

**CTI 2551 EIGHT CHANNEL  
ISOLATED THERMOCOUPLE INPUT MODULE  
INSTALLATION AND OPERATION GUIDE**

**Version 2.1  
CTI Part #062-00107**

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## PREFACE

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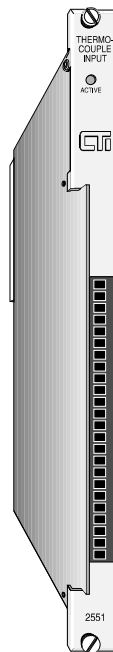
This *Installation and Operation Guide* provides installation and operation instructions for the CTI 2551 Eight Channel Isolated Thermocouple Input Module for SIMATIC® 505 programmable controllers. We assume you are familiar with the operation of SIMATIC® Series 505 programmable controllers. Refer to the appropriate SIMATIC® user documentation for specific information on the SIMATIC® 505 programmable controllers and I/O modules.

This *Installation and Operation Guide* is organized as follows:

Chapter 1 provides a description and software information for the module.

Chapter 2 covers installation and wiring.

Chapter 3 is a guide to troubleshooting.



**Figure 1** 2551 8-Channel Isolated Thermocouple Input Module



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## **USAGE CONVENTIONS**

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***NOTE:***

*Notes alert the user to special features or procedures.*

***CAUTION:***

*Cautions alert the user to procedures which could damage equipment.*

***WARNING:***

*Warnings alert the user to procedures which could damage equipment and endanger the user.*



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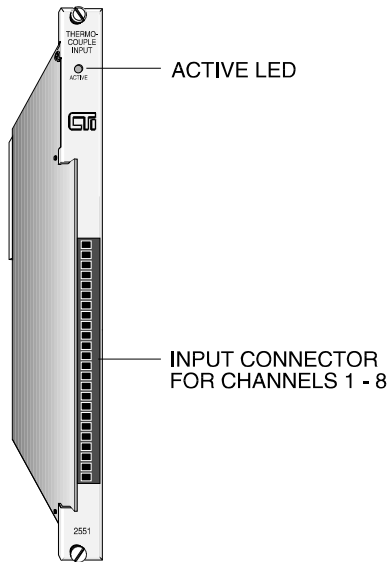
## CHAPTER 1. DESCRIPTION

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The Eight Channel Thermocouple Input Module is a member of Control Technology's family of I/O modules compatible with the SIMATIC® 505 Series programmable controllers. The Model 2551 is designed to translate a J or K thermocouple or millivolt input signal into an equivalent digital word which is then sent to the programmable controller (PLC).

The 2551 Thermocouple Input Module features built-in independent internal cold junction compensation for each thermocouple input for Types J, K, E, R, S, and T. No external cold junction compensation is required. Types R, S, E, and T thermocouples will be supported with internal cold junction compensation; however, a custom EPROM is required in order to support these additional thermocouple types. This is available by request only. Call CTI at 1-800-537-8398.

### 1.1 Front Panel Description



**Figure 2** 2551 Front Panel Description

### ***1.1.1 Active LED***

The Active LED will be illuminated when the module is functioning normally. If the Active LED is not lit, refer to Chapter 3 for troubleshooting.

### ***1.1.2 Input Connector for Channels 1-8***

The Model 2551 uses a fixed wiring connector to minimize the effects of the connector metallurgy on the accuracy of the measurement. This connector provides wiring terminals for channels 1-8.

## ***1.2 Asynchronous Operation***

The module operates asynchronously with respect to the PLC; a scan of the PLC and input sampling of the module do not occur at the same time. Instead, the module will translate all inputs in one module update (15 milliseconds maximum) and store the translated words in a buffer memory. The PLC retrieves the stored words from the module buffer memory at the start of the I/O scan.

### ***1.2.1 Immediate I/O Compatibility***

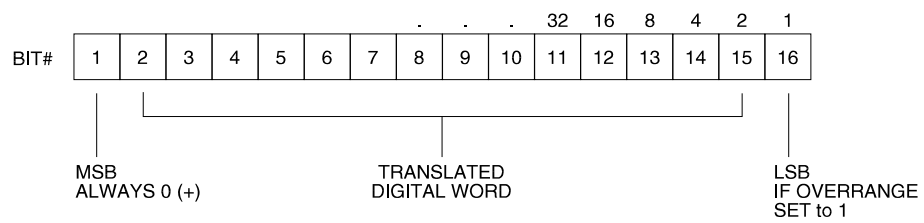
The Model 2551 has been tested and is compatible with the Immediate Read function of the SIMATIC® 545 and 555 PLC.

