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USER GUIDE
NI SMA-2164/2165 Test Fixture

Differential Digital I/O Accessory

The NI SMA-2164/2165 test fixture is a breakout box for National Instruments differential digital waveform generator/analyzer modules, arbitrary waveform generators, and NI FlexRIO™ adapter modules. This fixture provides an easy way to connect to other devices for testing and debugging.

The NI SMA-2164 is intended for use with devices with a matching Infiniband connector such as NI 6561/6562 modules, NI 6583 adapter modules, and NI 6587 adapter modules.
The NI SMA-2165 is intended for use with devices with matching VHDCI connectors such as NI 5421 modules and NI 6585 adapter modules. The NI SMA-2164/2165 may be compatible with other NI modules depending on the connector type and pinout.

This guide explains how to set up and use the NI SMA-2164/2165 test fixture.

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NATIONAL INSTRUMENTS™

Conventions

The following conventions are used in this manual:

<>	Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, DIO <0..3>.
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **Options»Settings»General** directs you to pull down the **Options** menu, select the **Settings** item, and select **General** from the last dialog box.
	This icon denotes a note, which alerts you to important information.
	This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on a product, refer to the *Specifications* section for information about precautions to take.
bold	Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.
italic	Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

What You Need to Get Started

To set up and use the NI SMA-2164/2165, you need the following items:

- ❑ (NI SMA-2164 only) NI SHB12X-B12X LVDS cable assembly
- ❑ (NI SMA-2165 only) NI SHC68-C68-D3 cable assembly
- ❑ Compatible NI digital waveform generator/analyzer, NI FlexRIO adapter module, or other NI device installed in a PXI or CompactPCI chassis

You also may need the following optional items:

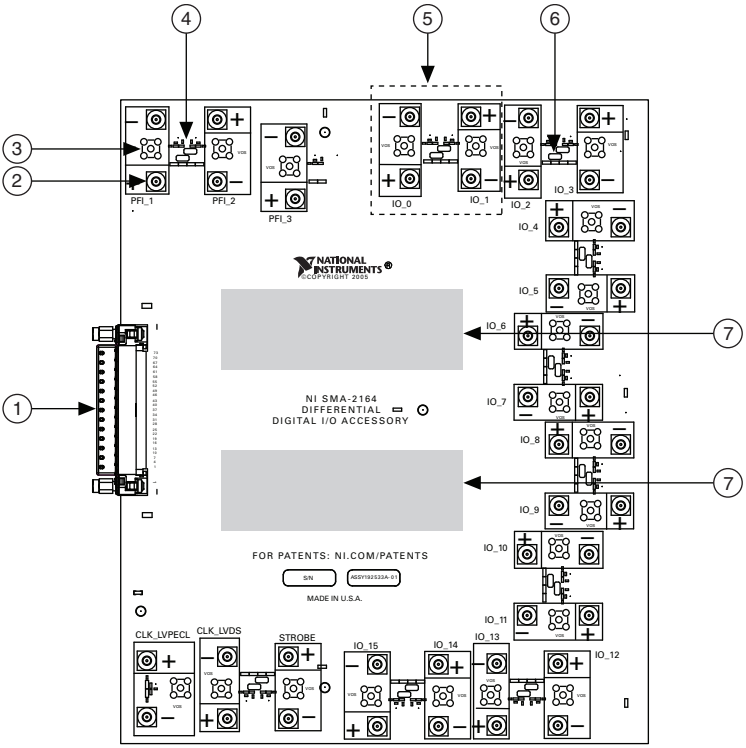
- ❑ SMA cables
- ❑ Resistors for termination or characterization. The NI SMA-2164/2165 ships populated with 0 Ω resistors.
- ❑ The documentation included with the digital waveform generator/analyzer and driver software

Related Documentation

Refer to the documentation set for the device that you are connecting to the NI SMA-2164/2165 for more information. Documentation is available at `ni.com/manuals` and in your hardware kit.

