**CTI 2559-TC**
**EIGHT POINT THERMOCOUPLE MODULE**
**INSTALLATION AND OPERATION GUIDE**
**Version 1.2**

**DOCUMENT DISCLAIMER STATEMENT**

Every effort has been made to ensure the accuracy of this document; however, errors do occasionally occur.  CTI provides this document on an "as is" basis and assumes no responsibility for direct or consequential damages resulting from the use of this document.  This document is provided without express or implied warranty of any kind, including but not limited to the warranties of merchantability or fitness for a particular purpose.  This document and the products it references are subject to change without notice.  If you have a comment or discover an error, please call us toll-free at 1-800-537-8398.

**REVISION HISTORY**

| Version 1.0 | 8/14/02 | Original Release |
|---|---|---|
| Version 1.1 | 9/23/04 | Changed manual to reflect changes in scaling operation |
| Version 1.2 | 4/21/2020 | Major edits, Added new product pics and corrected mV info |

# *PREFACE*

This *Installation and Operation Guide* provides installation and operation instructions for the CTI 2559-TC Eight-Point Thermocouple Input Model for SIMATIC® 505 programmable controllers. We assume you are familiar with the operation of SIMATIC® 505 programmable controllers. Refer to the appropriate 505 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 of the module.
Chapter 2 covers installation and wiring.
Chapter 3 is a guide to troubleshooting.
Appendix A details compatibility between the 2559-TC and the Siemens® 505-7028-A.

**The Model 2559-TC 8-Pt Thermocouple Module**

# *USAGE CONVENTIONS*

---

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

---

*CAUTION:*
*Cautions alert the user to procedures that could damage equipment.*

---

**WARNING:**
**Warnings alert the user to procedures that could damage equipment and endanger the user.**

---

# TABLE OF CONTENTS

# TABLE OF FIGURES

# CHAPTER 1. OVERVIEW

## 1.0. Product Summary

The CTI 2559-TC Eight-Point Thermocouple Module is a member of Control Technology's family of I/O modules compatible with the SIMATIC® 505 programmable controllers. It is designed to translate a J, K, T, E, R, S, N thermocouple or millivolt input signals from the thermocouple element into an equivalent digital word which is then sent to the programmable controller (PLC).

## 1.1. Front Panel Description

ACTIVE LED

TEMPERATURE SENSOR A

CHANNELS 1 – 8
FOR COMPLETE WIRING
DIAGRAM SEE *Figure 21
Screw Terminal Connector
Wiring*

TEMPERATURE SENSOR B
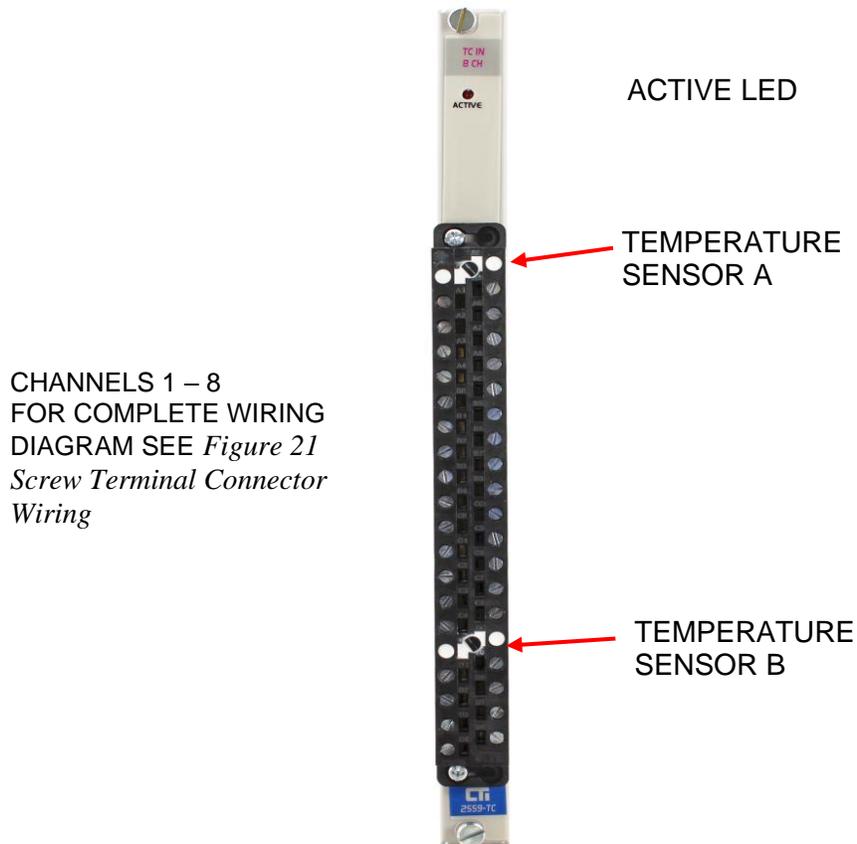
**Figure 1 CTI 2559-TC FRONT PANEL**

### 1.1.1. Active LED

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

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

The 2559-TC utilizes a modified 505 connector (a standard 505 connector is NOT interchangeable – see section 2.5 for details) to provide wiring terminals for Channels 1-8 thermocouple inputs and two temperature (cold junction compensation) sensors. The wiring connector accepts 14-22 AWG wire.

## 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 thermocouple inputs in one module update (9 milliseconds maximum) and store the translated words in buffer memory. The PLC retrieves the stored words from the module buffer memory at the start of the I/O scan.

## 1.3. Immediate I/O

The 2559-TC has been tested and is fully compatible with the immediate input instruction for the TI545 and 555 PLCs.

## 1.4. J, K, T, E, R, S, N, and mV Thermocouples

Each of the module's 8 channels may be configured to receive either J, K, T, E, R, S, N, or mV thermocouple input signals. Selection of thermocouple type or millivolts is made via internal dip switch settings and hardware jumpers (see 2.3. Configuring the Module).

## 1.5. Digital Word Map

Thermocouple and/or millivolt signals are translated into a 15-bit plus sign digital word. Since the PLC requires a 16-bit input word, the 15-bit value from the converter is placed into a 16-bit word for transmittal to the PLC, the extra bit being used to show the sign of the word.
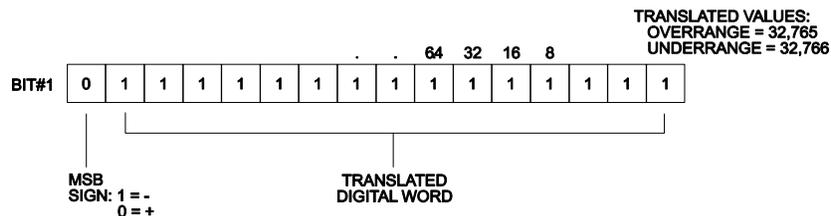


**Figure 2 Word Input to the PLC from the Module**

# 1.6. Thermocouple Input to Digital Conversion

## 1.6.1. Engineering Units

When module SCALING is disabled, data is reported as engineering units to the PLC as follows:

Thermocouple Mode, digital word (WX) = Degrees x 10
Millivolt Mode, digital word (WX) = -11,000 to +11,000

As an example, the following Figure 1.3 illustrates the effects of a change in input level going from 0 to 102.4°F in the Thermocouple Input Mode.

Example 1:

**0.0°F = (Digital Word (WX))/10**

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 |
| . | . | . | . | . | . | . | . | . | . | 32 | 16 | 8 | 4 | 2 | 1 |

Example 2:

**102.4°F = (Digital Word (WX))/10**

MSB                                 LSB

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| . | . | . | . | 1024 | | . | . | . | 32 | 16 | 8 | 4 | 2 | 1 | |

**Figure 3 Example Change in Input Level**

Millivolt data is reported as a scaled value as follows:

Millivolt Mode, digital word (WX) = -11,000 to +11,000
Where -55mV = -11,000 and +55mV = +11,000
Values between -55mV and +55mV are scaled linearly between these endpoints.

