SIEMENS

SIMATIC TI505

RTD Input Module

User Manual

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Registration	Second		

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Preface

This manual describes the Series 505™ Resistance Temperature Detector (RTD) Input Module (PPX:505–7038).

Other Manuals

Refer to the manuals listed below for instructions on installing, programming, and troubleshooting your controller and I/O.

- *SIMATIC® TI545™ System Manual*
- *SIMATIC® TI560T™/TI565T™ System Manual*
- *SIMATIC® TI505™ Programming Reference Manual*
- *SIMATIC® TI500™/TI505 TISOFT™ Release 4.2 User Manual*
- *TISOFT 1 and 2, Rel. 2.0 User Manual*

Agency Approvals

This module meets the standards of the following agencies:

- Underwriters Laboratories: UL® Listed (Industrial Control Equipment)
- Canadian Standards Association: CSA Certified (Process Control Equipment)
- Factory Mutual Approved; Class I, Div. 2 Hazardous Locations
- Verband Deutscher Elektrotechniker (VDE) 0160 Clearance/Creepage for Electrical Equipment (Self-Compliance)

Series 505 products have been developed with consideration of the draft standard of the International Electrotechnical Commission Committee proposed standard (IEC-65A/WG6) for programmable controllers.

Technical Assistance

If you need information that is not included in this manual, or if you have problems using the Series 505 RTD Input Module, contact your Siemens Industrial Automation, Inc. distributor or sales office. If you need assistance in contacting your distributor or sales office in the United States, call 1–800–964-4114.

Handling the Module

Many integrated circuit (IC) devices are susceptible to damage by the discharge of static electricity. Follow the suggestions listed below to reduce the probability of damage to these devices when you handle a controller, a base controller, or any of the I/O modules.

Both the module and the person who handles the module should be at the same ground potential. To accomplish this, fulfill the following conditions.

- Transport the module in an anti-static container or anti-static material.
- Ensure that the work area has a conductive pad with a lead that connects it to a common ground.
- Ground yourself. Make contact with the conductive pad or wear a grounded wrist strap.

Visual Inspection

If there is any visible damage to the module, contact your vendor for replacement.

Chapter 1

Product Overview

1.1 Introduction

Measuring Temperature with Resistance

A resistance thermometer consists of a resistance-temperature detector probe (RTD) and a resistance-measuring instrument (an RTD module).

RTDs are passive transducers that function on the principle that the resistance of a pure metal is proportional to its temperature. An RTD probe consists of a wire of constant cross-section and known length, which is wound around a core of insulating material and enclosed in a protective housing. The probe-type RTD is usually stem-sensitive; that is, it must be immersed sufficiently to affect the full length of RTD wire wound around the core.

Other types of probes available include the miniature tip-sensitive types for access to tight areas, thin film types for quicker-sensing, and washer-shaped types for easy-mounting surface-temperature measurement.

The Series 505 RTD Input module pulses a small amount of current through the RTDs attached to it. The module measures the voltage generated by the current through the RTDs and then determines the resistance.

Series 505 RTD Input Module

The RTD Input module (see Figure 1-1) provides eight RTD inputs in a single-wide, Series 505 format. It is compatible with two-, three-, and four-wire RTDs, with automatic lead wire resistance compensation for three-wire and four-wire RTDs.

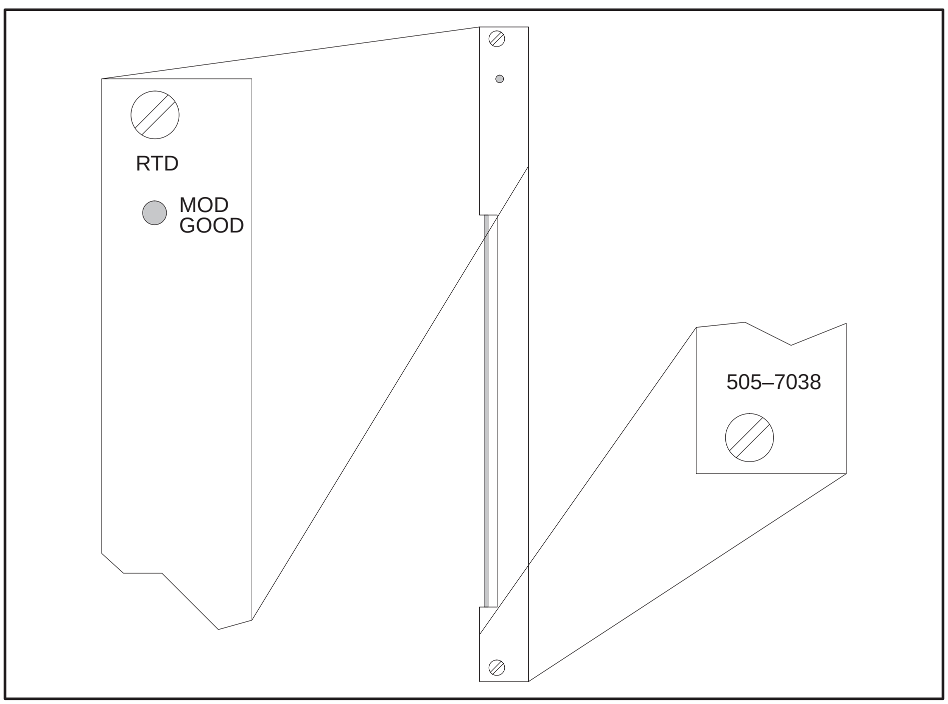


Figure 1-1 Series 505 RTD Input Module

1.2 Features and Performance Specifications

Table 1-1 Features

Inputs	8
Form factor	Single-wide
RTD compatibility	Platinum (4 types); copper; nickel (2 types); 2-, 3-, or 4-wire RTDs
RTD zero degree ohms	Configurable for eight different values
Input data format to the controller Refer to Table 1-2 for probe ranges	°F × 10 °C × 10 Ω × 10 (1.0 to 2000.0) Ω × 100 (1.00 to 320.00) Scaled counts, 0 to 32000
External power	None required
Error reporting	Configurable for separate error words or upscale error codes Module automatically detects open, shorted, or out-of-range inputs
Input noise filtering	Configurable for 50/60 Hz rejection
Internal resolution	0.003 Ω (19-bit)
Lead wire compensation	500 Ω max (<50 Ω recommended)

Table 1-2 Probe Temperature Ranges

	Platinum	Copper	Nickel
°F × 10	–328.0 to 1562.0	–328.0 to 500.0	–112.0 to 527.0
°C × 10	–200.0 to 850.0	–200.0 to 260.0	–80.0 to 275.0

Table 1-3 Performance Specifications

		Typical 20–30°C / 68–86°F	Specification Limit 0 to 60°C / 32 to 140°F
Mean accuracy (100 Ω platinum RTD)		0.1°C 0.2°F 0.03 Ω	0.6°C 1.2°F 0.25 Ω
Repeatability (100 Ω platinum RTD)		0.1°C 0.2°F 0.03 Ω	0.3°C 0.5°F 0.11 Ω
Absolute accuracy	100 Ω platinum	0.2°C 0.4°F	0.9°C 1.7°F
	Ω × 100	0.06 Ω	0.36 Ω
	Ω × 10	0.1 Ω + 0.05% of input Ω	0.1 Ω + 0.2% of input Ω
Common-mode rejection		100 dB	—
Normal-mode rejection at line frequency ±0.01 Hz		80 dB	—
Normal-mode rejection at line frequency ±3 Hz		25 dB	—
Update time per active input: all inputs <470 Ω		<110 ms @ 60 Hz filter	<120 ms @ 50 Hz filter
Step response time: 100 Ω platinum RTD		250 ms × number of active inputs	
Step response time: inputs to 2 kΩ		625 ms × number of active inputs	
Base power	+5 V	2.2 W max, 1.6 W typical	
	–5 V	0 W	
Isolation (inputs to controller)		1500 Vrms	

1.3 How to Set Up the RTD Module for the Best Performance

Choosing the Best RTD Type

The Series 505 RTD module has been optimized for the 100 Ω platinum RTD positive temperature range of 100 to 400 Ω. Mean accuracy and repeatability is best in this range.

