Installation Instructions

SLC 500™ RTD/Resistance Input Module

(Catalog Number 1746-NR8)

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Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout these installation instructions we use notes to make you aware of safety considerations:

ATTENTION

Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

For More Information

Related Publications

For	Refer to this Document	Pub. No.
A more detailed description on how to install and use your RTD/Resistance Input Module.	SLC 500™ RTD/Resistance Input Module User Manual	1746-UM003
A more detailed description on how to install and use your modular SLC 500 system.	SLC 500™ Modular Hardware Style Installation and Operation Manual	1747-UM011
A more detailed description on how to install and use your fixed SLC 500 system.	SLC 500™ Fixed Hardware Style Installation and Operation Manual	1747-6.21
A reference manual that contains status file data, instruction set, and troubleshooting information.	SLC 500™ Instruction Set Reference Manual	1747-RM001

How to Get More Information

If you would like a manual, you can:

- download a free electronic version from the internet at www.theautomationbookstore.com
- purchase a printed manual by:
  - contacting your local distributor or Rockwell Automation representative
  - visiting www.theautomationbookstore.com and placing your order
  - calling 1.800.963.9548 (USA/Canada) or 001.330.725.1547 (Outside USA/Canada)

Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only. The following WARNING statement applies to use in hazardous locations.

WARNING

EXPLOSION HAZARD

- Substitution of components may impair suitability for Class I, Division 2.
- Do not replace components or disconnect equipment unless power has been switched off.
- Do not connect or disconnect components unless power has been switched off.
- All wiring must comply with N.E.C. article 501-4(b).

Environnements dangereux

Cet équipement est conçu pour être utilisé dans des environnements de Classe 1, Division 2, Groupes A, B, C, D ou non dangereux. La mise en garde suivante s'applique à une utilisation dans des environnements dangereux.

ATTENTION

DANGER D'EXPLOSION

- La substitution de composants peut rendre cet équipement impropre à une utilisation en environnement de Classe 1, Division 2.
- Ne pas remplacer de composants ou déconnecter l'équipement sans s'être assuré que l'alimentation est coupée.
- Ne pas connecter ou déconnecter des composants sans s'être assuré que l'alimentation est coupée.

Overview

The RTD (Resistance Temperature Detector) module receives and stores digitally converted analog data from RTDs or other resistance inputs such as potentiometers into its image table for retrieval by all fixed and modular SLC 500 processors. An RTD consists of a temperature-sensing element connected by 2, 3 or 4 wires that provide input to the RTD module. The module supports connections from any combination of up to eight RTDs of various types (for example: platinum, nickel, copper, or nickel-iron) or other resistance inputs. See the input specifications beginning on page 19 for RTD types, their associated temperature ranges, and the analog input signal ranges that each 1746-NR8 channel supports. Each input channel is individually configurable for a specific input device. Broken sensor detection (open- or short-circuit) is provided for each input channel. In addition, the module provides indication if the input signal is out-of-range.

The module contains a removable terminal block providing connection for any mix of eight RTD sensors or resistance input devices. There are no output channels on the module. Module configuration is done via the user program. There are no DIP switches.

Channel Status LEDs

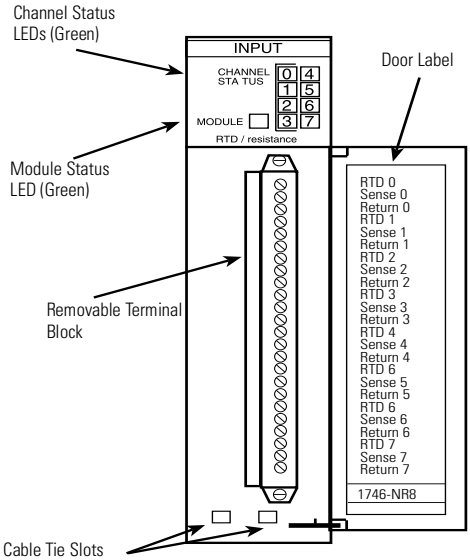
Channel status LEDs indicate the status for channels 0 through 7. Related error information is contained in the channel status word. This includes conditions such as:

- normal operation
- channel-related configuration errors
- open-circuit errors
- out-of-range errors

All channel errors are recoverable errors.