As an example, +55mV would be reported as

MSB                                 LSB

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|
| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| | | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

**Figure 4 mV Example Value**

### 1.6.2. Scale Units

When data format is selected as SCALING enabled the full temperature range of the thermocouple is scaled as an unsigned integer from 0 to 32000 for thermocouple units or –32,000 to +32,000 for mV units (range of +/-50mV). The following formulas may be used to calculate the scaled integer value for temperature and mV.

Temperature:    Scaled Integer = (measured temp - min temp) / (max temp - min temp) x 32000
    *example*: the scaled integer offset at 0ºC for a Type J thermocouple is:
    Scaled integer = (0 - (-210)) / (760 - (-210)) x 32000 = 6928
    *example*: the scaled integer overrange at 770ºC for a Type J thermocouple is:
    Scaled integer = (770 - (-210)) / (760 - (-210)) x 32000 = 32330

mV:    Scaled Integer = mV x (32,000 ÷ 50)
    *example:* the scaled integer offset at 20 mV is:
    Scaled Integer = 20 x (32,000 ÷ 50) = ~11636.36

The table below shows the scaling temperature ranges of each probe type.

| Probe Type | Temperature Range | |
|:---:|:---:|:---:|
| | ºC | ºF |
| J | -210 to 760 | -346 to 1400 |
| K | -220 to 1320 | -364 to 2408 |
| T | -230 to 400 | -382 to 752 |
| E | -240 to 700 | -400 to 1292 |
| R | 0 to 1768 | 32 to 3214 |
| S | 0 to 1768 | 32 to 3214 |
| N | -200 to 1300 | -328 to 2372 |

## 1.7. Effect of Out-of-Range Input Signals

The 2559-TC utilizes the underrange and overrange codes of 32766 and 32765, respectively, to indicate when a channel has reached individual limits. Thermocouple inputs exceeding the ANSI standard for the different types of thermocouples (listed on the following pages in Figures 1.4-1.11) will cause the overrange value, 32765, to be displayed and the maximum temperature for that thermocouple type to be returned. 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. The 2559-TC will report an open thermocouple condition within 200 milliseconds.

> *NOTE:*
> *The 2559-TC uses the overrange error code, 32765, to indicate an open thermocouple. An open thermocouple condition will report within 200 milliseconds.*

**Type J**

-8 Millivolts     +43 Millivolts

-60V     -210 to +760°C     +60V

| Module not protected, damage might occur | Reports underrange error code | Accuracy within specification | Reports overrange error code | Module not protected, damage might occur |
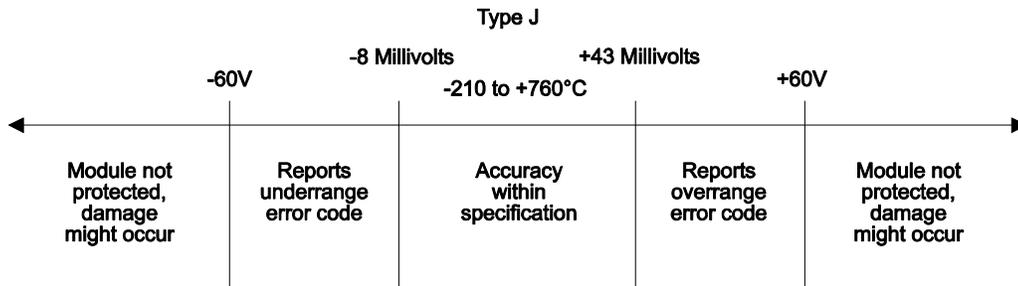
**Figure 5 Effect of Voltage Input on Type J Thermocouple**

**Type K**

-6 Millivolts     +55 Millivolts

-60V     -270 to +1372°C     +60V

| Module not protected, damage might occur | Reports underrange error code | Accuracy within specification | Reports overrange error code | Module not protected, damage might occur |
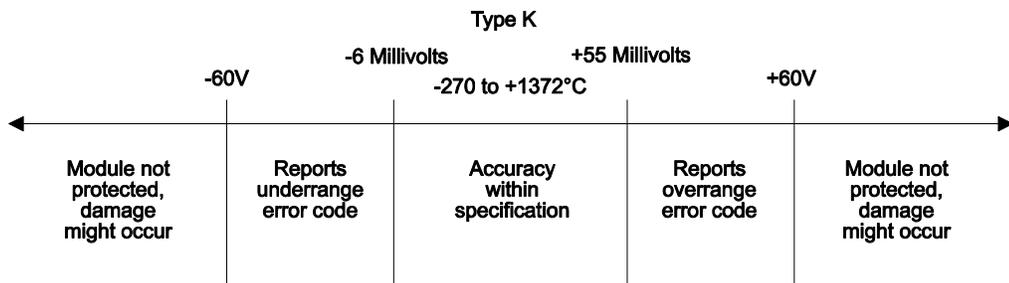
**Figure 6 Effect of Voltage Input on Type K Thermocouple**

**Type T**

-6 Millivolts     +21 Millivolts

-60V     -270 to +400°C     +60V

| Module not protected, damage might occur | Reports overrange error code | Accuracy within specification | Reports underrange error code | Module not protected, damage might occur |
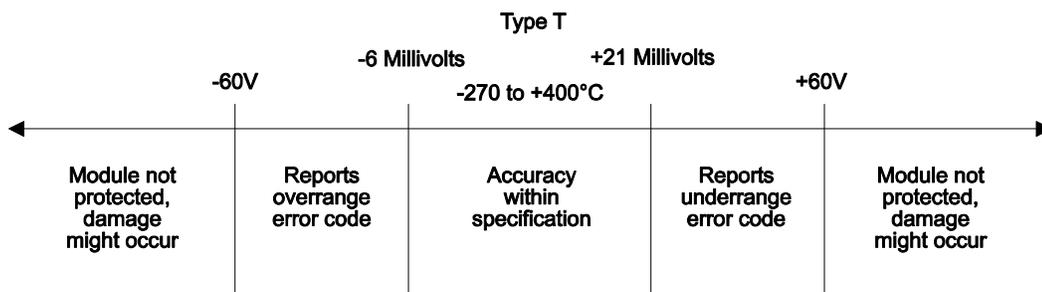
**Figure 7 Effect of Voltage Input on Type T Thermocouple**

Type E

-9 Millivolts          +77 Millivolts
        -60V                                              +60V
                        -270 to +1000˚C

| Module not protected, damage might occur | Reports underrange error code | Accuracy within specification | Reports overrange error code | Module not protected, damage might occur |
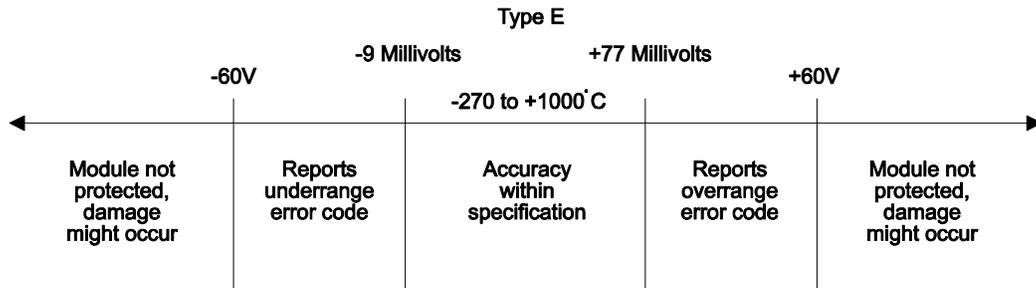
**Figure 8 Effect of Voltage Input on Type E Thermocouple**