Source-to-Return Resistance Affects Typical Accuracy

This module operates with source-to-return resistance from 1 to 2000 Ω. Typical accuracy is better than 0.03% of the reading from 50 to 2000 Ω. Below 50 Ω, absolute accuracy typically is better than 0.02 Ω.

Achieving Maximum Accuracy and Repeatability

Follow these guidelines to achieve maximum accuracy and repeatability:

- For low-temperature operation, choose an RTD with a higher 0°C resistance. Maximum accuracy occurs when the expected RTD operating range resistance falls between 100 and 400 Ω. See Appendix C for some common RTDs and their temperature/resistance values.
- Use platinum RTD probes. Platinum is the most stable material commonly used for RTDs; its initial and long-term accuracy are best.
- RTD probes can have self-heating effects. The RTD module uses very little current to excite the RTD element; however, in some situations, poor sensor thermal conductivity can cause temperature offset. The module pulses a current with a duty cycle less than 12.5%. This current source is nominally 2.5 mA when the source-to-return resistance is less than 500 Ω and 1 mA for source-to-return resistance greater than 500 Ω.
- To choose an RTD probe to fit the measurement task, refer to the RTD manufacturer's recommendations.
- Use low 0°C Ω (10 Ω copper) RTDs only when your required measurement accuracy is 2°C or more.
- Use two-wire connectivity only when your required measurement accuracy is greater than the offset that is generated by the lead wire resistance.
- Four-wire connectivity is best for accuracy and repeatability.

Handling Unused Inputs

Leave unused inputs unconnected for fastest response.

Using RLL to Get Readings of Better Repeatability

If your application requires absolute accuracy greater than that specified for this module, you can minimize the effect of repeatability error by writing a program in RLL to take the average of readings over a period of time. However, this occurs at the expense of update time.

Chapter 2
Installing the Module

2.1 Setting Options

Overview

Figure 2-1 shows the dipswitch locations. Avoid setting dipswitches with a pencil, as graphite can damage the switch assembly. Table 2-1 lists the features and options, and Figure 2-2 shows the option settings.

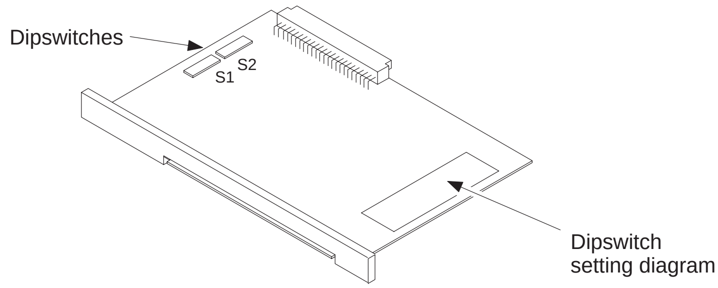


Figure 2-1 Dipswitch Locations

Table 2-1 Switch Assignments

Feature	Options	Assembly	Switches	Default
Input resistance at 0°C	One of eight values for input resistance at 0°C. Also selects the reporting scale for direct Ω input.	S1	1, 2, and 3	100 Ω
Probe type	One of 7 RTD curves.	S1	4, 5, and 6	Pt 0.003850 DIN
WX input format	°F × 10 °C × 10 ohms × 10 ohms × 100 scaled integer.	S1	7 and 8	°F × 10
Lead resistance compensation	2-, 3-, or 4-wire.	S2	1	3-wire
Error format	16WX/separate error words or 8WX/upscale errors (32752 and above).	S2	2	16WX
Input filtering	50 or 60 Hz.	S2	3	60 Hz
Calibration	Run or calibration mode.	S2	8	Run
NOTE: You must use 8WX error format with a SIMATIC® TI525™, SIMATIC® TI530™, or SIMATIC® TI530C™.				

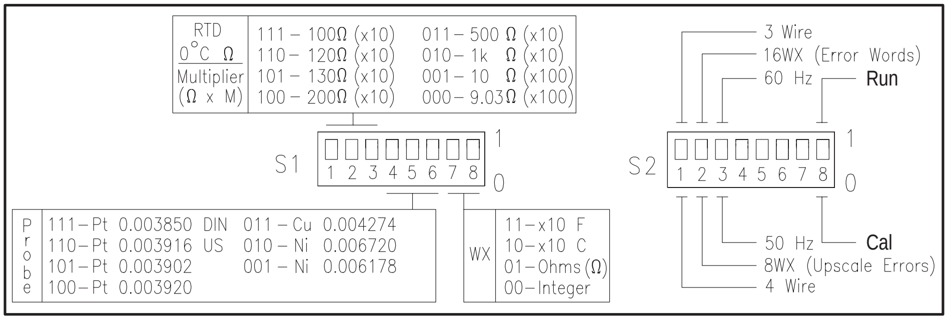
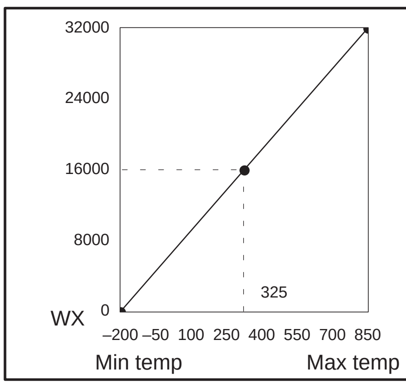


Figure 2-2 Dipswitch Setting Diagram

Integer Data Format

Refer to Table 2-1 for data format options. Figure 2-3 shows how the integer format works in an RTD application when a platinum probe is registering 325.0°C (mid-range). In general terms,

$$\textit{scaled integer} = 32000\left(\frac{\textit{actual temp} - \min \textit{temp}}{\max \textit{temp} - \min \textit{temp}}\right)$$



Probe type	Min temp	Max temp
Platinum	–200°C	850°C
Copper	–200°C	260°C
Nickel	–80°C	275°C

$$WX = 32000\frac{(t - (-200.0))}{(850.0 - (-200.0))} = 16000$$

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Figure 2-3 Integer Data Format

Guidelines for Selecting Error Format

The difference between 8WX and 16WX input formats consists primarily of how the module behaves when an error occurs. You must use 8WX format with a TI525, TI530, or TI530C. If the module is set for 8WX and an error occurs, the input data are replaced by an error word and that input ceases updating. You must correct the error condition before the input resumes updating.

If the module is set for 16WX inputs and an error occurs, the last valid data are frozen. An error word is reported in one of the last eight inputs as shown in Table 3-1. This allows the error to be detected in your application program without immediately affecting controller operation.

2.2 Field Wiring

⚠ WARNING

Use wires suitable for at least 75° C. Signal wiring connected to this module must be rated at least 300 V.

⚠ ATTENTION

Employer des fils d’alimentation pour au moins 75° C. Le cablage de signalisation raccorde dans cette boite doit convenir pour une tension nominale d’au moins 300 V.