## ***1.3 J or K Thermocouples***

Each of the module's eight channels may be configured to receive either J or K thermocouple input signals or a DC voltage signal ranging from 0 to 55 millivolts. Selection of J or K thermocouples or millivolts are made via internal switch settings (see sections 2.4.3 and 2.4.4).

## ***1.4 Digital Word Map***

Thermocouple and/or millivolt signals are translated into a 14-bit digital word. Since the PLC requires a 16-bit input word, the 14-bit value from the converter is placed into a 16-bit word for transmittal to the PLC. As shown in the following figure, of the two bits not used for the digital word, one is used to show the sign of the word, while the other is used to note values which are "overrange."



**Figure 3** *Word Input to the PLC from the Module*

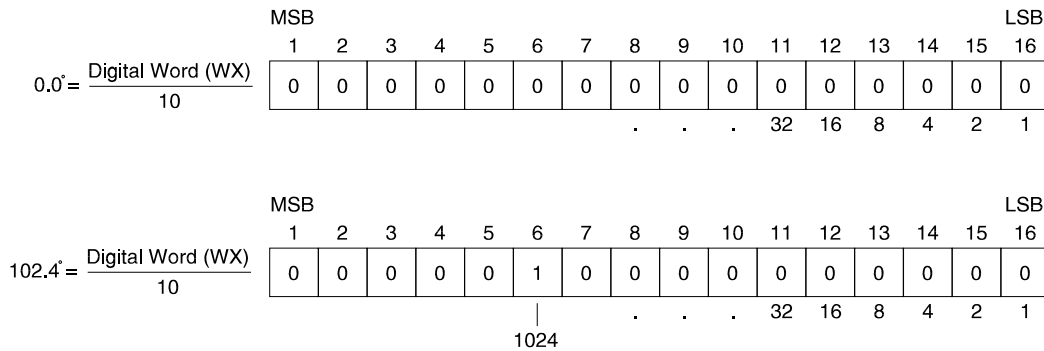
### 1.5 Thermocouple Input to Digital Conversion

The following equations may be used to calculate the digital word in decimal format which will result from a particular thermocouple input:

$$\text{Thermocouple Mode, Digital Word (WX)} = \text{Degrees} \times 10$$

$$\text{Millivolt Mode, Digital Word (WX)} = \text{Millivolts} \times 100$$

As an example, the following figure illustrates the effects of a change in input level going from 0° to



**Figure 4** Example Change in Input Level

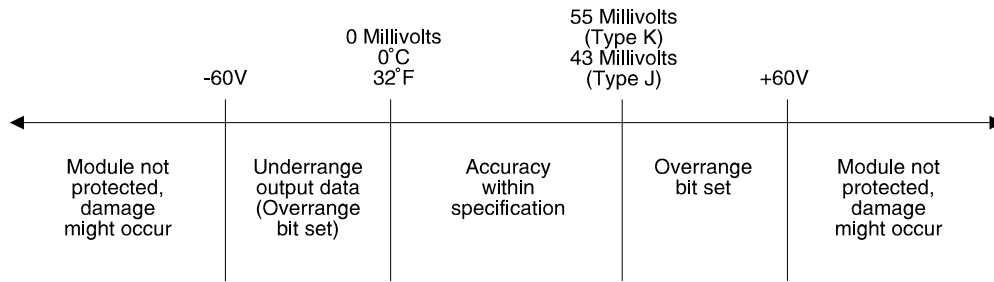
102.4°F in the Thermocouple Input Mode.

### 1.6 Effect of Out-of-Range Input Signals

Thermocouple inputs exceeding the ANSI standard of 760 degrees C for Type J or 1372 degrees C for Type K will cause the overrange bit to be set and the maximum temperature for that Thermocouple type to be returned. Temperatures below 0°C (32°F) will cause 0°C (32°F) to be read by the PLC and the overrange bit to be set.