Type R

0 Millivolts          +21.1 Millivolts
        -60V                                              +60V
                        0 to +1768°C

| Module not protected, damage might occur | Reports underrange error code | Accuracy within specification | Reports overrange error code | Module not protected, damage might occur |
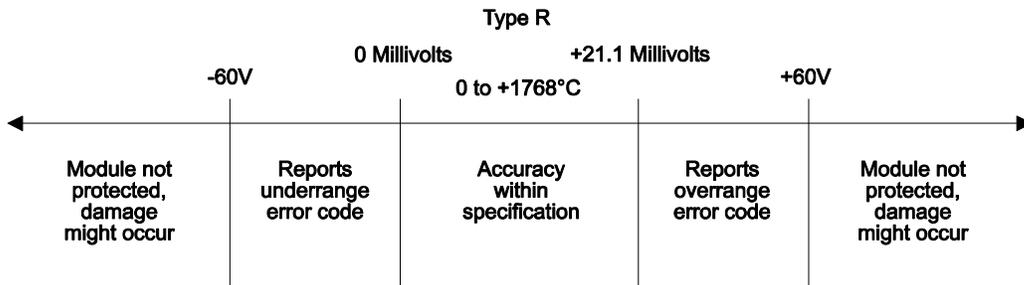
**Figure 9 Effect of Voltage Input on Type R Thermocouple**

Type S

0 Millivolts          +18.7 Millivolts
        -60V                                              +60V
                        0 to +1768°C

| Module not protected, damage might occur | Reports underrange error code | Accuracy within specification | Reports overrange error code | Module not protected, damage might occur |
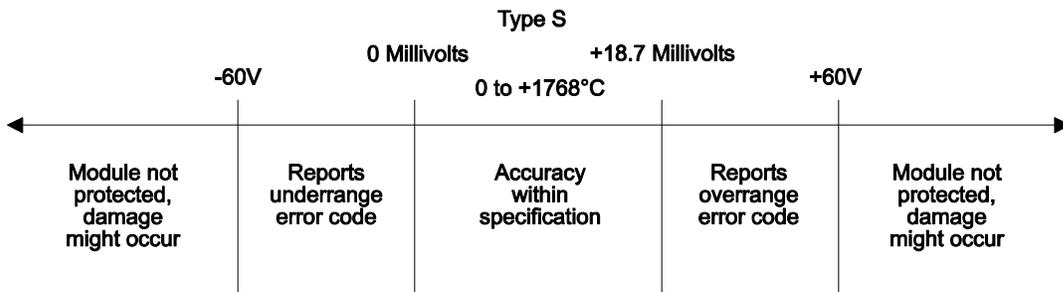
**Figure 10 Effect of Voltage Input on Type S Thermocouple**

Type N

-4.3 Millivolts          +47.5 Millivolts
        -60V                                              +60V
                        -270 to +1300˚C

| Module not protected, damage might occur | Reports underrange error code | Accuracy within specification | Reports overrange error code | Module not protected, damage might occur |
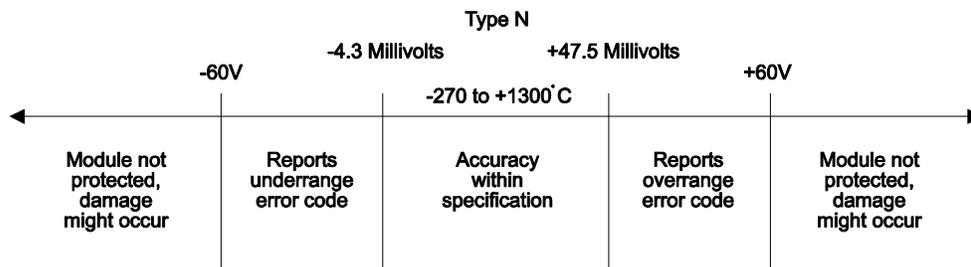
**Figure 11 Effect of Voltage Input on Type N Thermocouple**
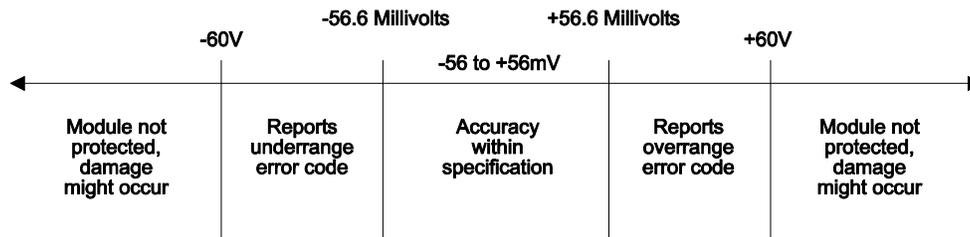
**Figure 12 Effect of Voltage Input on Type mV Input**

## 1.8. Additional Error Codes

In addition to input underrange and overrange error codes (see previous section 1.7.), there exists two other error codes to be aware of, namely the temperature sensor bad and math overflow codes. The 'temperature sensor bad' code is reported to the PLC when either of the two temperature sensors encapsulated in front panel connector goes bad. This is a rare occurrence, but would yield code 32,761 if it does occur.

The math overflow code of 32,763 occurs when the thermocouple type mV and SCALE modes are chosen, and the units tries to report a value under –32,000.
The following chart summarizes the 2559-TC error codes:

| Error Code | Error | Comment; Corrective Action |
|---|---|---|
| 32761 | Bad Temperature Sensor(s) | A temperature sensor (s) in front panel connector is faulty/defective; call CTI for replacement 2559-TC connector, P/N: 2559-FPC. |
| 32763 | Math Overflow | Low end range of mV/SCALE exceeded; Check process to determine if input is actually low. Determine if mV transmitter is defective. |
| 32765 | Channel Overrange | Input level is above normal input range (see Figures 1.4-1.11 for each thermocouple type); Check process to determine if input is actually high or if the transmitter is defective. |
| 32766 | Channel Underrange | Input level is above below input range (see Figures 1.4-1.11 for each thermocouple type); Check process to determine if input is actually low or if the transmitter is defective. |

**Figure 13 Error Codes**

## 1.9. Resolution

The module has a resolution of approximately 0.1ºC, 0.1ºF or exactly .01 millivolts.
The chart below shows the corresponding input resolution per step for each of the input
configuration modes:

| Units | Input Resolution / Step |
|-------|------------------------|
| Temp: ºC | ~0.05ºC |
| Temp: ºF | ~0.09ºF |
| Millivolts | 0.0017 millivolts |

**Figure 14 Input Resolution**

# *CHAPTER 2. INSTALLATION*

The installation of the Eight-Point Thermocouple Module involves the following steps:

*1.* Planning the installation,
*2.* Unpacking and configuring the module,
*3.* Inserting the module into the I/O base,
*4.* Wiring and connecting the module input connectors,
*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.

### 2.1.1. Calculating the I/O Base Power Budget

The Model 2559-TC requires 1.0 watt (maximum) of power from the I/O base. Use this value to verify that the base power supply is not exceeded.

### 2.1.2. Input Signal Wiring

Input signal wiring must be shielded twisted pair cable. A twisted pair will aid in the rejection of conducted and radiated interference from other energy sources. Standard practices usually require that all shields be tied together and grounded at a single point.