Module Status LED

The module status LED shows diagnostic or operating errors related to the module. These non-recoverable errors may be detected during power-up or during operation. Once an error has been detected, the module no longer communicates with the SLC processor. Channel states are disabled and data words are cleared (0). Failure of any diagnostic test results in a non-recoverable error and requires the assistance of your local distributor or Rockwell Automation.



Required Tools and Equipment

Have the following tools and equipment ready

- small blade screwdriver (0.100 inch slot width)
- RTD module (1746-NR8)
- RTD sensor or resistance input
- appropriate cable (if needed)
- programming equipment

Electrostatic Damage

Electrostatic discharge can damage semiconductor devices inside this module if you touch backplane connector pins or other sensitive areas. Guard against electrostatic damage by observing the following precautions.

ATTENTION

Electrostatic discharge can degrade performance or cause permanent damage. Handle the module as stated below.

- Wear an approved wrist strap grounding device when handling the module.
- Touch a grounded object to rid yourself of electrostatic charge before handling the module.
- Handle the module from the front, away from the backplane connector. Do not touch backplane connector pins.
- Keep the module in its static-shield bag when not in use, or during shipment.

Power Requirements

The RTD module receives its power through the SLC 500 chassis backplane from the fixed or modular +5V dc/+24V dc chassis power supply. The maximum current drawn by the module is shown in the table below.

5V dc Amps	24V dc Amps
0.100	0.055

When you are using a *modular system* configuration, add the values shown in the table above to the requirements of all other modules in the SLC chassis to prevent overloading the chassis power supply.

When you are using a *fixed system* controller, refer to the important note on page 8 about module compatibility in a 2-slot fixed expansion chassis.

Modular Chassis Considerations

Place your RTD module in any slot of an SLC 500 modular chassis (except slot 0) or a modular expansion chassis. Slot 0 is reserved for the modular processor or adapter module.

Fixed Expansion Chassis Considerations

IMPORTANT

The 2-slot, SLC 500 fixed I/O expansion chassis (1746-A2) supports many combinations of modules. The combinations that are not supported by the fixed expansion chassis are shown in the table below. For a complete listing of valid combinations using the RTD module in a 2-slot expansion chassis with another SLC I/O or communication module, refer to the table in the SLC 500™ RTD/Resistance Input Module User Manual.

For a complete listing of valid combinations using the RTD module in a 2-slot expansion chassis with another SLC I/O or communication module, refer to the table in the *SLC 500 RTD/Resistance Input Module User Manual*, publication number 1746-UM003.

General Considerations

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. RTD inputs are susceptible to electrical noises due to the small amplitudes of their signal.

Group your modules to minimize adverse effects from radiated electrical noise and heat. Consider the following conditions when selecting a slot for the RTD module. Position the module:

- in a slot away from power lines, load lines and other sources of electrical noise such as hard-contact switches, relays, and AC motor drives
- away from modules which generate significant radiated heat, such as the 32-point I/O modules

Module Installation and Removal

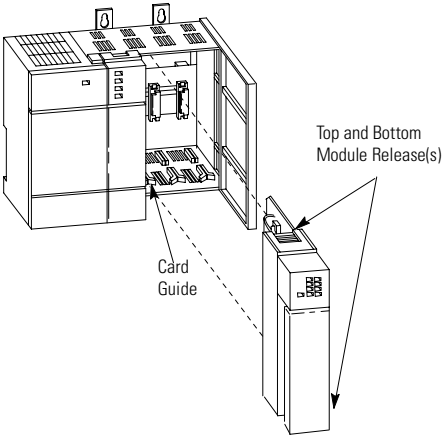
When installing the module in a chassis, it is not necessary to remove the terminal block from the module.

Module Installation Procedure

1. Align the circuit board of the RTD module with the card guides located at the top and bottom of the chassis.

2. Slide the module into the chassis until both top and bottom retaining clips are secured. Apply firm even pressure on the module to attach it to its backplane connector. Never force the module into the slot.

3. Cover all unused slots with the Card Slot Filler, Catalog Number 1746-N2.



Module Removal Procedure

1. Press the releases at the top and bottom of the module and slide the module out of the chassis slot.

2. Cover all unused slots with the Card Slot Filler, Catalog Number 1746-N2.

Terminal Block Wiring and Removal

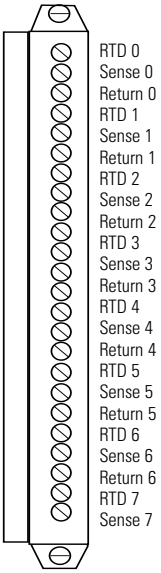
The RTD module contains an 24-position, removable terminal block. The terminal pin-out is shown below.

