

Front Panel Digital I/O and Indicators



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1.0 Introduction

The analog/digital signal converter products include front panel digital I/O connectors to facilitate communication with external hardware. These connectors typically carry general purpose I/O (GPIO) signals and triggers. This manual describes the connectivity and electrical characteristics of the 15-pin Nano-D connector interface and the optional coax trigger input.

There are two front panel LED indicators that report hardware activity based on a software selection. This manual describes the function of those indicators.

The latest product documentation and software is available for download from the Red Rapids website (www.redrapids.com).

1.1 Conventions

This manual uses the following conventions:

	Text in this format highlights useful or important information.
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	Text shown in this format is a warning. It describes a situation that could potentially damage your equipment. Please read each warning carefully.
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The following are some of the acronyms used in this manual.

- **AWG** American Wire Gauge
- **GPIO** General Purpose I/O
- **IEEE** Institute of Electrical and Electronics Engineers
- **JTAG** Joint Test Action Group
- **LED** Light Emitting Diode

1.2 Revision History

Version	Date	Description
R00	1/15/2016	Initial release.

2.0 Nano-D Connector

The circuit board mounted 15-pin Nano-D connector, shown in Figure 2-1, provides a space efficient solution for external digital I/O. Two screws securely attach the connector to the PWB to eliminate strain on the solder joints. The Nano-D connector is labeled GPIO on products that include a bezel or face plate.

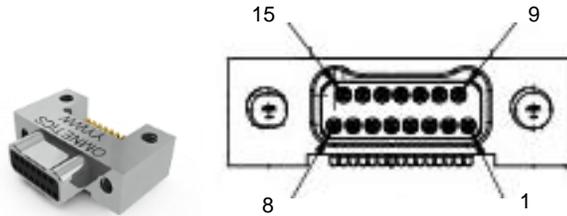


Figure 2-1 15-pin Nano-D Connector

An 18 inch Nano-D pigtail connector mates to the circuit board mounted connector. The connectors are secured using two hex head retention screws. The 30 AWG Teflon coated wires are color coded as shown in Figure 2-2. The pigtail connector assembly is available from Red Rapids or directly from Omnetics (PN A29000-115).

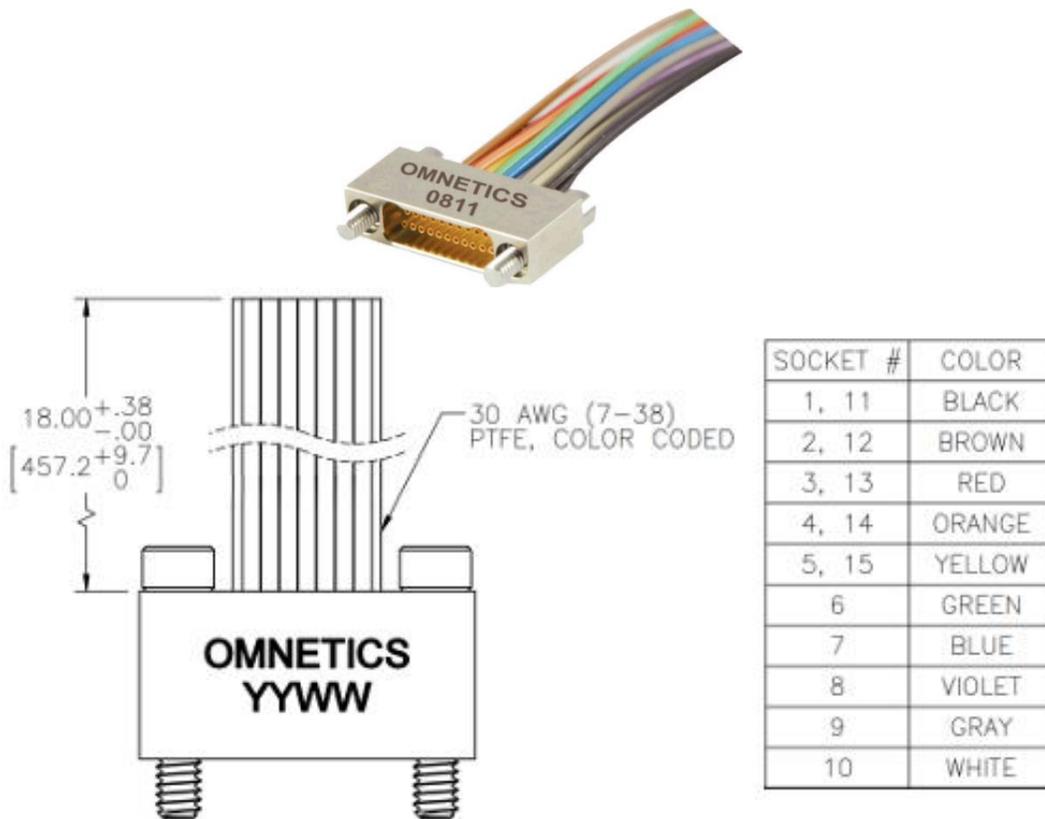


Figure 2-2 15-pin Nano-D Pigtail

2.1 Nano-D Pinout

The Nano-D connector supports four different functions as shown in Figure 2-3.

