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GETTING STARTED GUIDE

PXIe-4135

Single-Channel Precision System Source Measure Unit (SMU)

Note Before you begin, install and configure your chassis and controller.

This document explains how to install, configure, and test the PXIe-4135. The PXIe-4135 is a single-channel precision system SMU.

To access PXIe-4135 documentation, navigate to **Start**»**All Programs**»**National Instruments**»**NI-DCPower**»**Documentation**.

⚠ **Caution** Do not operate the PXIe-4135 in a manner not specified in this document. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

Contents

NATIONAL INSTRUMENTS™

Electromagnetic Compatibility Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) stated in the product specifications. These requirements and limits provide reasonable protection against harmful interference when the product is operated in the intended operational electromagnetic environment.

This product is intended for use in industrial locations. However, harmful interference may occur in some installations, when the product is connected to a peripheral device or test object, or if the product is used in residential or commercial areas. To minimize interference with radio and television reception and prevent unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any changes or modifications to the product not expressly approved by National Instruments could void your authority to operate it under your local regulatory rules.

⚠️ **Caution** To ensure the specified EMC performance, operate this product only with shielded cables and accessories connected to the LO/Sense LO, Output HI, and Sense HI connectors. Only twisted, shielded pair cable (i.e. Belden 83321E) should be used to connect the signals of the LO/Sense LO connector. Any compatible unshielded twisted-pair cable may be used for the safety interlock connector.

⚠️ **Caution** To ensure the specified EMC performance, the length of all I/O cables must be no longer than 3 m (10 ft).

Safety Guidelines for Hazardous Voltages

If hazardous voltages are connected to the device, take the following precautions. A hazardous voltage is a voltage greater than 42.4 Vpk voltage or 60 VDC to earth ground.

⚠️ **Caution** This module is rated for Measurement Category I. It is intended to carry signal voltages no greater than 250 V DC. This module can withstand up to 500 V DC impulse voltage. Do not use this module for connection to signals or for measurements within Categories II, III, or IV. Do not connect to MAINS supply circuits (for example, wall outlets) of 115 V AC or 230 V AC.

⚠️ **Caution** Isolation voltage ratings apply to the voltage measured between any channel pin and the chassis ground. When operating channels in series or floating on top of external voltage references, ensure that no terminal exceeds this rating.

Verifying the System Requirements

To use the NI-DCPower instrument driver, your system must meet certain requirements.

Refer to the product readme, which is available on the driver software media or online at *ni.com/manuals*, for more information about minimum system requirements, recommended system, and supported application development environments (ADEs).

Unpacking the Kit

⚠ **Caution** To prevent electrostatic discharge (ESD) from damaging the device, ground yourself using a grounding strap or by holding a grounded object, such as your computer chassis.

1. Touch the antistatic package to a metal part of the computer chassis.
2. Remove the device from the package and inspect the device for loose components or any other sign of damage.

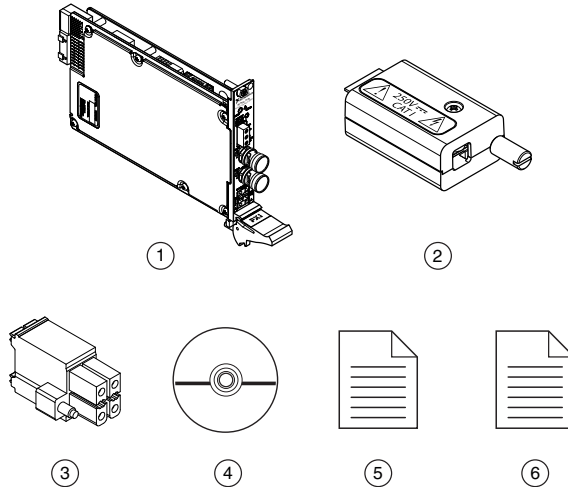⚠ **Caution** Never touch the exposed pins of connectors.

