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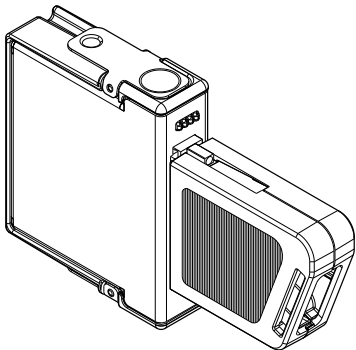
 **CLICK HERE**

NI-9351

GETTING STARTED GUIDE

NI 9351

4-Ch 0-20 mA 16-bit AI, 4-Ch 24 V Sinking DI,
4-Ch 24 V Sourcing DO, SIL3 Capable



This document provides information about connecting and installing the NI 9351 hardware. You must download a compiled User Program before deployment. For information about creating User Programs, deploying safety systems using the NI 9351, and diagnostics available on the NI 9351, go to ni.com/info and enter Info Code `safetymanual`.



Note Before you begin, complete the software and hardware installation procedures in your chassis documentation.



Note The guidelines in this document are specific to the NI 9351. The other components in the system might not meet the same safety ratings. Refer to the documentation for each component in the system to determine the safety and EMC ratings for the entire system.

Safety Guidelines

Operate the NI 9351 only as described in this document.



Caution This icon denotes a caution, which advises you to consult documentation where this symbol is marked.



Caution Do not operate the NI 9351 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.

Safety Voltages

Connect only voltages that are within the following limits:



Caution Do not connect hazardous voltages to the NI 9351. A hazardous voltage is a voltage greater than 42.4 V peak voltage or 60 V DC to earth ground.

Maximum voltages

$V_{\text{sup-to-COM}}$	30 V DC
DI-to-COM	30 V DC
DO-to-COM	0 V DC to V_{sup}

AI-to-COM	20 V DC
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AI V_{sup} -to-COM	30 V DC
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Caution DO channels are not protected for negative voltages or voltages greater than V_{sup} .

Isolation voltages

Channel-to-earth ¹ (up to 5,000 m)

Continuous	60 V DC, Measurement Category I
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Withstand	1,000 V RMS, verified by a 5 s dielectric withstand test
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Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as *MAINS* voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special

¹ Channels include V_{sup} , AI V_{sup} , and COM.

equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.



Caution Do not connect the NI 9351 to signals or use for measurements within Measurement Categories II, III, or IV.



Note Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are for other circuits not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.

Safety Guidelines for Hazardous Locations

The NI 9351 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4 Gc and Ex nA IIC T4 Gc hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the NI 9351 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.



Caution Do not disconnect I/O-side wires or connectors unless power has been switched off or the area is known to be nonhazardous.



Caution Do not remove modules unless power has been switched off or the area is known to be nonhazardous.




Caution Substitution of components may impair suitability for Class I, Division 2, or Zone 2.



Caution The system must be installed in an enclosure certified for the intended hazardous (classified) location, having a tool secured cover/door, where a minimum protection of at least IP54 is provided.

Special Conditions for Hazardous Locations Use in Europe and Internationally

The NI 9351 has been evaluated as Ex nA IIC T4 Gc equipment under DEMKO 12 ATEX 1202658X and is IECEx UL 14.0089X certified. Each NI 9351 is marked  II 3G and is suitable for use in Zone 2 hazardous locations, in ambient temperatures of $-40\text{ }^{\circ}\text{C} \leq T_a \leq 70\text{ }^{\circ}\text{C}$. If you are using the NI 9351 in Gas Group IIC hazardous locations, you must use the device in an NI chassis that has been evaluated as Ex nC IIC T4, Ex IIC T4, Ex nA IIC T4, or Ex nL IIC T4 equipment.



Caution Transient protection shall be provided that is set at a level not exceeding 140% of the peak rated voltage value of 85 V at the supply terminals to the equipment.



