Allen-Bradley

CompactBlock LDX RTD/Resistance Input Module

1790D-4R0, 1790D-T4R0, 1790P-T4R0

User Manual

Rockwell Automation

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of these products 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. In no event will Allen-Bradley be responsible or liable for indirect or consequential damage resulting from the use or application of these products.

Any illustrations, charts, sample programs, and layout examples shown in this publication 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.

Throughout this publication, notes may be used to make you aware of safety considerations. The following annotations and their accompanying statements help you to identify a potential hazard, avoid a potential hazard, and recognize the consequences of a potential hazard:

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

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

Rockwell Automation Support

Before you contact Rockwell Automation for technical assistance, we suggest you please review the troubleshooting information contained in this publication first.

If the problem persists, call your local Rockwell Automation representative or contact Rockwell Automation in one of the following ways:

Phone	United States/Canada	1.440.646.5800
	Outside United States/Canada	You can access the phone number for your country via the Internet: 1. Go to http://www.ab.com 2. Click on *Product Support* (http://support.automation.rockwell.com) 3. Under *Support Centers*, click on *Contact Information*
Internet		1. Go to http://www.ab.com 2. Click on *Product Support* (http://support.automation.rockwell.com)

Your Questions or Comments on this Manual

If you find a problem with this manual, please notify us by using the enclosed How Are We Doing form.

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Overview

This chapter describes the four-channel 1790D-4R0/T4R0 RTD/resistance Input module and explains how the controller reads resistance temperature detector (RTD) or direct resistance-initiated analog input data from the module. Included is:

- a general description of hardware features
- an overview of module and system operation
- compatibility

General Description

The 1790D-4R0/T4R0 (1790P-T4R0) module supports RTD and direct resistance signal measurement applications that require up to four channels. The module digitally converts analog data and then stores the converted data in its image table.

The module supports connections from any combination of up to four input devices. Each channel is individually configurable via software for 2- or 3-wire RTD or direct resistance input devices. Channels are compatible with 4-wire sensors, but the fourth sense wire is not used. When configured for RTD inputs, the module can convert the RTD readings into linearized digital temperature readings in °C or °F. When configured for resistance analog inputs, the module can convert voltages into linearized resistance values in ohms. The module assumes that the direct resistance input signal is linear prior to input to the module.

Each channel provides open-circuit (all wires) and over- and under-range detection and indication.

IMPORTANT The module accepts input from RTDs with up to 3 wires. If your application requires a 4-wire RTD, one of the two lead compensation wires is not used, and the RTD is treated like a 3-wire sensor. The third wire provides lead wire compensation. See Chapter 2, *Installation and Wiring*, for more information.

The module supports the following filter frequencies:

- 10 Hz
- 25 Hz
- 50 Hz
- 60 Hz
- 100 Hz
- 250 Hz
- 500 Hz

The module uses five input words for data and status bits. Module configuration is stored in the module memory. Configuration for 1790D-(T)4R0 is done via RSNetWorx for DeviceNet™ programming software. See Chapter 3, *Module Data, Status, and Channel Configuration,* for details on module configuration. Configuration for 1790P-T4R0 is done via PROFIBUS configuration software. See Appendix C for details.

RTD Compatibility

An RTD consists of a temperature-sensing element connected by two, three, or four wires that provide input to the module. The following table lists the RTD types that you can use with the module, including their temperature range, effective resolution, and accuracy.

Table 1.1 RTD Specifications

RTD Type	Temperature Range	Scaling (Counts)	Resolution*	Accuracy** (0 to 55°C)
100ohm Pt/α=0.00385	-200 to +850°C	-2000 to +8500	0.1°C	±2.1°C
200ohm Pt/α=0.00385	-200 to +850°C	-2000 to +8500	0.1°C	±2.1°C
500ohm Pt/α=0.00385	-200 to +650°C	-2000 to +6500	0.1°C	±1.7°C
100ohm Pt/α=0.003916	-200 to +640°C	-2000 to +6400	0.1°C	±1.68°C
200ohm Pt/α=0.003916	-200 to +640°C	-2000 to +6400	0.1°C	±1.68°C
500ohm Pt/α=0.003916	-200 to +640°C	-2000 to +6400	0.1°C	±1.68°C
100ohm Nickel	-60 to 250°C	-600 to 2500°C	0.1 °C	±0.62°C
120ohm Nickel	-80 to 260°C	-800 to 2600	0.1°C	±0.68°C
200ohm Nickel	-60C to 250°C	-600 to 2500	0.1°C	±1.62°C
500ohm Nickel	-60 to 250°C	-600 to 2500	0.1°C	±0.62°C

*Filter set for 10 Hz_3

**Module only

Resister Device Compatibility

The following table lists the specifications for the resistance devices that you can use with the module.

Table 1.2 Resistance Device Specifications

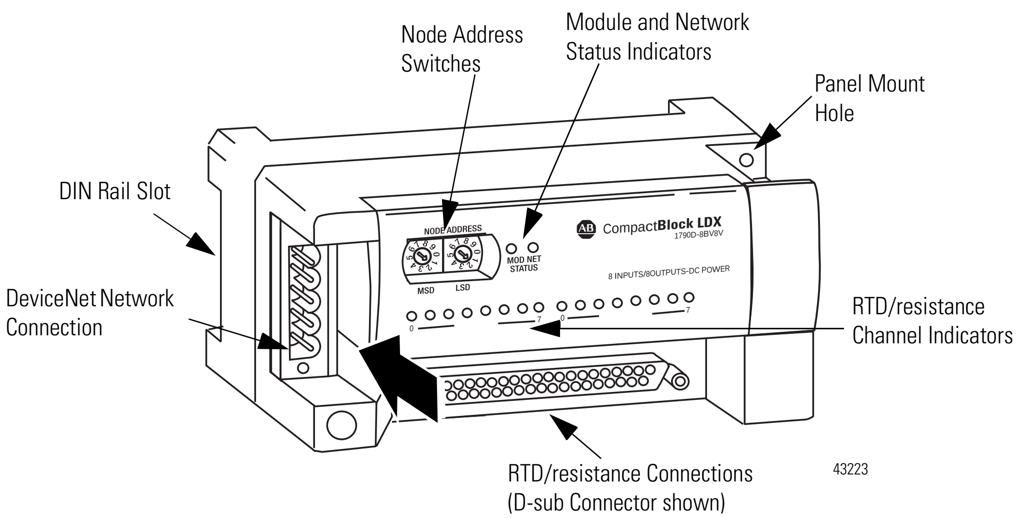
Resistance Type	Range	Scaling (Counts)	Resolution*	Accuracy (0 to 55°C)**
Resistance 100mΩ	1 to 650Ω	10 to 6250	100mΩ	±1.25Ω
Resistance 10mΩ	1 to 327Ω	100 to 32700	10Ω	±0.65Ω

*Filter set for 10 Hz
**Module only

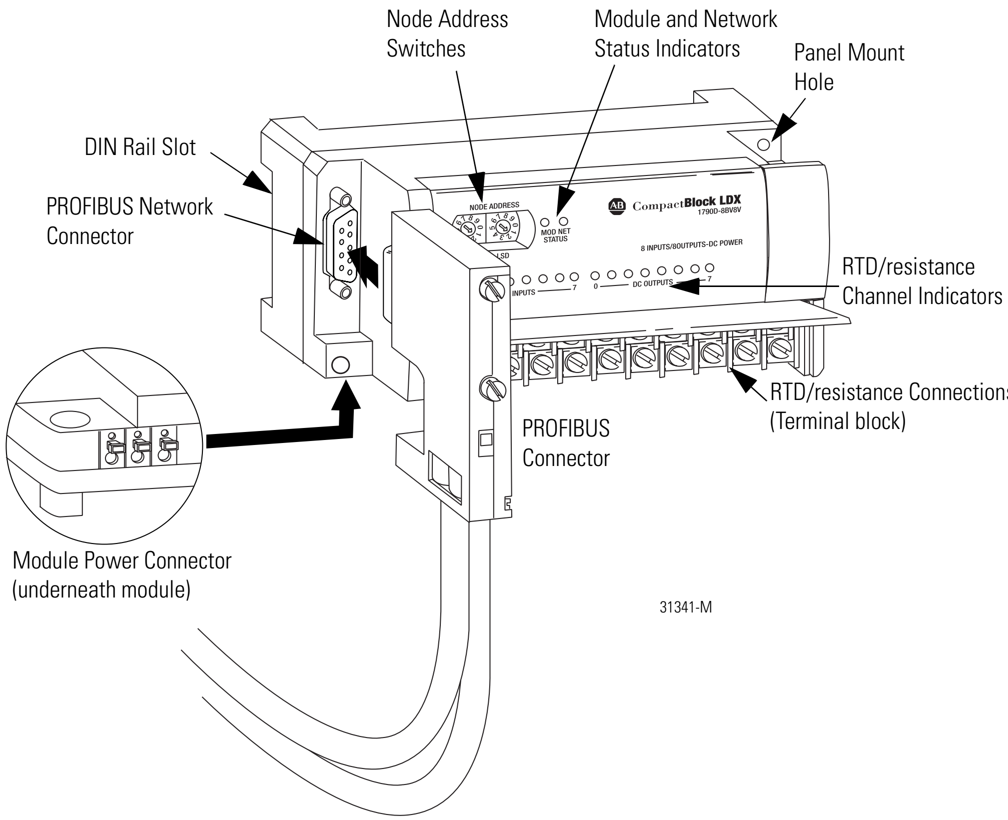
Hardware Features

The RTD/resistance module contains either a fixed terminal block (or a removable D-sub connector) providing connections for four 3-wire inputs for any combination of RTD and resistance input devices. Channels are wired as differential inputs. The illustration below shows the hardware features of the module.

1790D-4R0/T4R0 DeviceNet Module



1790P-T4R0 PROFIBUS DP Module



General Diagnostic Features

Module, network, and channel LEDs help you identify the source of problems that may occur during power-up or during normal channel operation. The LEDs indicate both status and power. See Chapter 4, *Diagnostics and Troubleshooting*, for details on power-up and channel diagnostics.

System Overview

The modules communicate to the controller or network scanner via the DeviceNet™ or PROFIBUS network. The modules also receive 24V dc power through DeviceNet. An external 24V dc auxiliary source is required to power the RTD/resistance channels.

System Operation

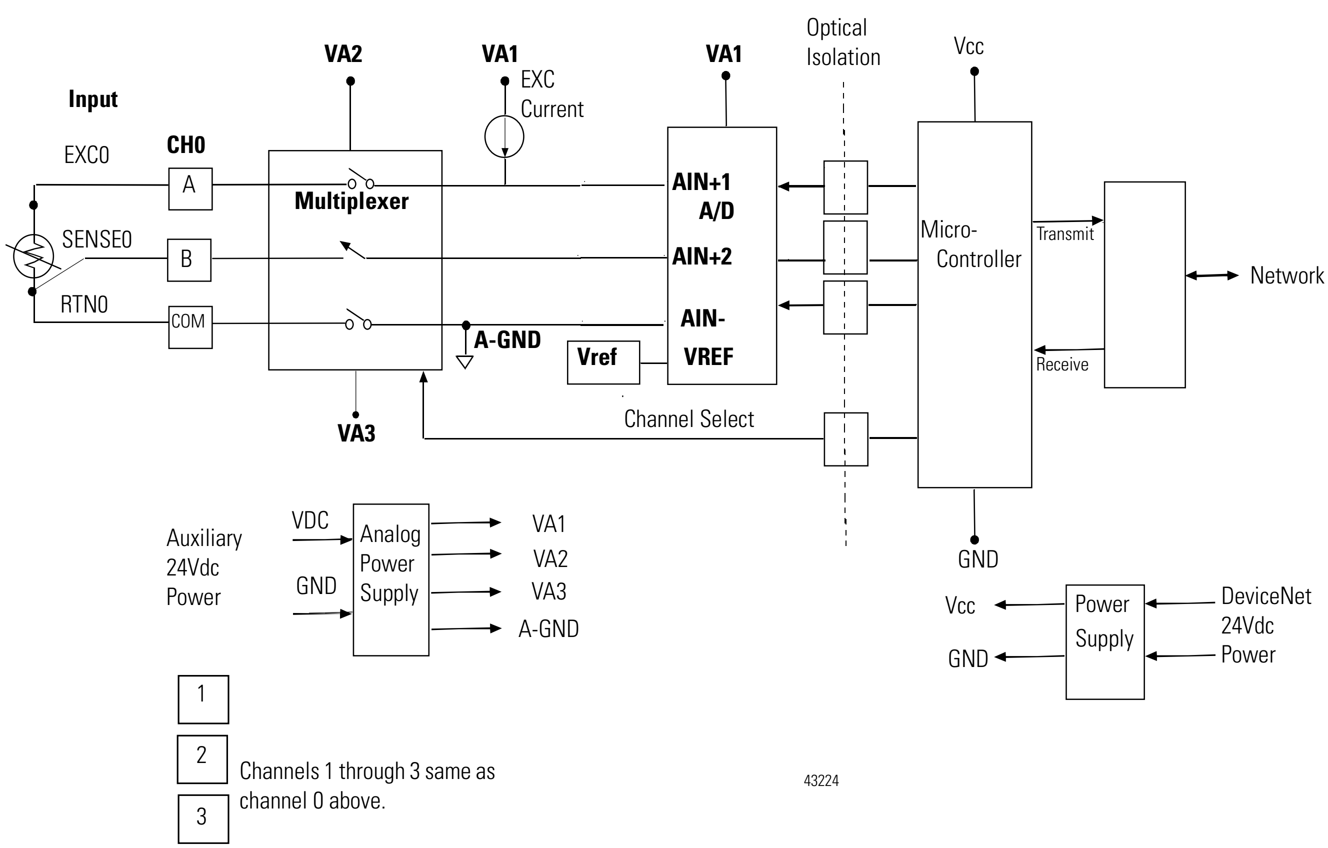
At power-up, the module performs a check of its internal circuits, memory, and basic functions. If no faults are found during power-up diagnostics, the module status LED is turned on (green).

Once a channel is properly configured and enabled, the module continuously converts the RTD or resistance input to a value within the range selected for that channel.

Each time the module reads an input channel, it tests the data for a fault (over- or under-range or open-circuit condition). If it detects a fault, the module sets a unique bit in the channel status word. See Input Data File on page 3-2. The module sends two's compliment binary converted RTD/ resistance data out over the network. See Appendix B for a description of two's compliment binary numbers.