✏ **Note** Do not install a device if it appears damaged in any way.

3. Unpack any other items and documentation from the kit.

Store the device in the antistatic package when the device is not in use.

Kit Contents

Figure 1. PXIe-4135 Kit Contents

1. PXIe-4135 Precision System SMU with triax caps installed
2. LO/Sense LO Output Connector Assembly
3. Safety Interlock Input Connector
4. Driver Software DVD
5. PXIe-4135 Getting Started Guide (this document)
6. Maintain Forced-Air Cooling Note to Users

Other Equipment

There are several required items not included in your device kit that you need to operate the PXIe-4135. Your application may require additional items not included in your kit to install or operate your device.

Required Items

- A PXI Express chassis and chassis documentation. For more information about compatible chassis options, refer to *ni.com*.
- A PXI Express embedded controller or MXI controller system that meets the system requirements specified in this guide and chassis documentation.
- One or more triaxial cable assemblies.

Optional Items

- NI screwdriver (part number 781015-01).

Preparing the Environment

Ensure that the environment you are using the PXIe-4135 in meets the following specifications.

Operating Environment

Ambient temperature range	0 °C to 55 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2. Meets MIL-PRF-28800F Class 3 low temperature limit and MIL-PRF-28800F Class 2 high temperature limit.)
Relative humidity range	10% to 90%, noncondensing (Tested in accordance with IEC 60068-2-56.)
Storage ambient temperature range	-40 °C to 70 °C (Tested in accordance with IEC 60068-2-1 and IEC 60068-2-2.)
Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Pollution Degree	2

Indoor use only.

Note Refer to the device specifications on *ni.com/manuals* for complete specifications.

Installing the Software

You must be an Administrator to install NI software on your computer.

1. Install an ADE, such as LabVIEW or LabWindows™/CVI™.

2. Insert the driver software media into your computer. The installer should open automatically.

   If the installation window does not appear, navigate to the drive, double-click it, and double-click autorun.exe.

3. Follow the instructions in the installation prompts.

   Note Windows users may see access and security messages during installation. Accept the prompts to complete the installation.

4. When the installer completes, select **Restart** in the dialog box that prompts you to restart, shut down, or restart later.

Safety

⚠ **Caution** Always refer to the specifications document for your device before connecting signals. Failure to observe the specified maximum signal ratings can cause shock, a fire hazard, or damage to the devices connected to the PXIe-4135. NI is not liable for any damage or injuries resulting from incorrect signal connections.

System Safety Guidelines

Safety Guidelines for System Design and Implementation

The PXIe-4135 is capable of generating hazardous voltages and working within hazardous voltage systems. It is the responsibility of the system designer, integrator, installer, maintenance personnel, and service personnel to ensure the system is safe during use.

- Ensure operators cannot access the PXIe-4135, cables, the device under test (DUT), or any other instruments in the system while hazardous voltages are present.
- Operator access points can include, but are not limited to, guards, gates, sliding doors, hinge doors, lids, covers, and light curtains.
- If using a test fixture enclosure, ensure that it is properly connected to safety ground.
- Ensure that the PXIe-4135 is properly secured to the chassis using the two front panel mounting screws.
- Double insulate all electrical connections that are accessible by an operator. Double insulation ensures protection if one layer of insulation fails. Refer to IEC 61010-1 for specific insulation requirements.

Safety Interlock System Integration

The PXIe-4135 includes a safety interlock circuit that places the outputs of the SMU in a safe state, regardless of the programmed state of the module.

- Do not short the safety interlock pins directly at the connector under any circumstances.
- Confirm on a regular basis that the safety interlock is functioning by performing a safety interlock test.
- Install mechanical detection switches that open the safety interlock circuit when the operator attempts to access the test fixture, disabling the hazardous voltage ranges of the instrument.
- Ensure the mechanical detection switches close the safety interlock circuit only when the operator has properly closed all entry points to the test fixture enclosure, enabling hazardous voltage ranges on the instrument.