Caution The system shall only be used in an area of not more than Pollution Degree 2, as defined in IEC/EN 60664-1.



Caution The system shall be mounted in an ATEX/IECEx-certified enclosure with a minimum ingress protection rating of at least IP54 as defined in IEC/EN 60079-15.



Caution The enclosure must have a door or cover accessible only by the use of a tool.

EMC 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.

Refer to the following guidelines to ensure specified EMC performance.



Notice Operate this product only with shielded cables and accessories.



Notice Keep the chassis ground connection to the cable shield as short as possible.

Special Conditions for Marine Applications

Some products are approved for marine (shipboard) applications. To verify marine approval certification for a product, visit ni.com/certification and search for the certificate.



Notice In order to meet the EMC requirements for marine applications, install the product in a shielded enclosure with shielded and/or filtered power and input/output ports. In addition, take precautions when designing, selecting, and installing measurement probes and cables to ensure that the desired EMC performance is attained.

Preparing the Environment

Ensure that the environment in which you are using the NI 9351 meets the following specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 70 °C
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Operating humidity (IEC 60068-2-30)	10% RH to 90% RH, noncondensing
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Pollution Degree	2
Maximum altitude	5,000 m

Indoor use only.



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

NI 9351 Pinout

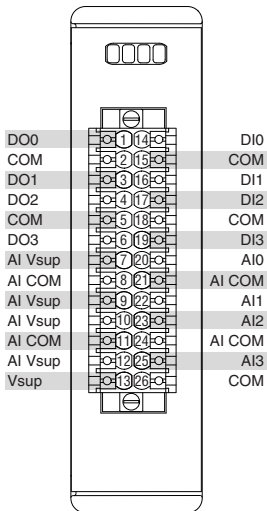


Table 1. Signal Descriptions

Signal	Description
AI	Analog input signal connection
AI COM	Analog input common reference connection. Internally connected to COM.
AI V_{sup}	Voltage supply connection. Not internally connected to V_{sup} .
COM	Common reference connection
DI	Digital input signal connection
DO	Digital output signal connection
V_{sup}	Voltage supply connection

NI 9351 LEDs

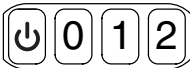


Table 2. LED Descriptions


LED	Description
	V_{sup} /Status
0	Internal Fault
1	I/O Fault
2	UserLED0

Table 3. LED Indicators

LED	LED Color	LED Pattern	Indication
V_{sup} /Status	Green	On	Module is powered on. Module is in Operational Mode and User Program is running.
		Flashing	Module powered on. Module is not in Operational Mode or User Program is not running.
		Off	Module is powered off.
Internal Fault	Red	Flashing	Module is in Fail-safe Mode.
		Off	Module is not in Fail-safe Mode.

Table 3. LED Indicators (Continued)

LED	LED Color	LED Pattern	Indication
I/O Fault	Red	Flashing	An I/O fault has been detected.
		Off	No I/O Fault has been detected.
UserLED0	Red	On	User-configurable.
		Flashing	
		Off	



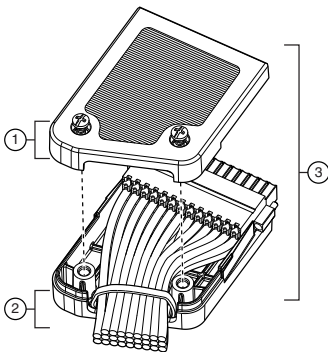
Note Refer to the C Series Functional Safety Manual on ni.com/manuals for detailed information on flash patterns in status and fault LEDs.

Installing the Connector Backshell



Caution You must use the included connector backshell to secure connections to the NI 9351.

Figure 1. Connector Backshell Installation



1. Align the connector backshell with the 26-pin spring terminal block.

2. Secure the cable bundle to the connector backshell using a zip tie.
3. Secure the connector backshell using the captive screws. Tighten to $0.5 \text{ N} \cdot \text{m}$ ($4 \text{ lb} \cdot \text{in.}$) torque.