Module Operation - DeviceNet Example

As shown in the block diagram below, each input channel of the module consists of an RTD/resistance connection that accepts excitation current; a sense connection that detects lead wire resistance; and a return connection. The signals are multiplexed to an A/D converter that reads the RTD or resistance value and the lead wire resistance.



From the readings taken by the converter, the module sends RTD or resistance data through the microcontroller to the DeviceNet network.

The PROFIBUS block diagram is similar.

Chapter Summary

In this chapter, you learned about the 1790D/4R0/T4R0 and 1790P-TR40 RTD/resistance modules. See Chapter 2 to learn how to install and wire the modules.

Installation and Wiring

Before You Begin

This chapter tells you how to:

- determine the power requirements for the modules
- avoid electrostatic damage
- install the module
- wire the module's terminal block

Power Requirements

1790D-4R0/T4R0

The module receives system power from the DeviceNet network. An auxiliary field supply provides power for the RTD/resistance channels.

Table 2.1 1790D-4R0/T4R0 Power Specifications

Power	Specification
DeviceNet	Supply voltage - 24V dc nominal Voltage range - 11-28.8V dc Power dissipation - 1.2W maximum @ 28.8V dc
Field	Supply voltage - 24V dc nominal Voltage range - 21.6-26.4V dc (±10%) Power dissipation - 1.5W maximum @ 26.4V dc

1790P-T4R0

The module requires external supplies for both system power and for the RTD/resistance channels.

Table 2.2 1790P-T4R0 Power Specifications

Power	Specification
PROFIBUS	Supply voltage - 24V dc nominal Voltage range - 19.2-28.8V dc Power dissipation - 2W maximum @ 28.8V dc
Field	Supply voltage - 24V dc nominal Voltage range - 21.6-26.4V dc (±10%) Power dissipation - 1.5W maximum @ 26.4V dc

General Considerations

The modules are suitable for use in a commercial or light industrial environment when installed in accordance with these instructions. Specifically, this equipment is intended for use in clean, dry environments (Pollution degree 2[1]) and to circuits not exceeding Over Voltage Category II[2] (IEC 60664-1).[3]

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.
- This product must be installed in an enclosure.
- All wiring must comply with N.E.C. article 501-4(b).

[1] Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation shall be expected.

[2] Over Voltage Category II is the load level section of the electrical distribution system. At this level transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.

[3] Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

Environment and Enclosure

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC publication 60664-1), at altitudes up to 2000 meters without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

ATTENTION

This equipment is supplied as "open type" equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as the Allen-Bradley publication 1770-4.1 ("Industrial Automation Wiring and Grounding Guidelines"), for additional installation requirements pertaining to this equipment.

Preventing Electrostatic Discharge

ATTENTION

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- If available, use a static-safe workstation.
- When not in use, store the equipment in appropriate static-safe packaging.

WARNING

If you insert or remove the module while power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Selecting a Location

Reducing Noise

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. RTD inputs are highly susceptible to electrical noise. Electrical noise coupled to the RTD inputs will reduce the performance (accuracy) of the module.

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

- away from sources of electrical noise such as hard-contact switches, relays, and AC motor drives
- away from modules which generate significant radiated heat.

In addition, route shielded, twisted-pair wiring away from any high voltage I/O wiring.

Protecting the Circuit Board from Contamination

The printed circuit boards of analog modules must be protected from dirt, oil, moisture, and other airborne contaminants. To protect these boards, the system must be installed in an enclosure suitable for the environment. The interior of the enclosure should be kept clean and the enclosure door should be kept closed whenever possible.

Installing CompactBlock LDX I/O

Follow these steps to install the block:

1. Set the node address on the base block.
2. Mount the base block.
3. Wire the terminal blocks.
4. Connect the network cable.

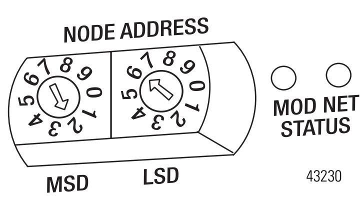
   These steps are explained in detail in the following procedures for both the 1790D-4R0/T4R0 DeviceNet and 1790P-T4R0 PROFIBUS DP modules.

Set the Node Address on the DeviceNet 1790D-4R0/T4R0 Base Block

Each base block comes with its internal program set for node address 63. To reset the node address, adjust the switches on the front of the block. The two switches are most significant digit (MSD) and least significant digit (LSD). The switches can be set between 00 and 63.

The rotary switches are read at block power up only. Switch settings between 64 and 99 cause the block to use the last valid node address stored internally.

Example: Node Address is set at 26



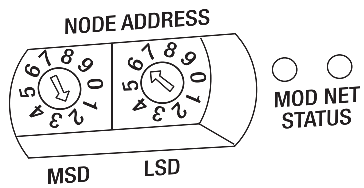
The node address may also be set through RSNetWorx for DeviceNet or a similar configuration tool. When software configuration is used for the node address, the switches must be set between 64 and 99.

Set the Station Address on the 1790P-T4R0 PROFIBUS DP Base Block

To set the station address, adjust the switches on the front of the base block. The two switches are most significant digit (MSD) and least significant digit (LSD). The switches can be set between 00 and 99.

The rotary switches are read at base block power up only.

Example: Node Address is set at 26



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Mounting

Mount the Base Block

You can mount the base block to a panel or DIN rail. We recommend that you ground the panel or DIN rail before mounting the block.

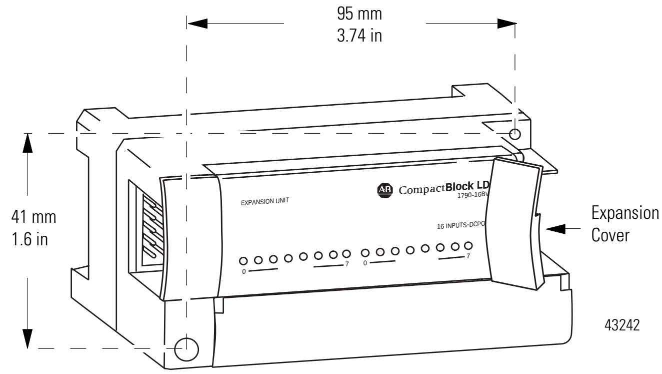
IMPORTANT The RTD and thermocouple base modules do not support any expansion blocks.

WARNING When used in a Class I, Division 2, hazardous location, this equipment must be mounted in a suitable enclosure with proper wiring method that complies with the governing electrical codes.

Panel Mounting

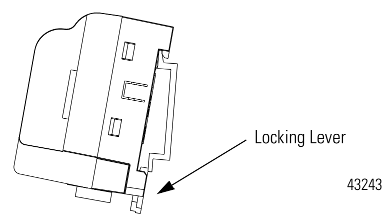
1. Place the block against the panel where you want to mount it.
2. Gently pull and position the expansion cover to the left.
3. Place a center punch, nail or similar device through the mounting holes in the block and make two marks on the panel (lower left and upper right corners of the module).
4. Remove the block and drill two holes in the panel to accommodate each of the mounting screws.

5. Replace the block on the panel and place a screw through each of the two mounting holes. Tighten the screws until the block is firmly in place.



DIN Rail Mounting

1. Hook the top slot of the block over the DIN Rail.
2. Pull down on the locking lever while pressing the block against the rail.



3. Push up on the locking lever to secure the block to the rail when the block is flush against the rail.

Connect the DeviceNet Cable to the 1790D-4R0/T4R0 Base Block

Follow these procedures when connecting the DeviceNet cable to the base block.

The required DeviceNet connector **is not supplied** with the block - you must purchase it separately. There are three types of connectors that you can order directly from Rockwell Automation or your local distributor:

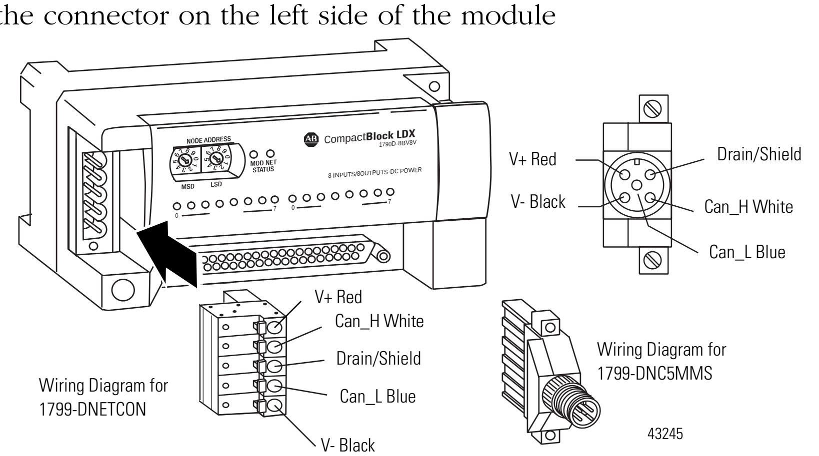
- 1799-DNETCON - 5-position open style connector
- 1799-DNETSCON - 5-position open style connector with locking screws
- 1799-DNC5MMS - 5-position open style to 5-pin micro male connector with locking screws

WARNING

If you connect or disconnect the DeviceNet cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Connect the DeviceNet wiring (drop line) to one of the DeviceNet connectors as shown below. A color-coded wiring diagram is also printed next to the connector on the left side of the module



Connect the PROFIBUS DP Terminal Connector to the 1790P-T4R0 Base Block

Follow these procedures to connect the PROFIBUS DP terminal connector to the base block.

WARNING

If you connect or disconnect the PROFIBUS cable with power applied to this module or any device on the network, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

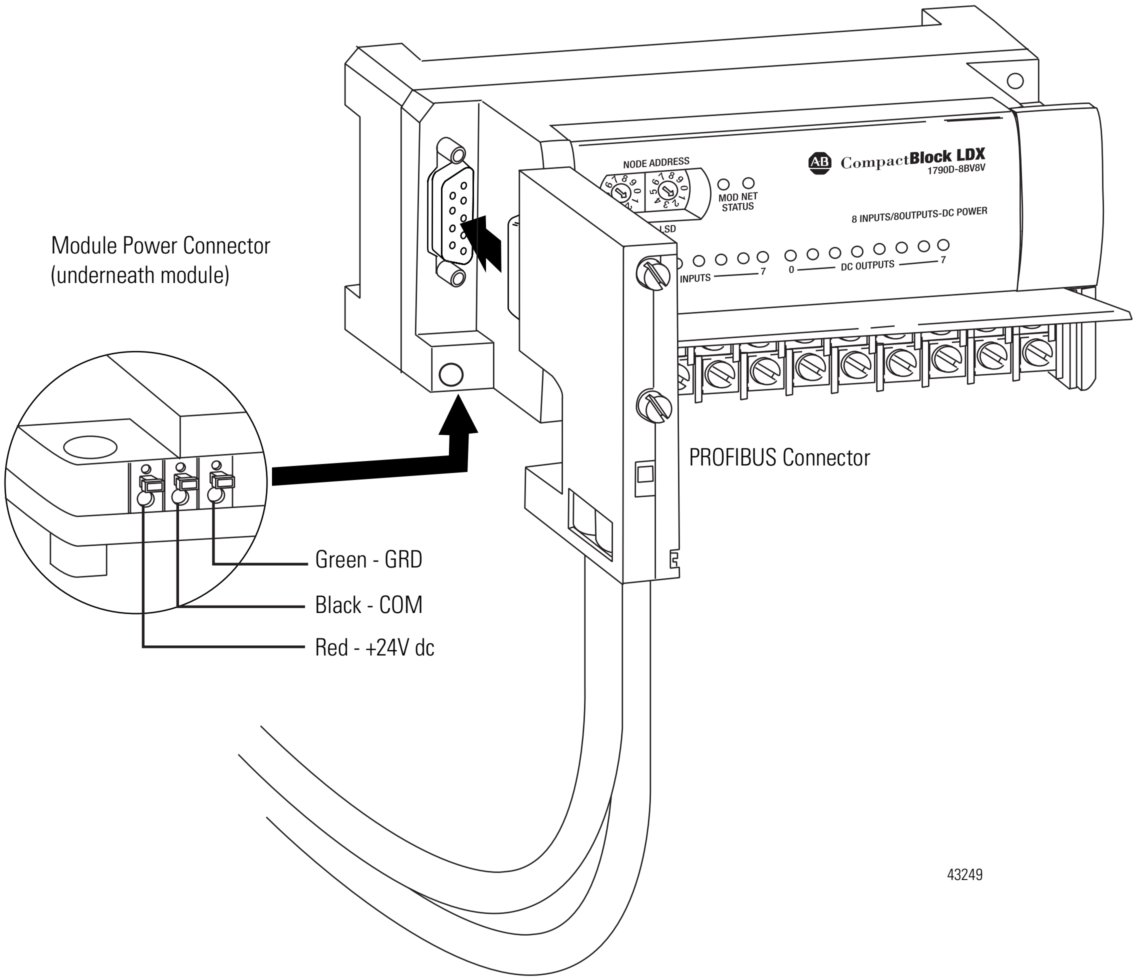
The required PROFIBUS female 9-pin D-sub connector **is not supplied** with the base block - you must purchase it separately.

Before you connect female 9-pin D-sub connector to the base block, make sure it is wired correctly as shown in the following table.

Table 2.3 Wiring Descriptions for 9-Pin D-Sub Connector

Pin Number:	Name:	Description:
1	shield	Shield, Protective Ground
2	M24V	Minus 24V Output Voltage
3	RxD/TxD-P	Receive/Transmit-Data-P
4	CNTR-P	Control-p
5	DGND	Data Ground
6	VP	Voltage-Plus
7	P24V	Plus 24V Output Voltage
8	RxD/TxD-N	Receive/Transmit-Data-N
9	CNTR-N	Control-N

Once you have properly wired the connector, attach it to the base block as shown below. Use the locking screws on the connector to fasten it to the base block.



Connect Power to the 1790P-T4R0 Block

To apply power to the block, refer to the above illustration.

Field Wiring Connections

System Wiring Guidelines

Consider the following when wiring your system:

General

- This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded.
- Route field wiring away from any other wiring and as far as possible from sources of electrical noise, such as motors, transformers, conductors, and ac devices. As a general rule, allow at least 15.2 cm (6 in.) of separation for every 120V of power.
- Routing field wiring in a grounded conduit can reduce electrical noise.
- If field wiring must cross ac or power cables, ensure that they cross at right angles.
- To ensure optimum accuracy, limit overall cable impedance by keeping your cable as short as possible. Locate the I/O system as close to your sensors or actuators as your application will permit.
- Tighten terminal screws with care. Excessive tightening can strip a screw.