ATTENTION

Disconnect power to the SLC before attempting to install, remove, or wire the removable terminal wiring block.
To avoid cracking the removable terminal block, alternate the removal of the terminal block release screws.

Terminal Wiring

Terminal screws accept a maximum of one #14 AWG (2 mm^2) wire. Tighten terminal screws only tight enough to immobilize wires. Maximum torque on terminal screws is 0.25 Nm (2.25 in-lb.).



Release Screw Max Torque = 0.25 Nm (2.25 in-lb)

Terminal Block Removal

If the terminal block is removed, use the write-on label located on the side of the terminal block to identify the module location and type.

To remove the terminal block:

1. Loosen the two terminal block release screws.
2. Grasp the terminal block at the top and bottom and pull outward and down.

Wiring Considerations

Follow the guidelines below when planning your system wiring.

Since the operating principle of the RTD module is based on the measurement of resistance, take special care in selecting your input cable. For 2-wire or 3-wire configuration, select a cable that has a consistent impedance throughout its entire length.

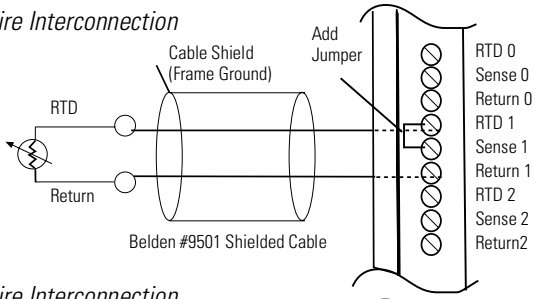
Configuration	Recommended Cable
2-wire	Belden™ #9501 or equivalent
3-wire less than 30.48 m (100 ft.)	Belden #9533 or equivalent
3-wire greater than 30.48 m (100 ft.) or high humidity conditions	Belden #83503 or equivalent

For a 3-wire configuration, the module can compensate for a maximum cable length associated with an overall cable impedance of 25 ohms.

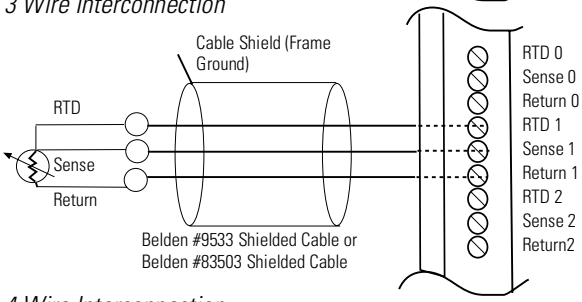
As shown in the figure on the next page, three configurations of RTDs can be connected to the RTD module:

- 2-wire RTD, which is composed of 2 RTD lead wires (RTD and Return)
- 3-wire RTD, which is composed of a Sense and 2 RTD lead wires (RTD and Return)
- 4-wire RTD, which is composed of 2 Sense and 2 RTD lead wires (RTD and Return). The second sense wire of a 4-wire RTD is left open.

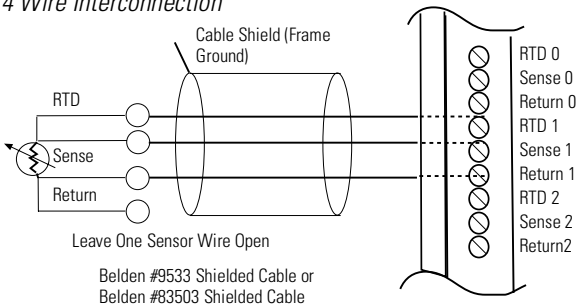
2 Wire Interconnection

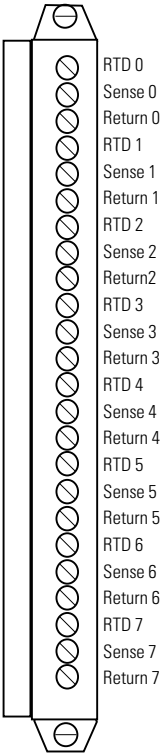


3 Wire Interconnection



4 Wire Interconnection





IMPORTANT

The RTD module requires three wires to compensate for lead resistance error. We recommend that you do not use 2-wire RTDs if long cable runs are required, as it reduces the accuracy of the system. However, if a 2-wire configuration is required, reduce the effect of the lead wire resistance by using a lower gauge wire for the cable (for example, use AWG #16 instead of AWG #24). Also, use cable that has a lower resistance per foot of wire. The module's terminal block accepts one AWG #14 gauge wire.