Figure 2. System Level Connection, Typical
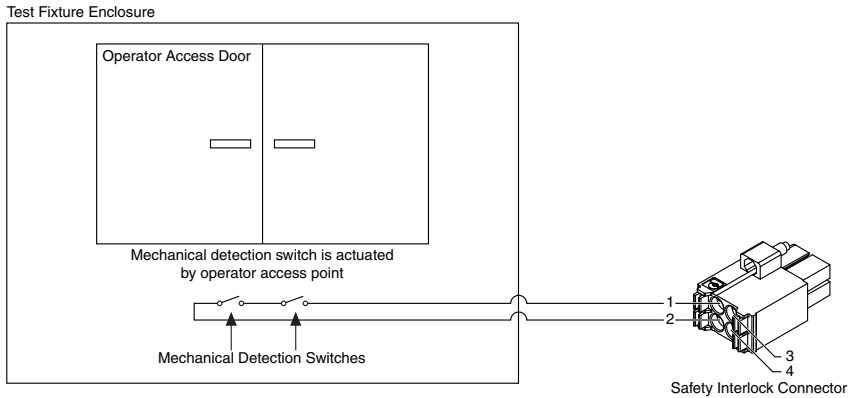
1. Safety Interlock Input
2. Safety Interlock Ground
3. Safety Interlock Pass Thru - Input
4. Safety Interlock Pass Thru - Ground

Related Information

Fore more information about the Safety Interlock, refer to the NI DC Power Supplies and SMUs Help.

Testing the Safety Interlock on page 13

Mechanical Detection Switch Recommendations

- Use high-reliability, fail-safe, normally open mechanical detection switches on all access points to the test fixture enclosure.
- Use two normally open switches wired in series so that a single switch failure does not compromise safety protections.
- Isolate switches so the operator cannot trigger or bypass the switches without the use of a tool.
- Ensure the switches' certifications meet your test application requirements. NI recommends UL-certified safety switches to ensure reliability.
- Install the switches in accordance with the switch manufacturer specifications.
- Test the switches periodically to ensure proper implementation and reliability.

Safety Guidelines for System Operation

⚠️ **Caution** Hazardous voltages of up to the maximum voltage of the PXIe-4135 may appear at the output terminals if the safety interlock terminal is closed. Open the safety interlock terminal when the output connections are accessible. With the safety interlock terminal open, the output voltage level/limit is limited to ±40 V DC, and

protection will be triggered if the voltage measured between the device HI and LO terminals exceeds ±(42 Vpk ±0.4 V).

⚠ **Caution** Do not apply voltage to the safety interlock connector inputs. The interlock connector is designed to accept passive, normally open contact closure connections only.

To ensure a system containing the PXIe-4135 is safe for operators, components, or conductors, take the following safety precautions:

- Ensure proper warnings and signage exist for workers in the area of operation.
- Provide training to all system operators so that they understand the potential hazards and how to protect themselves.
- Inspect connectors, cables, switches, and any test probes for any wear or cracking before each use.
- Before touching any of the connections to the high terminal or high sense on the PXIe-4135, discharge all components connected to the measurement path. Verify with a DMM before interaction with connections.

Installing the PXIe-4135

⚠ **Caution** To prevent damage to the PXIe-4135 caused by ESD or contamination, handle the module using the edges or the metal bracket.

1. Ensure the AC power source is connected to the chassis before installing the module.

   The AC power cord grounds the chassis and protects it from electrical damage while you install the module.
2. Power off the chassis.
3. Inspect the slot pins on the chassis backplane for any bends or damage prior to installation. Do not install a module if the backplane is damaged.
4. Remove the black plastic covers from all the captive screws on the module front panel.
5. Identify a supported slot in the chassis. The following figure shows the symbols that indicate the slot types.

