



SLC 500 Thermocouple/mV Analog Input Module

(Catalog Number 1746-NT8)

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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 or the area is known to be non-hazardous.
 - Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.
 - 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 I, Division 2, Groupes A, B, C, D ou non dangereux. La mise en garde suivante s'applique à une utilisation dans des environnements dangereux.

AVERTISSEMENT



DANGER D'EXPLOSION

- La substitution de composants peut rendre cet équipement impropre à une utilisation en environnement de Classe I, 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.
-

Module Overview

The module communicates with the SLC 500 processor and receives +5V dc and +24V dc power from the system power supply through the parallel backplane interface. No external power supply is required. You may install as many thermocouple modules in the system as the power supply can support.

Each module channel can receive input signals from a thermocouple or a millivolt analog input device. You configure each channel to accept either one. The module converts analog input voltages when it is configured for thermocouple input types. The analog input voltages are converted into cold-junction compensated, digital temperature readings. The module uses the National Institute of Standards and Technology (NIST) based on ITS-90 for thermocouple linearization.

When configured for millivolt analog inputs, the module converts analog values directly into digital counts. The module assumes that the mV input signal is linear prior to input to the module.

Input Ranges

The following two tables define thermocouple types and associated temperature ranges and the millivolt analog input signal ranges that each of the module's input channels will support. To determine the practical temperature range of your thermocouple, refer to the specifications in Appendix A of the *SLC 500 Thermocouple/mV Analog Input Module User Manual*, publication 1746-6.22.

Table A Thermocouple Temperature Ranges

Type	°C Temperature Range	°F Temperature Range
J	-210 °C to 760 °C	-346 °F to 1400 °F
K	-270 °C to 1370 °C	-454 °F to 2498 °F
T	-270 °C to 400 °C	-454 °F to 752 °F
B	300 °C to 1820 °C	572 °C to 3308 °F
E	-270 °C to 1000 °C	-454 °F to 1832 °F
R	0 °C to 1768 °C	32 °F to 3214 °F
S	0 °C to 1768 °C	32 °F to 3214 °F
N	0 °C to 1300 °C	32 °F to 2372 °F
CJC Sensor	-25 °C to 105 °C	-13 °F to 221 °F

Table B Millivolt Input Ranges

-50 to +50 mV	-100 to +100 mV
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Each input channel is individually configured for a specific input device. Each channel detects and indicates:

- open-circuit
- over-range
- under-range

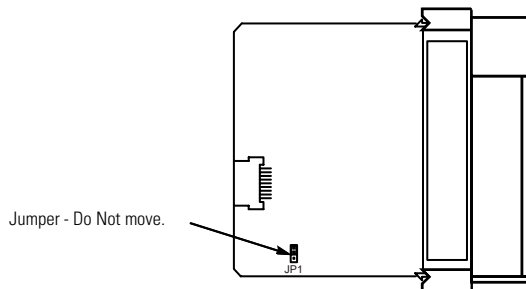
Hardware Features

The module fits into any single slot (other than slot 0) for I/O modules in either an SLC 500 modular system or an SLC 500 fixed system expansion chassis (1746-A2). It is a Class 1⁽¹⁾ module (uses 8 input words and 8 output words).

The module contains a removable terminal block providing connections for eight thermocouple and/or analog input devices. On the terminal block are two cold-junction compensation (CJC) sensors that compensate for the cold junction at ambient temperature. It should also be noted there are no output channels on the module. Configure the module with software rather than with jumpers or switches.

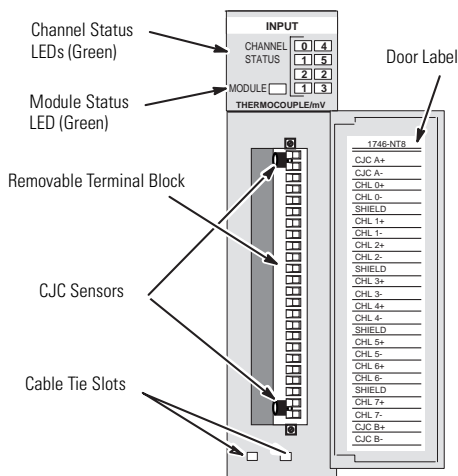
IMPORTANT

There is a jumper (JP1) on the circuit board. The module is shipped with the jumper in the up position as illustrated below. Do not change the position of JP1. The jumper is used for test purposes only.



(1) Requires use of a BlockTransfer in a remote configuration.