- To limit overall cable impedance, keep input cables as short as possible. Locate your I/O chassis as near the RTD sensors as your application permits.
- Ground the shield drain wire at one end only. The preferred location is at the chassis mounting tab of the chassis, under the RTD module. Refer to IEEE Std. 518, Section 6.4.2.7 or contact your sensor manufacturer for additional details.
- Route RTD/resistance input wiring away from any high-voltage I/O wiring, power lines, and load lines.
- Tighten terminal screws using a small flathead screwdriver. Each screw should be turned tight enough to immobilize the wire's end. Excessive tightening can strip the terminal screw. The torque applied to each screw should not exceed 0.25 Nm (2.25 in-lb.) for each terminal.
- Follow system grounding and wiring guidelines found in your *SLC 500 Installation and Operation Manual,* publication 1747-UM011.

When using a 3-wire configuration, the module compensates for resistance error due to lead wire length. For example, in a 3-wire configuration, the module reads the resistance due to the length of one of the wires and assumes that the resistance of the other wire is equal. If the resistances of the individual lead wires are much different, an error may exist. The closer the resistance values are to each other, the greater the amount of error that is eliminated.

IMPORTANT

To ensure temperature or resistance value accuracy, the resistance difference of the cable lead wires must be equal to or less than 0.01Ω

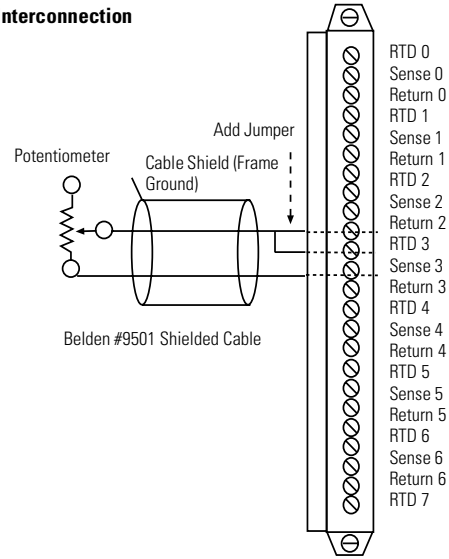
There are several ways to insure that the lead values match as closely as possible. They are as follows:

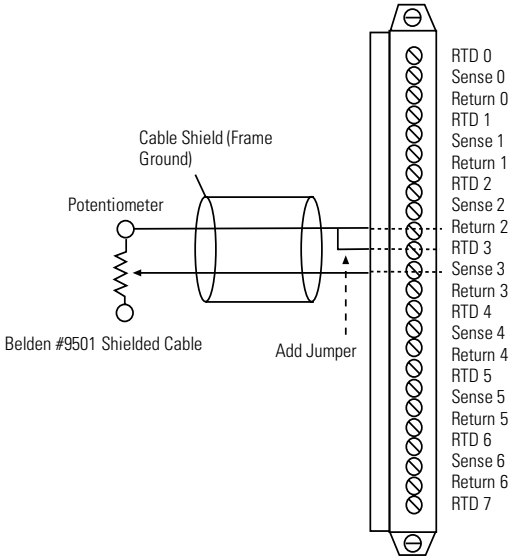
- Keep lead resistance as small as possible and less than 25Ω .
- Use quality cable that has a small tolerance impedance rating.
- Use a heavy-gauge lead wire which has less resistance per foot.