**Figure 3.** Chassis Compatibility Symbols
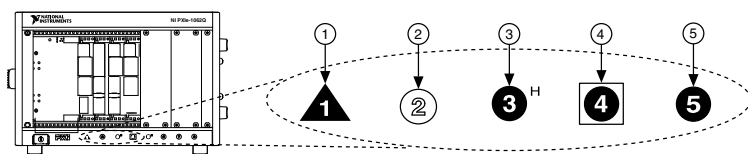
1. PXI Express System Controller Slot	4. PXI Express System Timing Slot
2. PXI Peripheral Slot	5. PXI Express Peripheral Slot
3. PXI Express Hybrid Peripheral Slot	

PXIe-4135 modules can be placed in PXI Express peripheral slots, PXI Express hybrid peripheral slots, or PXI Express system timing slots.

6. Touch any metal part of the chassis to discharge static electricity.

7. Ensure that the ejector handle is in the downward (unlatched) position.

8. Place the module edges into the module guides at the top and bottom of the chassis. Slide the module into the slot until it is fully inserted.

Figure 4. Module Installation
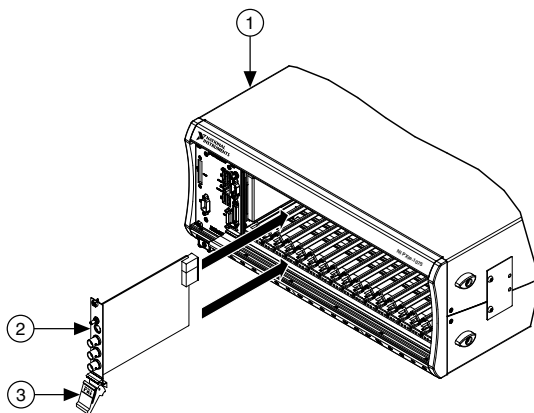
1. Chassis
2. Hardware Module
3. Ejector Handle in Downward (Unlatched) Position

9. Latch the module in place by pulling up on the ejector handle.

10. Secure the module front panel to the chassis using the front-panel mounting screws.

Note Tightening the top and bottom mounting screws increases mechanical stability and also electrically connects the front panel to the chassis, which can improve the signal quality and electromagnetic performance.

11. Cover all empty slots using EMC filler panels or fill using slot blockers to maximize cooling air flow, depending on your application.

12. Prepare the LO/Sense LO connector assembly.

Caution To ensure specified EMC performance, only use twisted, shielded pair cable (for example, Belden 83321E).

a) Open the LO/Sense LO connector assembly.

b) Use an insulation strip tool to expose the LO, sense LO, and ground cable conductors. The maximum strip length for the LO and sense LO cable is 10 mm (0.394 in.).

c) Insert each cable into the appropriate connector terminal. The cable drain wire should be terminated to the connector ground terminal.

d) Inspect the connection to the connector terminals to ensure no exposed metal is visible on the LO and sense LO cables beyond the body of the connector.

e) Clamp down using the screw terminals on the connector.

f) Verify that no exposed shield foil or braid extends outside of the backshell.

g) Use the cable tie to provide strain relief for the cable to the backshell.

h) Close the LO/sense LO connector assembly and tighten the retention screw to hold it in place.

13. Attach output connections.

a) Connect the triaxial cables to the module.

b) Connect the LO/sense LO connector assembly to the module. Tighten the thumbscrew on the connector assembly to hold it in place.

14. Ensure that the safety interlock connector is wired to a test fixture that ensures operator safety, and prepare the safety interlock cable for insertion into the safety interlock connector.

a) Measure and mark your strip length on the safety interlock cable.

Note The required wire strip length for the safety interlock cable is 7.5 mm (0.295 in.) minimum and 10 mm (0.394 in.) absolute maximum. The acceptable AWG range for the safety interlock cable is 16-24.

b) Use an insulation strip tool to expose cable of the appropriate length.

c) The safety interlock connector accepts both solid and multi-strand conductor cabling. If you are using a multi-stranded cable, twist the strands together before insertion. For additional cabling reliability, strip and tin multi-stranded conductors before insertion.

d) Insert the cable.

e) Inspect for loose strands and tighten any retention screws on the safety interlock connector assembly to hold it in place.

f) Connect the safety interlock connector to the device.