Avoiding Noise

To avoid noise problems, follow these guidelines when you install the module.

- Use the shortest possible wires.
- Select 50/60 Hz filtering to match the local AC power line frequency.
- Do not install the module adjacent to power-switching modules.
- Avoid placing signal wires parallel to high-energy wires. If the two must meet, cross them at right angles.
- Avoid bending the wire into sharp angles.
- Use wireways for wire routing.
- Use a four-wire conductor with a shield, and tie the shield to ground potential.
- Terminate shields at RTD sensor location to earth ground.
- Place wires so that they do not interfere with existing wiring.
- Never terminate the shield at both the RTD sensor and the module connector.

Power Requirements

The module consumes a maximum of 2.2 W of +5 V and no –5 V power from the base. No external power supply is required.

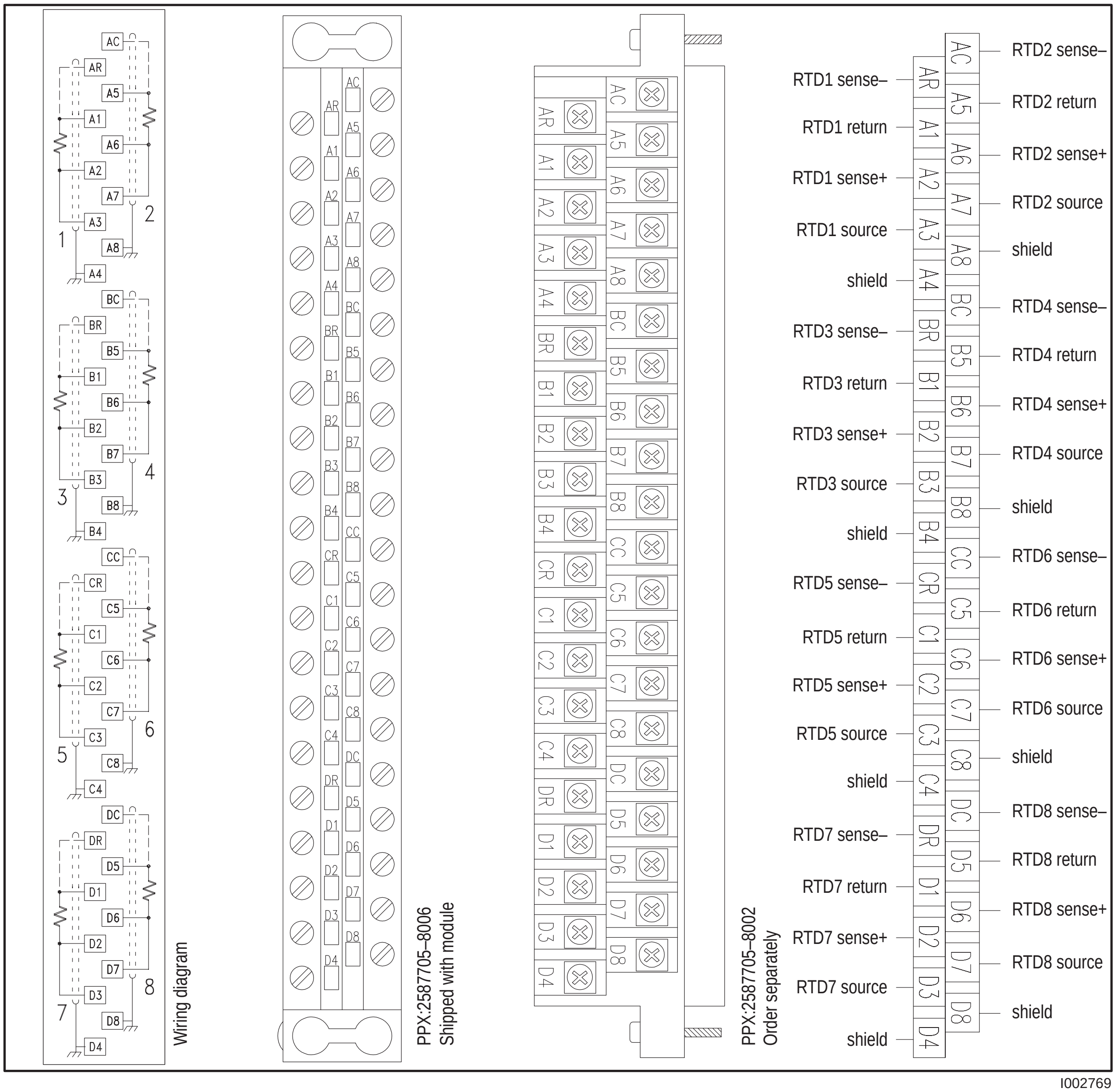


Figure 2-4 Terminal Blocks and Pinouts

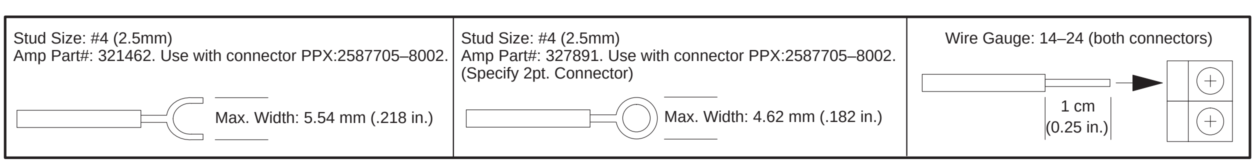


Figure 2-5 Wire Gauge and Stud Sizes

2.3 Wiring for Two-, Three- and Four-wire Applications

In general, you can use three-or four-wire twisted shielded, cable (14–24 AWG or 0.18–1.5mm^2, either stranded or solid-type). All eight channels have a common return. To provide isolation, use isolated sensors. In addition, it is good practice to label all wires. Figure 2-6 shows wiring diagrams for all three wiring configurations.

RTD Excitation

The module pulses a current with a duty cycle less than 12.5%. This current source is nominally 2.5 mA when the source-to-return resistance is less than 500 Ω and 1 mA for source-to-return resistance greater than 500 Ω.

To meet accuracy specifications, connect each RTD to one module input only. Use dual-element RTDs if you require redundant temperature measurement.

Using Four-wire RTDs

Four-wire RTDs provide the best accuracy. Changes in contact, wire, or terminal impedance can affect the accuracy of three-wire RTD readings, where four-wire RTDs are not affected. Refer to the following guidelines:

- Use four-wire shielded cable.
- The module has been optimized for source-to-return resistances of 400 Ω or less. For maximum accuracy, keep the RTD and wire impedances within this range. The maximum allowable source-to-return resistance is 2 kΩ.
- Wire impedance is relatively unimportant for Sense+ and Sense– wires; it must be ≤2 kΩ from the Sense lines to Return.
- Wire type and temperature coefficient do not affect accuracy for four-wire RTD applications.

Using Three-wire RTDs

Four-wire RTDs provide the best performance. However, if your application requires three-wire RTDs, consider the following guidelines:

- Connect one side of the RTD to Sense+ and Source, and connect the other side to Return.
- Try to achieve equal resistance between the Source and Return wires. Any difference in resistance between these two wires is registered as offset.
- If necessary, you can use shielded, twisted pair cable, but the twisted pair must go to Return and Source, and shield must go to Sense+. In this case, the shield is used as a conductor, not a shield, and noise may be a problem.

- For better accuracy, limit each lead wire resistance to below 50 Ω and ensure that the temperature coefficient of the Source and Return wires is the same.
- The module can accommodate up to 500 Ω lead resistance.
- Contact resistances can become significant for three-wire measurements; the module cannot compensate for these resistances.