1746-NT8 Features



Hardware	Function
Channel Status LED Indicators	Display operating and fault status of channels 0 through 7
Module Status LED	Displays operating and fault status of the module
Side Label (Nameplate)	Provides module information
Removable Terminal Block	Provides electrical connection to input devices
Door Label	Permits easy terminal identification
Self Locking Tabs	Secure module in chassis slot

Installing And Wiring Your Module

Read this section to install and wire your module. This section covers:

- avoiding electrostatic damage
- determining power requirements
- installing the module
- wiring signal cables to the module's terminal block

Electrostatic Damage

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

ATTENTION



ELECTROSTATICALLY SENSITIVE COMPONENTS

- Before handling the module, touch a grounded object to rid yourself of electrostatic charge.
- Handle the module from the front, away from the backplane connector. Do not touch backplane connector pins.
- Keep the module in its static-shield container when not in use or during shipment.

Failure to observe these precautions can degrade the module's performance or cause permanent damage.

Required Tools and Equipment

Have the following tools and equipment ready:

- 2.5 mm (0.1 in.) slot-head screwdriver
- thermocouple or millivolt sensor
- appropriate thermocouple extension wire (if needed)
- thermocouple/mV input module (1746-NT8)
- programming equipment

Power Requirements

The 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 following table.

Table C Maximum Current Drawn By the Module

5VDC Amps	24VDC Amps
0.120	0.070

Considerations for a Modular System

Place your module in any slot of an SLC 500 modular, or modular expansion chassis, except for the left-most slot (slot 0) reserved for the SLC processor or adapter modules.

Considerations for a Fixed Controller

The power supply in the 2-slot SLC 500 fixed I/O chassis (1746-A2) can support only specific combinations of modules. Make sure the chassis power supply can support the 1746-NT8 and additional module power requirements.

Selecting A Chassis Slot

Two factors determine where you should install your module in the chassis: ambient temperature and electrical noise. When selecting a slot for your module, try to position your module:

- in a chassis close to the bottom of the enclosure (where the air is cooler)
- away from modules that generate significant heat, such as the 1746-OA16 or the 1746-IA16
- in a slot away from ac or high-voltage dc modules, hard contact switches, relays, and ac motor drives
- away from the chassis power supply (if using a modular system)

Remember that in a modular system, a processor or adapter always occupies the first slot of the chassis.

Module Installation and Removal

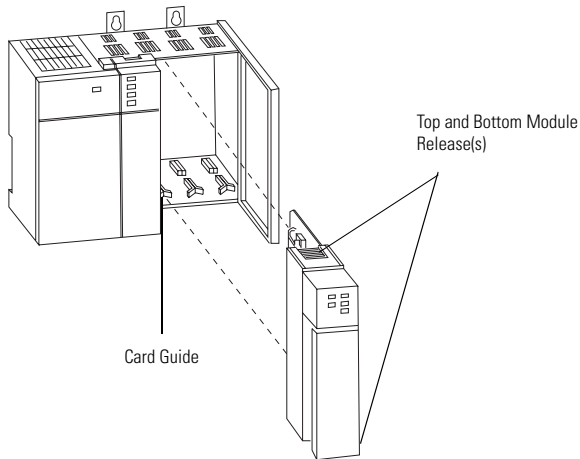
ATTENTION



Before installing or removing your module, always disconnect:

- power from the SLC 500 system
- any other power sources to the module
- any devices wired to the module

Failure to observe this precaution can cause unintended equipment operation and damage.



To insert your module into the chassis, follow these steps:

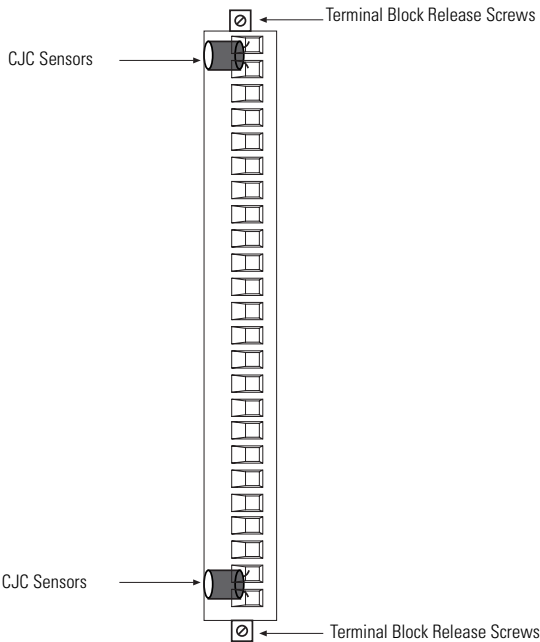
1. Before installing the module, connect ground wire to TB1. See page 15.
2. Align the circuit board of your module with the card guides at the top and bottom of the chassis.
3. Slide your module into the chassis until both top and bottom retaining clips are secure. Apply firm even pressure on your module to attach it to its backplane connector. Never force your module into the slot.
4. Cover all unused slots with the Card Slot Filler, Allen-Bradley part number 1746-N2.

