CTI 2501
EIGHT CHANNEL ANALOG INPUT /
FOUR CHANNEL ANALOG OUTPUT MODULE
INSTALLATION AND OPERATION GUIDE
Version 1.0

CTI Part # 062-00341-010

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REVISION HISTORY

Version 1.0	2/01/02	Original Release
	1/12/09	Added note that CN5 jumper must be installed for Rev F board

PREFACE

This *Installation and Operation Guide* provides installation and operation instructions for the CTI 2501 8 Analog Input / 4 Analog Output Module for Simatic® 505 programmable controllers. We assume you are familiar with the operation of Simatic® 505 programmable controllers. Refer to the appropriate user documentation for specific information on the Simatic® 505 programmable controllers and I/O modules.
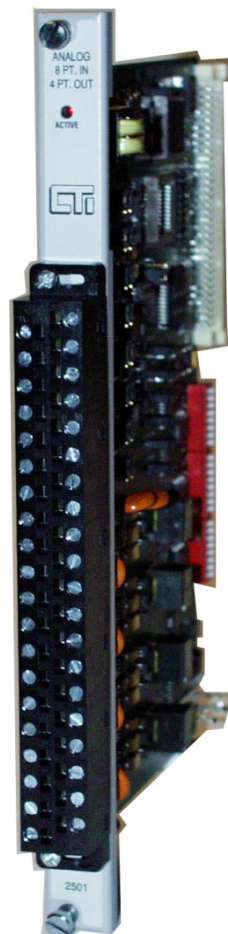
This *Installation and Operation Guide* is organized as follows:

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 2501 and the Siemens® 505-7012 and 505-7016.

The 2501 8 In / 4 Out Analog 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.**

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1. OVERVIEW

1.0. Product Summary

The CTI 2501 Eight Channel Analog Input / Four Channel Analog Output Module is a member of Control Technology's family of I/O modules compatible with the Simatic® 505 programmable controllers. The 2501 is designed to translate a digital word from the programmable controller (PLC) into an equivalent analog voltage and current signal, and to translate an analog input signal into an equivalent digital word which is then sent to the programmable controller.

1.1. Front Panel Description
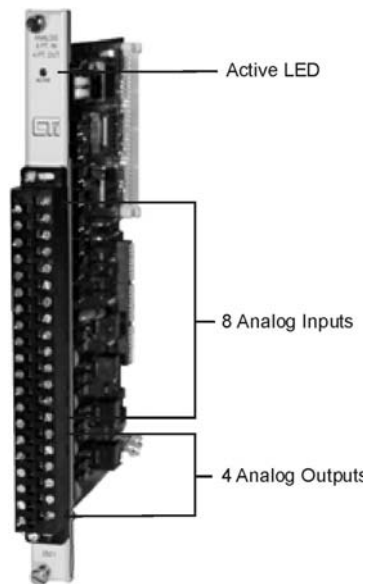
Figure 1.1 CTI 2501 Front Panel

1.1.1. Active LED

The Active LED will be illuminated when the module is functioning normally. If the Active LED is not lit, a serious problem exists with the module. If the LED is blinking the module requires calibration. Refer to Chapter 3 for troubleshooting.

1.1.2. Input/Output Connector

This connector provides wiring terminals for input channels 1-8, for output channels A-D, and for user supplied 24VDC power supply. The wiring connector accepts 14-22 AWG wire.

1.2. Asynchronous Operation

The module operates asynchronously with respect to the PLC so that a scan of the PLC and a module input or output scan cycle do not occur at the same time. For inputs, the module will translate all analog inputs in one module update 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. For the output, the signal change is dependent on the update time of the module. The following figure illustrates this relationship:
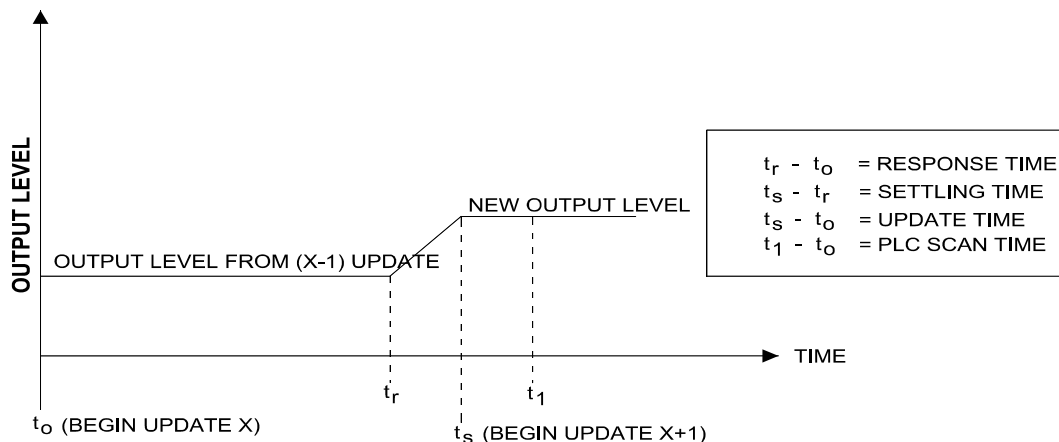
Figure 1.2 Relation of Update Time Change in Signal Output

1.3. Immediate I/O

The 2501 Analog Output Module is fully compatible with the Immediate output instructions for the 545 and 555 PLCs.

1.4. Unipolar or Bipolar Mode

Each input or output channel may be configured to provide either a bipolar or unipolar input/output signal. Selection of unipolar/bipolar mode is made via a jumper and dip switches (see Section 2.3).

1.5. Voltage or Current Input / Output

Each of the module's eight input channels may be configured to receive either voltage or current analog signals. For unipolar input signals, the range is 0 to 5VDC, 0 to 10VDC or 0 to +20mA. For bipolar input signals, the signal range is –5 to +5VDC, -10 to +10VDC or –20 to +20mA. Selection of voltage or current mode and voltage range are made via internal jumpers and dip switches (see Section 2.3).

Voltage and current output signals are both available simultaneously. For Unipolar output signals the ranges supported are 0 to 5VDC, 0 to 10VDC, and 0 to 20mA. For Bipolar outputs the ranges supported are -5 to +5VDC, -10 to +10VDC, and -20 to +20mA. Selection of voltage ranges and Unipolar and Bipolar operation are made via internal jumpers and DIP switches (see Section 2.3).

1.6. Using an Input with 20% Offset

Some applications use transducers that provide 1 to 5 volts (4 to 20mA) input signals instead of 0 to 5 volt (0 to 20mA) input signals. You can allow for this 20% offset by including some additional instructions in your RLL (Relay Ladder Logic) program.

First, subtract 6400 from the input data word (WX). Then, multiply the result by 125 and divide the product by 100. This yields the following equation:

$$(WX - 6400) \times 125 \div 100 = 20\% \text{ offset data word}$$

Consult your PLC programming manual (or program design guide) for information about RLL instructions used in the conversion.

1.7. Using the Module with the 20% Offset Input Scaling

If all eight inputs are used in offset mode the 2501 may be configured to perform the offset calculation automatically (see Section 2.3.4). Jumper JP1 when enabled will configure the module such that all inputs will be scaled for 1-5VDC or 4-20mA operation.