Using Two-wire RTDs

Run three or four wires from the RTD probe to the module. If you can run only two wires from the RTD probe to the module and accuracy is relatively unimportant, connect a jumper between Sense– and Return and another between Sense+ and Source at the module connector; be sure to set the module dipswitches for four-wire operation. Refer to Figure 2-6. Run two-wire, twisted/shielded pair cable to the RTD. Depending on the wiring environment, lead resistance and lead wire temperature drift cause temperature offsets. The module cannot differentiate between wire and sensor resistance in two-wire mode.

Using Intrinsic Safety Barriers

If your application requires intrinsic safety barriers, be sure to use four-wire RTDs. Otherwise, the series resistance imbalance degrades accuracy. Also, select the barrier for minimal leakage current, as this can affect accuracy in three- or four-wire modes.

NOTE: Normally, you must attach the shield *only* at the RTD location. If this is not possible, you can terminate the shield at the module. *Never* attach the shield at both the RTD location *and* the RTD module.

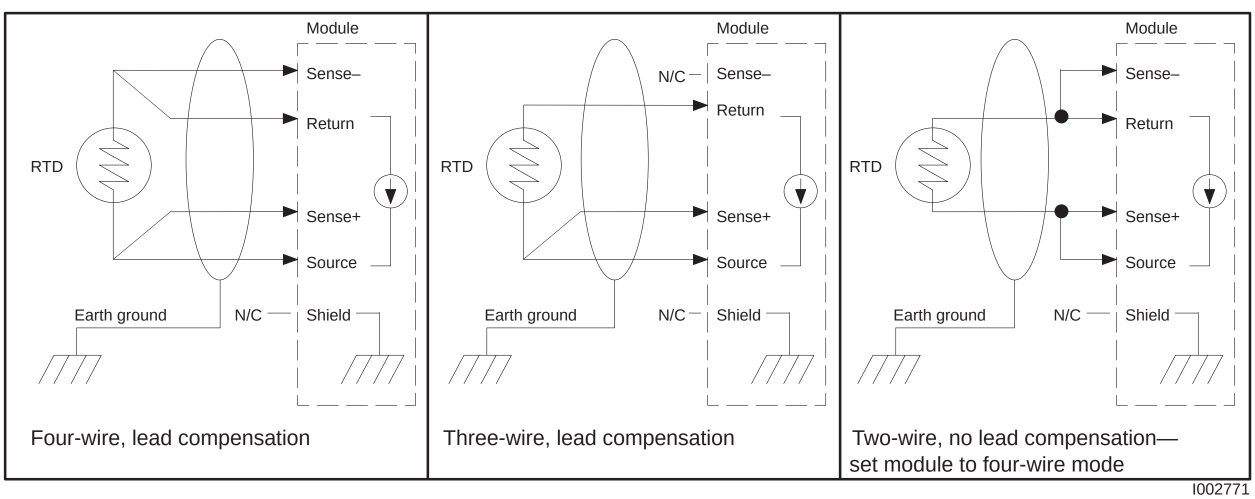


Figure 2-6 RTD Sensor Wiring Diagrams

2.4 Inserting the Module into the Base

⚠ WARNING

To minimize risk of potential shock hazard, turn off power to the I/O base and to any modules installed in the base before inserting or removing a module or installing a terminal block. Failure to do so may result in potential injury to personnel or damage to equipment.

Choosing a Slot

The RTD module fits into any available single I/O slot on any Series 505 base as shown in Figure 2-7. Avoid installing the module adjacent to high-energy switching modules or other potential sources of electromagnetic interference. Note the minimum torque required to provide grounding.

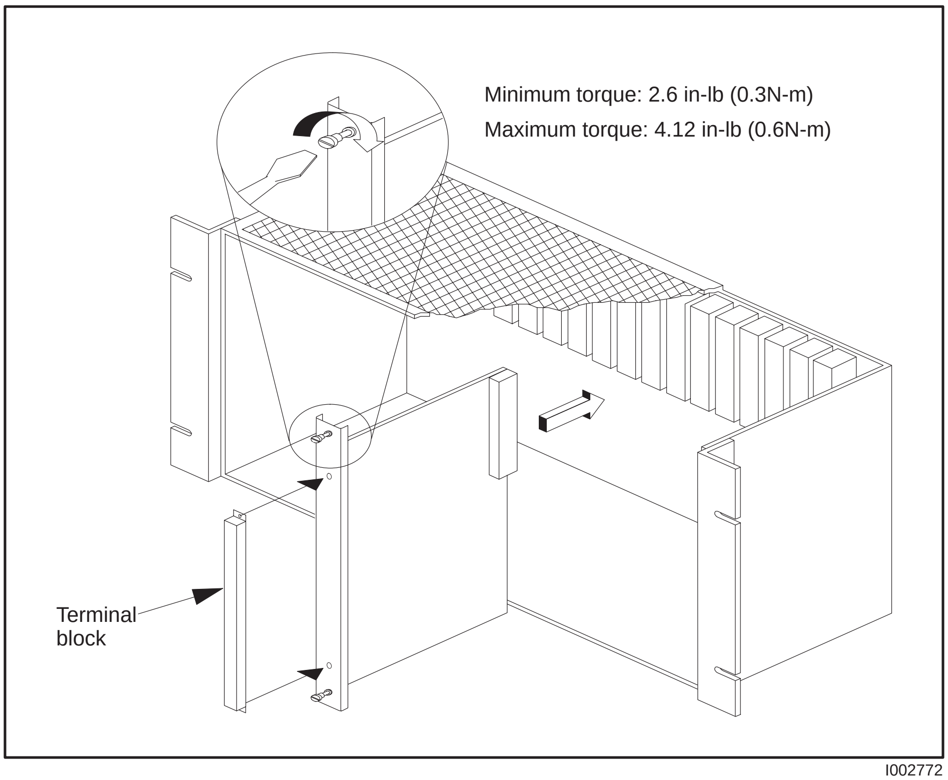


Figure 2-7 Inserting the Module into the Base

Checking Status Indicator

Within 6 seconds of power-up, the LED on the bezel comes on, indicating that the module is good. If the LED fails to come on, refer to Chapter 4 for troubleshooting procedures.

Chapter 3
Programming and Assigning I/O Points

3.1 Programming the Controller

Refer to your controller program design manual for specific details on designing a program.

WXs

Refer to Table 3-1 for the WX configuration.

Table 3-1 WXs

Format	Inputs	I/O Words	Values
WX16	8	WX 1–8 WX 9–16	Input points 1–8 Separate error words
WX8	8	WX 1–8	Input points 1–8; upscale errors

Word Format

Words are signed, 16-bit numbers. Refer to Figure 3-1 for the word format.

	MSB														LSB
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
sign bit	15 bits for process value														

Figure 3-1 Word Format

3.2 Logging the Module into the Controller

Selecting the I/O Definition Chart

Figure 3-2 shows a sample I/O definition chart with two modules installed in a four-slot base. Slot 1 holds a module configured for 16 WX; slot 2 holds a module configured for 8 WX. Refer to your TISOFT manual for detailed instructions.

I/O Address
The module is logged in as eight or 16 input words (WX).

Base Number
Displays number of the current base.

Slot Number
Install the module into any available I/O slot in the Series 505 base. See Section 2.4.

SF Module
Series 505 RTD is not an SF Module. The default for this definition is no.