The Model 2551 uses the least significant bit (16) to indicate an open thermocouple. The value of this bit is set to 1 when this condition occurs.

Open thermocouples report temperatures that are out of the allowable range. This condition may occur due to failure of the thermocouple or due to the thermocouple wire being cut or disconnected.



**Figure 5** *Effect of Voltage Input on Module Performance*

### 1.7 Resolution

The module has a resolution of approximately 0.3°C, 0.6°F or exactly 0.02 millivolts.

The chart below shows the corresponding input resolution per step for each of the input configuration modes :

UNITS	DIGITAL COUNTS/STEP	INPUT RESOLUTION PER STEP
Temp Degrees C	2	~ 0.3°C
Temp Degrees F	2	~ 0.6°F
Millivolts	2	0.02 Millivolts

**Figure 6** *Input Resolution*





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## CHAPTER 2. INSTALLATION

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The installation of the Eight Channel Thermocouple Input Module involves the following steps:

1. Planning the installation
2. Configuring the module
3. Inserting the module into the I/O base
4. Wiring the module input connector
5. Checking module operation

The steps listed above are explained in detail in the following pages.

### ***2.1 Planning the Installation***

Planning is the first step in the installation of the module. This involves calculating the I/O base power budget and routing the input signal wiring to minimize noise. The following sections discuss these important considerations.

### ***2.2 Calculating the I/O Base Power Budget***

The Model 2551 requires 2.4 watts of +5 VDC power from the I/O base. Use these values to verify that the base power supply capacity is not exceeded.

### ***2.3 Unpacking the Module***

Open the shipping carton and remove the special anti-static bag which contains the module.

***CAUTION:***

*The components on the 2551 module printed circuit card can be damaged by electricity discharge. To prevent this damage, the module is shipped in a special anti-static bag. Take the following precautions before removing the module from the bag, when opening the module, and when handling the printed circuit card during configuration.*

After discharging any static build-up, remove the module from the static bag. Do not discard the static bag. You will need it for the following configuration procedure.

## 2.4 Configuring the Module

The Model 2551 must be configured for J or K thermocouples or millivolt range and digital filtering/no filtering mode before wiring the input connectors and inserting the module into the I/O base.

**NOTE:**

*As shipped, all input channels are configured for J type thermocouples (degrees Celsius) and digital filtering enabled (see Figure 7).*

Changing the module input channel configuration involves the following steps:

1. Selecting J or K input mode for each channel
2. Selecting digital filtering or no filtering for the module
3. Selecting millivolt input if using in millivolt mode
4. Selecting degrees Celsius or Fahrenheit
5. Logging the configuration jumper settings for future reference

Each of these steps is described in the following sections.

### 2.4.1 Selecting J or K Thermocouple Input Mode

Locate the 8 J/K Thermocouple Compensation Jumpers corresponding to input channels 1 through 8. These jumpers are located adjacent to the input terminal strip (see Figures 7 and 8). For each input channel, select J thermocouple input mode by placing the jumper in the "J" position, or K thermocouple input mode by placing the jumper in the "K" positions.

Locate DIP switch 1 (Thermocouple Type Switches in Figure 8) on the Model 2551 circuit card and select either J or K type thermocouple for each of the eight inputs by turning each switch on or off. The "ON" position corresponds to type J thermocouple input.

### 2.4.2 Selecting Digital Filtering

Locate the Digital Filtering Jumper JP3 (see Figures 7 and 8). To enable digital filtering, set the jumper in the "ENABLED" position. Since many analog input signals contain noise, CTI recommends using digital filtering unless maximum response time is required. Digital filtering applies to both thermocouple or millivolt inputs.

The time step for digital filtering is .3 seconds. The filtering technique used provides that the full range of a voltage change reported to the PLC will be accomplished in 5 time steps or 1.5 seconds. The voltage change will be reported as a continuous exponential function over this time period with values at each time step as indicated:

- at .3 seconds, the value is 63% of full range;
- at .6 seconds, the value is 86% of full range;
- at .9 seconds, the value is 95% of full range, and;
- at 1.2 seconds, the value is 99% of full range.

Time steps of different duration may be ordered as a special option.

### ***2.4.3 Select Temperature or Millivolt Input***

Locate DIP switch 2 (Temperature/Millivolt Switches in Figure 8) on the Model 2551 card. The 8 switches may be set individually, to either Temperature (place the switch to the "ON" position) or to Millivolt (place the switch to the "OFF" position).