1.8. Digital Input Word Map

An analog input signal is translated into a 15-bit plus sign digital word. Since the PLC requires a 15-bit input word, the 15-bit plus sign value from the converter is placed into a 16-bit word for transmittal to the PLC.
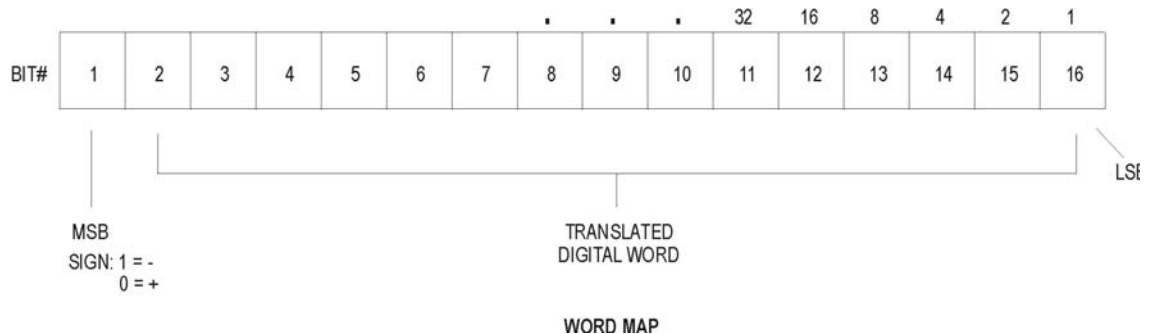
Figure 1.3 Word Input to the PLC from the Module

1.9. Analog to Digital Input Conversions

1.9.1. Unipolar Mode Conversion

The following equations may be used to calculate the digital word which will result from a particular voltage or current input in the Unipolar Input Mode:

0 to 5VDC range   Digital Word (WX) = (Input voltage x 32000) ÷ 5 volts
example: to generate an input voltage of 2.5VDC, the WX value input to the PLC is calculated as follows: WX = (2.5 x 32000) ÷ 5 = 16000

0 to 10VDC range   Digital Word (WX) = (Input voltage x 32000) ÷ 10 volts
example: 7.5VDC input
WX = (7.5 x 32000) ÷ 10 = 24000

0 to 20mA range   Digital Word (WX) = (Input current x 32000) ÷ 20mA
example: 10mA input
WX = (10 x 32000) ÷ 20 = 16000

1.9.2. Bipolar Mode Conversion

The following equations may be used to calculate the digital word which will result from a particular voltage or current input in the Bipolar Input Mode:

-5 to +5VDC range   Digital Word (WX) = (Input voltage x 32000) ÷ 5 volts
example: to generate an input voltage of -2.5VDC, the WX value input from the PLC is calculated as follows: WX = (-2.5 x 32000) ÷ 5 = -16000

-10 to +10VDC range Digital Word (WX) = (Input voltage x 32000) ÷ 10 volts
example: 10VDC input
WX = (10 x 32000) ÷ 10 = 32000

-20 to +20mA range   Digital Word (WX) = (Input current x 32000) ÷ 20mA
example: -15mA input
WX = (-15 x 32000) ÷ 20 = -24000

1.10. Effect of Out-of-Range Input Signals

The 2501 utilizes the underrange and overrange codes of 32758 and 32759, respectively, to indicate when a channel has reached individual limits. The value of the underrange or overrange condition varies from channel to channel. The reason for this is that as a channel is calibrated, all of the gains and offsets and dynamic ranges of the analog to digital converter of the system are compensated for in each analog input channel. Therefore, the point at which the analog to digital converter reaches a saturation point and can no longer produce a change in counts for corresponding change in input signal is called the overrange or underrange limit of the channel. This level may be different for

every channel. In Figures 1.4 and 1.7, the limits for the overrange and underrange values are the minimum limits for a given channel. The actual limits for an individual channel may be greater.

> *NOTE:*
> *+32750 is the last valid reported value before an overrange or overflow error is reported.*

1.10.1. Unipolar Mode

Signals falling below the lower limits in 0 to 5V Input Mode or 0 to 10V Input Mode are translated into a digital word that outputs a specific code to indicate an overrange or underrange condition. The underrange capability of any channel in Unipolar Mode may produce a negative value to the PLC for a number of counts before the underrange code is produced.
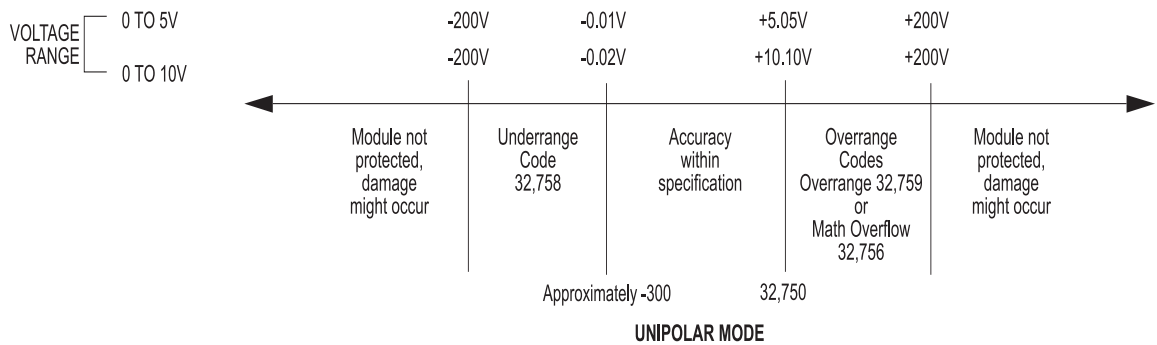
Figure 1.4 Voltage Input Limits (Unipolar)

Figures 1.5 and 1.6 show the binary values of typical overrange and underrange conditions for Unipolar mode.
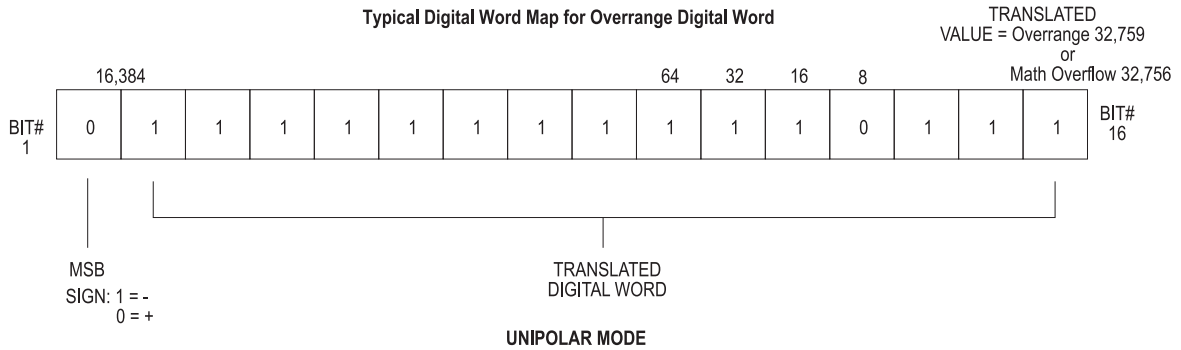
Figure 1.5 Overrange Word Value (Unipolar)
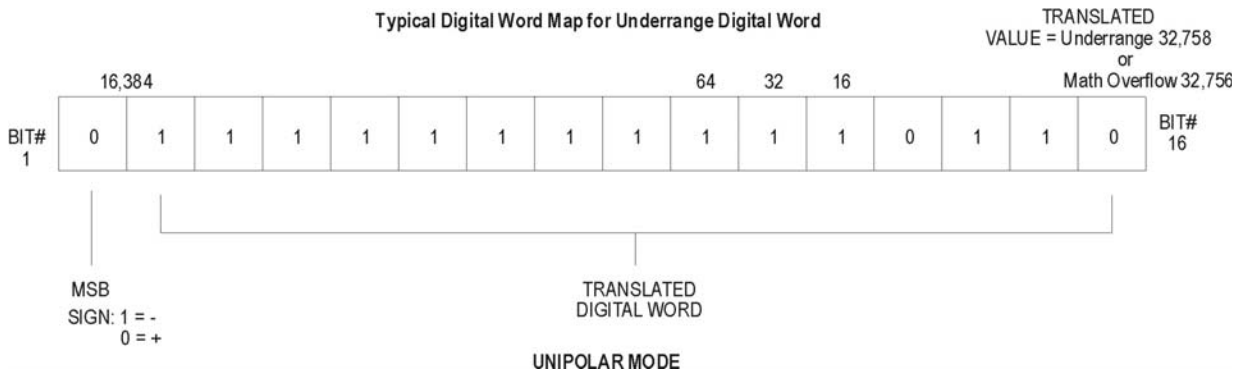
Figure 1.6 Underrange Word Value (Unipolar)

1.10.2. Bipolar Mode

In Bipolar Mode signals above or below the upper and lower limits in the -5 to +5VDC or -10 to +10VDC range are translated to a digital word and also utilize the overrange and underrange values. The actual limit for each channel will vary from channel to channel as described in the previous section.
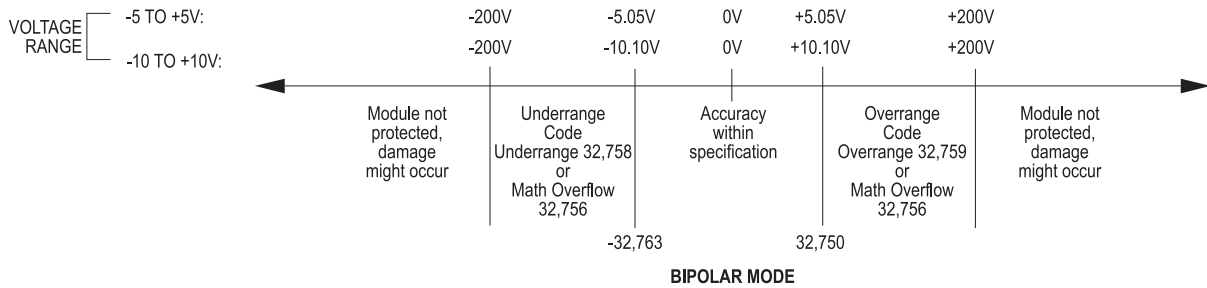
Figure 1.7 Voltage Input Limits (Bipolar)