Shield Grounding

- Use Belden shielded, twisted-pair wire to ensure proper operation and high immunity to electrical noise. Refer to the following table and the RTD Wiring Considerations below.

Table 2.4 Belden Shielded Wiring

Configuration	Recommended Cable(1)
2-wire	Belden™ 9501 or equivalent
3-wire less than 30.48 m (100ft.)	Belden 9533 or equivalent
3-wire greater than 30.48 m (100 ft.) or high humidity conditions	Belden 83503 or equivalent

(1) For additional information, see Table 2.5.

- Under normal conditions, the drain wire and shield junction should be connected to earth ground, via a panel or DIN rail mounting screw at the module end.
- Keep shield connection to ground as short as possible.
- If noise persists for a device, try grounding the opposite end of the cable. (You can only ground one end at a time.)
- Refer to *Industrial Automation Wiring and Grounding Guidelines*, Allen-Bradley publication 1770-4.1, for additional information.

RTD Wiring Considerations

Because the operating principle of the RTD module is based on the measurement of resistance, take special care when selecting your input cable. For 2-wire or 3-wire configurations, select a cable that has a consistent impedance throughout its entire length. Cable specifications are noted below.

Table 2.5 Cable Specifications

Description	Belden #9501	Belden #9533	Belden #83503
When used?	For 2-wire RTDs and potentiometers	For 3-wire RTDs and potentiometers. Short runs less than 100 feet and normal humidity levels.	For 3-wire RTDs and potentiometers. Long runs greater than 100 feet or high humidity levels.
Conductors	2, #24 AWG tinned copper (7 x 32)	3, #24 AWG tinned copper (7 x 32)	3, #24 AWG tinned copper (7 x 32)
Shield	Beldfoil aluminum polyester shield with copper drain wire	Beldfoil aluminum polyester shield with copper drain wire	Beldfoil aluminum polyester shield with tinned drain wire
Insulation	PVC	S-R PVC	Teflon
Jacket	Chrome PVC	Chrome PVC	Red Teflon
Agency Approvals	NEC Type CM	NEC Type CM	NEC Art-800, Type CMP
Temperature Rating	80°C	80°C	200°C

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 two-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). The module's terminal block accepts two AWG #14 gauge wires.

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.

To insure that the lead values match as closely as possible:

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

Wire Size and Terminal Screw Torque

Each terminal accepts up to two wires with the following restrictions:

Table 2.6 Wire Size and Terminal Screw Torque

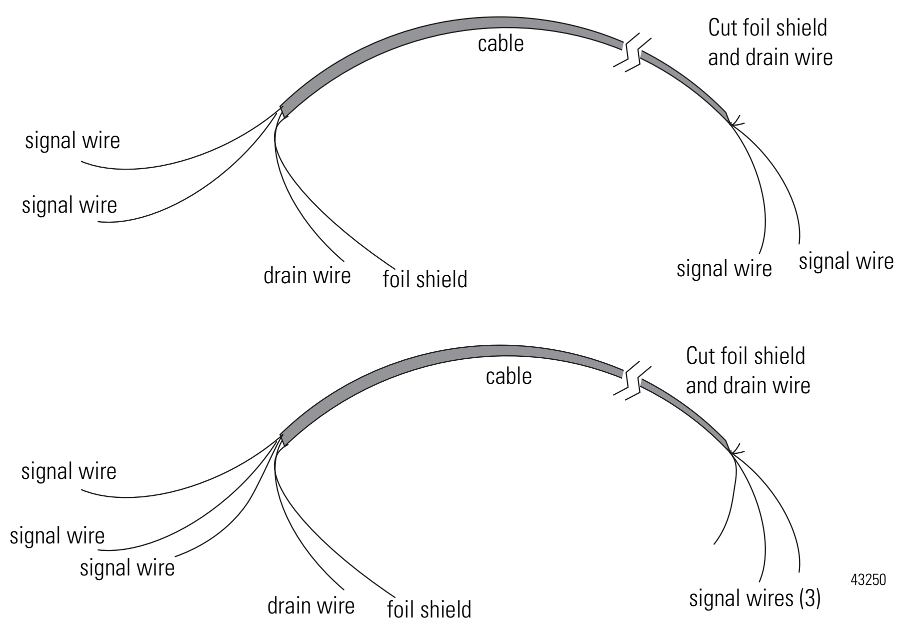
Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90°C (194°F)	#14 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)
Stranded	Cu-90°C (194°F)	#16 to #22 AWG	0.68 Nm (6 in-lbs)	0.46 Nm (4.1 in-lbs)

Wiring the Modules

ATTENTION

To prevent shock hazard, care should be taken when wiring the module to analog signal sources. Before wiring any module, disconnect power from the system power supply and from any other source to the module.

After the module is properly installed, follow the wiring procedure below and the RTD and potentiometer wiring diagrams on pages 2-15 through 2-16. To ensure proper operation and high immunity to electrical noise, always use Belden shielded, twisted-pair or equivalent wire.



To wire your 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 2-inch (5 cm) lengths. Strip about 3/16 inch (5 mm) of insulation away to expose the end of the wire.

ATTENTION

Be careful when stripping wires. Wire fragments that fall into a module could cause damage at power up.

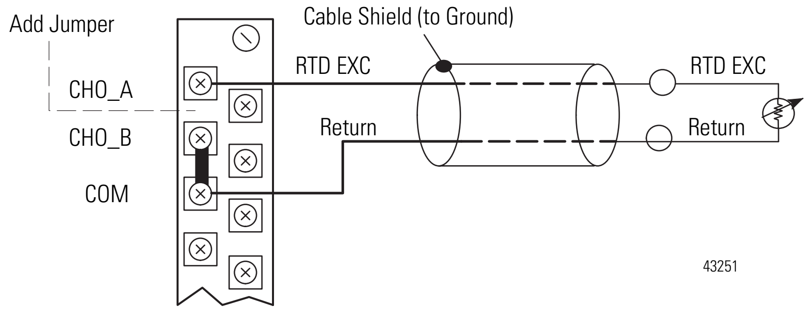
3. At the module end of the cable, twist the drain wire and foil shield together, bend them away from the cable, and apply shrink wrap. Then earth ground via a panel or DIN rail mounting screw at the end of the module. Keep the length of the drain wire as short at possible.
4. At the other end of the cable, cut the drain wire and foil shield back to the cable and apply shrink wrap.
5. Connect the signal wires to the terminal block as described for each type of input. See Wiring RTDs below or Wiring Resistance Devices (Potentiometers) on page 2-15.
6. Connect the other end of the cable to the analog input device.
7. Repeat steps 1 through 6 for each channel on the module.

Wiring RTDs

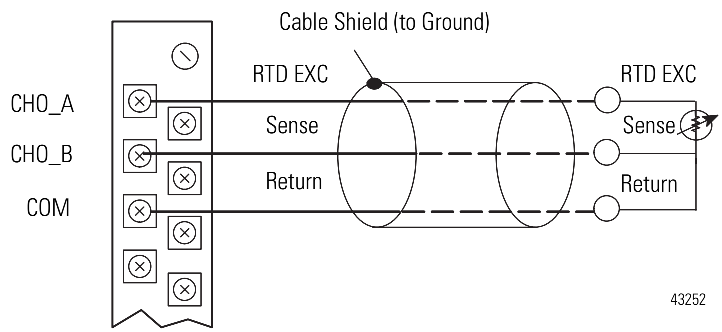
Three types of RTDs can be connected to the module:

- 2-wire RTD, which is composed of an RTD EXC (excitation) lead wire and a RTN (return) lead wire.
- 3-wire RTD, which is composed of a Sense and 2 RTD lead wires (RTD EXC and RTN).
- 4-wire RTD, which is composed of a Sense and 2 RTD lead wires (RTD EXC and RTN). The second sense wire from the 4-wire RTD is left open.

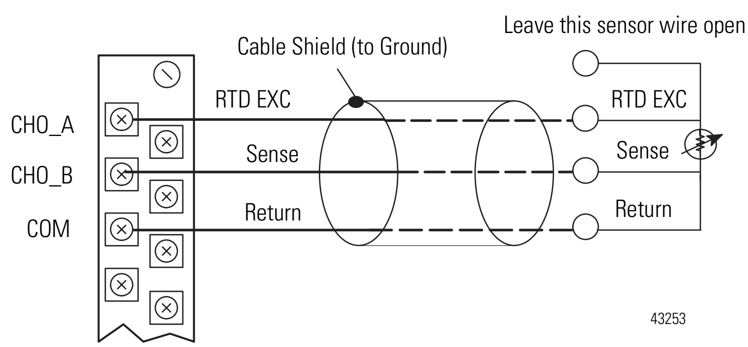
2-Wire RTD Configuration



3-Wire RTD Configuration



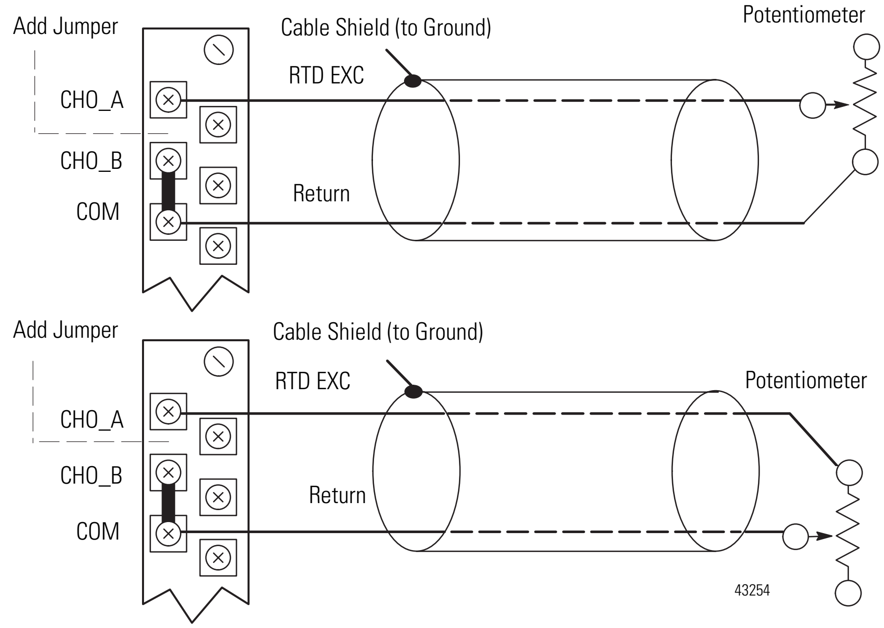
4-Wire RTD Configuration



Wiring Resistance Devices (Potentiometers)

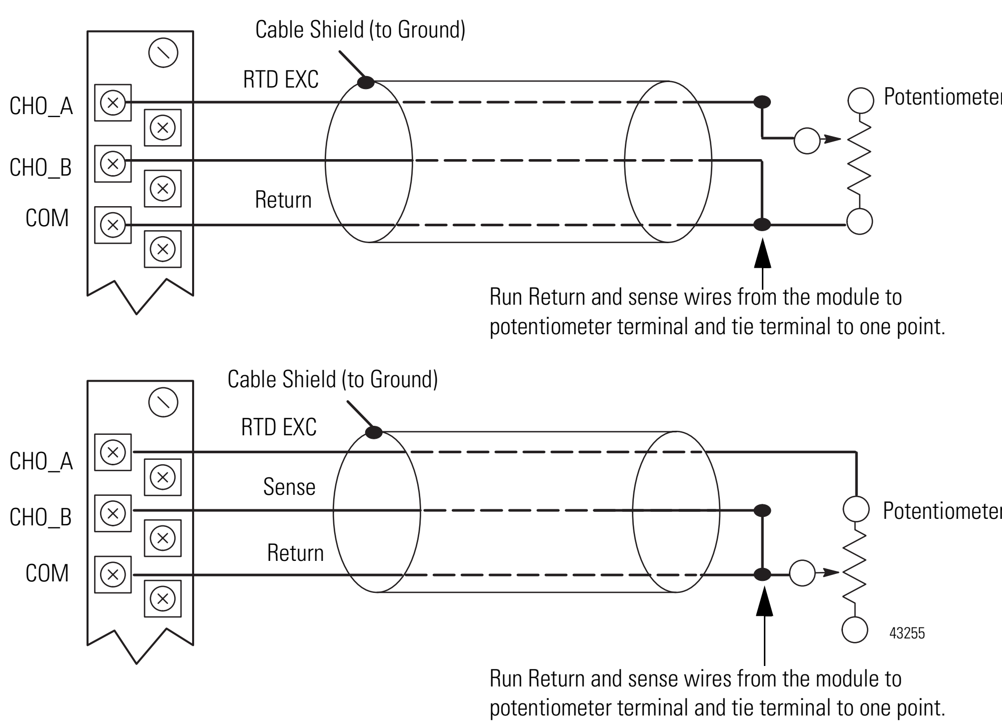
Potentiometer wiring requires the same type of cable as that for the RTDs. Potentiometers can be connected to the module as a 2-wire or 3-wire connection as shown in the following figure.

2-Wire Potentiometer Interconnection



TIP	The potentiometer wiper arm can be connected to either the EXC or return terminal depending on whether you want increasing or decreasing resistance.

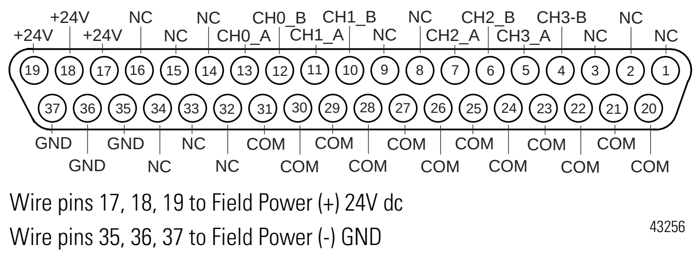
3-Wire Potentiometer Interconnection



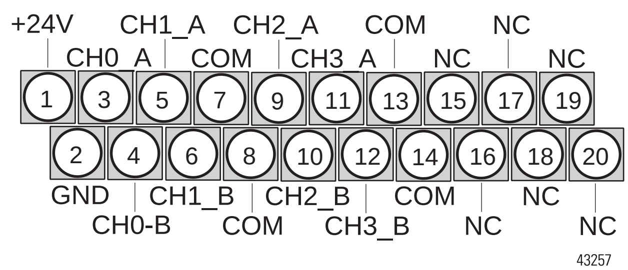
Wiring the Terminal Blocks

The following figures show how to wire the terminal blocks.

1790D-4R0-RTD Input Module D-Shell Wiring



1790D-T4R0 and 179P-T4R0 RTD Input Module D-Shell Wiring



Chapter Summary

In this chapter, you learned how to install and wire your modules. See Chapter 3 to learn about module data, status, and channel configuration with DeviceNet.

