



# **Terminator I/O Installation and I/O Manual**

Manual Number T1K-INST-M

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# Manual Revisions

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*If you contact us in reference to this manual, be sure and include the revision number.*

**Title:** Terminator Installation and I/O Manual

**Manual Number:** T1K-INST-M

<b>Edition/Rev</b>	<b>Date</b>	<b>Description of Changes</b>
Original	11/00	original issue
1st Edition, Rev A	02/01	added new module minor corrections
1st Edition, Rev B	07/01	added new modules
1st Edition, Rev C	04/02	added new modules minor corrections
1st Edition, Rev D	12/02	added new module general updates
1st Edition, Rev E	04/03	added new module; added Class 1, Division 2, Zone 2 Approval
2nd Edition	09/03	added new module minor corrections
2nd Edition, Rev A	09/04	added new modules minor corrections

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# Introduction

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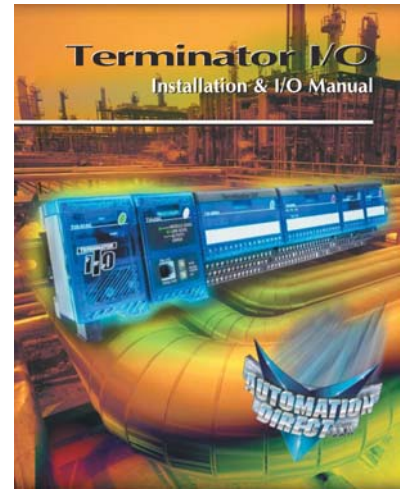
## In This Chapter. . . .

- About This Manual
  - Conventions Used
  - Terminator I/O Base Controllers
  - Terminator I/O System Components
-

## About This Manual

### The Purpose of this Manual

This manual is written for the user of the Terminator I/O line of field bus termination I/O products. This manual shows you how to install and wire the equipment. It provides specifications for the input and output modules.



### Supplemental Manuals

In addition to this manual, you will want to have the specific manual for your Terminator I/O Base Controller. In some cases you may need an additional manual such as the master PLC User Manual or perhaps the manual for the PC-based control software you may be using.

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When you see the “notepad” icon in the left-hand margin, the paragraph to its immediate right will be a **special note**.

The word **NOTE:** in boldface will mark the beginning of the text.

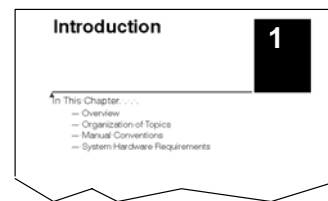


When you see the “exclamation mark” icon in the left-hand margin, the paragraph to its immediate right will be a **warning**. This information could prevent injury, loss of property, or even death (in extreme cases).

The word **WARNING:** in boldface will mark the beginning of the text.

### Key Topics for Each Chapter

The beginning of each chapter will list the key topics that can be found in that chapter.



## Terminator I/O Base Controllers

Terminator I/O offers six base controller modules. All modules include an on board RJ-12 RS-232 serial port.

The six base controllers are:

- Ethernet Base Controller
  - T1H-EBC
  - T1H-EBC100
- DeviceNet™ Base Controller
  - T1K-DEVNETS
- Profibus™ DP Base Controller
  - T1H-PBC
- Modbus™ RTU Base Controller
  - T1K-MODBUS
- **Direct**Logic Remote I/O Base Controller
  - T1K-RSSS



T1H-EBC



T1H-EBC100



T1K-DEVNETS



T1H-PBC



T1K-MODBUS



T1K-RSSS

## Terminator I/O System Components

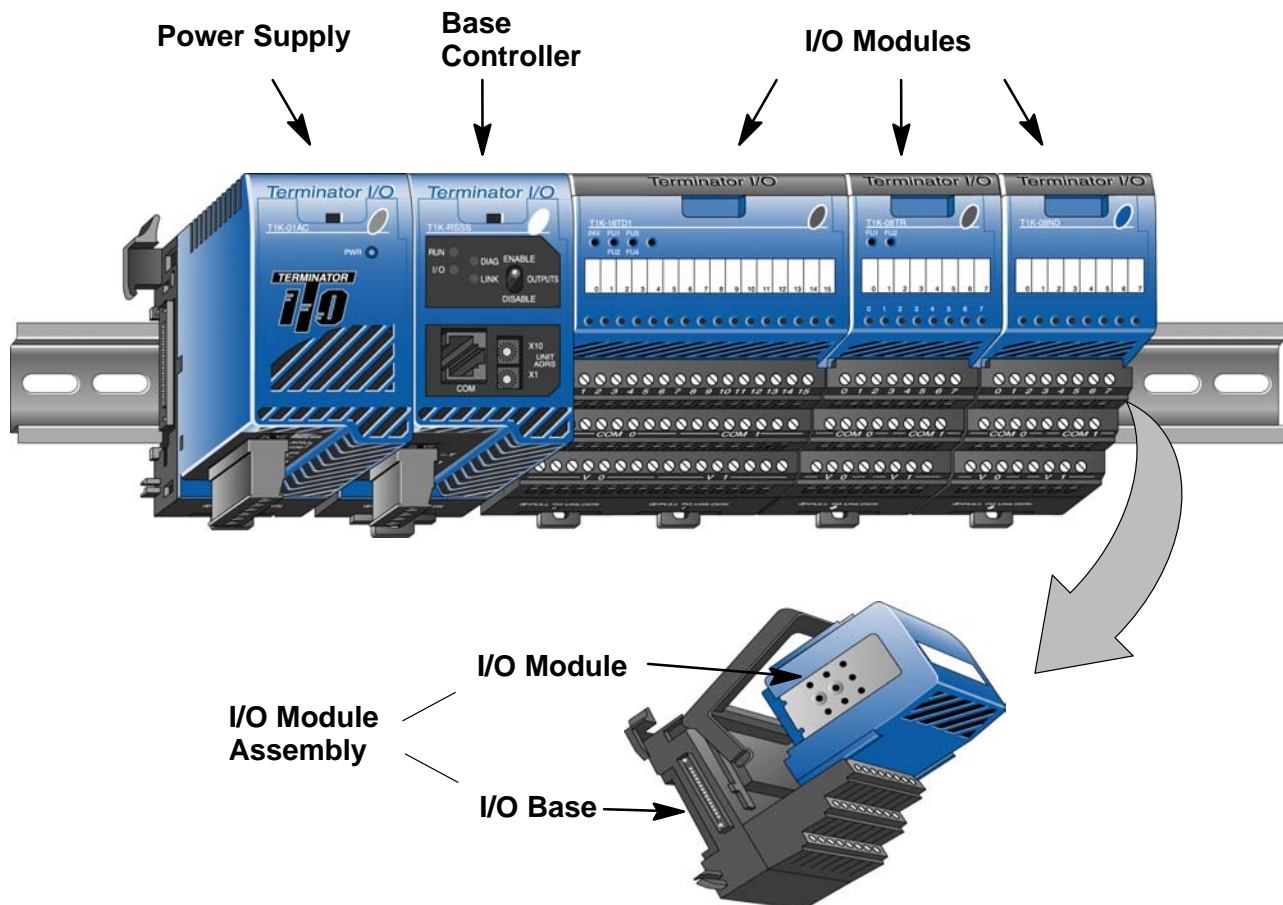
Terminator I/O is a modular system which combines the functions of terminal blocks and I/O modules for distributed I/O. Each Terminator I/O system has the following components: a Power Supply, a Base Controller, and one or more I/O Module(s). Terminator I/O systems can contain up to 16 I/O modules per slave (node). Each slave (node) system can be divided into one row of base I/O plus two rows of local expansion I/O using a base expansion cable.

### Power Supplies

120/240VAC and 12/24 VDC power supplies are available. The AC version has a built-in 24VDC supply. A power supply must be the leftmost component in a slave system followed by the base controller. Additional power supplies should be added between I/O modules to meet power budget requirements.

### I/O Modules

A Terminator I/O module assembly consists of an I/O module and a separate base, as shown below. A complete range of discrete modules which support 12/24 VDC, 110/220 VAC and up to 7A relay outputs is offered. The analog I/O modules provide 12 and 14 bit resolution and several selections of I/O signal ranges (including bipolar). The temperature input modules provide 16 bit resolution with several temperature input range selections. All Terminator I/O modules can be "Hot Swapped" (replaced) without removing system power (except for the base controller and power supply). Refer to the "I/O Module Hot Swap" section in Chapter 3 for details.



# Installation and Power Wiring

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## In This Chapter. . . .

- Safety Guidelines
  - Mounting Guidelines
  - Assembling the Components
  - Multiple Power Supplies / Local Expansion
  - Power Supply Wiring Guidelines
-

## Safety Guidelines



**WARNING:** Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system planning and installation. Automation systems can fail and may result in situations that can cause serious injury to personnel or damage to equipment. Do not rely on the automation system alone to provide a safe operating environment. You should use external electromechanical devices, such as relays or limit switches, that are independent of the application to provide protection for any part of the system that may cause personal injury or damage.

Every automation application is different, so there may be special requirements for your particular application. Make sure you follow all national, state, and local government requirements for the proper installation and use of your equipment.

### Plan for Safety

The best way to provide a safe operating environment is to make personnel and equipment safety part of the planning process. You should examine every aspect of the system to determine which areas are critical to operator or machine safety.

If you are not familiar with industrial control system installation practices, or your company does not have established installation guidelines, you should obtain additional information from the following sources.

- NEMA — The National Electrical Manufacturers Association, located in Washington, D.C., publishes many different documents that discuss standards for industrial control systems. You can order these publications directly from NEMA. Some of these include:  
*ICS 1, General Standards for Industrial Control and Systems*  
*ICS 3, Industrial Systems*  
*ICS 6, Enclosures for Industrial Control Systems*
- NEC — The National Electrical Code provides regulations concerning the installation and use of various types of electrical equipment. Copies of the NEC Handbook can often be obtained from your local electrical equipment distributor or your local library.
- Local and State Agencies — many local governments and state governments have additional requirements above and beyond those described in the NEC Handbook. Check with your local Electrical Inspector or Fire Marshall office for information.

### Safety Techniques

The publications mentioned provide many ideas and requirements for system safety. At a minimum, you should follow these regulations. Using the techniques listed below will further help reduce the risk of safety problems.

- Orderly system shutdown sequence in the control program.
- Emergency stop switch for disconnecting system power.

### Class 1, Division 2, Zone 2 Approval

This equipment is suitable for use in Class 1, Division 2, Zone 2, groups A, B, C and D or non-hazardous locations only.

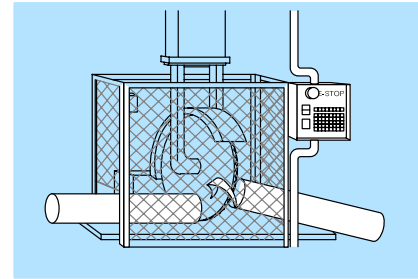


#### **WARNING: Explosion Hazard:**

- Substitution of components may impair suitability for Class 1, Division 2, Zone 2.
- Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

### Orderly System Shutdown

The first level of protection can be provided with the control program by identifying machine problems. Analyze your application and identify any shutdown sequences that must be performed. Typical problems are jammed or missing parts, empty bins, etc. that do not pose a risk of personal injury or equipment damage.



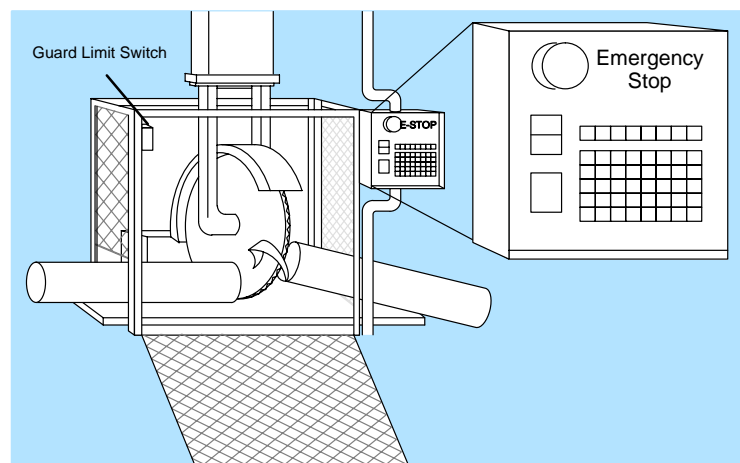
**WARNING:** The control program *must not* be the only form of protection for any problems that may result in a risk of personal injury or equipment damage.

### System Power Disconnect

By using electromechanical devices, such as master control relays and/or limit switches, you can prevent accidental equipment startup. When installed properly, these devices will prevent *any* machine operations from occurring.

For example, if the machine has a jammed part, the control program can turn off the saw blade and retract the arbor. However, since the operator must open the guard to remove the part, you must include a bypass switch to disconnect *all* system power any time the guard is opened.

The operator must also have a quick method of manually disconnecting *all* system power. This is accomplished with a mechanical device clearly labeled as an **Emergency Stop** switch.



After an Emergency shutdown or any other type of power interruption, there may be requirements that must be met before the control program can be restarted. For example, there may be specific register values that must be established (or maintained from the state prior to the shutdown) before operations can resume. In this case, you may want to use retentive memory locations, or include constants in the control program to ensure a known starting point.



# Mounting Guidelines

Before installing the Terminator I/O system you will need to know the dimensions of the components. The diagrams on the following pages provide the component dimensions to use in defining your enclosure specifications. Remember to leave room for potential expansion.

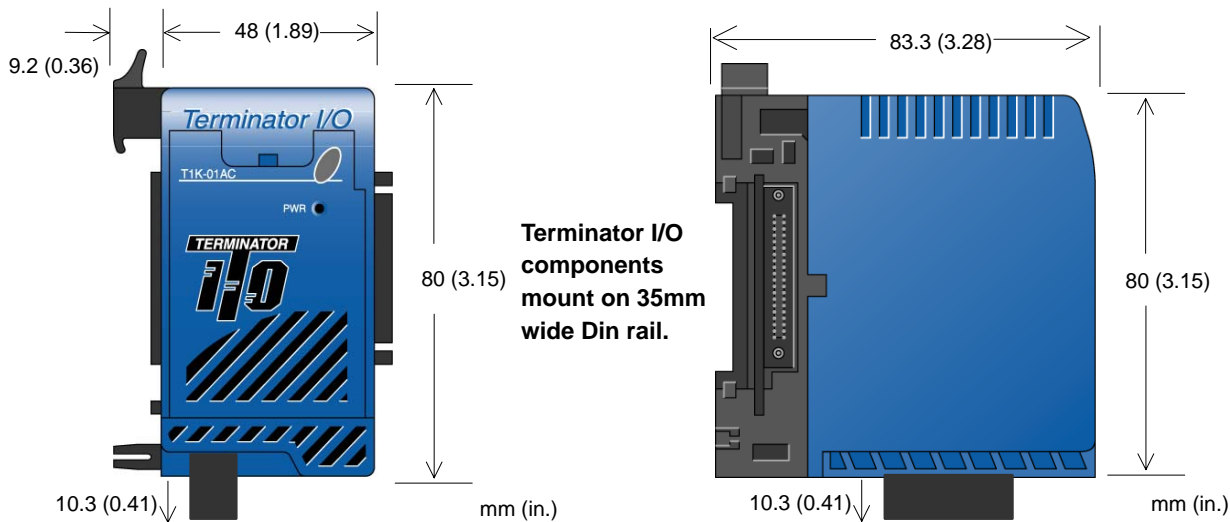


**NOTE:** If you are using other components in your system, refer to the appropriate manual to determine how those units can affect mounting dimensions.

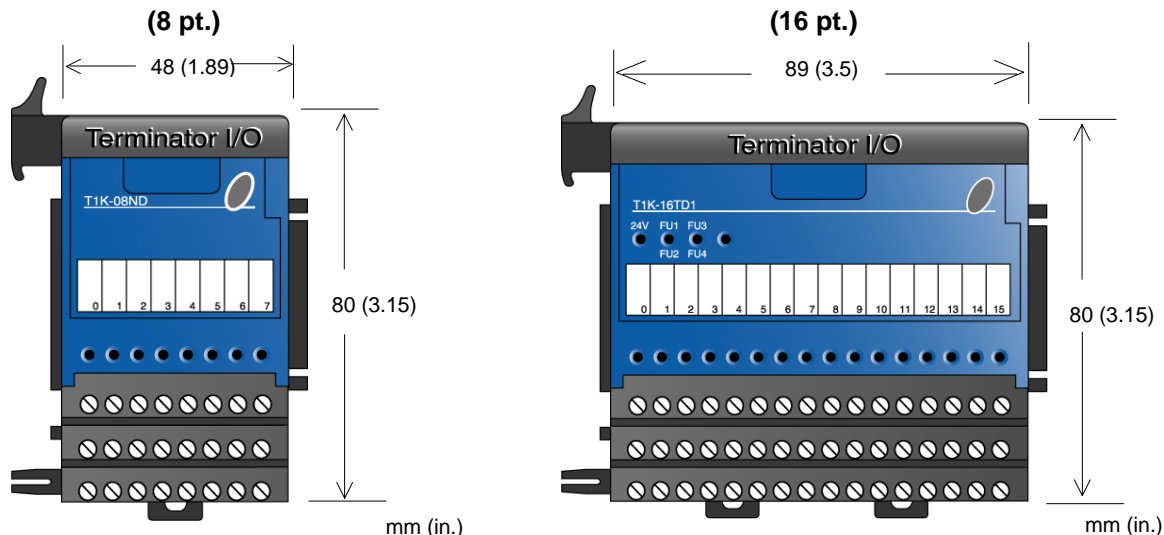
## Dimensions

The following diagrams show the base controller, power supply and I/O module dimensions. Terminator I/O components mount on 35mm wide Din rail.

### Base Controller / Power Supply



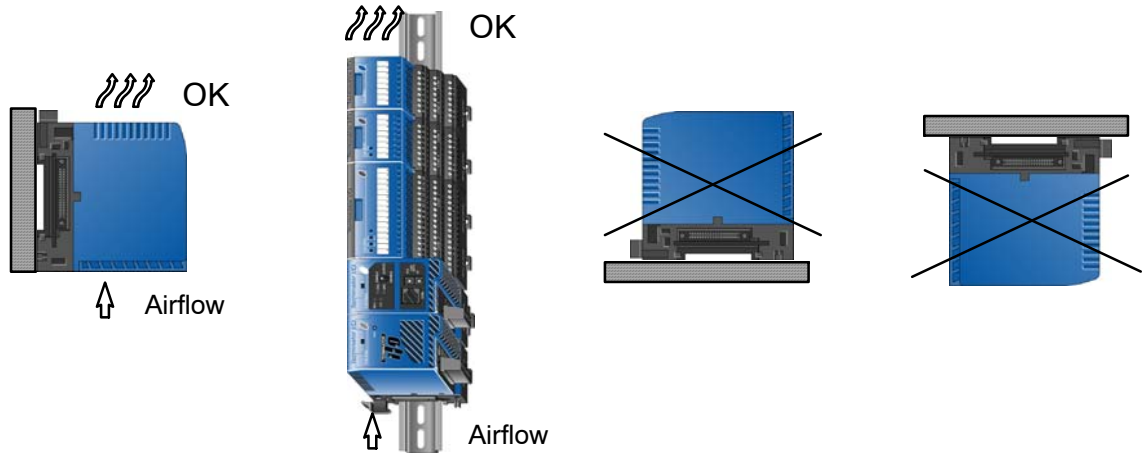
### I/O Modules



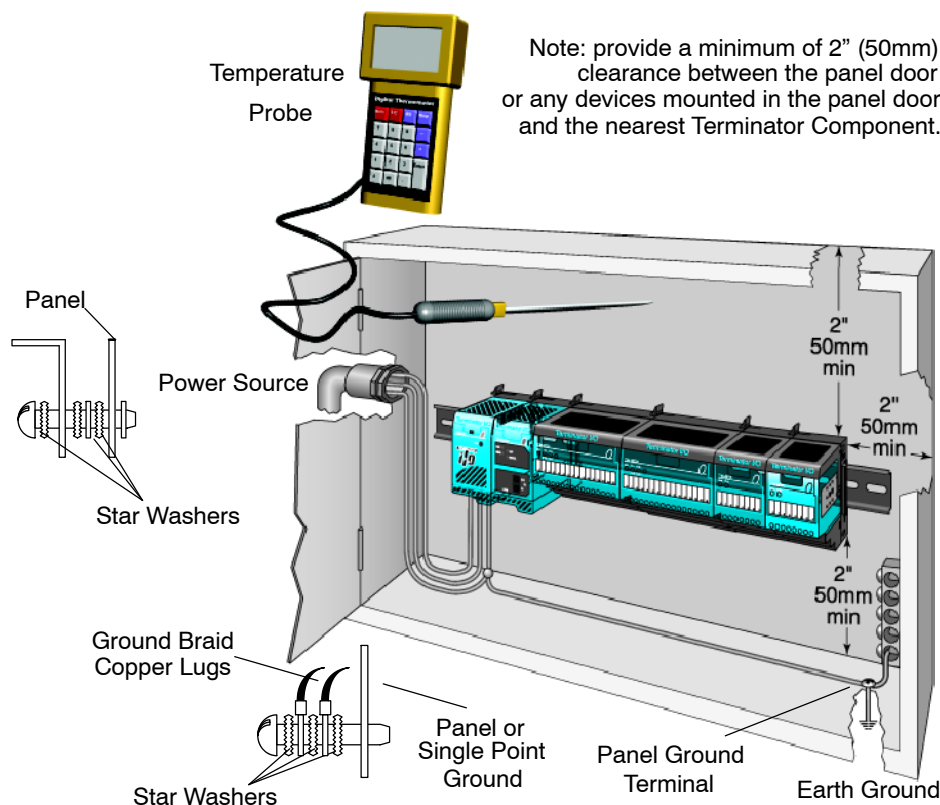
Installation and Power Wiring

**Panel Mounting and Layout**

It is important to design your panel properly to help ensure that the Terminator I/O products operate within their environmental and electrical limits. The system installation should comply with all appropriate electrical codes and standards. It is important that the system also conforms to the operating standards for the application to insure proper performance.



1. Mount the unit horizontally or vertically as shown to provide proper ventilation.
2. If you place more than one unit in a cabinet, there should be a minimum of 7.2" (183mm) between them.
3. Provide a minimum clearance of 2" (50mm) between the units and all sides of the cabinet. There should also be at least 1.2" (30mm) of clearance between the base and any wiring ducts.



4. There must be a minimum of 2" (50mm) clearance between the panel door and the nearest Terminator I/O component.
5. The ground terminal on the Terminator I/O power supply must be connected to a single point ground. Use copper stranded wire to achieve a low impedance. Copper eye lugs should be crimped and soldered to the ends of the stranded wire to ensure good surface contact. Remove anodized finishes and use copper lugs and star washers at termination points. A general rule is to achieve a 0.1 ohm of DC resistance between the Terminator I/O slave and the single point ground.
6. There must be a single point ground (i.e. copper bus bar) for all devices in the panel requiring an earth ground return. The single point of ground must be connected to the panel ground termination.

The panel ground termination must be connected to earth ground. For this connection you should use #12 AWG stranded copper wire as a minimum. Minimum wire sizes, color coding, and general safety practices should comply with appropriate electrical codes and standards for your region.

A good common ground reference (Earth ground) is essential for proper operation of the Terminator I/O. There are several methods of providing an adequate common ground reference, including:

- a) Installing a ground rod as close to the panel as possible.
- b) Connection to incoming power system ground.

7. Properly evaluate any installations where the ambient temperature may approach the lower or upper limits of the specifications. Place a temperature probe in the panel, close the door and operate the system until the ambient temperature has stabilized. If the ambient temperature is not within the operating specification for the Terminator I/O system, measures such as installing a cooling/heating source must be taken to get the ambient temperature within the Terminator I/O operating specifications.
8. Device mounting bolts and ground braid termination bolts should be #10 copper bolts or equivalent. Tapped holes instead of nut-bolt arrangements should be used whenever possible. To assure good contact on termination areas impediments such as paint, coating or corrosion should be removed in the area of contact.
9. The system is designed to be powered by 110/220 VAC or 24 VDC normally available throughout an industrial environment. Isolation transformers and noise suppression devices are not normally necessary, but may be helpful in eliminating/reducing suspect power problems.

## Enclosures

Your selection of a proper enclosure is important to ensure safe and proper operation of your Terminator I/O system. Applications of Terminator I/O systems vary and may require additional features. The minimum considerations for enclosures include:

- Conformance to electrical standards
- Protection from the elements in an industrial environment
- Common ground reference
- Maintenance of specified ambient temperature
- Access to equipment
- Security or restricted access
- Sufficient space for proper installation and maintenance of equipment

**Environmental Specifications**

The following table lists the environmental specifications that apply to the Terminator I/O modules. Be sure to check the specifications of the controller you are using. Also refer to the appropriate I/O module specifications in Chapter 3 for the temperature derating curves for the specific module.

Specification	Rating
Storage temperature	-4° F to 158° F (-20° C to 70° C)
Ambient operating temperature	32° F to 131° F (0° C to 55° C)
Ambient humidity*	5% – 95% relative humidity (non-condensing)
Vibration resistance	MIL STD 810C, Method 514.2
Shock resistance	MIL STD 810C, Method 516.2
Noise immunity	NEMA (ICS3-304) Impulse noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Atmosphere	No corrosive gases. The level for the environmental pollution = 2. (UL840)

\*Equipment will operate at low humidity. However, static electricity problems occur much more frequently at lower humidity levels. Make sure you take adequate precautions when you touch the equipment. Consider using ground straps, anti-static floor coverings, etc. if you use the equipment in low humidity environments.

**Power**

The power source must be capable of supplying voltage and current complying with the base power supply specifications.

Specification	AC Power Supply	DC Power Supply
Part Numbers	T1K-01AC	T1K-01DC
Input Voltage Range	110/220VAC (85-264VAC) 50/60Hz (47-63Hz)	12/24VDC (10.8-26.4VDC)) with less than 10% ripple
Maximum Inrush Current	20A	10A
Maximum Power	50 VA	20W
Voltage Withstand (dielectric)	1 minute @ 1500 VAC between primary, secondary, field ground	
Insulation Resistance	> 10 M ohm at 500 VDC	
Auxiliary 24 VDC Output	20-28 VDC, 10% ripple max. 300 mA. A max. of 500 mA @24VDC can be achieved if the 5VDC power budget rating of 2000mA is reduced to 1500mA. See power budget section.	None

**Agency Approvals**

Some applications require agency approvals. Typical agency approvals which your application may require are:

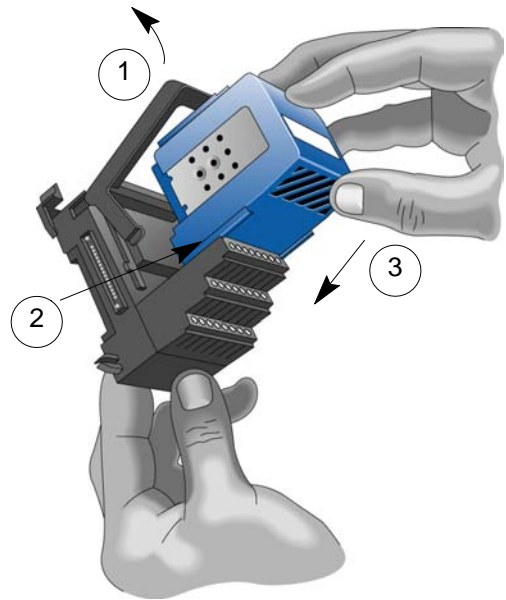
- UL (Underwriters' Laboratories, Inc.)
- CSA (Canadian Standards Association)
- FM (Factory Mutual Research Corporation)
- CUL (Canadian Underwriters' Laboratories, Inc.)

## Assembling the Components

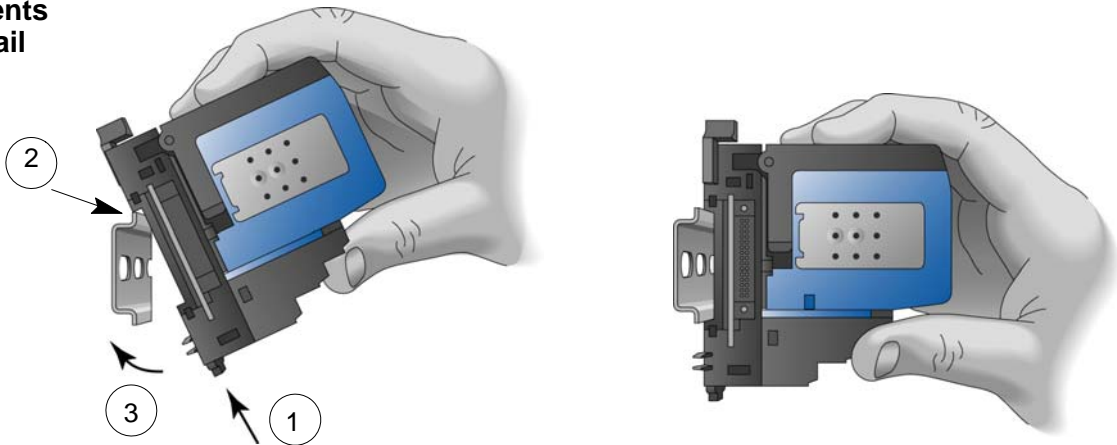
### Assembling the I/O Modules and Bases

#### Insert Module into Base

1. Pull base arm back to allow space for module to enter base.
2. Align module slides with base track.
3. Press module firmly into base.



### Mounting the Components on DIN Rail

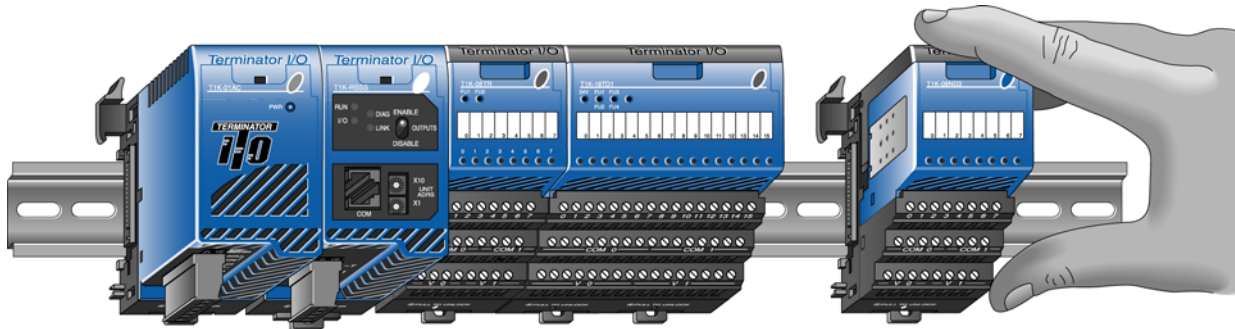


**NOTE:** Do not force the base controller on the DIN rail. Due to slight size variations in different manufacturers' DIN rail, it may be necessary to first unlatch the locking tab, rotate the module into place, then latch the locking tab.

#### Install on DIN Rail

1. Make sure the locking tab is in the latched position (pushed in).
2. Hook upper tab over upper flange of DIN rail.
3. Tilt the unit toward DIN rail until it snaps securely to DIN rail.

## Connecting the Components on the DIN Rail

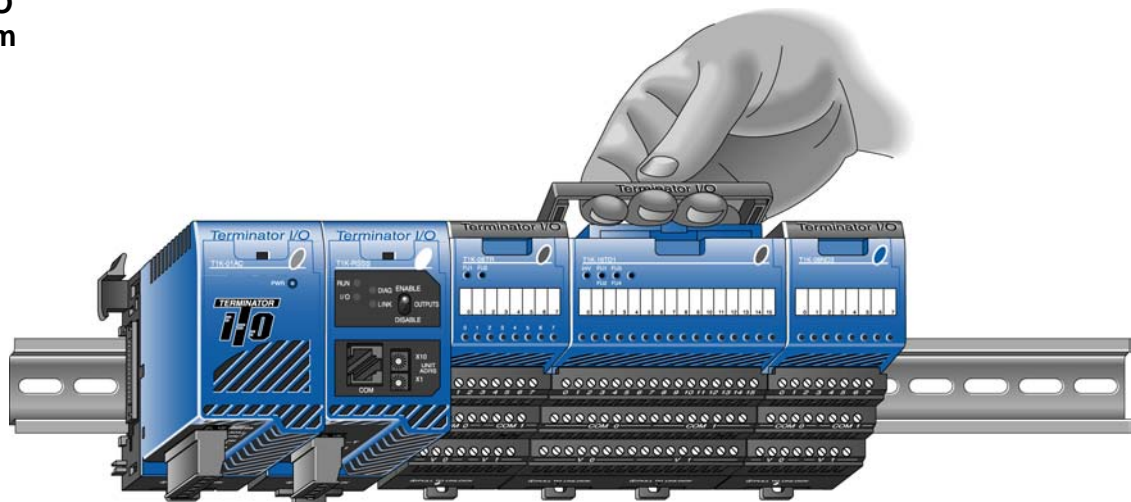


### Slide Assembly into Position on DIN Rail

Slide the module assembly on the DIN rail until the clip arm attaches securely to the adjacent module.

**NOTE:** One power supply is required in the leftmost component position followed by the base controller. Additional power supplies should be added between I/O modules as necessary to meet power budget requirements (see page 3-18). Each power supply powers the modules to its right, but is interrupted by the next power supply.

## Removing I/O Modules from the Base



To remove the module from the base, grip the center of the base arm and rotate outward releasing the module. Lift the module from the base.

To remove a module assembly from the DIN rail, lift the clip arm up and slide the module assembly away from the adjacent module. Pull the locking tab down (out) and lift the assembly off the DIN rail. Refer to the “I/O Module Hot Swap Feature” section in Chapter 3 to remove an I/O module with Terminator I/O system power ON.



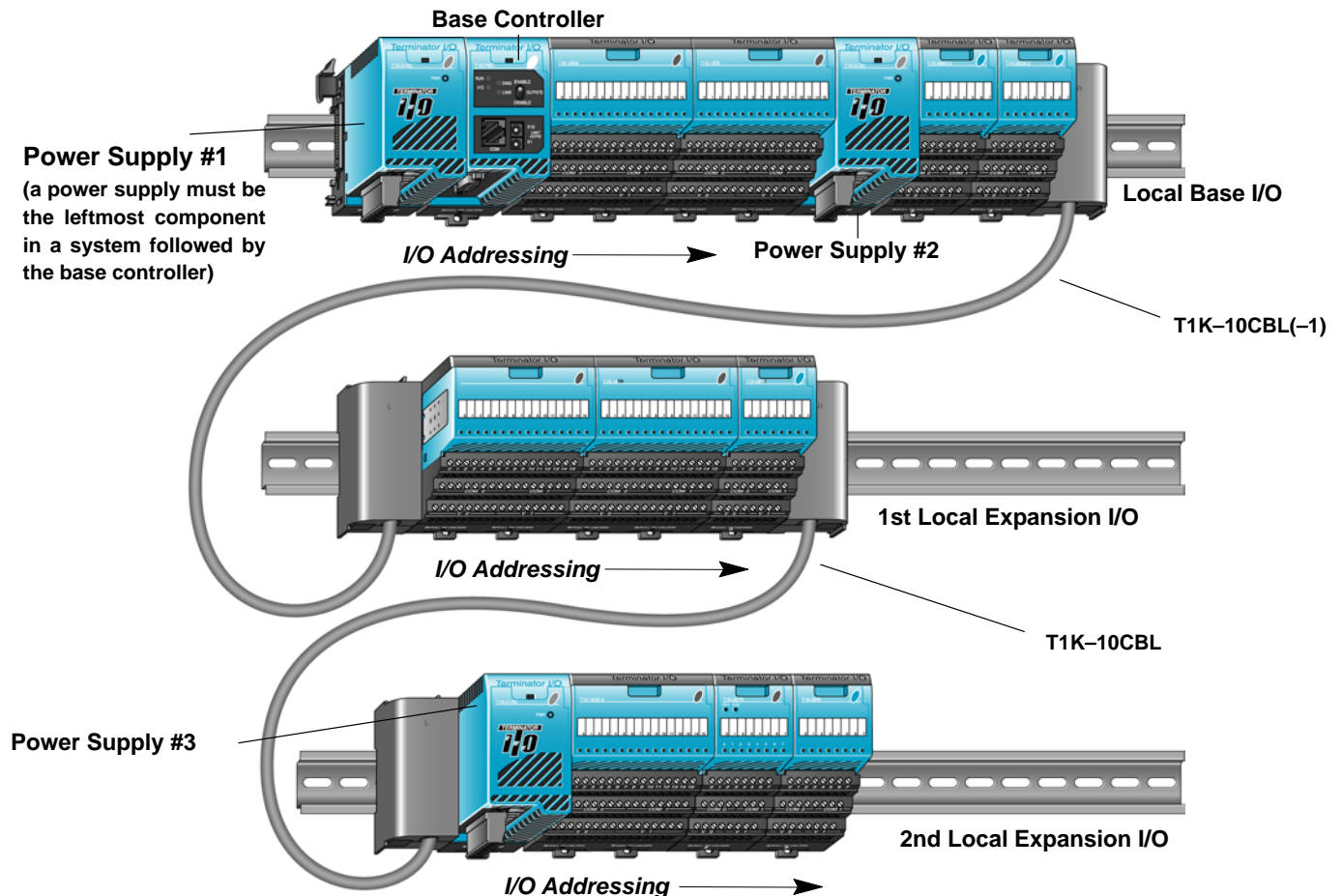
## Multiple Power Supplies / Local Expansion Configurations

### Multiple Power Supply Configuration

It is possible to have multiple power supplies in a single slave (node) system to meet power budget requirements. **One power supply is required in the leftmost component position followed by the base controller.** Additional power supplies should be added between I/O modules as necessary to meet power budget requirements. There are some restrictions on where power supplies can be placed in the system when using the T1K-05CBL-RR(-1) expansion base cable. Each power supply powers the modules to its right, but is interrupted by the next power supply. Each slave (node) system can be divided into one row of base I/O plus two rows of local expansion I/O up to a total of 16 I/O modules.

**Expansion cables are available in two configurations:** one that passes 24VDC base power through and one that does not (both cables pass the 5VDC base power). The (-1) version of the expansion cables pass 24VDC through on an isolated wire. Any local expansion DC input modules configured for "internal power" (current sourcing) must either have a power supply preceding it on the same base or, have a (-1) version cable pass 24VDC from a power supply on the preceding base.