Figures 1.8 and 1.9 show the binary values of typical overrange and underrange conditions for Bipolar Mode.
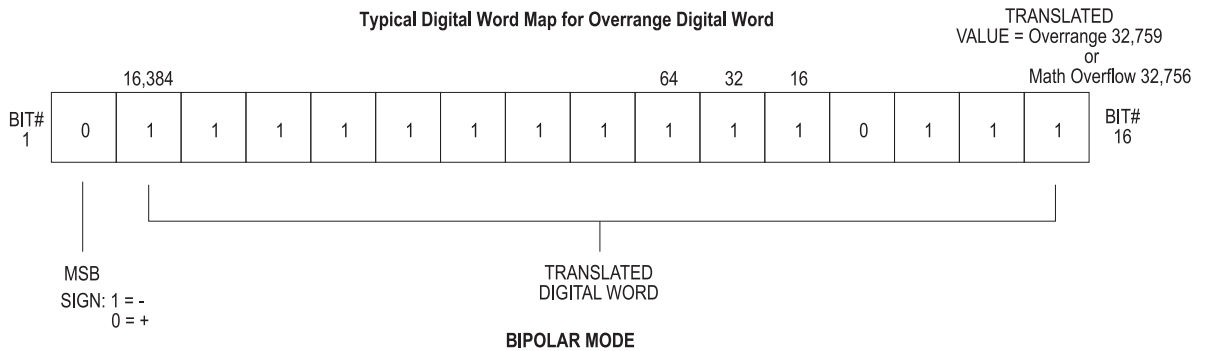
Figure 1.8 Overrange Word Value (Bipolar)

CTI 2501 Installation and Operation Guide

Typical Digital Word Map for Underrange Digital Word

TRANSLATED
VALUE = Underrange 32,758
or
Math Overflow 32,756

BIT#	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0

16,384 ... 64 32 16

MSB
SIGN: 1 = -
      0 = +

TRANSLATED
DIGITAL WORD

BIPOLAR MODE
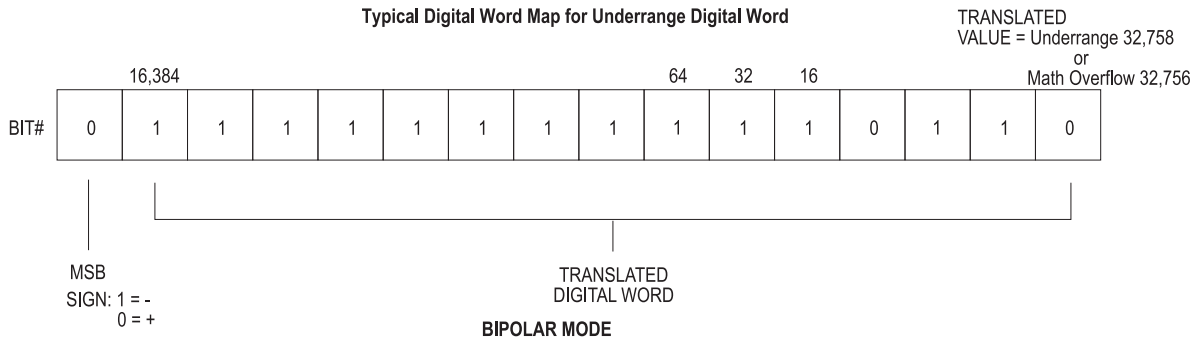
Figure 1.9 Underrange Word Value (Bipolar)

1.11. Input Resolution

The module has a resolution of 1 count out of 32000. This is the smallest unit into which the module will divide an input and is 1 part out of 32000. This relationship can be shown as:

1 count per step ÷ 32000 counts full scale = 1/32000

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

	RANGE CONFIGURATION	DIGITAL COUNTS / STEP	INPUT RESOLUTION PER STEP
UNIPOLAR	0 - 5 VDC	1	156 µV
	0 - 10 VDC	1	312 µV
	0 - 20 mA	1	0.625 µA
UNIPOLAR WITH 20% OFFSET	1 - 5 VDC	1	156 µV
	4 - 20 mA	1	0.625 µA
BIPOLAR	-5 TO +5 V	1	156 µV
	-10 TO +10 V	1	312 µV
	- 20 to + 20mA	1	0.625 µA

Figure 1.10 Input Resolution

1.12. Output Signal Description

Each of the four channels independently provides output signals that are either Unipolar or Bipolar. Ranges supported include 0 to 5VDC, 0 to 10VDC, 0 to 20mA, -5 to +5VDC, -10 to +10VDC, and -20 to +20mA. Both voltage and current outputs are available simultaneously so that either or both may be used for a particular channel.

1.12.1. Unipolar Output Operation

In the Unipolar mode the PLC sends a 16-bit word to the module for translation to an analog signal. Data to be translated occupies 12 bits. The four remaining bits are unused. The following figure illustrates a 16-bit word sent from the PLC to the module.
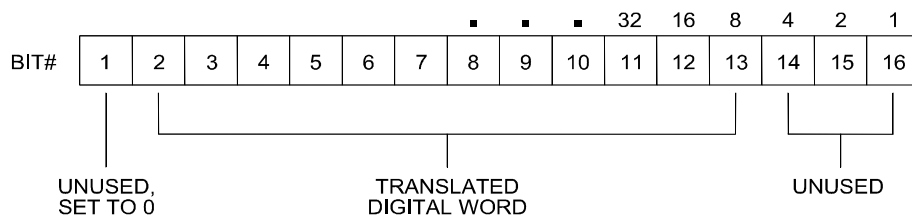
Figure 1.11 Word Output from the PLC to the Module

1.12.2. Bipolar Output Operation

In the Bipolar mode data to be translated occupies 11 bits plus a sign bit. The four remaining bits are unused.
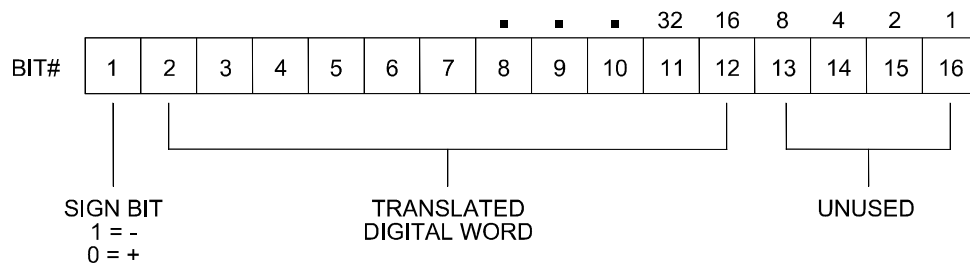
Figure 1.12 Bipolar Word Output from the PLC to the module

1.13. Digital to Analog Conversion: Output

1.13.1. Unipolar Mode Conversion

The following equations are used to calculate the digital word used to generate a Unipolar output signal:

0 to 5VDC range   Digital WY = (Output voltage x 32000) ÷ 5 volts
WY = (Desired Output Voltage x 32000) ÷ 5
for example, to generate an output voltage of 2.5VDC the WY value output from the PLC is calculated as follows: WY= (2.5x32000) ÷ 5 = 16000

0 to 10VDC range   Digital WY = (Output voltage x 32000) ÷ 10 volts

0 to 20mA range   Digital WY = (Output current x 32000) ÷ 20mA

1.13.2. Bipolar Mode Conversion

The following equations are used to calculate the digital word used to generate a Bipolar output signal.