Note the following general considerations when wiring the module:
• Always use the shortest possible cables
• Avoid placing low voltage wire parallel to high-energy wire (if the two wires must meet, cross them at a right angle)
• Avoid bending the wire into sharp angles
• Use wireways for wire routing
• Avoid placing wires on any vibrating surface

## 2.2. Unpacking the Module

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

> *CAUTION:*
> *HANDLING STATIC SENSITIVE DEVICES*
> *The components on the Model 2559-TC module printed circuit card can be damaged by static electricity discharge. To prevent this damage, the module is shipped in a special anti-static bag. Static control precautions should be followed when 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. Always use this bag for protection against static damage when the module is not inserted into the I/O backplane.**

> **WARNING:**
> **Ensure that the power supply is turned OFF before connecting the wires to the I/O base.**

> *NOTE:*
> *The 505 front panel connector supplied with the 2559-TC is a modified connector with temperature sensors built in. Do not attempt to use a standard connector, as the thermocouple measurements will not be recognized and an error code will be reported on all channels.*

## 2.3. Configuring the Module

The Model 2559-TC must be configured for the thermocouple type, scaling, digital filtering, and temperature units before wiring the input connectors and inserting the module into the I/O base. As shipped, all channels are configured for the type J thermocouple, scaling disabled, digital filtering enabled, and Fahrenheit (ºF) units (see Figure 2.1).

| CHANNEL NUMBER | THERMOCOUPLE TYPE JUMPER | JUMPER POSITION E or J,K,N,mV or R,S,T | DIP SWITCH SETTING |
|---|---|---|---|
| 1 | JP6/4/5 | JP4 (type J,K,N,mV) | CH 1 = 010 (type J) |
| 2 | JP14/12/13 | JP12 (type J,K,N,mV) | CH 2 = 010 (type J) |
| 3 | JP18/16/17 | JP16 (type J,K,N,mV) | CH 3 = 010 (type J) |
| 4 | JP22/20/21 | JP20 (type J,K,N,mV) | CH 4 = 010 (type J) |
| 5 | JP26/24/25 | JP24 (type J,K,N,mV) | CH 5 = 010 (type J) |
| 6 | JP30/28/29 | JP28 (type J,K,N,mV) | CH 6 = 010 (type J) |
| 7 | JP34/32/33 | JP32 (type J,K,N,mV) | CH 7 = 010 (type J) |
| 8 | JP38/36/37 | JP26 (type J,K,N,mV) | CH 8 = 010 (type J) |

| SCALING | JUMPER POSITION | DIGITAL FILTERING | JUMPER POSITION | TEMP UNITS JUMPER | JUMPER POSITION |
|---|---|---|---|---|---|
| JP1 | Dis | JP2 | En | JP3 | ºF |

**Figure 15 Shipping Jumper Configuration Locations**

Changing the configuration involves the following steps (notations in parenthesis are actual printed board titles) described in the following sections:

1. Selecting thermocouple type (E or J, K, N, mV or R, S, or T) for each channel
2. Selecting digital filtering (Enable (EN) or Disable (DIS)) for the module
3... Selecting scaling (Enable (EN) or Disable (DIS)) for the module
4. Selecting temperature units (Fahrenheit (F) or Celsius (C)) for the module

### 2.3.1. Selecting Thermocouple Type

This selection involves both changing the jumpers on a per channel basis as well as dip switch selection on a per channel basis.

The jumpers, per channel, can be set on one of three posts available used to determine thermocouple type. The three posts refer to groupings of thermocouple types: "E", "J, K, N, mV", and "R, S, T". Choose the post for the thermocouple type used. As shipped, each channel is set for thermocouple types J, K, N, mV.

Once the hardware jumpers are selected this information needs to be reported to the microcomputer. The information is reported via DIP switches SW1 and SW2 (see Figure 2.2). Each output channel uses 3 switches with a BCD code to indicate the state of the hardware jumpers. The following chart illustrates the BCD which is needed to achieve the desired thermocouple type.

| Type | MV | E | J | K | N | R | S | T |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| BCD code | 000 | 001 | 010 | 011 | 100 | 101 | 110 | 111 |

| 3 (MSB) | 2 | 1 (LSB) | Type |
|---------|-----|---------|------|
| OFF | OFF | OFF | mV |
| OFF | OFF | ON | E |
| OFF | ON | OFF | J |
| OFF | ON | ON | K |
| ON | OFF | OFF | N |
| ON | OFF | ON | R |
| ON | ON | OFF | S |
| ON | ON | ON | T |
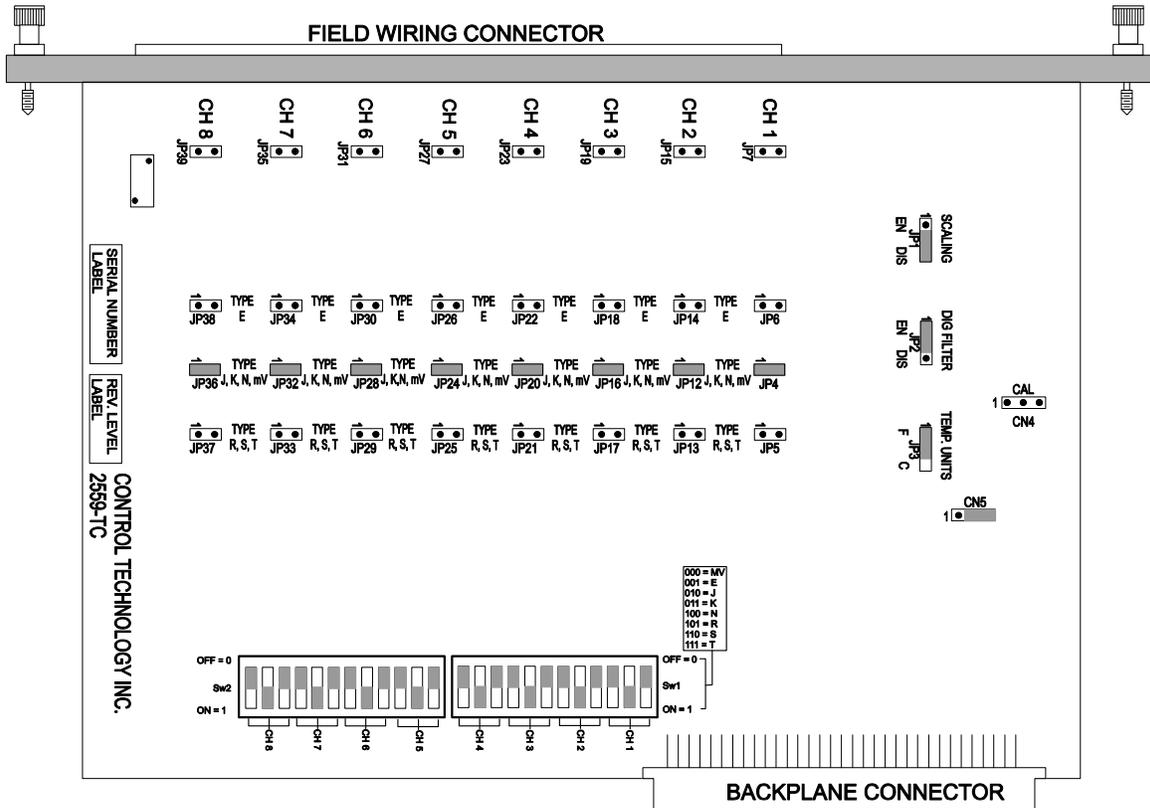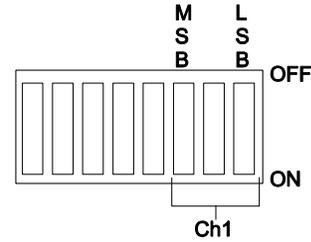


