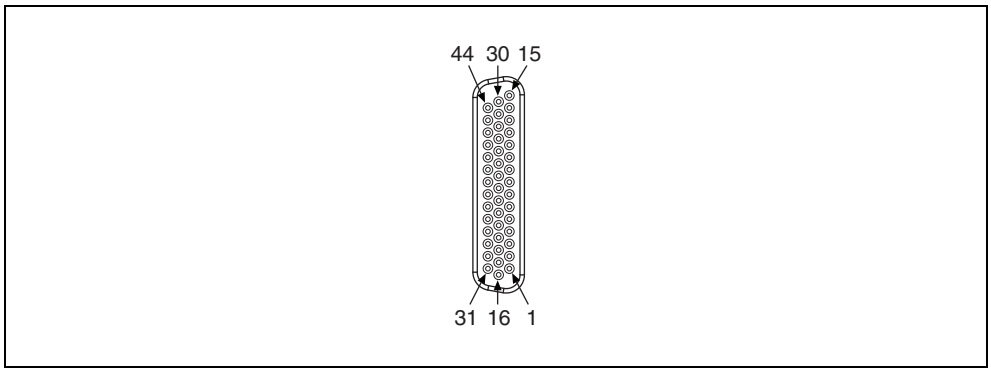


Figure 6. 44-Pin D-SUB Connector

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Table 1 lists pin numbers, signal names, and signal descriptions for the 44-pin D-SUB connector.

Table 1. D-SUB Connector Signals

Pin Number	Signal Name	Signal Description
1	+12 V Camera	+12 V Camera Power*
2	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
3	TTL I/O 1	General Purpose TTL Input/Output Line
4	TTL I/O 2	General Purpose TTL Input/Output Line
5	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
6	TTL I/O 3	General Purpose TTL Input/Output Line
7	TTL I/O 4	General Purpose TTL Input/Output Line
8	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
9	NC	No Connect
10	V_{iso}	Isolated Power
11	C_{iso}	Isolated Power Common
12	Iso Output 0	General Purpose Isolated Output
13	Iso Output 1	General Purpose Isolated Output
14	C_{iso}	Isolated Power Common
15	Iso Input 1+	Isolated Input Positive Connection
16	+12 V Camera	+12 V Camera Power*
17	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
18	TTL I/O 5	General Purpose TTL Input/Output Line
19	TTL I/O 6	General Purpose TTL Input/Output Line
20	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
21	TTL I/O 7	General Purpose TTL Input/Output Line
22	TTL I/O 8	General Purpose TTL Input/Output Line
23	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
24	NC	No Connect
25	V_{iso}	Isolated Power
26	C_{iso}	Isolated Power Common

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Table 1. D-SUB Connector Signals (Continued)

Pin Number	Signal Name	Signal Description
27	Iso Input 2+	Isolated Input Positive Connection
28	Iso Input 2–	Isolated Input Negative Connection
29	C_{iso}	Isolated Power Common
30	Iso Input 1–	Isolated Input Negative Connection
31	+5 V Camera	+5 V Camera Power*
32	+5 V Camera	+5 V Camera Power*
33	C_{iso}	Isolated Power Common
34	Phase A+	Quadrature Encoder Phase A Positive Connection
35	Phase A–	Quadrature Encoder Phase A Negative Connection
36	C_{iso}	Isolated Power Common
37	NC	No Connect
38	Phase B+	Quadrature Encoder Phase B Positive Connection
39	C_{iso}	Isolated Power Common
40	Phase B–	Quadrature Encoder Phase B Negative Connection
41	Iso Output 2	General Purpose Isolated Output
42	C_{iso}	Isolated Power Common
43	Iso Input 0+	Isolated Input Positive Connection
44	Iso Input 0–	Isolated Input Negative Connection

* Connect Camera Ground signals to Digital Ground.

Figure 7 shows the pinout of the 3-pin screw-terminal connector.