-5 to +5VDC range   WY = (Desired output voltage x 32000) ÷ 5 volts
Example: -5 volts output
WY = (-5 x 32000) ÷ 5 = -32000

-10 to +10VDC range   WY = (Desired output voltage x 32000) ÷ 10 volts
Example: -5 volts output
WY = (-5 x 32000) ÷ 10 = -16000

-20 to +20mA range   WY = (Desired output current x 32000) ÷ 20mA
Example: 4mA output
WY = (4 x 32000) ÷ 20 = 6400

1.14. Resolution: Output

1.14.1. Unipolar Mode

In Unipolar mode the module has a resolution of 8 counts out of 32000, or 1 part out of 4000. For the voltage range 0 to 5VDC the minimum step is 1.25mV. For the range 0 to 10VDC the minimum step is 2.5mV and for 0 to 20mA output the minimum step is 5 microamps.

1.14.2. Bipolar Mode

In Bipolar mode the module has a resolution of 16 counts out of 32000 or 1 part out of 2000. For the voltage range -5 to +5VDC the minimum step is 2.5mV. For the range -10 to +10VDC the minimum step is 5.0mV and for -20 to +20mA output the minimum step is 10 microamps.

	RANGE CONFIGURATION	DIGITAL COUNTS / STEP	INPUT RESOLUTION PER STEP
UNIPOLAR	0 - 5 VDC	8	1.25 mV
	0 - 10 VDC	8	2.5 mV
	0 - 20 mA	8	5 µA
BIPOLAR	-5 TO +5 VDC	16	2.5 mV
	-10 TO +10 VDC	16	5 mV
	-20 TO +20 mA	16	10 µA

Figure 1.13 Output Resolution

1.15. Using the Module with a Built-In 20% Offset Output Calculation

If all 4 outputs are used in Offset Mode, i.e., 4 to 20mA or 1 to 5VDC operation, the 2501 may be configured to automatically scale the digital word from the PLC. This is to be used in Unipolar mode only. Jumper JP10, when enabled, will configure all four outputs for offset operation. No relay ladder logic is required for output processing.

1 to 5VDC range   Digital WY = ((Output voltage-1) x 32000) ÷ 4 volts
WY = ((Desired Output Voltage-1) x 32000) ÷ 4
for example, to generate an output voltage of 3.0VDC the WY value output from the PLC is calculated as follows: WY= ((3-1)x32000) ÷ 4 = 16000

Note that WY=0 corresponds, in the voltage output range, to 1V, and WY=32,0000 corresponds to 5V.

4 to 20mA range   Digital WY = ((Output current - 4) x 32000) ÷ 16mA
WY = ((Desired Output Current - 4) x 32000) ÷ 16
for example, to generate an output voltage of 12mA the WY value output from the PLC is calculated as follows: WY= ((12-4)x32000) ÷ 16 = 16000

Note that WY=0 corresponds, in the current output range, to 4mA, and WY=32,0000 corresponds to 20mA.

> *NOTE:*
> *Jumper JP10 is labeled on the printed circuit board as Output Scaling (DIS(able)/EN(able)).*

CHAPTER 2. INSTALLATION

The installation of the 2501 Eight Channel Analog Input / Four Channel Output 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 output screw terminal connector
5. Connecting the 24VDC user power supply
6. 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:

1. Calculating the I/O base power budget
2. Selecting a proper user power supply and wiring
3. Routing the wiring to minimize noise, and
4. Selecting the proper wiring method for the type of output you will use.

The following sections discuss these important considerations of the installation.

2.1.1. Calculating the I/O Base Power Budget

The 2501 requires 3.0 watts (maximum) of +5VDC power from the I/O base. Before inserting the module into the I/O base, ensure that the base power supply capacity is not exceeded.

2.1.2. Choosing a Power Supply

The power supply should be a single voltage, 20-28VDC nominal 2.0 amp, UL Class 2 device. The compliance of the output circuits is directly related to the output voltage. The drive voltage and current are specified at 24VDC.

2.1.3. Wiring Consideration

The module requires separate wiring for the power supply and for the input and output signals. Power and signal wiring must be separated to prevent noise in the signal wiring. Input and output signal wiring must be shielded, twisted-pair cable, with 14 to 22 gauge stranded conductors. A twisted pair will aid in the rejection of conducted and radiated interference from other energy sources. The cable shield should always be terminated to earth ground at the I/O base. It should not be terminated at the output connector. Use the following guidelines when wiring the module:

- Always use the shortest possible cables
- Avoid placing power supply wires and signal wires near sources of high energy
- 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 wires into sharp angles
- Use wireways for wire routing
- Be sure to provide a proper earth ground for the cable shield at the I/O base
- Avoid placing wires on any vibrating surfaces

2.1.4. Requirements for Signal Wire Carrying Current

You must calculate the loop wiring resistance for any current output circuits. The loop resistance is determined by the length and type of wire, as well as the field device series resistance.

The circuit resistance must not exceed 1000 ohms. If a separate 20 volt power supply is used in the loop, the minimum resistance increases 1000 ohms, and the maximum resistance becomes 2000 ohms. Any value over 1000 ohms prevents the module from operating accurately. The following figure provides a schematic for wiring a loop with a resistance of less than 1000 ohms. It also shows a schematic for adding a power supply to allow loop resistance up to 2000 ohms. Use the following equation to determine the resistance of an output loop for a channel:

$$Resistance = (2 \times CL \times RFT) + TFL$$

where: CL is the cable length
RFT is the conductor resistance (ohms/unit length)
TFL is the resistance of the field device
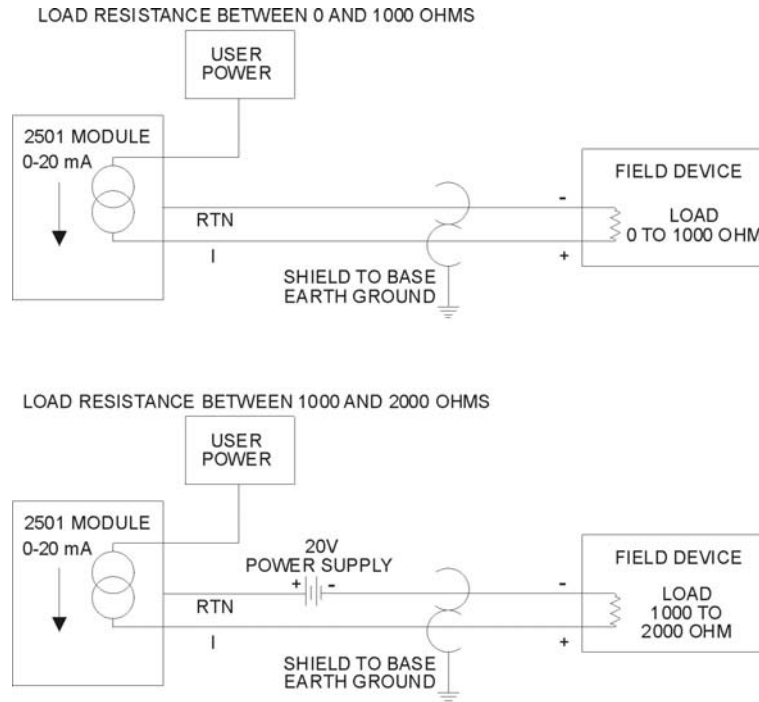
Figure 2.1 Current Output Circuits

2.1.5. Requirements for Signal Wire Providing Voltage

Applications using voltage signals require some special considerations to ensure the module's accuracy. Two additional parameters must be considered:

- Resistive load of the field device

- Capacitance of the cable wiring

The resistive load of the field device must be no lower than 1K ohms. The cable capacitance must be less than 0.01 microfarad.

The cable capacitance is a function of the cable length. To determine the maximum cable length allowed, find the nominal value of cable capacitance per unit length as given by the manufacturer. Use this value in the following equation to determine the maximum cable length:

Nominal Cable Capacitance (per unit length) = (0.01 microfarads) ÷ (Maximum Cable Length)

> *NOTE:*
> *Nominal capacitance is measured between the conductors. However, if one conductor is connected to the shield via a grounded power supply, then the nominal value will usually double in value.*

The length of a cable and the cable conductor resistance are used to find the fixed error which would appear at the field device. Use the following equation to determine the fixed error:

$$\text{Fixed Error (\%)} = \frac{[1-R1] \times 100}{[R1 + 2 \times CL \times RC]}$$

where: R1 is the field device resistive load
CL is the cable length
RC is the conductor resistance per unit length

The following figure provides a schematic for a voltage output circuit.
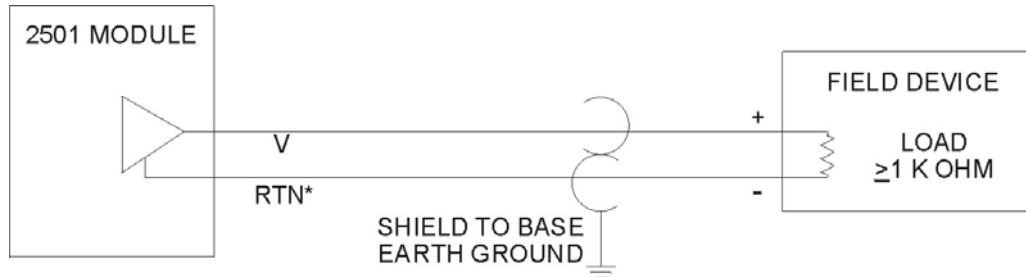
Figure 2.2 Voltage Output Circuit

2.2. Unpacking the Module

CAUTION:
HANDLING STATIC SENSITIVE DEVICES
The components on the 2501 printed circuit board 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.