**Figure 16 Configuration Jumper Board Locations**
(shown as shipped from factory)

**Figure 17 2559-TC PCB Component Layout Picture**
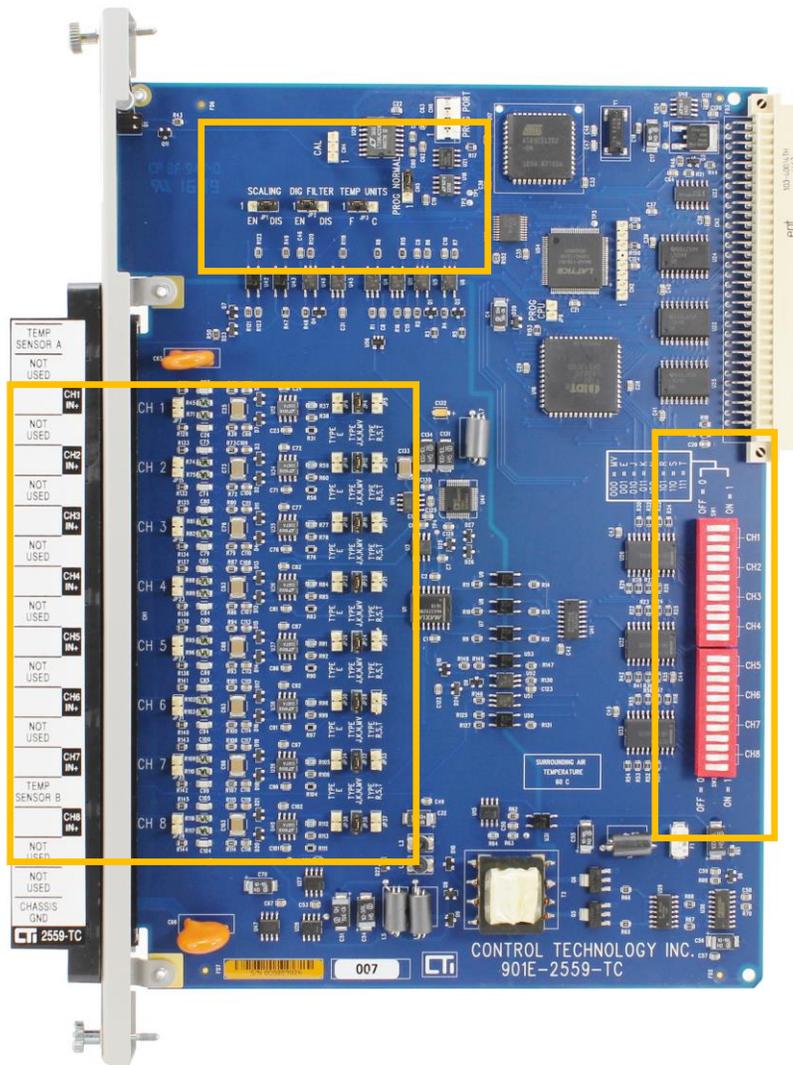
**Figure 18 Scaling, Filtering & Temp Selection Jumpers**



**Figure 19 Thermocouple Selection Jumpers**

**Figure 20 DIP Switch Signal Selections**

### 2.3.2. Selecting Digital Filtering

Locate the Digital Filtering Jumper "DIG FILTER" JP2 (see Figure 2.2). To enable digital filtering, set the jumper in the "EN" position; to disable, set to the "DIS" position. Since many analog input signals contain noise, CTI recommends using digital filtering unless maximum response time is required. As shipped, digital filtering is enabled for all 8 thermocouple inputs.

### 2.3.3. Selecting Offset Scaling

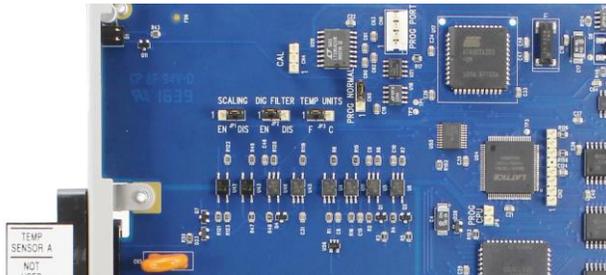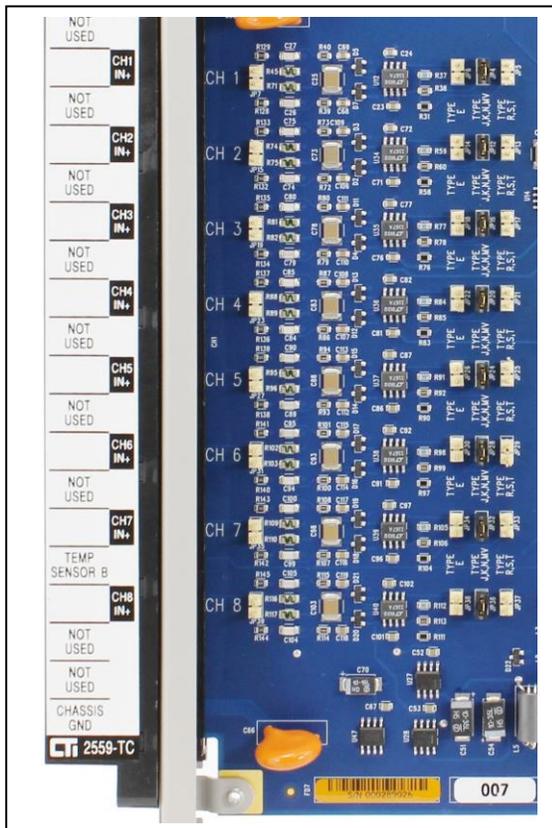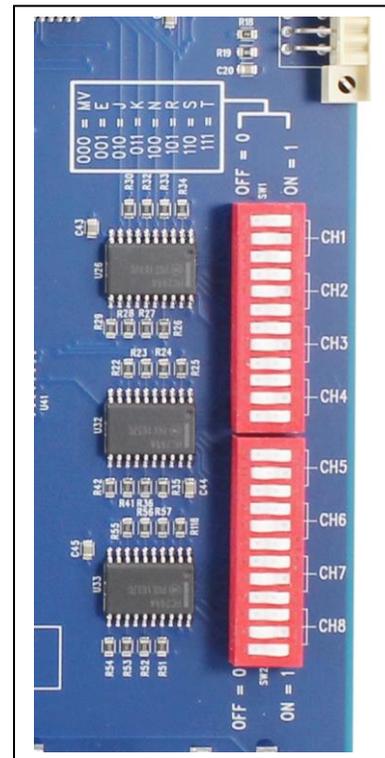Locate the Offset Scaling "SCALING" jumper JP1 (see Figure 2.2). To enable offset scaling for all eight inputs set the jumper to the "EN" position. The module will provide the formatted data range as 0-32000 for thermocouples and -32,000 to +32,000 for mV. To disable scaling (and use Engineering units), set the jumper to the "DIS" position. The module will then format the data range as $^{o}$C x10 or $^{o}$F x10 for thermocouples and mV from –10,000 to +10,000. As shipped, the jumper is in the DIS (disable) position.

### 2.3.4. Selecting Temperature Units

Locate the Temperature Units "TEMP UNITS" jumper JP3 (see Figure 2.2). To enable Fahrenheit units, set the jumper to the "F" position; to enable Celsius units, set the jumper to the "C" position. As shipped, the jumper is in the "F" (Fahrenheit) position.

### 2.3.5. Jumper Settings for Future Reference

See Appendix B. Jumper Settings Log Sheet to record any changes to the module's jumper settings.

## 2.4. Inserting the Module into the I/O Base

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 and backplane connector, 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 edge card at the back of the module when inserting or removing the module.