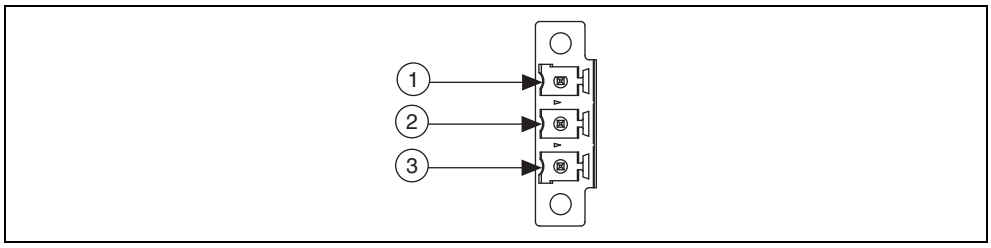


Figure 7. 3-Pin Screw-Terminal Connector

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Table 2 lists pin numbers, signal names, and signal descriptions for the 3-pin screw-terminal connector on the I/O Extension Board.

Table 2. 3-Pin Screw-Terminal Connector Signals

Pin Number	Signal Name	Signal Description
1	+12 V	+12 V Camera Power
2	Ground	Ground Reference for Camera Power
3	+5 V	+5 V Camera Power

Connecting an Isolated Input to Output Devices

You can wire an isolated input to both sourcing and sinking output devices. Refer to Figures 8 and 9 for wiring examples by output type. Refer to the *Specifications* section for information about switching thresholds and current requirements.

Caution Do *not* apply a voltage greater than 30 VDC to the isolated inputs. Voltages greater than 30 VDC may damage the I/O Extension Board.

Note Isolated inputs are compatible with 5 V logic if the external circuit meets the voltage and current requirements listed in the *Specifications* section.