### Example Using Two T1K-10CBL(-1) Expansion Cables

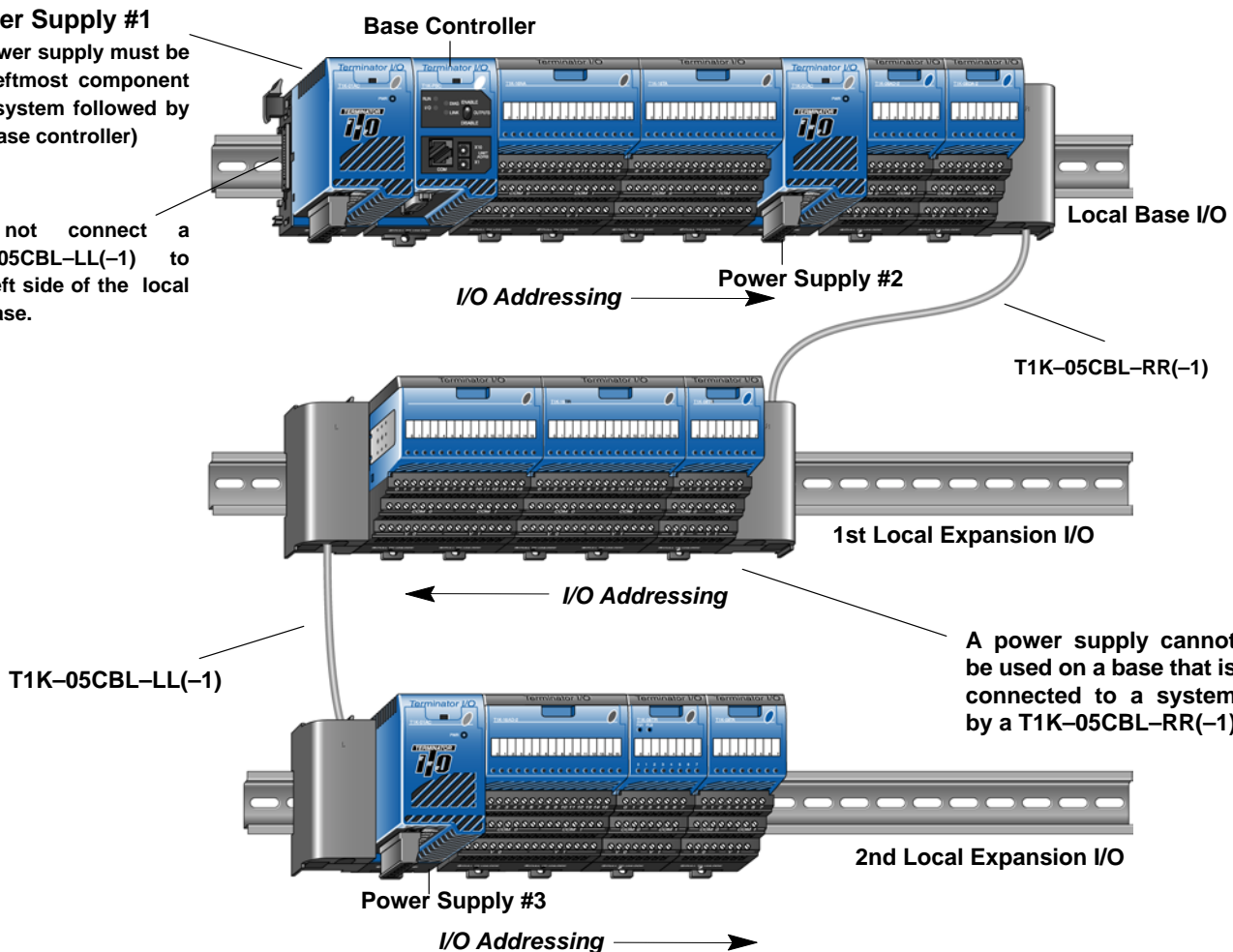


**System shown above:** The first power supply powers the base controller and the two I/O modules to its right. The second power supply powers the the two modules to its right and the three I/O modules on the first local expansion base. Power Supply #3 powers the three I/O modules to its right on the second local expansion base. This is only an example and the power budget requirements vary depending on the I/O modules used.

**Example Using T1K-05CBL-RR(-1) and T1K-05CBL-LL(-1) Expansion Cables**

**Power Supply #1**  
(a power supply must be the leftmost component in a system followed by the base controller)

Do not connect a T1K-05CBL-LL(-1) to the left side of the local I/O base.

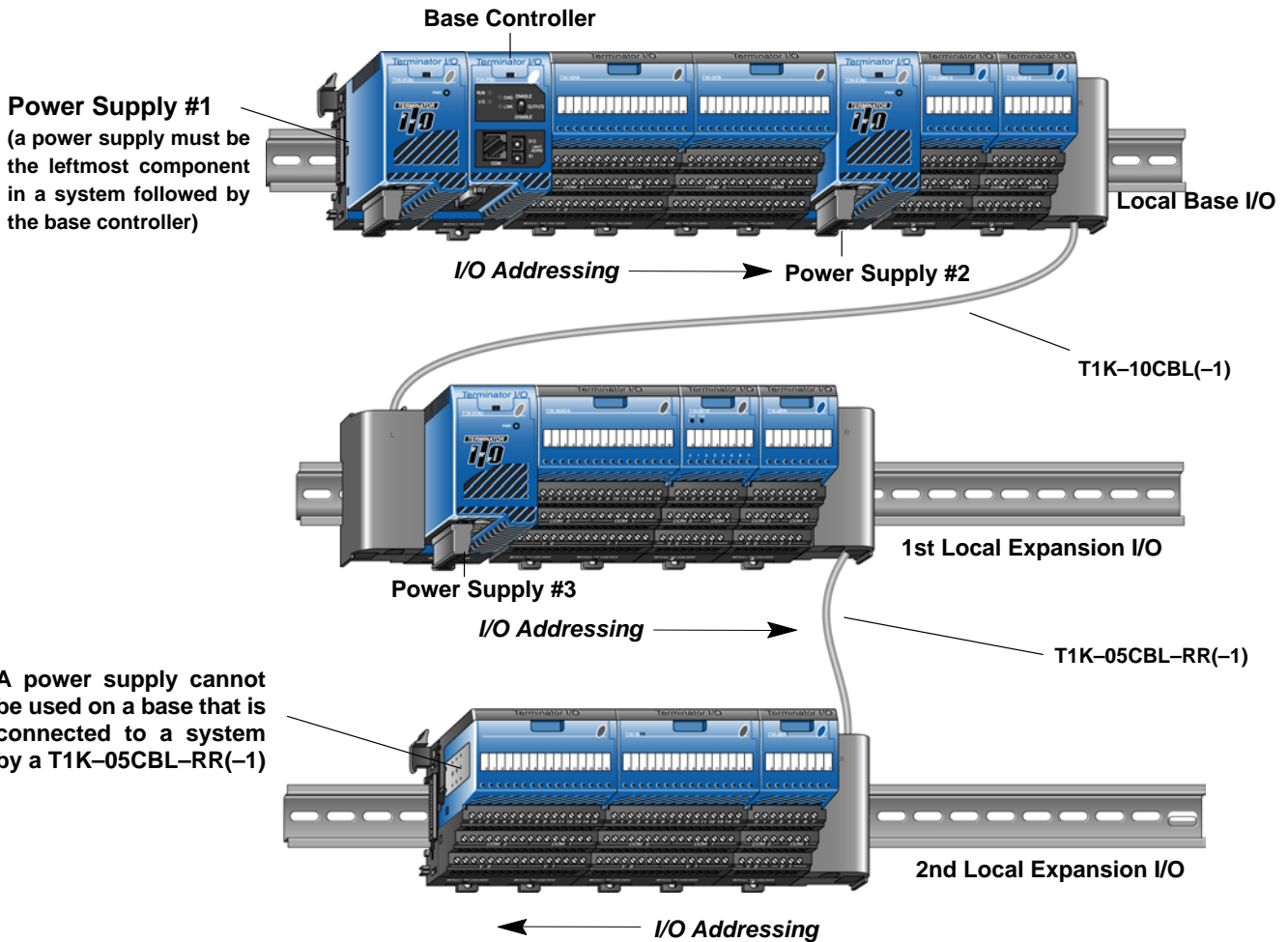


A power supply cannot be used on a base that is connected to a system by a T1K-05CBL-RR(-1)

**System shown above:** The first power supply powers the base controller and the two I/O modules to its right. The second power supply powers the the two modules to its right and the three I/O modules on the first local expansion base. When a T1K-05CBL-RR(-1) is used, the expansion I/O assignments are from right to left (reversed). A power supply cannot be used on a base that is connected to a system by a T1K-05CBL-RR(-1). Power Supply #3 powers the three I/O modules to its right on the second local expansion base. This is only an example and the power budget requirements vary depending on the I/O modules used.

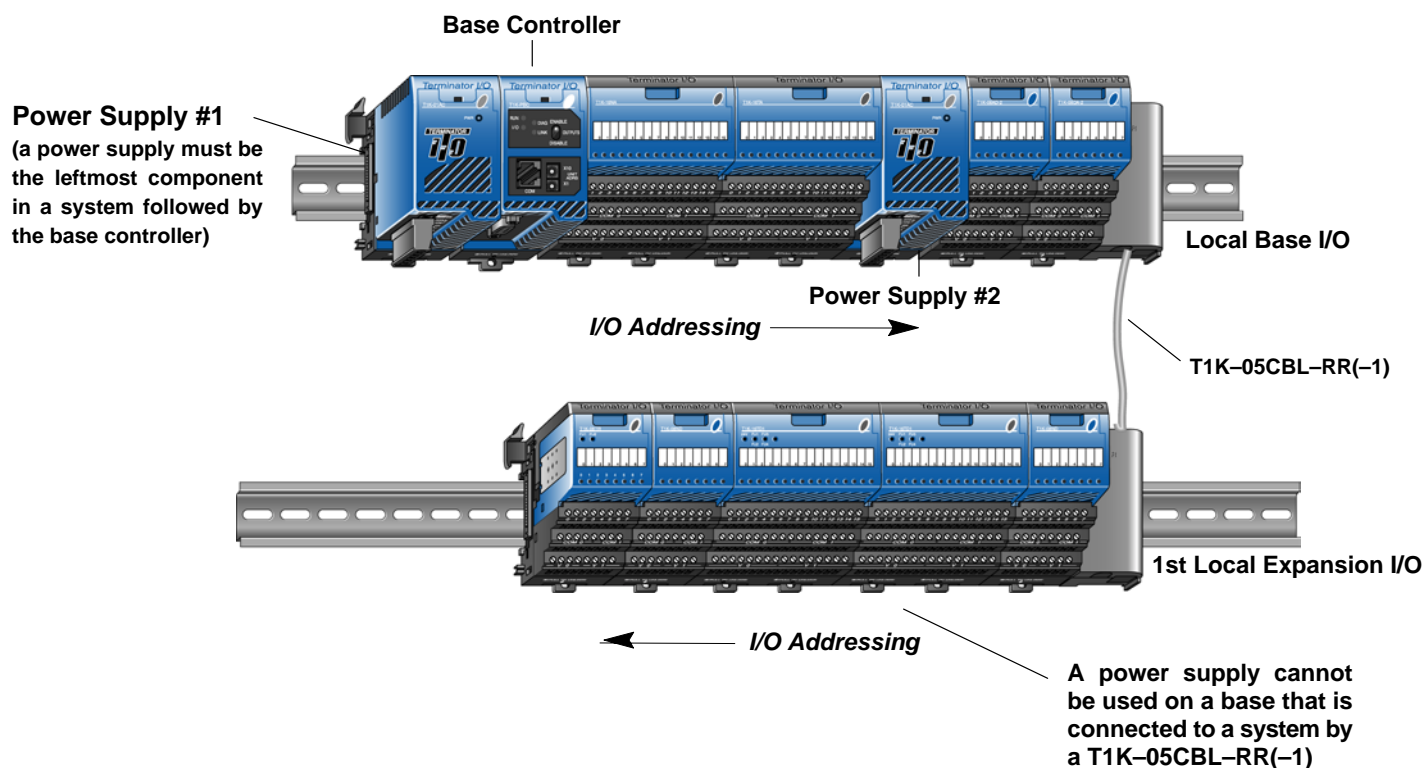


### Example Using T1K-10CBL(-1) and T1K-05CBL-RR(-1) Expansion Cables



**System shown above:** The first power supply powers the base controller and the two I/O modules to its right. The second power supply powers the the two modules to its right. Power Supply #3 powers the three I/O modules to its right on the first local expansion base and the three I/O modules on the second local expansion base. When a T1K-05CBL-RR(-1) is used, the expansion I/O assignments are from right to left (reversed). A power supply cannot be used on a base that is connected to a system by a T1K-05CBL-RR(-1). This is only an example and the power budget requirements vary depending on the I/O modules used.

### Example Using T1K-05CBL-RR(-1) Expansion Cable



**System shown above:** The first power supply powers the base controller and the two I/O modules to its right. The second power supply powers the the two modules to its right and the five I/O modules on the first local expansion base. When a T1K-05CBL-RR(-1) is used, the expansion I/O assignments are from right to left (reversed). A power supply cannot be used on a base that is connected to a system by a T1K-05CBL-RR(-1). This is only an example and the power budget requirements vary depending on the I/O modules used.

## Power Supply Wiring Guidelines

### Power Wiring

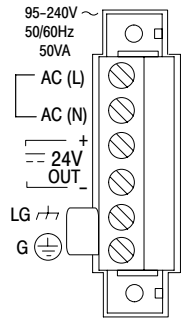
The diagram below shows the terminal connections located on the Terminator I/O AC and DC power supplies. The table below shows the wire guage size and recommended torque for the power supply screw terminals.



**NOTE:** You can connect either a 110 VAC or 220 VAC supply to the AC terminals. Special wiring or jumpers are not required as with some of the other **DirectLOGIC™** products.

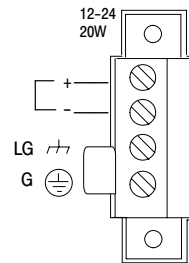


**110/220 VAC Terminal Strip**



T1K-01AC

**12/24 VDC Terminal Strip**



T1K-01DC

Power Supply	T1K-01AC	T1K-01DC
Wire Guage	Solid: 24 – 12 AWG Stranded: 24 – 12 AWG	Solid: 24 – 12 AWG Stranded: 24 – 12 AWG
Recommended Torque	4.43 – 5.31 lb-in (0.5 – 0.6 Nm)	4.43 – 5.31 lb-in (0.5 – 0.6 Nm)

# I/O Wiring and Specifications

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## In This Chapter. . . .

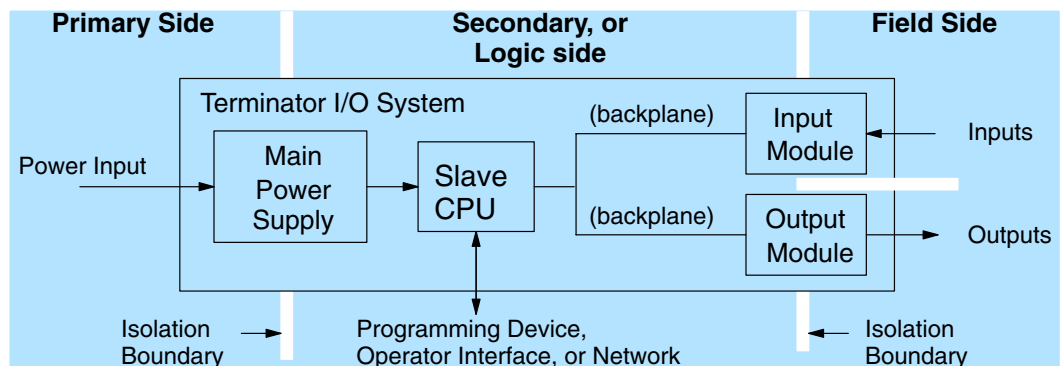
- I/O Wiring Strategies
  - I/O Modules Position, Wiring, and Specifications
  - I/O Module Hot Swap Feature
  - Calculating the Power Budget
  - I/O Specification Terms
-

## I/O Wiring Strategies

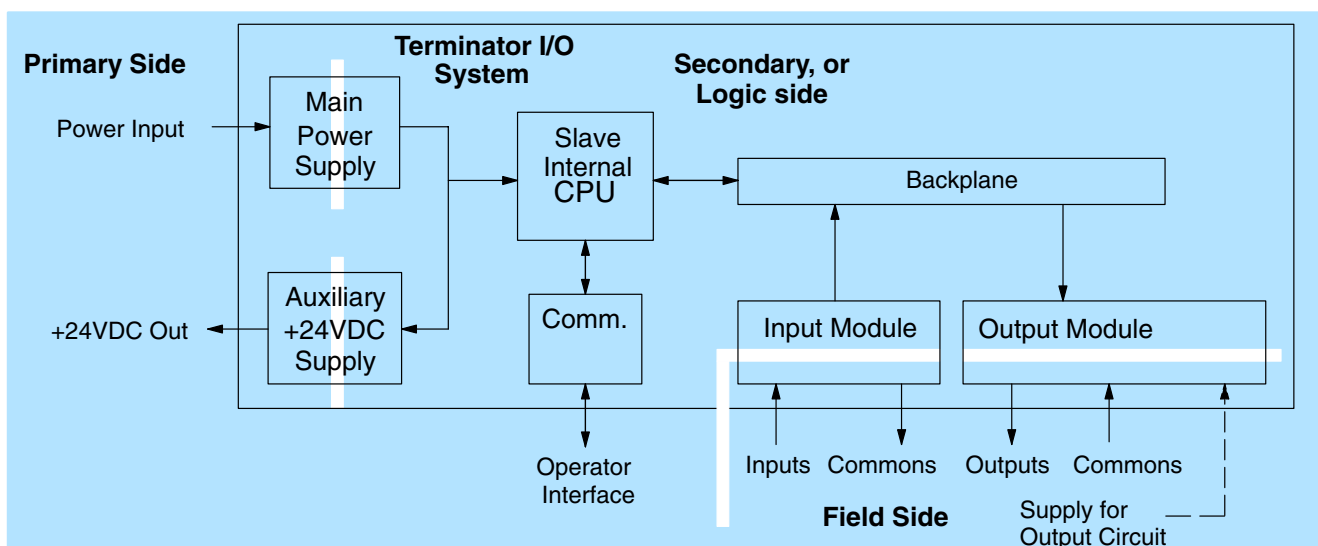
### Terminator I/O System Isolation Boundaries

The Terminator I/O system is very flexible and will work in many different wiring configurations. By studying this section before actual installation, you can probably find the best wiring strategy for your application. This will help to lower system cost, wiring errors, and avoid safety problems.

Terminator I/O system circuitry is divided into three main regions separated by isolation boundaries, shown in the drawing below. Electrical isolation provides safety, so that a fault in one area does not damage another. A transformer in the power supply provides magnetic isolation between the primary and secondary sides. Opto-couplers provide optical isolation in Input and Output circuits. This isolates logic circuitry from the field side, where factory machinery connects. Note the discrete inputs are isolated from the discrete outputs, because each is isolated from the logic side. Isolation boundaries protect the operator interface (and the operator) from power input faults or field wiring faults. *When wiring a Terminator I/O system, it is extremely important to avoid making external connections that connect logic side circuits to any other.*



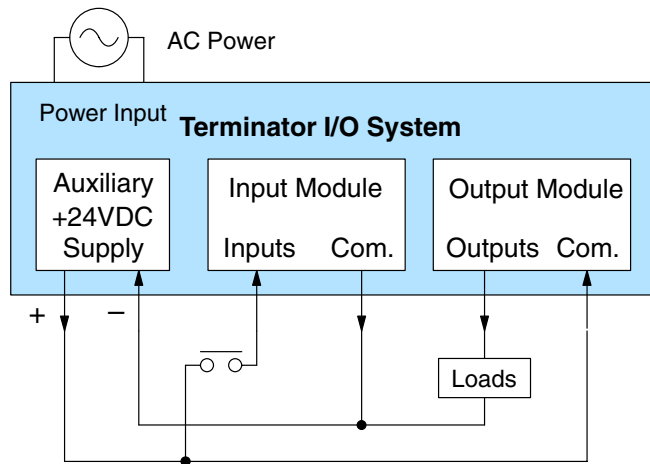
The next figure shows the physical layout of a Terminator I/O system, as viewed from the front. In addition to the basic circuits covered above, AC-powered bases include an auxiliary +24VDC power supply with its own isolation boundary. Since the supply output is isolated from the other three circuits, it can power input and/or output circuits!



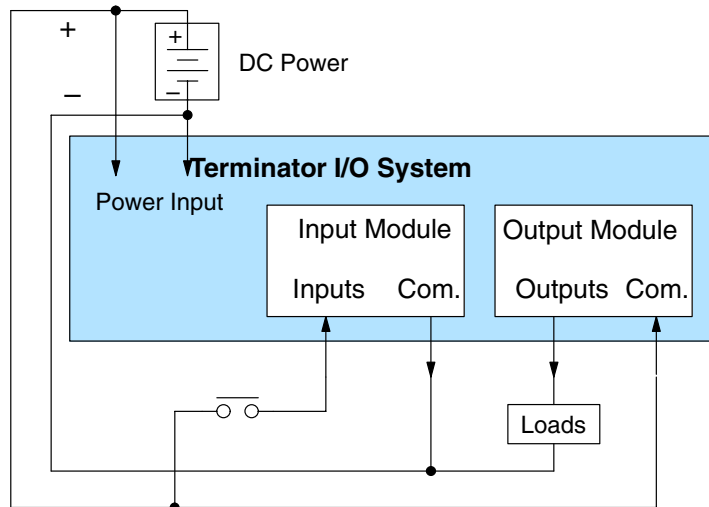
In some cases, using the built-in auxiliary +24VDC supply can result in a cost savings for your control system. It can power combined loads up to 500mA if power budget allows. Be careful not to exceed the current rating of the supply. If you are the system designer for your application, you may be able to select and design in field devices which can use the +24VDC auxiliary supply.

**Powering I/O Circuits with the Auxiliary Supply**

All AC power supplies feature an internal auxiliary supply. If input devices AND output loads need +24VDC power, the auxiliary supply may be able to power both circuits as shown in the following diagram.



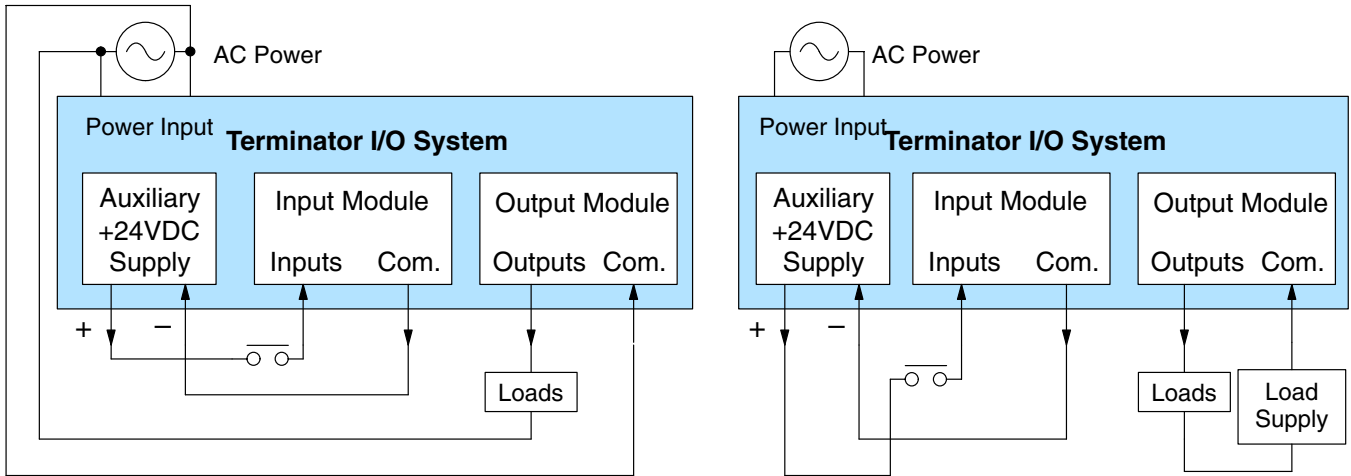
DC-powered units are designed for application environments in which low-voltage DC power is more readily available than AC. These include a wide range of battery-powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this type of application, all input devices and output loads typically use the same DC power source. Typical wiring for DC-powered applications is shown in the following diagram.



**Powering I/O Circuits Using Separate Supplies**

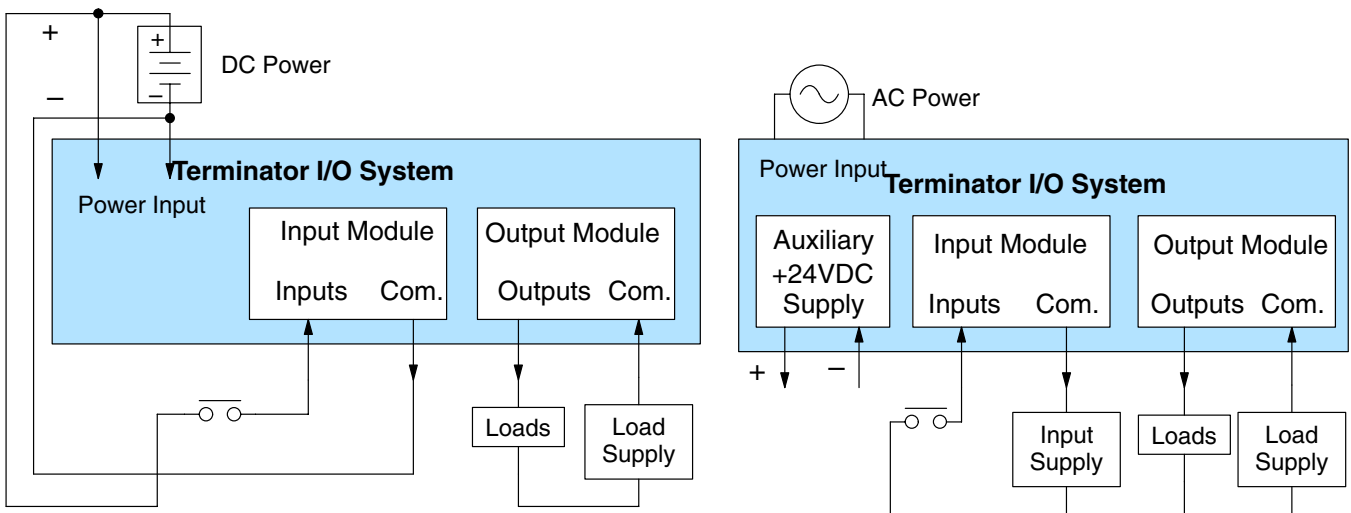
In most applications it will be necessary to power the input devices from one power source, and to power output loads from another source. Loads often require high-energy AC power, while input sensors use low-energy DC. If a machine operator is likely to come in close contact with input wiring, then safety reasons also require isolation from high-energy output circuits. It is most convenient if the loads can use the same power source as the Terminator I/O system, and the input sensors can use the auxiliary supply, as shown to the left in the figure below.

If the loads cannot be powered from the system supply, then a separate supply must be used as shown to the right in the figure below.



Some applications will use the external power source to also power the input circuit. This typically occurs on DC-powered systems, as shown in the drawing below to the left. The inputs share the system power source supply, while the outputs have their own separate supply.

A worst-case scenario, from a cost and complexity view-point, is an application which requires separate power sources for the Terminator I/O system, input devices, and output loads. The example wiring diagram below on the right shows how this can work, but also the auxiliary supply output is an unused resource. You will want to avoid this situation if possible.



**Sinking / Sourcing Concepts**

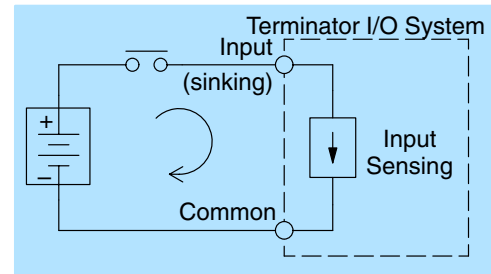
Before going further in the study of wiring strategies, you must have a solid understanding of “sinking” and “sourcing” concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring your success in installation. First the following short definitions are provided, followed by practical applications.

**Sinking = provides a path to supply ground (-)**

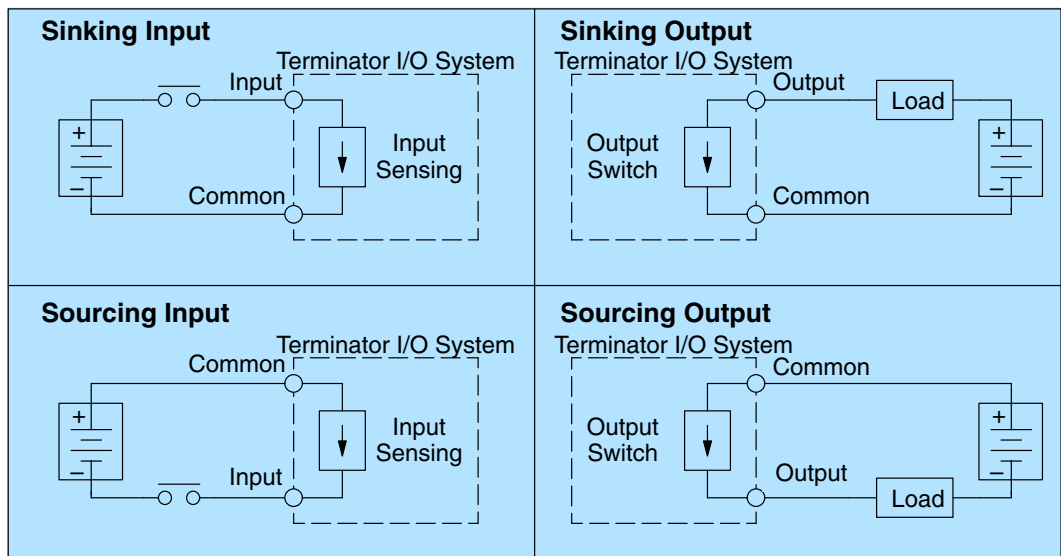
**Sourcing = provides a path to supply source (+)**

First you will notice these are only associated with DC circuits and not AC, because of the reference to (+) and (-) polarities. Therefore, *sinking and sourcing terminology only applies to DC input and output circuits*. Input and output points that are sinking or sourcing *only* can conduct current in only one direction. This means it is possible to connect the external supply and field device to the I/O point with current trying to flow in the wrong direction, and the circuit will not operate. However, you can successfully connect the supply and field device every time by understanding “sourcing” and “sinking”.

For example, the figure to the right depicts a “sinking” input. To properly connect the external supply, you will have to connect it so the input *provides a path to ground (-)*. Start at the Terminator I/O system input terminal, follow through the input sensing circuit, exit at the common terminal, and connect the supply (-) to the common terminal. By adding the switch, between the supply (+) and the input, the circuit has been completed. Current flows in the direction of the arrow when the switch is closed.



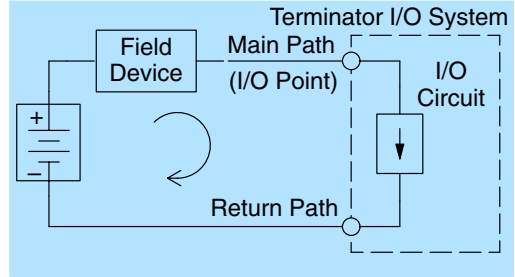
By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types as shown below. The I/O module specifications at the end of this chapter list the input or output type.



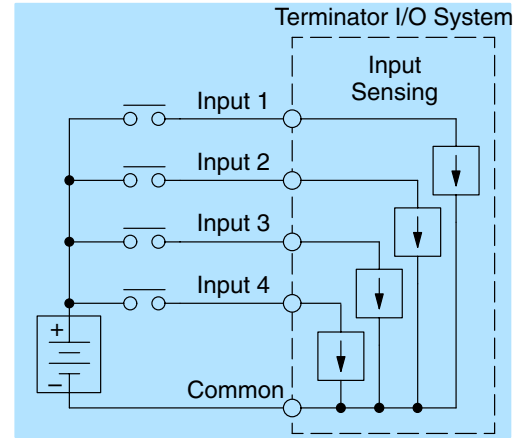


**I/O “Common” Terminal Concepts**

In order for an I/O circuit to operate, current must enter at one terminal and exit at another. Therefore, at least two terminals are associated with every I/O point. In the figure to the right, the Input or Output terminal is the *main path* for the current. One additional terminal must provide the *return path* to the power supply.



If there was unlimited space and budget for I/O terminals, every I/O point could have two dedicated terminals as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output points are in groups which share the return path (called *commons*). The figure to the right shows a group (or *bank*) of 4 input points which share a common return path. In this way, the four inputs require only five terminals instead of eight.

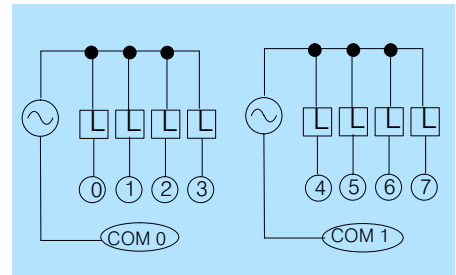
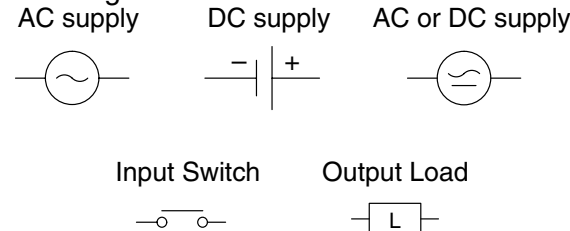


**NOTE:** In the circuit above, the current in the common path is 4 times any channel’s input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons.



Most Terminator I/O input and output modules group their I/O points into banks that share a common return path. The best indication of I/O common grouping is on the wiring label, such as the one shown to the right. The miniature schematic shows two circuit banks with four output points in each. The common terminal for each is labeled “COM 0” and “COM 1”, respectively.

In the wiring label example, the positive terminal of a DC supply connects to the common terminals. Some symbols you will see on the wiring labels, and their meanings are:

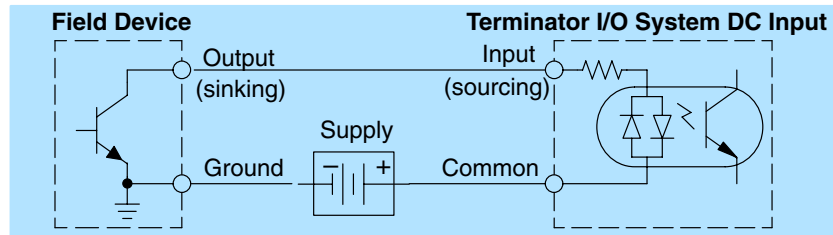


**Connecting DC I/O to “Solid State” Field Devices**

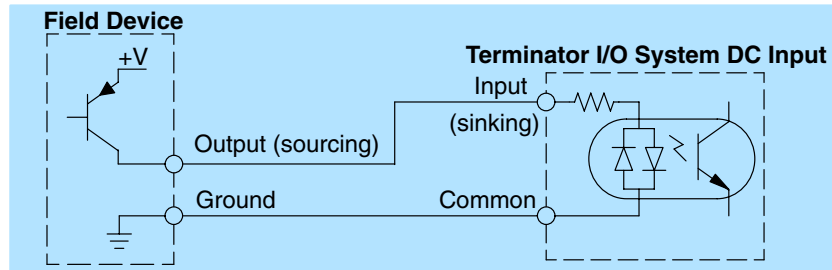
In the previous section on Sourcing and Sinking concepts, the DC I/O circuits were explained to only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *When connecting two devices in a series DC circuit, one must be wired as sourcing and the other as sinking.*

**Solid State Input Sensors**

Terminator I/O DC input modules are flexible because they detect current flow in either direction, so they can be wired as either sourcing or sinking. In the following circuit, a field device has an open-collector NPN transistor output. It sinks current from the input point, which sources current. The power supply can be the +24 auxiliary supply or another supply (+12 VDC or +24VDC), as long as the input specifications are met.



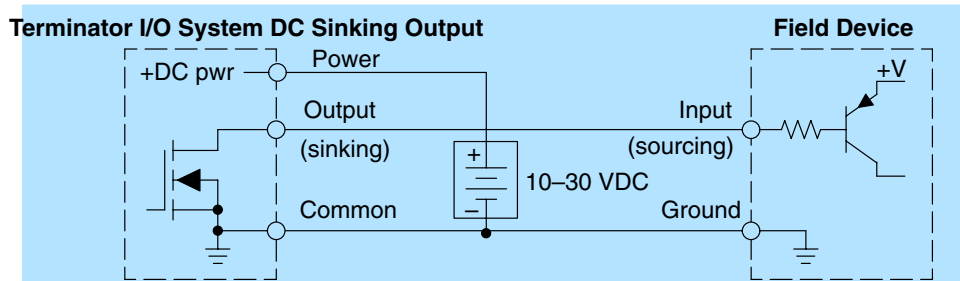
In the next circuit, a field device has an open-emitter PNP transistor output. It sources current to the input point, which sinks the current back to ground. Since the field device is sourcing current, no additional power supply is required.



**Solid State Output Loads**

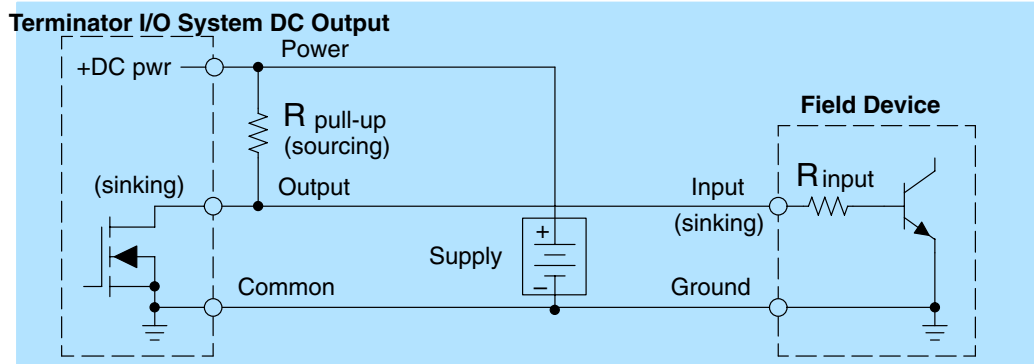
Sometimes an application requires connecting an output point to a solid state input on a device. This type of connection is usually made to carry a low-level control signal, not to send DC power to an actuator.

Several of the Terminator I/O DC output modules are the sinking type. This means that each DC output provides a path to ground when it is energized. In the following circuit, the output point sinks current to the output common when energized. It is connected to a sourcing input of a field device input.



I/O Wiring and Specifications

In the next example a sinking DC output point is connected to the sinking input of a field device. This is a little tricky, because both the Terminator I/O system output and field device input are sinking type. Since the circuit must have one sourcing and one sinking device, a sourcing capability needs to be added to the Terminator I/O system output by using a pull-up resistor. In the circuit below, a  $R_{pull-up}$  is connected from the output to the DC output circuit power input.



**NOTE 1:** DO NOT attempt to drive a heavy load (>25 mA) with this pull-up method  
**NOTE 2:** Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the Terminator I/O system output is OFF, from a ladder logic point-of-view. Your ladder program must comprehend this and generate an inverted output. Or, you may choose to cancel the effect of the inversion elsewhere, such as in the field device.

