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# NI-9478 Getting Started

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# Overview

This document explains how to connect to the NI-9478.



**Note** Before you begin, read the **NI-9478 Safety, Environmental, and Regulatory Information** document on [ni.com/manuals](http://ni.com/manuals) and complete the software and hardware installation procedures in your chassis documentation.



**Note** The guidelines in this document are specific to the NI-9478. 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



**Caution** Observe all instructions and cautions in the user documentation. Using the product in a manner not specified can damage the product and compromise the built-in safety protection.



**Attention** Suivez toutes les instructions et respectez toutes les mises en garde de la documentation d'utilisation. L'utilisation du produit de toute autre façon que celle spécifiée risque de l'endommager et de compromettre la protection de sécurité intégrée.

## Safety Voltages

Connect only voltages that are within the following limits:

Vsup-to-COM	50 V DC maximum, Measurement Category I
<b>Isolation</b>	

Channel-to-channel

None

**Channel-to-earth ground**

Continuous 60 V DC, Measurement Category I

Withstand 1,000 V RMS, verified by a 5 s dielectric withstand test



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



**Attention** Ne pas connecter le produit à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour effectuer des mesures dans ces catégories.

**Warning** Do not connect the product to signals or use for measurements within Measurement Categories II, III, or IV, or for measurements on MAINS circuits or on circuits derived from Overvoltage Category II, III, or IV which may have transient overvoltages above what the product can withstand. The product must not be connected to circuits that have a maximum voltage above the continuous working voltage, relative to earth or to other channels, or this could damage and defeat the insulation. The product can only withstand transients up to the transient overvoltage rating without breakdown or damage to the insulation. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in the system must be conducted prior to making measurements.

**Mise en garde** Ne pas connecter le produit à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour des mesures dans ces catégories, ou des mesures sur secteur ou sur des circuits dérivés de surtensions de catégorie II, III ou IV pouvant présenter des surtensions transitoires supérieures à ce que le produit peut supporter. Le produit ne doit pas être raccordé à des circuits ayant une tension maximale supérieure à la tension de fonctionnement continu, par rapport à la

terre ou à d'autres voies, sous peine d'endommager et de compromettre l'isolation. Le produit peut tomber en panne et son isolation risque d'être endommagée si les tensions transitoires dépassent la surtension transitoire nominale. Une analyse des tensions de fonctionnement, des impédances de boucle, des surtensions temporaires et des surtensions transitoires dans le système doit être effectuée avant de procéder à des mesures.

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



**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-9478 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-9478 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-9478 has been evaluated as Ex nA IIC T4 Gc equipment under DEMKO 07ATEX 0626664X and is IECEx UL 14.0089X certified. Each NI-9478 is marked Ⓢ II 3G and is suitable for use in Zone 2 hazardous locations, in ambient temperatures of  $-40\text{ °C} \leq T_a \leq 70\text{ °C}$ . If you are using the NI-9478 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.

## 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.

### Special Conditions for Marine Applications

Some products are approved for marine (shipboard) applications. To verify marine approval certification for a product, visit [ni.com/product-certifications](https://ni.com/product-certifications), search by model number, and click the appropriate link.



**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-9478 meets the following specifications.

Operating temperature (IEC 60068-2-1, IEC 60068-2-2)	-40 °C to 70 °C
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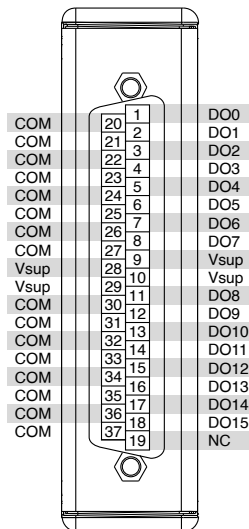
Operating humidity (IEC 60068-2-78)	10% RH to 90% RH, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m

Indoor use only.



**Note** Refer to the device datasheet on [ni.com/manuals](https://ni.com/manuals) for complete specifications.

## NI 9478 Pinout



Signal	Description
COM	Common reference connection
DO	Digital output signal connection
NC	No connection
V <sub>sup</sub>	Voltage supply connection

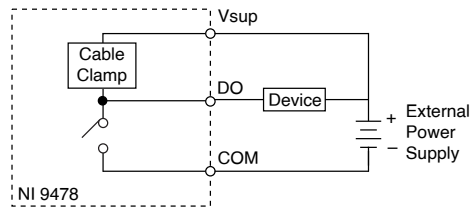
Table 1. NI-9478 Signal Descriptions



## Connecting Digital Devices

You can connect a variety of industrial devices, such as solenoids, motors, actuators, relays, and lamps to the NI-9478. You must connect an external power supply to the NI-9478. The power supply provides the current for the output channels.

Figure 1. Connecting an Industrial Device to the NI-9478



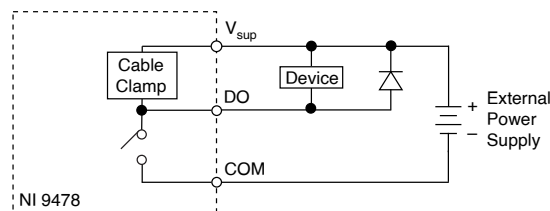
**Caution** Do not install or remove C Series modules from your system if the external power supply connected to the Vsup and COM pins is powered on.

Ensure that the devices you connect to the NI-9478 are compatible with the output specifications of the NI-9478. Refer to the device datasheet at [ni.com/manuals](http://ni.com/manuals) for output specifications.

## Protecting the Digital Outputs from Flyback Voltages

If the channel is switching an inductive or energy-storing device such as a solenoid, motor, or relay, and the device does not have flyback protection, install an external flyback diode.