Connecting an External Power Supply

You must connect an external power supply to the NI 9351. The module is independent from the chassis and requires an external power supply to operate.

Connect the positive lead of the power supply to the supply pin, V_{sup} , and the negative lead of the power supply to any common pin, COM.



Caution Do not remove or insert modules if the external power supply connected to the V_{sup} and COM pins is powered on.

The NI 9351 has current sourcing outputs, meaning the DO pin is driven to V_{sup} when the channel is turned on.

Powering Analog Devices

You can connect an external power supply to the NI 9351 to power analog devices connected to the module. Connect the positive lead of the power supply to a AI V_{sup} pin and the negative lead of the power supply to AI COM. Install a 2 A maximum, fast-acting fuse between the external power supply and the AI V_{sup} pin.



Note The AI V_{sup} pins are internally connected to each other. You can connect only one external voltage supply to the device.



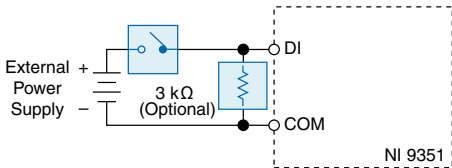
Caution Do not remove or insert modules if the external power supply connected to the AI V_{sup} and AI COM pins is powered on.

Functional Safety Editor I/O Configurations

Refer to the following diagrams to connect the NI 9351 based on the I/O configurations in the Functional Safety Editor. For more information about I/O Configurations, refer to the *C Series Functional Safety Manual* on ni.com/manuals.

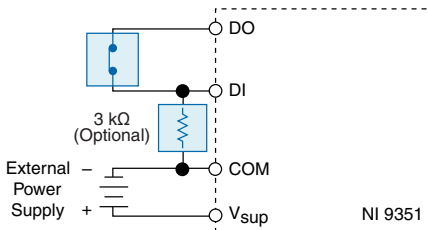
Digital Connections

NI 9351 Input Connection



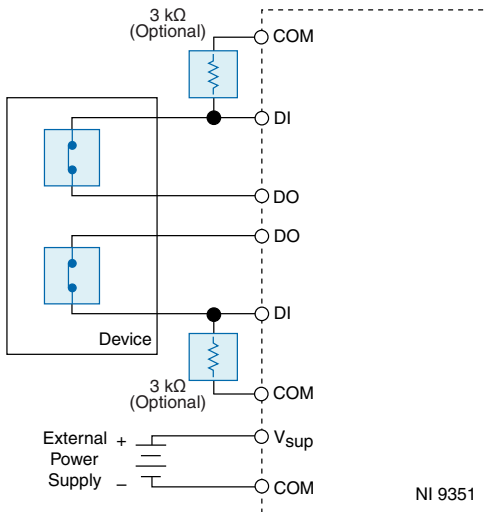
- Use this diagram for single input and dual input configurations.
- Use one of the following pairs for dual switches: DI0 and DI1, DI2 and DI3.

NI 9351 Single Input with Test Pulse Connection



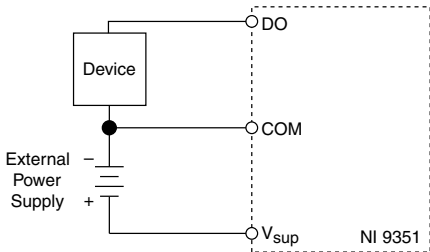
- Use this diagram for single input with test pulse configurations.
- Use test pulses to detect wiring faults on NC (normally closed) switches.
- Connect the DO pin to the NC (normally closed) switch to provide test pulse output.

NI 9351 Dual Input with Test Pulse Connection



- Use this diagram for dual input with test pulse configurations.
- Use one of the following pairs for dual switches: DI0 and DI1, DI2 and DI3.
- Use test pulses to detect wiring faults on NC (normally closed) switches.