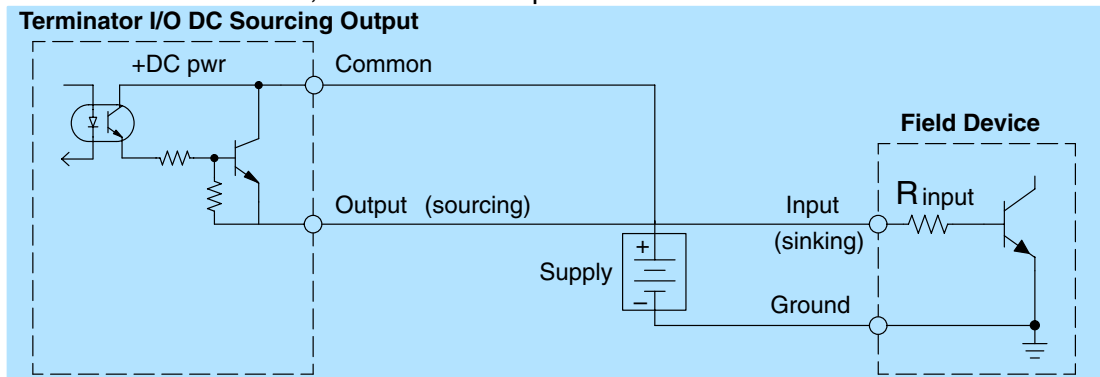
It is important to choose the correct value of  $R_{pull-up}$ . In order to do so, you need to know the nominal input current to the field device ( $I_{input}$ ) when the input is energized. If this value is not known, it can be calculated as shown (a typical value is 15 mA). Then use  $I_{input}$  and the voltage of the external supply to compute  $R_{pull-up}$ . Then calculate the power  $P_{pull-up}$  (in watts), in order to size  $R_{pull-up}$  properly.

$$I_{input} = \frac{V_{input} \text{ (turn-on)}}{R_{input}}$$

$$R_{pull-up} = \frac{V_{supply} - 0.7}{I_{input}} - R_{input}$$

$$P_{pull-up} = \frac{V_{supply}^2}{R_{pullup}}$$

Of course, the easiest way to drive a sinking input field device as shown below is to use a DC sourcing output module. The Darlington NPN stage will have about 1.5 V ON-state saturation, but this is not a problem with low-current solid-state loads.



## Relay Output Guidelines

Several output modules in the Terminator I/O family feature relay outputs: T1K-08TR, T1K-16TR, and T1K-08TRS. Relays are best for the following applications:

- Loads that require higher currents than the solid-state outputs can deliver
- Cost-sensitive applications
- Some output channels need isolation from other outputs (such as when some loads require different voltages than other loads)

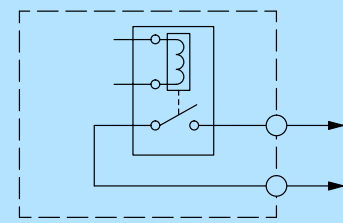
Some applications in which NOT to use relays:

- Loads that require currents under 10 mA
- Loads which must be switched at high speed or heavy duty cycle

Relay output module contacts are available in Form A type, or SPST (single pole, single throw) normally open.

Some relay output module's relays share common terminals, which connect to the wiper contact in each relay of the bank. Other relay modules have relays which are completely isolated from each other. In all cases, the module drives the relay coil when the corresponding output point is on.

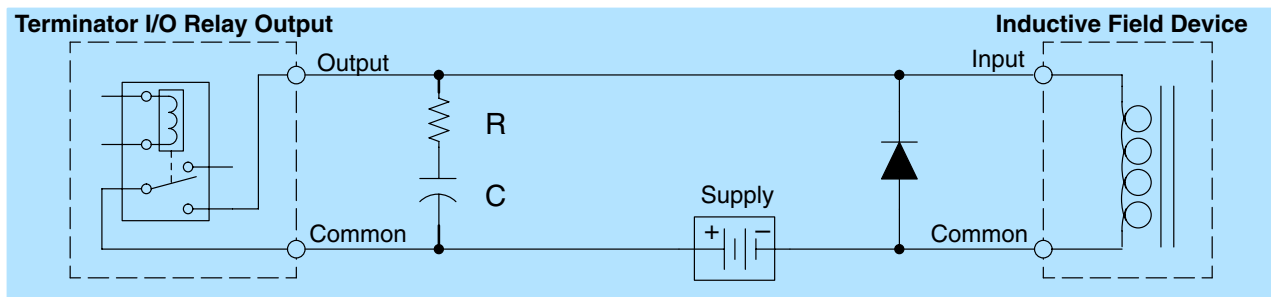
Relay with Form A contacts



## Prolonging Relay Contact Life

Relay contacts wear according to the amount of relay switching, amount of spark created at the time of open or closure, and presence of airborne contaminants. However, there are some steps you can take to help prolong the life of relay contacts:

- Switch the relay on or off only when the application requires it.
- If you have the option, switch the load on or off at a time when it will draw the least current.
- Take measures to suppress inductive voltage spikes from inductive DC loads such as contactors and solenoids (circuit given below).



Adding external contact protection may extend relay life beyond the number of contact cycles listed in the specification tables for relay modules. High current inductive loads such as clutches, brakes, motors, direct-acting solenoid valves, and motor starters will benefit the most from external contact protection.

The RC network must be located close to the relay module output connector. To find the values for the RC snubber network, first determine the voltage across the contacts when open, and the current through them when closed. If the load supply is AC, then convert the current and voltage values to peak values:

Now you are ready to calculate values for R and C, according to the formulas:

$$C (\mu\text{F}) = \frac{I^2}{10} \quad R (\Omega) = \frac{V}{10 \times I^x}, \text{ where } x = 1 + \frac{50}{V}$$

C minimum = 0.001  $\mu\text{F}$ , the voltage rating of C must be  $\geq V$ , non-polarized

R minimum = 0.5  $\Omega$ , 1/2 W, tolerance is  $\pm 5\%$

For example, suppose a relay contact drives a load at 120VAC, 1/2 A. Since this example has an AC power source, first calculate the peak values:

$$I_{\text{peak}} = I_{\text{rms}} \times 1.414, = 0.5 \times 1.414 = 0.707 \text{ Amperes}$$

$$V_{\text{peak}} = V_{\text{rms}} \times 1.414 = 120 \times 1.414 = 169.7 \text{ Volts}$$

Now, finding the values of R and C,:

$$C (\mu\text{F}) = \frac{I^2}{10} = \frac{0.707^2}{10} = 0.05 \mu\text{F}, \text{ voltage rating } \geq 170 \text{ Volts}$$

$$R (\Omega) = \frac{V}{10 \times I^x}, \text{ where } x = 1 + \frac{50}{V}$$

$$x = 1 + \frac{50}{169.7} = 1.29 \quad R (\Omega) = \frac{169.7}{10 \times 0.707^{1.29}} = 26 \Omega, 1/2 \text{ W}, \pm 5\%$$

If the contact is switching a DC inductive load, add a diode across the load as near to load coil as possible. When the load is energized the diode is reverse-biased (high impedance). When the load is turned off, energy stored in its coil is released in the form of a negative-going voltage spike. At this moment the diode is forward-biased (low impedance) and shunts the energy to ground. This protects the relay contacts from the high voltage arc that would occur as the contacts are opening.

For best results, follow these guidelines in using a noise suppression diode:

- DO NOT use this circuit with an AC power supply.
- Place the diode as close to the inductive field device as possible.
- Use a diode with a peak inverse voltage rating (PIV) at least 100 PIV, 3A forward current or larger. Use a fast-recovery type (such as Schottky type). DO NOT use a small-signal diode such as 1N914, 1N941, etc.
- Be sure the diode is in the circuit correctly before operation. If installed backwards, it short-circuits the supply when the relay energizes.

## I/O Modules Position, Wiring, and Specifications

### Multiple Power Supply Configuration

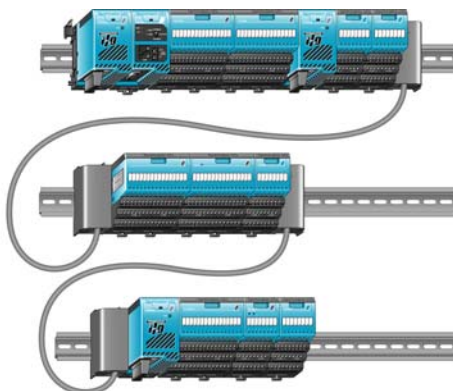
It is possible to have multiple power supplies in a single slave (node) system to meet power budget requirements. **One power supply is required in the leftmost component position followed by the base controller.** Additional power supplies should be added between I/O modules as necessary to meet power budget requirements (there are some restrictions on where power supplies can be placed in the system when using the T1K-05CBL-RR(-1) expansion base cable). Each power supply powers the modules to its right, but is interrupted by the next power supply. Each slave (node) system can be divided into one row of base I/O plus two rows of local expansion I/O up to a total of 16 I/O modules.

**Expansion cables are available in two configurations:** one that passes 24VDC base power through and one that does not (both cables pass the 5VDC base power). The (-1) version of the expansion cables pass 24VDC through on an isolated wire. Any local expansion DC input modules configured for “internal power” (current sourcing) must either have a power supply preceding it on the same base or, have a (-1) version cable pass 24VDC from a power supply on the preceding base.

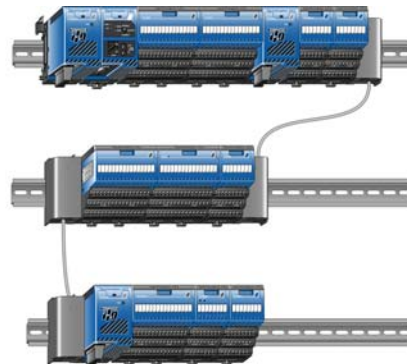
### Overview of I/O Expansion Configurations

There are several expansion I/O system configurations that can be created by using the local expansion cables. There are some restrictions on where power supplies can be placed in the system when using the T1K-05CBL-RR(-1) expansion base cable. **Refer to chapter 2 for details on the example systems shown below.**

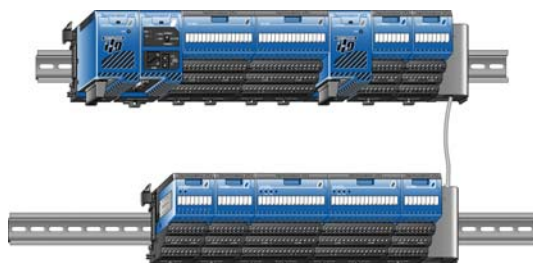
#### Example Using Two T1K-10CBL(-1) Expansion Cables



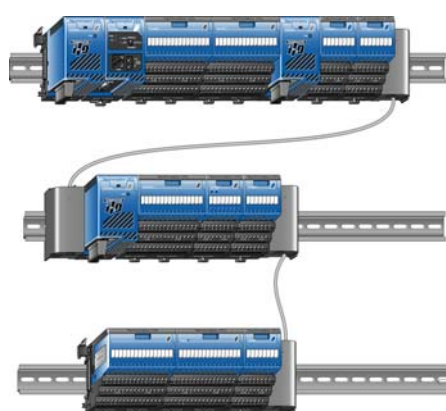
#### Example Using T1K-05CBL-RR(-1) and T1K-05CBL-LL(-1) Expansion Cables



#### Example Using T1K-05CBL-RR(-1) Expansion Cable



#### Example Using T1K-10CBL(-1) and T1K-05CBL-RR(-1) Expansion Cables



### Which Modules can go in a System

The table below lists by category those modules that you may use in a system.

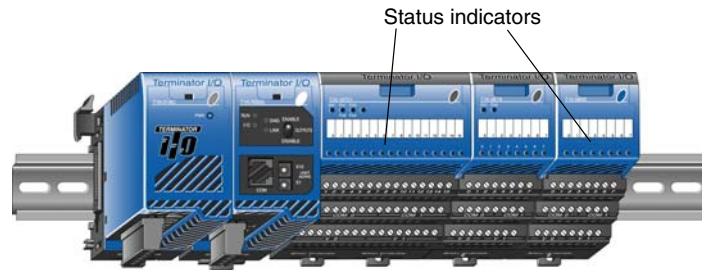
Terminator I/O Module / Unit	Slave System
Base Controller	Only <b>one</b> per slave (node) system. Mount to the right of the first power supply.
Additional Power Supplies	Yes (see Note)
DC Input Modules	Yes
AC Input Modules	Yes
DC Output Modules	Yes
AC Output Modules	Yes
Relay Output Modules	Yes
Analog Modules (volt, current, temp)	Yes
CTRIO Counter I/O Modules	Yes



**NOTE:** One power supply is required in the leftmost component position followed by the Base Controller. Additional power supplies should be added between I/O modules as necessary to meet power budget requirements. Each power supply powers the modules to its right, but is interrupted by the next power supply. It is not mandatory to have a power supply in the leftmost position on an expansion rack. Expansion cables are available in two configurations: one that passes 24VDC base power through and one that does not.

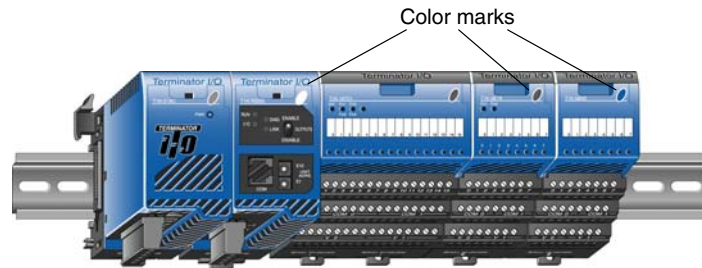
### Discrete Module Status Indicators

The discrete I/O modules provide LED status indicators to show the status of the I/O points. Most of the output modules have additional LEDs to indicate a blown fuse.



### Color Coding of I/O Modules

The Terminator I/O family of I/O modules have a color coding scheme to help you quickly identify the module as either a power supply, an input module or an output module. This is done through a color mark indicator located on the front of each module. The color scheme is listed below:



Module Type	Color Code
Power Supply	Green
Base Controller	White
Discrete / Analog Input	Blue
Discrete / Analog Output	Red

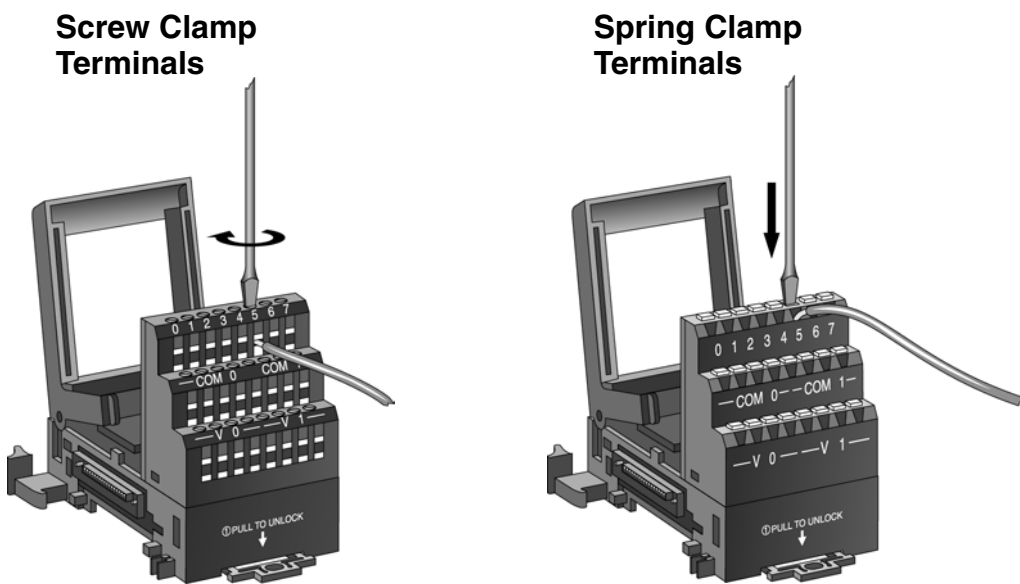


**Wiring the I/O Module Bases**

There are two types of terminal bases for the Terminator I/O modules: screw clamp and spring clamp connectors. The recessed screw heads help minimize the risk of someone accidentally touching active wiring.



**WARNING:** For some modules, field device power may still be present on the terminal block even though the Terminator I/O system power is turned off. To minimize the risk of electrical shock, check all field device power *before* you remove a wire.



Terminal Type	screw type	spring clamp type
Recommended Torque	1.77 – 3.54 lb–inch (0.2 – 0.4 Nm)	–
Recommended Screwdriver Blade Size	0.02in.x 0.125in. (0.5mm x 3mm)	push in on clamp using screwdriver blade size: (0.016 x 0.079.to 0.032 x0.16)in. (0.4 x 2 to 0.8 x 4)mm
Wire Gauge Size	solid conductor: 24–12AWG stranded conductor: 24–12AWG	solid conductor: 24–14AWG stranded conductor: 24–14AWG*

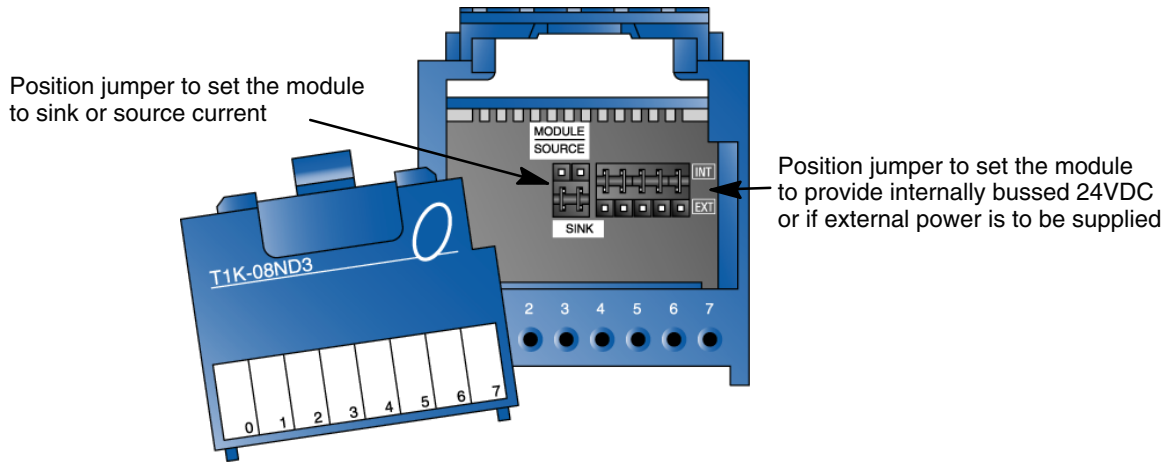
\*Twist conductors before inserting into gate



### Selecting Internal 24VDC Power Supply

The DC input field devices can be powered from the integrated 24 VDC power supply from the power supply bus. The T1K-08ND3 and T1K-16ND3 DC input modules have jumpers for selecting internal 24VDC power supply available for 2 and 3-wire field devices. The analog I/O and DC output modules do not have direct access to the internal bussed 24 VDC.

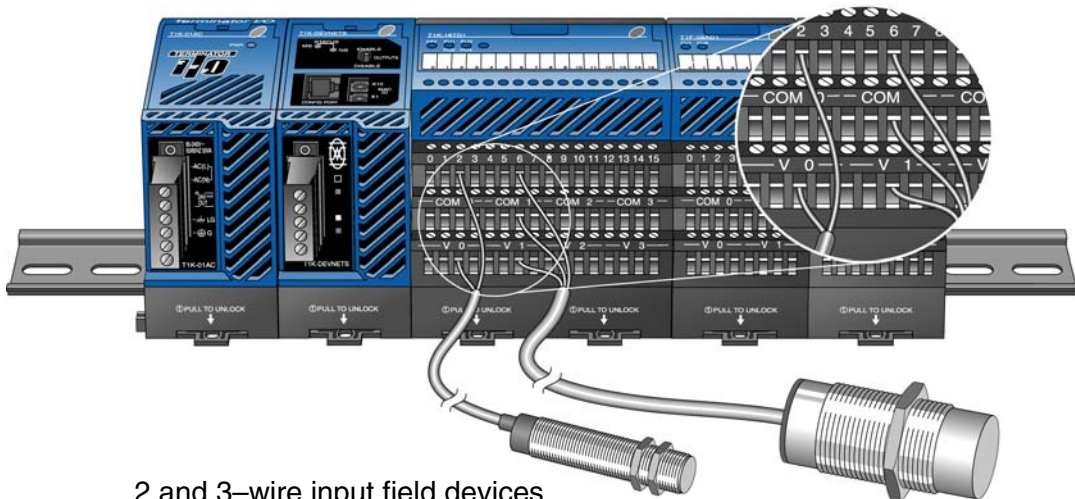
#### Jumpers located under top cover of T1K-08ND3 and T1K-16ND3



### Using Internal 24VDC Base Power

The diagram below shows DC input devices using internally bussed 24VDC for power. **If the module is set to “sink” current, +24VDC power is supplied to the input module base “COM” terminals and 0VDC is supplied to the module base “V” terminals. If the module is set to “source” current, +24VDC is supplied to the input module base “V” terminals and 0VDC is supplied to the module base “COM” terminals.**

#### Using Internally Bussed 24VDC (T1K-08ND3, T1K-16ND3 only)



2 and 3-wire input field devices

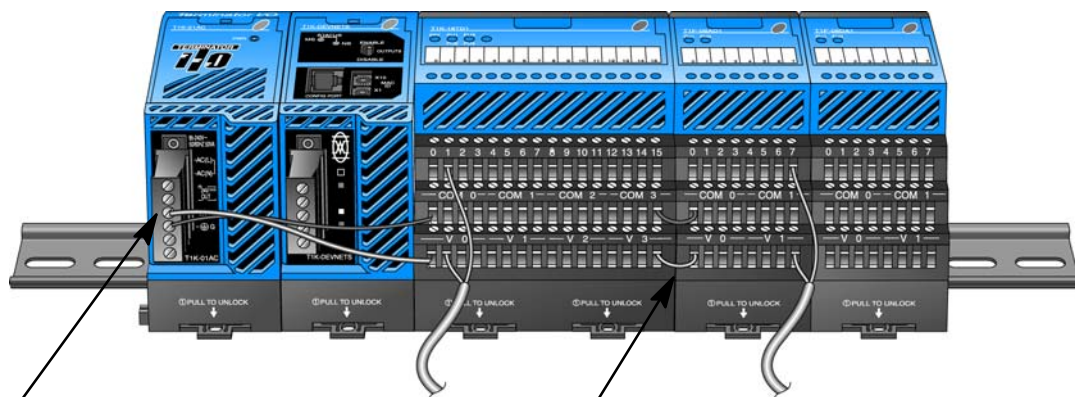
## External 24VDC Wiring Options

DC output and analog I/O modules do not have direct access to the internally bussed 24VDC. External user supplied 24 VDC power, or auxiliary 24 VDC from the T1K-01AC, can be applied directly to one end of the DC I/O module base terminal (V and COM) rows and jumpered across each base as needed in a system. This creates a “bus” (row) of 24VDC and a bus of 0VDC power. Be sure not to exceed the supply’s power budget.



**NOTE:** If you intend to use the I/O module Hot Swap feature, refer to the “Check External 24VDC Wiring Before Hot Swapping” section on page 3-17. The external 24VDC wiring options below are *not* recommended when intending to Hot Swap DC output or analog I/O modules.

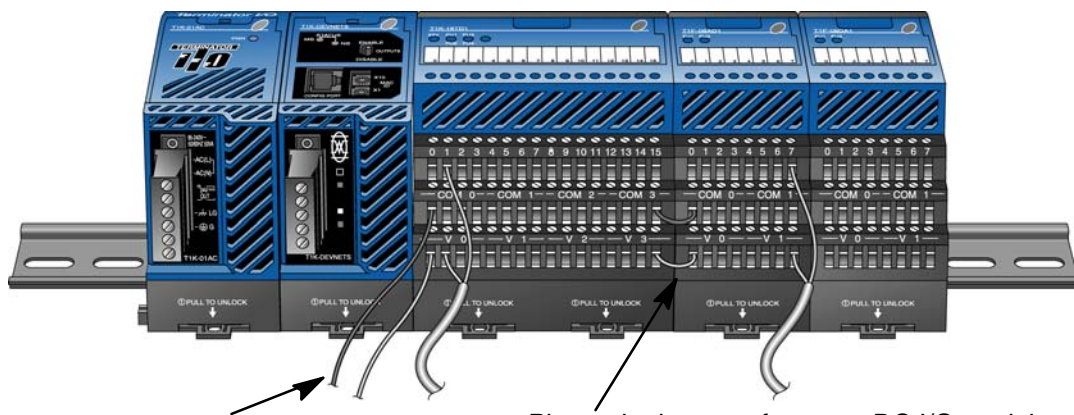
### Using T1K-01AC for External 24VDC Power



Use T1K-01AC external 24VDC create a power bus for the DC modules

Place wire jumpers from one DC I/O module base to another as necessary to continue the external 24VDC power bus

### Using an External 24VDC Power Supply



Use an external 24VDC power supply to create a power bus for the DC modules

Place wire jumpers from one DC I/O module base to another as necessary to continue the external 24VDC power bus

## I/O Wiring Checklist

Use the following guidelines when wiring the base terminals in your system.

1. There is a limit to the size of wire the terminals can accept. The table below lists the **suggested** AWG for each module type.

Terminal Type	Screw Type	Spring Type
Wire Gauge	Solid: 24 – 12 AWG Stranded: 24 – 12 AWG*	Solid: 24 – 14 AWG Stranded: 24 – 14 AWG*
Recommended Torque	1.77 – 3.54 lb-in (0.2 – 0.4 Nm)	–

\*Twist conductors before inserting into gate

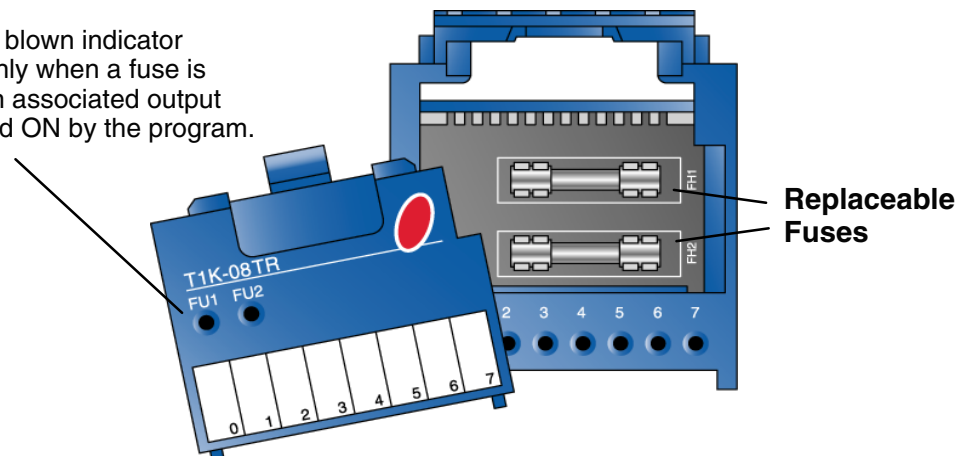
2. Always use a continuous length of wire, do not combine wires to attain a needed length.
3. Use the shortest possible wire length.
4. Use wire trays for routing where possible.
5. Avoid running wires near high-energy wiring.
6. Avoid running input wiring close to output wiring where possible.
7. To minimize voltage drops when wires must run a long distance, consider using multiple wires for the return line.
8. Avoid running DC wiring in close proximity to AC wiring where possible.
9. Avoid creating sharp bends in the wires.
10. To reduce the risk of having a module with a blown fuse, we suggest you add external fuses to your I/O wiring. A fast blow fuse, with a lower current rating than the I/O module fuse can be added to each common, or a fuse with a rating of slightly less than the maximum current per output point can be added to each output.

## Output Module Fusing

All Terminator I/O discrete output modules have internal user-replaceable fuses. For fuse specifications and part numbers for a specific output module, refer to the output module specifications later in this chapter. Be sure to remove system power or disable outputs via the Base Controller switch before attempting to remove the I/O module from its base. Refer to the next section “I/O Module Hot Swap Feature” if attempting to remove an I/O module with the system power ON.

### Fuses located under top cover of output modules

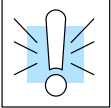
**Note:** A fuse blown indicator illuminates only when a fuse is blown and an associated output point is turned ON by the program.



Replaceable Fuses

## I/O Module Hot Swap Feature

The “Hot Swap” feature allows Terminator I/O modules to be replaced with Terminator I/O system power ON. Be careful not to touch the terminals with your hands or any conductive material to avoid the risk of personal injury or equipment damaged. Always remove power if it is equally convenient to do so.



**WARNING:** Only authorized personnel fully familiar with all aspects of the application should replace an I/O module with system power ON.

The following Base Controllers support the “Hot Swap” feature.

Base Controller	Supports “Hot Swap”
T1K-DEVNETS	Yes
T1K-MODBUS	Yes
T1K-RSSS	Yes
T1H-EBC(100)	Yes (refer to T1H-EBC-M or T1H-PBC-M User Manual for “Hot Swap” information)
T1H-PBC	

The following module types can be “Hot Swapped”.

Module	Can be “Hot Swapped”
Power Supply	No
Base Controller	No
I/O Modules (discrete / analog)	Yes

The following steps explain how to “Hot Swap” an I/O module.

1. Remove I/O module from base.
2. Install new I/O module of the same part number.
3. Verify that the Base Controller LEDs have returned to normal.

A feature that may be used in a non-continuous process application is the Outputs Enable/Disable switch. The switch is located on the front of the T1K-(DEVNETS, MODBUS, RSSS) base controllers. When the switch is in the Disable position all outputs are disabled (OFF), although discrete and analog input data continues to be read. This option may be used at a convenient time during the process application to replace an I/O module.

**Before “Hot Swapping” an analog I/O module or a DC output module in a Terminator I/O system, make sure that each of the analog I/O and DC output module’s 24VDC and 0VDC base terminals are wired directly to the external power supply individually (see diagram below).** If the external 24VDC / 0VDC is jumpered from base to base in a daisy chain fashion, and an analog I/O or DC output module is removed from its base, the risk of disconnecting the external 24VDC to the subsequent I/O modules exists.

Wire each analog I/O and DC output module independently to the external power supply.



Do not jumper modules together creating 24VDC bus for Hot Swap.

**Hot Swap:  
I/O Module  
Replacement**

**Outputs  
Enable/Disable  
Switch**

**Check External  
24VDC Wiring  
Before Hot  
Swapping**

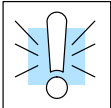


## Calculating the Power Budget

### Managing your Power Resource

When determining the types and quantity of I/O modules you will be using in the Terminator I/O system, it is important to remember there is a limited amount of power available from the power supply to the system. We have provided a chart to help you easily see the amount of power available with AC and DC power supplies. At the end of this section you will also find an example of power budgeting and a worksheet showing sample calculations.

If the I/O you chose exceeds the maximum power available from the power supply you can resolve the problem by simply adding another power supply .

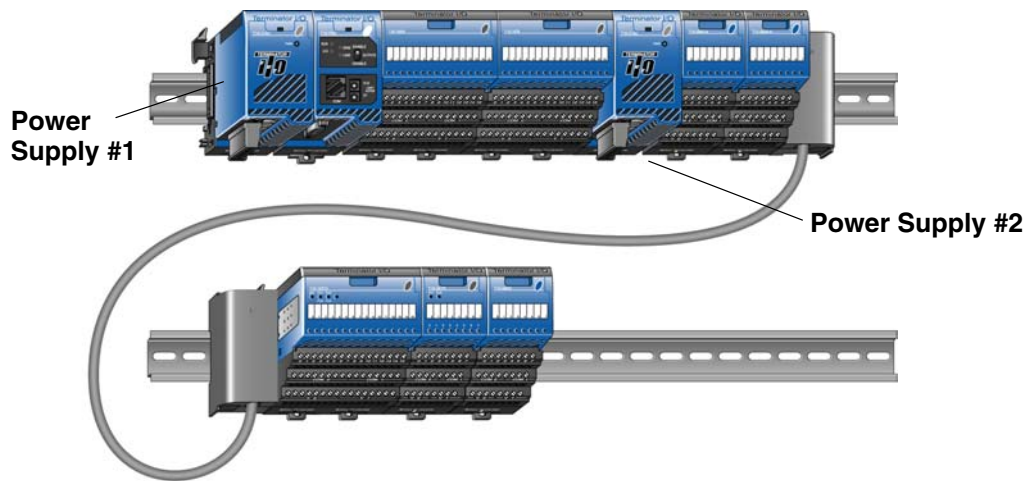


**WARNING:** It is *extremely* important to calculate the power budget correctly. If you exceed the power budget, the system may operate in an unpredictable manner which may result in a risk of personal injury or equipment damage.

### Power Supply Specifications

The following chart shows the amount of current **supplied** by the Terminator I/O power supply. Use this to calculate the power budget for your system. The Auxiliary 24V Power Source mentioned in the table can be used to power field devices or modules that require an external 24VDC.

AC Power Supply	5VDC Current Supplied in mA (internal)	Auxiliary 24VDC Power Source Current Supplied in mA.	DC Power Supply	5VDC Current Supplied in mA. (internal)	Auxiliary 24VDC Power Source Current Supplied in mA.
T1K-01AC	2000	300	T1K-01DC	2000	—
a max. of 500mA @ 24VDC can be achieved by lowering the 5VDC to 1500mA	1500	500	—	—	—



**Note on Power Supplies:** One power supply is required in the leftmost component position (power supply #1), as shown above. Additional power supplies should be added between I/O modules as necessary to meet power budget requirements. Each power supply powers the modules to its right, but is interrupted by the next power supply. It is not mandatory to have a power supply in the leftmost position on an expansion rack.

**System shown above:** The first power supply (ps#1) powers the network interface module and the two I/O modules to its right. The second power supply (ps#2) powers the remaining five I/O modules. This is only an example and the power budget requirements vary depending on the I/O modules used.

## Module Power Requirements

This chart shows the amount of maximum current **required** for each of the Terminator I/O modules. Use this information to calculate the power budget for your system. If an external 24VDC power source is required, you can use the built-in 24VDC auxiliary supply as long as you do not exceed the power budget. If any device is connected to the Controller's serial port that uses the 5VDC supply pin, be sure to include the device's power consumption in your 5VDC power budget calculation.

Base Controller and I/O Module Power Consumption					
Module	5VDC (mA)	24VDC (mA)	Module	5VDC (mA)	24VDC (mA)
<b>Base Controllers</b>			<b>AC Output Modules</b>		
T1K-RSSS	250	0	T1K-08TA	250	0
T1K-DEVNETS	190	(see note 1)	T1K-16TA	450	0
T1H-EBC(100)	350	0	T1K-08TAS	300	0
T1K-MODBUS	250	0	<b>Relay Output Modules</b>		
T1H-PBC	530	0	T1K-08TR	350	0
<b>DC Input Modules</b>			T1K-16TR	700	0
T1K-08ND3	35	0	T1K-08TRS	400	0
T1K-16ND3	70	0	<b>Analog Input Modules</b>		
<b>AC Input Modules</b>			T1F-08AD-1	75	50 (see note 2)
T1K-08NA-1	35	0	T1F-16AD-1	75	50 (see note 2)
T1K-16NA-1	70	0	T1F-08AD-2	75	50 (see note 2)
<b>DC Output Modules</b>			T1F-16AD-2	75	50 (see note 2)
T1K-08TD1	100	200 (see note 2)	T1F-16RTD	150	0
T1K-08TD2-1	100	0	T1F-14THM	60	70 (see note 2)
T1H-08TDS	200	0	<b>Analog Output Modules</b>		
T1K-16TD1	200	400 (see note 2)	T1F-08DA-1	75	150 (see note 2)
T1K-16TD2-1	200	0	T1F-16DA-1	75	150 (see note 2)
<b>Combination Analog Modules</b>			T1F-08DA-2	75	150 (see note 2)
T1F-8AD4DA-1	75	60 (see note 2 and 3)	T1F-16DA-2	75	150 (see note 2)
T1F-8AD4DA-2	75	70 (see note 2)	<b>Specialty Modules and other devices</b>		
			(see note 4)		
			T1H-CTRIO	400	0

Note 1: The T1K-DEVNETS consumes 45mA @ 11-25 VDC from the DeviceNet System.

Note 2: Use T1K-01AC 24VDC auxiliary supply or external user supply.

Note 3: 60mA plus 20mA per output loop

Note 4: If any device is connected to the Controller's serial port that uses the 5VDC supply pin, be sure to include the device's power consumption in your 5VDC power budget calculation.



**Important Power Budget Note:** For each power supply in a system, make sure the current required by the interface and I/O modules does not exceed the current supplied at both 5VDC and 24VDC.

### Power Budget Calculation Example

The following example shows how to calculate the power budget for the first slave unit of an I/O system.

SLAVE (Node) # 1			
Power Supply # 1	Module Part Number	5 VDC (mA) Required	24 VDC (mA) Required
Power Supplied T1K-01AC see p. 3-18		2000	300
Slave	T1H-EBC	350	0
Module	T1K-16NA-1	70	0
Module	T1K-16TA	450	0
Other (OI, etc.)	-	0	0
Maximum power required		870	0
Remaining Power Available		$2000 - 870 = 1130$	$300 - 0 = 300$
Power Supply # 2	Part Number	5 VDC (mA) Required	24 VDC (mA) Required
Power Supplied T1K-01AC see p. 3-18		1500	500
Module	T1K-08AD-2	75	50
Module	T1K-08AD-2	75	50
Module	T1K-16TD1	200	400
Module	T1K-08TR	350	0
Module	T1K-08ND3	35	0
Other	-	0	0
Maximum power required		735	500
Remaining Power Available		$1500 - 735 = 765$	$500 - 500 = 0$ (see note 1)

**Note 1:** An external user power supply must be used in if the 24VDC current requirement exceeds the T1K-01AC 24VDC auxiliary supply.

- Using the tables at the beginning of the Power Budgeting section of this chapter, fill in the information for the base controller, I/O modules, and any other devices that will use system power, including devices that use the 24 VDC output. Devices which fall into the “**Other**” category are devices such as an operator interface which also has power requirements but do attach as a module to the system.
- Add the current columns starting with the slave and put the total in the row labeled “**Maximum power required**”.
- Subtract the row labeled “**Maximum power required**” from the “**Power Supplied**”. Place the difference in the row labeled “**Remaining Power Available**”.
- If “**Maximum Power Required**” is greater than “**Power Supplied**” in either of the two columns, the power budget will be exceeded. It will be unsafe to use this configuration and you will need to restructure your I/O configuration.

### Power Budget Worksheet

SLAVE # _____			
Power Supply # _____	Module Part Number	5 VDC (mA) (required)	Auxiliary Power Source 24 VDC Output (mA) (required)
<b>Power Supplied</b>			
<b>Other</b>			
<b>Maximum power required</b>			
<b>Remaining Power Available</b>			

I/O Wiring and Specifications



## I/O Specification Terms

<b>Inputs or Outputs Per Module</b>	Indicates number of input or output points per module and designates current sinking, current sourcing, or either.
<b>Commons Per Module</b>	Number of commons per module and their electrical characteristics.
<b>Input Voltage Range</b>	The operating voltage range of the input circuit.
<b>Output Voltage Range</b>	The operating voltage range of the output circuit.
<b>Peak Voltage</b>	Maximum voltage allowed for the input circuit.
<b>AC Frequency</b>	AC modules are designed to operate within a specific frequency range.
<b>ON Voltage Level</b>	The voltage level at which the input point will turn ON.
<b>OFF Voltage Level</b>	The voltage level at which the input point will turn OFF.
<b>Input Impedance</b>	Input impedance can be used to calculate input current for a particular operating voltage.
<b>Input Current</b>	Typical operating current for an active (ON) input.
<b>Minimum ON Current</b>	The minimum current for the input circuit to operate reliably in the ON state.
<b>Maximum OFF Current</b>	The maximum current for the input circuit to operate reliably in the OFF state.
<b>Minimum Load</b>	The minimum load current for the output circuit to operate properly.
<b>External DC Required</b>	Some output modules require external power for the output circuitry.
<b>ON Voltage Drop</b>	Sometimes called “saturation voltage”, it is the voltage measured from an output point to its common terminal when the output is ON at max. load.
<b>Maximum Leakage Current</b>	The maximum current a connected maximum load will receive when the output point is OFF.
<b>Maximum Inrush Current</b>	The maximum current used by a load for a short duration upon an OFF to ON transition of a output point. It is greater than the normal ON state current and is characteristic of inductive loads in AC circuits.
<b>Base Power Required</b>	Power from the base power supply is used by the Terminator I/O modules and varies between different modules. The guidelines for using module power are explained in the power budget section of this manual.