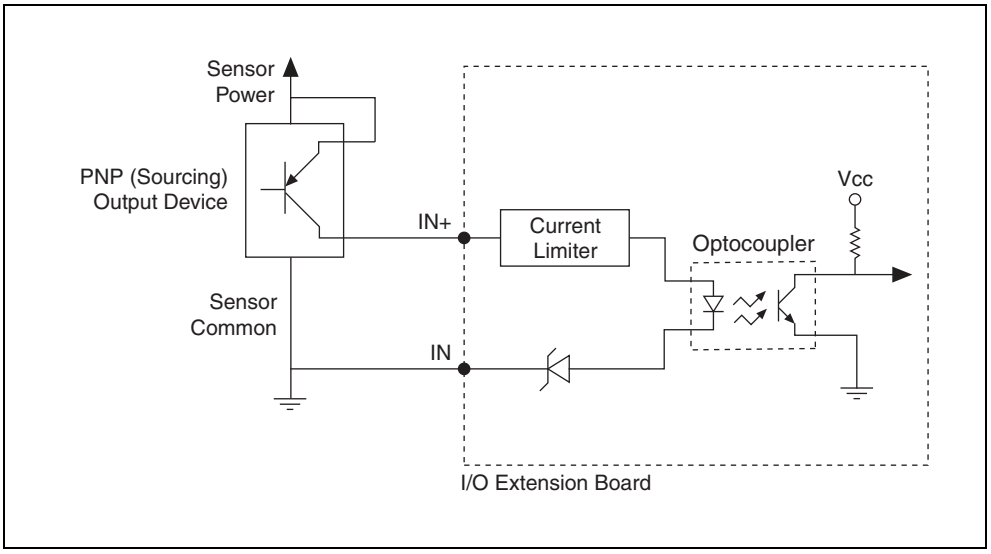


Figure 8. Example of Connecting an Isolated Input to a Sourcing Output Device

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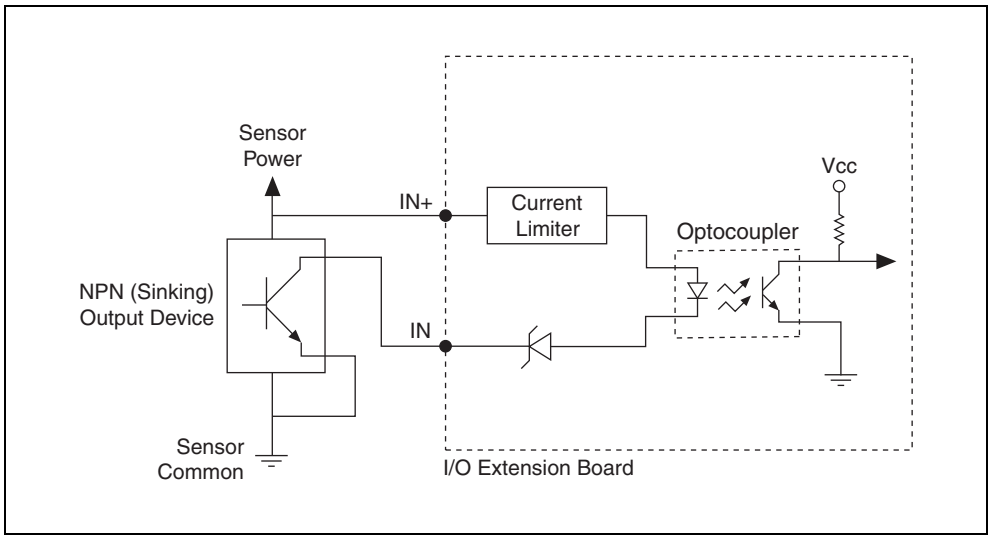


Figure 9. Example of Connecting an Isolated Input to a Sinking Output Device

Connecting an Isolated Output to an External Load

The digital output circuit sources current to external loads, as shown in the example in Figure 10.

Note The isolated outputs have current-limiting protection circuitry. If this circuitry is tripped, you can re-enable the outputs by cycling power on the I/O Extension Board or by toggling the output state in the software.

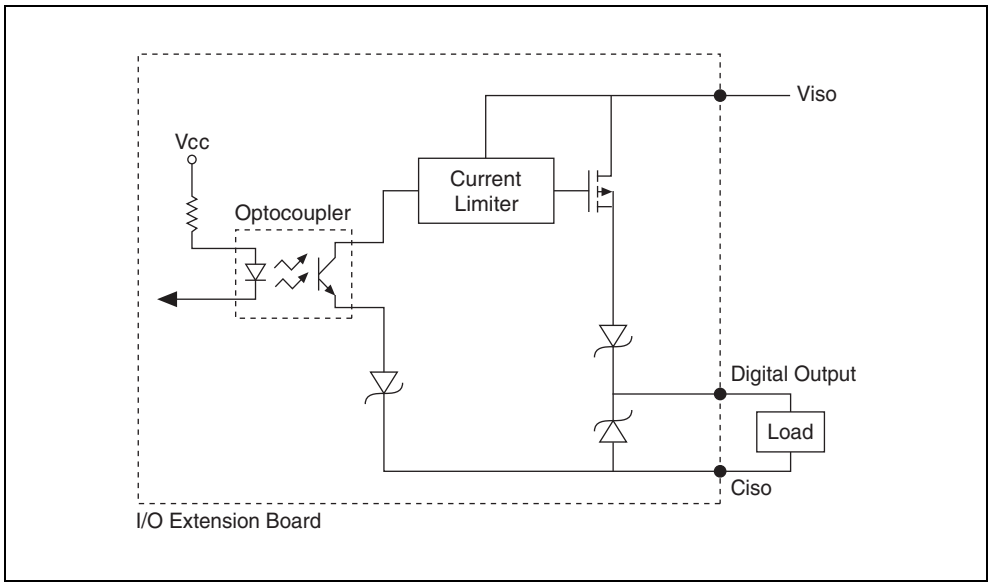


Figure 10. Example of Connecting an Isolated Output to an External Load

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Protecting Inductive Loads

When an inductive load, such as a relay or solenoid, is connected to an output, a large counter-electromotive force may occur at switching time due to energy stored in the inductive load. This flyback voltage can damage the outputs and the power supply.