Wiring Resistance Devices (Potentiometers) to the Module

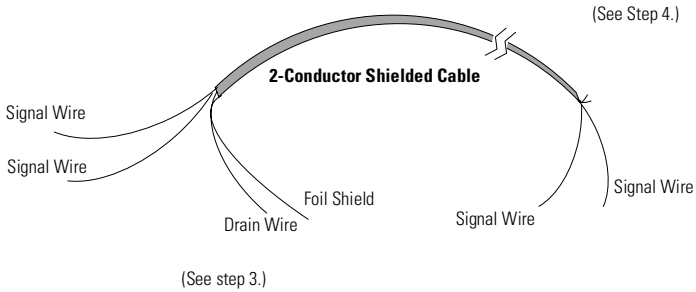
Potentiometer wiring requires the same type of cable as that for the RTD described on page 11. Potentiometers can be connected to the RTD module as a 2-wire interconnection as shown below.

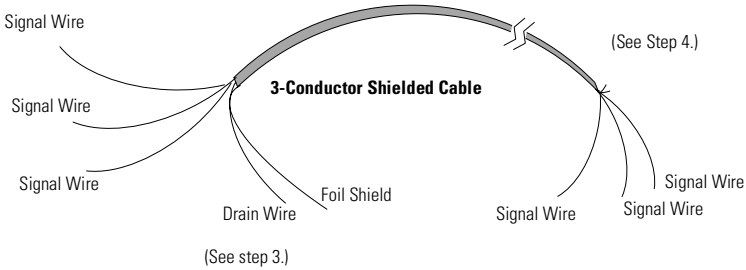
2 Wire Potentiometer Interconnection





Wiring Input Devices to the NR8 Module





To wire your NR8 module, follow these steps.

1. At each end of the cable, strip some casing to expose the individual wires.
2. Trim the signal wires to 5.08-cm (2-in.) lengths. Strip about 4.76 mm (3/16 in.) of insulation away to expose the end of the wire.
3. At one end of the cable twist the drain wire and foil shield together, bend them away from the cable, and apply shrink wrap. Then earth ground at the frame ground of the chassis.
4. At the other end of the cable, cut the drain wire and foil shield back to the cable and apply shrink wrap.
5. Connect the signal wires to the 1746-NR8 terminal block and the input.
6. Repeat steps 1 through 5 for each channel on the 1746-NR8 module.

Specifications

Electrical Specifications

Backplane Current Consumption	100 mA at 5V dc 55 mA at 24V dc
Backplane Power Consumption	1.82W maximum (0.5W at 5V dc, 1.32W at 24V dc)
External Power Supply Requirements	None
Number of Channels	8 (backplane isolated)
I/O Chassis Location	Any I/O module slot except slot 0
A/D Conversion Method	Sigma-Delta Modulation
Input Filtering	Low pass digital filter with programmable notch (filter) frequencies
Common Mode Rejection (28 Hz and 50/60 Hz Filter frequencies)	> 120 dB at 50 Hz (28 Hz and 50 Hz filter frequencies) > 120 dB at 60 Hz (28 Hz and 60 Hz filter frequencies)
Normal Mode Rejection (between [+] input and [-] input)	65 dB minimum at 50/60 Hz with 50/60 Hz filter 110 dB minimum at 50 Hz with 28 Hz filter 95 dB minimum at 60 Hz with 28 Hz filter
Max. common mode voltage	±1 volt
Max. allowed permanent overload(1)	Volts = ±5V dc; Current = ±5 mA
Input Filter Cut-Off Frequencies	7.80 Hz at 28 Hz filter frequency 13.65 Hz at 50/60 Hz filter frequency 209.6 Hz at 800 Hz filter frequency 1676 Hz at 6400 Hz filter frequency
Calibration	Module autocalibrates at power-up. Periodic calibration (every 5 minutes) can also be enabled.
Isolation	500V ac for 1 minute between inputs and chassis ground, and between inputs and backplane. 5V dc continuous between channels.

(1) Do not apply a voltage or current to the module.

Physical Specifications

LED Indicators	9 green status indicators, one for each of 8 channels and one for module status
Module ID Code	3508 - Class 1 12708 - Class 3
Maximum Termination Wire Size	One 14 AWG wire per terminal
Maximum Cable Impedance	25 ohms maximum impedance for 3-wire RTD configuration (see Cable Specifications on page 11.)
Terminal Block	1746-RT-35

Environmental Specifications

Operating Temperature	0°C to +60°C (+32°F to +140°F)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Relative Humidity	5% to 95% (without condensation)
Agency Certification	UL and C-UL approved
Hazardous Environment Classification	Class I, Division 2 Hazardous Environment Groups A, B, C, D
EMC	CE compliant for all applicable directives C-Tick compliant for all applicable acts