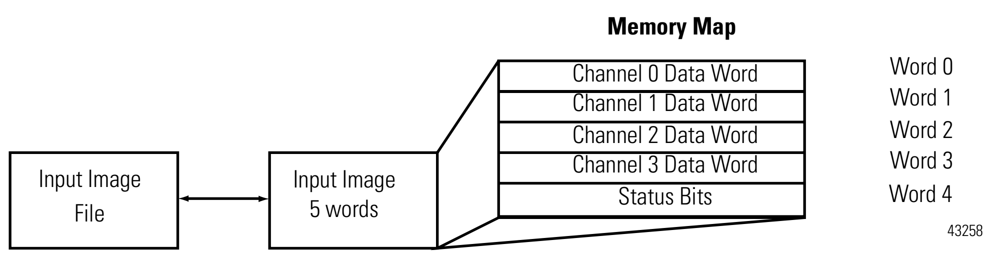
Module Data, Status, and Channel Configuration for DeviceNet

After installation of the RTD/resistance input module, you must configure it for operation, usually using the programming software compatible with the controller (for example, RSLogix 500™ or RSLogix 5000™) or scanner (RSNetWorx for DeviceNet). Once configuration is complete and reflected in ladder logic, you will need to get the module up and running and then verify its operation. This chapter includes information on the following:

- module memory map
- accessing input image file data
- configuring channels
- running the module

Module Memory Map

The module uses five input words for data and status bits (input image).



Input Image

The input image file represents data words and status words. Input words 0 through 3 hold the input data that represents the value of the analog inputs for channels 0 through 3. These data words are valid only when the channel is enabled and there are no errors. Input word 4 holds status bits.

Accessing Input Image File Data

Five words of the processor input image table are reserved for the module's image data. You can access the information in the input image file using the programming software configuration screen.

Input Data File

The input data table lets you access RTD input module read data for use in the control program, via word and bit access. The data table structure is shown in the tables below.

Table 3.1 Input Data Table

Word/ Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	RTD Input Data Channel 0															
1	RTD Input Data Channel 1															
2	RTD Input Data Channel 2															
3	RTD Input Data Channel 3															
4	Not Used				S11	S10	S9	S8	Not Used				S3	S2	S1	S0

Table 3.2 Input Data Table

Word	Decimal Bit	Description
Read Word 0	Bits 00-15	Channel 0 input data
Read Word 1	Bits 00-15	Channel 1 input data
Read Word 2	Bits 00-15	Channel 2 input data
Read Word 3	Bits 00-15	Channel 3 input data
Read Word 4	Bits 00-03	Underrange for individual channels - Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1 and so on.
		When set (1), the input signal is below the input channel's minimum range.
	Bits 04-07	Not used: Set to 0
	Bits 08-11	Overrange for individual channels - Bit 08 corresponds to input channel 0, bit 09 corresponds to input channel 1 and so on.
		When set (1), the input signal is above the input channel's maximum range, or open RTD is detected.
	Bit 12-15	Not used: Set to 0.

Input Data Values

Data words 0 through 3 correspond to channels 0 through 3 and contain the converted analog input data from the input device.

Under-Range Flag Bits (S0 to S3)

Over-range bits for channels 0 through 3 are contained in word 4, bits 0-3. When set (1), the under-range flag bit indicates an RTD temperature that is less than the minimum allowed temperature. The module automatically resets (0) the bit when the data value is again within the normal operating range.

Over-Range Flag Bits (S8 to S11)

Under-range bits for channels 0 through 3 are contained in word 4, bits 8-11. When set (1), the over-range flag bit indicates an RTD temperature that is greater than the maximum allowed temperature, a resistance input that is greater than the maximum allowed resistance for the module or an open channel is detected. The module automatically resets (0) the bit when the data value is again within the normal operating range.

Data Format

RTD/resistance data is presented in engineering units x1. The engineering units data format represents real temperature or resistance data provided by the module. RTD data is reported in either degrees C or degrees F.

Table 3.3 RTD Data Format

RTD Input Type	Range	Data Format Engineering Units x1 0.1°C	Data Format Engineering Units x1 0.1°F
100Ω Platinum 385	-200 to +850°C	-2000 to +8500	-3280 to +15620
200Ω Platinum 385	-200 to +850°C	-2000 to +8500	-3280 to +15620
500Ω Platinum 385	-200 to +650°C	-2000 to +6500	-3280 to +12020
100Ω Platinum 3916	-200 to +640°C	-2000 to +6400	-3280 to +1184
200Ω Platinum 3916	-200 to +640°C	-2000 to +6400	-3280 to +1184
500Ω Platinum 3916	-200 to +640°C	-2000 to +6400	-3280 to +1184
100Ω Nickel	-60 to +250°C	-600 to +2500	-760 to +4820
120Ω Nickel	-80 to +260°C	-800 to +2600	-1120 to +5000
200 Nickel	-60C to 250°C	-600 to +2500	-760 to +4820
500 Nickel	-60 to 250°C	-600 to +2500	-760 to +4820

Table 3.4 Resistance Data Format

Resistance Input	Range	Data Format Engineering Units x1
Resistance 100mΩ	1 to 625Ω	10 to 6250
Resistance 10mΩ	1 to 327Ω	100 to 32700

The module scales input data to the actual temperature values for the selected RTD type per RTD standard. It expresses temperatures in 0.1 degree units, either degrees C or degrees F, depending on which temperature scale is selected. For resistance inputs, the module expresses resistance in 0.1Ω units for the 100mΩ scale and in 0.01Ω units for the 10mΩ scale.

Negative temperatures are returned in 16-bit two's complement binary format. See Appendix B for a detailed explanation of two's complement binary numbers.

Filter Frequency

The module supports filter selections corresponding to filter frequencies of 10Hz, 25Hz, 50 Hz, 60 Hz, 100 Hz, 250 Hz, and 500 Hz. Your filter frequency selection is determined by the desired range for the input type, and the required effective resolution, which indicates the number of bits in the input data that do not vary due to noise. Also consider the required module update time when choosing a filter frequency. For example, the 10 Hz filter provides the greatest attenuation of 50 and 60 Hz noise and the greatest resolution, but also provides the slowest response speed.

The choice that you make for filter frequency will affect:

- noise rejection characteristics for module input
- channel step response
- channel cutoff frequency
- effective resolution
- module update time

Effects of Filter Frequency on Noise Rejection

The filter frequency that you choose for the module determines the amount of noise rejection for the inputs. A smaller filter frequency (e.g. 10Hz) provides the best noise rejection and increases effective resolution, but also increases channel update time. A larger filter frequency (e.g. 500 Hz) provides lower noise rejection, but also decreases the channel update time and effective resolution.

When selecting a filter frequency, be sure to consider channel cutoff frequency and channel step response to obtain acceptable noise rejection. Choose a filter frequency so that your fastest-changing signal is below that of the filter's cutoff frequency.

Common mode noise rejection for the module is better than 110 dB at 50 Hz (50 Hz filter) and 60 Hz (60 Hz filter). The module performs well in the presence of common mode noise. Improper earth ground can be a source of common mode noise.

NOTE Transducer power supply noise, transducer circuit noise, and process variable irregularities can also be sources of common mode noise.

Channel Step Response

Another module characteristic determined by filter frequency is channel step response, as shown in the following table. The step response is the time required for the analog input signal to reach 100 percent of its expected final value, given a full-scale step change in the input signal. Thus, if an input signal changes faster than the channel step response, a portion of that signal will be attenuated by the channel filter. The channel step response is calculated by a settling time of 3 x (1 / filter frequency).

Table 3.5 Filter Frequency vs. Channel Step Response

Filter Frequency	Step Response
10 Hz	300 ms
25 Hz	120 ms
50 Hz	60 ms
60 Hz	50 ms
100 Hz	30 ms
250 Hz	12 ms
500 Hz	6 ms

Channel Cutoff Frequency

The channel cutoff frequency (-3 dB) is the point on the input channel frequency response curve where frequency components of the input signal are passed with 3 dB of attenuation. The following table shows cutoff frequencies for the supported filters.

Table 3.6 Filter Frequency vs. Channel Cutoff Frequency

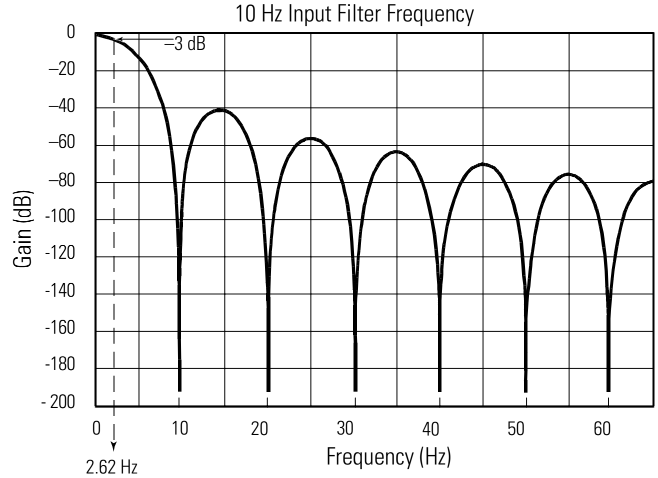
Filter Frequency	Channel Cutoff Frequency
10 Hz	2.62 Hz
25 Hz	6.55 Hz
50 Hz	13.1 Hz
60 Hz	15.7 Hz
100 Hz	26.2 Hz
250 Hz	65.5 Hz
500 Hz	131 Hz

All frequency components at or below the cutoff frequency are passed by the digital filter with less than 3 dB of attenuation. All frequency components above the cutoff frequency are increasingly attenuated, as shown in the graphs below for several of the input filter frequencies.

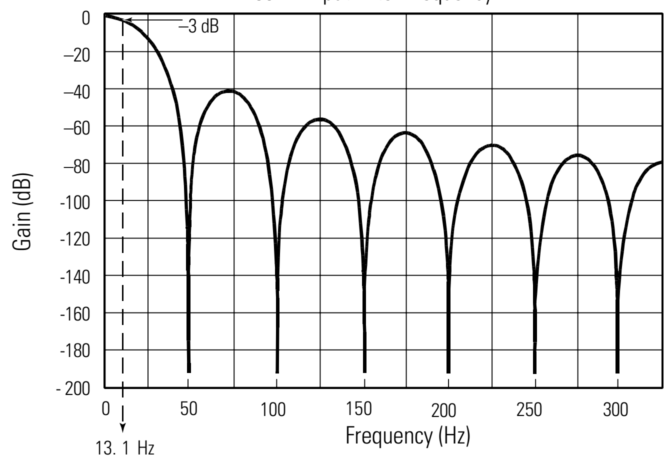
NOTE Channel cutoff frequency should not be confused with channel update time. The cutoff frequency simply determines how the digital filter attenuates frequency components of the input signal.

Frequency Response Graphs

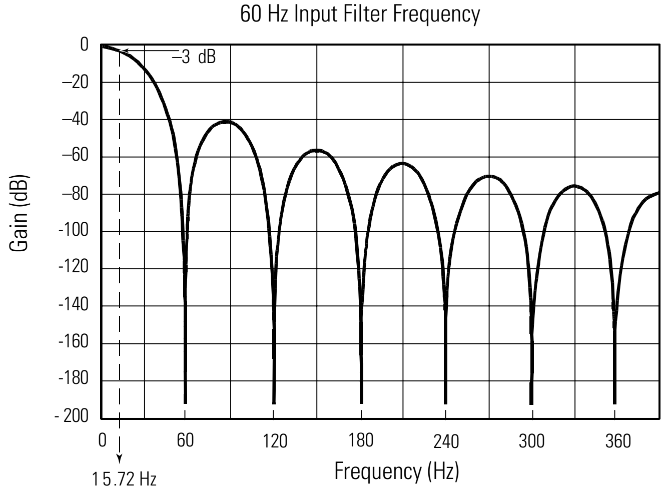
10 Hz Input Filter Frequency



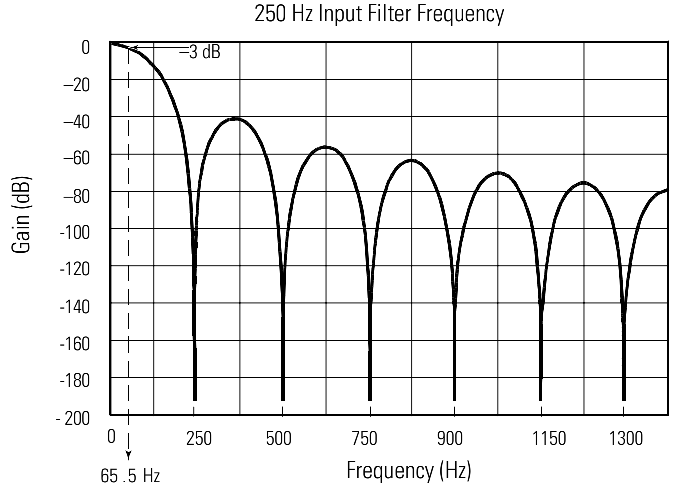
50 Hz Input Filter Frequency



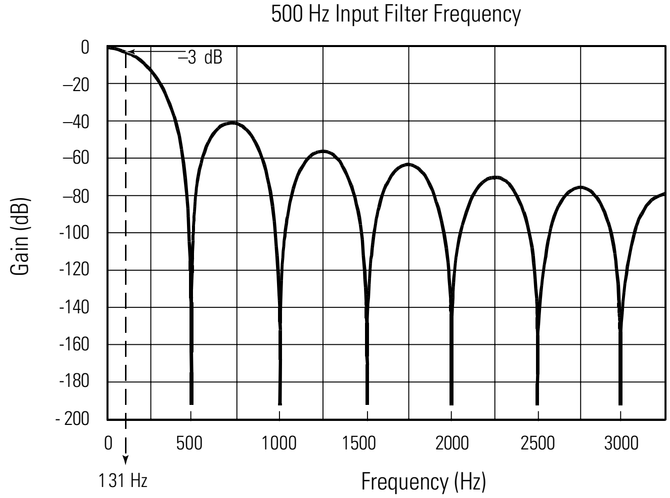
60 Hz Input Filter Frequency



250 Hz Input Filter Frequency



500 Hz Input Filter Frequency



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Effective Resolution

The table below identifies the number of significant bits used to represent the input data for each available filter frequency. The number of significant bits is defined as the number of bits that will have little or no jitter due to noise, and is used in defining the effective resolution.