## 2.5. Wiring the Input Connectors

Input signals are accepted through a connector assembly located on the front of the module. The connector assembly consists of a modified Siemens® front panel edge connector with built-in temperature sensors that mates with the printed circuit board. Wiring is connected to the front connector via recessed screw terminals. The screw terminals can accept wire sizes up to single stranded 14-gauge wire. The actual size used depends on the thermocouple wire providing the input signal.

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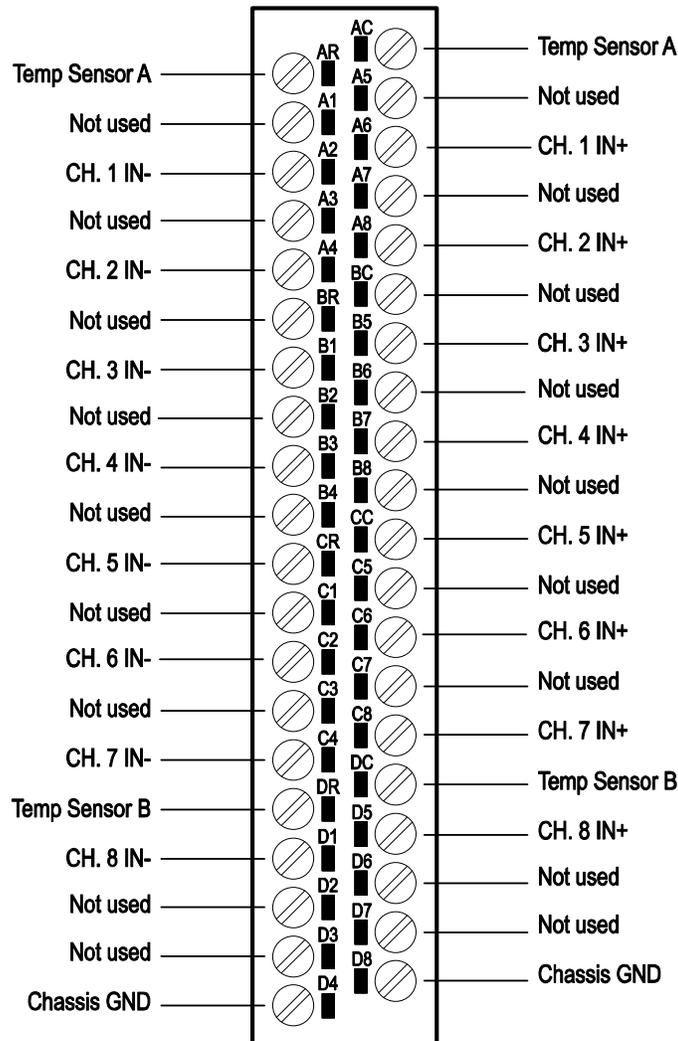


**Figure 21 Screw Terminal Connector Wiring**

## 2.5.1. Understanding the Modified Front Panel Connector

In order to provide the most accurate cold junction compensation and to avoid CJC calibration, the 2559-TC utilizes a modified front panel connector which has two temperature sensors directly set into the connector. These two temperature sensors are encapsulated in connector locations AR-AC and DR-DC, and are not user serviceable.

> *NOTE:*
> *If either of the two temperature sensors fail, an error code of 32,761 will be reported to the PLC and the modified connector needs replacing. In the unlikely event this occurs, contact CTI for replacement connector part number '2559-FPC' for your replacement front panel connector.*

## 2.5.2. Connecting Thermocouple Input Wiring

For thermocouple input circuits, connect the thermocouple wires to the screw terminals, as indicated in Figure 2.3 Screw Terminal Connector Wiring. Insert the wires in the appropriate holes on the front of the connector (see Figure 2.4 and 2.5). When the wires are inserted, tighten the screws. Repeat this procedure for the remaining thermocouple input channels. Ensure that the proper wire polarity is followed for each of the seven supported thermocouple probe types, as shown in Figure 2.6.  See also Appendix C for more detailed information on different thermocouple types.
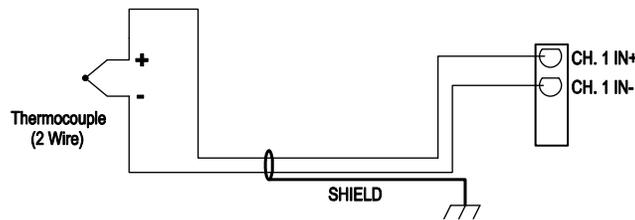


**Figure 22 Thermocouple wiring application**
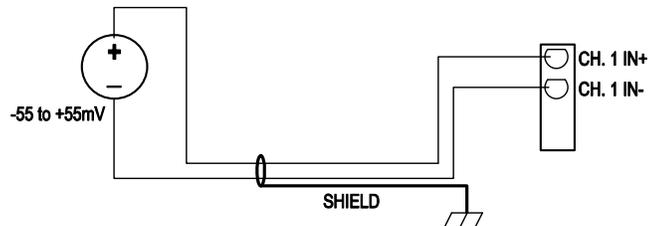


**Figure 23 Millivolt wiring application**

| Thermocouple Type | Negative (-) Lead | Positive (+) Lead |
|---|---|---|
| J | Copper-Nickel (Red) | Iron (White) |
| K | Nickel-Aluminum (Red) | Nickel-Chromium (Yellow) |
| T | Copper-Nickel (Red) | Copper (Blue) |
| E | Copper-Nickel (Red) | Nickel-Chromium (Purple) |
| R | Platinum (Red) | Platinum-13% Rhodium (Black) |
| S | Platinum (Red) | Platinum-10% Rhodium (Black) |
| N | Nisil (Red) | Nicrosil (Orange) |

**Figure 24 Thermocouple type and wire descriptions**

## 2.5.3. Connecting the Shield Wiring

Control Technology Inc. recommends that all wires be shielded twisted pair with a foil wrap shield and a separate drain wire and that they be installed in a metallic conduit. For millivolt applications, use Belden cable 8761 or equivalent which contains a foil wrap shield and a separate drain wire. The shield and the foil wrap should be twisted together and should be terminated at only one end. The other end should be left in an open circuit condition. CTI recommends that the shield be terminated at the PLC end of the signal wire. Special components are installed on the module to aid in the rejection of noise.

When entering the industrial cabinet the shield should be routed from the main terminal strip all the way to the PLC. Signal leads that do not maintain a shield from the terminal strip to the PLC act as antennas and are susceptible to radiated and conducted emissions in the cabinet. Unprotected cables may introduce measurement errors in the module.

The front connector on the module contains a CHASSIS terminal which may be used for the shield wire if the installation is in a noise free environment. If the installation is in an extremely noisy environment CTI strongly recommends that the shielded wires be terminated to the PLC chassis ground.