---

<b>OFF to ON Response</b>	The time the module requires to process an OFF to ON state transition.
<b>ON to OFF Response</b>	The time the module requires to process an ON to OFF state transition.
<b>Terminal Type</b>	Indicates whether the terminal type is a removable or non-removable connector or a terminal.
<b>Status Indicators</b>	The LEDs that indicate the ON/OFF status of an input point. These LEDs are electrically located on either the logic side or the field device side of the input circuit.
<b>Weight</b>	Indicates the weight of the module.
<b>Fuses</b>	Protective device for an output circuit, which stops current flow when current exceeds the fuse rating. They may be replaceable or non-replaceable, or located externally or internally.

## Specifications

### T1K-01AC, T1K-01DC Power Supply

Rev C

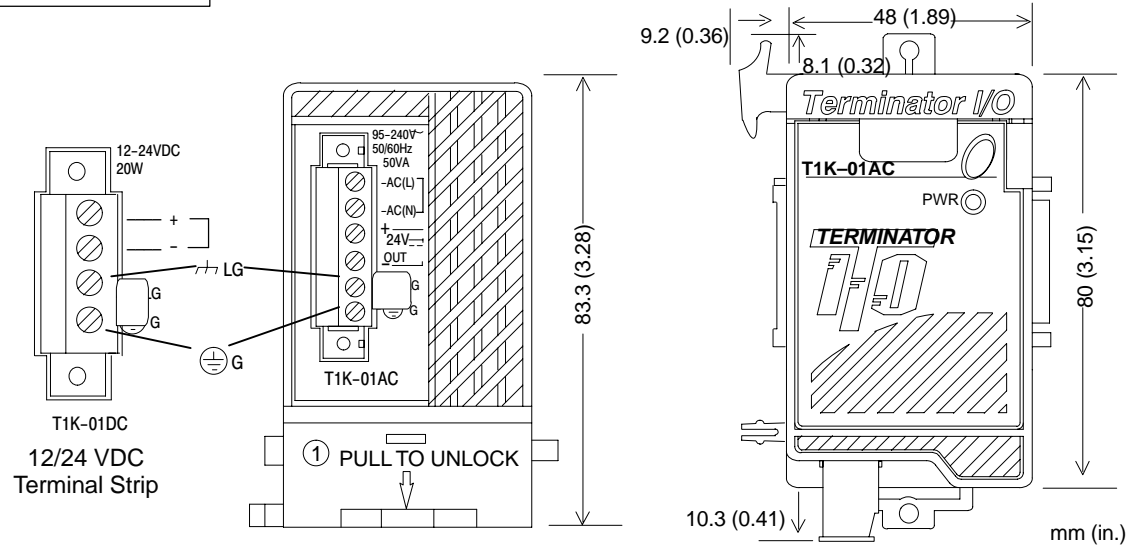
Specification	T1K-01AC	T1K-01DC
Input Voltage Range	110/220VAC (85–264VAC)	12/24VDC (10.8–26.4VDC)
Input Frequency	50/60Hz (47–63Hz)	–
Max. Power	50VA	20W
Max. Inrush Current	20A	10A
Insulation Resistance	> 10M ohm @ 500VDC	
Voltage Withstand (Dielectric)	1 min. @ 1500VAC between primary, secondary and field ground	
Auxiliary 24VDC supply	300mA max.	–
Output 1: <b>5VDC Base Power Supplied</b>	Voltage	5.25VDC (5.00 – 5.50VDC)
	Current	a) 2.0A max. b) 1.5A max.
	Ripple	5% max.
Output 2: <b>24VDC Base Power Supplied</b>	Voltage	24VDC (20.0 – 28.0 VDC)
	Current	a) 300mA max. b) 500mA max.
	Ripple	10% max.
Fuse	1 ( Primary), not replaceable	

Note that 500mA @ 24VDC is achieved by lowering the 5VDC to 1500mA

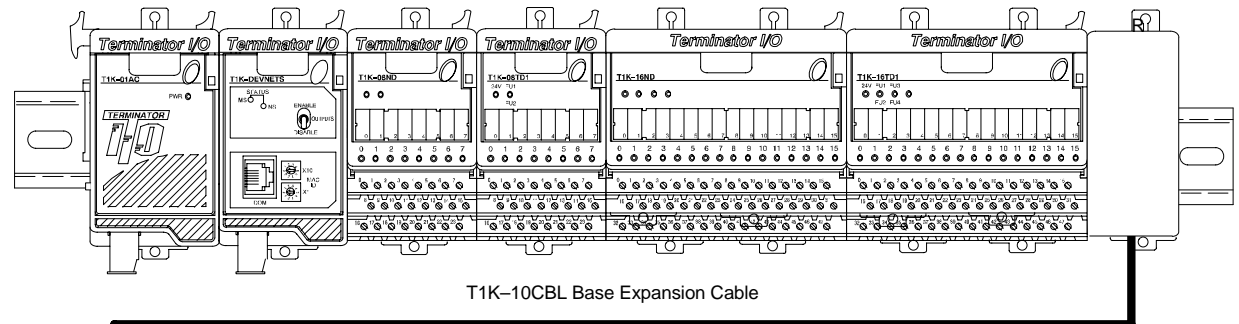
### Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	–4°F to 158°F (–20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3–304
	Impulse Noise 1us, 1000V
	FCC class A
	RFI (144MHz, 430MHz 10W, 10cm)

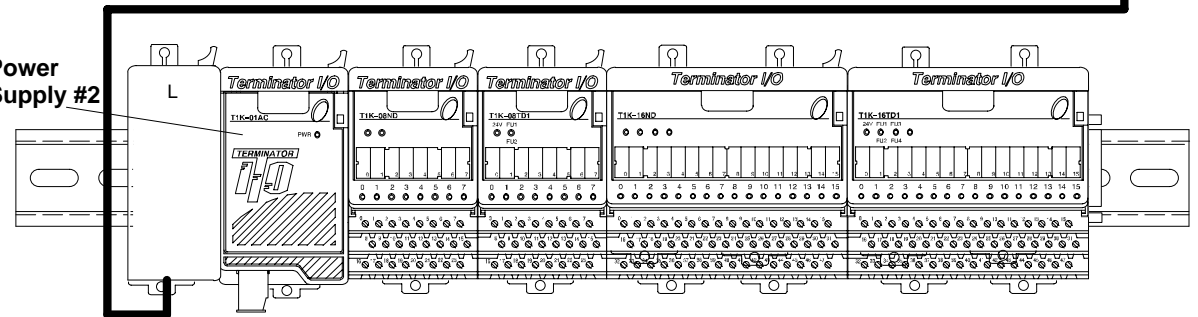
## Dimensions



### Power Supply #1



### Power Supply #2



Note 1: The T1K-DEVNETS consumes 45mA @ 11–25 VDC from the DeviceNet System

Note 2: Use T1K-01AC 24VDC auxiliary supply or external user supply

**Important Power Budget Note:** For each power supply in a system, make sure the current required by the interface and I/O modules does not exceed the current supplied at both 5VDC and 24VDC.

# Specifications

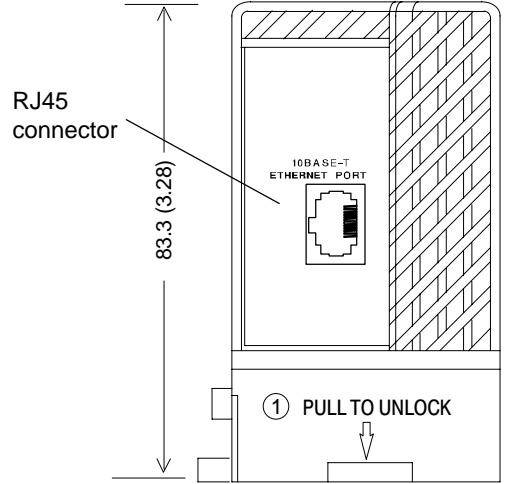
## T1H-EBC Ethernet Base Controller Rev A

Module Type	Ethernet slave
Communications	10Base-T
Auto-configuring	I/O type/position automatically identified during power-up
Ethernet Protocols	TCP/IP, IPX, MODBUS TCP (future)
Ethernet Port	RJ45
Node Address	1 to 99 (decimal) set by rotary switches or software (0 used for setting address via software only)
Link Distance	100 meters (328 feet)
Data Transfer Rate	10Mbps
LED Indicators	<p>MODULE GOOD (green): On = module passed diagnostic check during last power-up Fast blink = configured I/O module no longer reporting (see auto-configuring, above) Slow blink = unconfigured I/O module added to system (see auto-configuring, above)</p> <p>LINK GOOD (green): On = 10Base-T link pulses are being received</p> <p>ACTIVITY (red): On = Ethernet network activity detected</p> <p>ERROR (red): On = watchdog timer timeout represents hardware, communications, or network fault; power-on reset or reset within master device software</p>
Communications Port	RJ12, RS232C K-Sequence protocol, ASCII (not functional when used with H2-ERM)
Base Power Requirement	350mA@5VDC (EBC); Serial port supports up to 500mA@5VDC (add for power budget consumption).

## General Specifications

Installation Requirements	mounts to right of first power supply
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases, pollution level = 2 (UL 840)
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304 Impulse noise 1us, 1000V FCC class A RFI (144MHz, 430MHz, 10W, 10cm)

# Dimensions



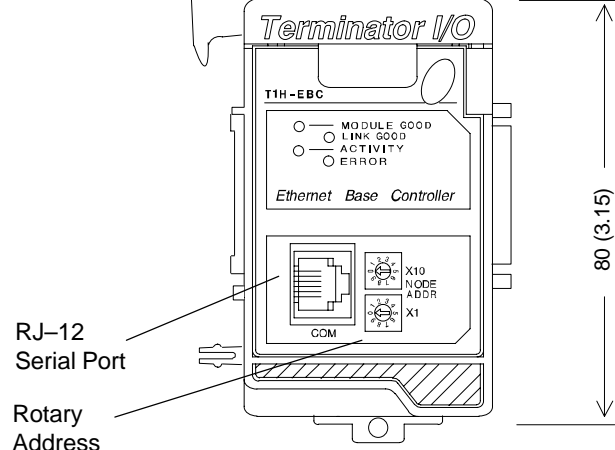
RJ45 connector

83.3 (3.28)

10BASE-T  
ETHERNET PORT

1 PULL TO UNLOCK

9.2 (0.36) 48 (1.89) 8.1 (0.32)



RJ-12 Serial Port

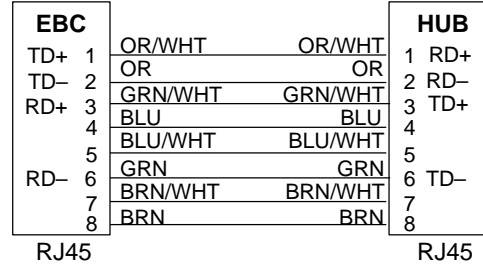
Rotary Address Switches

80 (3.15)

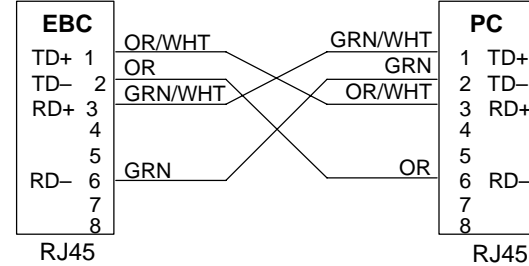
mm (in.)

## T1H-EBC Ethernet Port Pin-out

### Patch (Straight-through) Cable

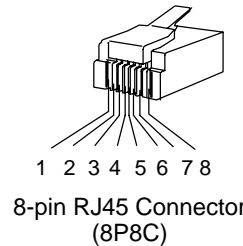


### Crossover Cable

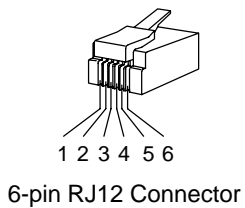


This diagram illustrates the standard wire positions in the RJ45 connector. We strongly recommend that you use **Category 5** or better, UTP cable.

### 10BaseT



### RJ12



## T1H-EBC Serial Port Pin-out

### Serial Port Pin Descriptions

1	0V	Power (-) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive Data (RS232C)
4	TXD	Transmit Data (RS232C)
5	RTS	Request to Send
6	CTS	Clear to Send

**Specifications**

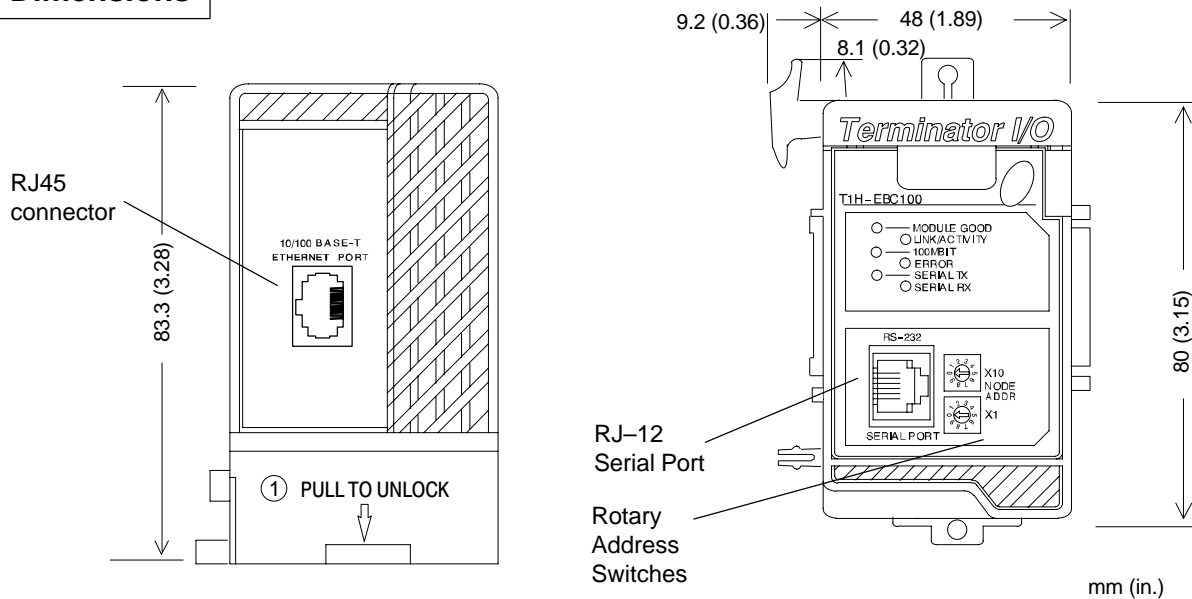
**T1H-EBC100 Ethernet Base Controller**

Module Type	Ethernet slave
Communications	10/100Base-T
Auto-configuring	I/O type/position automatically identified during power-up
IP Configuration	-Obtain an IP address from a DHCP Server automatically at power-up (Default); -Dedicated IP address using NetEdit3 or HTML configuration
Ethernet Protocols	TCP/IP, UDP/IP, IPX, MODBUS TCP
Ethernet Port	RJ45
Node Address	1 to 99 (decimal) set by rotary switches or software; 0 (default, used for setting address via software only)
Link Distance	100 meters (328 feet)
Data Transfer Rate	100Mbps or 10Mbps (auto-detect)
LED Indicators	<p>MODULE GOOD (green): On = module passed diagnostic check during last power-up Fast blink = configured I/O module no longer reporting (see auto-configuring, above) Slow blink = unconfigured I/O module added to system (see auto-configuring, above)</p> <p>LINK/ACTIVITY (green): On= Ethernet network activity detected</p> <p>100MBIT (green): On= Ethernet activity is auto-detected at 100Mbps Off = (with LINK/ACTIVITY On) Ethernet activity is auto-detected at 10Mbps</p> <p>ERROR (red): On = watchdog timer timeout represents hardware, communications, or network fault; power-on reset or reset within master device software</p> <p>SERIAL TX (green): On= EBC RJ12 serial port is transmitting</p> <p>SERIAL RX (green): On= EBC RJ12 serial port is receiving</p>
Note: All indicators re-initialize during power-up.	
Serial Communications Port	RJ12, RS232C K-Sequence protocol, ASCII, MODBUS RTU (not functional when used with HX-ERM)
Base Power Requirement	350mA@5VDC (EBC100); Serial port supports up to 500mA@5VDC (add for power budget consumption).

**General Specifications**

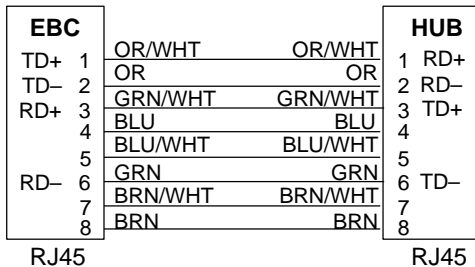
Installation Requirements	mounts to right of first power supply
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases, pollution level = 2 / (UL 840)
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304 Impulse noise 1us, 1000V FCC class A RFI (144MHz, 430MHz, 10W, 10cm)

**Dimensions**

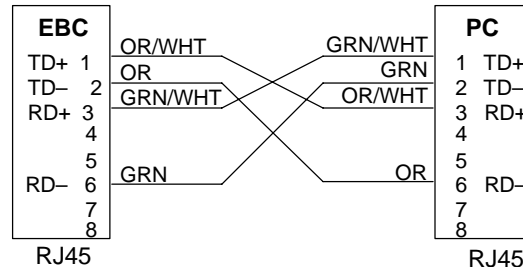


**T1H-EBC100 Ethernet Port Pin-out**

**Patch (Straight-through) Cable**

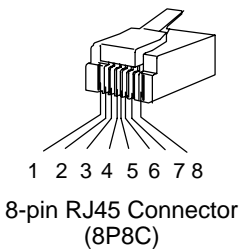


**Crossover Cable**



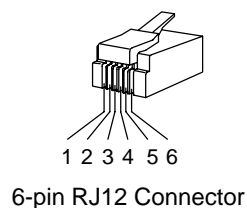
This diagram illustrates the standard wire positions in the RJ45 connector. We strongly recommend that you use **Category 5** or better, UTP cable.

**10/100Base-T**



**T1H-EBC100 Serial Port Pin-out**

**RJ12**



**Serial Port Pin Descriptions**

1	0V	Power (-) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive Data (RS232C)
4	TXD	Transmit Data (RS232C)
5	RTS	Request to Send
6	CTS	Clear to Send

# Specifications

# T1K-DEVNETS

## Communications Specification

Rev B

Communication Form	DeviceNet Communication Protocol (Slave) Predefined Master/Slave Group 2 Server only	
Network Node Address	0 to 63 (Rotary switch setting)	
Data Packet	0 to 8 Bytes (Data beyond eight bytes are divided.)	
Communication Rate (Max. cable length)	125KB 250KB 500KB	(1640 ft./ 500m) (820 ft./ 250m) (328 ft./ 100m)
Communication Status Indicators	<p>MS: Module Status LED Green: normal device operation Red: unrecoverable controller fault</p> <p>NS: Network Status LED Green: communication link online and connected Green flashing: on-line, but not connected Red: critical link or controller failure Red flashing: connection time-out</p>	
DeviceNet Power Consumption	45mA @ 11 to 25 VDC	
Base Power Consumption	190mA @ 5VDC	

## DeviceNet Specification

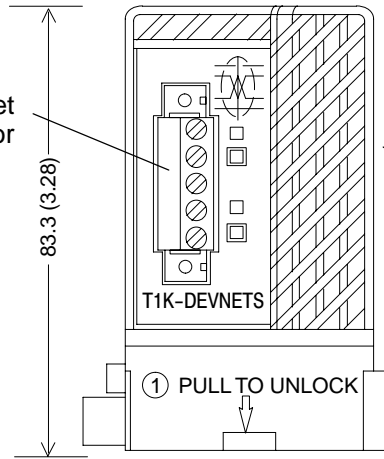
Device Type	Generic
Explicit Peer to Peer Message	No
I/O Peer to Peer Message	No
Configuration Consistency	No
Fault Node Recovery	No
Communication Baud Rate 125K, 250K, 500K	Yes
Master/Scanner	No
I/O Slave Message	No
Bit Strobe	No
Polling	Yes
Cyclic	No
Change of State	No

## General Specifications

Installation Requirement	must mount to right of first power supply in a slave system
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	5% - 95% relative humidity (non-condensing)
Voltage Withstand	1500VAC, 1 minute (DeviceNet connector internal)
Insulation Resistance	500VDC, 10MΩ (DeviceNet connector internal)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Noise Immunity	NEMA (ICS3-304) Impulse noise 1μs, 1000V FCC class A RFI (145MHz, 435MHz 10W, 10cm)
Atmosphere	No corrosive gases Environmental Pollution Level 2
Weight	6.0 oz (170 g)

# Dimensions

DeviceNet Connector



83.3 (3.28)

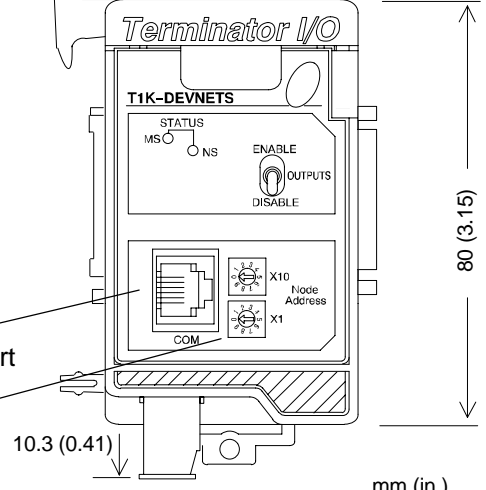
9.2 (0.36) 48 (1.89) 8.1 (0.32)



DIP Switch located under hinged cover on side of unit

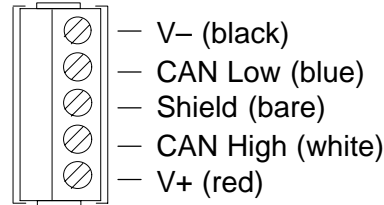
RJ-12 Serial Port

Rotary Node Switches



mm (in.)

## T1K-DEVNETS port pin-out



Use Belden Cable 3084A, or equivalent.

## T1K-DEVNETS DIP Switch Settings

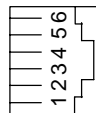
DIP SW OFF | ON

SW1	DeviceNet Baud Rate
SW2	Reserved
SW3	I/O Polling Diagnostics Enable / Disable
SW4	Hold Outputs (on Comm. Error)
SW5	Maintenance Port Baud Rate
SW6	Reserved
SW7	Reserved
SW8	RTS/CTS Enable/Disable

**\*Note: Default setting assigns the node's first Input and Output word to I/O Diagnostics.**

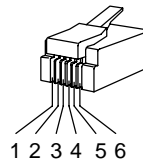
Factory Default Settings Shown (all OFF)

## Serial Port



RJ12 plug on cable

Pin	Signal
1	0V
2	+ 5V
3	RXD
4	TXD
5	RTS
6	CTS



SW 4 Disable I/O Polling Diagnostics	
I/O Diagnostics	SW4
Enable	OFF
Disable	ON

SW 5 Hold Outputs	
Outputs	SW5
Turn Off	OFF
Hold	ON

SW 1-2 DeviceNet Baud Rate		
Baud Rate	SW1	SW2
125kbps	OFF	OFF
250kbps	ON	OFF
500kbps	OFF	ON
Reserved	ON	ON

SW 6 Maintenance Port Baud Rate	
Baud Rate	SW6
9600 bps	OFF
19200 bps	ON

SW 8 RTS / CTS Enable / Disable	
RTS/CTS	SW8
Disable	OFF
Enable	ON

\*See Dip Switch 4 Note above.

# Specifications

## T1K- MODBUS Base Controller

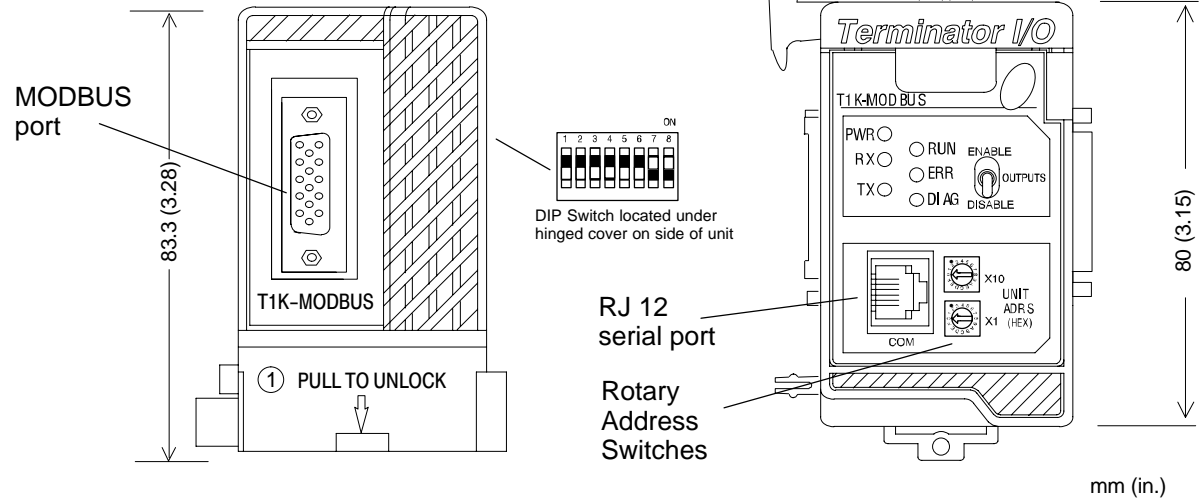
Rev A

Communication Protocol	MODBUS RTU (Slave)
MODBUS Connector	15-pin female D-shell
MODBUS Port Type	RS-232C, RS422/485
Station Address	1 to F7h (247), Rotary switch setting
Number of I/O Points	Discrete: Inputs: 1024, Outputs: 1024; Analog: Inputs: 64 Channels, Outputs: 64 Channels
Communication Baud Rate	(300, 600, 1200, 2400, 4800, 9600, 19.2k, 38.4k) bps Dip Switch 1-3 Set
Communication Data	8-bit (fixed), 1 Start bit, 1 or 2 Stop bit Parity: None/Odd/Even; configure using Setup Tool Defaults: 8 (fixed), 1, 1, Odd
Communication Time out	500ms, 1s, 2.5s, 5s, 10s, 25s, 60s Default: 1s; configure using Setup Tool
RTS On / Off Delay Time	(0, 2, 5, 10, 50, 100, 500) ms Default: 0ms; configure using Setup Tool
Status Indicators	RWR (Green): ON when power good RX (Green): ON when data is being received TX (Green): ON when data is being transmitted RUN (Green): ON when communicating with Master ERR (Red): Communication error DIAG (Red): I/O system error
Output Enable Switch	Enable: outputs are enabled Disable: outputs are disabled
Installation Requirement	must mount to right of first power supply in a slave system
Base Power Requirement	250mA @ 5VDC
Communications Port (RJ 12 Serial Port)	RJ12, RS232C Use to configure MODBUS port using MODBUS Setup Tool Utility or use to upgrade firmware Baud rate: 9600, 19.2k bps (set with Dip Switch 6) Fixed settings: 8 data bits, 1 start bit, 1 stop bit, parity Odd

## General Specifications

Installation Requirement	must mount to right of first power supply in a slave system
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Ambient Humidity	30% - 95% relative humidity (non-condensing)
Atmosphere (UL 840)	No corrosive gasses. The level for the environmental pollution = 2.
Voltage Withstand	1500VAC, 1 minute (15-pin connector internal)
Insulation Resistance	500VDC, 10MΩ
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Noise Immunity	NEMA (ICS3-304) Impulse noise 1μs, 1000V FCC class A RFI (145MHz, 435MHz)
Atmosphere	No corrosive gasses Environmental Pollution Level 2
Weight	6.0 oz (170 g)

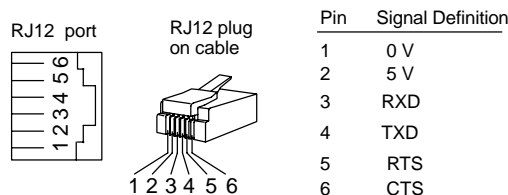
# Dimensions



## MODBUS Port Pin-Out

Pin	Signal Definition
1	5V 5 VDC
2	TXD Transmit Data (RS-232C)
3	RXD Receive Data (RS-232C)
4	RTS Request to Send (RS-232C)
5	CTS Clear to Send (RS-232C)
6	RXD- Receive Data - (RS-422)
7	0V Logic Ground
8	0V Logic Ground
9	TXD+ Transmit Data + (RS-422)
10	TXD - Transmit Data - (RS-422)
11	RTS+ Request to Send + (RS-422)
12	RTS - Request to Send - (RS-422)
13	RXD + Receive Data + (RS-422)
14	CTS + Clear to Send + (RS-422)
15	CTS - Clear to Send - (RS-422)

## Serial Port Pin-out



## T1K-MODBUS DIP Switch Settings

SW 1-3 MODBUS Port Baud Rate			
Baud Rate	SW1	SW2	SW3
300 bps	OFF	OFF	OFF
600 bps	ON	OFF	OFF
1200 bps	OFF	ON	OFF
2400 bps	ON	ON	OFF
4800 bps	OFF	OFF	ON
9600 bps	ON	OFF	ON
19200 bps	OFF	ON	ON
38400 bps	ON	ON	ON

SW 4 Communication Setting Mode	
Default Mode	OFF
Option Mode (see T1K-MODBUS Manual)	ON

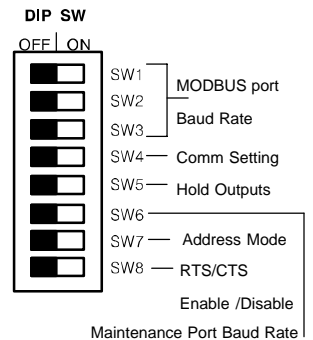
SW 5 Hold Outputs	
Outputs	SW5
Turn Off	OFF
Hold	ON

Default Mode	
Communication Data	8 Bit
Start Bit	1 bit
Stop Bit	1 bit
Parity Bit	Odd
Communication Time Out	1 s
RTS ON Delay Time	0 ms
RTS OFF Delay Time	0 ms

SW 6 Maintenance Port Baud Rate	
Baud Rate	SW6
9600 bps	OFF
19200 bps	ON

SW 7 MODBUS RTU Addressing Mode	
Mode	SW7
584/984	OFF
Direct Logic	ON

SW 8 RTS / CTS Enable / Disable	
RTS/CTS	SW8
Disable	OFF
Enable	ON



## Specifications

### T1K-RSSS Remote I/O Base Controller

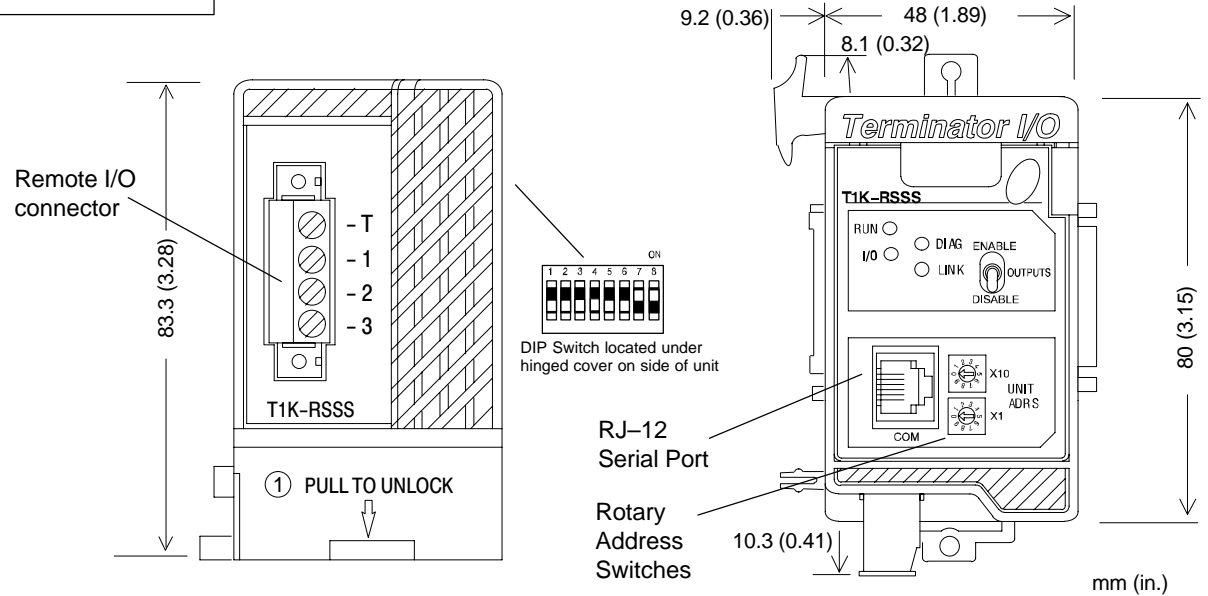
Rev A

Module Type	non-intelligent slave			
Protocol	SM-NET		RM-NET	
Station Address	1 to 31 set by rotary switches		1 to 7 set by rotary switches	
Number of Masters per PLC CPU	Check PLC CPU / remote Master module remote I/O specifications			
Max. Slave I/O Points per PLC CPU				
Baud Rate / Communication Distance (set by DIP switches)	Baud rate	Distance	Baud rate	Distance
	19.2kbps	1.2Km	19.2kbps	1.2Km
	38.4kbps	1.2Km	38.4kbps	1.2Km
	153.6kbps	600m		
	307.2kbps	300m		
	614.4kbps	100m		
LED Indicators	RUN: On when communication is active. DIAG: On when a slave hardware failure error occurs. I/O: Fast Blink: I/O error (250ms on/off time) Slow Blink: I/O configuration error while outputs are enabled (500ms on/off time) Continuous ON: I/O and configuration error LINK: On when a communication error occurs.			
Output Enable Switch	Enable: outputs are enabled Disable: outputs are disabled			
Communications Port (active in SM-NET only)	RJ12, RS232C (K-Sequence) Dip switch selectable: Baud rate: 4800-38400bps *select 9600 baud for operator interface (default) (other baud rates are for updating T1K-RSSS) Parity: odd (default), even Fixed settings: 8 data bits, 1 start bit, 1 stop bit			
Base Power Requirement	250mA @ 5VDC			
Communication Cabling	for remote I/O, RS-485 twisted pair Belden 9841 or equivalent			

### General Specifications

Installation Requirements	must mount to right of first power supply in a slave system
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases, pollution level = 2 (UL 840)
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304 Impulse noise 1us, 1000V FCC class A RFI (144MHz, 430MHz, 10W, 10cm)

## Dimensions

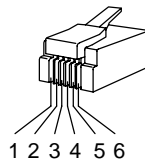


### T1K-RSSS DIP Switch Settings

1	2, 3, 4	5	6	7, 8
<b>Mode</b>	<b>Baud Rate</b>	<b>switch position</b>	<b>Output Default</b>	<b>Serial Port Parity</b>
OFF = SM-NET ON = RM-NET	Baud Rate	2 3 4	OFF = Clear ON = Hold	Serial Port Baud Rate
	19.2k	0 0 0		Baud Rate
	38.4k	X 0 0		4.8k
	153.6k	0 X 0		9.6k
	307.2k	X X 0		19.2k
	614.4k	0 0 X		38.4k
	X = ON, 0 = OFF			X = ON, 0 = OFF
	Baud rates above 38.4k for SM-NET only			Port Active in SM-NET only
				Use 9.6k, odd parity for Operator Interface

### T1K-RSSS Serial Port Pin-out

RJ12 plug on cable



RJ12 socket on T1K-RSSS



#### Port Pinout

Pin	Signal Definition
1	0 V
2	5 V
3	RS232C Data In
4	RS232C Data Out
5	5 V
6	0 V



## Specifications

### T1H-PBC Profibus Base Controller

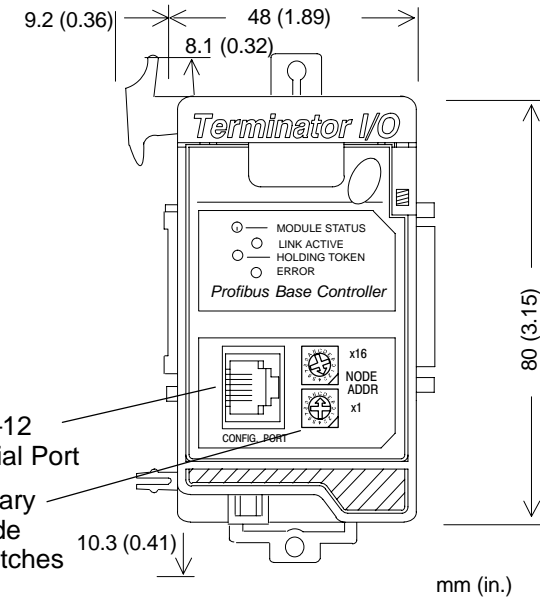
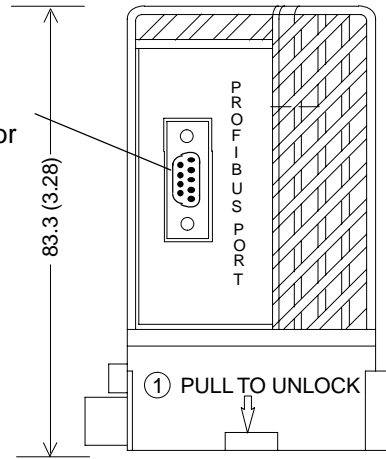
Module Type	Profibus Network Interface Module
Maximum Expansion	32 stations per segment, repeaters max./segment, 126 stations maximum
Communications	RS-485
Auto-configuring	GSD file in Master
Profibus Profile	DP (Decentralized Periphery)
Profibus Port	9-pin D-shell
Node Address	1 to 126 (decimal) set by rotary switches (0 used by Master)
Segment Distance	100 meters (327 feet) to 1200 meters (3270feet)
Baud Rate	Selectable from 9.6 kbps to 12 Mbps
LED Indicators	STATUS (Module): ON = module power-up check passed OFF = module power-up check failed ACTIVE (Link): ON = Network is active OFF = Network is not active TOKEN (Holding): ON = PBC is configured correctly and running OFF = Incorrect I/O configuration ERROR: ON = watchdog timer timeout represents hardware, communications, or network fault; power-on reset or reset within master device software
Communications Port	RJ12, RS232C (used for firmware upgrade only)
Base Power Requirement	530mA @ 5VDC (supplied by base power supply)