I/O MODULE DEFINITION FOR : CHANNEL 1 BASE 00

Slot	I/O Address	X	Y	WX	WY	Special Function
1	 0001	 00	.. 00	.. **16**	.. 00	.... No
2	 0017	 00	.. 00	.. 08	.. 00	.... No
3	 0000	 00	.. 00	.. 00	.. 00	.... No
4	 0000	 00	.. 00	.. 00	.. 00	.... No

(X, Y, WX, WY: Number of Bit and Word I/O)

I000725

Figure 3-2 Sample I/O Definition Chart

Viewing the I/O Configuration Chart

Use **SHOW** or a similar menu selection to display the I/O configuration chart. The configurations in Figure 3-2 appear as shown in Figure 3-3. Slot 1 holds a module configured for 16 WX; slot 2 holds a module configured for 8 WX.

I/O CONFIGURATION CHART FOR CHANNEL . . . 1 BASE 00
I/O POINTS

	1	2	3	4	5	6	7	8
SLOT 1	WX0001	WX0002	WX0003	WX0004	WX0005	WX0006	WX0007	WX0008
	9	10	11	12	13	14	15	16
SLOT 1	WX0009	WX0010	WX0011	WX0012	WX0013	WX0014	WX0015	WX0016
	17	18	19	20	21	22	23	24
SLOT 2	WX0017	WX0018	WX0019	WX0020	WX0021	WX0022	WX0023	WX0024
SLOT 3								
SLOT 4								

Figure 3-3 I/O Configuration Chart

Chapter 4
Troubleshooting and Maintenance

4.1 Symptoms and Corrective Actions

If you need assistance with any of the problems or corrective actions listed below, call your Siemens Industrial Automation, Inc. distributor.

Table 4-1 Symptoms and Corrective Actions

Symptom	Possible Cause	Corrective Action
Incorrect readings	Connections incorrect	Trace wiring connections.
	Signal wire noise	Use shielded wire; refer to Section 2.2.
	Module not configured	Check I/O configuration.
	Unbalanced lead wires	Refer to Section 2.3.
	Dipswitches set incorrectly	Refer to Section 2.1.
CPU nonfatal error on TISOFT screen	Module configured incorrectly	Reconfigure the module.
	Module not seated in base	Install correctly and reconfigure.
	Module failed	Return the module for repair.

4.2 Messages and Error Codes

Table 4-2 Messages and Error Codes in Controller Memory

Signed Integer	Hex Code	Problem	Description	Corrective Action
32767	7FFF	Failed module	Module has set fail bit; MOD GOOD LED indicator goes off	Check dipswitches. Reseat module in base. Return for repair.
32766	7FFE	Input underrange	RTD input is below expected range	Check dipswitches. Check wiring, sensor.
32765	7FFD	Input overrange	RTD input is above expected range	Check dipswitches. Check wiring, sensor.
32764	7FFC	Source short	Short from Source to Return	Check wiring, sensor.
32763	7FFB	Sense short	Short from Sense+ to Return (3-wire) or from Sense+ to Sense– (4-wire)	Check wiring, sensor.
32762	7FFA	Input not wired	All three inputs are open or improperly wired: Source, Sense+, and Sense–	Wire module channel.
32761	7FF9	Source open	Source to Return ≥3500 Ω	Check Source wire.
32760	7FF8	Sense+ open	Sense+ Resistance ≥2500 Ω	Check Sense+ wire.
32759	7FF7	Sense– open	Sense– Resistance ≥2500 Ω	Check Sense– wire.
32758	7FF6	Source-to-Return overrange	>2000 Ω from Source to Return	Check wiring, sensor.
32757	7FF5	EEPROM fail	Corrupt EEPROM calibration data	Attempt to re-calibrate. Return for repair.
32756	7FF4	Cal out-of-range	Calibration input on this channel is out-of-range	Check calibration values. Refer to Section 4.3.
32755	7FF3	Cal complete	Calibration is successful	Return module to operation.
32754	7FF2	Not used		
32753	7FF1	Not used		
32752	7FF0	Not used		
4	0004	Four-wire mode	Module is correctly performing 4-wire conversions for this input (separate error words only)	Module channel functioning properly
3	0003	Three-wire mode	Module is correctly performing 3-wire conversions for this input (separate error words only)	Module channel functioning properly
0	0000	No data	Module not yet configured (separate error words only)	Configure module.

4.3 Calibrating the Module

How Often to Calibrate the Module

Although the RTD module does not require calibration at installation, some applications may require periodic calibration. If you operate in an environment where the ambient temperature cycles outside the range of 20°C to 30°C, more frequent calibration may be required. Also, if the application environment is a constant temperature outside the 20°C to 30°C range, calibration at the application temperature may improve system accuracy.

Drift

Without calibration, expected mean accuracy drift per year is 0.05% of the ohms input value; this is equivalent to the following temperature values for common RTDs.

Table 4-3 Module Mean Accuracy Drift per Year Without Calibration

Measured Temperature		100-ohm Platinum		10-ohm Copper		120-ohm Nickel	
°C	°F	°C	°F	°C	°F	°C	°F
–200	–328	0.1	0.2	0.1	0.2	—	—
–100	–148	0.1	0.3	0.1	0.3	—	—
0	32	0.2	0.4	0.2	0.4	0.1	0.3
100	212	0.2	0.5	0.2	0.4	0.2	0.4
200	392	0.3	0.6	0.3	0.5	0.2	0.4
260	500	0.3	0.6	0.3	0.6	0.2	0.4
400	752	0.4	0.8	—	—	—	—
600	1112	0.5	1.0	—	—	—	—
800	1472	0.7	1.3	—	—	—	—

Recommended Equipment

Calibration requires a standard Series 505 I/O connector and four precision resistors. These resistors must meet or exceed the specifications outlined in Table 4-4. You can order a connector by contacting your Siemens Industrial Automation, Inc. distributor and asking for PPX:2587705–8009. Figure 4-1 shows how to assemble a calibration connector, using the precision resistors listed in Table 4-4.

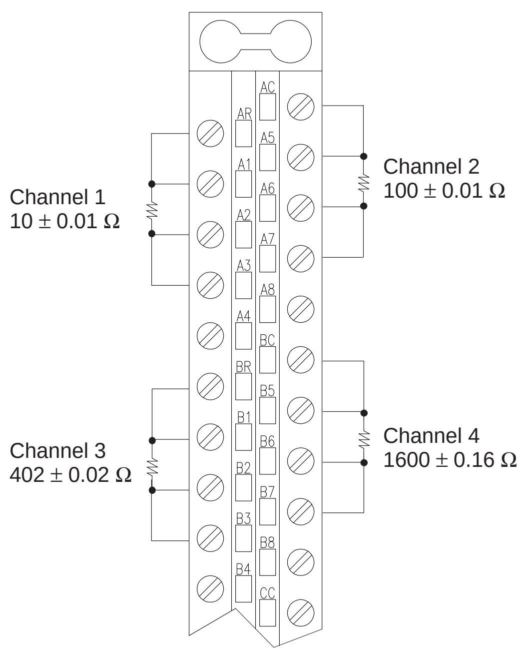
Table 4-4 Precision Resistor Values

Ohms	Tolerance	Temperature Coefficient
10	0.1%	25 ppm/°C
100	0.01%	10 ppm/°C
402	0.005%	10 ppm/°C
1600	0.01%	10 ppm/°C

Calibration Procedure

Follow these steps to calibrate the module. No warmup period is required.