Terminal Block Removal

To remove the terminal block:

1. Loosen the two terminal block release screws. To avoid cracking the terminal block, alternate between screws as you remove them.
2. Using a screwdriver or needle-nose pliers, carefully pry the terminal block loose. When removing or installing the terminal block be careful not to damage the CJC sensors.

Terminal Block Diagram with CJC Sensors



ATTENTION



POSSIBLE EQUIPMENT OPERATION

Before wiring your module, always disconnect power from the SLC 500 system and from any other source to the module.

Failure to observe this precaution can cause unintended equipment operation and damage.

Cold Junction Compensation (CJC)

To obtain accurate readings from each of the channels, the cold-junction temperature (temperature at the module's terminal junction between the thermocouple wire and the input channel) must be compensated for. Two cold junction compensating sensors are integrated in the removable terminal block. They must remain installed to retain accuracy.

ATTENTION

Do not remove or loosen the cold junction compensating temperature transducers located on the terminal block. Both CJC's are critical to ensure accurate thermocouple input readings at each channel. The module will not operate in thermocouple mode if a CJC is not connected.

Failure to observe this precaution can cause unintended equipment operation and damage.

Wiring Guidelines

Isolation

The 1746-NT8 module provides the following electrical isolation:

- 12.5V dc electrical isolation channel to channel
- 500V dc electrical isolation channel to chassis ground
- 500V dc electrical isolation channel to backplane

Care must be taken when choosing a thermocouple type and connecting it to the 1746-NT8 module from the environment being measured. If adequate precautions are not taken for a given thermocouple type, the electrical isolation of the 1746-NT8 module may be compromised.

Thermocouple Junctions

There are three types of thermocouple junctions:

- Grounded Junction - The measuring junction is physically connected to the protective metal sheath providing electrical continuity between junction and sheath.
- Ungrounded Junction - The measuring junction is electrically isolated from the protective metal sheath. (Ungrounded Junction can also be called Insulated Junction.)
- Exposed Junction - Does not have a protective metal sheath so the measuring junction is exposed.

TIP

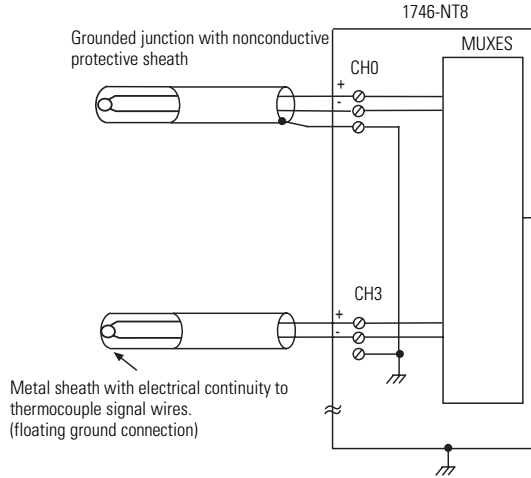


Refer to Appendix A of the *SLC 500 Thermocouple/mV Analog Input User Manual*, publication 1746-6.22 for additional information on wiring and using grounded junction, ungrounded junction, and exposed junction thermocouple types.

Grounded Junction Thermocouples

As shown in the following illustration, the shield input terminals are internally connected together, which are then connected to chassis ground. Using grounded junction thermocouples with electrically conductive sheaths removes the thermocouple signal to chassis ground isolation of the module. This is inherent to the thermocouple construction. In addition, if multiple grounded junction thermocouples are used, the module's channel-to-channel isolation is removed since there is no isolation between signal and sheath and the sheaths are tied together. It should be noted that the isolation is removed even if the sheaths are connected to chassis ground at a location other than the module, since the module is connected to chassis ground.