For millivolt operation, the selection of J or K thermocouple described in Section 2.4.1 does not matter.

Wiring requirements are shown in Figures 10 and 11. To maintain accuracy specifications, CTI recommends that thermocouple extension wiring to the Model 2551 be of the same type as the thermocouple leads. Note that the aggregate wiring size for the shield wiring that can be accommodated by the terminal is 14 AWG. For millivolt operation, the G terminal will accept two 18 AWG or smaller wires.

For temperature operation the value reported to the PLC should be divided by 10. Hence, the value 1024 means 102.4 degrees.

For millivolt operation the value reported to the PLC should be divided by 100. Hence, the value 1024 means 10.24 millivolts.

### 2.4.4 Select Degrees Celsius or Fahrenheit

Locate the temperature scaling jumper JP4 on the right hand side of the module (see Figure 7) and select either degrees Celsius or Fahrenheit by positioning the jumper in the "DEG F" or "DEG C" position.

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siti  
on.

CHANNEL NUMBER	3 WIRE / 4 WIRE RTD COMPENSATION JUMPER	POSITION (BOTTOM TOP)				SWITCH POSITION VS CHANNEL # SW1 & SW2	THERMOCOUPLE TYPE SWITCHES (SW1)		TEMP / MILLIVOLT SWITCHES (SW2)	
		1	2	3	4		OFF	ON	OFF	ON
1	JP5	J	K,T	R,S	*	1	K	J	Millivolts	Temp
2	JP6	J	K,T	R,S	*	2	K	J	Millivolts	Temp
3	JP7	J	K,T	R,S	*	3	K	J	Millivolts	Temp
4	JP8	J	K,T	R,S	*	4	K	J	Millivolts	Temp
5	JP9	J	K,T	R,S	*	5	K	J	Millivolts	Temp
6	JP10	J	K,T	R,S	*	6	K	J	Millivolts	Temp
7	JP11	J	K,T	R,S	*	7	K	J	Millivolts	Temp
8	JP12	J	K,T	R,S	*	8	K	J	Millivolts	Temp

ALL CHANNELS 1-8	CALIBRATION JUMPER	DIGITAL FILTERING JUMPER	FAHRENHEIT / CENTIGRADE SELECT
		JP2 UP - Run DOWN - Calibrate*	JP3 UP - Filtering Disabled DOWN - Filtering Enabled

\* NOTE: These modules are factory calibrated and do not require customer calibration. Do not place jumpers in Position 4.