1. Remove power from the base containing the RTD module to be calibrated.
2. Remove the field wiring I/O connector from the RTD module.
3. Remove the RTD module from the base.
4. Set S2 dipswitch 8 to the Cal (0) position.
5. Install the precision resistors as shown in Figure 4-1.
6. Reinsert the RTD module into the base.
7. Apply power to the base. The module LED begins blinking slowly. After about 2 minutes, the LED begins blinking quickly, indicating that the calibration process is complete.
8. Reverse the steps and return the module to operation.



I/O connector (PPX:2587705–8009)
with precision resistors installed

Note: *It is not necessary to connect inputs 5 through 8.*

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Figure 4-1 Calibration Connector Wiring

4.4 Calibration Troubleshooting

If the LED does not follow the pattern defined in the last step of Section 4.3, one or more of the calibration resistors may be out of range. Refer to the controller input values from the module. If the module is set for 16 WX, this information is available in module inputs 9–12; otherwise, these values appear in the first four module inputs. Table 4-5 shows the values.

Table 4-5 Calibration Controller Input Values

Integer	Hex	Description
32757	7FF5	Calibration data in the module EEPROM are bad. Try to recalibrate the module. If unsuccessful, return for repair.
32756	7FF4	The calibration resistor on this channel is out of acceptable range. Verify with a 0.01% ohmmeter that this resistor is within the required tolerance.
32755	7FF3	Calibration has completed with no errors. Return module to operation.

Appendix A
Typical Values for Common RTDs

These values represent average expected performance of the Series 505 RTD module alone. System performance specifications also are affected by RTD performance and any wiring impedance mismatch or variability.

Table A-1 100-ohm Platinum

Format	Range	Mean Accuracy	Repeatability	Absolute Accuracy	Resolution
°F	–328 to +1562	0.2	0.2	0.4	0.1
°C	–200 to +850	0.1	0.1	0.2	0.1
Ω	17 to 396	0.03	0.03	0.06	0.1
Integer	0 to 32000	5	5	10	1

Table A-2 10-ohm Copper

Format	Range	Mean Accuracy	Repeatability	Absolute Accuracy	Resolution
°F	–328 to +500	1.3	1	2.3	0.1
°C	–200 to +260	0.7	0.5	1.2	0.1
Ω	1.1 to 21.2	0.03	0.02	0.05	0.01
Integer	0 to 32000	51	37	88	1

Table A-3 120-ohm Nickel

Format	Range	Mean Accuracy	Repeatability	Absolute Accuracy	Resolution
°F	–112 to +527	0.2	0.2	0.4	0.1
°C	–80 to +275	0.1	0.1	0.2	0.1
Ω	65 to 402	0.03	0.03	0.06	0.1
Integer	0 to 32000	10	9	19	1

Appendix B
Typical Accuracy Versus Input Ohms

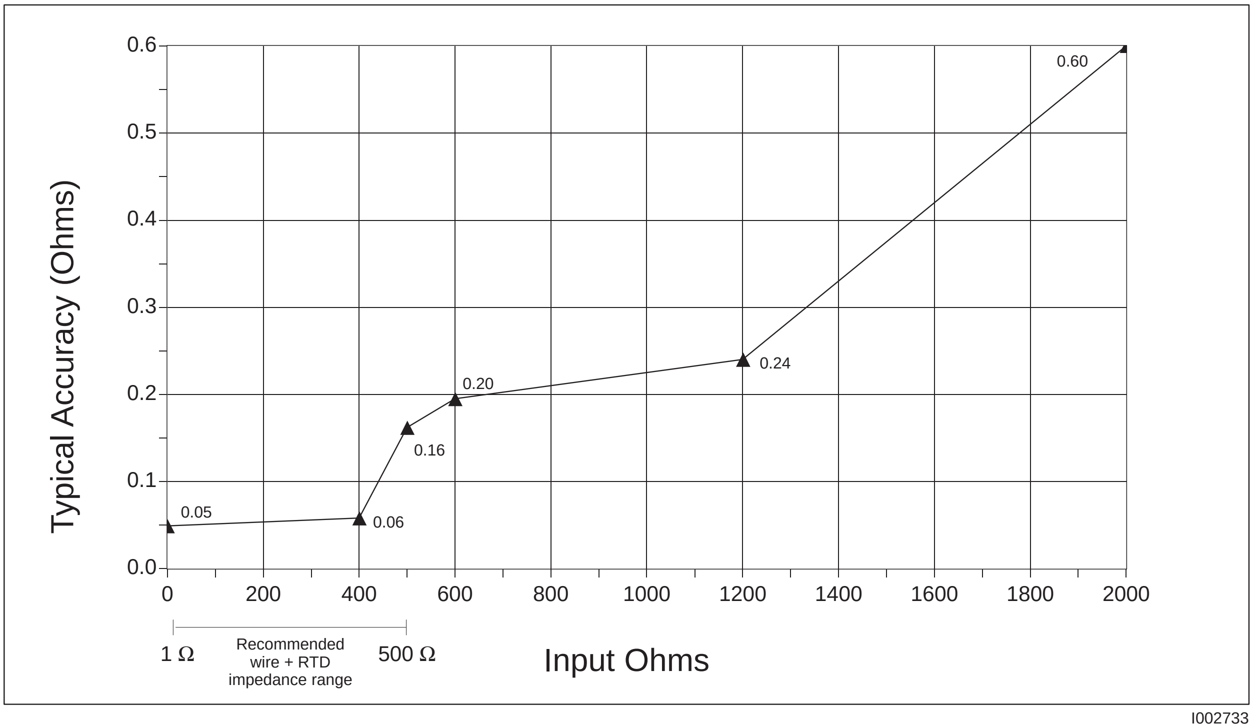


Figure B-1 Typical Accuracy Versus Input Ohms

Appendix C
RTD Temperature Versus Resistance

This appendix compares temperature and resistance values for common RTD probes.

Table C-1 Platinum 0.003850 DIN

°F	°C	100 Ω	200 Ω	500 Ω
–328	–200	18.49	36.99	92.47
–148	–100	60.25	120.51	301.27
32	0	100.00	200.00	500.00
212	100	138.50	277.00	692.50
392	200	175.84	351.68	879.20
572	300	212.02	424.04	1060.09
752	400	247.04	494.08	1235.19
932	500	280.90	561.79	1404.48
1112	600	313.59	627.19	1567.97
1292	700	345.13	690.26	1725.66
1472	800	375.51	751.02	1877.55
1562	850	390.26	780.53	1951.31

Table C-2 120-ohm Nickel

°F	°C	0.006720	DIN 0.006178
–112	–80	66.60	72.59
–58	–50	86.16	89.11
32	0	120.00	120.00
122	50	157.75	154.93
212	100	200.64	194.14
302	150	248.95	238.39
392	200	303.45	288.95
482	250	366.53	347.57
527	275	401.69	380.60

Table C-3 10-ohm Copper 0.004274

°F	°C	Ohms
–328	–200	1.17
–238	–150	3.44
–148	–100	5.68
–58	–50	7.86
32	0	10.00
122	50	12.14
212	100	14.27
302	150	16.41
392	200	18.57
482	250	20.73
500	260	21.16