Table 3.7 Input Effective Resolution Versus Input Filter Selection

Input Type	Range	10 Hz	25 Hz	50/60 Hz	100 Hz	250 Hz	500 Hz
100 ohm Pt α=385	-200/850°C	Sign + 14 bits 0.1°C	Sign + 14 bits 0.1°C	Sign + 14 bits 0.1°C	Sign + 14 bits 0.1°C	Sign + 13 bits 0.2°C	Sign + 11 bits 0.5°C
200 ohm Pt α=385	-200/850°C	Sign + 14 bits 0.1°C	Sign + 14 bits 0.1°C	Sign + 14 bits 0.1°C	Sign + 14 bits 0.1°C	Sign + 13 bits 0.2°C	Sign + 11 bits 0.5°C
500 ohm Pt α=385	-200/650°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 11 bits 0.4°C
100 ohm Pt α=3916	-200/640°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 11 bits 0.4°C
200 ohm Pt α=3916	-200/640°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 11 bits 0.4°C
500 ohm Pt α=3916	-200/640°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 13 bits 0.1°C	Sign + 11 bits 0.4°C
100 ohm Nickel	-60/250°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 11 bits 0.2°C
120 ohm Nickel	-80/260°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 11 bits 0.2°C
200 ohm Nickel	-60/250°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 11 bits 0.2°C
500 ohm Nickel	-60/250°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 12 bits 0.1°C	Sign + 11 bits 0.2°C
Resistance 100mΩ	1/625 Ω	Sign + 13 bits 0.1Ω	Sign + 13 bits 0.1Ω	Sign + 13 bits 0.1Ω	Sign + 13 bits 0.1Ω	Sign + 13 bits 0.1Ω	Sign + 13 bits 0.4Ω
Resistance 100mΩ	1/327 Ω	Sign + 15 bits 0.1Ω	Sign + 15 bits 0.1Ω	Sign + 15 bits 0.1Ω	Sign + 15 bits 0.1Ω	Sign + 13 bits 0.04Ω	Sign + 11 bits 0.2Ω

Determining Module Update Time

The module update time is defined as the time required for the module to sample and convert the input signals. The module sequentially samples the channels in a continuous loop. Module update time is dependent on the number of input channels and the input filter selection.

The fastest update time occurs with the 500Hz filter enabled. The following table shows update times for all filter frequencies.

Table 3.8 Module Update Time

Filter Frequency	Module Update Time
10 Hz	2.2 seconds
25 Hz	840 milliseconds
50 Hz	420 milliseconds
60 Hz	348 milliseconds
100 Hz	224 milliseconds
250 Hz	88 milliseconds
500 Hz	48 milliseconds

DeviceNet RTD/ Resistance Module (1790D-4R0/T4R0)

Configuring 1790D-4R0/T4R0 RTD/resistance modules is as easy as pointing and clicking. RSNetWorx™ lets you simply identify the network and configure the I/O modules with easy-to-use Electronic Data Sheets (EDS) files - just point to the field and click on your selection.

To obtain the EDS files you need to configure the modules, go to the following website: **http:/www.ab.com/networks/eds**.

EDS files for blocks with matching catalog numbers (for D-Shell and terminal block versions) are the same. Thus, on the website or in RSNetWorx for DeviceNet, there may be only one catalog number listed for both versions.

When using 3rd party configuration software, simply load the EDS files into the software and follow the vendor's instructions.

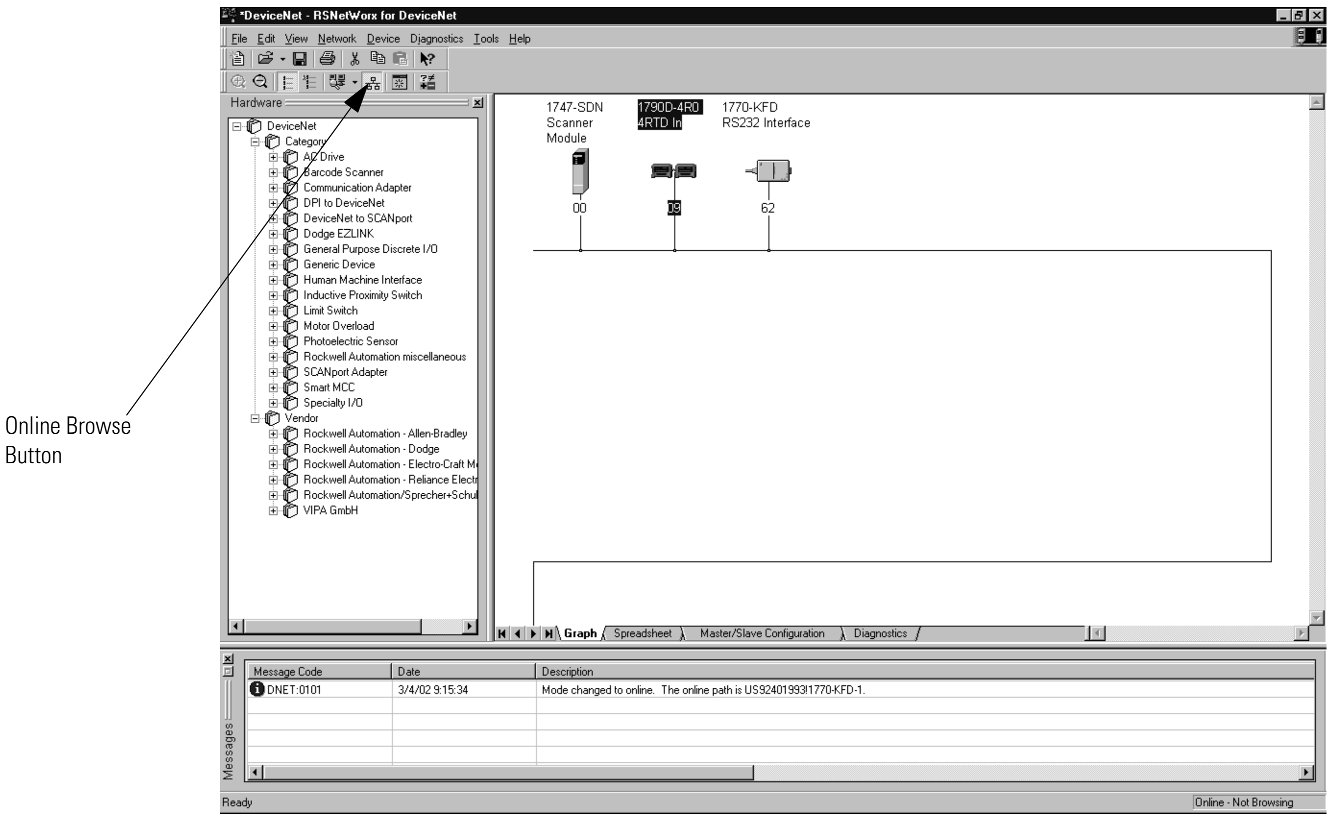
The following example takes you through configuring your RTD/ resistance module with RSNetWorx for DeviceNet, version 3.00 or later.

NOTE Refer to Appendix C to configure the 1790P-T4R0 PROFIBUS module.

Configure DeviceNet RTD/Resistance Modules Using RSNetWorx

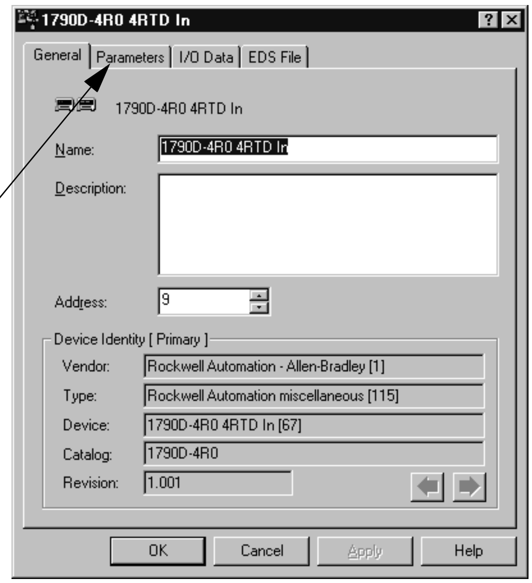
Following the steps below to configure 1790D-4R0/T4R0 RTD/resistance modules.

1. Open RSNetWorx for DeviceNet.
2. Using the selections on the left of the window below, construct you system. (If your network is up, just click on the Online Browse button.)



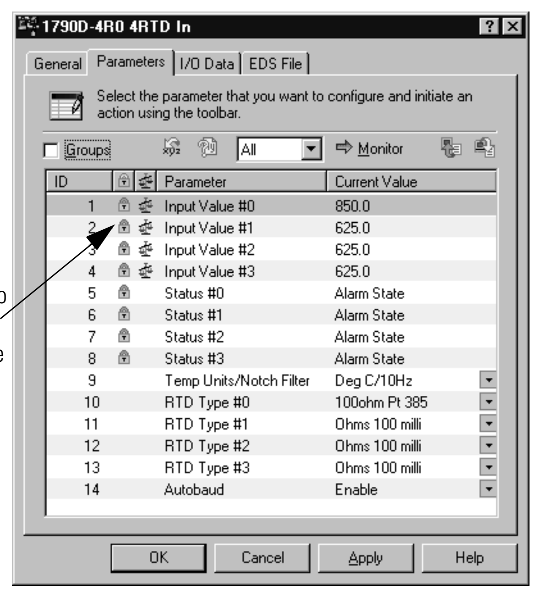
3. After setting up your system, double-click on the module you want to configure. (If you are online, upload the configuration and existing parameters from the module display.) A window similar to the following appears.

Click the device **Parameters** tab to display the screen in which you can set parameters.



RTD/resistance modules will have parameters similar to the following.

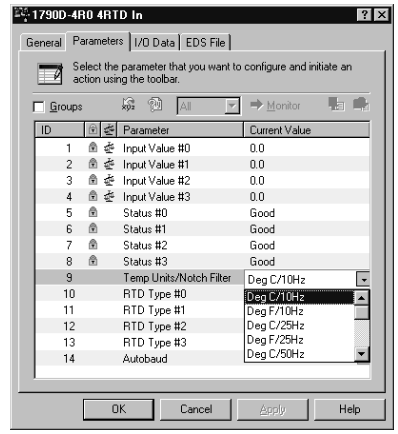
If you see a lock next to an entry, this indicates that you cannot change that parameter.



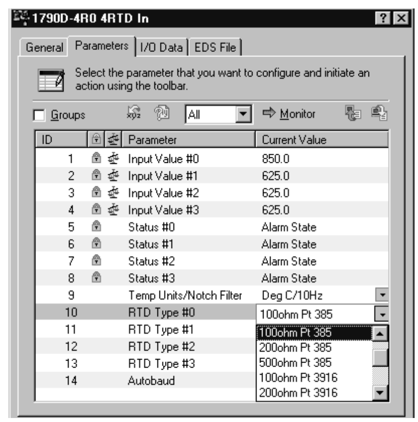
On this screen, you see all the parameters for the module. These include Autobaud, RTD Input value, combined temperature units/filter frequency, module status and Input RTD/resistance type.

Module configuration parameters include Temperature Units/Notch Filter frequency, RTD/resistance Input type and Autobaud.

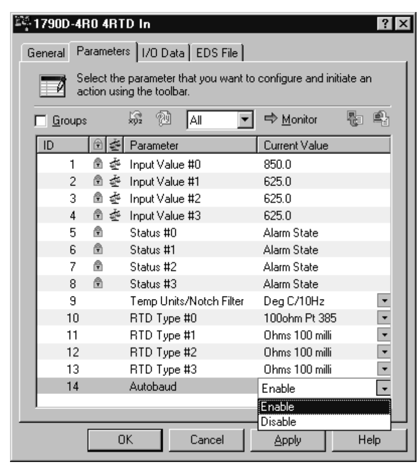
Select the desired temperature units (in degrees C or F) and notch filter frequency. ALL four channels will be configured identically.

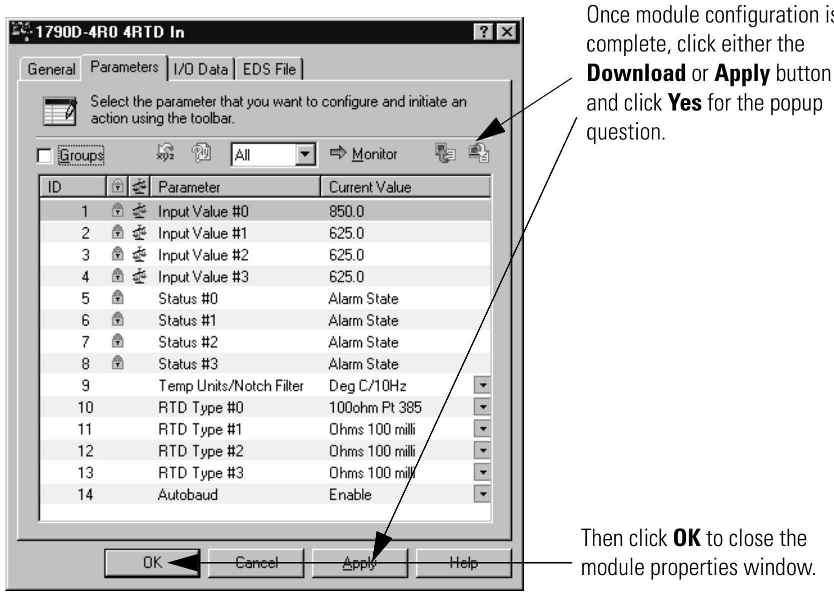


Select the RTD/ resistance input type for each channel from the dropdown list.



Select to have Autobaud either Enabled or Disabled.