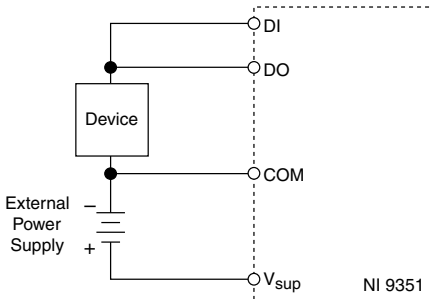
NI 9351 Output Connection



- Use this diagram for the following configurations:
 - Single output
 - Dual output

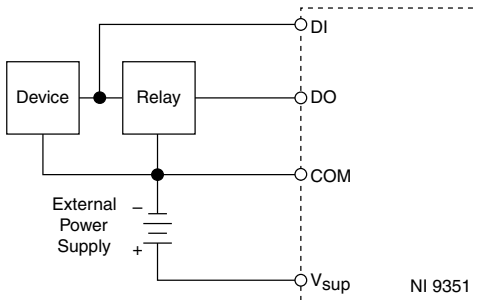
- Single output with internal test pulse
- Dual output with internal test pulse

NI 9351 Output with External Test Pulse Connection



- Use this diagram for single output with external test pulse and dual output with external test pulse configurations.
- Connect a wire from the external monitoring location to a DI channel to monitor the test pulse.
- Connect the DI channel number that corresponds to the DO channel number. Single output with test pulse connections use DOn and DIn. Dual output with test pulse connections use DOn and DIn, DOn+1 and DIn+1.

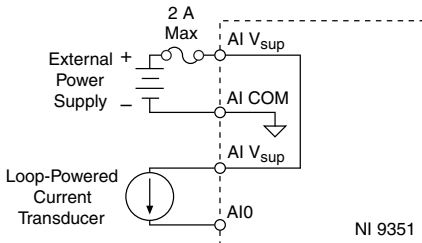
NI 9351 Single Output with External Readback Connection



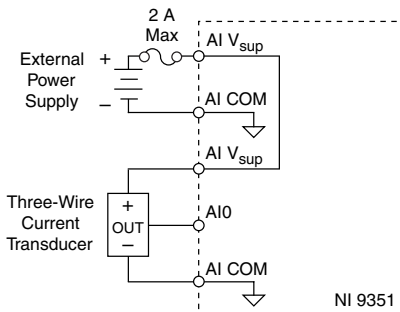
- Use this diagram for single output with external readback configurations.
- Connect a wire from the external monitoring location to a DI channel to monitor the output value.

Analog Connections

NI 9351 Loop-Powered Current Transducer Connection



NI 9351 Three-Wire Current Transducer Connection



NI 9351 Single Input (1oo1) Configuration



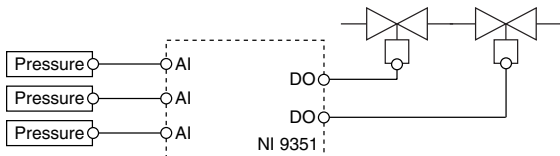
NI 9351 Dual Input (1oo2) Configuration



NI 9351 Triple Input (2oo3) Configuration



NI 9351 HIPPS Configuration



NI 9351 Connection Guidelines

- Make sure that devices you connect to the NI 9351 are compatible with the module specifications.
- You must use a two-wire ferrule to create a secure connection when connecting two wires or stranded wires to a single terminal.
- Push a solid wire or ferrule directly into the terminal.
- When inserting a stranded wire without a ferrule, first open the terminal by pressing the push button.
- Verify that all strands of a stranded wire are securely retained.
- Connect one COM terminal for each DO and each DI connection until all COM terminals are populated. It is acceptable but not preferred to populate COM terminals with jumpers to meet this requirement. This requirement does not apply to the AI COM terminals.



Caution After inserting a wire into a spring terminal, test the connection by gently pulling on the wire to verify that it is securely retained.