Appendix D

Specifications

D.1 Physical and Environmental Specifications

Minimum torque for bezel screws	2.6 in-lb (0.3N-m)
Maximum torque for bezel screws	4.12 in-lb (0.6N-m)
Input signal wiring	Shielded, twisted cable (12–26 AWG or 0.16–3.2 mm^2, either stranded or solid-type)
Spade lug for use with connector PPX:2587705–8002	Amp part number 321462
Ring lug for use with connector PPX:2587705–8002	Amp part number 327891
Module power required from base	+5 V: 2.2 W max, 1.6 W typical –5 V: 0 W
Operating temperature	0° to 60°C (32° to 140°F)
Storage temperature	–40° to +70°C (–40° to 158°F)
Relative humidity	5% to 95% noncondensing
Pollution degree	2, IEC 664, 664A
Vibration	Sinusoidal IEC 68-2-6, Test Fc 0.15 mm peak-to-peak, 10–57 Hz; 1.0 g, 57–150 Hz Random IEC 68-2-34, Test Fdc, equivalent to NAVMAT P–9492 0.04 g^2/Hz, 80–350 Hz
Electrostatic discharge	IEC 801, Part 2, Level 4, (15 kV)
Shock	IEC 68-2-27; Test Ea
Noise immunity, conducted	IEC 801, Part 4, Level 3 MIL STD 461B CS01, CS02 and CS06; IEC 255–4 Appendix E EEC 4517/79 COM (78) 766 Final Part 4
Noise immunity, radiated	IEC 801, Part 3, Level 3; MIL STD 461B RS01, and RS02 IEC 801, Part 4, Level 3
Isolation, inputs to controller	1500 Vrms
Corrosion protection	All parts of corrosion-resistant material or plated or painted as corrosion protection

D.2 Definition of Terms

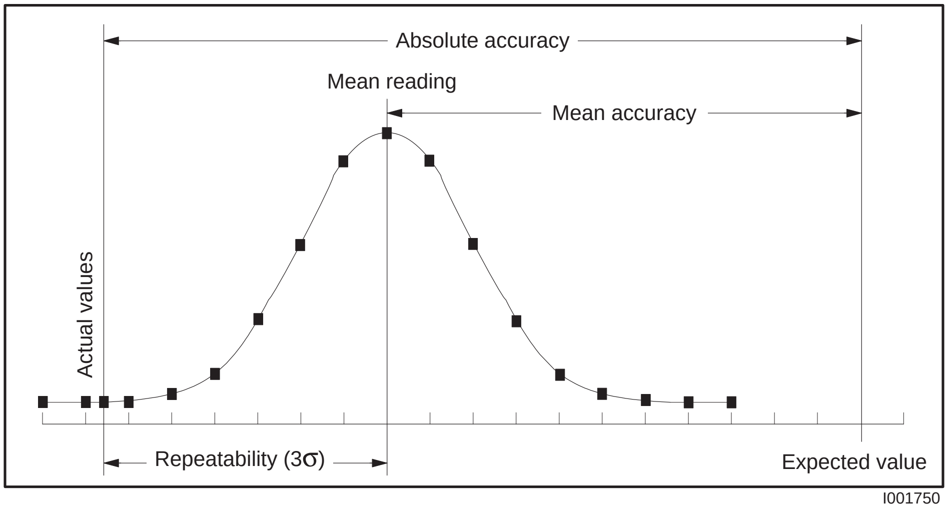


Figure D-1 Distribution of Readings

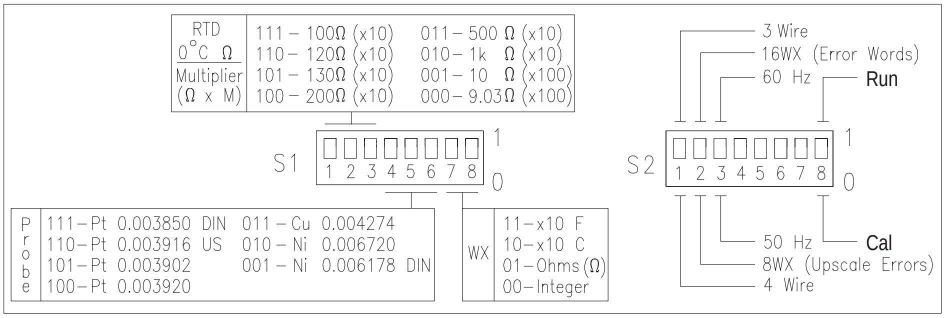
Mean Accuracy Average deviation from the expected value on a given point. The normal distribution is constructed of discrete step sizes. The mean accuracy and the three σ points are the result of statistical calculations.

Repeatability Three standard deviations from the mean reading (3σ) on a given channel. This is a measurement of the noise in the module.

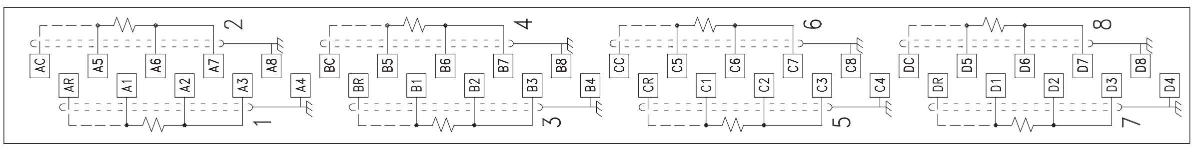
Absolute Accuracy Sum of mean accuracy and repeatability; e.g., a mean accuracy of 5 counts plus a repeatability of 5 counts yields an absolute accuracy of 10 counts.

Resolution The amount of change in the input needed to cause a one-count change in the output.

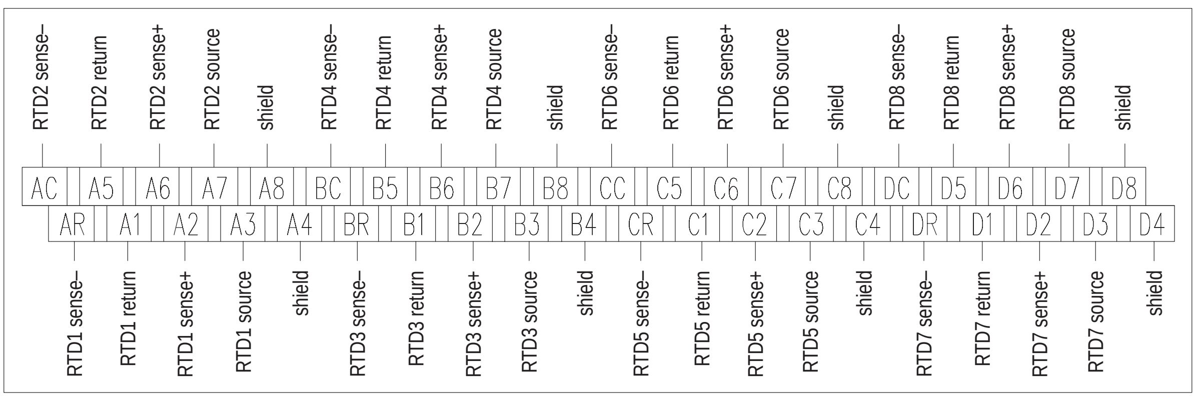
D.3 Series 505 RTD Input Module Quick Reference



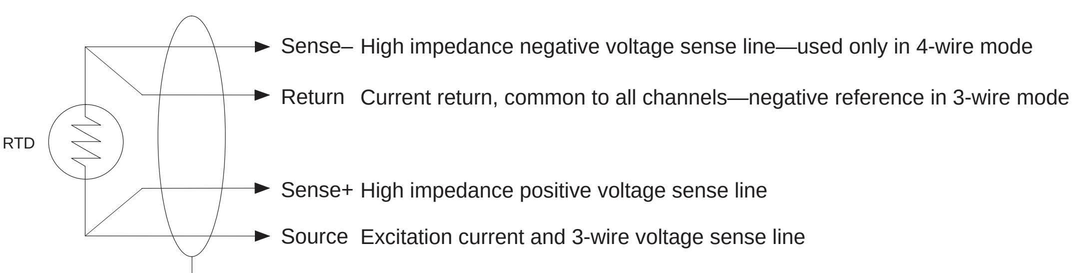
Dipswitch Label



Wiring Diagram



Pinouts



For accurate 3-wire lead compensation, match return and source lead impedances and temperature coefficients.