Parts Locator

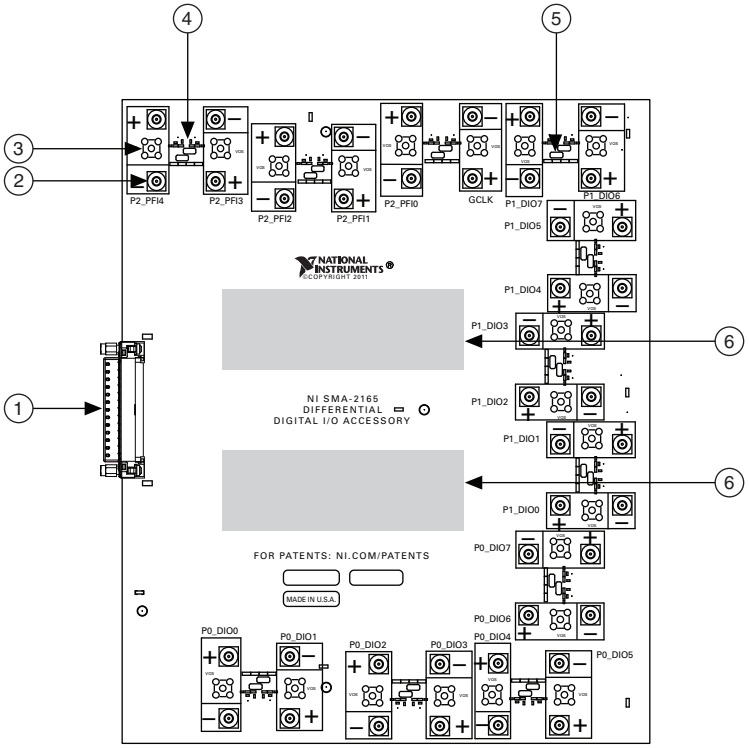
Refer to Figure 1 to locate connectors and components on the NI SMA-2164.



1	73-Pin Infiniband Connector	4	Resistor Network	6	Solder Pads
2	SMA Connector	5	Area Enlarged in Figure 8	7	Labeling Strips
3	Solder Pads				

Figure 1. NI SMA-2164 Parts Locator Diagram

Refer to Figure 2 to locate connectors and components on the NI SMA-2165.

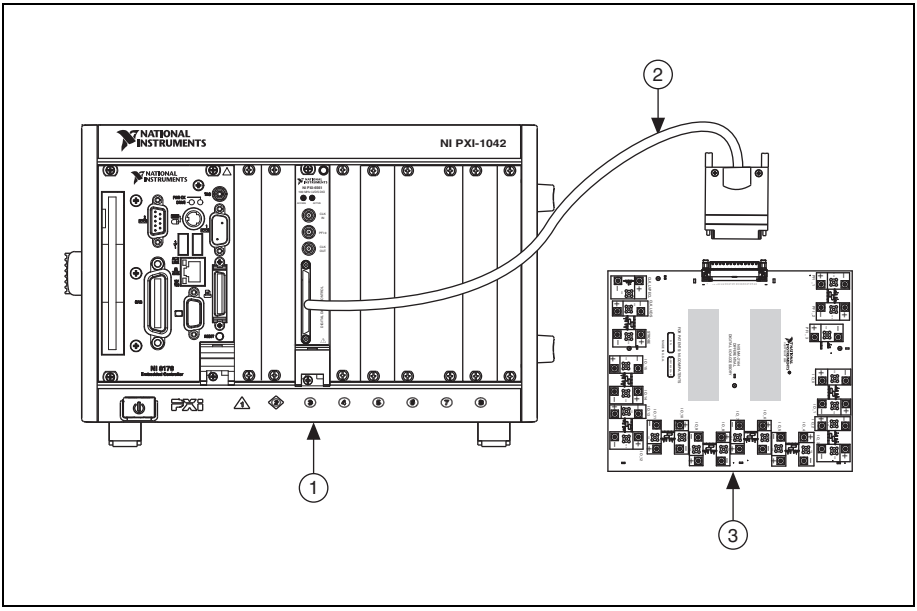


1	68-Pin VHDCI Connector	3	Solder Pads	5	Solder Pads
2	SMA Connector	4	Resistor Network	6	Labeling Strips