Power Supply

Users must use a limited power source (LPS) supply suitable to the safety needs and configuration of the implemented system. Implement one of the following options to ensure continued compliance with IEC 61010-1.

- The V_{sup} must be powered from a Class 2 or Limited Power Source (LPS), SELV source, 30 V DC maximum.
- The V_{sup} must be powered from a SELV source, 30 V DC maximum, with supplementary overcurrent protection in series, 8 A maximum breaking capacity at 120 s.
- The C Series Functional Safety module and associated controller must be installed in an end-use fire enclosure.



Notice For Functional Safety applications, use a power supply with 4 kV common-mode surge rating to meet Functional Safety EMC Requirements. This may be achieved with external surge suppression.

Pull-Down Resistor

- NI recommends connecting an external 3 k Ω pull-down resistor to each digital input channel in use.
- Resistor power must be rated at minimum to 300 mW at system ambient temperatures. A larger rating can increase reliability.
- A pull-down resistor reduces input signal response times when channels are driven by sourcing outputs.
- The user is responsible for evaluating and choosing the appropriate resistor and terminal block based on the system requirements.
- Follow mounting and thermal guidelines in the CompactRIO controller documentation.

Refer to the table below for suggested terminal blocks for mounting the resistor.

Table 4. Third Party Terminal Blocks

Third Party Manufacturer	Series
Phoenix Contact	UTTB
Weidmuller	WTR

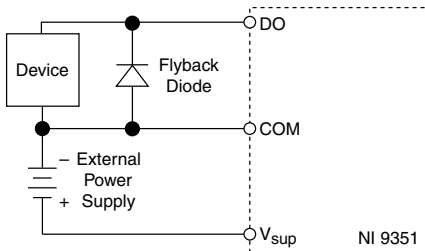


Note For more information on reducing response times, refer to the *Safety Response Time* section of the *C Series Functional Safety Manual* on ni.com/manuals.

Protecting the NI 9351 from Flyback Voltages

Install an external flyback diode on any digital output connection to inductive or energy-storing devices that do not have flyback protection. Inductive or energy storing devices include solenoids, motors, and relays.

Figure 2. Connecting a Flyback Diode to the NI 9351



High-Vibration Application Connections

If your application is subject to high vibration, NI recommends that you use ferrules to terminate stranded wire.

You must follow these guidelines to meet the shock and vibration performance specifications stated in the device datasheet on ni.com/manuals.

- Panel mount the system.
- Provide strain relief for the module by securing the cabling to a supporting fixture no more than 8 cm (3 in.) away from the opening of the connector backshell.
- Ensure that the supporting fixture for strain relief is stiff and rigidly coupled to the chassis mounting surface.
- Ensure that you do not directionally bias the module when applying strain relief.

Digital I/O Protection

The NI 9351 provides overcurrent and short-circuit protection for each DO channel.



Caution Overvoltage and negative voltage conditions can damage the NI 9351. Check the voltage specifications for all devices that you connect to the NI 9351.



Caution Connecting an external power supply to a DO terminal may cause the module to power on. Carefully check all DO and Vsup connections.



Note Refer to the device datasheet on ni.com/manuals for more information about I/O protection ratings.

Analog Input Protection

The NI 9351 provides overvoltage protection for each AI channel.

Some overvoltage conditions may cause an internal temperature fault, forcing the module into Fail-safe Mode. Conditions that may cause an internal temperature fault include:

- A fault on a single channel exceeding 20 V
- Faults on multiple channels

For fault voltage derating above 55 °C, refer to the device datasheet on ni.com/manuals.

Overtemperature Protection

The NI 9351 has an internal temperature sensor that will cause the module to enter Fail-safe Mode if the internal temperature limit is exceeded.



Note Overtemperature protection will not cause the module to enter Fail-safe Mode under normal operating conditions.

Worldwide Support and Services

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.

Visit ni.com/services for information about the services NI offers.

Visit ni.com/register to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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