Figure 7 Factory Configuration Jumper Settings

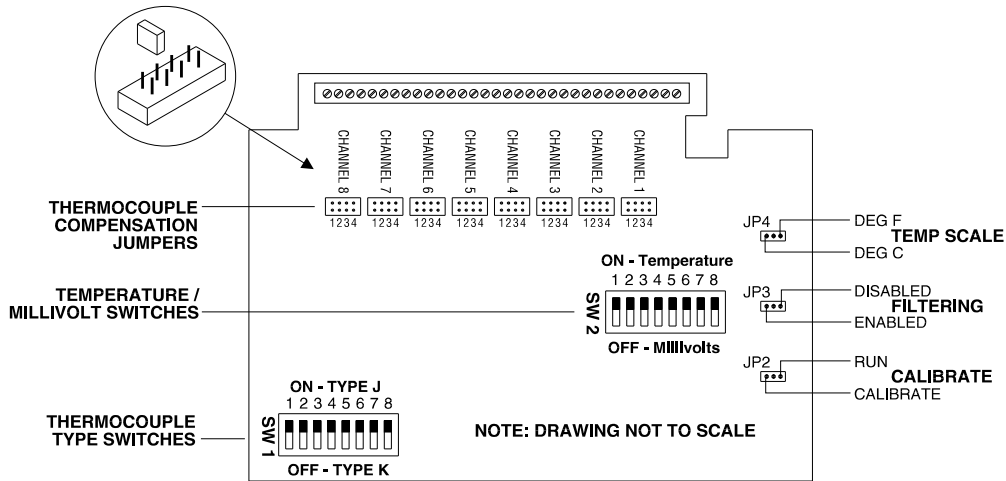


Figure 8 Configuration Jumper Location

## 2.5 Inserting the Module Into the I/O Base

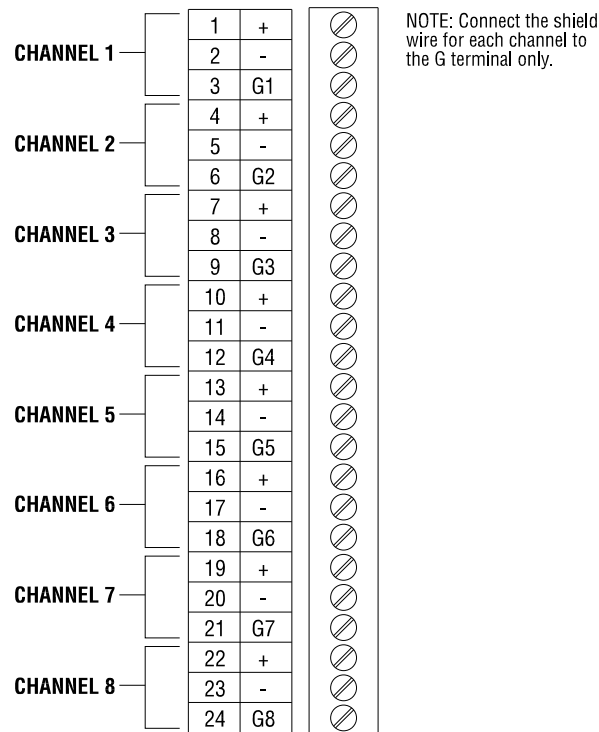
**WARNING:**  
Remove power from the I/O base before inserting or removing a module.

Insert the module into the I/O base by carefully pushing the module into the slot. When the module is fully seated in the slot, tighten the captive screws at the top and bottom to hold the module in place. To remove the module from the I/O base, loosen the captive screws, then remove the module from the I/O base. Be careful not to damage the connector card at the back of the module when inserting or removing the module.

## 2.6 Wiring the Input Connectors

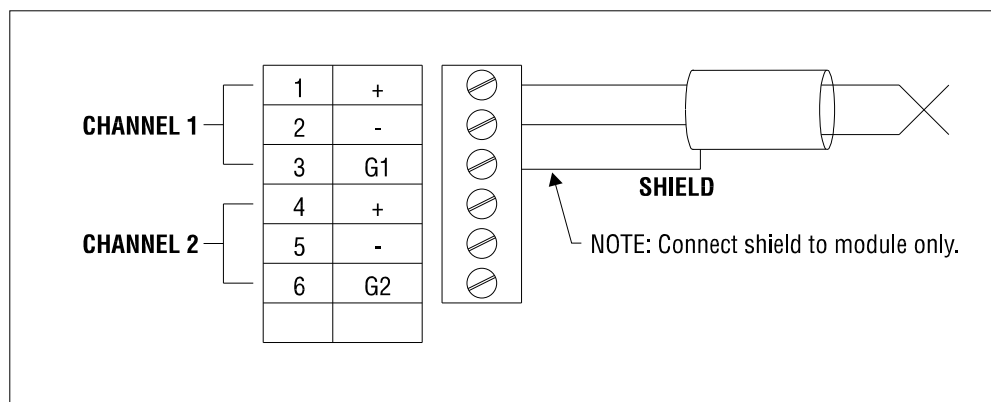
Thermocouple input signals are accepted through a screw terminal connector block located on the front of the module. Consult the thermocouple manufacturer's recommendations for selecting the input wire type and size.

To assign an input to a specific channel, locate the appropriate channel position on the screw terminal block as shown in the following figure:

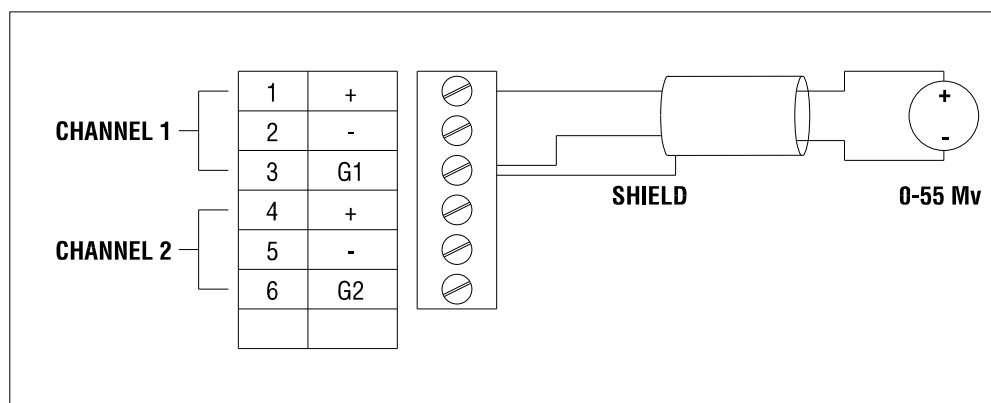


**Figure 9** Screw Terminal Block Wiring





**Figure 10** *Thermocouple Wiring Application*



**Figure 11** *Millivolt Wiring Application*

**NOTE:**

*If a separate shield is used for Thermocouple or Millivolt measurements it should be terminated at screw position Gn of each channel group. The shielding for the cable should always be terminated at the Model 2551. Each isolated input channel contains its own local ground for the shield wire. The input isolation amplifier is designed in this manner by the manufacturer. Standard practices usually require that all shields be tied together and grounded at a single point. In an isolated system this will actually impede the system to reject noise. The correct method for terminating the shields on an isolated channel is to connect them to the channel's local ground. This will provide the best performance. There should never be any shield termination at the source end of the signal wire.*



## 2.7 Checking Module Operation

First, turn on the base supply power. If the module diagnostics detect no problems, the status indicator on the front of the module will light. If the status indicator does not light (or goes out during operation), the module has detected a failure. For information on viewing failed module status, refer to your SIMATIC® TISOFT user manual. To diagnose and correct a module failure, refer to the next section on troubleshooting.

You must also check that the module is configured in the memory of the PLC. This is important because the module will appear to be functioning regardless of whether it is communicating with the PLC. To view the PLC memory configuration chart listing all slots on the base and the inputs or outputs associated with each slot, refer to your SIMATIC® TISOFT Programming Manual. An example chart is shown in the Figure 12.

**NOTE:**  
*If thermocouples are not available for testing, the module will report ambient temperature by simply jumpering the (+) and (-) terminals with a short wire 26-18 gauge.*

In this example, the Model 2551 Module is inserted in slot 1 in I/O base 0. Data for channel 1 appears in word location WX1, data for channel 2 appears in word location WX2, etc. For your particular module, look in the chart for the number corresponding to the slot occupied by the module. If word

I/O MODULE DEFINITION FOR CHANNEL . . . . . 1					BASE . . . . . 00		
SLOT	I/O ADDRESS	X	Y	WX	WY	SPECIAL FUNCTION	
01	0001	00	00	<b>08</b>	00	NO	
02	0002	00	00	00	00	NO	
.	.	.	.	.	.	.	
.	.	.	.	.	.	.	
15	0000	00	00	00	00	NO	
16	0000	00	00	00	00	NO	

**Figure 12** Example I/O Configuration Chart

memory locations appear on this line, then the module is registered in the PLC memory and the module is ready for operation.



If the line is blank or erroneous, re-check the module to ensure that it is firmly seated in the slots. Generate the PLC I/O configuration chart again. If the line is still incorrect, contact your local distributor or CTI at 1-800-537-8398 for further assistance.

***NOTE:***

*Refer to Hewlett-Packard Applications Note 290 or Omega Temperature Handbook, Volume 26, Section T, for "practical thermocouple measurement" applications.*

***CAUTION:***

For proper operation, ensure that the Model 2551 and the thermocouple wires are not subjected to large temperature gradients during operation.



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## CHAPTER 3. TROUBLESHOOTING

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If the module provides improper readings or the status indicator is not on, use the following chart to determine the appropriate corrective action.

When it is inconvenient to visually check the status indicator, use the TISOFT "Display Failed I/O" or "Show PLC Diagnostics" support functions. Note that if the module power supply (user supply) fails, the module will still be logged into the PLC even though it is not operating. In this case, "Display Failed I/O" will not provide the information to accurately diagnose the problem.