Input Specifications

RTD Types	platinum, nickel, nickel iron, copper (For additional information on RTD types, see page 21.)
Temperature Scale (Selectable)	°C or °F and 0.1°C or 0.1°F
Resistance Scale (Selectable)	1Ω or 0.1Ω for all resistance ranges except for 150Ω; or 0.1Ω or 0.01Ω for 150Ω potentiometer.
Input Step Response	Refer to the *SLC 500™ RTD/Resistance Input Module User Manual*, publication number 1747-UM003A.
Channel Turn-On Time	Requires up to one module update time *plus* module calibration time.
Channel Turn-Off Time	Requires up to one module update time.
Reconfiguration Time	Requires up to one module update time *plus* module calibration time.
Channel Scan Time (with lead resistance)	28 Hz = 250 ms 50/60 Hz = 147 ms 800 Hz = 18 ms 6400 Hz = 10 ms
Channel Scan Time (without lead resistance)	28 Hz = 125 ms 50/60 Hz = 75 ms 800 Hz = 10 ms 6400 Hz = 6 ms
RTD Excitation Current	RTD setting: **0.25 mA** - Recommended for use with higher resistance ranges for both RTDs and direct resistance inputs (1000Ω RTDs and 3000Ω resistance input). Refer to RTD manufacturer for recommendations. **1.0 mA** -Recommended to use for all other RTD and direct resistance inputs, except 1000Ω RTDs and 3000Ω resistance input ranges are limited. Refer to RTD manufacturer for recommendations.

RTD Temperature Ranges, Resolution, and Repeatability

Input Type		Temp. Range (0.25 mA Excitation)(1)	Temp. Range (1.0 mA Excitation)(1)	Resolution	Repeatability
Platinum (385)(2)	100Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +850°C (-328°F to +1562°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
	200Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +850°C (-328°F to +1562°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
	500Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +390°C (-328°F to +698°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
	1000Ω	-200°C to +850°C (-328°F to +1562°F)	-200°C to +50°C (-328°F to +122°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
Platinum (3916)(2)	100Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +630°C (-328°F to +1166°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
	200Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +630°C (-328 °F to +1166°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
	500Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +380°C (-328°F to +698°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
	1000Ω	-200°C to +630°C (-328°F to +1166°F)	-200°C to +50°C (-328°F to +122°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
Copper (426)(2) (3)	10Ω	-100°C to +260°C (-328°F to +500°F)	-100°C to +260°C (-148°F to +500°F)	0.1°C (0.1°F)	±0.2°C (±0.4°F)
Nickel (618)(2) (4)	120Ω	-100°C to +260°C (-328°F to +500°F)	-100°C to +260°C (-328°F to +500°F)	0.1°C (0.1°F)	±0.1°C (±0.2°F)
Nickel (672)(2)	120Ω	-80°C to +260°C (-328°F to +500°F)	-80°C to +260°C (-328°F to +500°F)	0.1°C (0.1°F)	±0.1°C (±0.2°F)
Nickel Iron (518)(2)	604Ω	-200°C to +200°C (-328°F to +392°F)	-200°C to +180°C (-328°F to +338°F)	0.1°C (0.1°F)	±0.1°C (±0.2°F)

(1) The temperature range for the 1000Ω RTD is dependent on the excitation current.

(2) The digits following the RTD type represent the temperature coefficient of resistance (α), which is defined as the resistance change per ohm per °C. For instance, Platinum 385 refers to a platinum RTD with α = 0.00385 ohms/ohm - °C or simply 0.00385/°C.

(3) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(4) Actual value at 0°C is 100Ω per DIN standard.

Input Type		Resistance Range (0.25 mA Excitation)	Resistance Range (1.0 mA Excitation)	Resolution	Repeatability (28 Hz, 50/60 Hz)
Resistance	150Ω	0 to 150Ω	0 to 150Ω	0.01Ω	±0.04Ω
	500Ω	0 to 500Ω	0 to 500Ω	0.1Ω	±0.2Ω
	1000Ω	0 to 1000Ω	0 to 1000Ω	0.1Ω	±0.2Ω
	3000Ω	0 to 3000Ω	0 to 1200Ω	0.1Ω	±0.2Ω

The module accuracy is dependent on the RTD/Resistance type, the excitation current, and the input filter selection. The following table shows the module accuracy and temperature drift when the module has been auto-calibrated at the operating temperature and when the module's temperature changes but has not been recalibrated.

