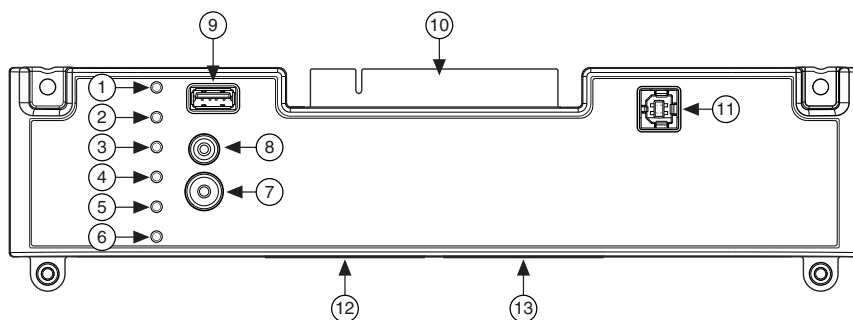


# NI ELVIS RIO Control Module

The NI ELVIS RIO Control Module is a reconfigurable I/O (RIO) device that is used to design control, robotics, and mechatronics systems.

This document contains pinouts, connectivity information, dimensions, and mounting instructions for the NI ELVIS RIO CM. The NI ELVIS RIO CM provides the I/O shown in the following figure and connects to a host computer through a USB connection.

**Figure 1. NI ELVIS RIO CM Features**



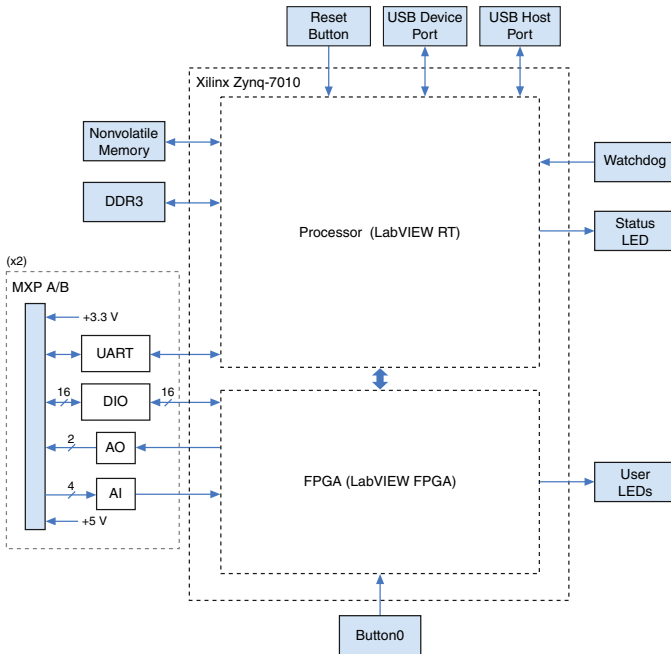
- |                          |                                     |
|--------------------------|-------------------------------------|
| 1. Power LED             | 8. Reset Button                     |
| 2. Status LED            | 9. USB Host Port                    |
| 3. LED0                  | 10. Workstation Interface Connector |
| 4. LED1                  | 11. USB Device Port                 |
| 5. LED2                  | 12. MXP Connector A                 |
| 6. LED3                  | 13. MXP Connector B                 |
| 7. Button0 (User Button) |                                     |

## Hardware Overview

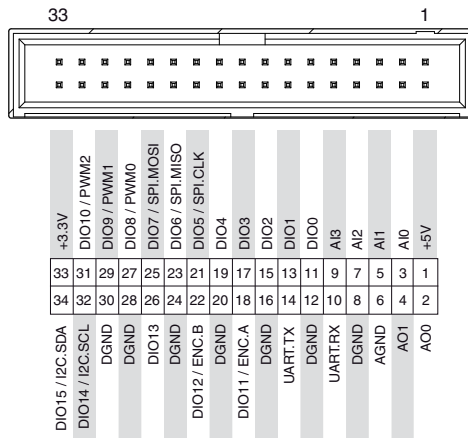
The NI ELVIS RIO CM provides analog input (AI), analog output (AO), digital input and output (DIO), and power output in a compact embedded device. The NI ELVIS RIO CM connects to a host computer through a USB connection.

The following figure shows the arrangement and functions of NI ELVIS RIO CM components.