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

2.3. Configuring the Module

The 2501 must be configured using dip switches and jumpers both on a module and per-channel basis. The configuration parameters are: density mode, outputs at power up, simulation mode, input/output scaling, digital filtering, voltage or current inputs, input voltage range, unipolar/bipolar input mode, and output voltage range. As shipped, the jumpers are set in the positions outlined in Figure 2.4 Shipping Jumper Configuration Locations.

Configuring the 2501 for operation consists of the following steps (notations in parenthesis are actual printed board titles; see Figure 2.3 Jumper and Switch Locations for actual board layout):

1. Selecting Hi (HI) or Lo (LO) Density mode for the module.
2. Selecting Last Value (LAST) or Zero (ZERO) output at power up for the module.
3.   Selecting the 7012 (7012) or 7016 (7016) simulation mode for the module.
4. Selecting input/output scaling (EN) or no input/output scaling (DIS) for the module.
5. Selecting digital filtering (EN) or no filtering (DIS) for the module.
6. Selecting voltage (VOLTAGE) or current (20MA) mode for each input channel.
7. Selecting 0 to 5V (5V) or 0 to 10V (10V) input voltage range for each channel.
8. Selecting unipolar (UNI) or bipolar (BI) mode for each input channel.
9. Selecting 0 to 5V (5V) or 0 to 10V (10V) output voltage range for each channel.
10. Selecting unipolar (UNI) or bipolar (BI) mode for each output channel.
11. Configuring DIP switches to report the hardware selections to the microcomputer.
12. <u>Do not change the setting of jumper CN5 from its location as shipped</u>. Version F (901F-2501) and older of the board require this jumper to be installed on pins 2-3. Older versions do not require the jumper.
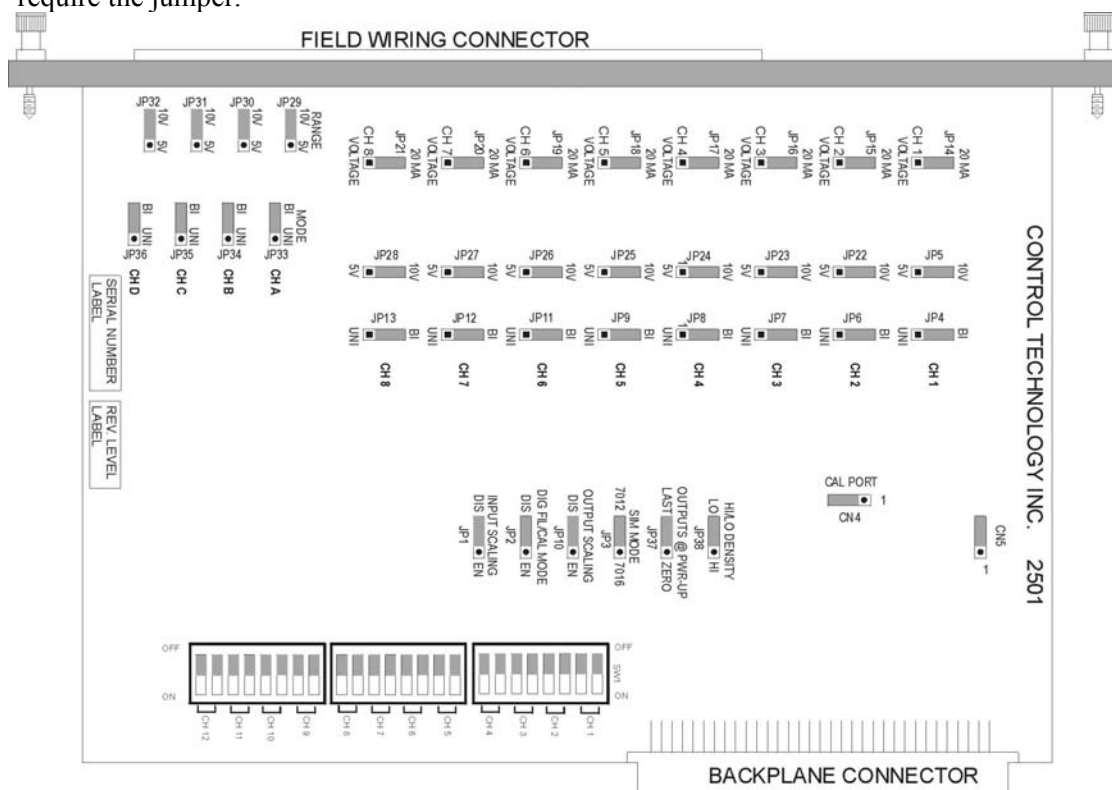
Figure 2.3 Jumper and Switch Locations

Channel Number	Voltage Current Jumper	Jumper Position *V or 20mA*	Voltage Range Jumper	Jumper Position *5V or 10V*	Unipolar/ Bipolar Jumper	Jumper Position *Uni or Bi*
1	JP14	20mA	JP5	5V	JP4	UNI
2	JP15	20mA	JP22	5V	JP6	UNI
3	JP16	20mA	JP23	5V	JP7	UNI
4	JP17	20mA	JP24	5V	JP8	UNI
5	JP18	20mA	JP25	5V	JP9	UNI
6	JP19	20mA	JP26	5V	JP11	UNI
7	JP20	20mA	JP27	5V	JP12	UNI
8	JP21	20mA	JP28	5V	JP13	UNI
A	-	-	JP29	5V	JP33	UNI
B	-	-	JP30	5V	JP34	UNI
C	-	-	JP31	5V	JP35	UNI
D	-	-	JP32	5V	JP36	UNI

All Channels 1-8 IN, A-D OUT	Hi/Lo Density *Hi or Lo*	Outputs at Power Up *Last or Zero*	SIM Mode *7012 or 7016*	Output Scaling *Dis or En*	Dig Fil/ Cal Mode *Dis or En*	Input Scaling *Dis or En*
Jumper	JP38	JP37	JP3	JP10	JP2	JP1
Jumper Position	HI	LAST	7012	DIS	EN	DIS

Figure 2.4 Shipping Jumper Configuration Locations

2.3.1. Selecting Hi or Lo Density Mode

The 2501 is shipped to log in as a 12WX and 4WY module, which simulates the Siemens® 7012 mode (see Figure 2.7). This represents one of two HI density modes the 2501 is capable of handling. The second HI mode simulates the 7016 in which there are 20WX and 4WY (see Figure 2.8). Error codes are defined in Figure 2.5. The Low density mode exists to provide yet another alternative input/output combination, namely an 8WX input mode (see Figure 2.6). The analog outputs are not driven and remain at zero volts/amps out.