Figure 2. NI SMA-2165 Parts Locator Diagram

Installing Cables

The NI SHB12X-B12X LVDS cable is designed for use with the NI SMA-2164 and the NI SHC68-C68-D3 cable is designed for use with the NI SMA-2165. Figure 3 shows how to connect either of these cables to another NI device.



1	An NI Device Installed in a PXI Chassis	3	NI SMA-2164/2165
2	NI SHB12X-B12X LVDS or NI SHC68-C68-D3 Cable		

Figure 3. Connecting a Device to the NI SMA-2164/2165

Refer to Figure 3 as you complete the following steps to install the NI SHB12X-B12X LVDS or the NI SHC68-C68-D3 cable.

Caution Disconnect power from the device, accessory, and any other connected hardware before connecting the cable to prevent damage to the hardware and personal injury. NI is *not* liable for damage resulting from improper connections.

1. Install the driver software for your device using the installation instructions available with your device.

Note Always install the module in a computer or PXI/CompactPCI chassis *before* attaching any cables or accessories. Refer to your device documentation for instructions on installing the module.

2. Attach either end of the NI SHB12X-B12X LVDS or the NI SHC68-C68-D3 cable to the appropriate connector on your other NI device and secure the cable with the captive screws on the cable connector.

Notes Do *not* use cables other than the NI SHB12X-B12X LVDS cable with the NI SMA-2164, and do *not* use cables other than the NI SCH68-C68-D3 cable with the NI SMA-2165. NI is not liable for any damage resulting from improper cable connections.

3. Attach and secure the other end of the NI SHB12X-B12X LVDS or the NI SHC68-C68-D3 cable to the connector on the NI SMA-2164 or NI SMA-2165, respectively, and secure them together with the captive screws on the cable connector, as shown in Figure 3.

Connecting Signals

Each DIO, PFI, and clock channel on your connected NI device corresponds to a specific pin on the NI SMA-2164/2165. Most channels are routed differentially to high-bandwidth SMA connectors, but some channels may be used for other purposes depending on your NI device. Refer to you device documentation for more information.

You can make connections to the DIO, PFI, or clock channels on the NI SMA-2164/2165 using an SMA coaxial cable or by soldering directly to the inline circuits. Examples of how to make these connections are provided in the following sections.

Caution *Before* powering down the chassis, remove power from the prototyping area of the NI SMA-2164/2165. NI is *not* liable for any damage resulting from improper signal connections.

Caution Connections that exceed any of the maximum ratings for the NI SMA-2164/2165 or the connected NI device can damage the module and the computer. Maximum input ratings are provided in the *Specifications* section and in the specifications document that shipped with the other NI device. NI is not liable for any damage resulting from such signal connections.

Figure 4 shows the pinout of the NI SMA-2164 connector. Table 1 describes the pinout signals.