To limit flyback voltages at the inductive load, install a flyback diode across the load. Mount the flyback diode as close to the load as possible. Use this protection method if you connect any of the isolated outputs on the I/O Extension Board to an inductive load.

Figure 11 shows an example of using an external flyback diode to protect inductive loads.

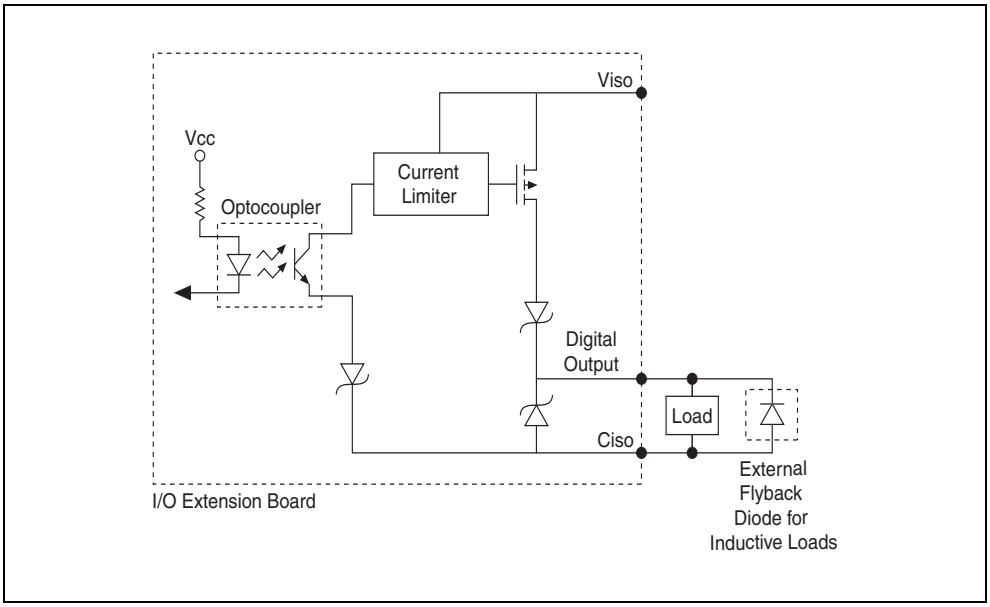


Figure 11. Example of Using an External Flyback Diode for Inductive Loads

Connecting to a Quadrature Encoder

The I/O Extension Board accepts either single-ended TTL or differential (RS-422 compatible) line driver inputs. If a single-ended encoder is used, the encoder lines must be connected to the positive connection for each phase.

Shielded encoder cables are recommended for all applications. Unshielded cables are more susceptible to noise and can corrupt the encoder signals.

Note If the encoder cable length is greater than 3.05 m (10 ft), encoders with line driver outputs are recommended.

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Figure 12 shows the encoder inputs circuit.