Error Code	Error Code Definition
32,759	Input Overrange
32,758	Input Underrange
32,757	Input Failure (Not Used on the 2501)
32,756	Input Conversion or Arithmetic Overflow
32,755	Output Overrange
32,754	Output Underrange
32,753	Output 24V Power Supply Failure

Figure 2.5 CTI/ Siemens® Error Code Definitions

Density Mode	Channel	Inputs	Item	Simulation Mode
Lo	1	WX1	Input data or error code	none
Lo	2	WX2	Input data or error code	none
Lo	3	WX3	Input data or error code	none
Lo	4	WX4	Input data or error code	none
Lo	5	WX5	Input data or error code	none
Lo	6	WX6	Input data or error code	none
Lo	7	WX7	Input data or error code	none
Lo	8	WX8	Input data or error code	none

Figure 2.6 Word Mapping for Lo Density, No Simulation

Density Mode	Channel	Inputs	Item	Simulation Mode
Hi	1	WX1	Input data or error code	7012
Hi	2	WX2	Input data or error code	7012
Hi	3	WX3	Input data or error code	7012
Hi	4	WX4	Input data or error code	7012
Hi	5	WX5	Input data or error code	7012
Hi	6	WX6	Input data or error code	7012
Hi	7	WX7	Input data or error code	7012
Hi	8	WX8	Input data or error code	7012
Hi	9	WX9	Output data echo or error code	7012
Hi	10	WX10	Output data echo or error code	7012
Hi	11	WX11	Output data echo or error code	7012
Hi	12	WX12	Output data echo or error code	7012

Figure 2.7 Word Mapping for Hi Density, 7012 Simulation

Density Mode	Channel	Inputs	Item	Simulation Mode
Hi	1	WX1	Input data	7016
Hi	2	WX2	Input data	7016
Hi	3	WX3	Input data	7016
Hi	4	WX4	Input data	7016
Hi	5	WX5	Input data	7016
Hi	6	WX6	Input data	7016
Hi	7	WX7	Input data	7016
Hi	8	WX8	Input data	7016
Hi	1	WX9	Error code	7016
Hi	2	WX10	Error code	7016
Hi	3	WX11	Error code	7016
Hi	4	WX12	Error code	7016
Hi	5	WX13	Error code	7016
Hi	6	WX14	Error code	7016
Hi	7	WX15	Error code	7016
Hi	8	WX16	Error code	7016
Hi	9	WX17	Output data echo or error code	7016
Hi	10	WX18	Output data echo or error code	7016
Hi	11	WX19	Output data echo or error code	7016
Hi	12	WX20	Output data echo or error code	7016

Figure 2.8 Word Mapping for Hi Density, 7016 Simulation

2.3.2. Selecting Either Zero or Last Value Output at Power Up

Upon power up of the base power, the 2501 allows the user to choose between either a zero output value or last output value when transitioning to the next update. A hardware JP37 jumper setting (see Figure 2.3) sets the entire module for the mode chosen. The normal shipping configuration is in the LAST VALUE mode.

2.3.3. Selecting Simulation Mode

Locate the Simulation Mode "SIM MODE" jumper JP3 (see Figure 2.3). To enable 7012 simulation mode for the module set the jumper to the "7012" position. To enable the 7016 simulation mode for the module set the jumper to the "7016" position. As shipped, the 7012 mode is enabled.

2.3.4. Selecting Automatic Input/Output Scaling Mode

Some applications require an Offset Input/Output Scaling Mode for 4-20mA or 1-5VDC. The PLC can adjust a loop calculation to provide an offset scaling input/output. If the application does not use the PID control block then the processing must be done in relay ladder logic. The 2501 can perform this offset calculation and input or output an offset signal independent of the PLC. Selecting this function with JP1 (input) or JP10 (output) causes all inputs and outputs to be scaled. Move the

jumper to the ENABLED position to select this function. The normal shipping configuration is DISABLED for both inputs and outputs.

2.3.5. Selecting Digital Filtering

Locate the Digital Filtering Jumper "DIG FIL/CAL MODE" JP2 (see Figure 2.3). 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. The built-in digital filtering has a time constant of 0.3 seconds, meaning it reaches 63% of its final value in 0.3s and settles to within a high precision within 1.5 seconds.

As shipped, digital filtering is ENABLED for all 8 analog inputs.

2.3.6. Selecting Voltage or Current Input Mode

Locate the 8 Voltage/Current Jumpers corresponding to input channels 1 through 8 (see Figure 2.3 for the location of these jumpers). For each input channel, select current mode by placing the jumper in the "20MA" position or voltage mode by placing the jumper in the "VOLTAGE" position. For each input channel set to current mode, you must set the corresponding Voltage Range Jumper to the 5V.

2.3.7. Selecting Voltage Input Range

Locate the Voltage Range Jumpers corresponding to input channels 1 through 8 (see Figure 2.3). For each input channel operating in current mode, set the corresponding Voltage Range Jumper to 5V.

CAUTION:
For each input channel configured for current mode, the corresponding Voltage Range Jumper must be set to 5V.

For each input channel operating in voltage mode, set the corresponding Voltage Range Jumper to "5V" for 0 to +5V or –5 to +5V input range or "10V" for 0 to +10V or –10 to +10V input range.

2.3.8. Selecting Unipolar or Bipolar Input Mode

Locate the Unipolar/Bipolar Jumpers for each channel (see Figure 2.3). Set each jumper to "UNI" for unipolar operation or "BI" for bipolar operation for each input channel with input ranges of 0 to 5VDC, 0 to 10VDC, -5 to +5VDC or -10 to +10VDC. Select 5VDC range for all current applications.

NOTE:
The 5V input signal range configuration is used for both 0 to 5VDC and 1 to 5VDC or 0 to 20mA and 4 to 20mA input signal ranges.

2.3.9. Selecting Output Voltage Range

The 2501 is capable of supporting Unipolar or Bipolar applications with an output range of 0 to 5VDC, 0 to 10VDC, -5 to +5VDC or -10 to +10VDC. For each channel a hardware jumper selects the range for that output circuit (see Figure 2.3). Select 5VDC range for all current applications.

2.3.10. Selecting Unipolar or Bipolar Output

Each output channel on the 2501 supports Unipolar or Bipolar output operation. Hardware jumpers select operation of the output (see Figure 2.3). Select Bipolar for applications that drive the outputs from -5 to +5VDC, -10 to +10VDC, or -20 to +20mA.

2.3.11. Setting DIP Switches to Match the Hardware Selections

Once the hardware jumpers are selected this information needs to be reported to the microcomputer. The information is reported via DIP switches SW1, SW2, and SW3. Each input and output channel uses 2 switches with a BCD code to indicate the state of the hardware jumpers.

2 (MSB)	1 (LSB)	Range
OFF	OFF	Unipolar 5VDC
OFF	ON	Unipolar 10VDC
ON	OFF	Bipolar 5VDC
ON	ON	Bipolar 10VDC
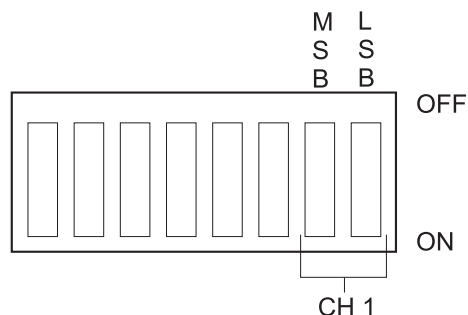
> *NOTE:*
> *The OFF position is selected by actuating the switch in the direction of the center of the printed circuit board.*

> *NOTE:*
> *Standard shipping configuration is all switches in the OFF position which denotes the Unipolar 5VDC range.*

2.3.12. Jumper CN5

Do not change the setting of jumper CN5 from its location as shipped. Version F and older of the board require this jumper to be installed on pins 2-3. Older versions do not require the jumper.

2.3.13. 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

When the module is fully seated in the slot, captive screws at the top and bottom will hold the module in place. To remove the module from the I/O base, loosen these captive screws, and then remove the module from the I/O base. Do not damage the edge connector at the back of the module when inserting or removing the module.

WARNING:
Always remove power from the I/O base before inserting a module to minimize the risk of injury of damage to equipment. Never insert a module into a powered I/O base.

2.5. Wiring the Output Connector

Output signals are provided through a connector assembly located on the front of the module. The connector assembly consists of a header attached to the printed circuit card and a mating removable screw terminal connector (see Figure 2.9). Wiring is connected through the removable screw terminal connector.
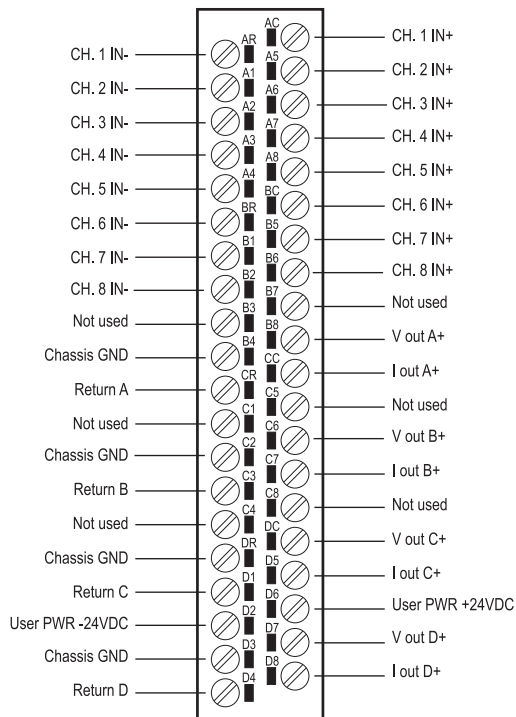
Figure 2.9 Output Screw Terminal Connector Wiring

2.5.1. Connecting Voltage Output Wiring

First, loosen the wire locking screws on the output screw terminal plug. For voltage output circuits, connect the signal wire to the V_{OUT} screw terminal, and the return wire to the Return (channel ground) screw terminal. Insert the wires in the appropriate holes next to the screws. When the wires are inserted, tighten the screws. Repeat this procedure for the remaining voltage output channels.