Grounded Junction Thermocouples



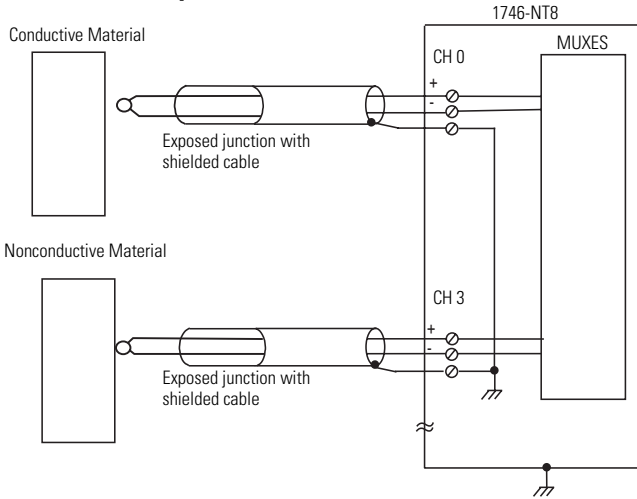
As shown in the wiring diagram above, it is recommended that grounded junction thermocouples have either protective sheaths made of electrically insulated material (e.g. ceramic), or that the metal protective sheaths be floated. The metal sheaths would need to be floated with respect to any path to chassis ground or to another thermocouple metal sheath. This means the metal sheath must be insulated from electrically conductive process material and have all connections to chassis ground broken. It should be noted that a floated sheath may result in a less noise-immune thermocouple signal.

Exposed Junction Thermocouples

Recommended wiring for exposed junction thermocouples is shown in the following illustration. Using exposed junction thermocouples may result in removal of channel-to-channel isolation. This may occur if multiple exposed thermocouples are in direct contact with electrically conductive process materials. To prevent violation of channel-to-channel isolation:

- For multiple exposed thermocouples, do not allow the measuring junction of the thermocouple to make direct contact with electrically conductive process material.
- Use all ungrounded junction thermocouples instead of the exposed junction type.

Exposed Junction Thermocouples



Cable Wiring Considerations

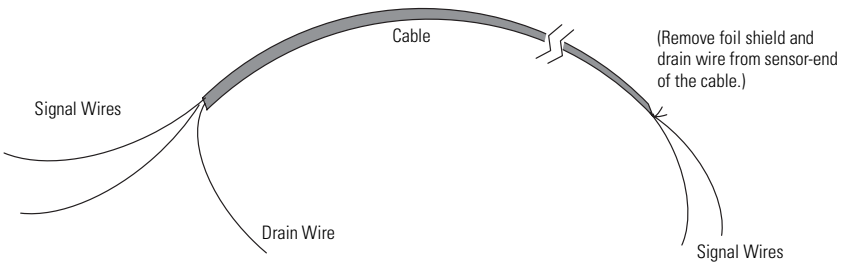
Follow these guidelines to wire your input signal cables:

- Power, input, and output (I/O) wiring must be in accordance with Class 1, Division 2 wiring methods [Article 501-4(b) of the National Electrical Code, NFPA 70] and in accordance with the authority having jurisdiction.
- Route the field wiring away from any other wiring and as far as possible from sources of electrical noise, such as motors, transformers, contactors, and ac devices. As a general rule, allow at least 15.2 cm (6 in.) of separation for every 120 V of power.
- Routing the field wiring in a grounded conduit can reduce electrical noise further.
- If the field wiring must cross ac or power cables, ensure that they cross at right angles.
- To limit the pickup of electrical noise, keep thermocouple and millivolt signal wires as far from power and load lines as possible.
- For high immunity to electrical noise, use Belden™ 8761 (shielded, twisted pair) or equivalent wire for millivolt sensors; you can also use shielded, twisted pair thermocouple extension lead wire specified by the thermocouple manufacturer. Using the incorrect type of thermocouple extension wire or not following the correct polarity may cause invalid readings.

- Ground the shield drain wire at only one end of the cable. The preferred location is at the shield connections on the terminal block. (Refer to IEEE Std. 518, Section 6.4.2.7 or contact your sensor manufacturer for additional details.)
- Keep all unshielded wires as short as possible.
- Excessive tightening can strip a screw. Tighten screws no more than 0.25 Nm.
- Follow system grounding and wiring guidelines found in your SLC 500 Installation and Operation Manual.