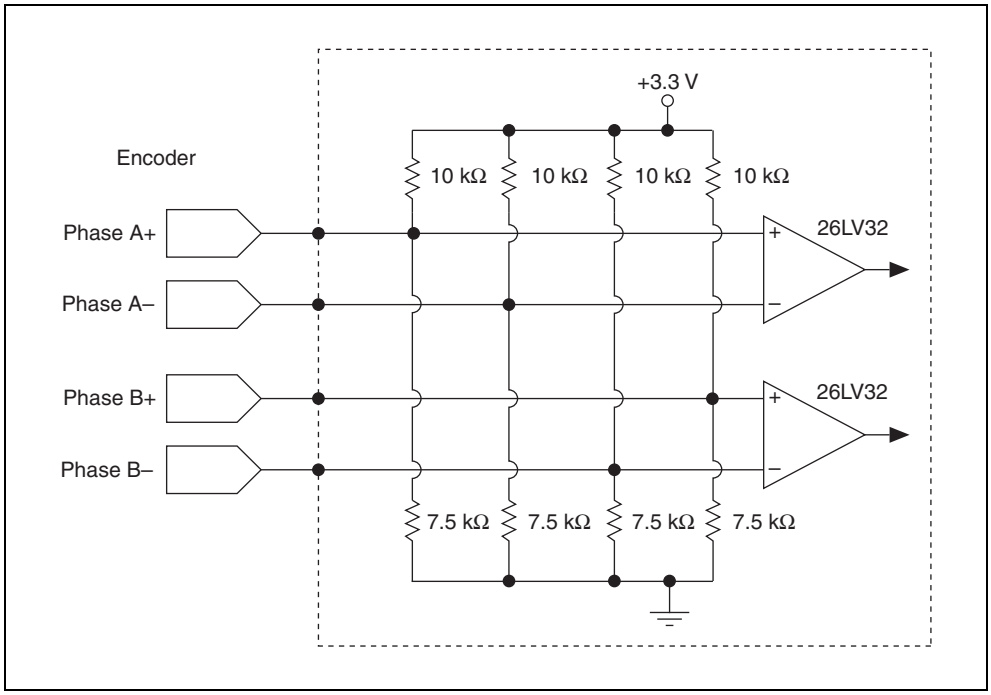


Figure 12. Encoder Inputs Circuit

Figure 13 shows an example of connecting differential line drivers.

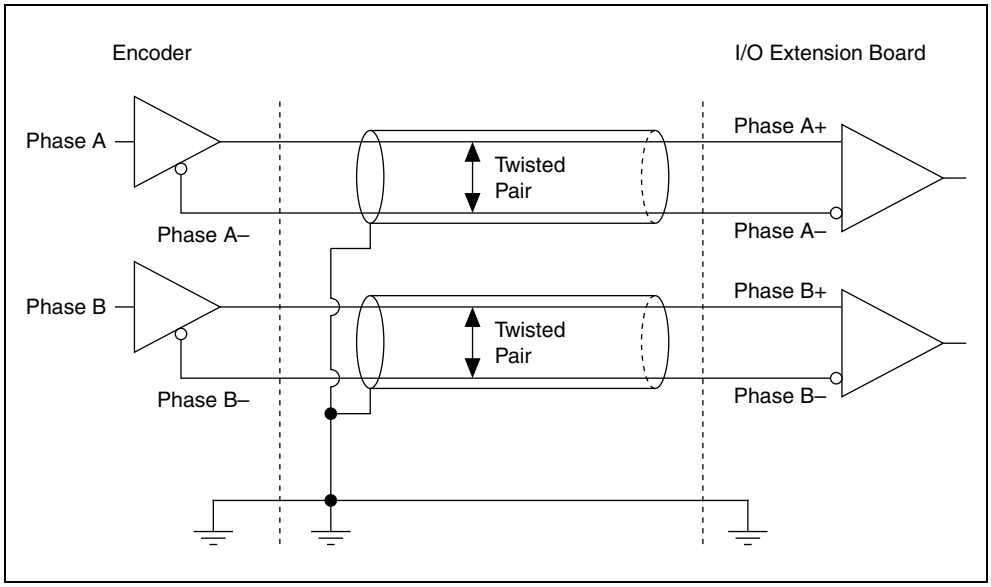


Figure 13. Example of Connecting Differential Line Drivers

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Figure 14 shows an example of connecting single-ended drivers.