15. Power on the chassis.

16. Perform the safety interlock test.

Related Information

Testing the Safety Interlock on page 13

PXIe-4135 Front Panel

Figure 5. PXIe-4135 Front Panel
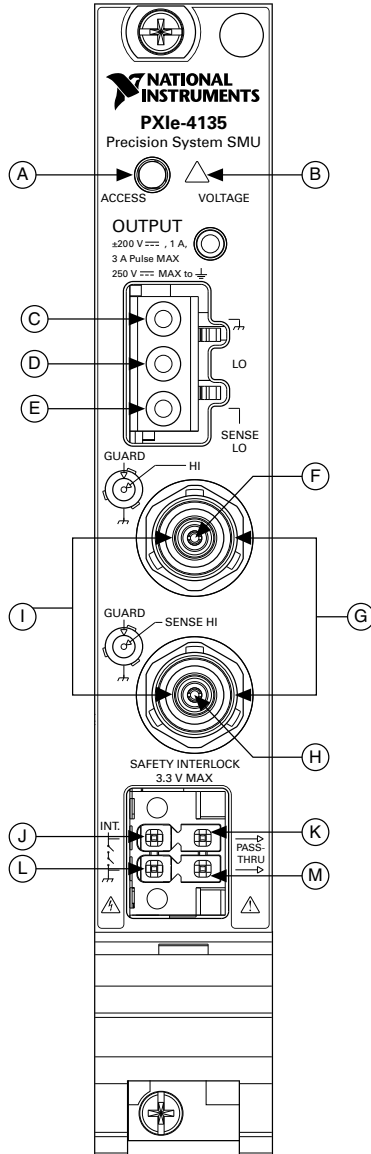
Table 1. Front Panel Connectors

	Description
A	Access Status LED
B	Voltage Status LED
C	Chassis ground
D	Output LO
E	Sense LO
F	Triaxial connector pin Output HI
G	Triaxial connector inner shield, Guard
H	Triaxial connector pin, Sense HI
I	Triaxial connector outer shield, Chassis ground
J	Safety Interlock Input
K	Safety Interlock Pass Thru - Input
L	Safety Interlock Ground
M	Safety Interlock Pass Thru - Ground

Accessories

Table 2. PXIe-4135 Accessories

Accessory	Manufacturer	Part Number
Additional Connector Kit with Interlock Connector for PXIe-4135 SMU	NI	784484-01
Safety Interlock Connector	Phoenix Contact	1790292

Configuring the PXIe-4135 in MAX

Use Measurement & Automation Explorer (MAX) to configure your NI hardware. MAX informs other programs about which NI hardware products are in the system and how they are configured. MAX is automatically installed with NI-DCPower.

1. Launch MAX.
2. In the configuration tree, expand **Devices and Interfaces** to see the list of installed NI hardware.

Installed modules appear under the name of their associated chassis.

3. Expand your **Chassis** tree item.

   MAX lists all modules installed in the chassis. Your default names may vary.

   📝 **Note** If you do not see your module listed, press <F5> to refresh the list of installed modules. If the module is still not listed, power off the system, ensure the module is correctly installed, and restart.

4. Record the identifier MAX assigns to the hardware. Use this identifier when programming the PXIe-4135.

5. Self-test the hardware by selecting the item in the configuration tree and clicking **Self-Test** in the MAX toolbar.

   The MAX self-test performs a basic verification of hardware resources.

Testing the Safety Interlock

To ensure safe operation of the PXIe-4135, periodically test the safety interlock for proper functionality. The recommended test interval is at least once per day of continuous usage.