CTI has exhaustively tested this product to maximize its ability to reject noise from inductive sources as well as showering arcs, fast transients and other high frequency generators and has determined that the best performance results from connecting all shield wires together at the PLC module and terminating this single wire to the chassis ground with a large current capacity conductor. CTI recommends using a #8 gauge wire or larger from the PLC chassis to the earth ground connection.
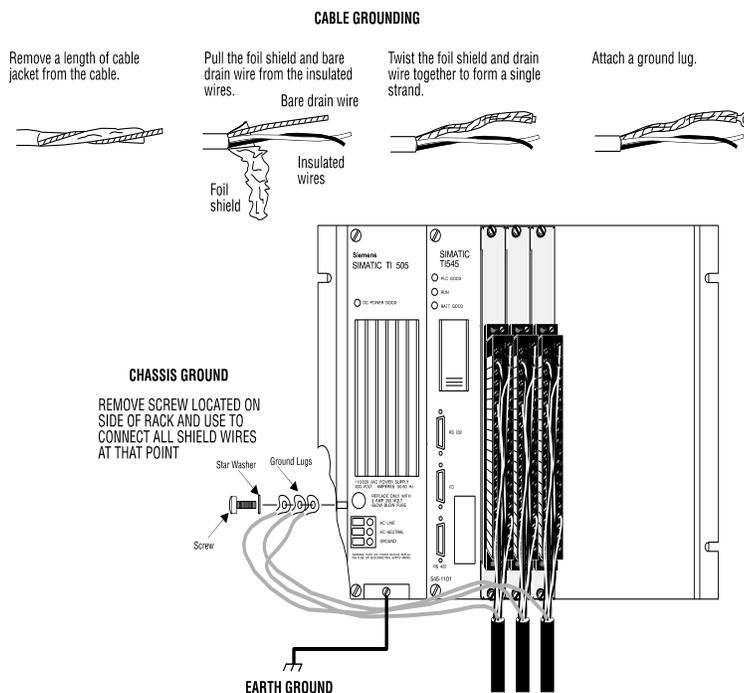


**Figure 25 Shield Wire Termination**

## 2.6. Installing the Screw Terminal Connector

When all the input signal wires are connected to the screw terminal connector, carefully install the connector on the front of the module.
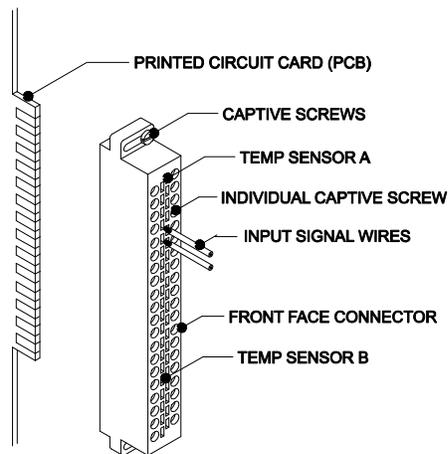


**Figure 26 Input Connector Assembly**

## 2.7. Calibration of the Module

Unlike its Siemens® counterpart, the CTI 2559-TC needs no calibration of inputs or cold junction compensation.

> *NOTE:*
> *The 2559-TC Thermocouple Input Module is calibrated at the factory. No further calibration is required. All calibration parameters are stored in non-volatile memory. There are no user adjustments on this product. As shipped there is no jumper required on the CAL input.*

## 2.8. Checking Module Operation

First turn on the base 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, begins blinking (or goes out during operation), the module has detected a failure. For information on viewing failed module status, refer to your 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 TISOFT Programming Manual. An example chart is shown in the following figure.

| I/O Module Definition for Channel.......1   Base..…...00 | | | | | | |
|---|---|---|---|---|---|---|
| | | **Number of Bit and Word I/O** | | | | |
| | **I/O Address** | | | | | **Special** |
| **Slot** | | **X** | **Y** | **WX** | **WY** | **Function** |
| 1 | 0001 | 00 | 00 | 08 | 00 | NO |
| 2 | 0000 | 00 | 00 | 00 | 00 | NO |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| 15 | 0000 | 00 | 00 | 00 | 00 | NO |
| 16 | 0000 | 00 | 00 | 00 | 00 | NO |

**Figure 27 Example I/O Configuration Chart**

In this example, the 2559-TC 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 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 memory 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 2559-TC and the thermocouple wires are not subjected to drafts or large temperature gradients during operation.*

---

*NOTE:*
*In the event the 2559-TC detects an onboard module failure, the module will assert the module fail line and report the module failure in the I/O Status Word, which is reported to the PLC CPU. CTI strongly recommends the user application monitor the I/O Module Status Words which are Status Words 11-26 and apply to Controllers TI/545, TI/555, TI/560 & 565, and the TI/575. The I/O Module Status Word can be used to report a module failure for an I/O Module in any of the 505 I/O slots. Please refer to Siemens® SIMATIC® TI505 Programming Reference Manual for more information. If a module failure is reported by the status word, the module should be replaced with a working unit and the failed module sent in for repair.*

---

*NOTE:*
*It may take 15-30 minutes after initial installation for temperature readings to stabilize.*

# *CHAPTER 3. TROUBLESHOOTING*

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

| Symptom | Probable Cause | Corrective Action |
|---|---|---|
| Indicator is not lit. | Base or PLC power is off. | Turn base or PLC on. |
| Indicator is blinking. | No calibration data. | Return to CTI for calibration. |
| Incorrect inputs. | Wrong addresses for word input. | Check program for correct work input addresses. |
| | Not logged in. | Read I/O configuration. |
| | Incorrectly calibrated. | Return the module to CTI for calibration. DO NOT ATTEMPT TO CALIBRATE. |
| | Blown fuse. | Measure F1 for continuity. Short all inputs and verify ambient temperature measurement. |
| Input does not work with PID loop or analog alarm block. | Value is not reported as integer 0-32,000. | Select SCALE format with jumper JP1 by placing in "EN" position. |
| Value is too large. | Temperature is reported to PLC as value x10. | Divide value by 10 in PLC. |
| Incorrect values to PLC. (values off by 10-15 degrees) | DIP switch not set in correct position. | Verify position of DIP switch. |
| | Wrong thermocouple type selected by jumpers. | Verify position(s) of jumpers. |
| | Temperature sensor(s) damaged. | Order special front panel connector from CTI, P/N '2559-FPC'. (see section 2.5.1.) |

**Figure 28 Troubleshooting Matrix**

> *CAUTION:*
> **The module fuse F1 is not user serviceable. If this fuse is blown, the module has a serious component failure and should be returned to CTI for repair.**

When it is inconvenient to visually check the status indicator, use the TISOFT "Display Failed I/O" or "Show PLC Diagnostics" support functions. If after consulting the chart above, you are unable to diagnose the problem, contact your local distributor or CTI at 1-800-537-8398 for further assistance.

# *HARDWARE SPECIFICATIONS*

| | |
|---|---|
| Input Channels: | 8 thermocouple inputs |
| Thermocouple Types: | J, K, T, E, R, S, N, and mV |
| Isolation: | 1500V channel-to-backplane |
| Input Overrange Protection: | 30 VDC or VAC continuous, 120VAC for 10 sec |
| Measurement Ranges: | J: -210ºC to 760ºC (-350ºF to 1400ºF) |
| | K: -270ºC to 1372ºC (-450ºF to 2500ºF) |
| | T: -270ºC to 400ºC (-454ºF to 752ºF) |
| | E: -270ºC to 1000ºC (-454ºF to 1832ºF) |
| | R: 0ºC to 1768ºC (32ºF to 3214ºF) |
| | S: 0ºC to 1768ºC (32ºF to 3214ºF) |
| | N: -260 ºC to 1300 ºC (-436ºF to 2372ºF) |
| | mV: -55 to +55mV |
| Millivolt Input Impedance: | 4.4MΩ DC, >10KΩ @60 Hz |
| Data Presentation: | Scaling Enabled: 0 to 32,000 (temperature) |
| | -32,000 to +32,000 (mV) |
| | Scaling Disabled: ºC x10 or ºF x10 (temperature) |
| | -10,000 to +10,000 (mV) |
| Measurement Units: | ºC or ºF (selectable by module) |
| Digital Filtering Time Constant: | 80 mSec |
| Update Time: | 9 mSec all channels |
| Repeatability: | +/- 1ºC, +/-2ºF for all thermocouple types |
| Accuracy: | J +/- 1ºC at 25ºC ambient |
| | K +/- 1ºC at 25ºC ambient |
| | T +/- 1ºC at 25ºC ambient |
| | E +/- 1ºC at 25ºC ambient |
| | R +/- 2ºC at 25ºC ambient* |
| | S +/- 2ºC at 25ºC ambient* |
| | N +/- 1ºC at 25ºC ambient |
| | mV +/- 0.5% full scale or +/- 500µV |
| | *reduced accuracy for measurements below 500ºC |
| ADC Resolution: | 16 bits |
| Common Mode Rejection: | >110 dB @ 60 Hz |
| Normal Mode Rejection: | >60 dB @ 60 Hz, >50 dB @ 50 Hz |
| Connector: | Removable |
| Wire Gauge: | 14-22 AWG |
| Backplane Power: | 1.0 Watt (maximum) |
| Module size: | Single-wide |
| Operating Temperature: | 0º to 60ºC (32º to 140º F) |
| Storage Temperature: | -40º to 85º C (-40º to 185º F) |
| Relative Humidity: | 5% to 95% non-condensing |
| Agency Approvals Pending: | UL, ULC, Class 1-Div.2, CE |
| Shipping Weight: | 1.5 lbs. (0.68 Kg) |