**Figure 2. NI ELVIS RIO CM Hardware Block Diagram**



## MXP Connector Pinout



**Table 1.** Signal Descriptions

Signal Name	Reference	Direction	Description
+5V	DGND	Output	+5 V power output.
AI <0..3>	AGND	Input	0 V to 5 V, referenced single-ended AI. Refer to the <i>AI Channels</i> section for more information.
AO <0..1>	AGND	Output	0 V to 5 V, referenced single-ended AO. Refer to the <i>AO Channels</i> section for more information.
AGND	—	—	Reference for AI and AO.
+3.3V	DGND	Output	+3.3 V power output.
DIO <0..15>	DGND	Input or Output	General-purpose digital lines with +3.3 V output, 3.3 V-/5 V-compatible input. Refer to the <i>DIO Lines</i> section for more information.
UART.RX	DGND	Input	UART receive input. UART lines are electrically identical to DIO lines.
UART.TX	DGND	Output	UART transmit output. UART lines are electrically identical to DIO lines.
DGND	—	—	Reference for digital signals, +5 V, and +3.3 V.



**Note** MXP connectors A and B have identical sets of signals and are distinguished in software by the connector name, such as ConnectorA/DIO1 and ConnectorB/DIO1. Refer to the software documentation for information about configuring and using signals.



**Note** Some pins carry secondary functions as well as primary functions.

## Interfaces

### AI Channels

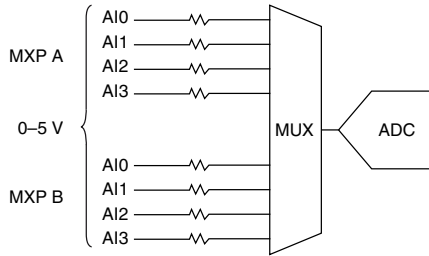
The NI ELVIS RIO CM MXP connectors A and B have four single-ended AI channels per connector, AI0-AI3, which you can use to measure signals of 0 V to 5 V. The channels are multiplexed to a single analog-to-digital converter (ADC) that samples all channels.



**Note** For important information about improving measurement accuracy by reducing noise, visit [ni.com/info](https://ni.com/info) and enter the Info Code `analogwiring`.

The following figure shows the AI topology of the NI ELVIS RIO CM.

**Figure 3. NI ELVIS RIO CM AI Circuitry**

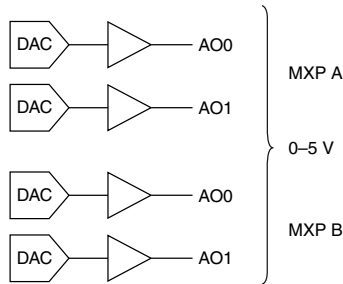


## AO Channels

The NI ELVIS RIO CM MXP connectors A and B have two AO channels per connector, AO0 and AO1, which you can use to generate signals of 0 V to 5 V. Each channel has a dedicated digital-to-analog converter (DAC), which allows all AO channels to update simultaneously. The DACs for the AO channels are controlled by a serial communication bus from the FPGA. MXP connectors A and B share this bus and therefore, all channels must share the same update rate.

The following figure shows the AO topology of the NI ELVIS RIO CM.

**Figure 4. NI ELVIS RIO CM AO Circuitry**



## Converting Raw Data Values to Voltage

You can use the following equations to convert raw AI and AO data values to volts:

$$V = \text{Raw Data Value} \times \text{LSB Weight}$$

$$\text{LSB Weight} = \text{Nominal Range} \div 2^{\text{Resolution}}$$

where

Raw Data Value is the value returned by the FPGA I/O node,

LSB Weight is the value in volts of the increment between data values,

Nominal Range is the absolute value in volts of the full, peak-to-peak nominal range of the channel, and

Resolution is the resolution of the ADC or DAC in bits (Resolution = 12)

For AI and AO channels on the MXP connectors,

$$\text{LSB Weight} = 5 \text{ V} \div 2^{12} = 1.221 \text{ mV}$$

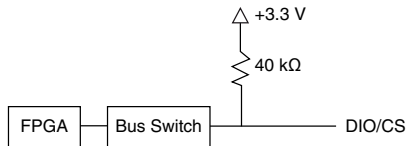
$$\text{Maximum Reading} = 4095 \times 1.221 \text{ mV} = 4.999 \text{ V}$$

## DIO Lines

The NI ELVIS RIO CM provides 3.3 V general-purpose DIO lines on the MXP connectors.