1. A dedicated trigger input terminated into a 50 ohm load.

2. Four bidirectional GPIO pins that can be individually programmed as either input triggers or discrete digital outputs.
3. Two reserved pins that can be factory programmed to perform application specific functions requested by a customer.
4. A JTAG programming interface that is used to restore firmware in the unlikely event that flash memory is corrupted and cannot be restored from software.

The remaining pins are assigned to power and ground.

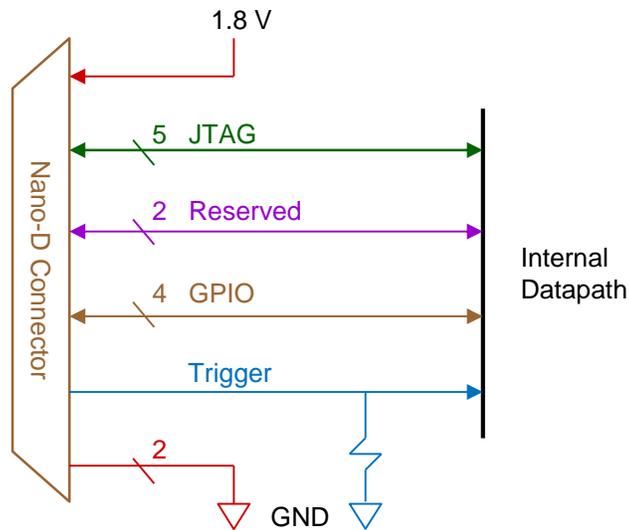


Figure 2-3 Nano-D Connector Wiring

Table 2-1 lists the signal assignments for all fifteen Nano-D connector pins.

Table 2-1 Nano-D Pin Assignments

Nano-D Pin	Signal Type	Signal Name
1	Bidirectional	GPIO #1
2	Bidirectional	GPIO #2
3	Bidirectional	GPIO #3
4	Bidirectional	GPIO #4
5	Bidirectional	Reserved
6	Bidirectional	Reserved
7	Input	Trigger
8	Power	GND
9	Power	GND
10	Input	TMS
11	Input	TCK
12	Output	TDO
13	Input	TDI
14	Power	1.8 V
15	Input	VPP

2.1.1 GPIO Trigger Interface

The trigger pin assignments to the Nano-D connector are highlighted in Table 2-2.

Table 2-2 Trigger Pin Assignments Highlighted

Nano-D Pin	Signal Type	Signal Name
1	Bidirectional	GPIO #1
2	Bidirectional	GPIO #2
3	Bidirectional	GPIO #3
4	Bidirectional	GPIO #4
5	Bidirectional	Reserved
6	Bidirectional	Reserved
7	Input	Trigger
8	Power	GND
9	Power	GND
10	Input	TMS
11	Input	TCK
12	Output	TDO
13	Input	TDI
14	Power	1.8 V
15	Input	VPP

The trigger pin is connected to the datapath through a 5 V tolerant Schmitt Trigger (Texas Instrument PN 74LVC1G17) with the input terminated to 50 ohms. The electrical characteristics presented at the Nano-D connector are listed in Table 2-3.

Table 2-3 GPIO Trigger Electrical Characteristics

Symbol	Description	MIN	MAX
V_{T+}	Positive Going Input Threshold	0.76 V	1.13 V
V_{T-}	Negative Going Input Threshold	0.35 V	0.59 V
$V_{T+} - V_{T-}$	Hysteresis	0.36 V	0.64 V
t_{PD}	Propagation Delay	2.8 ns	9.9 ns
t_{OPLH}, t_{OPHL}	Output Propagation Delay	0.3 ns	4.0 ns
C_i	Input Capacitance	4.5 pF (typical)	

The GPIO trigger input can be used to start and stop channel processing in the datapath or provide a 1 PPS signal to the on-board time of day clock.

2.1.1 GPIO Interface

The pin assignments for the GPIO interface to the Nano-D connector are highlighted in Table 2-4.