- specifications subject to change without notice -

# APPENDIX A. COMPATIBILITY WITH SIEMENS® 505-7028-A

## Overview

The CTI 2559-TC Thermocouple Module was designed to be a drop-in replacement for the Siemens® Model 505-7028-A. From set up of the module to wiring and PLC reporting, the user will find many similarities between the CTI and Siemens® models.

## Using the CTI 2559-TC in a 505-7028-A application

The CTI 2559-TC should fulfill all the following requirements for the 505-7028-A replacement, as outlined below:

## Module setup

The CTI 2559-TC sets up the same as its Siemen's counterpart, *without* any input *or* CJC calibration needed. See Chapter 2.3 Configuring the Module for Operation to determine the details in module setup.

## Wiring

The wiring of the input connector is the same between the modules, although the 2559-TC utilizes a modified 505 front panel connector. See Section 2.5. for details on the modified connector and a detailed explanation of how proper wiring is accomplished.

## PLC Reporting

The word format is the same between the modules. See Chapter 1 for a more detailed explanation on PLC reporting.

# *APPENDIX B. JUMPER SETTINGS LOG SHEET*

| CHANNEL NUMBER | THERMO TYPE JUMPER | JUMPER POSITION E or J,K,N,mV or R,S,T | DIP SWITCH SETTING |
|---|---|---|---|
| 1 | JP6/4/5 | | |
| 2 | JP14/12/13 | | |
| 3 | JP18/16/17 | | |
| 4 | JP22/20/21 | | |
| 5 | JP26/24/25 | | |
| 6 | JP30/28/29 | | |
| 7 | JP34/32/33 | | |
| 8 | JP38/36/37 | | |

| SCALING | JUMPER POSITION | DIGITAL FILTERING | JUMPER POSITION | TEMP UNITS JUMPER | JUMPER POSITION |
|---|---|---|---|---|---|
| JP1 | | JP2 | | JP3 | |

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

---

**NOTE:**
*The 2559-TC Thermocouple Input Module is calibrated at the factory. No further calibration is required. All calibration parameters are stored in non-volatile memory. There are no user adjustments on this product. As shipped there is no jumper required on the CAL input.*

---

# APPENDIX C. THERMOCOUPLE WIRE GUIDE

| ANSI Code | Color Code Thermocouple Grade | Color Code Extension Grade | Lead Material + Lead | Lead Material - Lead | Magnetic Lead | Maximum Useful Temperature Range | EMF (mV) Over Useful Temperature Range |
|---|---|---|---|---|---|---|---|
| J | WHITE + BROWN RED - | WHITE + BLACK RED - | IRON Fe | CONSTANTAN COPPER-NICKEL Cu-Ni | IRON (+) | 32 to 1382°F 0 to 750°C Thermocouple Grade 32 to 392°F 0 to 200°C Extension Grade | 0 to 42.283 |
| K | YELLOW + BROWN RED - | YELLOW + YELLOW RED - | CHROMEL NICKEL-CHROMIUM Ni-Cr | ALUMEL NICKEL-ALUMEL Ni-Al | ALUMEL (-) | -328 to 2282°F -200 to 1250°C Thermocouple Grade 32 to 392°F 0 to 200°C Extension Grade | -5.973 TO 50.633 |
| T | BLUE + BROWN RED - | BLUE + BLUE RED - | COPPER Cu | CONSTANTAN COPPER-NICKEL Cu-Ni | NONE | -328 to 662°F -200 to 350°C Thermocouple Grade -76 to 212°F -60 to 100°C Extension Grade | -5.602 to 17.816 |
| E | PURPLE + BROWN RED - | PURPLE + PURPLE RED - | CHROMEL NICKEL-CHROMIUM Ni-Cr | CONSTANTAN COPPER-NICKEL Cu-Ni | NONE | -328 to 1652°F -200 to 900°C Thermocouple Grade 32 to 392°F 0 to 200°C Extension Grade | -8.824 to 68.783 |
| N | ORANGE + BROWN RED - | ORANGE + ORANGE RED - | OMEGA-P™ NICROSIL Ni-Cr-Si | OMEGA-N™ NISIL Ni-Si-Mg | NONE | -450 to 2372°F -270 to 1300°C Thermocouple Grade 32 to 392°F 0 to 200°C Extension Grade | -4.345 to 47.502 |
| R | NONE ESTABLISHED | BLACK + GREEN RED - | PLATINUM- 13% RHODUIM Pt-13% Rh | PLATINUM Pt | NONE | -32 to 2642°F 0 to 1450°C Thermocouple Grade 32 to 300°F 0 to 150°C Extension Grade | 0 to 16.741 |
| S | NONE ESTABLISHED | BLACK + GREEN RED - | PLATINUM- 10% RHODIUM Pt-10% Rh | PLATINUM Pt | NONE | -32 to 2642°F 0 to 1450°C Thermocouple Grade 32 to 300°F 0 to 150°C Extension Grade | 0 to 14.973 |
| B | NONE ESTABLISHED | GREY + GREY RED - | PLATINUM- 30% RHODIUM Pt-30% Rh | PLATINUM- 6% RHODIUM Pt-6% Rh | NONE | 32 to 3092°F 0 to 1700°C Thermocouple Grade 32 to 212°F 0 to 100°C Extension Grade | 0 to 12.426 |
| G | NONE ESTABLISHED | WHITE + WHITE - BLUE TRACE RED - | TUNGSTEN W | TUNGSTEN- 26% RHENIUM W-26% Re | NONE | -32 to 4208°F 0 to 2320°C Thermocouple Grade 32 to 500°F 0 to 260°C Extension Grade | 0 to 38.564 |
| C | NONE ESTABLISHED | WHITE + WHITE - RED TRACE RED - | TUNGSTEN- 5% RHENIUM W-5% Re | TUNGSTEN- 26% RHENIUM W-26% Re | NONE | 32 to 4208°F 0 to 2320°C Thermocouple Grade 32 to 1600°F 0 to 870°C Extension Grade | 0 to 37.066 |
| D | NONE ESTABLISHED | WHITE + WHITE - YELLOW TRACE RED - | TUNGSTEN- 3% RHENIUM W-3% Re | TUNGSTEN- 25% RHENIUM W-25% Re | NONE | 32 to 4208°F 0 to 2320°C Thermocouple Grade 32 to 500°F 0 to 260°C Extension Grade | 0 to 39.506 |

Chart used with permission from Omega Engineering, Inc.

# LIMITED PRODUCT WARRANTY

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 (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 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.

# *REPAIR POLICY*

In the event that the Product should fail during or after the warranty period, a Return Material Authorization (RMA) number can be requested orally 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 the product is 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 office at 1-800-537-8398.