RTD Accuracy and Temperature Drift Specifications

Input Type		Accuracy(1) (0.25 mA Excitation)	Accuracy(1) (1.0 mA Excitation)	Temperature Drift(2) (0.25 mA Excitation)	Temperature Drift(2) (1.0 mA Excitation)
Platinum (385)(3)	100Ω	±0.5°C (±0.9°F)	±0.7°C (±1.3°F)	±0.012°C/°C (±0.012°F/°F)	±0.020°C/°C (±0.020°F/°F)
	200Ω	±0.6°C (±1.1°F)	±0.7°C (±1.3°F)	±0.015°C/°C (±0.015°F/°F)	±0.020°C/°C (±0.020°F/°F)
	500Ω	±0.7°C (±1.3°F)	±0.5°C (±0.9°F)	±0.020°C/°C (±0.020°F/°F)	±0.012°C/°C (±0.012°F/°F)
	1000Ω	±1.2°C (±2.2°F)	±0.4°C (±0.7°F)	±0.035°C/°C (±0.035°F/°F)	±0.010°C/°C (±0.010°F/°F)
Platinum (3916)(3)	100Ω	±0.4°C (±0.7°F)	±0.6°C (±1.1°F)	±0.010°C/°C (±0.010°F/°F)	±0.015°C/°C (±0.015°F/°F)
	200Ω	±0.5°C (±0.9°F)	±0.6°C (±1.1°F)	±0.011°C/°C (±0.011°F/°F)	±0.015°C/°C (±0.015°F/°F)
	500Ω	±0.6°C (±1.1°F)	±0.4°C (±0.7°F)	±0.015°C/°C (±0.015°F/°F)	±0.012°C/°C (±0.012°F/°F)
	1000Ω	±0.9°C (±1.6°F)	±0.3°C (±0.6°F)	±0.026°C/°C (±0.026°F/°F)	±0.010°C/°C (±0.010°F/°F)
Copper (426)(3) (4)	10Ω	±0.5°C (±0.9°F)	±0.8°C (±1.4°F)	±0.008°C/°C (±0.008°F/°F)	±0.008°C/°C (±0.008°F/°F)
Nickel (618)(3) (5)	120Ω	±0.2°C (±0.4°F)	±0.2°C (±0.4°F)	±0.003°C/°C (±0.003°F/°F)	±0.005°C/°C (±0.005°F/°F)
Nickel (672) (3)	120Ω	±0.2°C (±0.4°F)	±0.2°C (±0.4°F)	±0.003°C/°C (±0.003°F/°F)	±0.005°C/°C (±0.005°F/°F)
Nickel Iron (518) (3)	604Ω	±0.3°C (±0.5°F)	±0.3°C (±0.5°F)	±0.008°C/°C (±0.008°F/°F)	±0.008°C/°C (±0.008°F/°F)
Resistance	150Ω	±0.2Ω	±0.15Ω	±0.004Ω/°C (0.002Ω/°F)	±0.003Ω/°C (±0.002Ω/°F)
	500Ω	±0.5Ω	±0.5Ω	±0.012Ω/°C (±0.007Ω/°F)	±0.012Ω/°C (±.0.007Ω/°F)
	1000Ω	±1.0Ω	±1.0Ω	±0.025Ω/°C (±0.014Ω/°F)	±0.025Ω/°C (±0.014Ω/°F)
	3000Ω	±1.5Ω	±1.2Ω	±0.040Ω/°C (±0.023Ω/°F)	±0.040Ω/°C (±0.023Ω/°F)

(1) The accuracy values assume that the module was calibrated within the specified temperature range of 0°C to +60°C (+32°F to +140°F).

(2) Temperature drift specifications apply to a module that has not been calibrated.

(3) The digits following the RTD type represent the temperature coefficient of resistance (α), which is defined as the resistance change per ohm per °C. For instance, Platinum 385 refers to a platinum RTD with α= 0.00385 ohms/ohm - °C or simply 0.00385/°C.

(4) Actual value at 0°C is 9.042Ω per SAMA standard RC21-4-1966.

(5) Actual value at 0°C is 100Ω per DIN standard.

Notes:

Notes:

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