RTD/resistance module parameters may be monitored real time. The most convenient way to monitor module parameters is to:

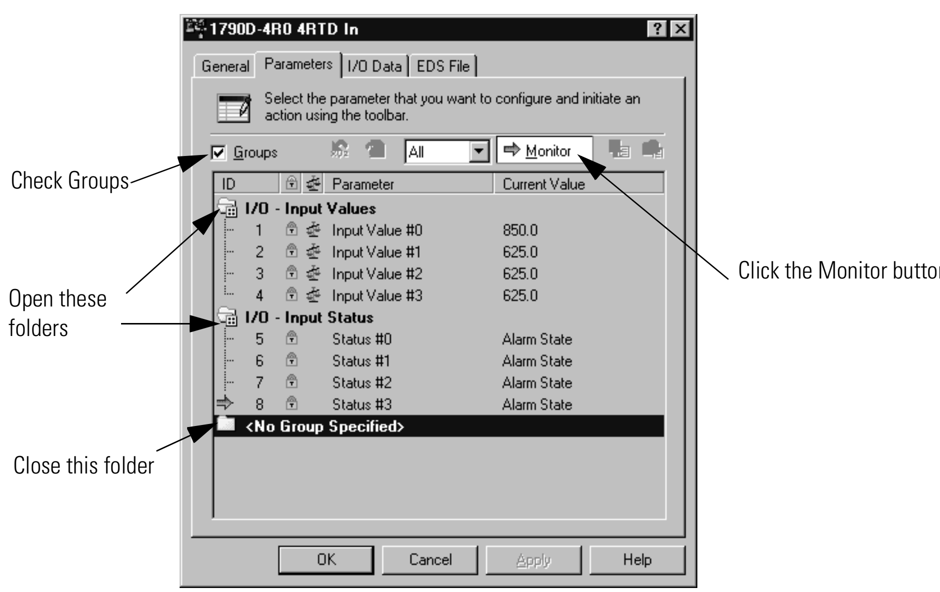
a. Click the Groups checkbox.

b. Close the No Group Specified folder

c. Open the I/O Input Values and I/O Input Status folders.

d. Click the Monitor button.

The module parameters are sequentially updated.



Chapter Summary

In this chapter, you learned how to setup and configure your module. See Chapter 4 to learn how to troubleshoot using the module indicators.

Diagnostics and Troubleshooting

This chapter describes module troubleshooting, containing information on:

- safety considerations when troubleshooting
- module vs. channel operation
- the module's diagnostic features
- critical vs. non-critical errors
- module condition data
- contacting Rockwell Automation for assistance

Safety Considerations

Safety considerations are an important element of proper troubleshooting procedures. Actively thinking about the safety of yourself and others, as well as the condition of your equipment, is of primary importance.

The following sections describe several safety concerns you should be aware of when troubleshooting your control system.

ATTENTION

Never reach into a machine to actuate a switch because unexpected motion can occur and cause injury.

Remove all electrical power at the main power disconnect switches before checking electrical connections or inputs/outputs causing machine motion.

Indicator Lights

When the green MOD and NET LED on the thermocouple module are illuminated, it indicates that power is applied to the module, that it has passed its internal tests and that the module is communicating on the network.

Activating Devices When Troubleshooting

When troubleshooting, never reach into the machine to actuate a device. Unexpected machine motion could occur.

Stand Clear of the Equipment

When troubleshooting any system problem, have all personnel remain clear of the equipment. The problem could be intermittent, and sudden unexpected machine motion could occur. Have someone ready to operate an emergency stop switch in case it becomes necessary to shut off power.

Program Alteration

There are several possible causes of alteration to the user program, including extreme environmental conditions, Electromagnetic Interference (EMI), improper grounding, improper wiring connections, and unauthorized tampering. If you suspect a program has been altered, check it against a previously saved master program.

Safety Circuits

Circuits installed on the machine for safety reasons, like over-travel limit switches, stop push buttons, and interlocks, should always be hard-wired to the master control relay. These devices must be wired in series so that when any one device opens, the master control relay is de-energized, thereby removing power to the machine. Never alter these circuits to defeat their function. Serious injury or machine damage could result.

Module Operation vs. Channel Operation

The module performs diagnostic operations at both the module level and the channel level. Module-level operations include functions such as power-up, configuration, and communication with a controller.

Channel-level operations describe channel related functions, such as data conversion and over- or under-range detection.

Internal diagnostics are performed at both levels of operation. When detected, module error conditions are indicated by the module status LED. Channel over-range or under-range conditions are reported in the module's input data table.

Power-up Diagnostics

Power-up diagnostics includes module status and network status.

Module Status

At module power-up, a series of internal diagnostic tests are performed. These diagnostic tests must be successfully completed. The following table shows module status LED indictor operation.

Table 4.1 Module Status Power-up Diagnostics

1790D-4R0/T4R0, 1790P-T4R0		
LED Indicator:	**Status:**	**Description:**
Module Status	Solid Red	Unrecoverable fault
	Flashing Red	Recoverable fault
	Solid Green	Normal operation - OK
	Flashing Green	Standby
	Off	No power

Network Status

The network status LED indicator shows the condition of the network connection. The following tables show network status LED indicator operation.

Table 4.2 Network Status Power-up Diagnostics for 1790D-4R0/T4R0)

1790D-4R0/T4R0		
LED Indicator:	**Status:**	**Description:**
Network Status	Solid Red	Unrecoverable communication fault
	Flashing Red	Recoverable communication fault
	Solid Green	Communication path complete - OK
	Flashing Green	Communication path incomplete
	Off	Device not online or not powered

Table 4.3 Network Status Power-up Diagnostics for the 1790P-T4R0

1790P-4R0		
LED Indicator:	**Status:**	**Description:**
Network Status	Solid Green	Communication path complete - OK
	Flashing Green	Communication path incomplete
	Off	No power or baud rate search

Channel Diagnostics

When an input channel is enabled, the module performs a diagnostic check to see that the channel has been properly configured. In addition, the channel is tested on every scan for configuration errors, over-range and under-range, and broken input conditions.

Non-critical module errors are typically recoverable. Channel errors (over-range or under-range errors) are non-critical. Non-critical error conditions are indicated in the module input data table.

Out-of-Range Detection

When the input signal data received at the channel word is out of the defined operating range, an over-range or under-range error is indicated in input data word 4.

Possible causes for an out-of-range condition include:

- The temperature is too hot or too cold for the RTD being used.
- The wrong RTD is being used for the input type selected, or for the configuration that you have programmed.
- The input device is faulty.
- The signal input from the input device is beyond the scaling range.

Open-Wire Detection

The module performs an open-circuit input test on all channels on each scan. Whenever an open-circuit condition occurs, the overrange input bit for that channel is set in input data word 4.

Possible causes of a broken input condition include:

- the input device is broken
- a wire is loose or cut
- the input device is not installed on the configured channel
- an RTD is internally shorted
- an RTD is not installed correctly

Module Error Definition Table

RTD/resistance module errors are expressed on a channel basis in input read word 4. The structure of the status data is shown in the following table.

Table 4.4 Word Bit Position

Word	Bit Description															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
4	Not Used				S11	S10	S9	S8	Not Used				S3	S2	S1	S0

Table 4.5 Word/Bit Description

Word	Decimal Bit	Description
Read Word 4	Bits 00-03	Underrange for individual channels. Bit 00 corresponds to input channel 0, bit 01 corresponds to input channel 1 and so on. When set (1), the input signal is below the input channel's minimum range
	Bits 04-07	Not used: Set to 0
	Bit 08-11	Overrange for individual channels. Bit 08 corresponds to input channel 0, bit 09 corresponds to input channel 1 and so on. When set (1), the input signal is above the input channel's maximum range, or open RTD is detected
	Bit 12-15	Not used: Set to 0

Channel LED Indicator Operation

Individual channel LED indicator operation is shown in the following table.

Table 4.6 Individual Channel LEDs Indicator

I/O Channel LED Status Indicator	
Status:	**Description**
Flashing Green/Red	Power up
Off	Off line
Red	On line and no field power
Red	DeviceNet connection and no field power
Flashing Red	Field power and open wire
Green	Field power and valid input
Flashing Red	Input over range, open input
Flashing Red	Input under range
Flashing Red	Recoverable fault

Contacting Rockwell Automation

If you need to contact Rockwell Automation for assistance, please have the following information available when you call:

- a clear statement of the problem, including a description of what the system is actually doing. Note the LED state; also note input and output image words for the module.
- a list of remedies you have already tried
- processor type and firmware number (See the label on the processor)
- hardware types in the system, including all I/O modules
- fault code if the processor is faulted

Chapter Summary

In this chapter, you learned how to perform diagnostic and troubleshooting on the 1790D/4R0/T4R0 and 1790P-TR40 RTD/resistance modules. See the appendixes for module specifications, binary number information, and module configuration for PROFIBUS.

Specifications

Environmental Specifications

Environmental Specifications	
Operating Temperature	0 to 55°C (32 to 131°F) IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)
Storage Temperature	-40 to 85°C (-40 to 185°F) IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock)
Relative Humidity	5-90% non-condensing IEC 60068-2-30 (Test Db, Un-packaged Non-operating)
Operating Altitude	2000m
Vibration	I2g @ 10-500Hz EC60068-2-6 (Test Fc, Operating)
Shock: Operating Non-operating	I0g 30g IEC60068-2-27 Test Ea, (Unpackaged Shock)
Emissions	Group 1, Class A CISPR 11
ESD Immunity	8kV air discharges IEC 61000-4-2
Radiated RF Immunity	10V/m with 1kHz sine-wave 80%AM from 80MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM @ 900Mhz IEC 61000-4-3
EFT/B Immunity	±1kV @ 5kHz on power ports +2kV @ 5kHz on signal ports ±2kV @ 5kHz on communications ports IEC 61000-4-4
Surge Transient Immunity	±1kV line-line(DM) and ±2kV line-earth(CM) on power ports ±1kV line-line(DM) and ±2kV line-earth(CM) on signal ports ±2kV line-earth(CM) on shielded ports IEC 61000-4-5
Conducted RF Immunity	10Vrms with 1kHz sine-wave 80%AM from 150kHzto 80MHz IEC 61000-4-6
Enclosure Type Rating	None (open style)
Mounting	DIN rail or screw
Dimensions	52 x 104 x 42mm (2.03 x 4.07 x 1.64in)
Weight	0.3lb (0.1kg)

DeviceNet Specifications

Specification	Value
Network protocol	I/O Slave messaging: - Poll command - Bit Strobe command - Cyclic command - COS command
Network length	500 meters maximum @ 125Kbps 100 meters maximum @ 500Kbps
Indicators	1 red/green module status 1 red/green network status
Number of nodes	64 maximum - rotary switch type node address setting
Communication rate	125Kbps, 250Kbps, 500Kbps - auto baud rate selection
Isolation	Type test 1250Vac rms for 60 seconds between field power and DeviceNet (I/O to logic)
Wiring	Refer to publication DN-6.7.2

PROFIBUS DP Specifications

PROFIBUS DP Specifications	
Network Protocol	PROFIBUS-DP (EN50170) Communication of the slave with a Class 1 master Communication of the slave with a Class 2 master
Redundancy	Not supported
Repeater Control Signal	RS485 signal
Implementation Type	DPC31
Freeze Mode	Supported
Sync Mode	Supported
Auto Baud Rate	Supported
Fail Safe Mode	Supported
Station Type	Slave
FMS Support	Not supported
Indicators	1 red/green module status 1 red/green network status
Number of nodes	100 maximum - rotary switch type node address setting (0-99)
Network Length/ Communication rate	9.6Kbps @ 1000m (3280ft) 19.2Kbps @ 1000m (3280ft) 45.45Kbps @ 1000m (3280 ft) 93.75Kbps @ 1000m (3280ft) 187.5Kbps @ 1000m (3280ft) 500Kbps @ 400m (1312ft) 1.5mbps @ 200m (656ft) 3mbps @ 100m (328ft) 6mbps @ 100m (328ft) 12mbps @ 100m (328ft)
Isolation	Type test 1250Vac rms for 60 seconds between field power and PROFIBUS (I/O to logic)

General Specifications

General Specifications		
Wiring Category	2[1]	
Product Certifications (when product or packaging is marked)	c-UL-us	UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada
	CE[2]	European Union 89/336/EEC EMC Directive, compliant with: EN 50081-2; Industrial Emissions EN 50082-2; Industrial Immunity EN61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity
	C-Tick[2]	Australian Radiocommunications Act, compliant with: AS/NZS 2064; Industrial Emissions
	ODVA	ODVA conformance tested to ODVA DeviceNet specifications
DeviceNet Power	Supply voltage - 24V dc nominal Voltage range - 11-28.8V dc Power dissipation - 1.2W maximum @ 28.8V dc	
PROFIBUS Power	Supply voltage - 24V dc nominal Voltage range - 19.2-28.8V dc Power dissipation - 2W maximum @ 28.8V dc	
Field Power	Supply Voltage - 24Vdc nominal Voltage Range - 21.6-26.4V dc (±10%) Power Dissipation - 1.5W maximum @ 26.4V dc	
Isolation	I/O to logic: photocoupler isolation Isolation voltage: Type Test 1250V ac rms for 60 seconds DeviceNet to logic: non-isolated Field power: non-isolated	
Indicators	4 red/green I/O status	
Wiring		
1790D-4R0	37-pin D-Shell connector	
1790D-T4R0	Terminal block connector screw torque: 7 inch pounds maximum	

[1] Refer to publication 1770-4.1, *Programmable Controller Wiring and Grounding Guidelines.*

[2] See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates and other certification details.

IMPORTANT This module does not support any expansion modules.

RTD/Resistance Specifications

RTD/resistance Specifications				
Inputs per module	4 channel, RTD/Resistance Input			
Input Range	1-625			
Sensors Supported	Sensor Type	Degree	Counts	Resolution
	Resistance 100mΩ	1 to 625Ω	10 to 6250	100mΩ
	Resistance 10mΩ	1 to 327Ω	100 to 32700	10mΩ
	100ohm Pt/α =0.00385	-200 to +850°C	-2000 to +8500	0.1°C
	200ohm Pt/α =0.00385	-200 to +850°C	-2000 to +8500	0.1°C
	500ohm Pt/α =0.00385	-200 to +650°C	-2000 to +6500	0.1°C
	100ohm Pt/α =0.003916	-200 to +640°C	-2000 to +6400	0.1°C
	200ohm Pt/α =0.003916	-200 to +640°C	-2000 to +6400	0.1°C
	500ohm Pt/α =0.003916	-200 to +640°C	-2000 to +6400	0.1°C
	100ohm Nickel	-60 to 250°C	-600 to 2500	0.1°C
	120ohm Nickel	-80 to 260°C	-800 to 2600	0.1°C
	200ohm Nickel	-60 to 250°C	-600 to 2500	0.1°C
	500ohm Nickel	-60 to 250°C	-600 to 2500	0.1°C
Resolution	16 bits across 625ohms, 0.1°C/bit or 0.1°F/bit (RTD Sensors) 20bit Sigma-Delta modulation converter			
Data Format	16 bit Integer (2's compliment)			
Module Scan Time	8ms/channel @ Notch Filter = 60Hz			
Overall accuracy	0.2% Full scale @ 0°C-55°C			
Settable Notch Filter	10Hz (default), 25Hz, 50Hz, 60Hz, 100Hz, 250Hz, 500Hz			
Open Wire Detection	Out of range, open wiring			
Excitation Current	1mA			
Input Impedance	5M ohm			

Two's Complement Binary Numbers

The processor memory stores 16-bit binary numbers. Two's complement binary is used when performing mathematical calculations internal to the processor. Analog input values from the RTD/resistance module are returned to the processor in 16-bit two's complement binary format. For positive numbers, the binary notation and two's complement binary notation are identical.