### General Specifications

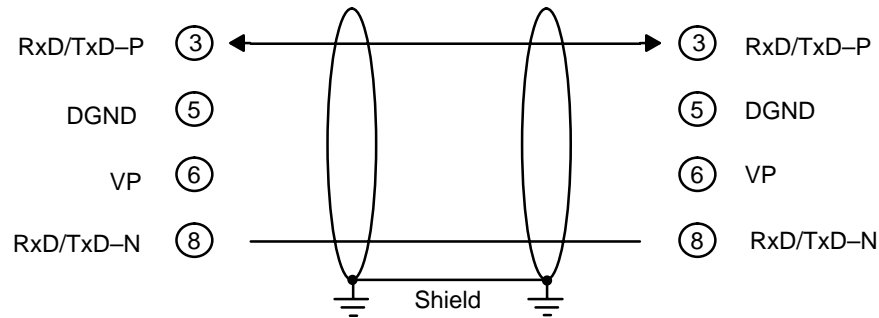
Installation Requirement	must mount to right of first power supply
Operating Temperature	32° F to 131° F (0° C to 55° C)
Storage Temperature	-4° F to 158° F (-20° C to 70° C)
Relative Humidity	5% - 95% (non-condensing)
Environmental Air	No corrosive gases, pollution level = 2 (UL840)
Vibration	MIL STD 810C, Method 514.2
Shock	MIL STD 810C, Method 516.2
Noise Immunity	NEMA (ICS3-304) Impulse noise 1µs, 1000V FCC class A RFI (145MHz, 435MHz 10W, 10cm)
Manufacturer	Host Automation Products

## Dimensions

Profibus Connector



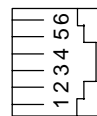
### T1H-PBC port pin-out



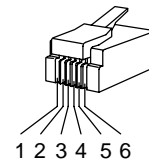
**Use Belden Profibus 3079A Cable or Siemens 6XV1 830 0AH10**

### Serial (Config) Port

(Use for firmware upgrades only)



RJ12 plug on cable



### Serial Port Pin Descriptions

1	0V	Power (-) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive Data (RS232C)
4	TXD	Transmit Data (RS232C)
5	RTS	Request to Send
6	CTS	Clear to Send

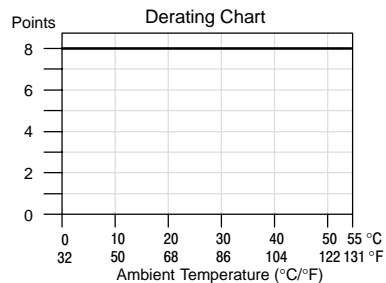
# Specifications

## T1K-08ND3 DC Input

Inputs Per Module	8 (sink/source)
Commons Per Module	ext. power: 2, isolated (4 pts. / com) int. power: 2, all 8 pts. internally connected
Operating Voltage Range	12-24 VDC
Input Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	30 VDC
Input Current (Typical)	4mA @ 12 VDC, 8.5mA @ 24 VDC
Input Impedance	2.8 K ohm
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Min. ON Current	4mA
Max. OFF Current	0.5mA
OFF to ON Response	2-8ms, Typ: 4ms
ON to OFF Response	2-8ms, Typ: 4ms
Base Power Required	35mA @ 5VDC
Status Indicators	Logic Side
Weight	70g

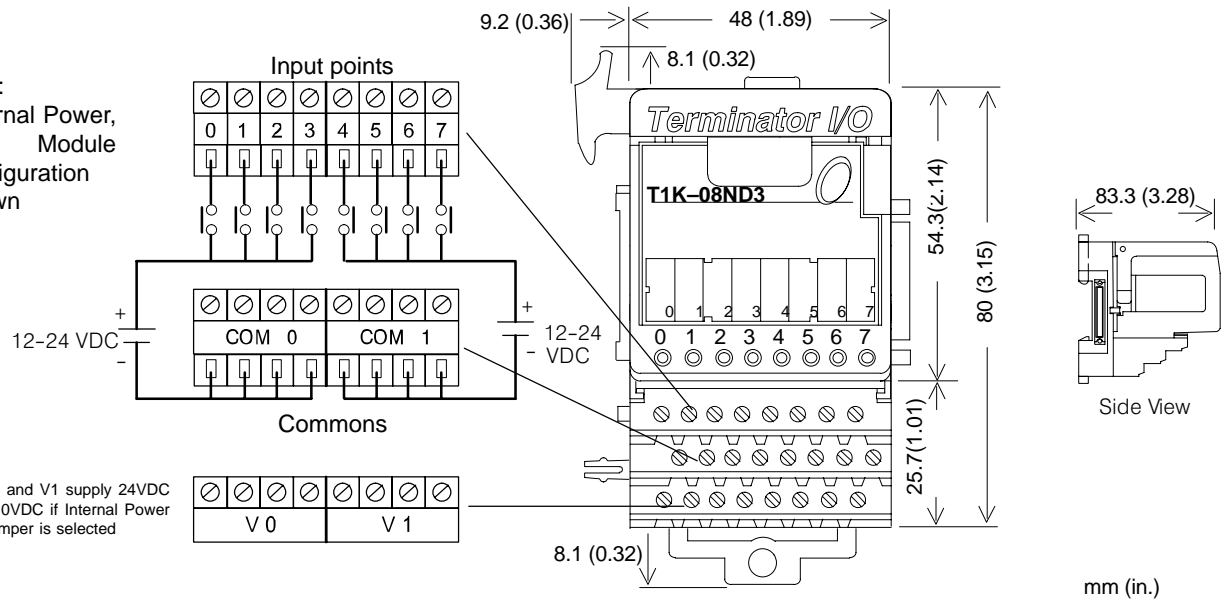
## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

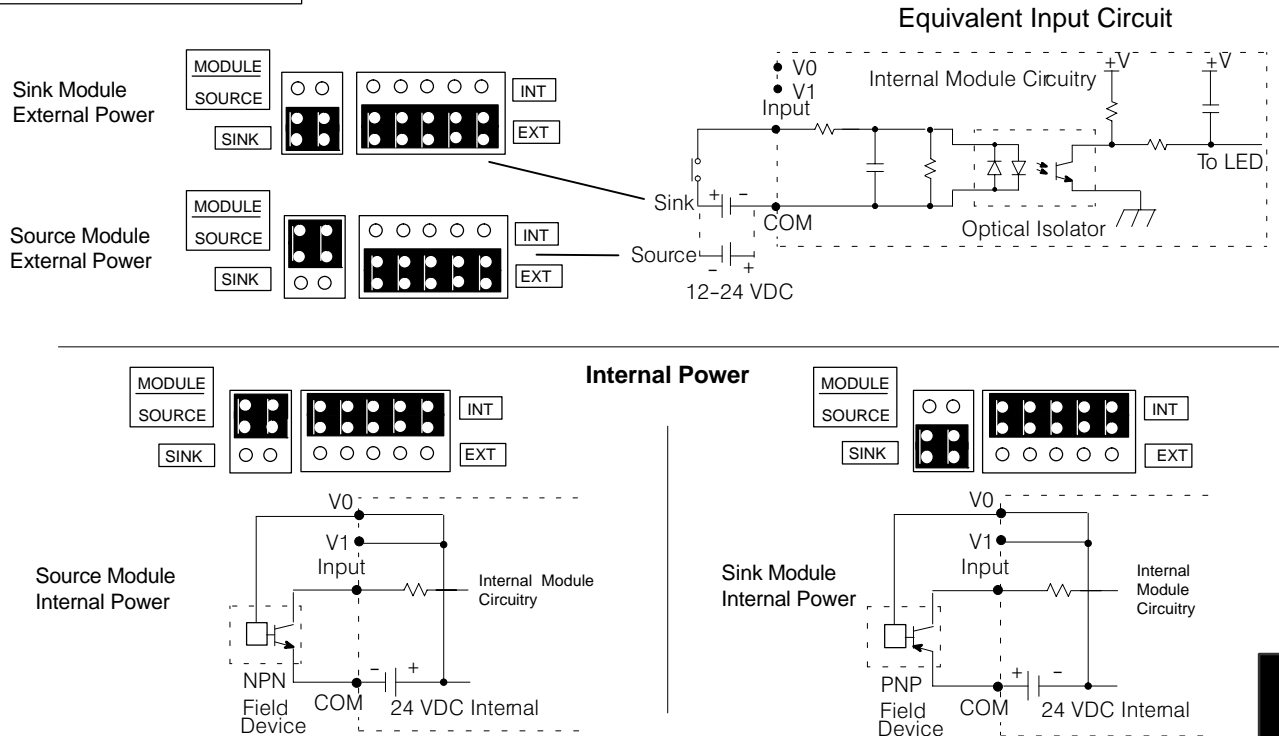


# Wiring & Dimensions

Note:  
External Power,  
Sink Module  
Configuration  
Shown



## Jumper Selection



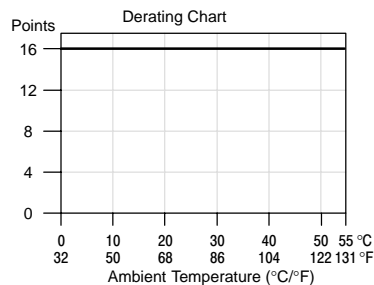
# Specifications

## T1K-16ND3 DC Input

Inputs Per Module	16 (sink/source)
Commons Per Module	ext. power : 4, isolated (4 pts. / com) int. power : 4, all 16 pts. internally connected
Operating Voltage Range	12-24 VDC
Input Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	30 VDC
Input Current (Typical)	4mA @ 12 VDC, 8.5mA @ 24 VDC
Input Impedance	2.8 K ohm
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Min. ON Current	4mA
Max. OFF Current	0.5mA
OFF to ON Response	2-8ms, Typ: 4ms
ON to OFF Response	2-8ms, Typ: 4ms
Base Power Required	70mA @ 5VDC
Status Indicators	Logic Side
Weight	120g

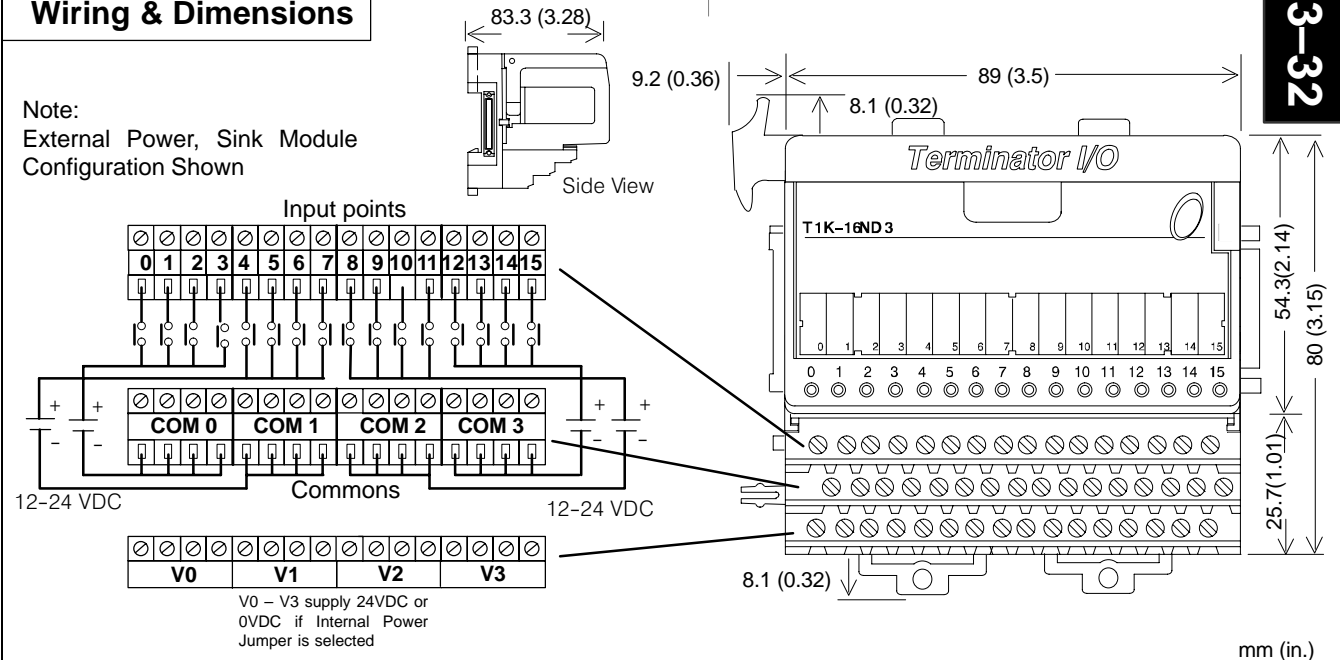
## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A



# Wiring & Dimensions

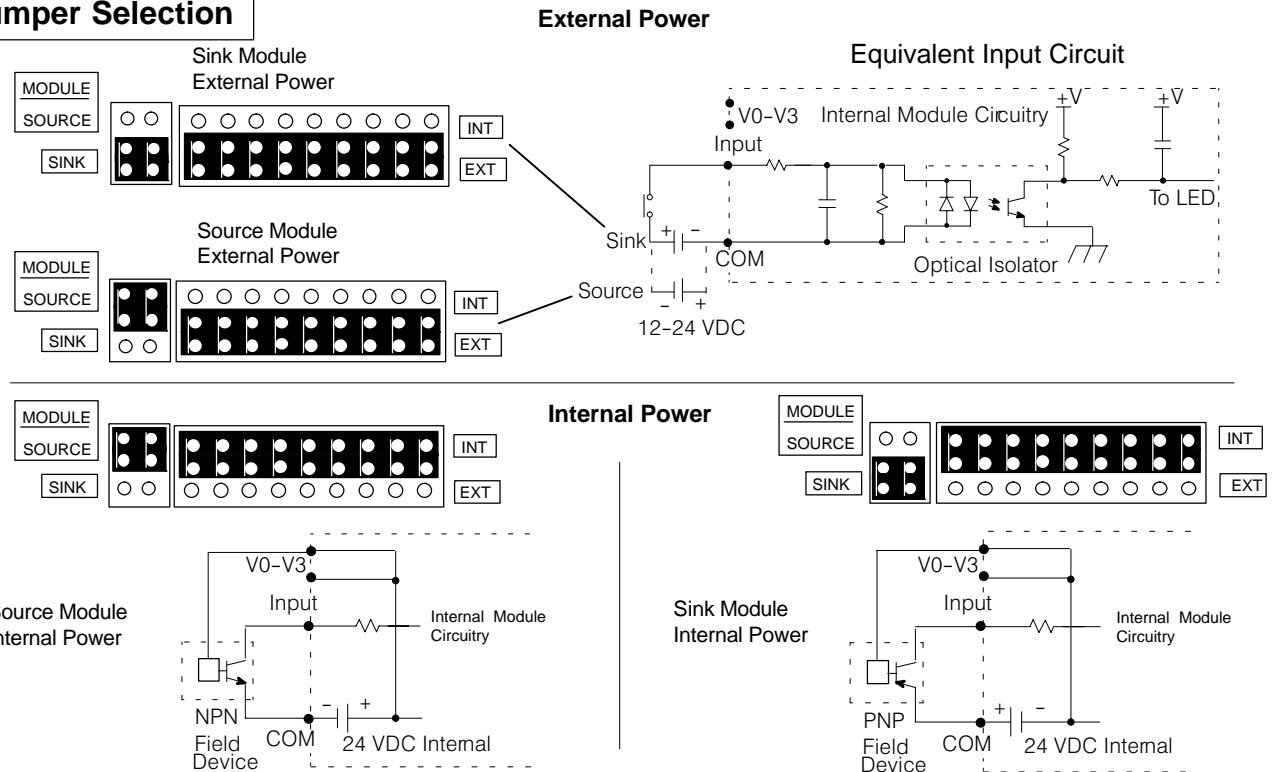
Note:  
External Power, Sink Module  
Configuration Shown



3-32

mm (in.)

## Jumper Selection



## Specifications

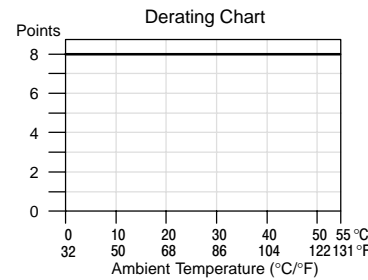
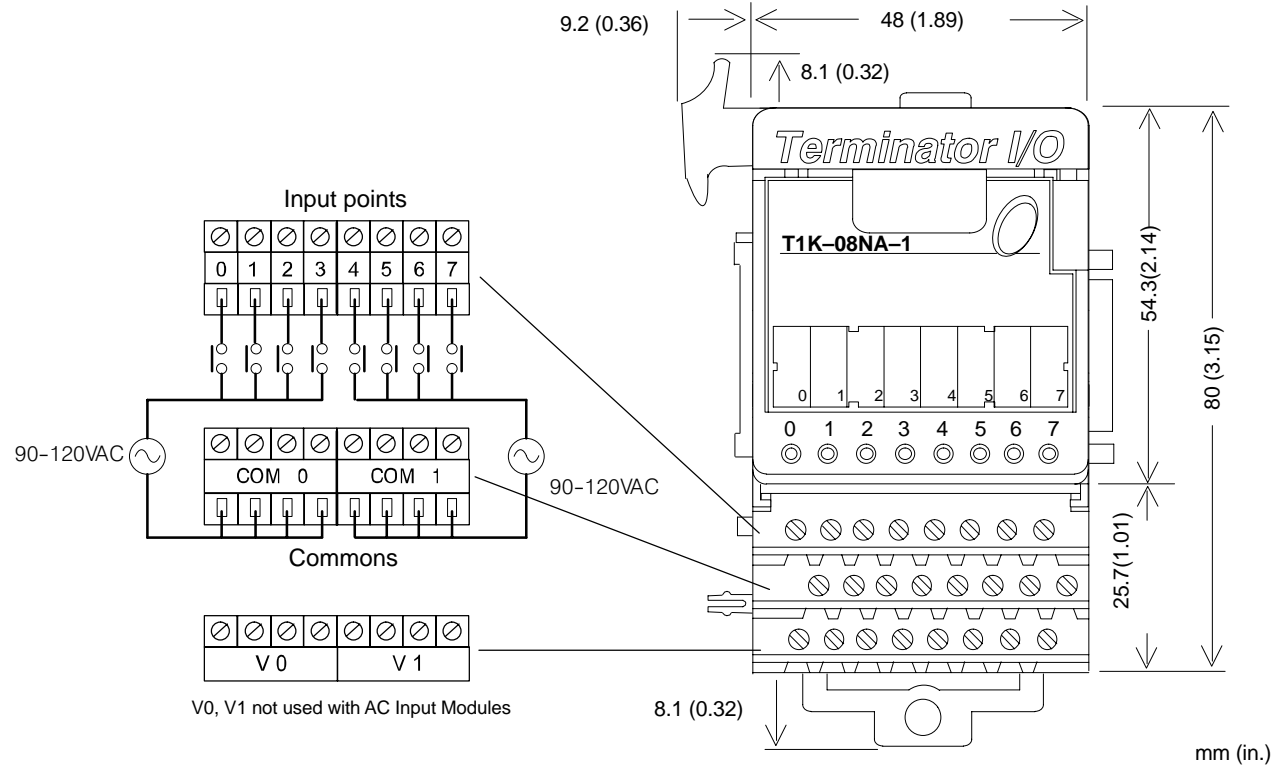
### T1K-08NA-1 AC Input

Inputs Per Module	8
Commons Per Module	2, 4 pts. / com (isolated)
Operating Voltage Range	90-120VAC, 47-63Hz
Input Voltage Range	80-132VAC, 47-63Hz min. / max.
Input Current	8mA @ 100VAC (50Hz) 10mA @ 100VAC (60Hz) 12mA @ 132VAC (50Hz) 15mA @ 132VAC (60Hz)
Input Impedance	14K ohm @ 50Hz, 12K ohm @ 60Hz
ON Current/Voltage	> 6mA @ 75VAC
OFF Current/Voltage	< 2mA @ 20VAC
OFF to ON Response	< 40ms
ON to OFF Response	< 40ms
Base Power Required	35mA @ 5VDC
Status Indicators	Logic Side
Weight	70g

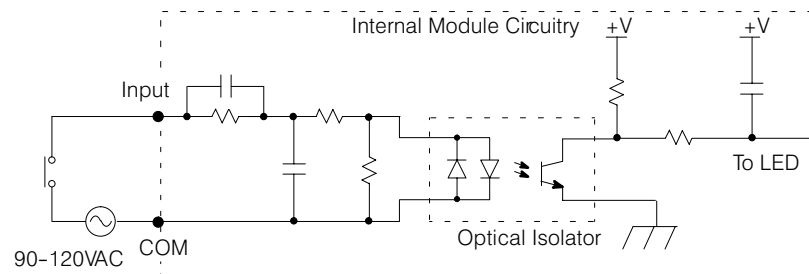
### Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

## Wiring & Dimensions



### Equivalent Input Circuit



## Specifications

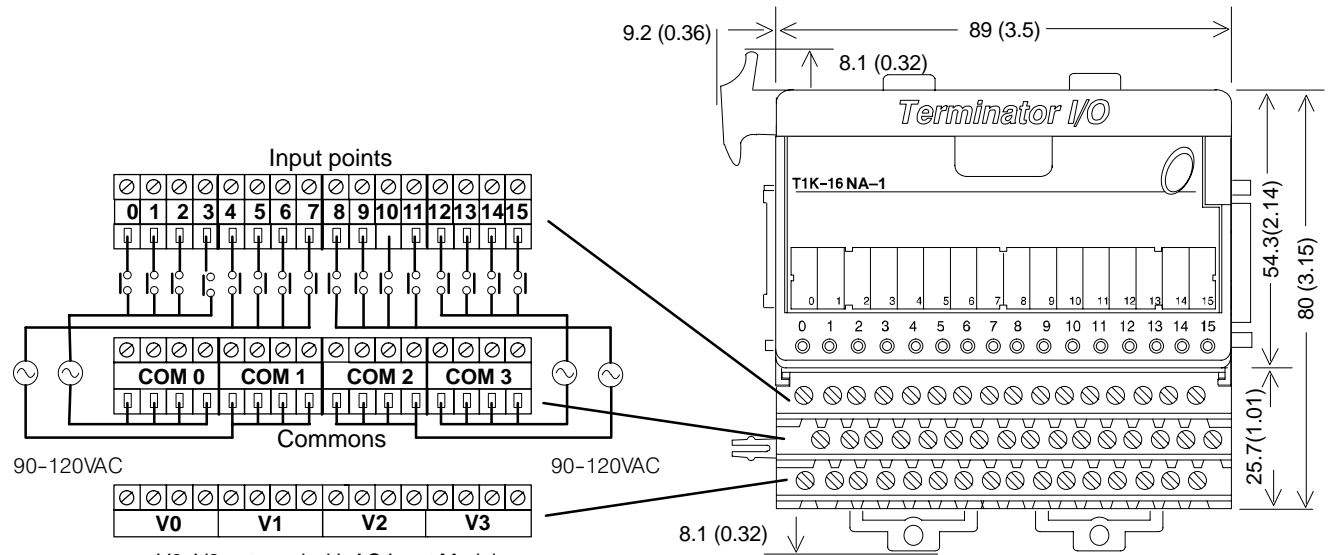
### T1K-16NA-1 AC Input

Inputs Per Module	16
Commons Per Module	4, 4 pts. / common (isolated)
Operating Voltage Range	90-120VAC, 47-63Hz
Input Voltage Range	80-132VAC, 47-63Hz min. / max.
Input Current	8mA @ 100VAC (50Hz) 10mA @ 100VAC (60Hz) 12mA @ 132VAC (50Hz) 15mA @ 132VAC (60Hz)
Input Impedance	14K ohm @ 50Hz, 12K ohm @ 60Hz
ON Current/Voltage	> 6mA @ 75VAC
OFF Current/Voltage	< 2mA @ 20VAC
OFF to ON Response	< 40ms
ON to OFF Response	< 40ms
Base Power Required	70mA @ 5 VDC
Status Indicators	Logic Side
Weight	120g

### Environmental Specifications

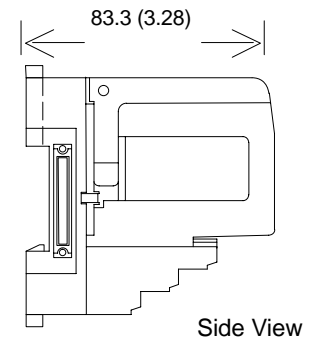
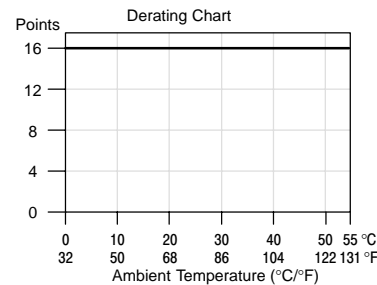
Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

## Wiring & Dimensions

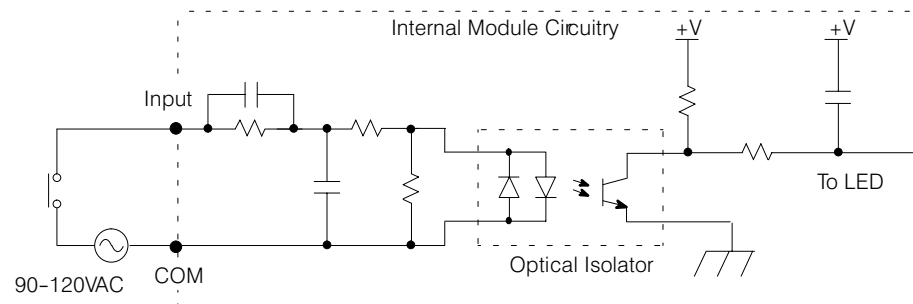


3-34

mm (in.)



### Equivalent Input Circuit



# Specifications

## T1K-08TD1 DC Output

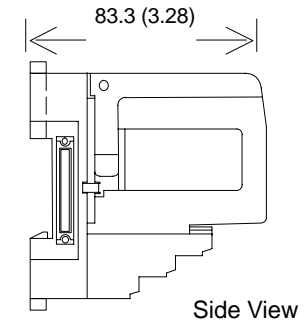
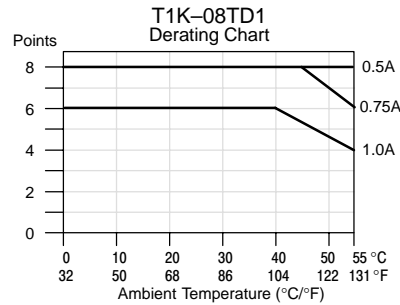
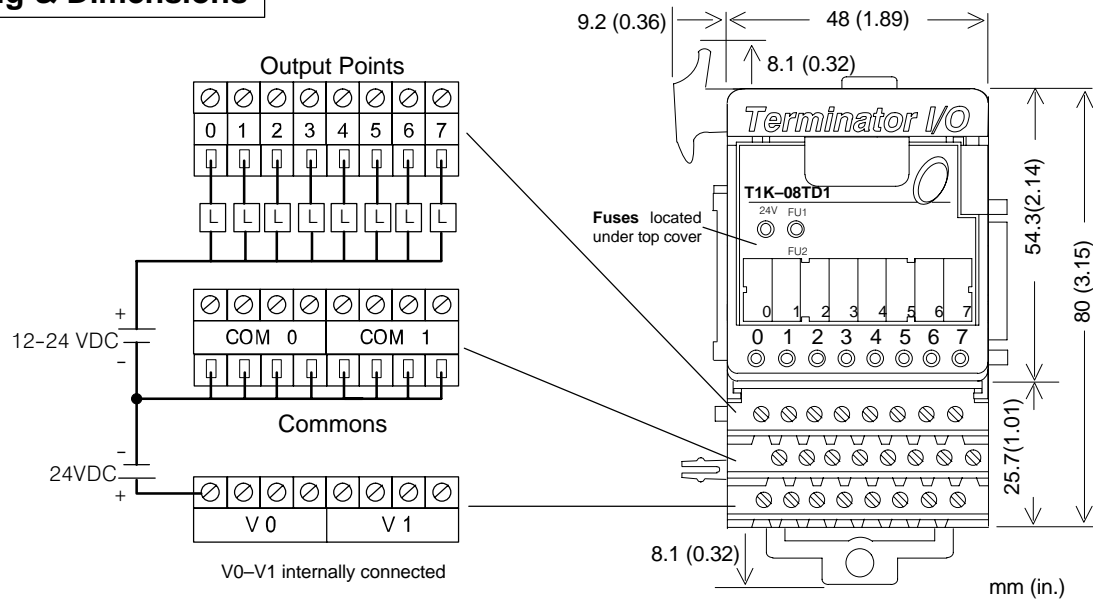
Rev A

Outputs Per Module	8 (sink)
Commons Per Module	2 internally connected
Operating Voltage Range	6-27 VDC
Output Voltage Range	5-30 VDC min. / max.
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15uA @ 30VDC
ON Voltage Drop	0.3VDC @ 1.0A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10us
ON to OFF Response	< 60us
Base Power Required	100mA @ 5VDC
External Power Required	200mA max. @ 20-28VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	24V ON = low external power FU1/FU2 ON = fuse 1 or fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-1	2, (6.3A, 250V / common), (4pts. / fuse) NQ3-6.3 SOC corp.
Weight	85g

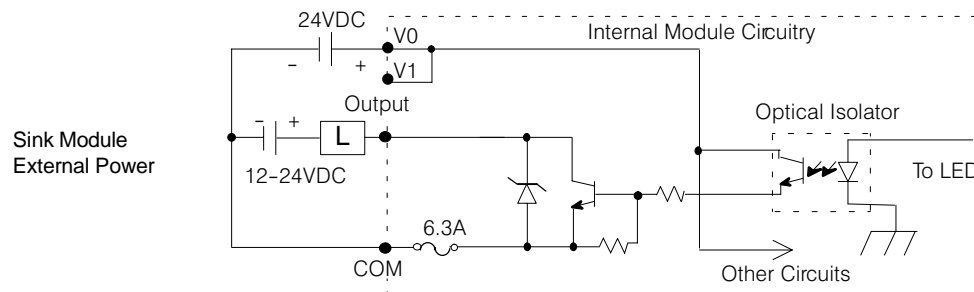
## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

# Wiring & Dimensions



## Equivalent Output Circuit



# Specifications

## T1K-08TD2-1 DC Output

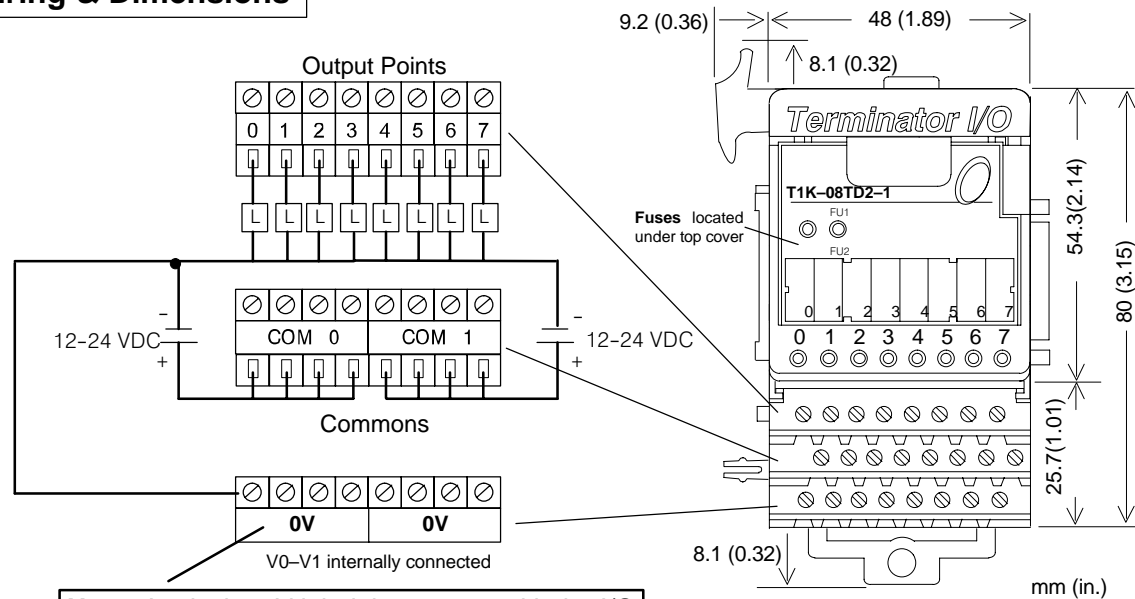
Rev A

Outputs Per Module	8 (sourcing)
Commons Per Module	2 internally connected
Operating Voltage Range	12-24 VDC
Output Voltage Range	10.8-26.4 VDC min. / max.
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15uA @ 26.4VDC
ON Voltage Drop	1.2VDC @ 1.0A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10us
ON to OFF Response	< 0.5ms
Base Power Required	100mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1/FU2 ON = fuse 1 or fuse 2 blown
Fuses (User Replaceable)	2, (6.3A, 250V / common), (4pts. / fuse) NQ3-6.3 SOC corp.
Weight	100g

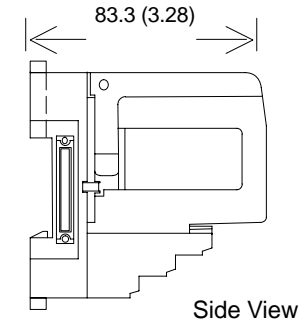
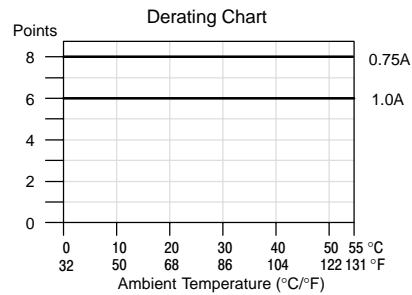
## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

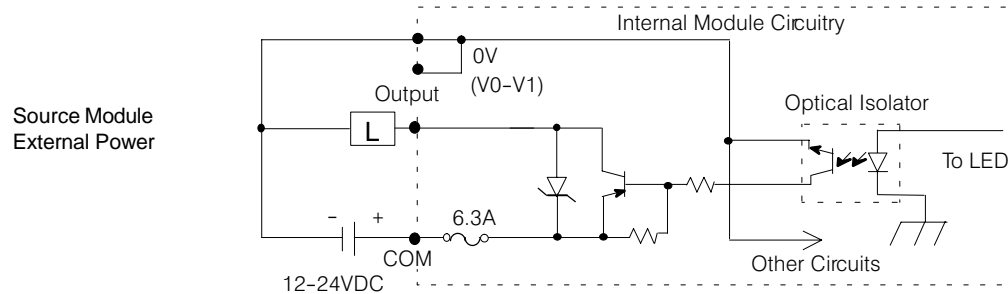
# Wiring & Dimensions



**Note:** Apply the 0V label that comes with the I/O module to I/O base terminal points V0-V1 to properly identify the 0VDC terminal points.



## Equivalent Output Circuit



## Specifications

### T1H-08TDS Isolated DC Output

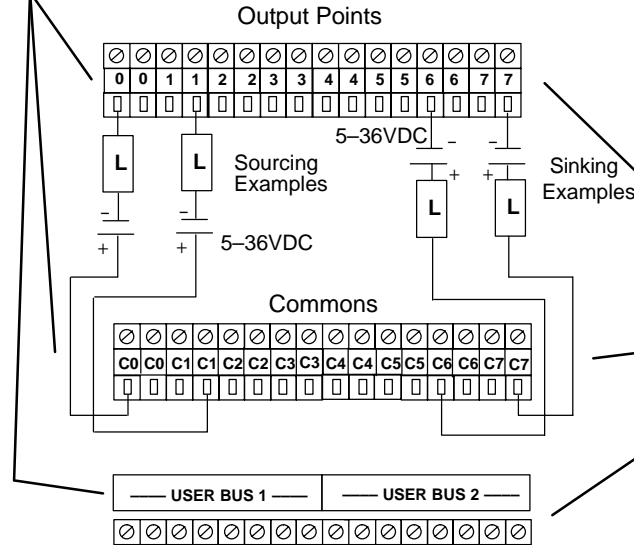
Outputs Per Module	8 (isolated, sink/source)
Commons	8 (isolated)
Operating Voltage Range	5 to 36VDC
Max. Voltage	36VDC
Output Clamp Voltage	40VDC
Max. Load Current	2A per point, 16A per module, 32 to 140°F (0 to 60°C)
Electronic Over Current Protection	Output trips at 6A min., 12A max.
Max. Load Voltage	36VDC
Max. Leakage Current	75μA
Max. ON State Voltage Drop	0.3V at 2A, 0.15V at 1A
Inrush Current	5A for 20ms
OFF to ON Response	< 3μs
ON to OFF Response	< 100μs
Base Power Required	200mA max.
Thermal Shutdown	Between T <sub>junction</sub> = 302°F to 374°F (150°C to 190°C)
Overtemperature Reset	Thermal shutdown temp. minus 5°F (15°C)
Status Indications	Logic Side
Weight	93.6g

### Environmental Specifications

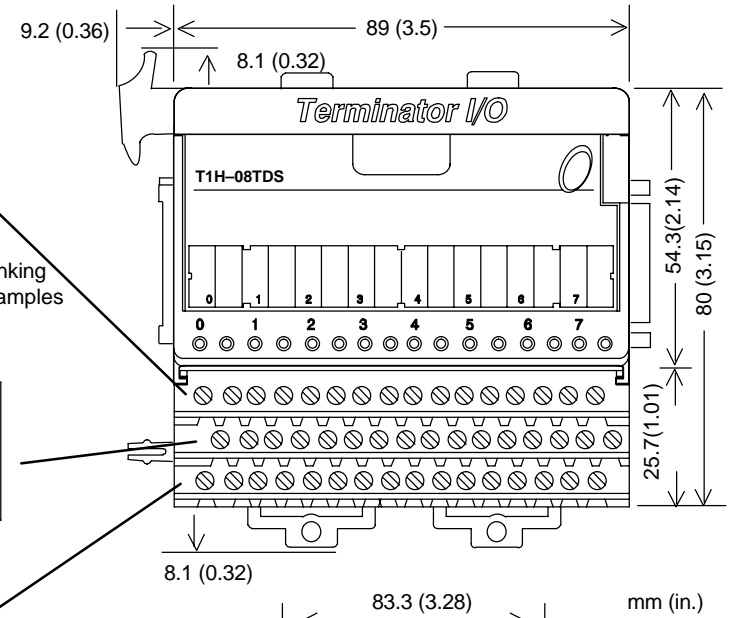
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

## Wiring & Dimensions

**Note:** Apply the labels that come with the I/O module to the I/O base to properly identify the terminal points.

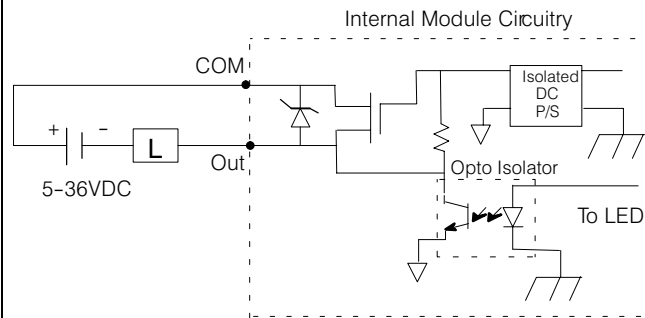


No connection: Eight User Bus 1 terminals bussed together for distribution; same for eight User Bus 2 terminals.