If after consulting the chart above, you are unable to diagnose or solve the problem, contact your local

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Indicator is not lit	Base or PLC power is off	Turn base or PLC on
	Wrong connections	Trace wiring to check connections
Incorrect inputs	Wrong addresses for word input	Check program for correct word input addresses
	Not logged-in	Read I/O configuration
	Incorrectly calibrated	Return the module to CTI for calibration. DO NOT CALIBRATE.
Input does not work with PID loop or analog alarm block	Blown fuse	Return the module to CTI for service
	Value is not reported as integer 0-32000	Call special function in PID block and analog alarm block
Value is too large	Temperature is reported to PLC as value X10	Divide value by 10 in PLC
Incorrect values to PLC	Compensation jumpers in wrong position	Verify position of cold junction compensation jumpers for each channel
Values off by 10-15 degrees	Linearization DIP switch	Verify SW1 is set to correct position for thermocouple type selected

**Figure 13** *Troubleshooting Matrix*

distributor or CTI at 1-800-537-8398 for further assistance.



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## ***SPECIFICATIONS***

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Channels Per Module:	Eight
Size:	Single wide SIMATIC® 505 module
Millivolt Signal Range:	0 to +55 millivolts full scale
Standard Thermocouple Types:	J, 0 to 760°C (32-1400°F) K, 0 to 1372°C (32-2501°F) selectable channel by channel
Special Order Types:	C, 0 to 2320°C E, 0 to 1000°C R, 0 to 1768°C and S, 0 to 1768°C selectable channel by channel T, 0 to 400°C
Isolation (channel-to-channel):	1500 VDC
Isolation (channel-to-PLC):	1500 VDC
Resolution:	20uV or 0.03% of full scale Degrees C or F resolution value +/- .3°C, +/- .6°F
Repeatability:	20uV or 0.03% of full scale
Input Impedance:	>10 KiloOhm @ 60Hz >1000 MegaOhm @ DC
Common-mode Rejection:	>110dB @ 60 Hz
Normal-mode Rejection:	>45dB @ 50/60 Hz (digital filtering enabled)
Input Protection:	20,000 Volts ESD 120 VAC +input to -input 60 VAC +input to common 60 VAC -input to common

Accuracy (0 to 60°C): for J Thermocouples:	+/- 1°C, from 0 - 760°C +/- 2°F, from 32 - 1400°F
for K Thermocouples:	+/- 1°C, from 0 - 1372°C +/- 2°F, from 32 - 2501°F
for Millivolts	0 - 55 mV, +/- 0.06 mV or 0.1% full scale
Input Bandwidth @ -3dB point: (digital filtering disabled) (digital filtering enabled)	5.5 Hz 0.16 Hz (single pole filter)
Filtering Time Constant: (digital filtering disabled) (digital filtering enabled)	50 mV step input, 28 mS 50 mV step input, 1 second
Update Time:	<15 mS for all eight channels
Open Thermocouple Reporting:	to PLC as least significant bit number 16 set to one
Cold Junction Compensation:	Built in and automatic for thermocouple types J, K, E, T, R, and S
Field Wiring Connector:	Accepts 18 - 26 AWG (non removable)
Module Power from Base:	2.4W @ 5VDC
Operating Temperature:	0 to 60°C 32 to 140°F
Relative Humidity:	5% to 95% non-condensing
Agency Approvals:	UL, UL Canada, FM (Class I, Div 2), CE

***Specifications subject to change without notice.***



## JUMPER SETTINGS LOG SHEET

Record the configuration jumper settings on this log for future reference. Make additional copies if necessary.

CHANNEL NUMBER	3 WIRE / 4 WIRE RTD COMPENSATION JUMPER	POSITION (BOTTOM TOP)				SWITCH POSITION VS CHANNEL # SW1 & SW2	THERMOCOUPLE TYPE SWITCHES (SW1)		TEMP / MILLIVOLT SWITCHES (SW2)	
		1	2	3	4		OFF	ON	OFF	ON
1	JP5	J	K,T	R,S	*	1	K	J	Millivolts	Temp
2	JP6	J	K,T	R,S	*	2	K	J	Millivolts	Temp
3	JP7	J	K,T	R,S	*	3	K	J	Millivolts	Temp
4	JP8	J	K,T	R,S	*	4	K	J	Millivolts	Temp
5	JP9	J	K,T	R,S	*	5	K	J	Millivolts	Temp
6	JP10	J	K,T	R,S	*	6	K	J	Millivolts	Temp
7	JP11	J	K,T	R,S	*	7	K	J	Millivolts	Temp
8	JP12	J	K,T	R,S	*	8	K	J	Millivolts	Temp