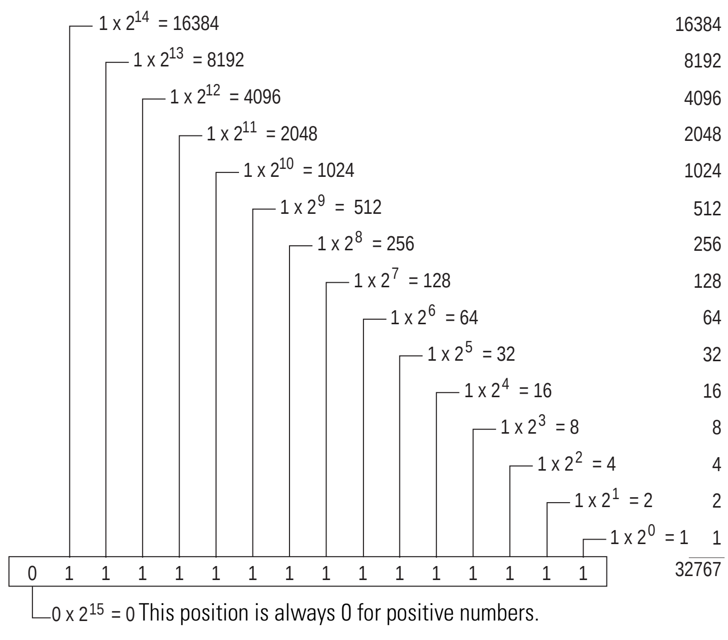
As indicated in the figure on the next page, each position in the number has a decimal value, beginning at the right with 2^0 and ending at the left with 2^{15}. Each position can be 0 or 1 in the processor memory. A 0 indicates a value of 0; a 1 indicates the decimal value of the position. The equivalent decimal value of the binary number is the sum of the position values.

Positive Decimal Values

The far left position is always 0 for positive values. As indicated in the figure below, this limits the maximum positive decimal value to 32767 (all positions are 1 except the far left position). For example:

0000 1001 0000 1110 = $2^{11}+2^{8}+2^{3}+2^{2}+2^{1}$ = 2048+256+8+4+2 = 2318

0010 0011 0010 1000 = $2^{13}+2^{9}+2^{8}+2^{5}+2^{3}$ = 8192+512+256+32+8 = 9000

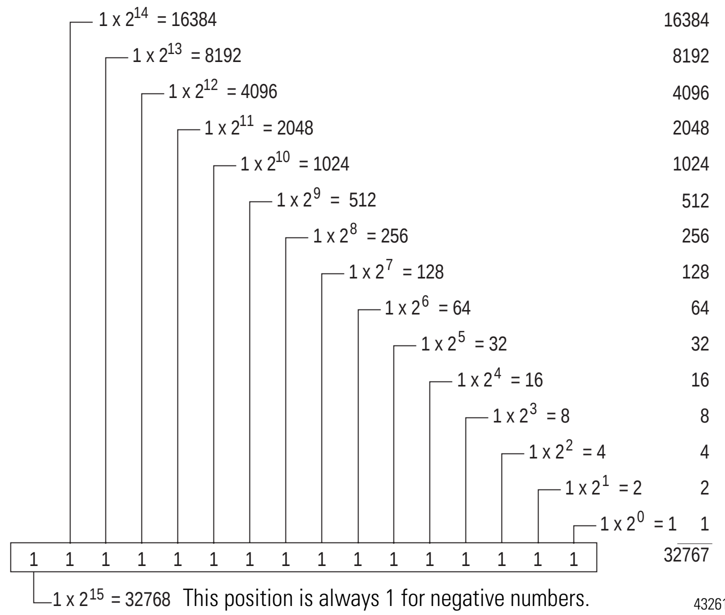


Negative Decimal Values

In two's complement notation, the far left position is always 1 for negative values. The equivalent decimal value of the binary number is obtained by subtracting the value of the far left position, 32768, from the sum of the values of the other positions. In the figure below (all positions are 1), the value is 32767 - 32768 = -1. For example:

$$1111\ 1000\ 0010\ 0011 = (2^{14}+2^{13}+2^{12}+2^{11}+2^{5}+2^{1}+2^{0}) - 2^{15} =$$

$$(16384+8192+4096+2048+32+2+1) - 32768 = 30755 - 32768 = -2013$$



Module Configuration for PROFIBUS

After installation of the RTD/resistance module, you must configure it for operation, usually by using the programming software compatible with the controller or scanner. This appendix includes PROFIBUS configuration information.

Chapter 3 contains detailed information on module parameters and performance. While configuring your RTD/resistance module for operation on PROFIBUS, refer to Chapter 3 for the following information:

- module memory map
- input data file
- data format
- filter frequencies
- channel step response
- channel cutoff frequency
- effective resolution
- module update time

Configure PROFIBUS RTD/Resistance Modules (1790P-T4R0)

Configuration of the 1790P-T4R0 RTD/resistance modules is accomplished through PROFIBUS configuration software with easy-to-use-GSD files. To obtain the GSD files you need to configure the module, access the following website.

http://www.ab.com/networks/gsd.

The example in this chapter shows you how to configure the RTD/ resistance module with the SST PROFIBUS Configuration tool.

Configure RTD/ Resistance Modules Using the SST PROFIBUS Configuration Tool

The configuration example outlined in this section is written for an experienced PROFIBUS user. Refer to your scanner and network documentation for more complete details.

Open your SST PROFIBUS Configuration tool.

IMPORTANT	If online, make sure the processor is in Program mode.

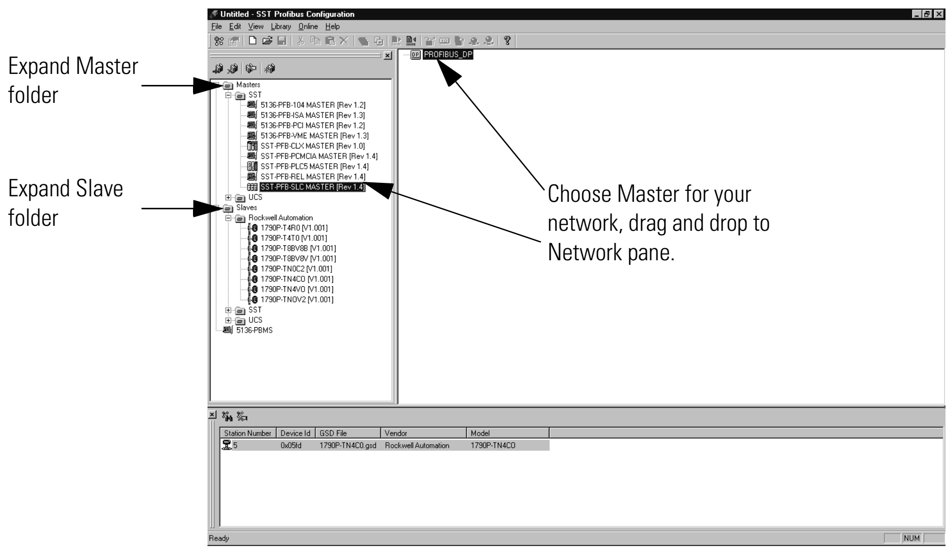
If it's not already installed, add the RTD/resistance module GSD file from the dropdown menu. Access:

1. **Library>Add GSD**.
2. Click **File>New**.

   If the PROFIBUS devices pane is closed, choose:
3. **View>Library** to open the pane.

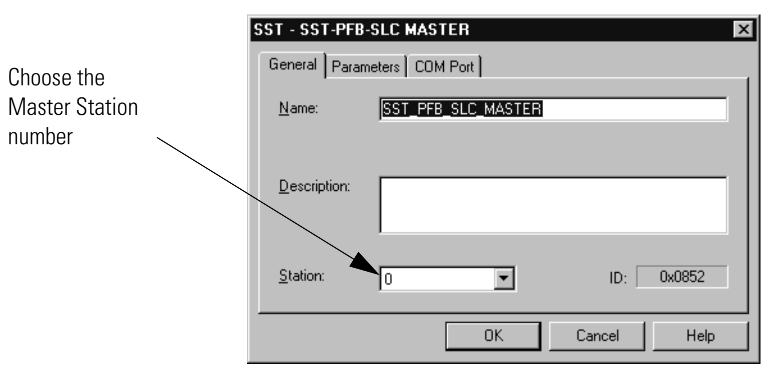
   If the on-line Browse pane is closed, choose:
4. **View>On-line** to open the pane.

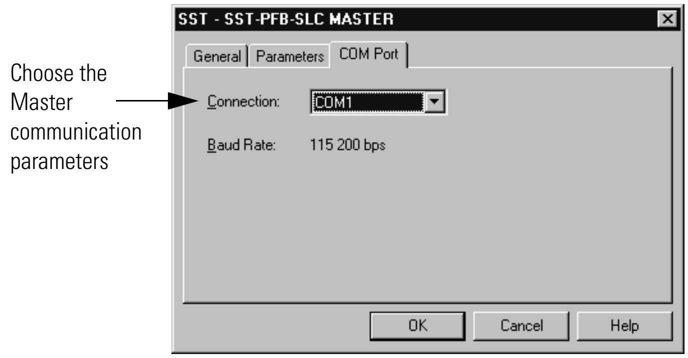
   You should now be ready to set up your system.
5. Expand the Master and Slaves folders in the PROFIBUS Device pane.



6. Choose the Master device for your network, drag and drop the device to the Network pane.

   From the following window:



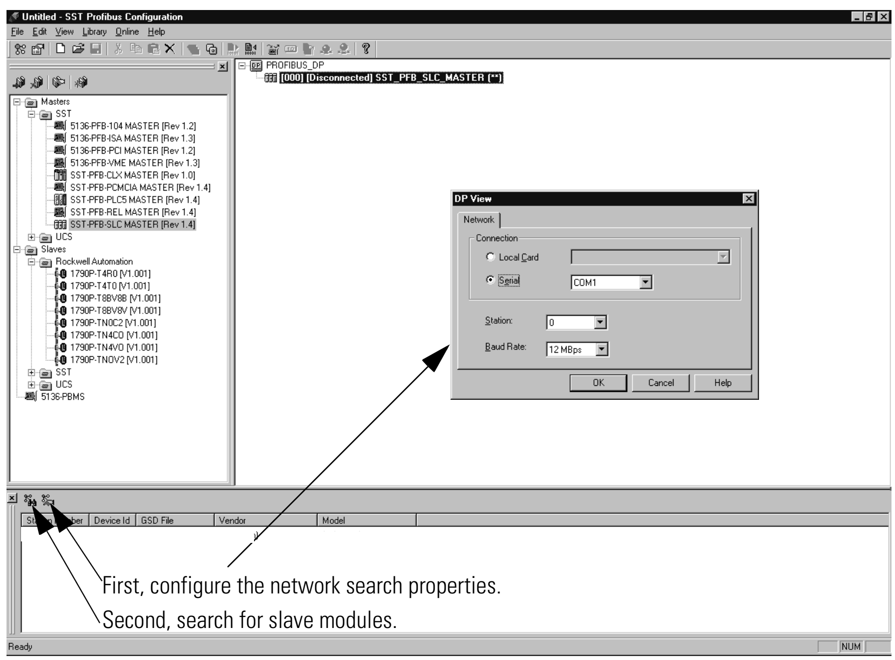


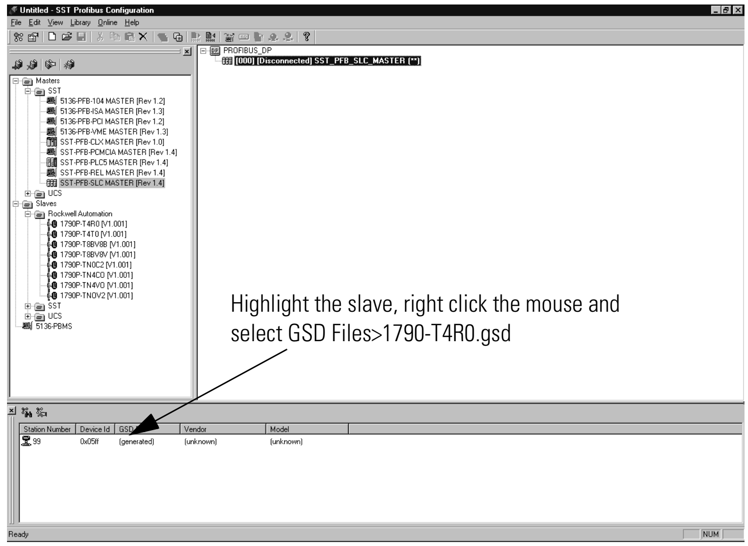
You can add modules to the network by:

1. Selecting slaves from the PROFIBUS Device pane
2. Dragging and dropping them to the network pane

   Or, if online, by performing a search for slaves

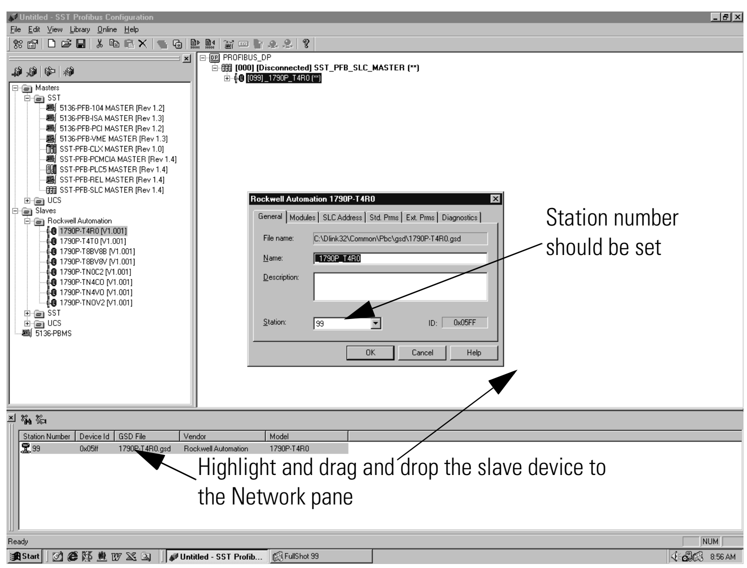
   See the following screens for an outline of this procedure.