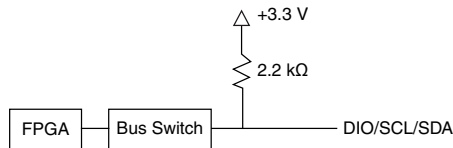
DIO <13..0> on the MXP have 40 kΩ pull-up resistors to 3.3 V, as shown in the following figure.

**Figure 5.** DIO Lines with 40 kΩ Pull-up Resistors to 3.3 V



DIO <15..14> on the MXP have 2.2 kΩ pull-up resistors to 3.3 V, as shown in the following figure.

**Figure 6.** DIO Lines with 2.2 kΩ Pull-up Resistors to 3.3 V



You can program all MXP DIO lines individually as inputs or outputs. Secondary digital functions include SPI, I<sup>2</sup>C, PWM, and quadrature encoder input.



**Note** For information about configuring the behavior of the DIO lines, visit [ni.com/info](http://ni.com/info) and enter the Info Code `elvisriocmhelp`.

When a DIO line is floating, it floats in the direction of the pull resistor. A DIO line may be floating in any of the following conditions:

- When the NI ELVIS RIO CM device is starting up.
- When the line is configured as an input.
- When the NI ELVIS RIO CM device is powering down.

You can add a stronger resistor to a DIO line to cause it to float in the opposite direction.

## UART Lines

The NI ELVIS RIO CM has one UART receive input line and one UART transmit output line on each MXP connector.

The UART lines on the MXP are electrically identical to DIO <13..0> on the MXP. Similarly, UART.RX and UART.TX have 40 kΩ pull-up resistors to 3.3 V.

## USB Device Port

You can deploy and debug code by connecting a USB cable from the USB device port on the NI ELVIS RIO CM to a computer.

## USB Host Port

The NI ELVIS RIO CM USB host port supports the following devices:

- Web cameras that conform to the USB Video Device Class (UVC) protocol.
- Machine vision cameras that conform to the USB3 Vision standard and are backward compatible with the USB 2.0 specification.
- Basler ace USB3 cameras.
- USB Flash drives.<sup>1</sup>
- USB-to-IDE adapters formatted with FAT16 and FAT32 file systems.<sup>1</sup>

## Front Panel Buttons

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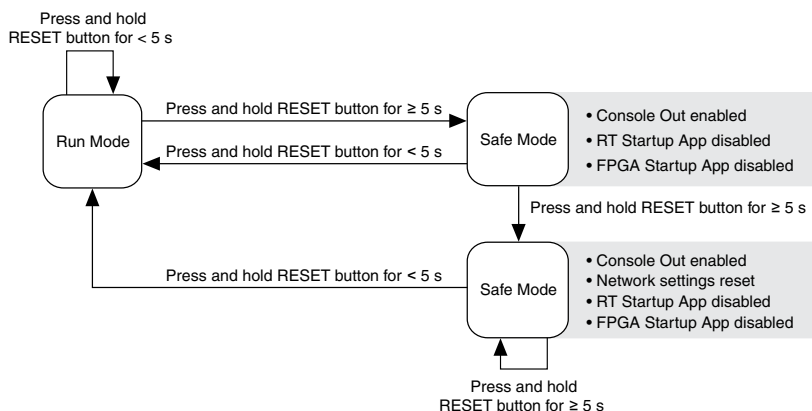
### Reset Button

Pressing and releasing the Reset button restarts the processor and the FPGA. The following figure shows the reset behavior of the NI ELVIS RIO CM.

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<sup>1</sup> LabVIEW usually maps USB devices to the /**u**, /**v**, /**w**, or /**x** drive, starting with the /**u** drive if it is available.

**Figure 7. Reset Button Behavior**



When the NI ELVIS RIO CM is in safe mode, you can communicate with it by using the UART lines on MXP connector A. You require the following items to communicate with the NI ELVIS RIO CM device over UART:

- USB-to-TTL serial UART converter cable (for example, part number TTL-232RG-VSW3V3-WE from FTD Chip)

You must configure your serial-port terminal program with the following settings:

- 115,200 bits per second
- Eight data bits
- No parity
- One stop bit
- No flow control

## User Button

The User Button produces a logic TRUE when depressed and a logic FALSE when not depressed. The User Button is not debounced in hardware.