RTD Sensor Wiring Diagram

I002774

Features	
Inputs	8
Form Factor	Single-wide
RTD compatibility	Platinum (four types) Copper Nickel (two types) 2-, 3-, or 4-wire RTDs
Zero ° Ω	Configurable for eight different values
Input data format to the controller	°F × 10 (default) °C × 10 Ω × 10 (1.0–2000.0) Ω × 100 (1.00–320.00) Scaled counts, 0–32000
External power	None required
Calibration	Module self-calibrates continuously
Error reporting	Configurable for separate error words or upscale error codes Module automatically detects open, shorted, or out-of-range inputs
Input noise filtering	Configurable for 50/60Hz rejection
Internal resolution	0.003 Ω (19-bit)

Errors		
Signed Integer	**Hex Code**	**Problem**
32767	7FFF	Failed module
32766	7FFE	Input underrange
32765	7FFD	Input overrange
32764	7FFC	Source short
32763	7FFB	Sense short
32762	7FFA	Input not wired
32761	7FF9	Source open
32760	7FF8	Sense+ open
32759	7FF7	Sense– open
32758	7FF6	Source-to-return overrange
32757	7FF5	EEPROM fail
32756	7FF4	Cal out-of-range
32755	7FF3	Cal complete
32754	7FF2	Not used
32753	7FF1	Not used
32752	7FF0	Not used
4	0004	Four-wire mode
3	0003	Three-wire mode
0	0000	No data

Performance Specifications		Typical 20–30°C / 68–86°F	Specification Limit 0 to 60°C / 32 to 140°F
Mean accuracy (100 Ω platinum RTD)		0.1°C 0.2°F 0.03 Ω	0.6°C 1.2°F 0.25 Ω
Repeatability (100 Ω platinum RTD)		0.1°C 0.2°F 0.03 Ω	0.3°C 0.5°F 0.11 Ω
Absolute accuracy	100 Ω platinum	0.2°C 0.4°F	0.9°C 1.7°F
	Ω × 100	0.06 Ω	0.36 Ω
	Ω × 10	0.1 Ω + 0.05% of input Ω	0.1 Ω + 0.2% of input Ω
Common-mode rejection		100 dB	—
Normal-mode rejection at line frequency ±0.01 Hz		80 dB	—
Normal-mode rejection at line frequency ±3 Hz		25 dB	—
Update time per active input: all inputs <470 Ω		<110 ms @ 60 Hz filter	<120 ms @ 50 Hz filter
Step response time: 100 Ω platinum RTD		250 ms × number of active inputs	
Step response time: inputs to 2 kΩ		625 ms × number of active inputs	
Base power	+5 V	2.2 W max, 1.6 W typical	
	–5 V	0 W	
Isolation (inputs to controller)		1500 Vrms	

Probe Temperature Ranges	Platinum	Copper	Nickel
°F × 10	–328.0 to 1562.0	–328.0 to 500.0	–112.0 to 527.0
°C × 10	–200.0 to 850.0	–200.0 to 260.0	–80.0 to 275.0

Series 505
Resistance Temperature Detector
Input Module

Advance Information

Feature List

- Eight channels in a single-wide Series 505 I/O module
- Supports standard RTDs (settings same for all eight channels
  - Selection from industry standard RTD materials/alpha types

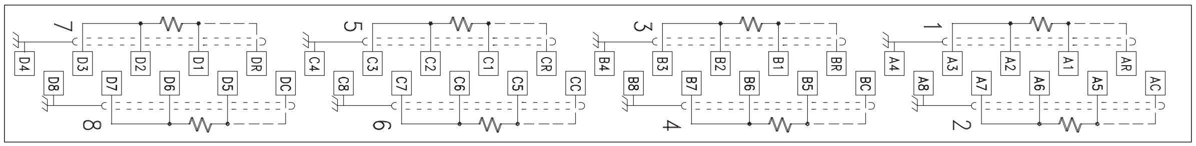
Platinum	0.003850	European DIN Standard
	0.003916	American Curve
	0.003900	(0.003902 also)
Nickel	0.006178	European DIN Standard
	0.006720	
Copper	0.004274	

  - Selection from commonly available zero degree ohm values

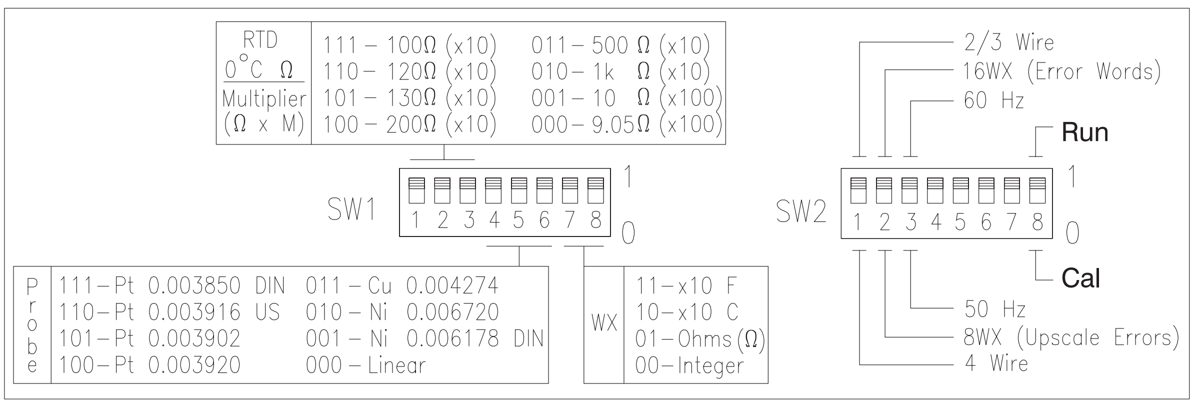
100	9.05	(10Ω at 25°C)
120	10.00	
130	500	
200	1000	(limited support)

- No user calibration required (module continually performs self-calibration)
- Option for direct ohms input for use with other resistive sensors
- Automatic lead wire compensation up to 500Ω for three-wire RTDs
- Errors cause no change in input values
  - Reported in separate inputs
  - Data maintained at last valid value when error occurs
  - Separate bits for opens, shorts, underrange, overrange, wiring error, and setup error
  - Option available for traditional 8WX with errors overwriting data
- Accuracy: 0.1°C typical (0.5°C over full operating ranges)
- Resolution: 0.1°C or °F, .1/.01Ω, or 1 in 32000 counts
- Repeatability: 0.1°C
- Common-mode noise rejection: 120dB
- Normal-mode noise rejection: 80dB @ 60Hz (deviation <0.01Hz)
  30dB @ 60Hz (deviation <3Hz)
- Update speed: 120ms per channel; 960ms for all eight channels
- 2.5 or 1mA current source pulsed to RTD being measured
- Standard Series 505 front-accessible/removable 40-pin connector

Advance Information concerns new products in the preproduction phase of development.
Characteristic data and other specifications are subject to change without notice.



Field Wiring Connector Label



Dipswitch Settings

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