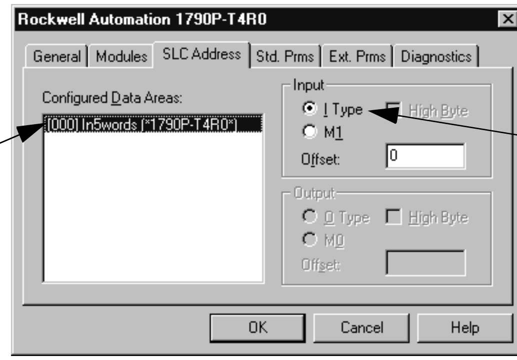
7. Highlight the slave from the Online Browse pane and drag and drop it to the Network pane.

   The slave station number should be set. (If you dragged and dropped from the PROFIBUS Device pane, you must set the station number.)



8. Click the SLC address tab for data size information and to set the I/O data type. For this example, we choose I Type (Input Image in the processor).

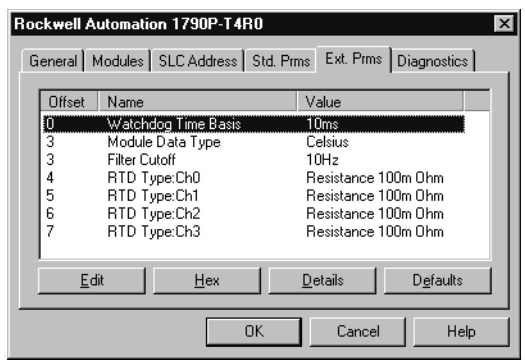
The 1790P-T4R0 module produces 5 words of data.



The produced 5 words will appear in the processor input data table.

9. Click the **Ext. Prms** tab.

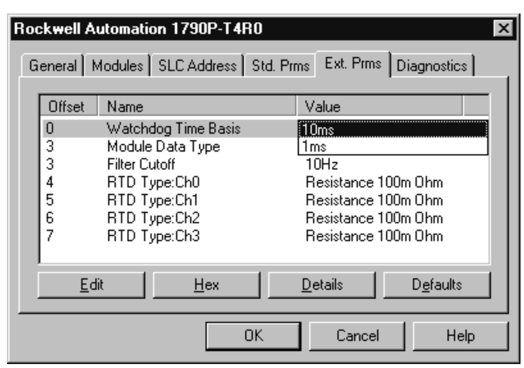
This is where the parameters that can be set for the slave RTD/ resistance module are configured.



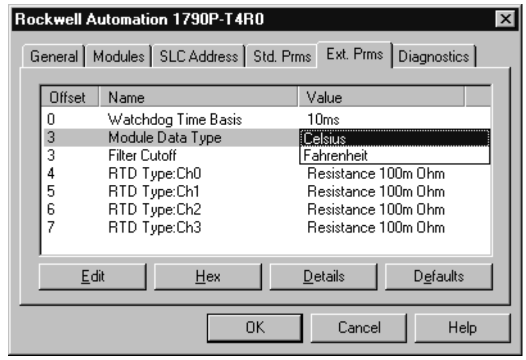
On this screen, you see all the parameters for the module. These include watchdog time, temperature units, filter frequency, and input RTD/ resistance type.

Module configuration parameters include watchdog time base, temperature units, filter frequency, and input RTD/resistance type.

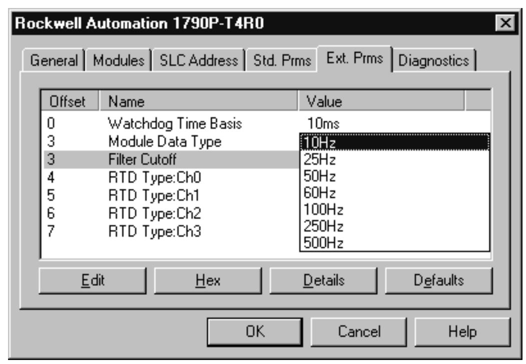
Select the watchdog time base (10 ms or 1 ms).



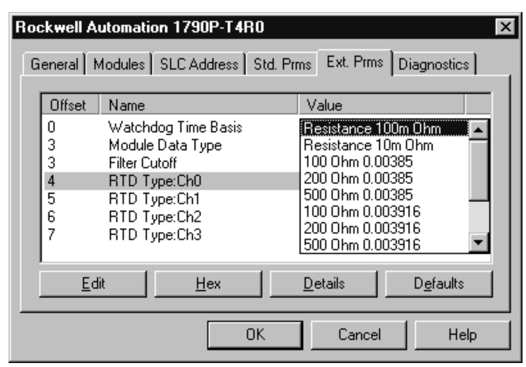
Select the temperature units (degrees C or F). All four channels will be configured identically.



Select the filter cutoff frequency desired. All four channels will be configured identically.



Select the RTD/ resistance input type for each channel from the dropdown list.



10. When configuration is complete, click the **OK** button to close the module properties screen.

Save the Configuration

To close the configuration:

1. Choose **File>Save As**.

2. Specify a file name and location to save your configuration.

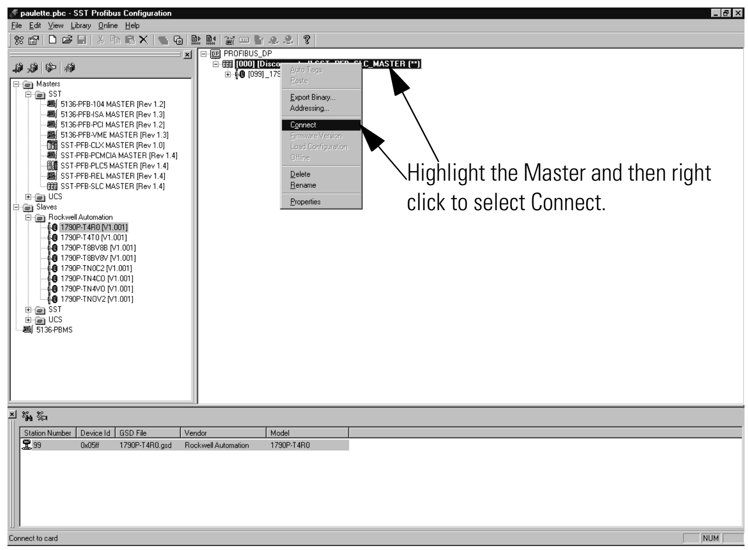
3. Click **Save**.

This saves your project as a .pbc (PROFIBUS configuration file).

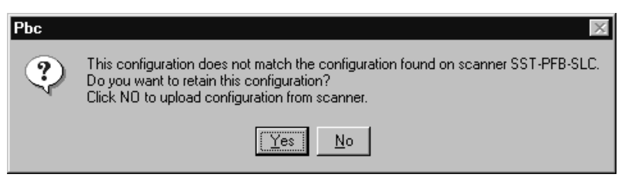
Download the Configuration

To download the configuration:

1. Verify that the processor is in Program Mode.
2. Make sure the serial communication cable is connected between the PC comm port and the scanner serial port.
3. Highlight Master in the Network pane.
4. Right click to select Connect from the menu. (Or, choose **Edit>Connect**).

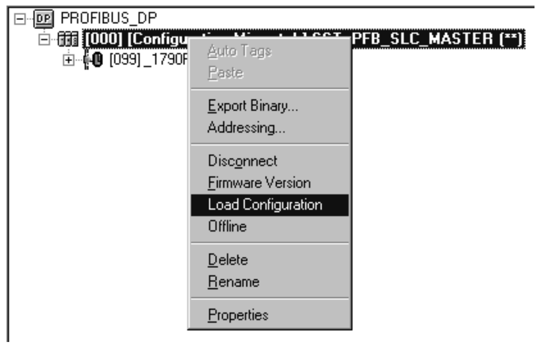


You may be prompted with a message indicating a configuration mismatch between what is in the scanner and your current PROFIBUS project. In this case, select **Yes** to retain your configuration.



Any configuration mismatches display for the Master status.

5. Load the configuration to the Master through one of the following methods.
    - Right click on the Master and select Load Configuration from the menu.



Or,

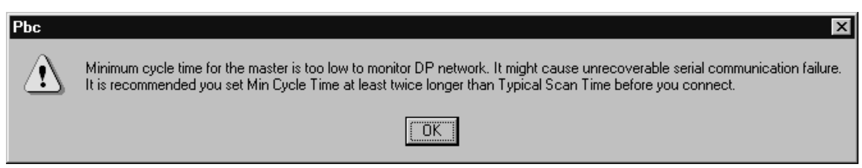
- Select the **Load configuration** icon in the toolbar.

  If the scanner is online, the following message displays:

  Card is online. Do you want to load configuration.

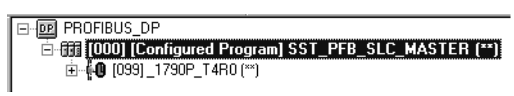
- Select **Yes** to load your new configuration.

You may receive this message:



This is only a warning that if your Min Cycle Time is not twice as long as the Scan Time then you may lose serial communications. This message can usually be ignored unless you require online monitoring.

The Master status now changes to the Configured Program Mode.



Your scanner is now configured and ready.

6. Turn the processor to Run mode.

The Net LED on the RTD/resistance module should turn solid green as should the Comm LED on the scanner. The connection should report OK.

The master should now display:

Summary

This appendix illustrated how to configure your PROFIBUS RTD/ resistance module with the SST PROFIBUS Configuration tool.

For more information, consult your PROFIBUS network documentation, PROFIBUS scanner documentation and network configuration tool documentation.

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here refer to *Allen-Bradley's Industrial Automation Glossary*, Publication AG-7.1.

A/D Converter– Refers to the analog to digital converter inherent to the module. The converter produces a digital value whose magnitude is proportional to the magnitude of an analog input signal.

attenuation – The reduction in the magnitude of a signal as it passes through a system.

channel – Refers to input interfaces available on the module's terminal block. Each channel is configured for connection to a thermocouple or millivolt input device, and has its own data and diagnostic status words.

channel update time – The time required for the module to sample and convert the input signals of one enabled input channel and update the channel data word.

common mode rejection – For analog inputs, the maximum level to which a common mode input voltage appears in the numerical value read by the processor, expressed in dB.

common mode rejection ratio (CMMR) – The ratio of a device's differential voltage gain to common mode voltage gain. Expressed in dB, CMRR is a comparative measure of a device's ability to reject interference caused by a voltage common to its input terminals relative to ground. $CMRR=20\ Log_{10\ (V1/V2)}$

common mode voltage – The voltage difference between the negative terminal and analog common during normal differential operation.

common mode voltage range – The largest voltage difference allowed between either the positive or negative terminal and analog common during normal differential operation.

cut-off frequency – The frequency at which the input signal is attenuated 3 dB by a digital filter. Frequency components of the input signal that are below the cut-off frequency are passed with under 3 dB of attenuation for low-pass filters.

data word – A 16-bit integer that represents the value of the input channel. The channel data word is valid only when the channel is enabled and there are no channel errors. When the channel is disabled the channel data word is cleared (0).

dB – (decibel) A logarithmic measure of the ratio of two signal levels.

digital filter – A low-pass filter incorporated into the A/D converter. The digital filter provides very steep roll-off above it's cut-off frequency, which provides high frequency noise rejection.

effective resolution – The number of bits in a channel configuration word that do not vary due to noise.

excitation current – A user-selectable current that the module sends through the input device to produce an analog signal that the module can process and convert to temperature (RTD) or resistance in ohms (resistance device).

filter – A device that passes a signal or range of signals and eliminates all others.

filter frequency – The user-selectable frequency for a digital filter.

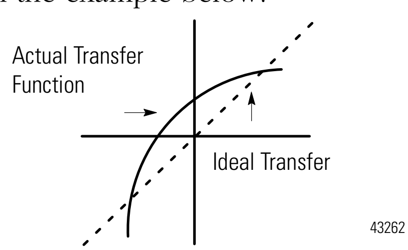
full-scale – The magnitude of input over which normal operation is permitted.

full-scale range – The difference between the maximum and minimum specified analog input values for a device.

input data scaling – Data scaling that depends on the data format selected for a channel configuration word. Scaling is selected to fit the temperature or voltage resolution for your application.

input image – The input from the module to the controller. The input image contains the module data words and status bits.

linearity error – Any deviation of the converted input or actual output from a straight line of values representing the ideal analog input. An analog input is composed of a series of input values corresponding to digital codes. For an ideal analog input, the values lie in a straight line spaced by inputs corresponding to 1 LSB. Linearity is expressed in percent full-scale input. See the variation from the straight line due to linearity error (exaggerated) in the example below.



LSB – Least significant bit. The LSB represents the smallest value within a string of bits. For analog modules, 16-bit, two's complement binary codes are used in the I/O image. For analog inputs, the LSB is defined as the rightmost bit of the 16-bit field (bit 0). The weight of the LSB value is defined as the full-scale range divided by the resolution.

module scan time – same as *module update time*

module update time – The time required for the module to sample and convert the input signals of all enabled input channels and make the resulting data values available to the processor.

multiplexer – An switching system that allows several signals to share a common A/D converter.

normal mode rejection – (differential mode rejection) A logarithmic measure, in dB, of a device's ability to reject noise signals between or among circuit signal conductors. The measurement does not apply to noise signals between the equipment grounding conductor or signal reference structure and the signal conductors.

number of significant bits – The power of two that represents the total number of completely different digital codes to which an analog signal can be converted or from which it can be generated.

overall accuracy – The worst-case deviation of the digital representation of the input signal from the ideal over the full input range is the overall accuracy. Overall accuracy is expressed in percent of full scale.

repeatability – The closeness of agreement among repeated measurements of the same variable under the same conditions.

resolution – The smallest detectable change in a measurement, typically expressed in engineering units (e.g. 1°C) or as a number of bits. For example a 12-bit system has 4096 possible output states. It can therefore measure 1 part in 4096.

RTD – Resistance temperature detector. A temperature-sensing device that consists of a temperature-sensing element connected by two, three, or four lead wires that provide input to the module. The RTD uses the basic concept that the electrical resistances of metals increase with temperature. When a small current is applied to the RTD, it creates voltage that varies with temperature. The module processes and converts this voltage into a temperature value.

sampling time – The time required by the A/D converter to sample an input channel.

step response time – The time required for the channel data word signal to reach a specified percentage of its expected final value, given a full-scale step change in the input signal.

update time – see "module update time"

Notes:

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Pub. Title/Type CompactBlock LDX RTD/Resistance Input Module

Cat. No.	1790D-(T)4R0, 1790P-T4R0	Pub. No.	1790-UM002A-EN-P	Pub. Date	May 2002	Part No.	957657-66

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