Preparing and Wiring the Cables

To prepare and connect cable leads and drain wires, follow these steps:



1. At each end of the cable, strip some casing to expose individual wires.
2. Trim signal wires to 5-inch lengths beyond the cable casing. Strip about 4.76 mm (0.1875 in.) of insulation to expose the ends of the wires.
3. At the module-end of the cables:
 - extract the drain wire and signal wires
 - remove the foil shield
 - bundle the input cables with a cable strap
4. Connect the following pairs of drain wires together.
 - Channels 0 and 1
 - Channels 2 and 3
 - Channels 4 and 5
 - Channels 6 and 7

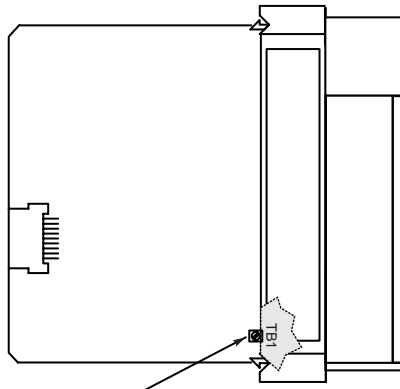
Keep drain wires as short as possible.

5. Connect the drain wires to the shield inputs of the terminal block if appropriate for thermocouple used. See “Wiring Guidelines” on page 10 for more information.
 - Channel 0 and 1 drain wires to pin 5
 - Channel 2 and 3 drain wires to pin 10
 - Channel 4 and 5 drain wires to pin 15
 - Channel 6 and 7 drain wires to pin 20
6. Connect the signal wires of each channel to the terminal block.

IMPORTANT

Only after verifying that your connections are correct for each channel, trim the lengths to keep them short. Avoid cutting leads too short.

7. Connect TB1 chassis ground connector to the nearest chassis mounting bolt with 14 gauge wire. (On the face of the module, TB1 is near the lower part of the terminal block on the primary side of the PCB.)



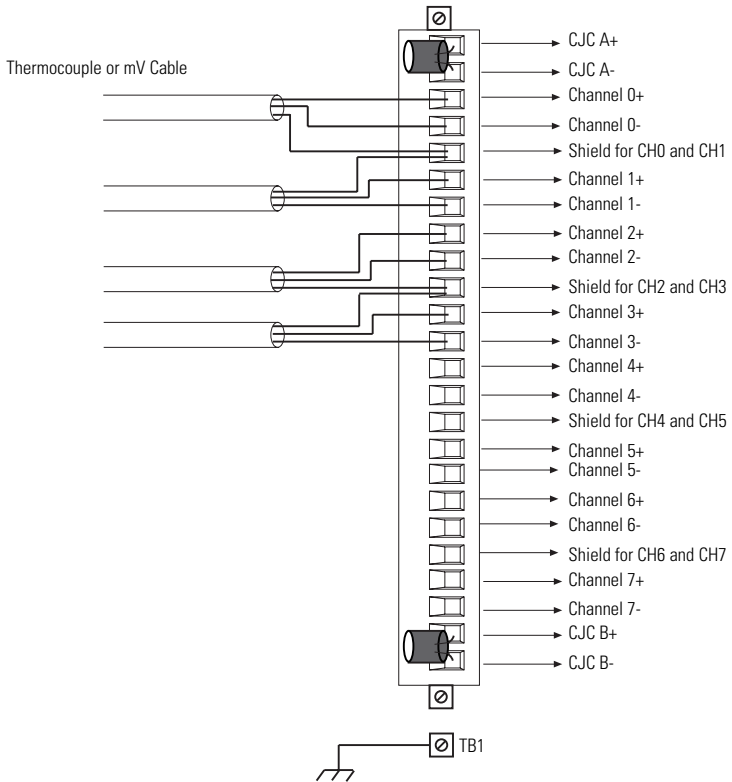
Connect ground wire to TB1 before installing module.

8. At the sensor-end of cables from thermocouple/mV devices:
 - remove the drain wire and foil shield
 - apply shrink wrap as an option
 - connect to thermocouple/mV devices keeping the leads short

IMPORTANT

If noise persists, try grounding the opposite end of the cable instead. (Ground one end only.)