Table 2-4 GPIO Pin Assignments Highlighted

Nano-D Pin	Signal Type	Signal Name
1	Bidirectional	GPIO #1
2	Bidirectional	GPIO #2
3	Bidirectional	GPIO #3
4	Bidirectional	GPIO #4
5	Bidirectional	Reserved
6	Bidirectional	Reserved
7	Input	Trigger
8	Power	GND
9	Power	GND
10	Input	TMS
11	Input	TCK
12	Output	TDO
13	Input	TDI
14	Power	1.8 V
15	Input	VPP

The GPIO pins are connected to the datapath through bidirectional voltage translators (Fairchild PN FXL2TD245). The electrical characteristics presented at the Nano-D connector are listed in Table 2-5.

Table 2-5 GPIO Electrical Characteristics

Symbol	Description	MIN	MAX
V_{IH}	High Level Input Voltage	2.0 V	N/A
V_{IL}	Low Level Input Voltage	N/A	0.8 V
I_{OL}, I_{OH}	Output Current	N/A	± 24 mA
V_{OH}	$I_{OH} = \text{MAX}$	2.2 V	N/A
V_{OL}	$I_{OL} = \text{MAX}$	N/A	0.55 V
t_{IPLH}, t_{IPLH}	Input Propagation Delay	0.5 ns	5.4 ns
t_{OPLH}, t_{OPLH}	Output Propagation Delay	0.3 ns	4.0 ns
C_{IO}	Input/Output Capacitance	5.0 pF (typical)	

The voltage translator presents a high impedance input to incoming signals. There is a hardware option to add a termination resistor between the signal and ground if different input impedance is required as shown in Figure 2-4. The resistors are added in pairs as shown in the figure.

The GPIO interface can be used to receive four triggers in addition to the dedicated GPIO and coax trigger inputs. Alternatively, each pin can be programmed to supply digital control signals to external peripherals. The direction of each pin and the logic value assigned to outputs is selected through software.

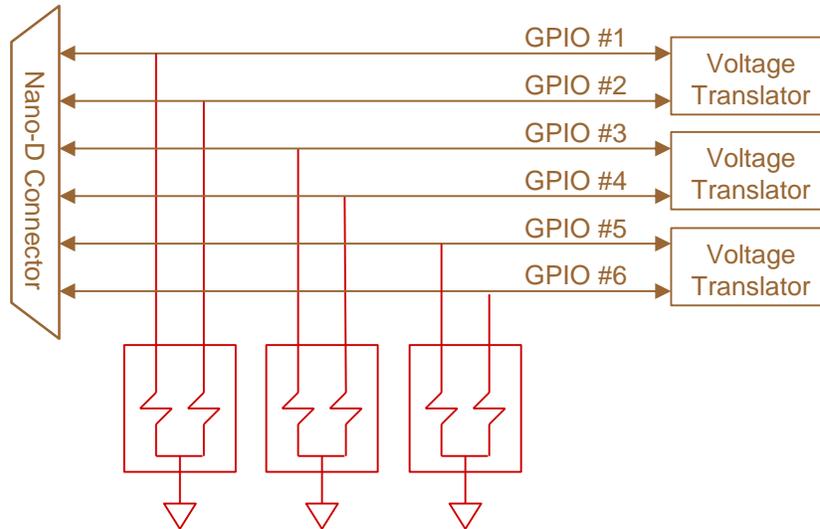


Figure 2-4 Optional GPIO Termination Resistors

2.1.2 Reserved Pins

The reserved pins on the Nano-D connector are highlighted in Table 2-6. These pins can be used to provide custom interface functions if needed. Contact Red Rapids to discuss any applications specific requirements.

Table 2-6 Reserved Pins Highlighted

Nano-D Pin	Signal Type	Signal Name
1	Bidirectional	GPIO #1
2	Bidirectional	GPIO #2
3	Bidirectional	GPIO #3
4	Bidirectional	GPIO #4
5	Bidirectional	Reserved
6	Bidirectional	Reserved
7	Input	Trigger
8	Power	GND
9	Power	GND
10	Input	TMS
11	Input	TCK
12	Output	TDO
13	Input	TDI
14	Power	1.8 V
15	Input	VPP

2.1.3 JTAG Interface

The pin assignments for the JTAG programming interface to the Nano-D connector are highlighted in Table 2-7. The four JTAG signals (Txx) are defined by the IEEE 1149.1 (Standard Test Access Port and Boundary-Scan Architecture) specification. The VPP input is connected to the programming voltage pin of the non-volatile flash memory that is used to store the firmware.