2.5.2. Connecting Current Output Wiring

For current output circuits, connect the signal wire to the I_{OUT} screw terminal, and the return wire to the Return (channel ground) screw terminal. Insert the wires in the appropriate holes next to the screws. When the wires are inserted, tighten the screws. Repeat this procedure for the remaining current output channels.

2.5.3. Connecting the Shield Wiring

See Figure 2.10 below for a description of cable grounding and chassis ground.
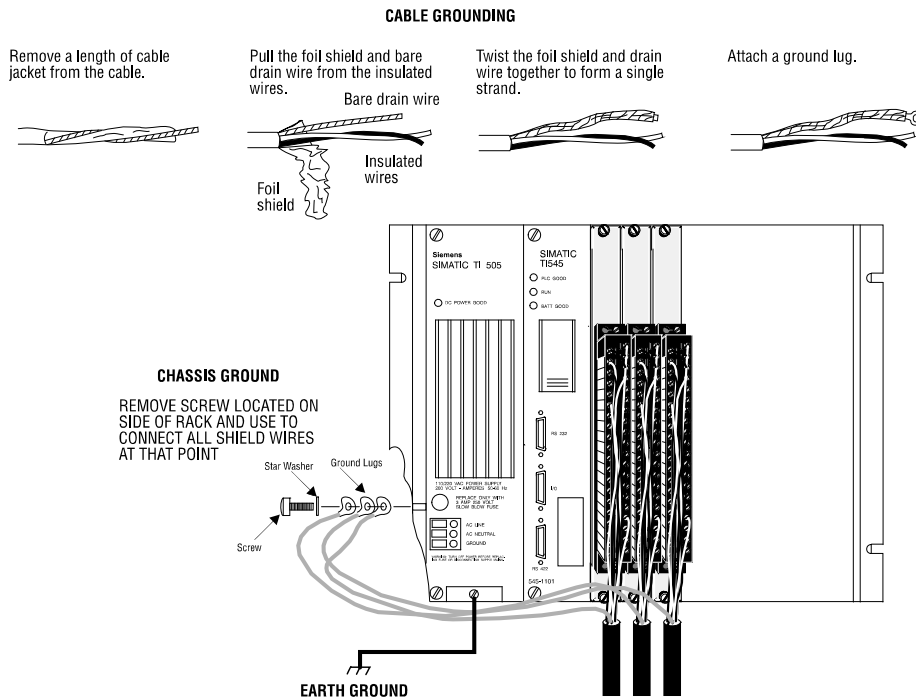
Figure 2.10 Connecting the Shield Wiring

NOTE:
Five static drains are recommended on the 2501 to prevent static charges from building up. The eight analog inputs, which share the same isolated common, may be protected by a single 10K to Meg resistor from ANY analog negative (-) terminal to chassis ground. If ANY of the circuits being

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monitored provide a static drain, then the resistor is not only not required, but not recommended - a ground loop would result. Each of the four analog outputs require a separate static drain if the circuits being driven does not provide a static discharge path. A 10K to 1 Meg resistor to chassis ground should be sufficient. (Note also that chassis ground is available on front panel connector pins B4, C2, DR, and D3.)

2.6. Inserting the Screw Terminal Connector

When all the output signal wires are connected to the screw terminal connector, carefully insert the connector into its header. Both the plug and header are keyed to prevent reverse wiring. When the screw terminal is fully inserted onto the header, use the captive screws to secure the connector to the front panel.

PRINTED CIRCUIT CARD (PCB)

CAPTIVE SCREWS

INDIVIDUAL CAPTIVE SCREW

INPUT SIGNAL WIRES

FRONT FACE CONNECTOR
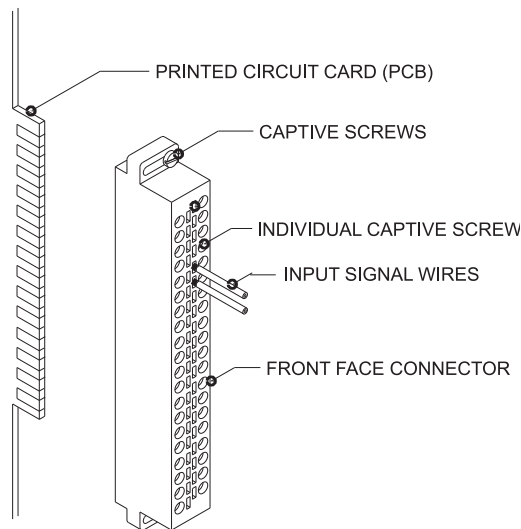
Figure 2.11 Attaching the Screw Terminal Connector

2.7. Connecting the 24VDC User Power Supply

The power supply is connected to the "D2" and "D6" positions for the connector on the front of the module (as shown in Figure 2.9). Be sure to check that the fuse is present and intact. The fuse will blow if the +24VDC power falls below ~21VDC or goes above ~31VDC, and will report a power supply error code (+32753) to the PLC (see Figure 2.5 CTI/ Siemens® Error Code Definitions). See Chapter 3 Troubleshooting for recommendations for replacement fuses.

2.8. Checking Module Operation

First, turn on the base supply power. If diagnostics detects no problems, the front panel status indicator will light. If the 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 TISOFT Programming Manual. To diagnose and correct a module failure, refer to Chapter3 Troubleshooting.

NOTE:

> *If 24VDC power fails or is removed and then later restored, the module will automatically resume normal operation. No external reset is required after power is restored.*

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. Example charts are shown in the following figures, one for each login mode. Also, note the Wxs and Wys mix in Figure 2.12 below.

Module Configuration		Analog		I/O Words	Values
		Inputs	Outputs		
Lo:	8WX	8	0	WX1-8	Input data 1-8 / error words
Hi, 7012:	12WX 4WY	8	4	WX1-8 WX9-12 WY13-16	Input data / error words Output echo / error words Output points A-D
Hi, 7016:	20WX 4WY	8	4	WX1-8 WX9-16 WX17-20 WY21-24	Input data Input error words Output echo / error words Output points A-D

Figure 2.12 WXs and Wys mix

In this first example, the 2501 Module is inserted in slot 1 in I/O base 0, logging in as a Lo Density module (see Figure 2.13). Input data for channel 1 appears in word location WX1, data for channel 2 appears in word location WX2, etc. through channel 8 and WX8. 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.

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 2.13 I/O Configuration Chart: Lo Density

In the second example, the 2501 Module is inserted in slot 1 in I/O base 0, logging in as a High Density, 7012 module (see Figure 2.14). Input data for channel 1 appears in word location WX1,

data for channel 2 appears in word location WX2, etc. through channel 8 and WX8. Output data for channels 9-12 appear in word locations WX 9-12. 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.

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	12	04	NO
2	0000	00	00	00	00	NO
.	.	.	.	.	.	.
.	.	.	.	.	.	.
15	0000	00	00	00	00	NO
16	0000	00	00	00	00	NO

Figure 2.14 I/O Configuration Chart: Hi Density, 7012 Mode

In this third and final example, the 2501 Module is inserted in slot 1 in I/O base 0, logging in as a High Density, 7016 module (see Figure 2.15). Input data for channel 1 appears in word location WX1, data for channel 2 appears in word location WX2, etc., through channel 8 and WX8. Input error codes appear in word locations WX9-16, and output data and error codes appear in word locations WX17-20. 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.

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	20	04	NO
2	0000	00	00	00	00	NO
.	.	.	.	.	.	.
.	.	.	.	.	.	.
15	0000	00	00	00	00	NO
16	0000	00	00	00	00	NO

Figure 2.15 I/O Configuration Chart: Hi Density, 7016 Mode

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:*
> *In the event a CTI analog module detects no user 24VDC or 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® 505 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.*

2.9. Power Cycling

The 2501 reacts in the following ways upon various power cycling scenarios:

Base Power (5V)	User Power (24V)	2501 in Last Value Mode	
		Unipolar Mode*	Bipolar Mode*
On	Transition off	Output to zero.	Output to zero.
On	Transition on	Output from zero to PLC value.	Output from zero to full scale (+), then PLC value.
Transition off	On	Maintains last value.	Maintains last value.
Transition on	On	Maintains last value.	Maintains last value.
Off	Transition on	Output stays at zero.	Output to full scale.