ALL CHANNELS	CALIBRATION JUMPER	DIGITAL FILTERING JUMPER	FAHRENHEIT / CENTIGRADE SELECT
1-8	JP2 UP - Run DOWN - Calibrate*	JP3 UP - Filtering Disabled DOWN - Filtering Enabled	JP4 UP - Degrees F DOWN - Degrees C

\* NOTE: These modules are factory calibrated and do not require customer calibration. Do not place jumpers in Position 4.

**Figure 14** Factory Configuration Jumper Settings

**NOTE:**  
*The Model 2551 Thermocouple Input Module is calibrated at the factory. No further calibration is required. All calibration parameters are sorted in non-volatile memory. There are no user adjustments on this product.*



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***USER NOTES***

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## **LIMITED PRODUCT WARRANTY**

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CTI warrants that this CTI Industrial Product shall be free from defects in material and workmanship for a period of one (1) year after purchase from CTI or from an authorized CTI Industrial Distributor. This CTI Industrial Product will be newly manufactured from new and/or serviceable used parts which are equal to new in the Product.

Should this CTI Industrial Product fail to be free from defects in material and workmanship at any time during this one (1) year warranty period, CTI will repair or replace (at its option) parts or Products found to be defective and shipped prepaid by the customer to a designated CTI service location along with proof of purchase date and associated serial number. Repair parts and replacement Product furnished under this warranty will be on an exchange basis and will be either reconditioned or new. All exchanged parts or Products become the property of CTI. Should any Product or part returned to CTI hereunder be found by CTI to be without defect, CTI will return such Product or part to the customer.

This warranty does not include repair of damage to a part or the Product resulting from: failure to provide a suitable environment as specified in applicable Product specifications, or damage caused by an accident, disaster, acts of God, neglect, abuse, misuse, transportation, alterations, attachments, accessories, supplies, non-CTI parts, non-CTI repairs or activities, or to any damage whose proximate cause was utilities or utility like services, or faulty installation or maintenance done by someone other than CTI.

Control Technology Inc. reserves the right to make changes to the Product in order to improve reliability, function, or design in the pursuit of providing the best possible Product. CTI assumes no responsibility for indirect or consequential damages resulting from the use or application of this equipment.

**THE WARRANTY SET FORTH ABOVE IN THIS ARTICLE IS THE ONLY WARRANTY CTI GRANTS AND IT IS IN LIEU OF ANY OTHER IMPLIED OR EXPRESSED GUARANTY OR WARRANTY ON CTI PRODUCTS, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE AND IS IN LIEU OF ALL OBLIGATIONS OR LIABILITY OF CTI FOR DAMAGES IN CONNECTION WITH LOSS, DELIVERY, USE OR PERFORMANCE OF CTI PRODUCTS OR INTERRUPTION OF BUSINESS, LOSS OF USE, REVENUE OR PROFIT. IN NO EVENT WILL CTI BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**

SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR CONSUMER PRODUCTS, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU.

THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY FROM STATE TO STATE.



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## ***REPAIR POLICY***

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In the event that the Product should fail during or after the warranty period, a Return Material Authorization (RMA) number can be requested verbally or in writing from CTI main offices. Whether this equipment is in or out of warranty, a Purchase Order number provided to CTI when requesting the RMA number will aid in expediting the repair process. The RMA number that is issued and your Purchase Order number should be referenced on the returning equipment's shipping documentation. Additionally, if under warranty, proof of purchase date and serial number must accompany the returned equipment. The current repair and/or exchange rates can be obtained by contacting CTI's main office at 1-800-537-8398.

When returning any module to CTI, follow proper static control precautions. Keep the module away from polyethylene products, polystyrene products and all other static producing materials. Packing the module in its original conductive bag is the preferred way to control static problems during shipment. **Failure to observe static control precautions may void the warranty.** For additional information on static control precautions, contact CTI's main office at 1-800-537-8398.