## LED Indications

### Power LED

The Power LED is lit while the NI ELVIS RIO CM is powered on. This LED indicates that the power supply connected to the device is adequate.

### Status LED

The Status LED is off during normal operation. The NI ELVIS RIO CM runs a power-on self test (POST) when you apply power to the device. During the POST, the Power and Status LEDs turn on. When the Status LED turns off, the POST is complete. The NI ELVIS RIO CM

indicates specific error conditions by flashing the Status LED a certain number of times every few seconds, as shown in the following table.

**Table 2. Status LED Indications**

Number of Flashes Every Few Seconds	Indication
2	The device has detected an error in its software. This usually occurs when an attempt to upgrade the software is interrupted. Reinstall software on the device.
3	The device is in safe mode.
4	The software has crashed twice without rebooting or cycling power between crashes. This usually occurs when the device runs out of memory. Review your LabVIEW Real-Time VI and check the memory usage. Modify the VI as necessary to solve the memory usage issue.
Continuously flashing or solid	The device has detected an unrecoverable error. Contact NI.

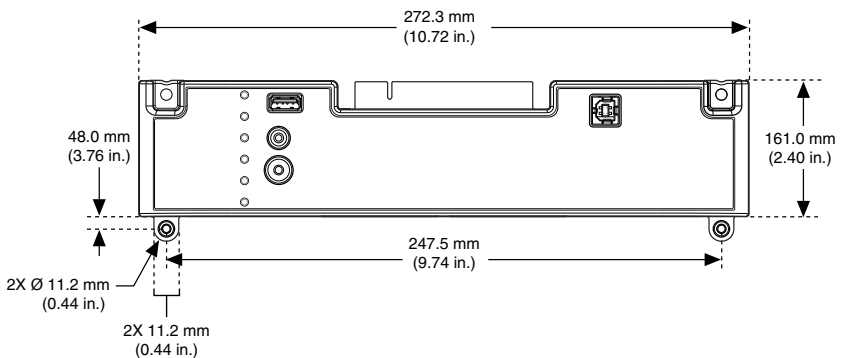
## LEDs 0-3

You can use LEDs 0-3 to help debug your application or easily retrieve application status. Logic TRUE turns an LED on and logic FALSE turns an LED off.

## Physical Dimensions

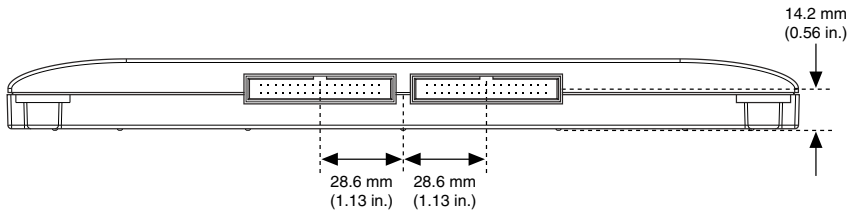
The following figures describe the physical dimensions of the NI ELVIS RIO CM enclosure and its features.

**Figure 8. NI ELVIS RIO CM Dimensions, Top View**

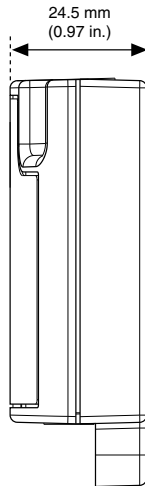




**Figure 9. NI ELVIS RIO CM Dimensions, Front View**



**Figure 10. NI ELVIS RIO CM Dimensions, Side View**



**Note** For more information about the dimensions of the system, detailed 2-dimensional drawings and 3-dimensional models, visit [ni.com/dimensions](https://ni.com/dimensions) and search for the product name.

## Warranty

For customers other than private individual users in the EU: The NI ELVIS RIO CM is warranted against defects in materials and workmanship for a period of three years from the date of shipment, as evidenced by receipts or other documentation. NI will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

For private individual users in the EU: Based on your statutory rights, NI will—through its distributor—cure defects in materials and workmanship within two years from delivery.

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