Base Power (5V)	User Power (24V)	2501 in Zero Mode	
		Unipolar Mode*	Bipolar Mode*
On	Transition off	Output to zero.	Output to zero.
On	Transition on	Output from zero to PLC value.	Output from zero to full scale (+), then to zero, then to PLC value.
Transition off	On	Maintains last value.	Maintains last value.
Transition on	On	Output to zero for several seconds, then to PLC value.	Output to zero, then to PLC value.
Off	Transition on	Output stays at zero.	Output from zero to full scale (+).

*See Section 2.3.2. Selecting Either Zero or Last Value Output at Power Up for further explanation.

CHAPTER 3. TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
Indicator is not lit	Base power is off	Turn base on
	Defective module	Return module to CTI for repair
Indicator is blinking	Calibration data is corrupted or missing	Return module to CTI for calibration
	PCB 901F-2501 only: Jumper CN5 is missing	Install jumper at CN5 pins 2-3 "normal"
Incorrect inputs	Blown fuse	Replace fuse (see below)
	Wrong addresses for word input	Check program for correct word input addresses
	Not logged in	Read I/O configuration
	Incorrect jumper or dipswitch setting	Refer to Section 2.3 for settings
	Incorrectly calibrated	Return module to CTI for calibration
	Noisy signal	Check for proper shield termination at input connectors
	Offset scale enabled	If JP10 is enabled all inputs are scaled for offset operation

Figure 3.1 Troubleshooting Matrix

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.

> *CAUTION:*
> *The module fuse F2 is user serviceable. If this fuse continuously blows, the module has a serious component failure and should be returned to CTI for repair, or the module is being supplied voltage in excess of ~31VDC.*

In the event the user serviceable fuse F2 blows, its replacement should be a 0.5 A, 250V Time Lag 5x20mm fuse (Schurter 0034.3114 or equivalent).

If after consulting the chart above, you are unable to diagnose or solve the problem, contact your local distributor or CTI at 1-800-537-8398 for further assistance.

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SPECIFICATIONS

Input Specs:

Input Channels:	8 analog input channels
Input Range:	Unipolar: 0 to 5VDC, 0 to 10VDC, or 0 to 20mA
	Bipolar: -5 to +5VDC, -10 to +10VDC, or -20 to +20mA
Resolution:	Unipolar: 15 bits plus sign:
	0-5VDC range=156μV/step
	0-10VDC range=312.5μV/step
	0-20mA range=0.625μA/step
	Bipolar: 15 bits plus sign:
	0-5VDC range=156μV/step
	0-10VDC range=312.5μV/step
	0-20mA range=0.625μA/step
Accuracy:	Voltage Mode: 0.125% of full scale from 0° to 60°C
	Current Mode: 0.225% of full scale from 0° to 60°C
Digital Filtering Time Constant:	0.3 Sec
DC Input Resistance:	Voltage Mode: 780kΩ
	Current Mode: 250Ω
Repeatability:	0.0025%
Common Mode Rejection:	>120db @ 60Hz (digital filtering disabled)
Normal Mode Rejection:	>40db @ 500Hz (digital filtering enabled)
Isolation	1500VDC channel-to-PLC
Input Protection:	Input ESD Protection: 20,000V, IEC 1000-4-2, level 4
	Overrange Protection: +/- 300VDC

Output Specs:

Output Channels:	4 analog output channels
Output Range:	Unipolar: 0 to 5VDC, 0 to 10VDC, or 0 to 20mA
	Bipolar: -5 to +5VDC, -10 to +10VDC, or -20 to +20mA
Resolution (7012 or 7016 Mode):	Unipolar: 12 bits:
	0-5VDC range = 1.25mV/step
	0-10VDC range = 2.5mV/step
	0-20mA range = 5μA/step
	Bipolar: 12 bits:
	-5 to +5VDC range = 2.5mV/step
	-10 to +10VDC range = 5.0mV/step
	-20 to +20mA range = 10μA/step
Accuracy:	Voltage Mode: <1% of full scale from 0-60°C over load range
	Current Mode: <1% of full scale from 0-60°C over load range
Capacitance Drive:	0.01 microfarads
Load Resistance:	Voltage: 1KΩ minimum, no maximum
	Current: 0Ω to 1KΩ max. @ 24VDC or greater
User Supply:	20 to 30VDC @ 0.25 Amps (maximum ripple of 0.4V) UL Class 2 power supply
Isolation:	1500VDC channel-to-channel and channel-to-PLC

Module Specs:

Update Time:	5.6 mSec all channels, LO Density Mode
	6.7 mSec all channels, HI Density, 7012 or 7016 Mode
Connector:	Removable
Wire Gauge:	14-22 AWG
User Serviceable Fuse:	0.5A, 250V time lag 5x20 mm (Schurter 0034.3114 or equiv.)
Backplane Power Consumption:	3.0 Watts
Module Size:	Single-wide
Operating Temperature:	0° to 60°C (32° to 140°F)
Storage Temperature:	-40° to 85°C (-40° to 185°F)
Relative Humidity:	5% to 95% non-condensing
Agency Approvals Pending:	UL, UL-C, Class 1-Div 2, CE
Shipping Weight:	1.5 lb. (0.68 Kg)

*Specifications subject to change without notice.

APPENDIX A. COMPATIBILITY WITH SIEMENS® 505-7012/7016

Overview

The CTI 2501 8 Analog Input / 4 Analog Output Module was designed to be a drop-in replacement for the Siemens® Models 505-7012 and 505-7016. From set up of the module to wiring and PLC reporting, the user will find many similarities between the CTI and Siemens® modules.

Using the CTI 2501 in a 505-7012 and/or 505-7016 application

The CTI 2501 should fulfill all the following requirements for the 505-7012 and 505-7016 replacement(s), as outlined below:

Module setup

Since the CTI 2501 allows for both Unipolar and Bipolar setup, the module does have a slightly different module setup. See Chapter 2.3 Configuring the Module for Operation to determine the details in module setup.

Wiring

The wiring of the output connector is the same between the modules. See Chapter 2.5. Wiring the Output Connector for a detailed explanation of how this is accomplished.

If the module is used to supply voltage, the requirements of the input voltage to the module (20-30VDC) remains the same in order to supply the resistive load of the field device (>1000Ω). However, the maximum load resistance for current output drops to 600Ω at 20VDC and then climbs linearly to 1000Ω at 24-30VDC.

Also noteworthy is the isolation achieved module to module with the same power supply by using the CTI 2501 versus the Siemens® modules. With the 2501, each module is dielectrically isolated from a common 24V power supply.

PLC Reporting

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

Power Cycling

When the user power is supplied and the base power is transitioning on, the 2501 has the option to either transition to hold the last output value until the next PLC update, as the Siemens® modules do, or to go to zero until the next PLC update. See section 2.3.2. Selecting Either Zero or Last Value Output at Power Up for further details.

APPENDIX B. JUMPER SETTINGS LOG SHEET

Channel Number	Voltage Current Jumper	Jumper Position *V or 20mA*	Voltage Range Jumper	Jumper Position *5V or 10V*	Unipolar/ Bipolar Jumper	Jumper Position *Uni or Bi*
1	JP14		JP5		JP4	
2	JP15		JP22		JP6	
3	JP16		JP23		JP7	
4	JP17		JP24		JP8	
5	JP18		JP25		JP9	
6	JP19		JP26		JP11	
7	JP20		JP27		JP12	
8	JP21		JP28		JP13	
A	-		JP29		JP33	
B	-		JP30		JP34	
C	-		JP31		JP35	
D	-		JP32		JP36	

All Channels 1-8 IN, A-D OUT	Hi/Lo Density *Hi or Lo*	Outputs at Power Up *Last or Zero*	SIM Mode *7012 or 7016*	Output Scaling *Dis or En*	Dig Fil/ Cal Mode *Dis or En*	Input Scaling *Dis or En*
Jumper	JP38	JP37	JP3	JP10	JP2	JP1
Jumper Position						

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

CTI 2501 Installation and Operation Guide

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 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.