Testing with an Application Development Environment

1. Disconnect the output connector from the PXIe-4135 front panel.

2. Ensure that the safety interlock input on the test fixture is closed.

3. Set the **niDCPower Output Function** property or `NIDCPOWER_OUTPUT_FUNCTION` attribute to DC Voltage for the PXIe-4135.

4. Set the voltage level range to 200 V, and set the voltage level to 42.4 V.

5. Set the current limit range to 1 mA, and set the current limit to 1 mA.

6. Initiate the session.

7. Verify that the Voltage Status Indicator is amber.

8. Open the safety interlock input using the test fixture.

9. Verify that the Voltage Status Indicator is red.

10. Reset the device using the niDCPower Reset VI or the `niDCPower Reset` function.

11. Verify that the Voltage Status Indicator is green.

   ⚠️ **Caution** If the PXIe-4135 fails the safety interlock test, discontinue use of the device and contact an authorized NI service representative to request a Return Material Authorization (RMA).

Testing with the NI-DCPower Soft Front Panel

1. Disconnect the output connector from the PXIe-4135 front panel.

2. Ensure that the safety interlock input on the test fixture is closed.

3. In the NI-DCPower SFP, set Output Function to DC Voltage.

4. Set Voltage Level Range to 200 V, and set Voltage Level to 42.4 V.

5. Set Current Limit to 1 mA, and set Current Limit Range to 1 mA.

6. Ensure that Local sense is selected.

7. Check the **Output Enabled** checkbox to enable the output.

8. Verify that the Voltage Status Indicator is amber.

9. Open the safety interlock input using the test fixture.

10. Verify that the Voltage Status Indicator is red and that a hazardous voltage error message appears.

11. On the error message dialog, click **OK** to prompt the PXIe-4135 to attempt to clear the error and re-initialize the session to default values.

12. Verify that the Voltage Status Indicator is green.

⚠ **Caution** If the PXIe-4135 fails the safety interlock test, discontinue use of the device and contact an authorized NI service representative to request a Return Material Authorization (RMA).

Programming the PXIe-4135

You can generate signals interactively using the NI-DCPower Soft Front Panel (SFP) or you can use the NI-DCPower instrument driver to program your device in the supported ADE of your choice.

Table 3. PXIe-4135 Programming Options

Application Programming Interface (API)	Location	Description
NI-DCPower SFP	Available from the start menu at **Start**»**All Programs**»**National Instruments**»**NI-DCPower**»**NI-DCPower Soft Front Panel**.	The NI-DCPower SFP acquires, controls, and presents data. The NI-DCPower SFP operates on the PC, to provide additional display capabilities.
NI-DCPower Instrument Driver	LabVIEW—Available on the LabVIEW Functions palette at **Measurement I/O**»**NI-DCPower**.	NI-DCPower configures and operates the device hardware and performs basic acquisition and measurement options using LabVIEW VIs or LabWindows/CVI functions.
	C or LabWindows/CVI—Available at **Program Files**»**IVI Foundation**»**IVI**»**Drivers**»**NI-DCPower**.	
	Microsoft Visual C/C++—NI-DCPower does not ship with installed C/C++ examples.	Refer to the *Creating an Application with Microsoft Visual C and C++* topic of the *NI DC Power Supplies and SMUs Help* to manually add all required include and library files to your project.

Troubleshooting

If an issue persists after you complete a troubleshooting procedure, contact NI technical support or visit *ni.com/support*.

What Should I Do if the PXIe-4135 Doesn't Appear in MAX?

1. In the MAX configuration tree, expand **Devices and Interfaces**.
2. Expand the **Chassis** tree to see the list of installed hardware, and press <F5> to refresh the list.
3. If the module is still not listed, power off the system, ensure that all hardware is correctly installed, and restart the system.

4. Navigate to the Device Manager.

Operating System	Description
Windows 10/8.1	Right-click the Start button, and select **Device Manager**.
Windows 7	Select **Start»Control Panel»Device Manager**.