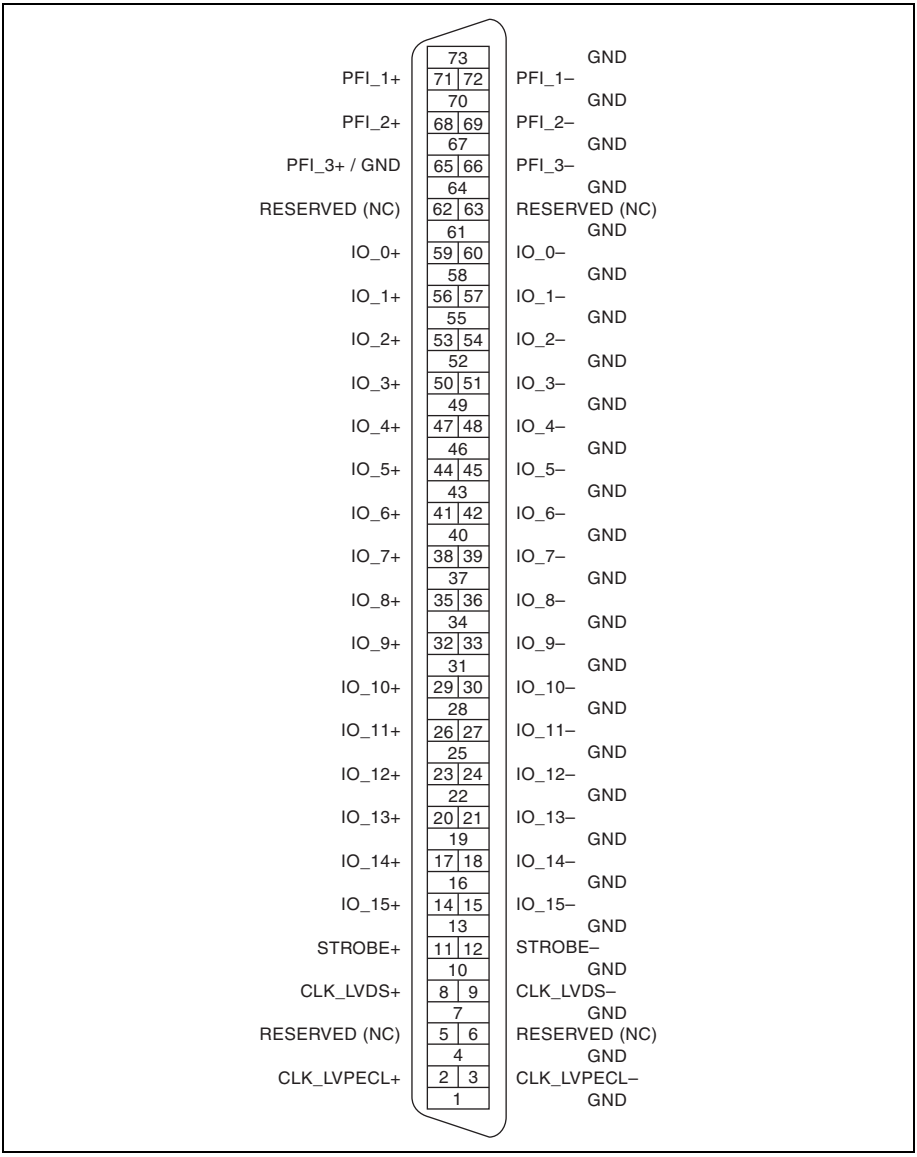


Figure 4. NI SMA-2164 Connector Pinout

Note If you are designing a custom cabling solution with the NI SMA-2164 connector (779157-01) and the NI SHB12X-B12X LVDS cable (192344-01), the pinout is *reversed* at the end connector. Refer to your connected device documentation for more information.

Table 1. NI SMA-2164 Signal Descriptions

Signal Name	Signal Description
CLK_LVDS+	Positive terminal for the LVDS exported Sample clock.
CLK_LVDS–	Negative terminal for the LVDS exported Sample clock.
CLK_LVPECL+	Positive terminal for the LVPECL exported Sample clock.
CLK_LVPECL–	Negative terminal for the LVPECL exported Sample clock.
STROBE+	Positive external Sample clock source, which can be used for dynamic acquisition.
STROBE–	Negative external Sample clock source, which can be used for dynamic acquisition.
IO_<0..15>+	Positive bidirectional digital I/O data channels 0 through 15.
IO_<0..15>–	Negative bidirectional digital I/O data channels 0 through 15.
PFI_<1..3>+	Positive input terminals to the connected device for external triggers, or positive output terminals from the connected device for events.
PFI_<1..3>–	Negative input terminals to the connected device for external triggers, or negative output terminals from the connected device for events.
GND	Ground reference for signals.
RESERVED	These terminals are reserved for future use. Do *not* connect to these pins.