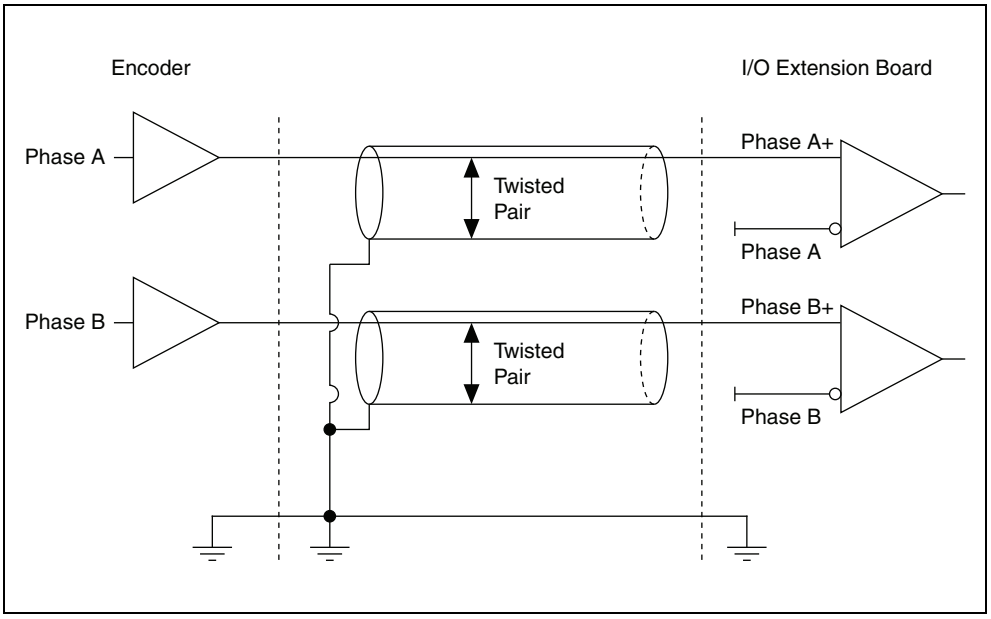


Figure 14. Example of Connecting Single-Ended Drivers

Optional 37-Pin Terminal Block

Use the 37-pin Terminal Block to convert the 44-pin D-SUB connection to a 37-pin D-SUB connection.

Figure 15 shows the pinout of the 37-pin Terminal Block.

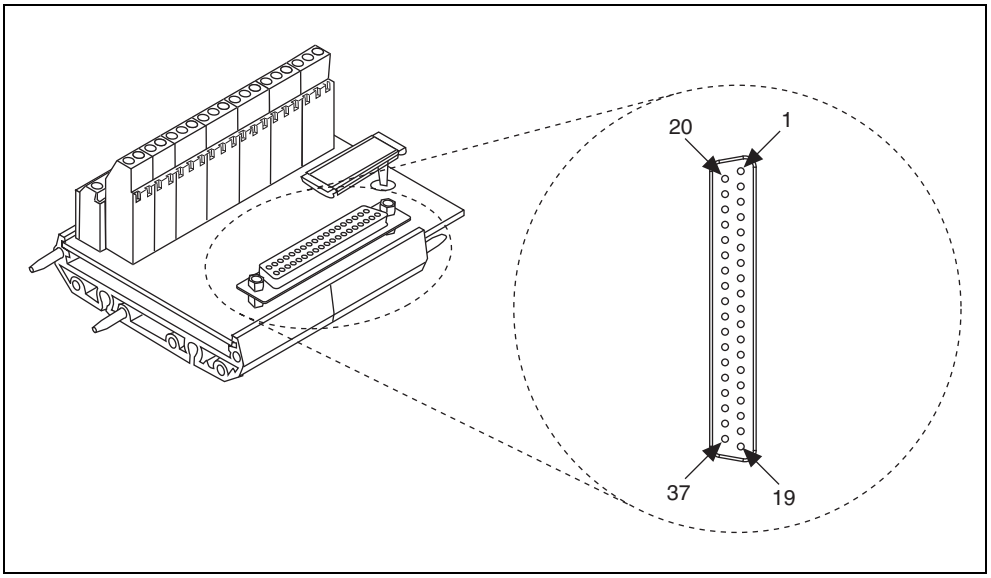


Figure 15. 37-Pin Terminal Block

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Table 3 lists pin numbers, signal names, and signal descriptions for the 37-pin Terminal Block.