5. If you are using a PXI or PXI Express controller, verify that a **National Instruments** entry appears in the **System Devices** list. Reinstall NI-DCPower and the module if error conditions appear in the list. If you are using an MXI controller, right-click **PCI-to-PCI Bridge**, and select **Properties** from the shortcut menu to verify that the bridge is enabled.

Why Is the ACCESS LED Off When the Chassis Is On?

The LEDs may not illuminate until the module has been configured in MAX. Before proceeding, verify that the PXIe-4135 appears in MAX.

If the ACCESS LED fails to illuminate after you power on the PXI Express chassis, a problem may exist with the PXI Express power rails, a hardware module, or the LED.
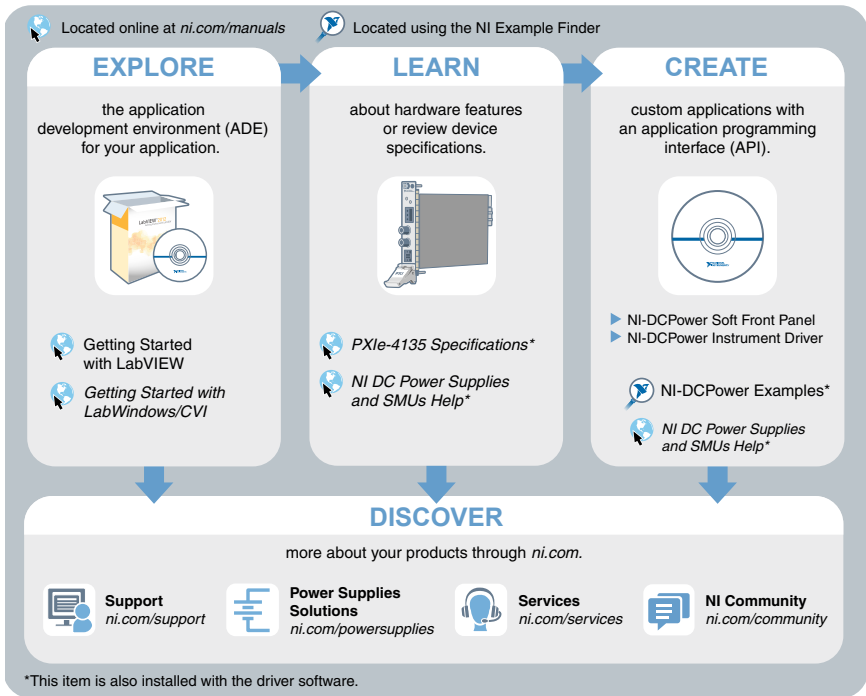
1. ⚠ **Caution** Apply external signals only while the PXIe-4135 is powered on. Applying external signals while the module is powered off may cause damage. Disconnect any signals from the PXI Express module front panels.

2. Remove any front panel connections from the PXIe-4135.

3. Power off the PXI Express chassis.

4. Remove the module from the PXI Express chassis and inspect it for damage. Do not reinstall a damaged module.

5. Install the module in a different PXI Express chassis slot from which you removed it.

6. Power on the PXI Express chassis.

7. Verify that the module appears in MAX.

8. Reset the module in MAX and perform a self-test.

If the ACCESS LED still fails to illuminate and failures continue, contact NI technical support or visit *ni.com/support*.

Related Information

For more information about LED status indicator behavior, see the front panel topic for your device in the NI DC Power Supplies and SMUs Help.

Where To Go Next

EXPLORE

the application development environment (ADE) for your application.

- Getting Started with LabVIEW
- *Getting Started with LabWindows/CVI*

LEARN

about hardware features or review device specifications.

- *PXIe-4135 Specifications**
- *NI DC Power Supplies and SMUs Help**

CREATE

custom applications with an application programming interface (API).

- ▶ NI-DCPower Soft Front Panel
- ▶ NI-DCPower Instrument Driver

- NI-DCPower Examples*
- *NI DC Power Supplies and SMUs Help**

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*This item is also installed with the driver software.

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The NI website 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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