Refer to your device documentation for more information about the signals on your connected device. For information about how the signals on your connected device map to the SMA connectors on the NI SMA-2164/2165, visit `ni.com/info` and enter `216xpinmap`.

Figure 5 shows the pinout of the NI SMA-2165 connector. Table 2 describes the pinout signals.

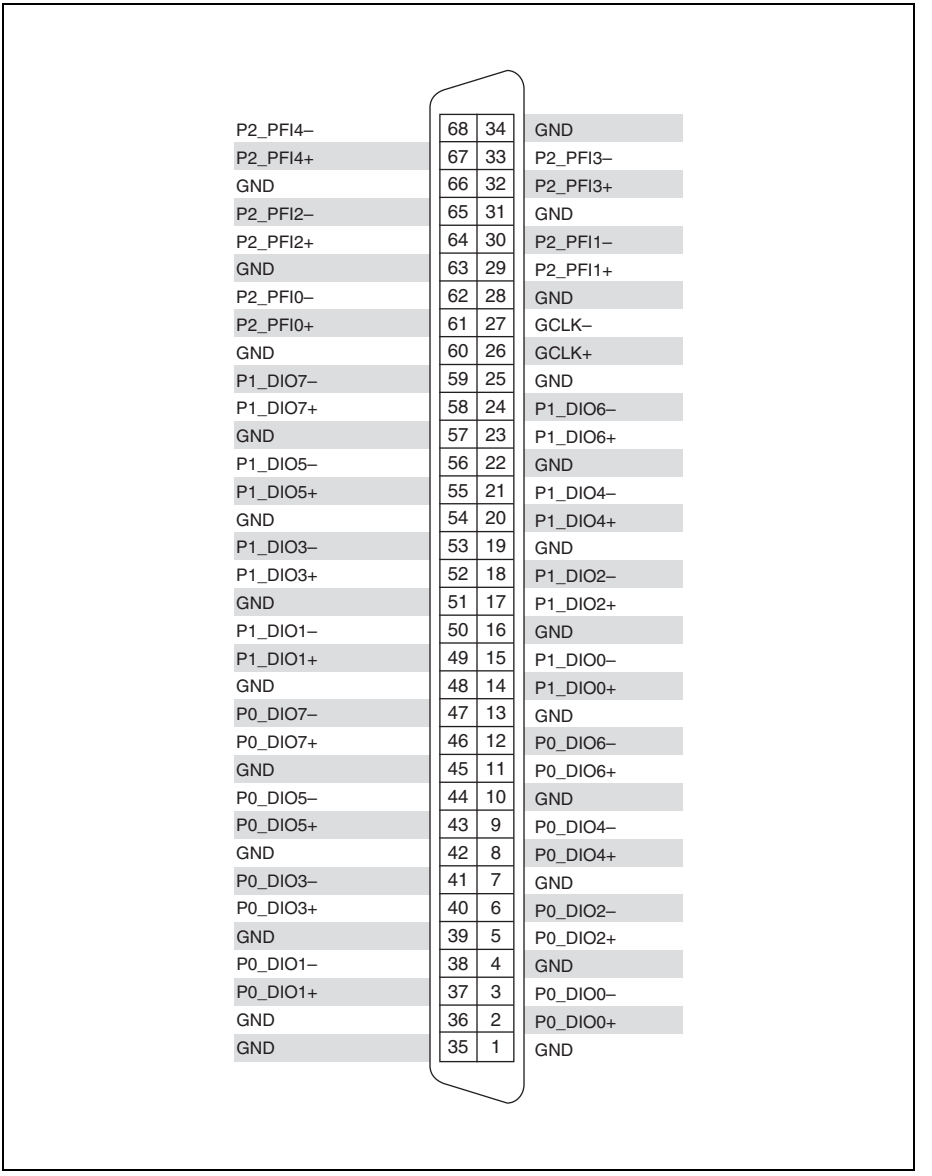


Figure 5. NI SMA-2165 Connector Pinout

Table 2. NI SMA-2165 Signal Descriptions

Signal Name	Signal Description
GLCK+	Positive terminal for the global clock.
GLCK–	Negative terminal for the global clock.
P0_DIO<0..7>+	Positive bidirectional digital I/O data channels 0 through 7 on port 0.
P0_DIO<0..7>–	Negative bidirectional digital I/O data channels 0 through 7 on port 0.
P1_DIO<0..7>+	Positive bidirectional digital I/O data channels 0 through 7 on port 1.
P1_DIO<0..7>–	Negative bidirectional digital I/O data channels 0 through 7 on port 1.
P2_PFI<0..4>+	Positive input terminals to the connected device for external triggers, or positive output terminals from the connected device for events.
P2_PFI<0..4>–	Negative input terminals to the connected device for external triggers, or negative output terminals from the connected device for events.
GND	Ground reference for signals.