Table 3. 37-Pin Terminal Block Signals

Pin Number	Signal Name	Signal Description
1	+12 V Camera	+12 V Camera Power*
2	+12 V Camera	+12 V Camera Power*
3	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
4	TTL I/O 1	General Purpose TTL Input/Output Line
5	TTL I/O 2	General Purpose TTL Input/Output Line
6	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
7	TTL I/O 3	General Purpose TTL Input/Output Line
8	TTL I/O 4	General Purpose TTL Input/Output Line
9	Iso Input 1+	Isolated Input Positive Connection
10	Iso Input 1–	Isolated Input Negative Connection
11	+5 V Camera	+5 V Camera Power*
12	C_{iso}	Isolated Power Common
13	+5 V Camera	+5 V Camera Power*
14	Phase A+	Quadrature Phase A Positive Connection
15	Phase A–	Quadrature Phase A Negative Connection
16	C_{iso}	Isolated Power Common
17	V_{iso}	Isolated Power
18	C_{iso}	Isolated Power Common
19	Iso Output 0	General Purpose Isolated Output
20	TTL I/O 5	General Purpose TTL Input/Output Line
21	TTL I/O 6	General Purpose TTL Input/Output Line
22	Digital Ground	Direct connection to Digital Ground on the I/O Extension Board
23	TTL I/O 7	General Purpose TTL Input/Output Line
24	TTL I/O 8	General Purpose TTL Input/Output Line
25	NC	No Connect
26	Phase B+	Quadrature Phase B Positive Connection
27	Phase B–	Quadrature Phase B Negative Connection
28	C_{iso}	Isolated Power Common

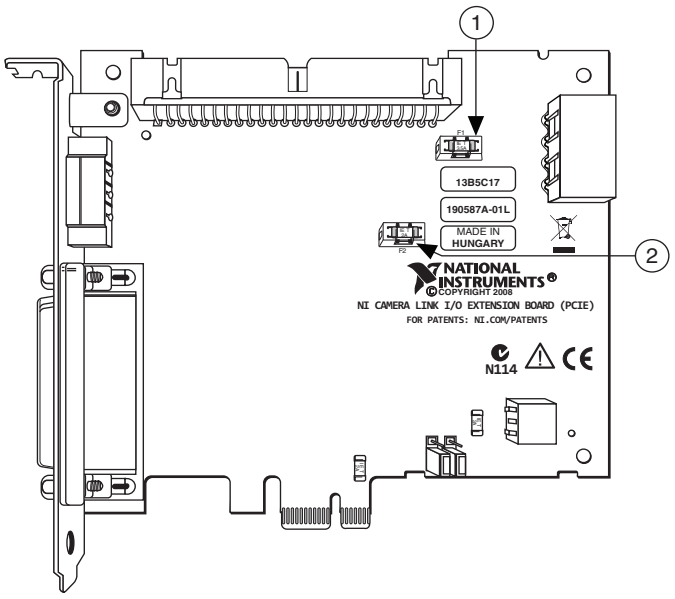
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Table 3. 37-Pin Terminal Block Signals (Continued)

Pin Number	Signal Name	Signal Description
29	Iso Output 2	General Purpose Isolated Output
30	Iso Input 0+	Isolated Input Positive Connection
31	Iso Input 0–	Isolated Input Negative Connection
32	C_{iso}	Isolated Power Common
33	V_{iso}	Isolated Power
34	C_{iso}	Isolated Power Common
35	Iso Output 1	General Purpose Isolated Output
36	Iso Input 2+	Isolated Input Positive Connection
37	Iso Input 2–	Isolated Input Negative Connection
* Connect Camera Ground signals to Digital Ground.		

Fuses

The NI Camera Link I/O Extension Board (PCIe) has two replaceable fuses. Refer to Figure 16 for the fuse locations. The fuses protect a camera attached to the 3-pin screw terminal connector from overcurrent through the camera power ATX connector on the I/O Extension Board.



1 Power Fuse (2 A) 2 Power Fuse (3.5 A)

Figure 16. Locations of Replaceable Fuses

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Testing Fuses

You can check the continuity of the fuse with a handheld DMM.