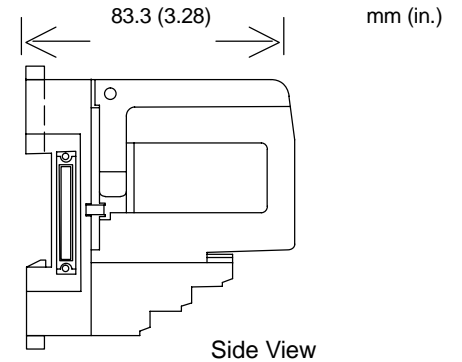
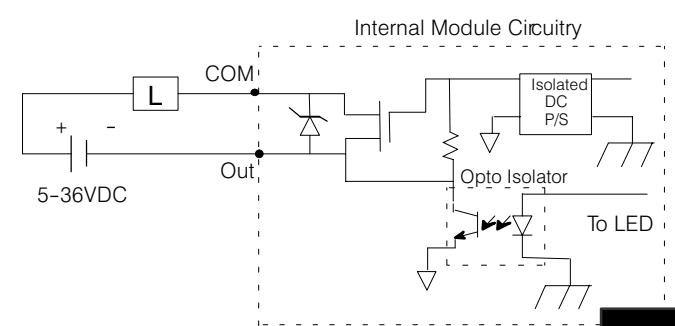


### Equivalent Output Circuit

#### Sourcing (High Side Switching)



#### Sinking (Low Side Switching)





# Specifications

## T1K-16TD1 DC Output

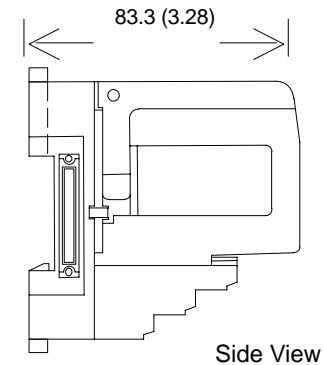
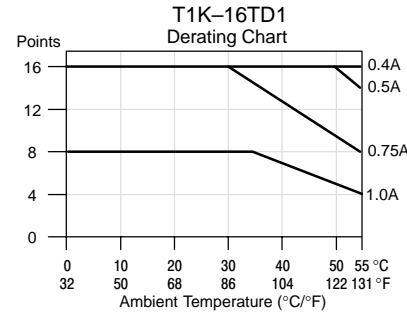
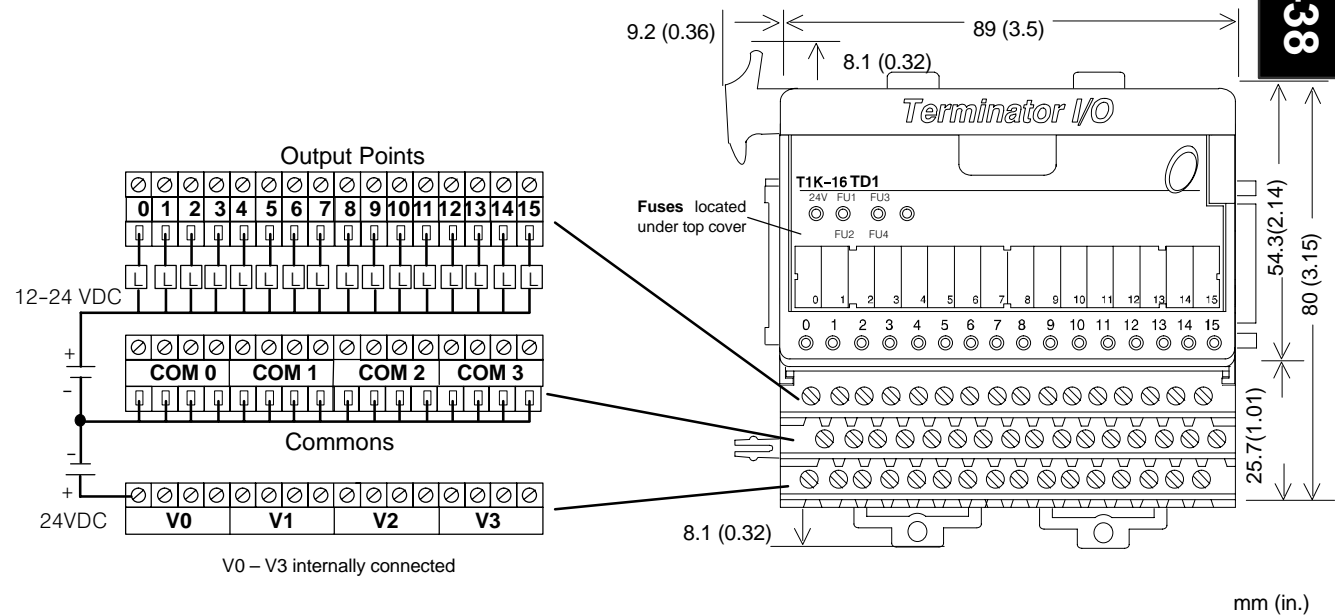
Rev A

Outputs Per Module	16 (sink)
Commons Per Module	4 internally connected
Operating Voltage Range	6-27 VDC
Output Voltage Range	5-30 VDC min. /max.
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15uA @ 30VDC
ON Voltage Drop	0.3VDC @ 1.0A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10us
ON to OFF Response	< 60us
Base Power Required	200mA @ 5VDC
External Power Required	400mA max. @ 20-28VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	24V ON = low external power FU1/FU2 ON = fuse 1 or 2 blown FU3/FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable)	4, (6.3A, 250V / common), (4 pts. / fuse) T1K-FUSE-1
Weight	140g

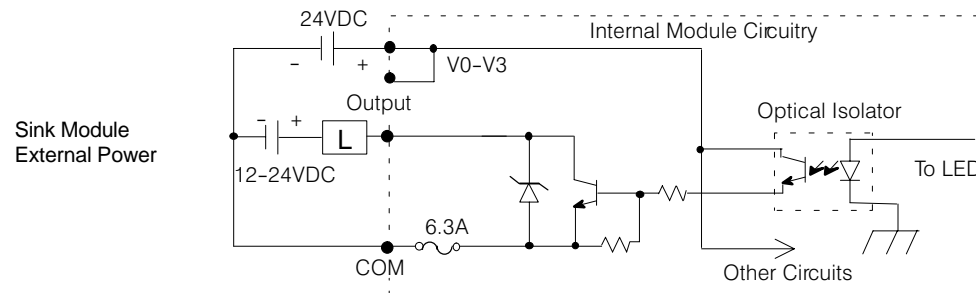
## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

# Wiring & Dimensions



## Equivalent Output Circuit



## Specifications

### T1K-16TD2-1 DC Output

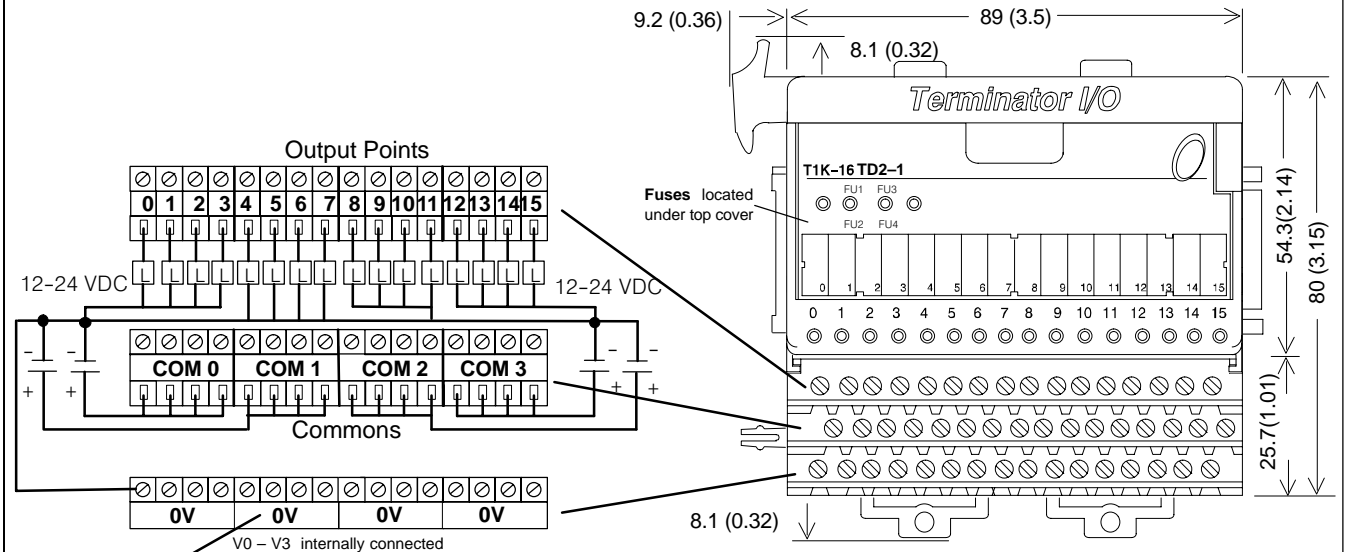
Rev A

Outputs Per Module	16 (source)
Commons Per Module	4 internally connected
Operating Voltage Range	12-24 VDC
Output Voltage Range	10.8-26.4 VDC
Peak Voltage	50 VDC
Max. Load Current	1A / pt., 4A/common (subject to derating)
Max. Leakage Current	15uA @ 26.4 VDC
ON Voltage Drop	1.2 VDC @ 1.0A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10us
ON to OFF Response	< 0.5ms
Base Power Required	200mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1/FU2 ON = fuse 1 or 2 blown FU3/FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable) T1K-FUSE-1	4, (6.3A, 250V / common), (4 pts. / fuse) NQ3-6.3 SOC corp.
Weight	140g

### Environmental Specifications

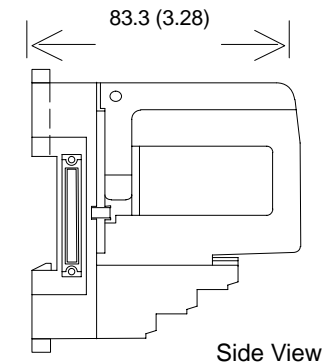
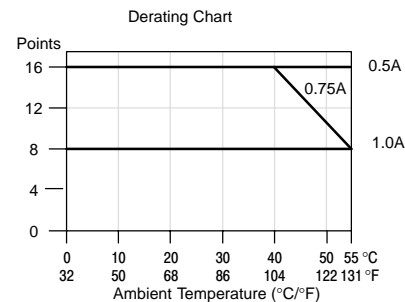
Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

## Wiring & Dimensions



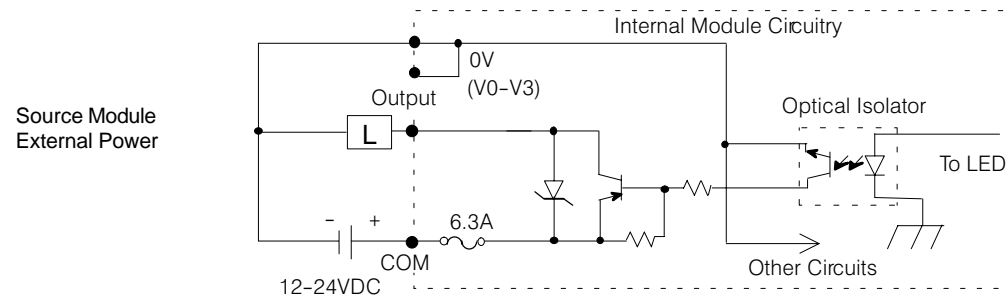
**Note:** Apply the 0V label that comes with the I/O module to I/O base terminal points V0-V3 to properly identify the 0VDC terminal points.

mm (in.)



Side View

### Equivalent Output Circuit



# Specifications

## T1K-08TA AC Output

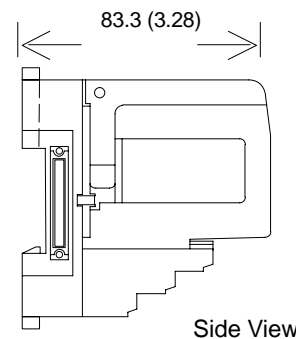
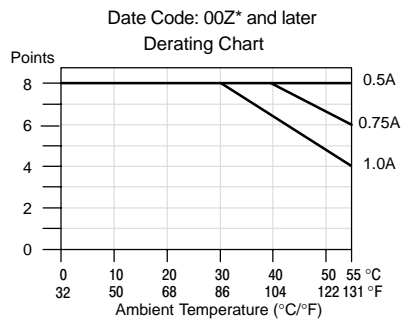
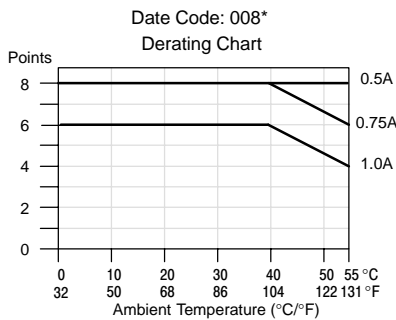
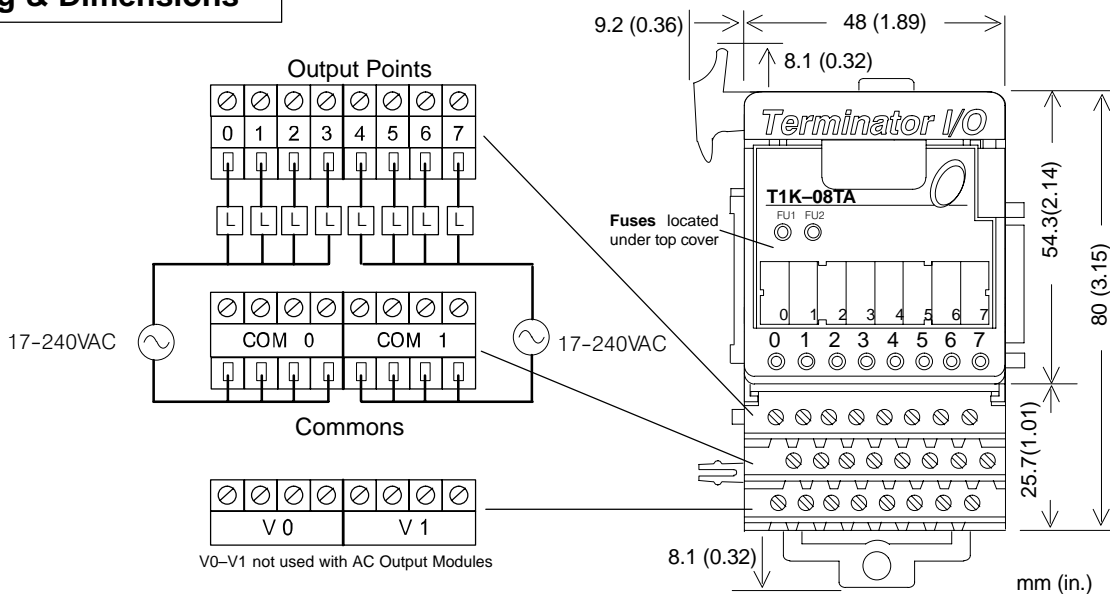
Rev B

Outputs Per Module	8
Commons Per Module	2, 4 pts. / common (isolated)
Operating Voltage Range	17-240 VAC (47-63Hz)
Output Voltage Range	15-264 VAC (47-63Hz) min. /max.
Max. Load Current	1A / pt., 4A /common(subject to derating)
ON Voltage Drop	1.5VAC @ > 50mA, 4.0VAC @ < 50mA
Max. Leakage Current	4mA @ 264 VAC
Max. Inrush Current	10A for 10ms
Min. Load	10mA
OFF to ON Response	< 1ms
ON to OFF Response	< 1ms + 1/2 cycle
Base Power Required	250mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1 ON = fuse 1 blown FU2 ON = fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-2	2, (10A, 250V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	140g

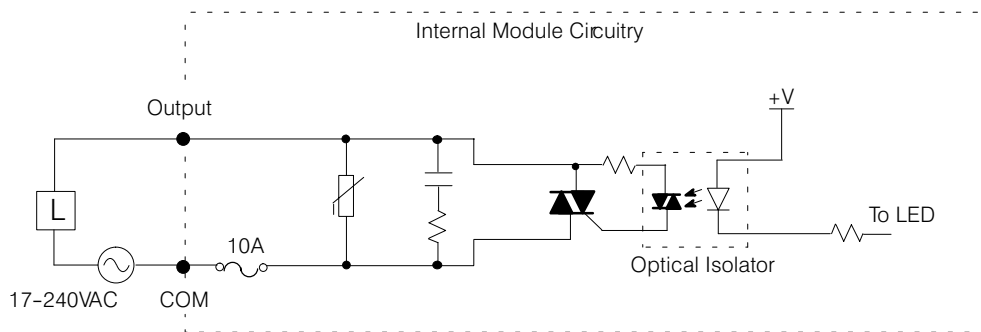
## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

# Wiring & Dimensions



## Equivalent Output Circuit



## Specifications

### T1K-16TA AC Output

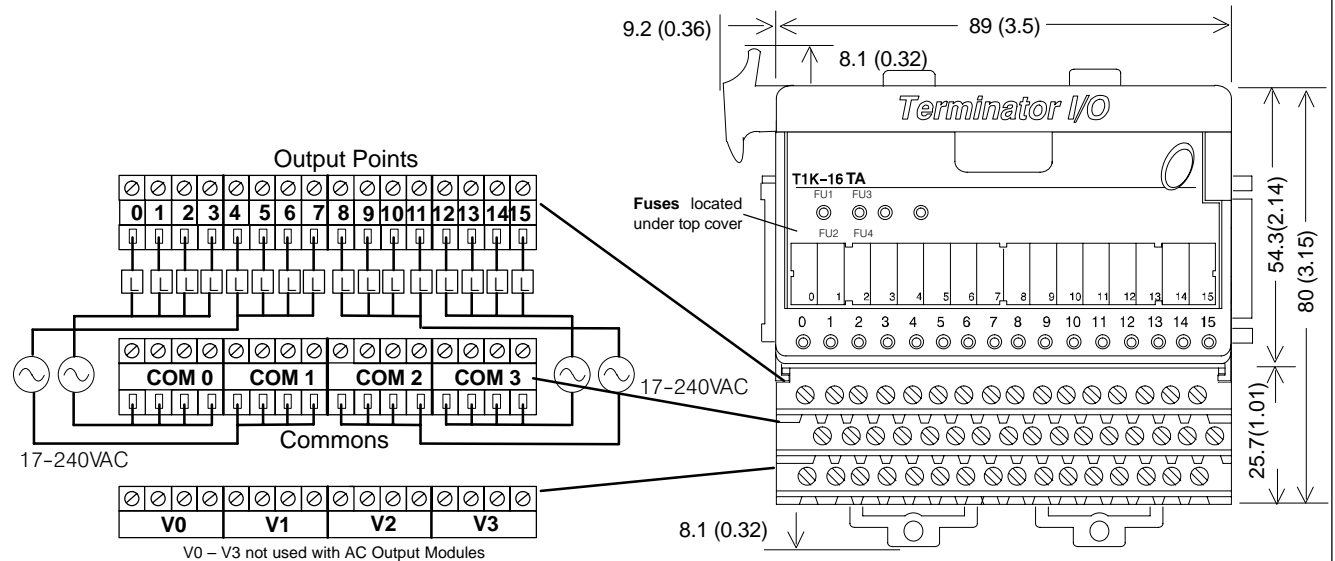
Rev B

Outputs Per Module	16
Commons Per Module	4, 4 pts. / common (isolated)
Operating Voltage Range	17-240 VAC (47-63Hz)
Output Voltage Range	15-264 VAC (47-63Hz) min. /max.
Max. Load Current	1A / pt., 4A/common (subject to derating)
ON Voltage Drop	1.5VAC @ > 50mA, 4.0VAC @ < 50mA
Max. Leakage Current	4mA @ 264 VAC
Max. Inrush Current	10A for 10ms
Min. Load	10mA
OFF to ON Response	< 1ms
ON to OFF Response	< 1ms + 1/2 cycle
Base Power Required	450mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1/FU2 ON = fuse 1 or 2 blown FU3/FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable) T1K-FUSE-2	4, (10A, 250V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	190g

### Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

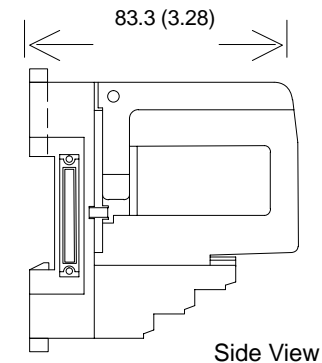
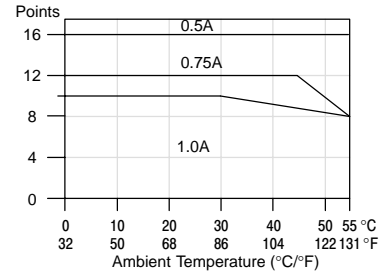
## Wiring & Dimensions



mm (in.)

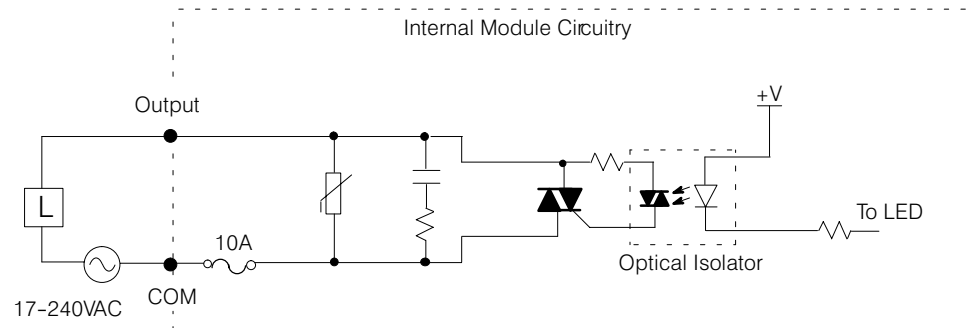
Date Code: 012\* and Later

Derating Chart



Side View

### Equivalent Output Circuit



# Specifications

## T1K-08TAS AC Output

Rev A

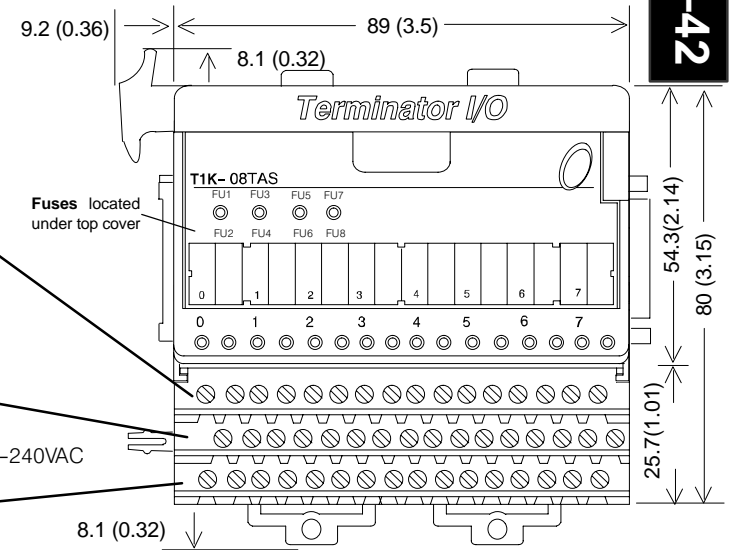
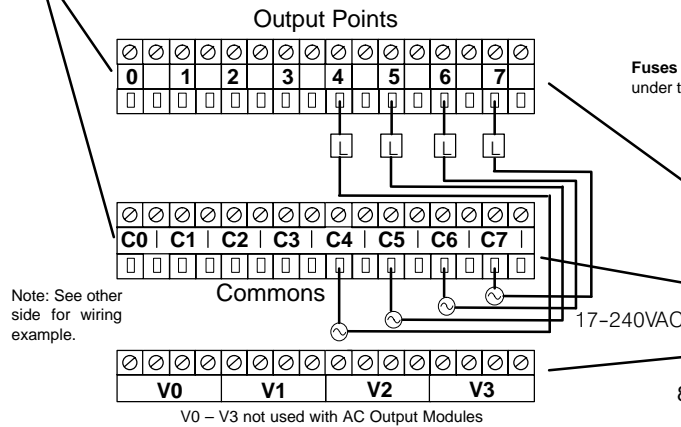
Outputs Per Module	8
Commons Per Module	8, 1 pt. / common (isolated)
Operating Voltage Range	17-240 VAC (47-63Hz)
Output Voltage Range	15-264 VAC (47-63Hz) min. /max.
Max. Load Current	2A / pt. (subject to derating)
ON Voltage Drop	1.5VAC @ > 50mA, 4.0VAC @ < 50mA
Max. Leakage Current	4mA @ 264 VAC
Max. Inrush Current	10A for 10ms
Min. Load	10mA
OFF to ON Response	< 1ms
ON to OFF Response	< 1ms + 1/2 cycle
Base Power Required	300mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1/FU2 ON = fuse 1 or 2 blown FU3/FU4 ON = fuse 3 or 4 blown FU5/FU6 ON = fuse 5 or 6 blown FU7/FU8 ON = fuse 7 or 8 blown
Fuses (User Replaceable) T1K-FUSE-3	8, (10A, 250V / common), (1 pt. / fuse) NQ3-10 SOC Corp.
Weight	190g

## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

# Wiring & Dimensions

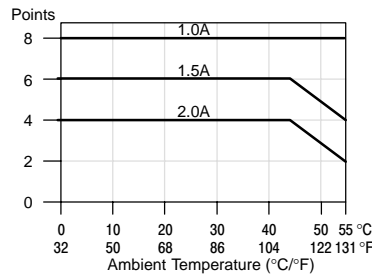
**Note:** Apply the labels that come with the I/O module to the I/O base to properly identify the terminal points.



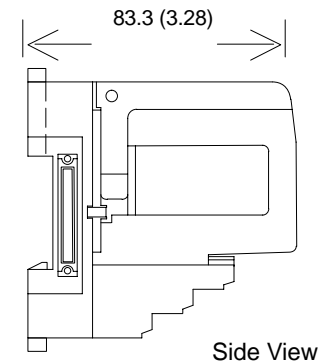
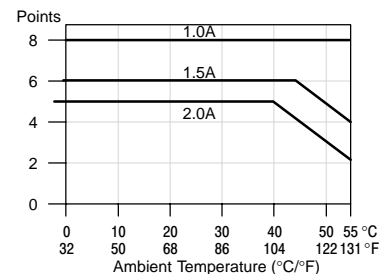
3-42

mm (in.)

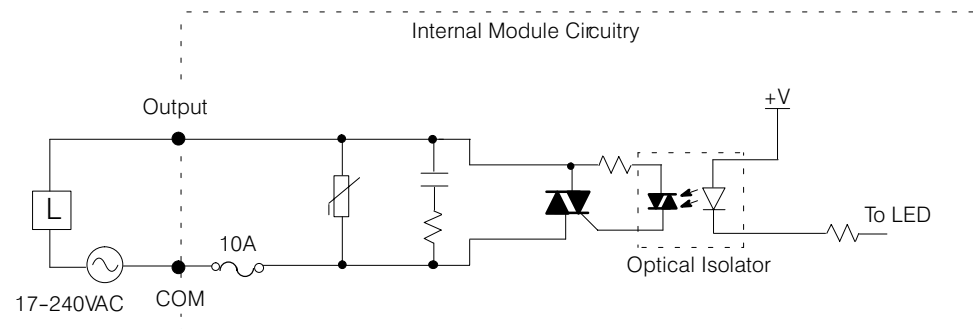
Date Code: 008\*  
Derating Chart



Date Code: 012\* and later  
Derating Chart



## Equivalent Output Circuit



# Specifications

## T1K-08TR Relay Output

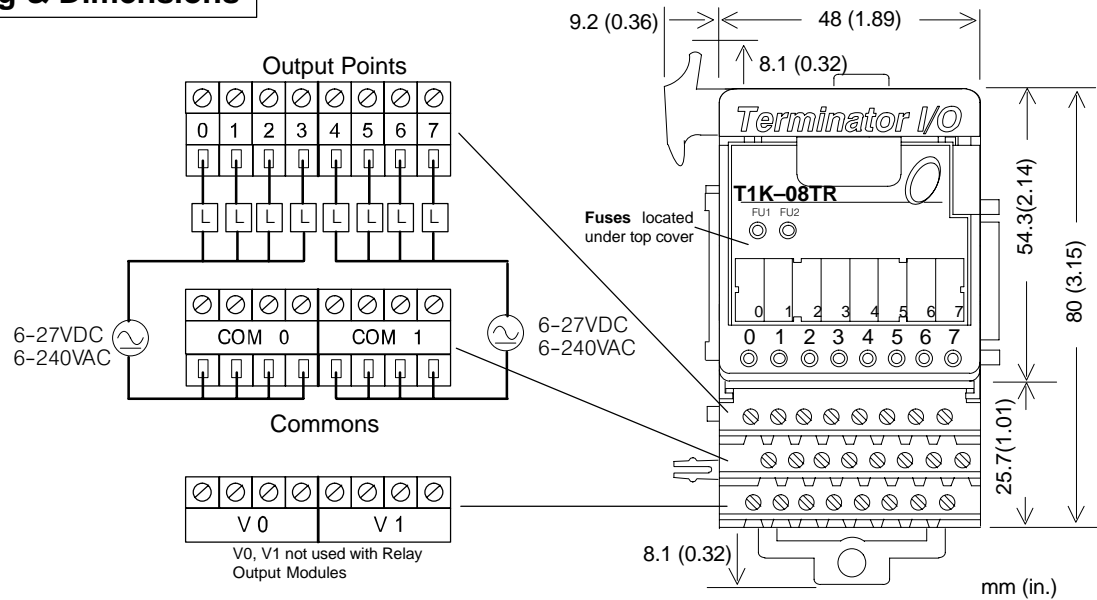
Rev A

Outputs Per Module	8
Output Type	Relay Form A (SPST) normally open
Commons Per Module	2, 4 pts. / common (isolated)
Operating Voltage Range	6-240 VAC (47-63Hz), 6-27 VDC
Output Voltage Range	5-264 VAC (47-63Hz) min. /max. 5-30 VDC min. /max.
Max. Load Current	2A / pt., 8A / common
Max. Leakage Current	0.1mA @ 264 VAC
Max. Inrush Current	6A for 10ms / pt.; 20A for 10ms / com
Min. Load	5mA @ 5VDC
OFF to ON Response	< 15ms
ON to OFF Response	< 10ms
Base Power Required	350mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1 ON = fuse 1 blown FU2 ON = fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-2	2, (10A, 250V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	110g

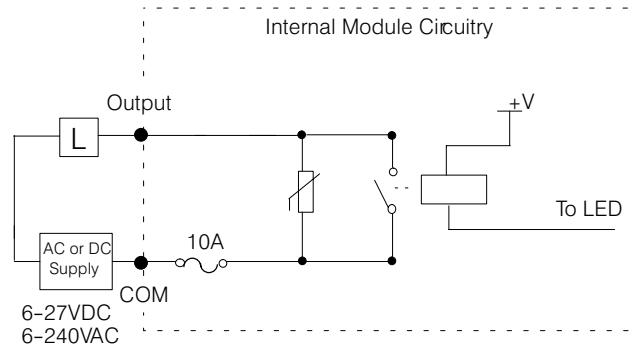
## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

# Wiring & Dimensions

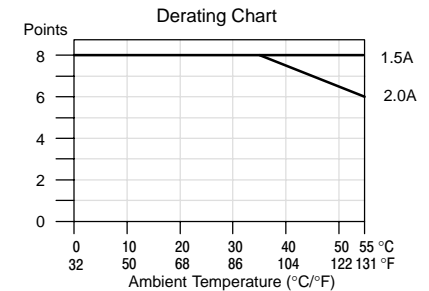
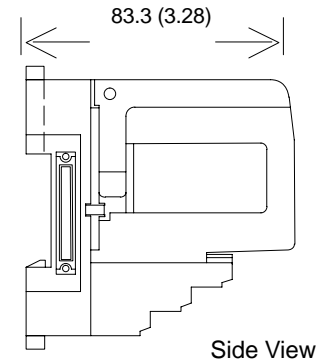


## Equivalent Output Circuit



Typical Relay Life (Operations) at Room Temperature

Voltage & Type of Load	Load Current	
	1A	2A
24 VDC Resistive	500K	250K
24 VDC Solenoid	100K	50K
110 VAC Resistive	500K	250K
110 VAC Solenoid	200K	100K
220 VAC Resistive	350K	200K
220 VAC Solenoid	100K	50K



# Specifications

## T1K-16TR Relay Output

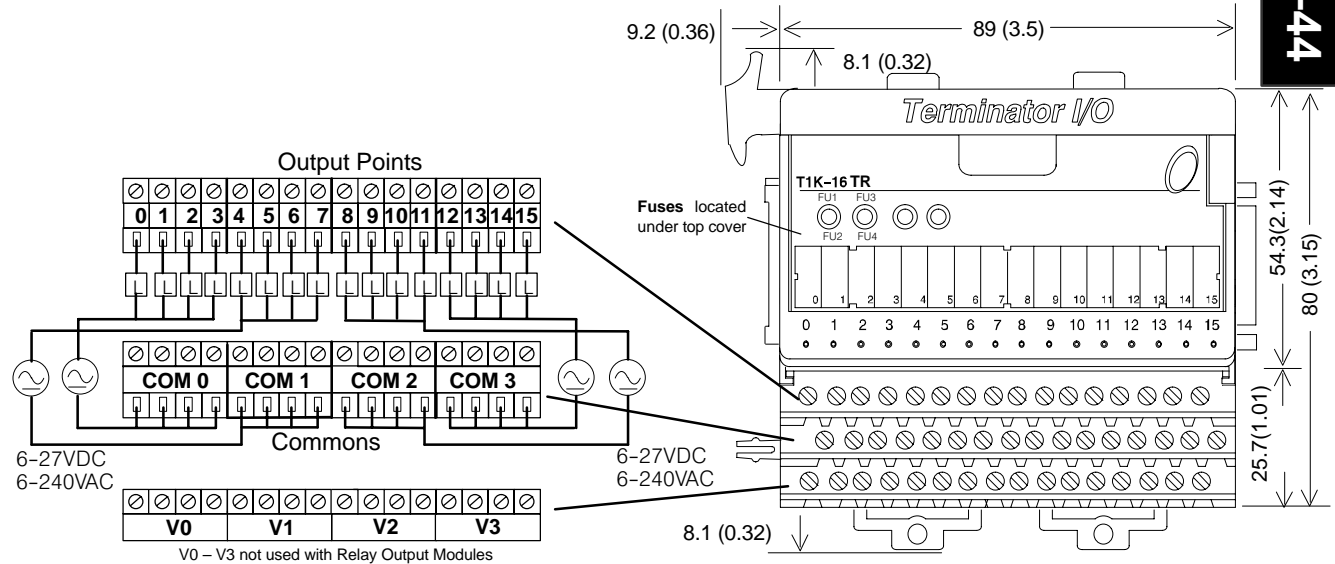
Rev C

Outputs Per Module	16
Output Type	Relay Form A (SPST) normally open
Commons Per Module	4, 4 pts. / common (isolated)
Operating Voltage Range	6-240 VAC, 6-27 VDC
Output Voltage Range	5-264 VAC (47-63Hz) min. / max. 5-30 VDC min. / max.
Max. Load Current	2A / pt., 6A / common (subject to derating)
Max. Leakage Current	0.1mA @ 264 VAC
Max. Inrush Current	6A for 10ms / pt.; 20A for 10ms / com
Min. Load	5mA @ 5VDC
OFF to ON Response	< 15ms
ON to OFF Response	< 10ms
Base Power Required	700mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1/ FU2 ON = fuse 1 or 2 blown FU3/ FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable) T1K-FUSE-2	4, (10A, 250V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	200g

## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

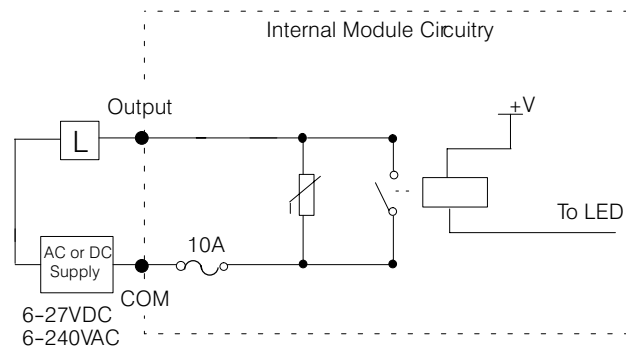
# Wiring & Dimensions



3-44

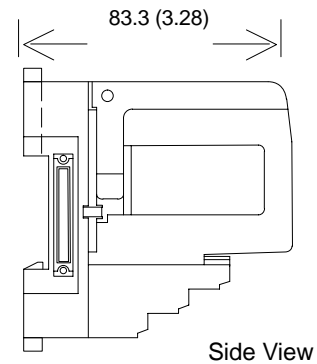
mm (in.)