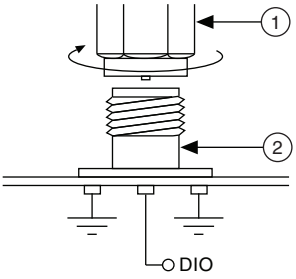
Refer to your device documentation for more information about the signals on your connected device. For information about how the signals on your connected device map to the SMA connectors on the NI SMA-2164/2165, visit `ni.com/info` and enter `216xpinmap`.

Using SMA Connectors

Each signal pair is labeled on the NI SMA-2164/2165. These connectors are arranged so that you can make quick connections to each polarity using a standard SMA coaxial cable assembly. Connectivity is made by inserting the cable receptacle onto the appropriate connector and tightening the receptacle sufficiently.

Note Refer to the receptacle documentation to assure that proper connections are made to signal and ground.

Figure 6 shows how to make an SMA coaxial cable assembly connection.



1	SMA Cable	2	SMA Connector

Figure 6. SMA Coaxial Cable Connection

Making a Solder Connection

Each signal pair is routed through a simple circuit to provide solder and probe access to the signals. Signal pairs are routed to a symmetric circuit, as shown in Figure 7.

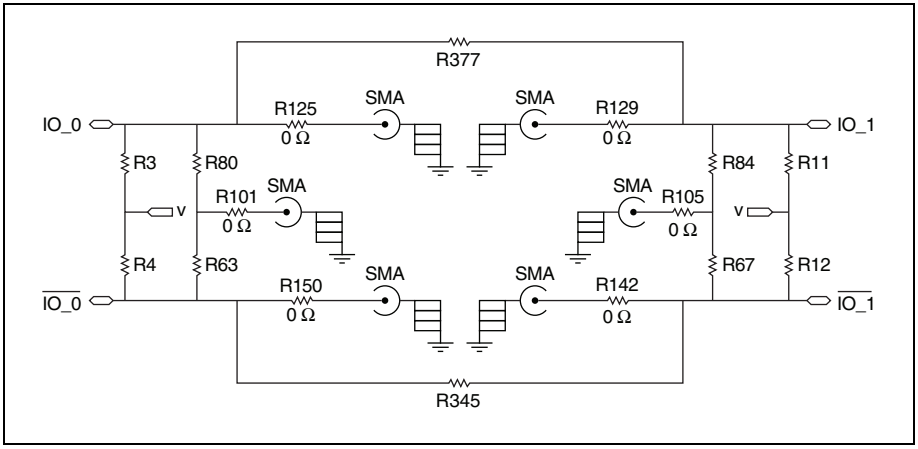


Figure 7. Symmetric Circuit

Figure 8 is an enlarged portion of Figure 1. Figure 8 shows the routing of the signal pairs and the placement of the resistors shown in Figure 7.