Replacing Fuses

To replace a blown fuse on the I/O Extension Board, complete the following steps:

1. Disconnect the 50-pin ribbon cable from the I/O Extension board.
2. Disconnect the power connector from the camera power ATX connector.
3. Remove all signal wires and cables from the accessory.
4. Remove the device from the computer expansion slot.
5. Replace the blown fuse while referring to Figure 16 for the fuse location. You can order additional fuses from Littelfuse at `www.littelfuse.com` or from electronics distributors.

Fuse	Littelfuse Part Number	Description
Power fuse (2 A)	0452002.MRL or 0454002.MR	2 A, 125 V, NANO^2 Slo-Blo Subminiature Surface Mount Fuse, 6.10 × 2.69 mm
Power fuse (3.5 A)	045203.5MRL or 045403.5MR	3.5 A, 125 V, NANO^2 Slo-Blo Subminiature Surface Mount Fuse, 6.10 × 2.69 mm

Specifications

The following specifications apply to the NI Camera Link I/O Extension Board (PCIe). All specifications are typical at 0 to 40 °C, unless otherwise stated.

TTL I/O

Caution TTL I/O lines provide no short-circuit protection. Failure to protect against short-circuit conditions will result in damage to the device.

Number of external TTL I/O lines 8

Trigger input

- Voltage range ..... 0 V to 5 V (TTL)
  - Input high voltage ..... 2 V to 5 V
  - Input low voltage ..... 0 V to 0.8 V
- Polarity ..... Programmable, active high or active low
- Maximum pulse rate ..... 2 MHz
- Minimum pulse detected ..... 250 ns

Trigger output

- Voltage range ..... 0 V to 5 V (TTL)
  - Output high voltage ..... 2.4 V at 5 mA source
  - Output low voltage ..... 0.55 V at 2 mA sink
- Polarity ..... Programmable, active high or active low

Power-on state ..... Input (high-impedance) 22 kΩ jumper selectable pull-up to 5 V, pull-down to digital ground, or tri-state

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Optically Isolated Inputs

Number of channels 3

Type ..... Current sinking or sourcing

Input voltage range ..... 0 V to 30 V

- Input ON voltage ..... 3.5 V to 30 V
- Input OFF voltage ..... 0 V to 2 V

Turn-on current ..... 7.1 mA (typical)
14 mA (maximum)

Current limiting ..... 14 mA

Maximum pulse rate ..... 100 kHz

Minimum pulse detected ..... 10 µs

Reverse polarity protection ..... Yes, –30 V

Optically Isolated Outputs

Number of channels 3

Type ..... Current sourcing

On-state voltage range ..... 5 V to 30 V, maximum

- Maximum on-state voltage drop from V_{iso} ..... 1.2 V at 100 mA

Output current

- 5 V_{iso} ..... 50 mA, maximum
- 24 V_{iso} ..... 100 mA, maximum
- 30 V_{iso} ..... 100 mA, maximum

Maximum pulse rate ..... 10 kHz

Minimum pulse generated ..... 100 µs

Reverse polarity protection ..... Yes, –30 V

Quadrature Encoder Inputs

Number of channels (+/– pairs) 2

Differential input threshold ..... ± 0.2 V (maximum), RS-422 compatible

Voltage range ..... 0 to 5.5 VDC

Single-ended input threshold ..... TTL compatible

- Input high voltage ..... 2.0 V
- Input low voltage ..... 0.8 V

Maximum quadrature count rate ..... 0.5 MHz

Camera Power

+5 VDC ..... 2.5 A

+12 VDC ..... 1.5 A

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Physical Characteristics

Dimensions .....10.7 cm × 12 cm (4.20 in. × 4.72 in.)

Weight .....92.0 g (3.25 oz)

Environment

The I/O Extension Board is intended for indoor use only.

Operating temperature .....0 °C to 40 °C

Storage temperature .....–30 °C to 80 °C

Relative humidity .....10% to 90%, noncondensing

Pollution Degree 2

Approved at altitudes up to 2,000 m.

Safety

The I/O Extension Board meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326 (IEC 61326): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Note For EMC compliance, operate this device with shielded cabling. In addition, all covers and filler panels *must* be installed.

CE Compliance CE

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for this product, visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

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