## Equivalent Output Circuit

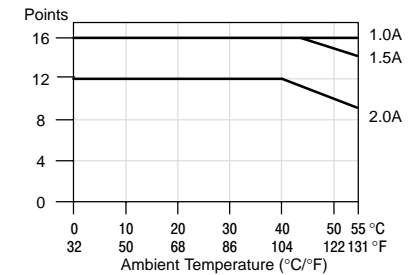


Typical Relay Life (Operations) at Room Temperature

Voltage & Type of Load	Load Current	
	1A	2A
24 VDC Resistive	500K	250K
24 VDC Solenoid	100K	50K
110 VAC Resistive	500K	250K
110 VAC Solenoid	200K	100K
220 VAC Resistive	350K	200K
220 VAC Solenoid	100K	50K



Date Code: 012\* and later  
Derating Chart



# Specifications

## T1K-08TRS Relay Output

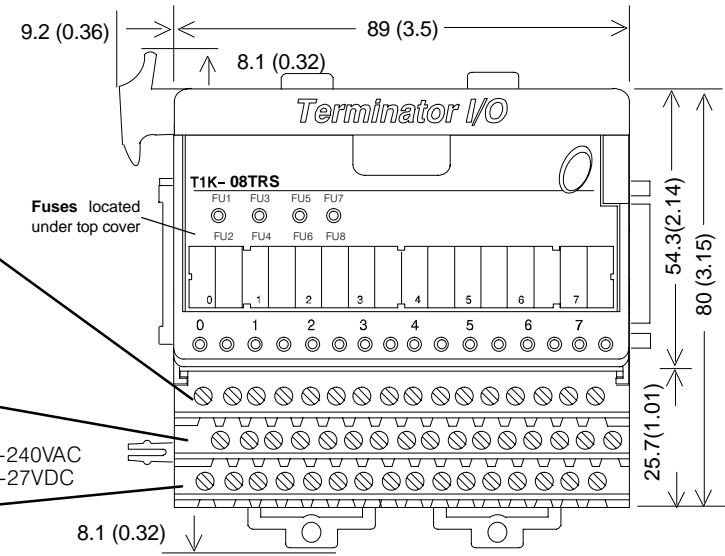
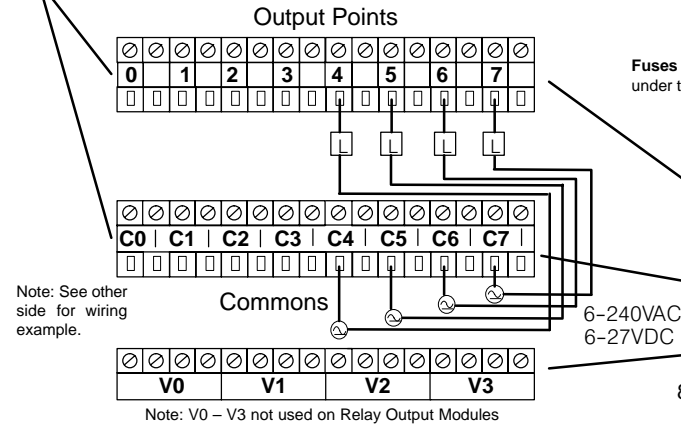
Outputs Per Module	8
Output Type	Relay Form A (SPST) normally open
Commons Per Module	8, 1 pt. / common (isolated)
Operating Voltage Range	6-240 VAC (47-63Hz), 6-27 VDC
Output Voltage Range	5-264 VAC (47-63Hz) min. / max. 5-30 VDC min. / max.
Max. Load Current	7A / pt. (subject to derating)
Max. Leakage Current	0.1mA @ 264 VAC
Max. Inrush Current	8A for 10ms
Min. Load	5mA @ 5VDC
OFF to ON Response	< 15ms
ON to OFF Response	< 10ms
Base Power Required	400mA @ 5VDC
Status Indicators	Logic Side
Error Status Indications (LEDS)	FU1/ FU2 ON = fuse 1 or 2 blown FU3/ FU4 ON = fuse 3 or 4 blown FU5/ FU6 ON = fuse 5 or 6 blown FU7/ FU8 ON = fuse 7 or 8 blown
Fuses (User Replaceable) T1K-FUSE-3	8, (10A, 250V / common), (1 pt. / fuse) NQ3-10 SOC Corp.
Weight	185g

## Environmental Specifications

Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3-304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

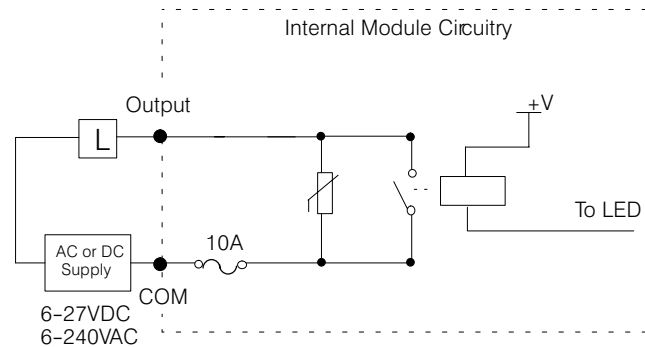
# Wiring & Dimensions

**Note:** Apply the labels that come with the I/O module to the I/O base to properly identify the terminal points.



mm (in.)

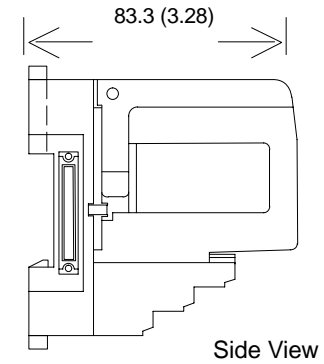
## Equivalent Output Circuit



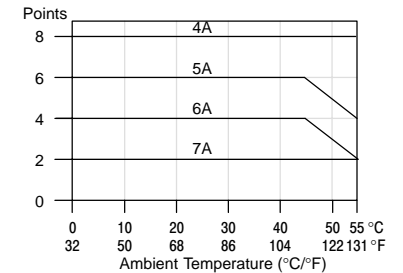
Typical Relay Life (Operations) at Room Temperature

Voltage & Type of Load	Load Current			
	1A	2A	5A	7A
24 VDC Resistive	1000K	500K	200K	100K
24 VDC Solenoid	300K	100K	**	**
110 VAC Resistive	1000K	500K	200K	100K
110 VAC Solenoid	300K	100K	**	**
220 VAC Resistive	500K	250K	125K	60K
220 VAC Solenoid	300K	100K	**	**

\*\* Solenoid (inductive) loads > 2A cannot be used.



Derating Chart





# Specifications

Rev B

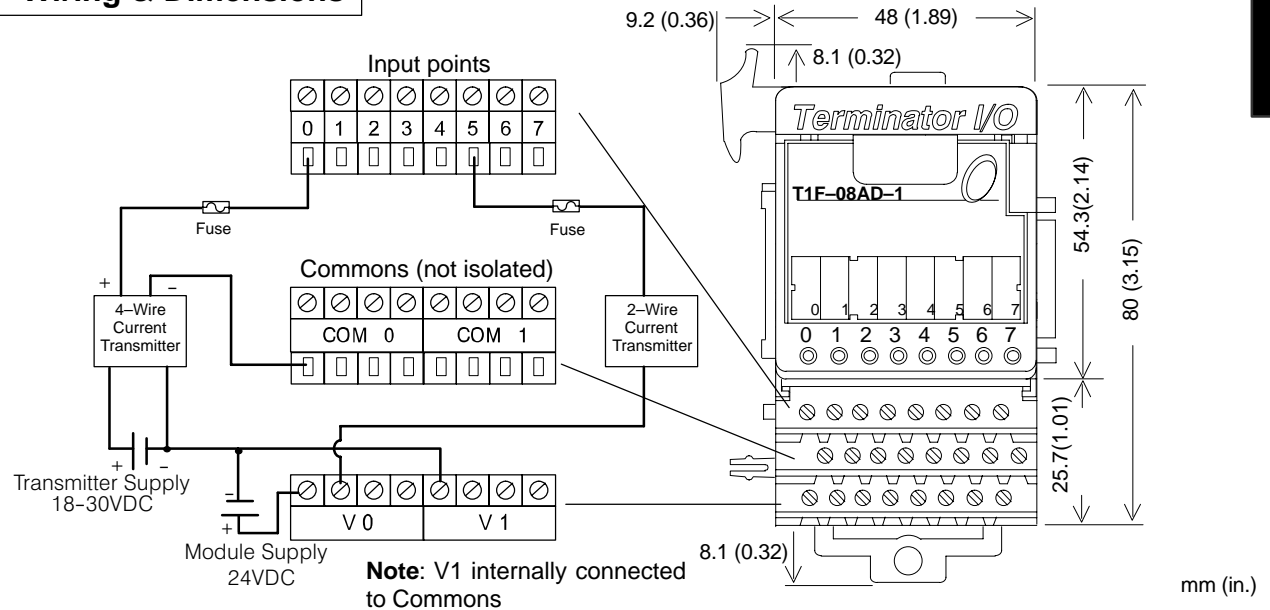
## T1F-08AD-1 8 Channel Current Analog Input

Number of Channels	8, single ended (1 common)
Input Ranges	0–20mA, 4–20mA, –20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	–3db @ 500Hz, –20db/decade
Input Resistance	250 ohm
Absolute Max. Ratings	8V max. input
Conversion Time (Default: Normal Mode)	Normal Mode: 5ms per channel *Fast Mode: 0.5ms per channel
Linearity Error	+ / – 2 count max.
Input Stability	+ / – 1 count
Full Scale Error (Offset Error not included)	16 counts max.
Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale) all errors included	0.18% @ 25°C 0.36% @ 60°C
Master Update Rate	8 channels per scan max.
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	18–30 VDC, 50mA, class 2
Recommended Fuse	0.032A, Series 217 Fast Acting
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	–20 to 70°C (–4 to 158°F)
Accuracy vs. Temperature	+ / – 50 ppm / °C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304
Weight	136g

### Input Range Resolution:

–20 to 20mA	–8192 to 8191 counts
0 – 20mA	0 – 8191 counts
4 – 20mA	1638 – 8191 counts

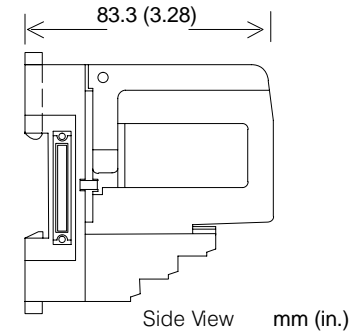
# Wiring & Dimensions



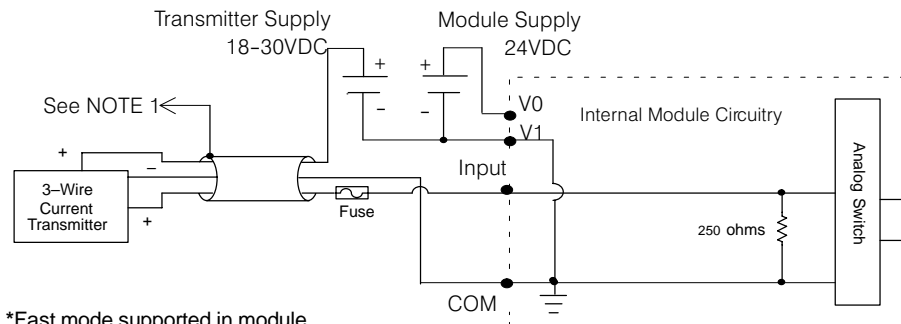
**Note:** V1 internally connected to Commons

### NOTES:

- 1: Shields should be grounded at the signal source.
- 2: More than one external power supply can be used, provided all the power supply commons are connected.
- 3: A Series 217, 0.032A fast-acting fuse is recommended for 4–20 mA current loops.
- 4: If the power supply common of an external power supply is not connected to the 0V terminal on the module, then the output of the external transmitter must be isolated. To avoid “ground loop” errors, recommended 4–20 mA transmitter types are:  
–For 2 or 3 wire connections: Isolation between the input supply signal and the power supply.  
–For 4 wire connections: Isolation between the input supply signal, the power supply and the 4–20mA output.

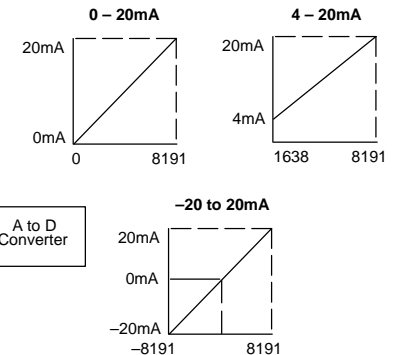


### Equivalent Input Circuit



\*Fast mode supported in module hardware version B or later.

### Input Signal Ranges



# Specifications

Rev B

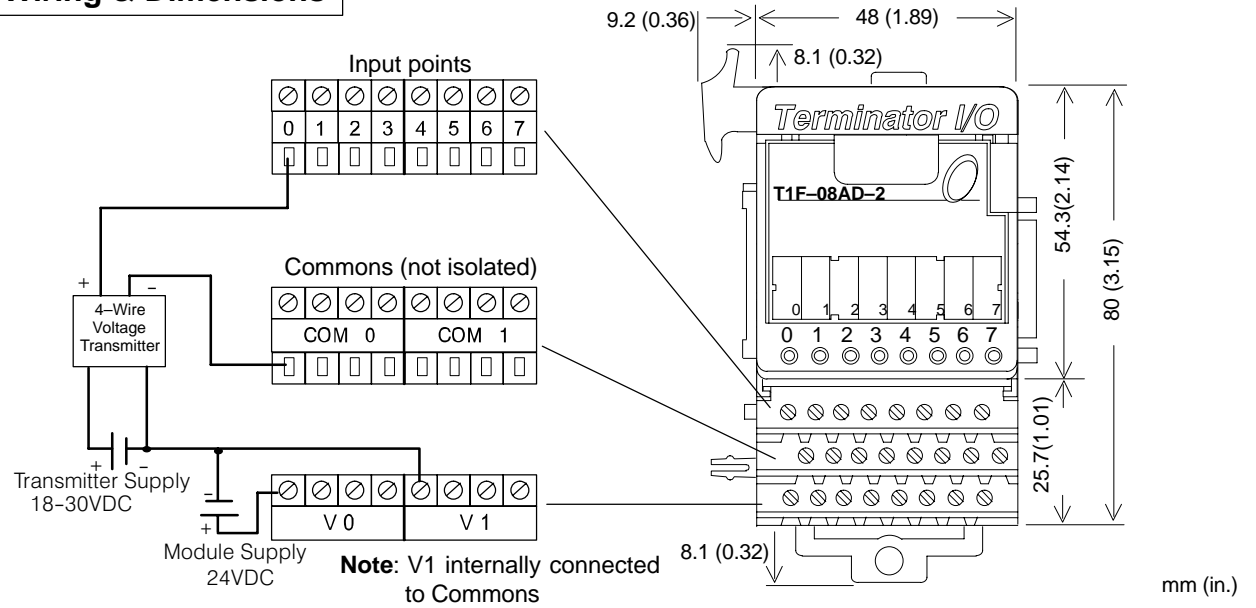
## T1F-08AD-2 8 Channel Voltage Analog Input

Number of Channels	8, single ended (1 common)
Input Ranges	0-5V, 0-10V, +/- 5V, +/- 10V
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	-3db @ 500Hz, -20db/decade
Input Resistance	200K ohm min.
Absolute Max. Ratings	Fault Protected Input 130V(rms) or 100VDC
Conversion Time (Default: Normal Mode)	Normal Mode: 5ms per channel *Fast Mode: 0.5ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Calibration Full Scale Error	8 counts max.
Calibration Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.08% @ 25°C 0.26% @ 60°C
Master Update Rate	8 channels per scan max.
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	18-30 VDC, 50mA, class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	+ / - 50 ppm / °C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
weight	136g

### Input Range Resolution:

0 - 5V	0 - 4095 counts
0 - 10V	0 - 8191 counts
+ / - 5V	-4095 to 4095 counts
+ / - 10V	-8192 to 8191 counts

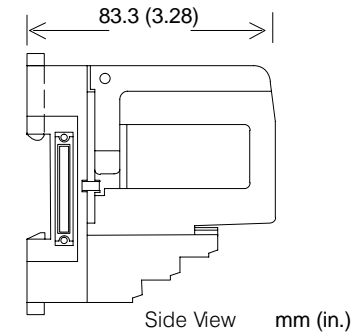
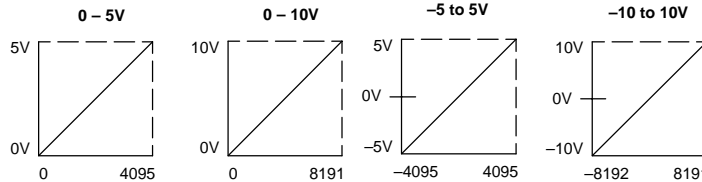
# Wiring & Dimensions



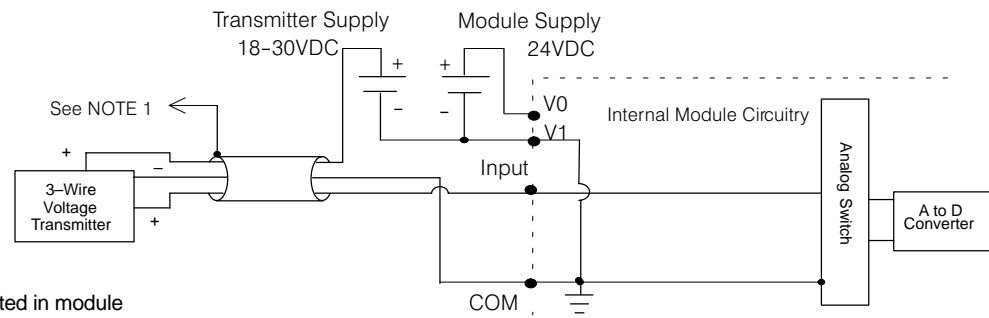
### NOTES:

- 1: Shields should be grounded at the signal source.
- 2: Unused inputs should be connected to Common (0VDC).
- 3: More than one external power supply can be used, provided all the power supply commons are connected.

### Input Signal Ranges



### Equivalent Input Circuit



\*Fast mode supported in module hardware version B or later.

# Specifications

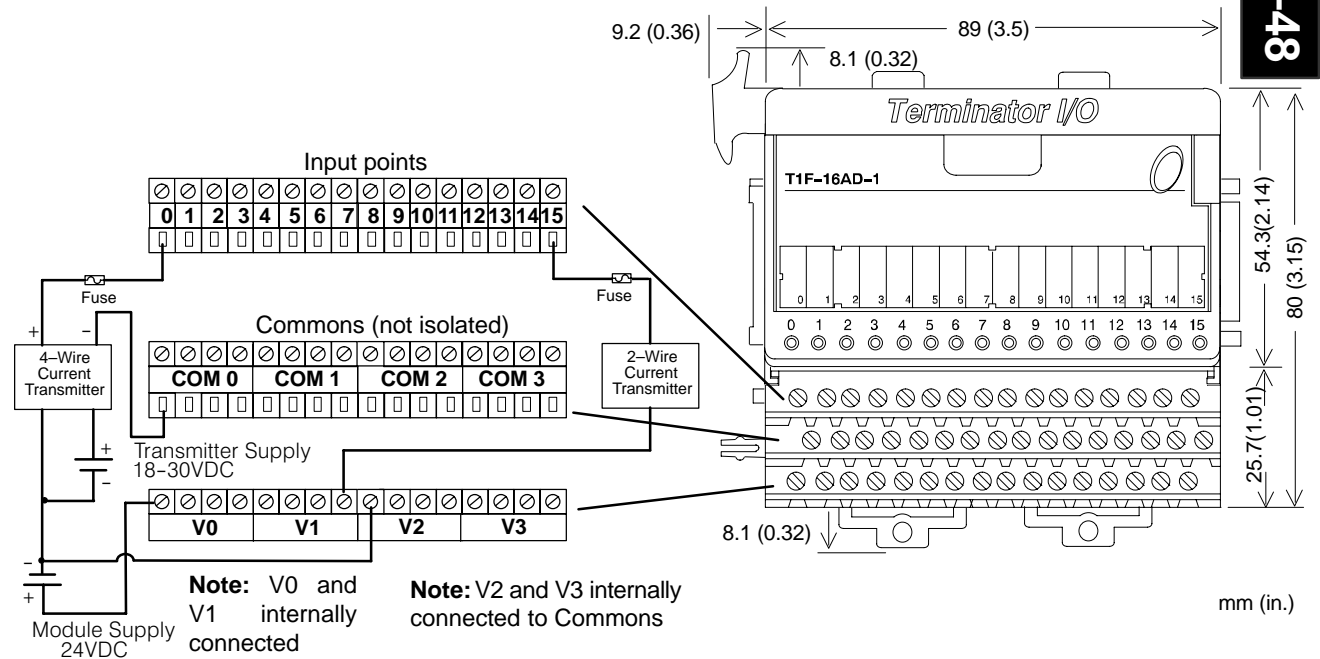
## T1F-16AD-1 16 Channel Current Analog Input

Number of Channels	16, single ended (1 common)
Input Ranges	0-20mA, 4-20mA, -20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	-3db @ 500Hz, -20db/decade
Input Resistance	250 ohm
Absolute Max. Ratings	8V max. input
Conversion Time	5ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Full Scale Error (Offset Error not included)	16 counts max.
Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale) all errors included	0.18% @ 25°C , 0.36% @ 60°C
Master Update Rate	16 channels per scan max.
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	18-30 VDC, 50mA, class 2
Recommended Fuse	0.032A, Series 217 Fast Acting
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	+ / - 50 ppm / °C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	168g

### Input Range Resolution:

-20 to 20mA	-8192 to 8191 counts
0 - 20mA	0 - 8191 counts
4 - 20mA	1638 - 8191 counts

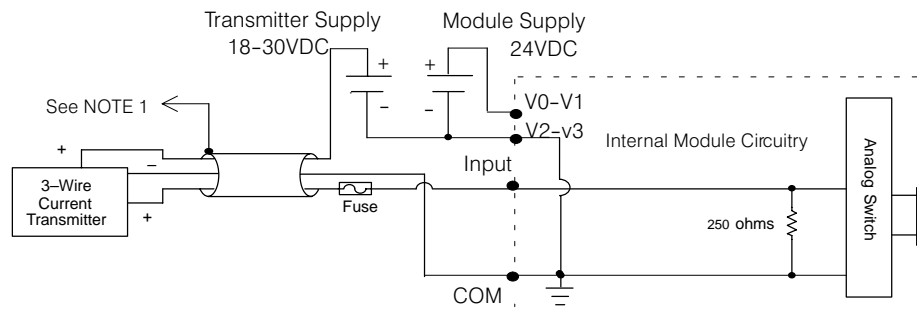
# Wiring & Dimensions



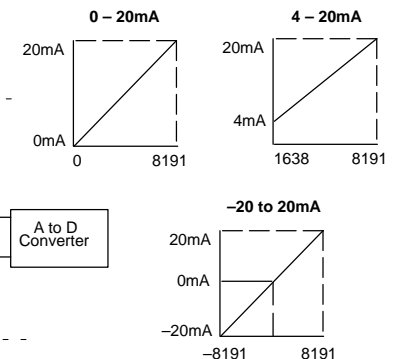
### NOTES:

- 1: Shields should be grounded at the signal source.
- 2: More than one external power supply can be used, provided all the power supply commons are connected.
- 3: A Series 217, 0.032A fast-acting fuse is recommended for 4-20 mA current loops.
- 4: If the power supply common of an external power supply is not connected to the 0V terminal on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4-20 mA transmitter types are:
  - For 2 or 3 wire connections: Isolation between the input supply signal and the power supply.
  - For 4 wire connections: Isolation between the input supply signal, the power supply and the 4-20mA output.

### Equivalent Input Circuit



### Input Signal Ranges



## Specifications

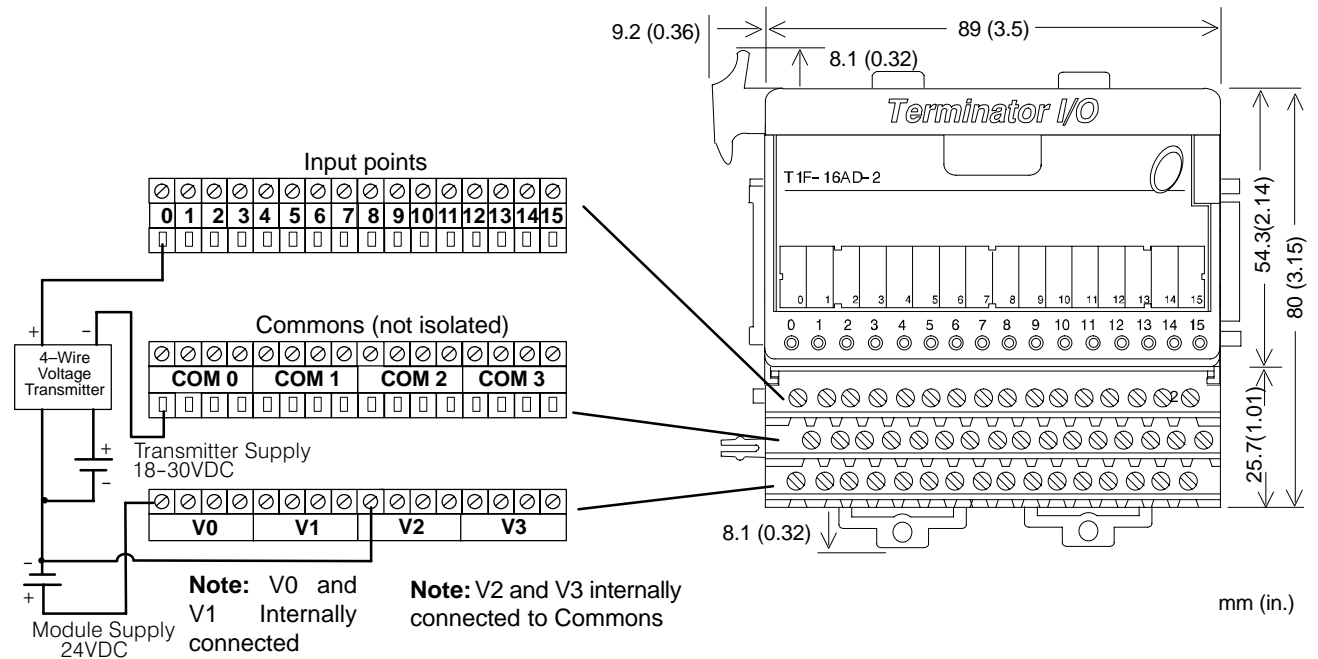
### T1F-16AD-2 16 Channel Voltage Analog Input

Number of Channels	16, single ended (1 common)
Input Ranges	0-5V, 0-10V, +/- 5V, +/- 10V
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	-3db @ 500Hz, -20db/decade
Input Resistance	200K ohm min.
Absolute Max. Ratings	Fault Protected Input 130V(rms) or 100VDC
Conversion Time	5ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Calibration Full Scale Error	8 counts max.
Calibration Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.08% @ 25°C 0.26% @ 60°C
Master Update Rate	16 channels per scan max.
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	18-30VDC, 50mA, class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	+ / - 50 ppm / °C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	168g

#### Input Range Resolution:

0 - 5V	0 - 4095 counts
0 - 10V	0 - 8191 counts
+ / - 5V	-4095 to 4095 counts
+ / - 10V	-8192 to 8191 counts

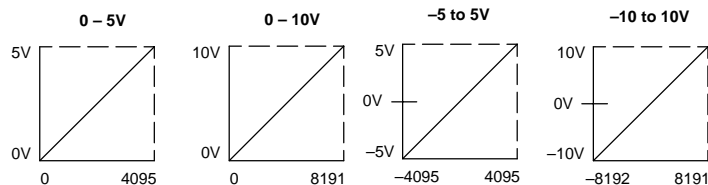
## Wiring & Dimensions



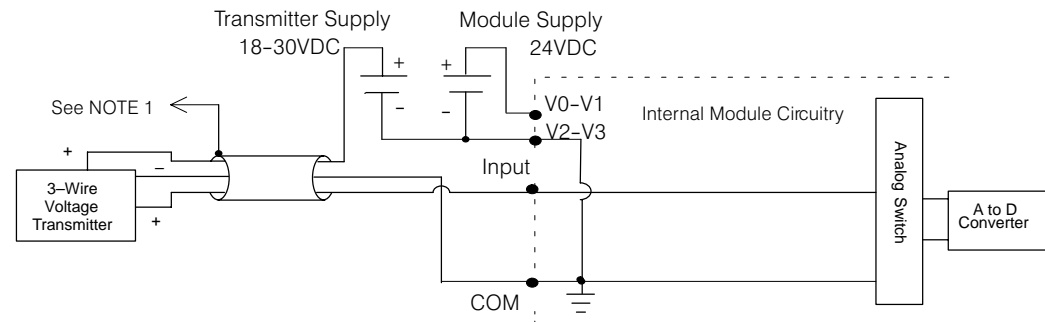
#### NOTES:

- 1: Shields should be grounded at the signal source.
- 2: Unused inputs should be connected to Common (0VDC).
- 3: More than one external power supply can be used, provided all the power supply commons are connected.

#### Input Signal Ranges



#### Equivalent Input Circuit



# Specifications

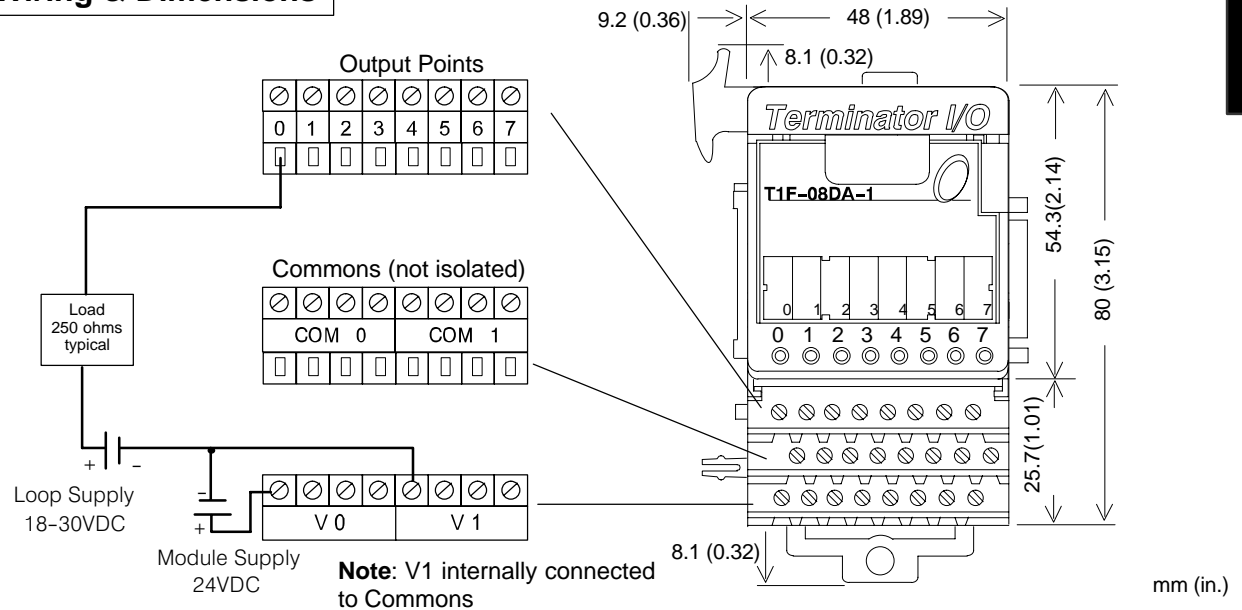
## T1F-08DA-1 8 Channel Current Analog Output

Rev B

Number of Channels	8
Output Ranges	0–20mA, 4–20mA
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Max. Loop Supply	30 VDC
Peak Output Voltage	30 VDC
Max. Load (Ohm) / Power Supply	620/18V, 910/24V, 1200/30V
Min. Load (ohm) / Power Supply**	0/24V, 350/30V @ 40°C 250/24V, 600/30V @ 60°C
Linearity Error (end to end)	+ / - 2 count max. + / - 0.050% of full scale max
Conversion Settling Time	400us max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	0 – 20mA: + / - 5 counts max. 4 – 20mA: + / - 6 counts max.
Accuracy vs. Temperature	+ / - 50 ppm/°C full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors included	0.2% @ 25°C , 0.4% @ 60°C
Master Update Rate	8 channels per scan max.
Output Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	21.6–26.4VDC, 150mA class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	145g

\*\*max. allowable output power dissipation. For example, at 60°C and 24VDC, there must be a load of at least 250 ohms on the output circuit. Smaller loads will damage the analog output circuit.

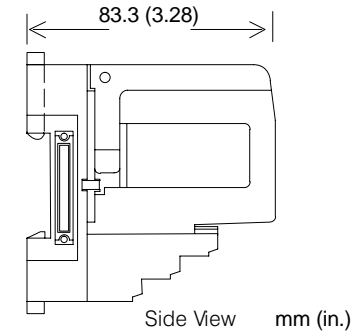
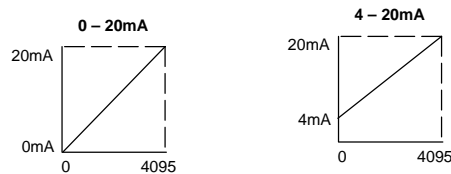
# Wiring & Dimensions



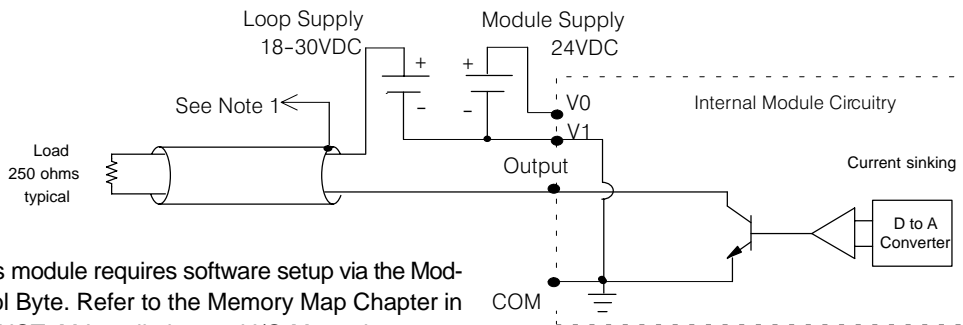
### NOTES:

- 1: Shields should be connected to the 0V terminal of the module or the 0V of the power supply.
- 2: Unused current outputs should remain open (no connections) for minimum power consumption.

### Output Signal Ranges



### Equivalent Output Circuit



**Note:** This module requires software setup via the Module Control Byte. Refer to the Memory Map Chapter in the T1K-INST-M Installation and I/O Manual.

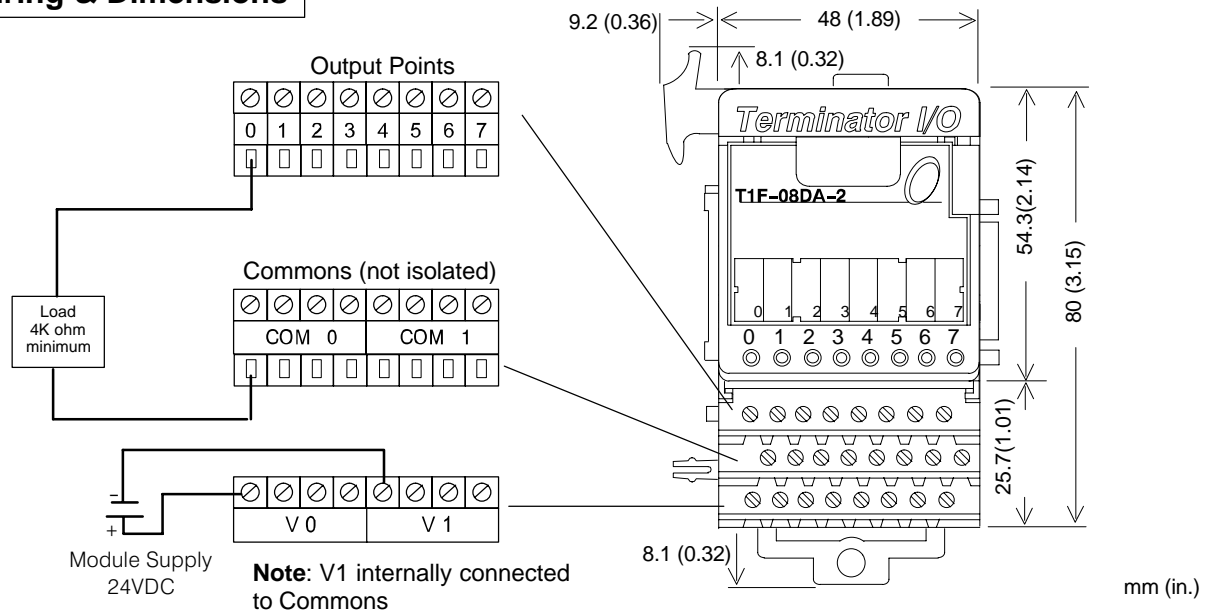
## Specifications

### T1F-08DA-2 8 Channel Voltage Analog Output Rev B

Number of Channels	8
Output Ranges	0-5V, 0-10V, +/- 5V, +/- 10V
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15 VDC
Load Impedance	4K ohm min.
Load Capacitance	0.01uF max.
Linearity Error (end to end)	+ / - 2 count max. + / - 0.050% of full scale max
Conversion Settling Time	100us max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	10V ranges: + / - 6 counts max 5V ranges: + / - 11 counts max
Accuracy vs. Temperature	+ / - 50 ppm/°C full scale calibration change
Max. Full Scale Inaccuracy (% of full scale); all errors and temp drift included	10V ranges: + / - 0.2% @ 25°C + / - 0.4% @ 60°C 5V ranges: + / - 0.3% @ 25°C + / - 0.5% @ 60°C
Master Update Rate	8 channels per scan max.
Output Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	21.6-26.4VDC, 150mA class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	145g

**Note:** This module requires software setup via the Module Control Byte. Refer to the Memory Map Chapter in the T1K-INST-M Installation and I/O Manual.

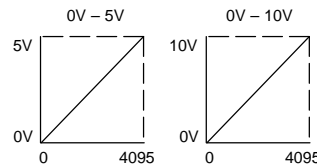
## Wiring & Dimensions



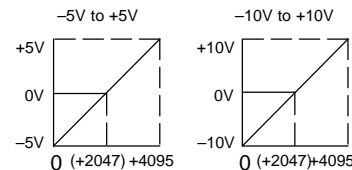
### NOTES:

- 1: Shields should be connected to the 0V terminal of the module or the 0V terminal of the power supply.
- 2: Unused voltage outputs should remain open (no connections) for minimum power consumption.

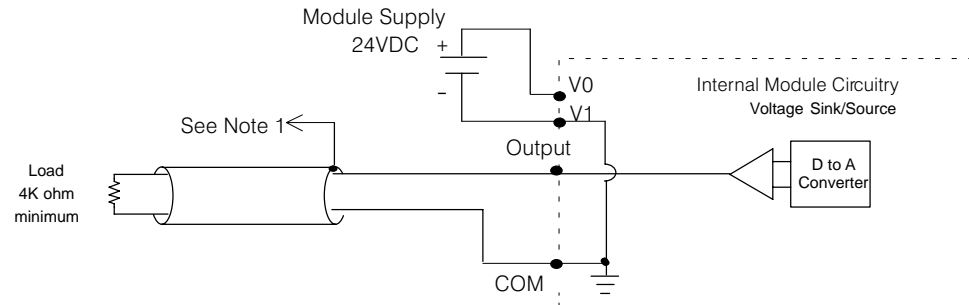
### Unipolar Ranges



### Bipolar Ranges



### Equivalent Output Circuit



# Specifications

## T1F-16DA-1 16 Channel Current Analog Output

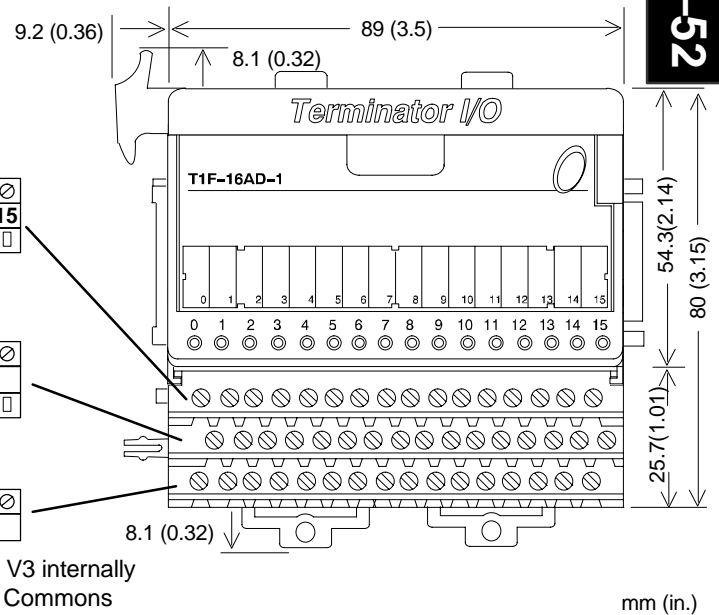
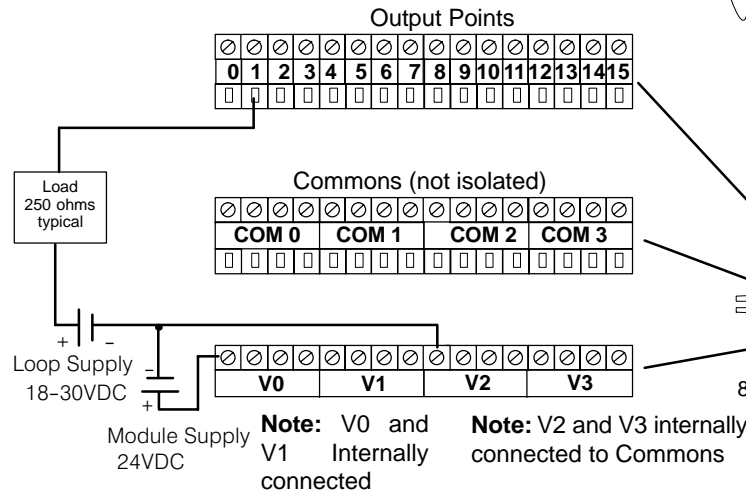
Rev B

Number of Channels	16
Output Ranges	0–20mA, 4–20mA
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Max. Loop Supply	30 VDC
Peak Output Voltage	30 VDC
Max. Load (ohm) / Power Supply	620/18V, 910/24V, 1200/30V
Min. Load (ohm) / Power Supply**	0/24V, 350/30V @ 40°C 250/24V, 600/30V @ 60°C
Linearity Error (end to end)	+ / - 2 count max. + / - 0.050% of full scale max
Conversion Settling Time	400us max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	0 – 20mA: + / - 5 counts max. 4 – 20mA: + / - 6 counts max.
Accuracy vs. Temperature	+ / - 50 ppm/°C full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors included	0.2% @ 25°C, 0.4% @ 60°C
Master Update Rate	16 channels per scan max.
Output Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	21.6–26.4VDC, 150mA class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	172g

\*\*max. allowable output power dissipation. For example, at 60°C and 24VDC, there must be a load of at least 250 ohms on the output circuit. Smaller loads will damage the analog output circuit.