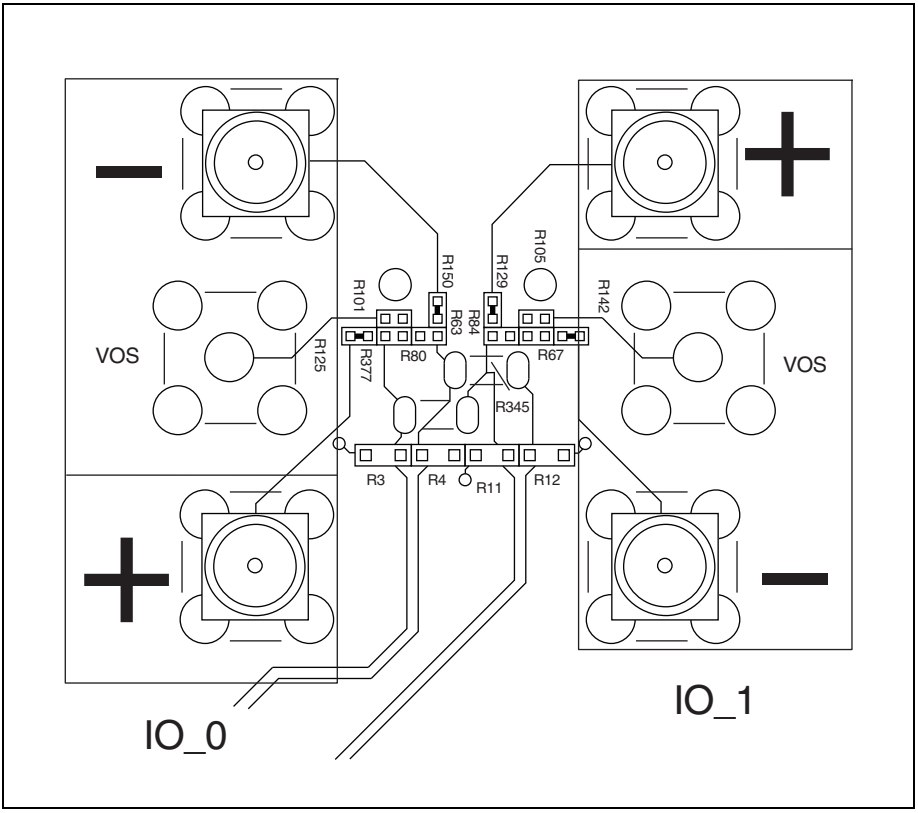


Figure 8. Solder Connection

Note This figure shows channels IO_0 and IO_1 on the NI SMA-2164. This circuit is copied on the NI SMA-2164/2165 on each pair of channels, though the reference designators vary. Figure 7 is the schematic representation of the PCB shown in Figure 8.

The resistors in the locations of R3, R4, R11, R12, R101, R377, R80, R67, R84, R105, and R345 above are unpopulated and discussed further in the *Cleaning the Accessory* and *Prototyping Circuits* sections. These pads are available for probing and for soldering.

Terminating Signals

Termination of high-speed digital signals is necessary to prevent signal reflections and force signal channels to a known state when no signal is present. Pads for terminating resistors are connected to all DIO and control channels on the NI SMA-2164/2165. These pads are labeled in Figures 1 and 2 and are shown in more detail in Figure 8.

Note Proper termination needs are application-specific. For some special considerations for choosing resistor values, refer to the *Cleaning the Accessory* section.

Minimizing the Effects of Stubs

Stubs are unterminated tributaries from the original signal path. Stubs decrease the signal quality of the system by adding reflections to the transmission channels. To minimize the effect of stubs, termination is placed at the end of the signal path.

Note Refer to your connected device documentation for more information about proper signal termination.

If your signal transmission line ends on the NI SMA-2164/2165, you can use the provided resistor pads to solder termination resistors. If your signal terminates somewhere other than the NI SMA-2164/2165, NI recommends terminating the transmission line at the final signal destination. Each signal pair is routed through a symmetric circuit, shown in Figure 7.