Terminal Block Diagram with Input Cable



Module Specifications

Electrical Specifications

Backplane Current Consumption	120 mA at 5V dc, 70 mA at 24V dc
Backplane Power Consumption	2.28W maximum (0.5W at 5V dc, 1.68W at 24V dc)
Number of Channels	8 (backplane and channel-to-channel isolated)
I/O Chassis Location	Any I/O module slot except 0
A/D Conversion Method	Sigma-Delta Modulation
Input Filtering	Low pass digital filter with programmable notch (filter) frequencies
Normal Mode Rejection (between [+] input and [-] input)	Greater than 100 dB at 50/60 Hz
Common Mode Rejection (between input and ground)	Greater than 100 dB at 50/60 Hz
Input Filter Cut-Off Frequencies 2.6 Hz at 10 Hz filter frequency 13.1 Hz at 50 Hz filter frequency 15.72 Hz at 60 Hz filter frequency 65.5 Hz at 250 Hz filter frequency	Greater than 100 dB at 50/60 Hz
Calibration	Module auto-calibrates at power-up and approximately every two minutes thereafter
Input Over voltage Protection	$\pm 30V$ dc continuous, 600W pulsed for 1 msec.
Isolation	500V dc continuous between inputs and chassis ground, and between inputs and backplane. 12.5V dc continuous between channels.

Physical Specifications

LED Indicators	9 green status indicators, one for each of 8 channels and one for module status
Module ID Code	3533
Maximum Wire Size	One 14 AWG wire or two 22 AWG wires per terminal

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)
Certification	UL & CUL approved
Hazardous Environment Classification	Class I, Division 2 Hazardous Environment Groups A, B, C, D
EMC	CE compliant

Input Specifications

Type of Input (Selectable)	Thermocouple Type J	-210°C to +760°C	(-346°F to +1400°F)
	Thermocouple Type K	-270°C to +1370°C	(-454°F to +2498°F)
	Thermocouple Type T	-270°C to +400°C	(-454°F to +752°F)
	Thermocouple Type E	-270°C to +1000°C	(-454°F to +1832°F)
	Thermocouple Type R	0°C to +1768°C	(+32°F to +3214°F)
	Thermocouple Type S	0°C to +1768°C	(+32°F to +3214°F)
	Thermocouple Type B	+300°C to +1820°C	(+572°F to +3308°F)
	Thermocouple Type N	0°C to +1300°C	(+32°F to +2372°F)
	Millivolt (-50 mV dc to +50 mV dc)		
	Millivolt (-100 mV dc to +100 mV dc)		
Thermocouple Linearization	NIST ITS-90 standard		
Cold Junction Compensation	Accuracy $\pm 1.72^\circ\text{C}$, -25°C to +105°C Analog Devices AD592CN		
Input Impedance	Greater than 10M Ω		
Temperature Scale (Selectable)	°C or °F and 0.1°C or 0.1°F		
DC Millivolt Scale (Selectable)	0.1 mV or 0.01 mV		
Open Circuit Detection (Selectable)	Upscale, Downscale, Zero, or Disabled		
Time to Detect Open Circuit	One channel cycle time		
Input Step Response	0 to 95% in 400 msec (10 Hz)		
Display Resolution	See Channel Data Word Resolution table in Chapter 4 of the <i>SLC 500™ Thermocouple/mV Analog Input Module</i> manual, publication 1746-6.22.		
Overall Module Accuracy at 25°C (77°F)	See Module Accuracy Tables, in Appendix A of the <i>SLC 500™ Thermocouple/mV Analog Input Module</i> manual, publication 1746-6.22.		

Overall Module Accuracy (0°C to 60°C, 32°F to 140°F)	See Module Accuracy Tables, in Appendix A of the <i>SLC 500™ Thermocouple/mV Analog Input Module</i> manual, publication 1746-6.22.
Overall Module Drift	See Module Accuracy Tables, in Appendix A of the <i>SLC 500™ Thermocouple/mV Analog Input Module</i> manual, publication 1746-6.22.
Module Update Time	Dependent upon enabled channels (see Update Time, in the <i>SLC 500™ Thermocouple/mV Analog Input Module</i> manual, publication 1746-6.22)
Channel Turn-Off Time	Up to one module update time

For More Information

For	Refer to this Document	Pub. No.
A more detailed description on how to install and use your SLC 500™ Thermocouple/mV Input Module	SLC 500™ Thermocouple/mV Analog Input Module User Manual	1746-6.22
A more detailed description on how to install and use your SLC 500™ Modular Hardware Style Control System.	SLC 500™ Modular Hardware Style Installation and Operation Manual	1747-6.2
More information on proper wiring and grounding techniques.	Automation Wiring and Grounding Guidelines	1770-4.1

How to Get More Information

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