Table 2-7 JTAG Pin Assignments Highlighted

Nano-D Pin	Signal Type	Signal Name
1	Bidirectional	GPIO #1
2	Bidirectional	GPIO #2
3	Bidirectional	GPIO #3
4	Bidirectional	GPIO #4
5	Bidirectional	Reserved
6	Bidirectional	Reserved
7	Input	Trigger
8	Power	GND
9	Power	GND
10	Input	TMS
11	Input	TCK
12	Output	TDO
13	Input	TDI
14	Power	1.8 V
15	Input	VPP

The VPP input provides data protection to the flash contents. A pull-down resistor on the circuit board holds this pin low unless the VPP input of the JTAG interface is tied to 1.8 V. The flash cannot be programmed while VPP is grounded. The JTAG interface supplies the 1.8 V power source needed to drive the VPP input high. Pin #14 and pin #15 can simply be tied together to enable flash programming. It should be noted that there is also a hardware option to drive VPP high on the circuit board so that the flash can be programmed through software without the JTAG interface connected.

3.0 SMA Connector

The circuit board mounted SMA coax connector, shown in Figure 3-1, provides a controlled impedance input trigger to the datapath. The specific style of connector found on a particular product will depend on whether it is convection or conduction cooled. The SMA will be labeled TRIG on products that include a bezel or face plate. Some products offer the coax trigger input as a build option due to space constraints. These products allow a single connector to function as either a trigger or an external clock/reference input.

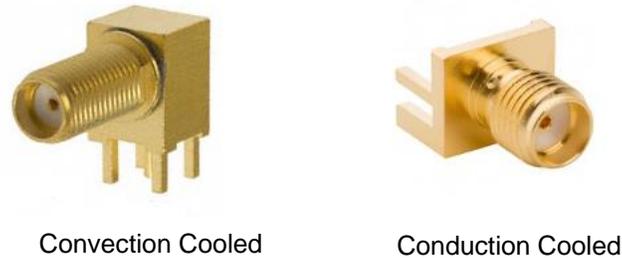


Figure 3-1 SMA Connector

SMA cables are readily available from a wide range of suppliers. The RG316 cable shown in Figure 3-2 is just one example.



Figure 3-2 SMA Cable

3.1 SMA Pinout

The center conductor of the SMA connector is wired to the datapath as shown in Figure 3-3. The case of the connector is wired to ground.

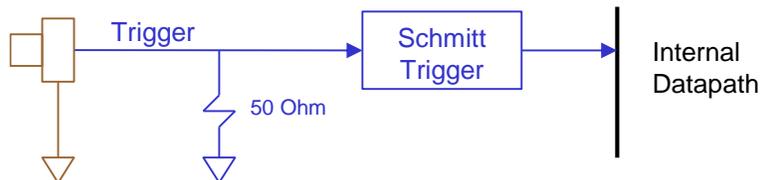


Figure 3-3 SMA Connector Wiring

3.1.1 Coax Trigger Interface

The trigger input is connected to the datapath through a 5 V tolerant Schmitt Trigger (Texas Instrument PN 74LVC1G17) with the input terminated to 50 ohms.

The electrical characteristics presented at the SMA connector are listed in Table 3-1.

Table 3-1 Coax Trigger Electrical Characteristics

Symbol	Description	MIN	MAX
V_{T+}	Positive Going Input Threshold	0.76 V	1.13 V
V_{T-}	Negative Going Input Threshold	0.35 V	0.59 V
$V_{T+} - V_{T-}$	Hysteresis	0.36 V	0.64 V
t_{PD}	Propagation Delay	2.8 ns	9.9 ns
t_{OPLH}, t_{OPHL}	Output Propagation Delay	0.3 ns	4.0 ns
C_i	Input Capacitance	4.5 pF (typical)	

The coax trigger input can be used to start and stop channel processing in the datapath or provide a 1 PPS signal to the on-board time of day clock.

4.0 LED Indicators

There are two light emitting diodes (LEDs) located on either side of the Nano-D connector as shown in Figure 4-1. These diodes can be toggled on and off based on hardware activity. The diodes are not labeled on any bezel or face plate.

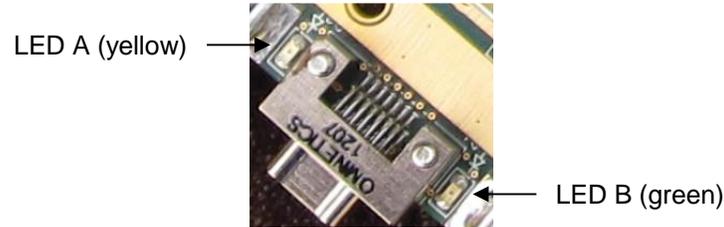


Figure 4-1 LED Positions Adjacent To Nano-D Connector

The specific function of each LED is programmed through software. LED A is used to monitor input triggers and can be set to flash based on transitions detected on the GPIO, coax, or software trigger sources. LED B is used to monitor datapath activity and can be set to flash when specific channels are active.

The LED indicators can assist with application debug since they provide visual feedback based on hardware activity. The monitor selections are not mutually exclusive, a single LED can report on any number of available hardware activities simultaneously.