Differentially Terminating DIO and Control Signals

Unpopulated resistors like R80, R63, R67, and R84 in Figure 8 can be populated with 0402-sized resistors to provide termination. It is recommended that these resistors are each populated with 50 Ω resistors to provide the expected 100 Ω of differential termination.

Using the Prototyping Area

The NI SMA-2164/2165 prototyping area is designed to aid you in the following tasks:

- Prototyping and testing circuits—Use the NI SMA-2164/2165 in conjunction with other NI devices for prototyping, evaluating, and testing custom circuits and/or components.
- Creating custom interfaces—Use the NI SMA-2164/2165 for creating custom interfaces to other cables or devices. You can use the prototyping area to mount and interface the integrated circuits (ICs) or connectors required for your application.
- Prototyping a DUT load board—Use the NI SMA-2164/2165 as a simple DUT interface board or as a prototype of a custom DUT load board.

The prototyping area is labeled in Figure 1. Also labeled in that diagram are the erasable labeling strips for your notes as you use the prototyping area.

Prototyping Circuits

Each signal pair is routed to a simple debug and prototyping circuitry illustrated in Figure 7.

By placing or removing components, each circuit can be configured to accomplish one of the following tasks, which are described in more detail in the following sections.

- Differentially terminate the signals—For more information about differential termination, refer to the *Differentially Terminating DIO and Control Signals* section.
- Externally provide a common mode or offset voltage to a differential signal—If an application requires an externally provided offset voltage, you may populate the R3, R4, R11, and R12 resistor locations with 0603-sized resistors to provide a connection point. For balanced application to a differential signal, it is recommended that R0 and R1 each be populated with a 3.74 kΩ resistor.

  The node shared by the resistors in the R3, R4, R11, and R12 location is electrically connected between all DIO circuits.
- Externally probe or measure the common mode or offset of a differential signal—If an application requires that the offset voltage be measured on a differential signal, you can populate the R80 and R63 resistor locations. R80 and R63 are connected at a node which is connected to an SMA pad through a 0 Ω jumper. This SMA can be populated for coaxial connectivity to the offset voltage of the signal. The R80 and R63 resistor locations should each be 50 Ω if termination is required, else, larger values of 3.74 kΩ are more appropriate.
- Channel-to-channel connectivity—If it is required that two channels be connected to one another (for round-trip delay elimination for example), you can connect neighboring channels by populating a size 1206 0 jumper on resistor locations R345 and R377 in Figure 8. By populating these resistors, IO_0 connects to IO_1, IO_2 connects to IO_3, and so on, and CLKOUT_LVDS connects to STROBE.

Cleaning the Accessory

Disconnect all cables to the NI SMB-2164/2165 before cleaning. To remove light dust, use a soft, nonmetallic brush. To remove other contaminants, use alcohol wipes. The unit must be completely dry and free from contaminants before returning to service.

Specifications

Digital I/O

DIO channels ..... 16, differential

Control I/O channels ..... 6, differential

Resistors

Number 44

Voltage

Maximum voltage ..... 5 V

Prototyping Area

Dimensions ..... 4 cm × 9 cm
(1.57 in. × 3.54 in.)

Solder pads ..... 154, unconnected

Traces

Type ..... Matched length to 100 mils

AC impedance ..... 100 Ω differential

Physical

Dimensions ..... 17.55 cm × 2.07 cm × 20.32 cm
(6.91 in. × 0.816 in. × 8 in.)

I/O connectors ..... One 73-pin Infiniband connector or one 68-pin VHDCI connector, and 44 SMA connectors

Weight ..... 216 g (7.6 oz)

CE Compliance CE

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

Caution When connected to other test objects, this product may cause radio interference. In a residential environment, the user may be required to take adequate measures to reduce the radio interference.

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

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