Figure 2. Connecting a Flyback Diode



## Cable Inductance

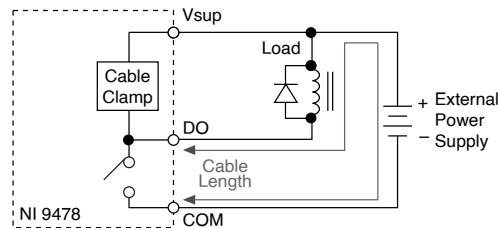
The inductance of the cabling stores energy when a channel is on and driving current. When a channel turns off, energy in the cabling is released as flyback

voltage, which dissipates as heat in the NI-9478. The heat dissipated increases with higher switching frequencies, higher currents, and longer cables.

## Reducing Cable Length

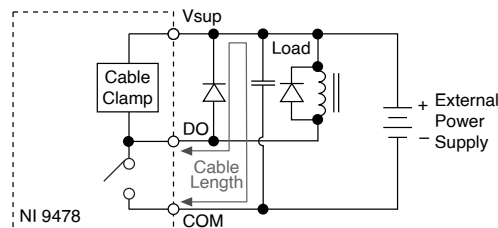
The effective cable length is the total distance from DO to COM.

Figure 3. Cable Length of the NI-9478



NI recommends adding a capacitor across the power supply leads and a diode from the DO lead to the Vsup lead. Connecting a capacitor and a diode reduces the effective cable length and dissipated heat.

Figure 4. Cable Length of the NI-9478 with a Capacitor and Diode



**Note** NI recommends that you use a capacitor with a capacitance of at least 20  $\mu\text{F}$ .

## I/O Protection

The NI 9478 provides protection against overcurrent and short-circuit conditions.

### Overcurrent Protection

The NI-9478 provides two configurable current limit thresholds, Limit A and Limit B. The device monitors each output channel. You can review the output status in software to determine if the current has exceeded the limit threshold.

You can configure each channel on the NI-9478 to disable the output that exceeds the current limit threshold. Some applications require a large inrush current that

may exceed the current limit threshold. You can disable overcurrent protection by setting no current limit for that channel.



**Caution** If you disable overcurrent protection, the NI-9478 is no protected against overcurrent or short-circuit conditions. Verify the wiring is correct and that you are operating the NI-9478 within the specifications.

## Overcurrent Refresh

The NI-9478 provides an overcurrent refresh setting. This setting enables the channel to recover within a specified refresh period. If the refresh setting is disabled, the channel remains off until it receives a command from the software.

## Safe Operating Conditions

The total amount of current that you can switch with a channel depends on the duty cycle of the channel, the ambient temperature, the switching frequency, and the amount of current switched by other channels within the same module at the same time.

NI recommends using 2 meters of cable for safe operating conditions. Higher currents, higher frequencies, and longer cables contribute to increased heat in the NI-9478. Refer to the device datasheet at [ni.com/manuals](http://ni.com/manuals) for safe operating conditions.

You can determine safe operating specifications for the NI-9478 by using the following equation.

Figure 5. Safe Operating Conditions Equation

$$P = 4\% (I_{out}^2) + [0.12\% (\text{length} - 0.2)(I_{out}^2) + 0.04\% I_{out} + 1] \text{freq}$$

$$P = 4\% (I_{out}^2) + [0.12\% (\text{length} - 0.2)(I_{out}^2) + 0.04\% I_{out} + 1] \text{freq}$$

where

- **P** is the percentage of total allowable power the channel uses
- **I<sub>out</sub>** is the output current in amperes while the channel is on
- **length** is the total cable length in meters
- **freq** is the frequency rate in kHz at which the output channel goes through an on-off cycle

Calculate the percentage of total allowable power each channel uses then add the percentages for all the channels. For ambient temperatures from 55 °C to 70 °C, the total power for all channels must remain under 100%. For temperatures below 55 °C, the total power of all channels can run up to 150%.

### Example One

The NI-9478 passes 1.25 A current through 2.0 meters of cable. The channel cycles on for 40 μs and off for 10 μs for a total output period of 50 μs. This yields an output frequency of 20 kHz, using 14.8% of the total power budget.

Figure 6. Example Equation One

$$4 \% (1.25^2) + [0.12 \% (2.0 - 0.2)(1.25^2) + 0.04 \% (1.25 + 1)]20 = 14.8 \%$$

$$4 \% (1.25^2) + [0.12 \% (2.0 - 0.2)(1.25^2) + 0.04 \% (1.25 + 1)]20 = 14.8 \%$$

### Example Two

The NI-9478 is on and passing 3 A of current through 2.0 meters of cable for 0.25 seconds. The channel passes 1.25 A of current at 20 kHz for 1.25 seconds. The channel then drives the load off for 4 seconds.

While the channel is on, the output frequency is 0 kHz and the channel uses 36% of the total power budget. The channel uses 14.8% of the total power budget driving at 20 kHz and 0% when the channel is off. The total percentage of allowable power over the complete 5.5 second cycle is 5%.

Figure 7. Example Equation Two

$$\frac{36 \% (0.25s) + 14.8 \% (1.25s) + 0 \% (4s)}{5.5s} = 5 \% \frac{36 \% (0.25s) + 14.8 \% (1.25s) + 0 \% (4s)}{5.5s} = 5 \%$$

## Where to Go Next

### NI Services

Visit [ni.com/support](http://ni.com/support) to find support resources including documentation, downloads, and troubleshooting and application development self-help such as tutorials and examples.

Visit [ni.com/services](http://ni.com/services) to learn about NI service offerings such as calibration options, repair, and replacement.

Visit [ni.com/register](https://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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