# Wiring & Dimensions

**Note:** This module requires software setup via the Module Control Byte. Refer to the Memory Map Chapter in the T1K-INST-M Installation and I/O Manual.



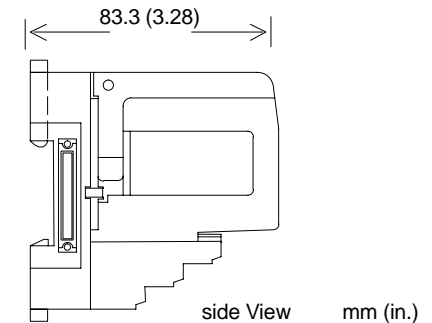
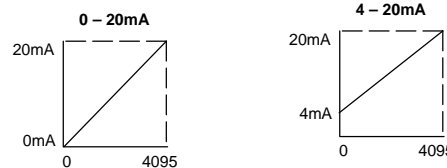
3-52

mm (in.)

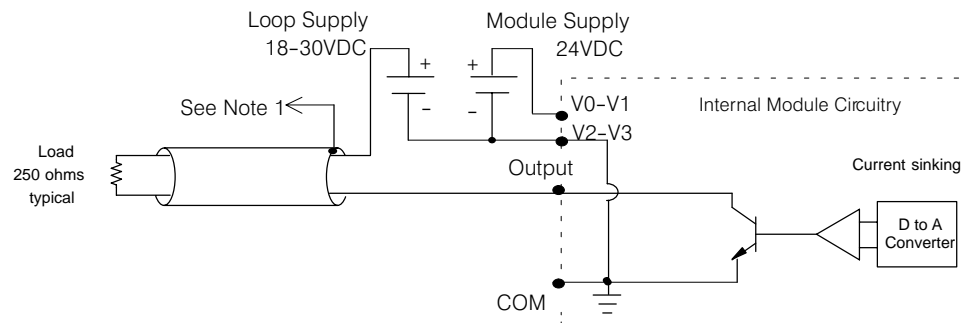
### NOTES:

- 1: Shields should be connected to the 0V terminal of the module or the 0V of the power supply.
- 2: Unused current outputs should remain open (no connections) for minimum power consumption.

### Output Signal Ranges



### Equivalent Output Circuit



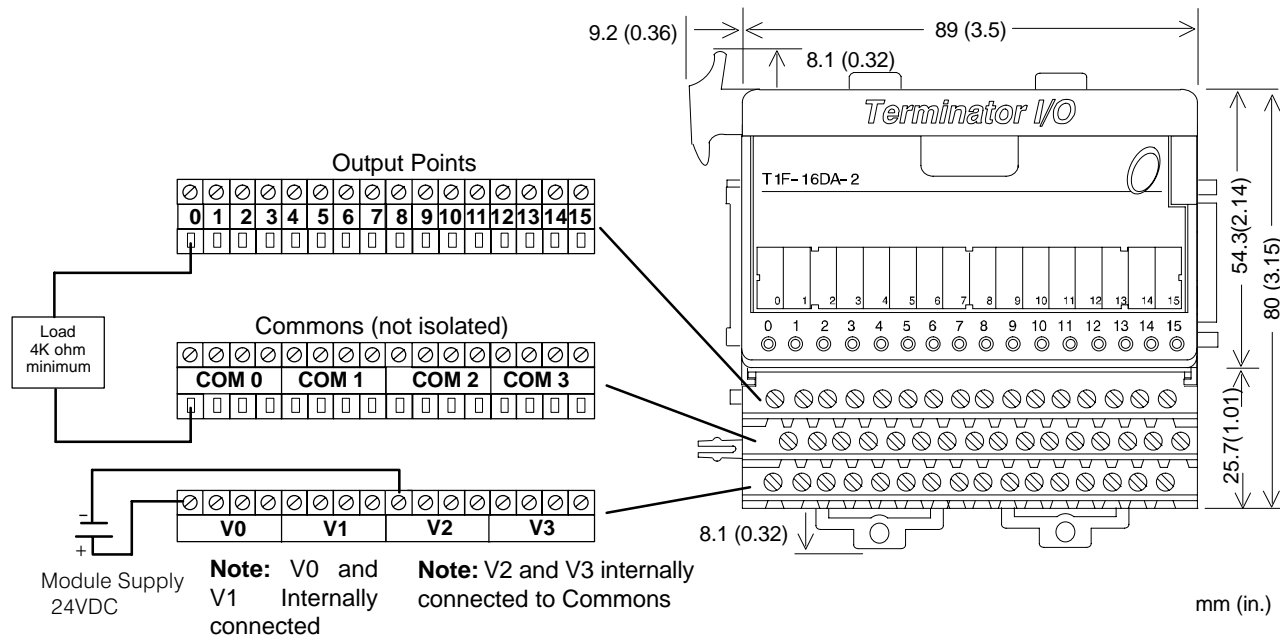
## Specifications

### T1F-16DA-2 16 Channel Voltage Analog Output Rev B

Number of Channels	16
Output Ranges	0-5V, 0-10V, +/- 5V, +/- 10V
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15 VDC
Load Impedance	4K ohm min.
Load Capacitance	0.01uF max.
Linearity Error (end to end)	+ / - 2 count max. + / - 0.050% of full scale max
Conversion Settling Time	100us max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	10V ranges: + / - 6 counts max 5V ranges: + / - 11 counts max
Accuracy vs. Temperature	+ / - 50 ppm/°C full scale calibration change
Max. Full Scale Inaccuracy (% of full scale); all errors and temp drift included	10V ranges: + / - 0.2% @ 25°C + / - 0.4% @ 60°C 5V ranges: + / - 0.3% @ 25°C + / - 0.5% @ 60°C
Master Update Rate	16 channels per scan max.
Output Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Power Supply	21.6-26.4VDC, 150mA class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	172g

**Note:** This module requires software setup via the Module Control Byte. Refer to the Memory Map Chapter in the T1K-INST-M Installation and I/O Manual.

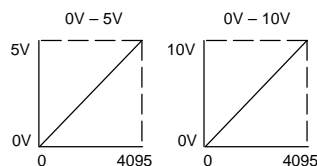
## Wiring & Dimensions



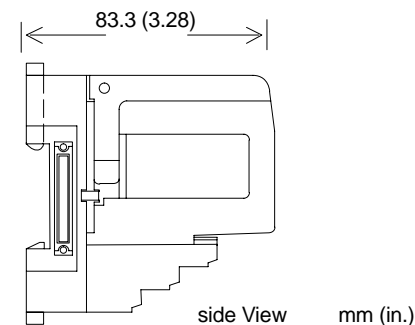
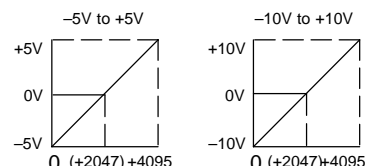
### NOTES:

- 1: Shields should be connected to the 0V terminal of the module or the 0V of the power supply.
- 2: Unused voltage outputs should remain open (no connections) for minimum power consumption.

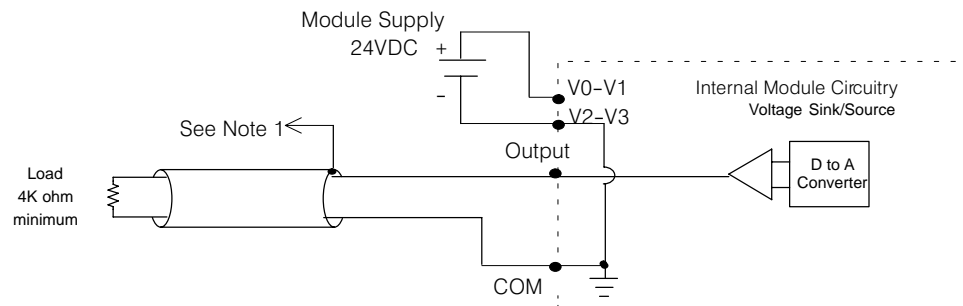
### Unipolar Ranges



### Bipolar Ranges



### Equivalent Output Circuit





# Specifications

## T1F-16RTD RTD Input Module

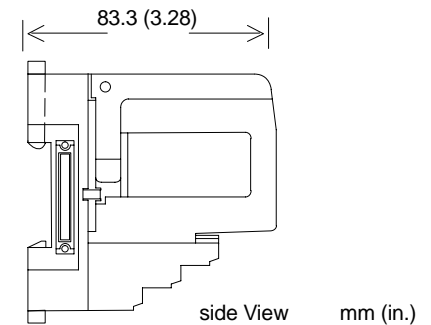
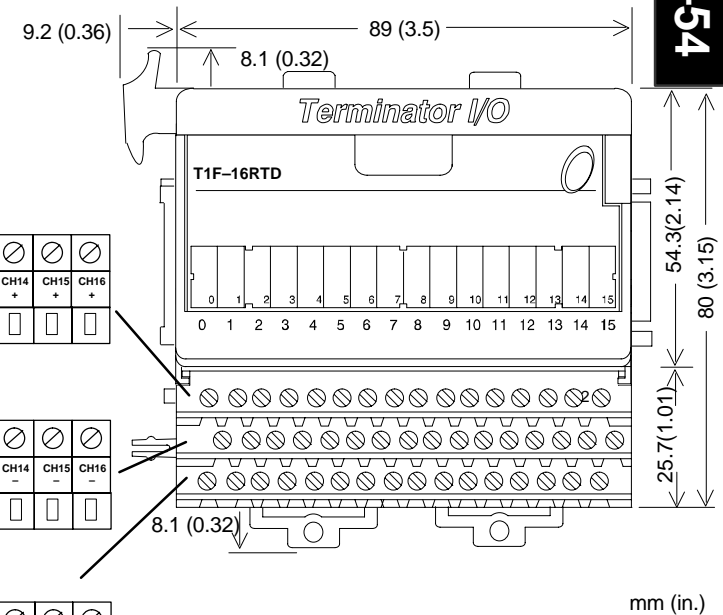
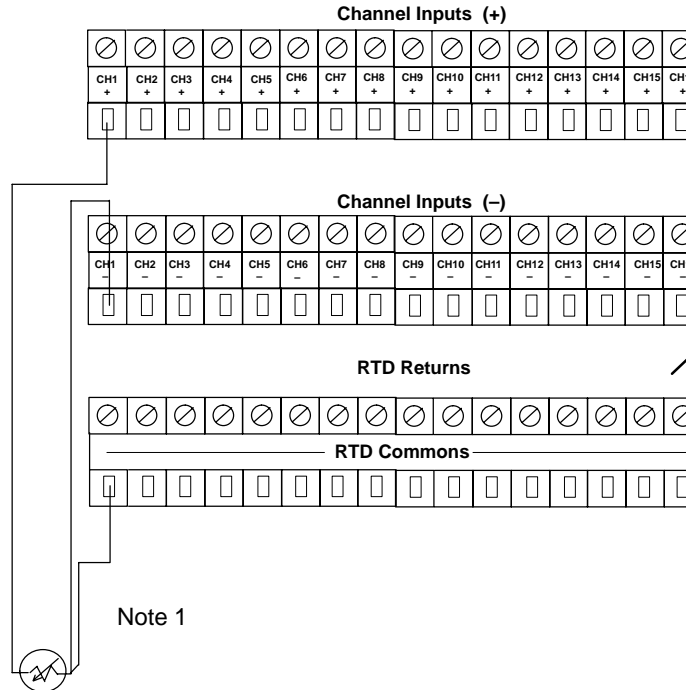
Number of Channels	16
Resolution	+ / - 0.1°C or °F
Common Mode Range	0 - 5VDC
Notch Filter	>50db notches @ 50/60 Hz f - 3db=13.1 Hz
Absolute Max. Ratings	+ / - 50 VDC
Converter Type	Charge balancing, 24-bit
Sampling Rate	140ms / channel
Master Update Rate	16 channels per scan max.
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	150mA @ 5VDC
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Temperature Drift	25ppm / °C (max.)
Maximum Inaccuracy	+ / - 1°C
RTD Excitation Current	200uA
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	168g

### RTD Input Ranges:

Input Ranges	Pt100 -200°C to 850°C -328°F to 1562°F Pt1000 -200°C to 595°C -328°F to 1103°F jPt100 -38°C to 450°C -36°F to 842°F Type CU-10/25 -200°C to 260°C -328°F to 500°F 120Ω Nickel -80°C to 260°C -112°F to 500°F
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# Wiring & Dimensions

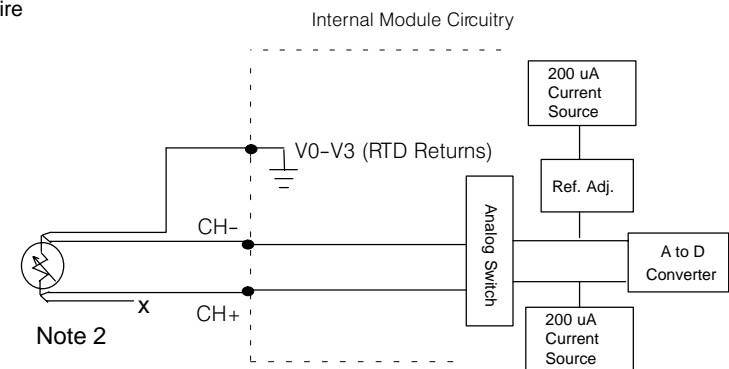
**Note:** Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.



### NOTES:

- 1: The three wires connecting the RTD to the module must be the same type and length. Do not use the shield or drain wire for the third connection.
- 2: If an RTD sensor has four wires, the plus sense wire should be left unconnected as shown.

### Equivalent Input Circuit



## Setting Module Jumpers

### T1F-16RTD

#### Select Input Type (see Note 2)

RTD Input	Jumper		
	RTD-0	RTD-1	RTD-2
Pt100 Ω	X	X	
Pt1000 Ω			X
jPt100 Ω		X	
Type CU-10 Ω			
Type CU-25 Ω	X		
120Ω Nickel	X		X

X = Jumper Installed,  
Blank Space = Jumper Removed

#### NOTES:

**Note 1:** The module comes from the factory with all of the Number of Channels jumpers installed for sixteen channel operation. Use the table to determine the proper settings.

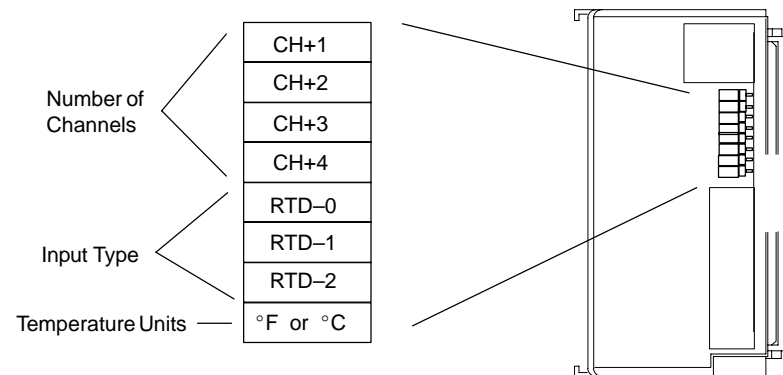
**Note 2:** The module comes the factory with the Input Type jumpers selected for Pt100 Ω operation. Use the table to determine the proper settings.

#### Select Number of Channels (see Note 1)

Number of Channels	Jumper			
	CH+1	CH+2	CH+3	CH+4
1				
2	X			
3		X		
4	X	X		
5			X	
6	X		X	
7		X	X	
8	X	X	X	
9				X
10	X			X
11		X		X
12	X	X		X
13			X	X
14	X		X	X
15		X	X	X
16	X	X	X	X

X = Jumper Installed,  
Blank Space = Jumper Removed

#### Jumpers Located Under Module Top Cover



#### Select Temperature Units

Temperature Units	Jumper
°F	X
°C	

X = Jumper Installed,  
Blank Space = Jumper Removed

#### T1F-RTD Data Format: Data format for each of the 16 RTD input channels

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	BO	-	-	-	-	-	-	-	-	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

D15 to D0: 16-bit temperature data, D15 is the most significant bit (MSB). The temperature data has one implied decimal, so the readings are in tenths of degrees.

Negative temperature readings are represented in 2's complement format.

BO: Channel burn out bit; 1= channel RTD sensor burn out or RTD is disconnected from either input terminal

0= channel OK

- : Unused channel bits are all = 0

# Specifications

## T1F-14THM 14 Channel Thermocouple Input

Rev E

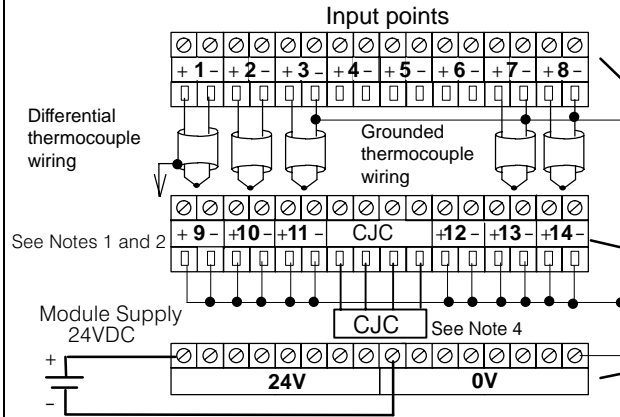
Use with I/O Module Base	T1K-16B screw type terminal base only
Number of Channels	14, differential
Common Mode Range	+ / - 5VDC
Common Mode Rejection	90db min. @ DC, 150db min. @ 50/60 Hz
Input Impedance	1M ohm
Absolute Max. Ratings	Fault Protected Input + / - 50 VDC
Master Update Rate	14 channels per scan max.
Input Points Required	512 discrete pts. or 16 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	60mA @ 5VDC
External Power Supply	24VDC +/- 5%, 70mA, class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	+ / - 5 ppm / °C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	168g

### Thermocouple specifications:

Input Ranges	Type J -190 to 760°C -310 to 1400°F Type E -210 to 1000°C -346 to 1832°F Type K -150 to 1372°C -238 to 2502°F Type R 65 to 1768°C 149 to 3214°F Type S 65 to 1768°C 149 to 3214°F Type T -230 to 400°C -382 to 752°F Type B 529 to 1820°C 984 to 3308°F Type N -70 to 1300°C -94 to 2372°F Type C 65 to 2320°C 149 to 4208°F
Display Resolution	+ / - 0.1°C or + / - 0.1°F
Cold Junction Compensation (CJC Part #: T1F-CJC)	automatic
Conversion Time	100ms per channel
Warm Up Time	30 minutes typically, +/- 1°C repeatability
Linearity Error	+ / - 0.05 °C max. , + / - 0.01°C typical
Maximum Inaccuracy	+ / - 3°C

# Wiring & Dimensions

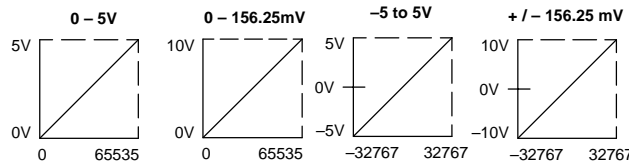
**Note:** Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points. Also, the CJC sense unit must be installed to the I/O base. (see wiring diagram below)



### NOTES:

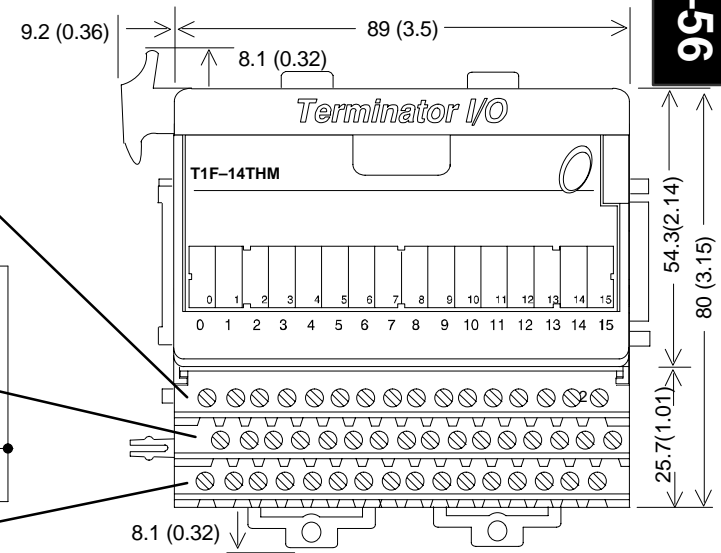
- 1: Shields should be grounded at the signal source.
- 2: Unused inputs should be connected to Common (0VDC).
- 3: When using 0-156mV and 5V ranges, connect (-) or 0V terminals to 0V to ensure common mode range acceptance
4. **The Cold Junction Compensation (part #: T1F-CJC) temperature sense unit that comes with the module must be installed into the I/O base terminals to perform CJC of the thermocouple inputs.**

### Voltage Input Signal Ranges

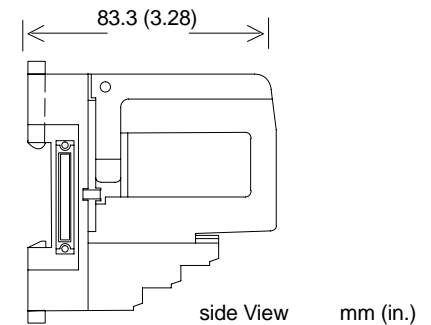


### Voltage specifications:

Input Voltage Ranges	0-5V, +/- 5V, 0-156.25mV, +/-156.25mV
Resolution	16 bit ( 1 in 65535)
Full Scale Calibration Error (Offset Error Included)	+/- 13 counts typ., +/- 33 max.
Offset Calibration Error	+/- 1 count max. @ 0V input
Linearity Error (End to End)	+/- 1 count max.
Max. Inaccuracy	+/- 0.02% @ 25°C (77°F)

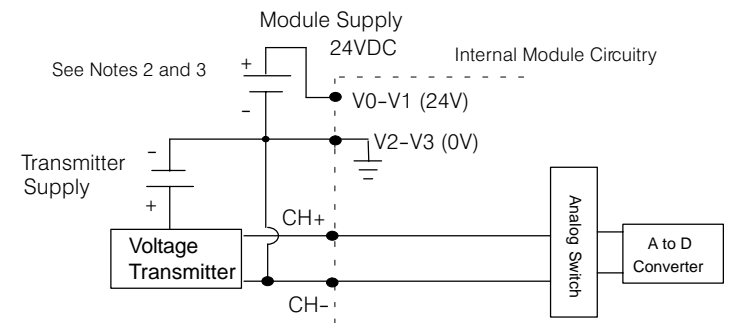


mm (in.)



side View mm (in.)

### Equivalent Input Circuit



# Setting Module Jumpers

X = Jumper Installed,  
Blank Space = Jumper Removed

## T1F-14THM

### Select Input Type (see Note 3)

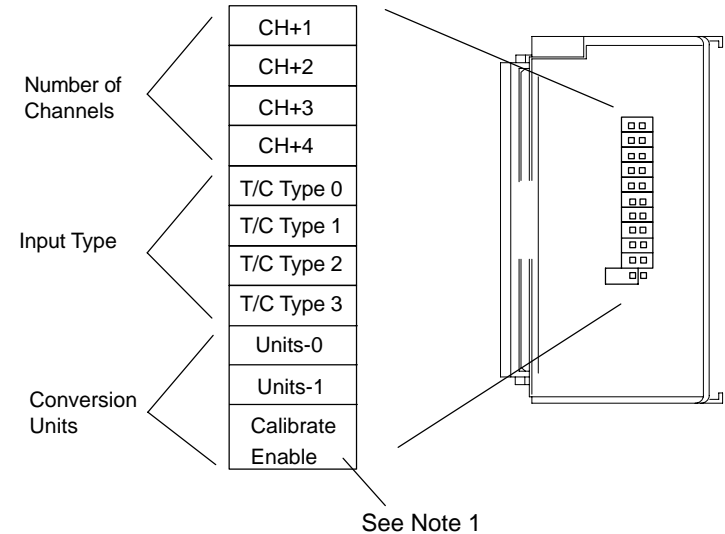
Rev D

Thermocouple / Voltage Inputs	Jumper			
	T/C Type 0	T/C Type 1	T/C Type 2	T/C Type 3
J	X	X	X	X
K		X	X	X
E	X		X	X
R			X	X
S	X	X		X
T		X		X
B	X			X
N				X
C	X	X	X	
0-5V.		X	X	
±5V.	X		X	
0-156mV.			X	
±156mV.	X	X		

### Select Number of Channels (see Note 2)

Number of Channels	Jumper			
	CH+1	CH+2	CH+3	CH+4
1				
2	X			
3		X		
4	X	X		
5			X	
6	X		X	
7		X	X	
8	X	X	X	
9				X
10	X			X
11		X		X
12	X	X		X
13			X	X
14	X	X	X	X

### Jumpers Located Under Module Top Cover



### Select the Conversion Units:

#### Thermocouple Conversion Units (see Note 4)

Jumper	Temperature Conversion Units			
	Magnitude °F	Plus Sign °C	2's Complement °F	°C
Units-0	X		X	
Units-1	X	X		

#### Voltage Conversion Units (see Note 5)

Jumper	Voltage Conversion Units	
	Magnitude Plus Sign	2's Complement
Units-0	X	X
Units-1	X	

#### NOTES:

**Note 1:** The Calibrate Enable jumper comes from the factory not installed. Installing the jumper disables the thermocouple active burn-out detection circuitry, which enables a thermocouple calibrator to be connected to the module. To make sure that the output of the thermocouple calibrator is within the 5V common mode voltage range of the module, connect the negative side of the differential voltage input channel to the 0V terminal, then connect the thermocouple calibrator to the differential inputs (for example, Ch 3+ and Ch 3-).

**Note 2:** The module comes with all of the Number of Channels jumpers installed for fourteen channel operation. Use the table to determine the proper settings.

**Note 3:** The module comes with all of the Input Type jumpers installed for J type thermocouple operation. Use the table to determine the proper settings.

**Note 4:** The module comes with the Conversion Units jumpers set for magnitude plus sign with Fahrenheit units selected. All thermocouple types are converted into a direct temperature reading with one implied decimal place. Negative temperatures can be represented in either 2's complement or magnitude plus sign format. If the temperature is negative, the most significant bit is the sign bit. 2's complement data format may be required to correctly display bipolar data on some operator interfaces.

**Note 5:** The bipolar voltage input ranges may be converted to a 15-bit magnitude plus sign or a 16-bit 2's complement value.

### T1F-14THM Data Format: Data format for each of the 14 input channels

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
-	-	-	-	-	-	-	BO	-	-	-	-	-	-	-	-	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

D15 to D0: 16-bit temperature data, D15 is the most significant bit (MSB). See Notes 4 and 5.

BO: Channel burn out bit; 1= channel thermocouple sensor burn out or thermocouple is disconnected from either input terminal

0= channel OK

- : Unused channel bits are all = 0

# Specifications

## T1F-8AD4DA-1 8 Channel Current Analog Input / 4 Channel Current Analog Output

Input Channel Specifications: Rev A

Number of Channels	8, single ended (1 common)
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Input Ranges	0-20mA, 4-20mA, -20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response Input active low-pass filter	-3db @ 100Hz, -20db/decade
Input Resistance	250 ohm
Absolute Max. Ratings	+/- 8V max. input
Conversion Time	8.5ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Full Scale Error (Offset Error not included)	16 counts max.
Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale) all errors included	0.18% @ 25°C 0.36% @ 60°C
Recommended Fuse	0.032A, Series 217 Fast Acting

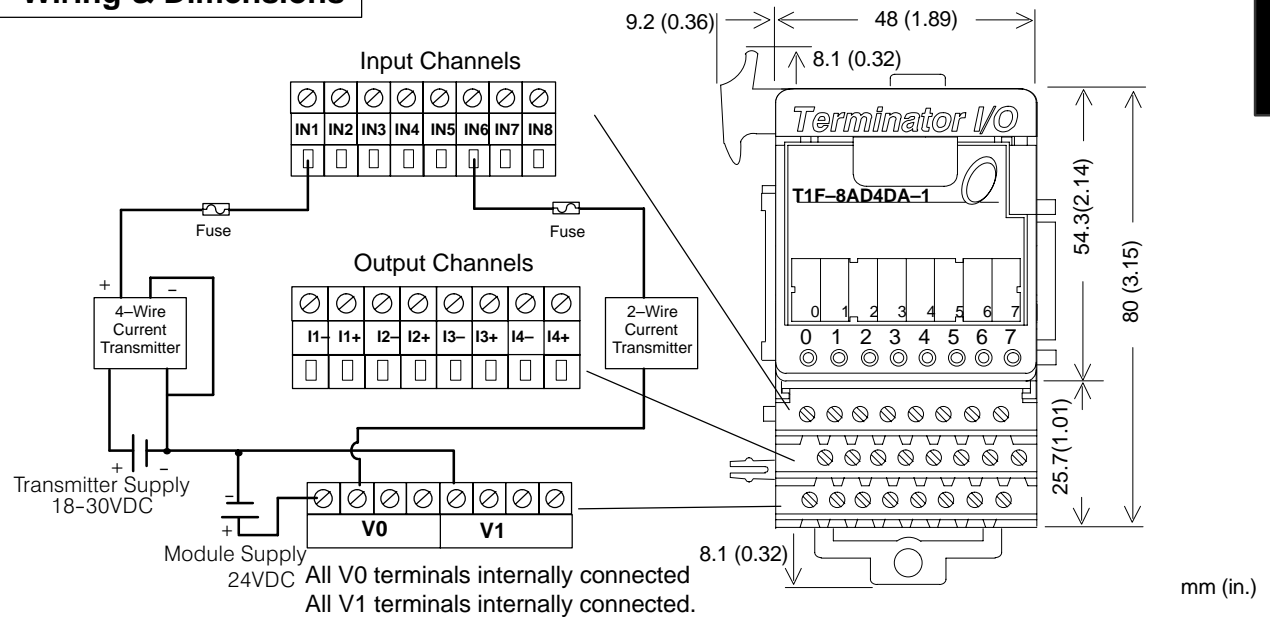
### Input Range Resolution:

-20 to 20mA	-8192 to 8191 counts
0 - 20mA	0 - 8191 counts
4 - 20mA	1638 - 8191 counts

### Module General Specifications:

CPU Update Rate	12 channels per scan max.
Base Power Required	75mA @ 5VDC
External Module Power Supply	21.6-26.4VDC, 60mA, class 2 (plus 20mA per output loop)
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	+ / - 50 ppm / °C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Weight	136g

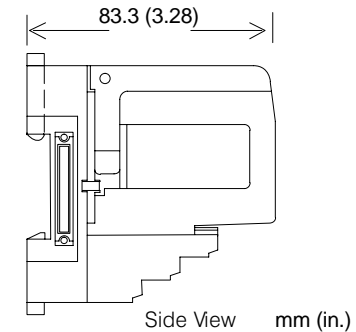
# Wiring & Dimensions



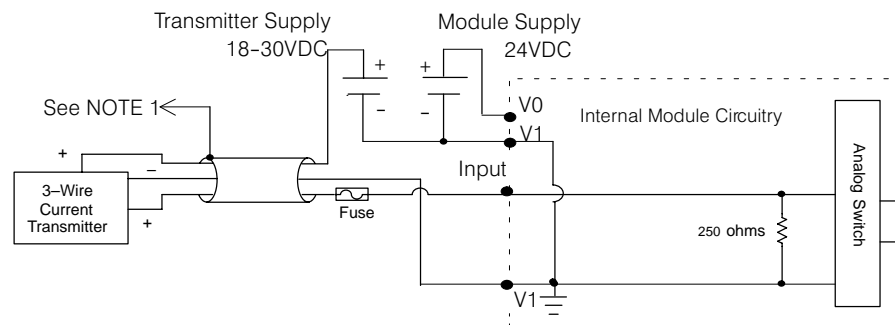
**Note:** Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.

### NOTES:

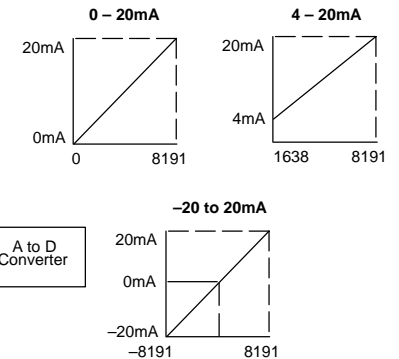
- 1: Shields should be grounded at the signal source.
- 2: More than one external power supply can be used, provided all the power supply commons are connected.
- 3: A Series 217, 0.032A fast-acting fuse is recommended for 4-20 mA current loops.
- 4: If the power supply common of an external power supply is not connected to the 0V terminal on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4-20 mA transmitter types are:
  - For 2 or 3 wire connections: Isolation between the input supply signal and the power supply.
  - For 4 wire connections: Isolation between the input supply signal, the power supply and the 4-20mA output.



### Equivalent Input Circuit



### Input Signal Ranges



# Specifications

## T1F-8AD4DA-1

### Output Channel Specifications:

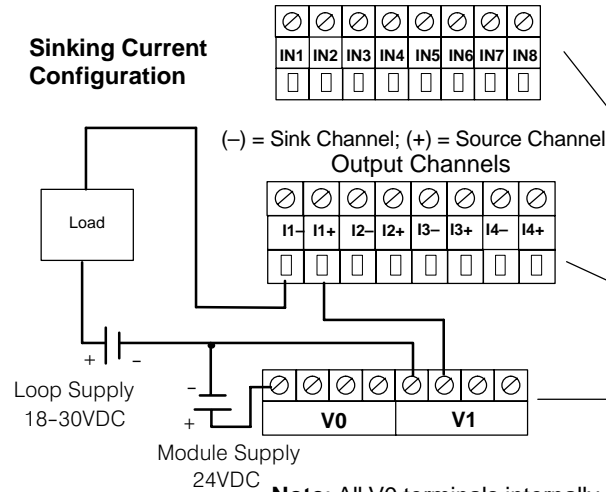
Rev A

Number of Channels	4, sink/source; individually configured by wiring
Output Points Required	128 discrete pts. or 4 dwords (d (double) word = 32 bit word) Network Interface dependent
Output Ranges	4-20mA
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Max. Loop Supply	30 VDC
Source Load (ohms) / Loop Power Supply	0 - 400/18-30V
Sink Load (ohm) / Loop Power Supply	0-600ohm/18V, 0-900ohm/24V 0-1200ohm/30V
Total Load (Sink plus Source)	600 $\Omega$ /18V, 900 $\Omega$ /24V, 1200 $\Omega$ /30V
Linearity Error (end to end)	+ / - 2 count max. + / - 0.050% of full scale max
Conversion Settling Time	400us max. full scale change
Full Scale Calibration Error (Note: source error depends upon the load from source terminal to ground)	SINK: + / - 12 counts max. @ any load SOURCE: + / - 26 counts max. @ 400 ohm load + / - 18 counts max. @ 250 ohm load + / - 12 counts max. @ 125 ohm load
Offset Calibration Error	SINK: + / - 6 counts max. @ (any load) SOURCE: + / - 10 counts max. @ 400 ohm load + / - 8 counts max. @ 250 ohm load + / - 6 counts max. @ 125 ohm load
Max. Full Scale Inaccuracy (% of full scale) all errors included	SINK: (any load) 0.3% @ 25°C (any load) 0.5% @ 60°C SOURCE: 400 $\Omega$ load 0.63% @ 25°C 400 $\Omega$ load 0.83% @ 60°C 250 $\Omega$ load 0.44% @ 25°C 250 $\Omega$ load 0.64% @ 60°C 125 $\Omega$ load 0.30% @ 25°C 125 $\Omega$ load 0.50% @ 60°C

**Note:** This module requires software setup via the Module Control Byte. Refer to the Memory Map Chapter in the T1K-INST-M Installation and I/O Manual.

# Wiring & Dimensions

## Sinking Current Configuration

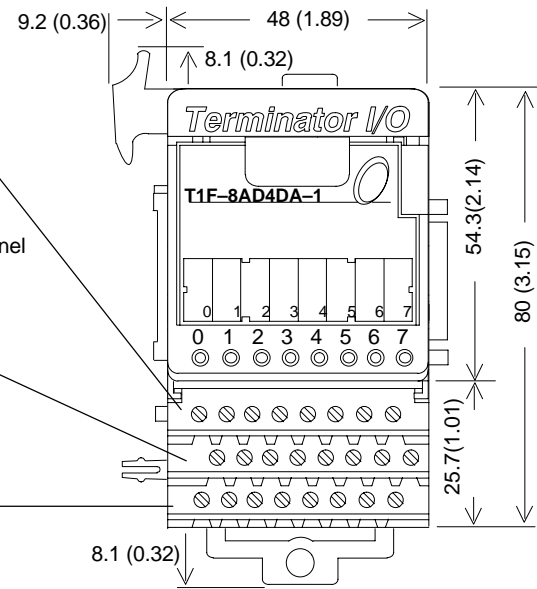
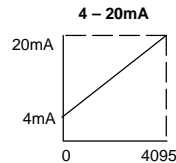


**Note:** All V0 terminals internally connected  
All V1 terminals internally connected.

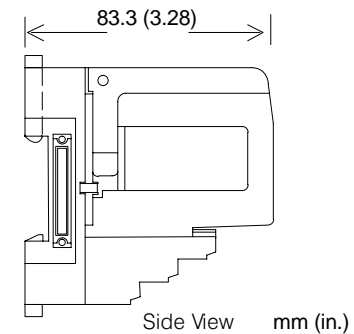
## NOTES:

- 1: Shields should be connected to the 0V terminal of the module or the 0V of the power supply.
- 2: Unused current outputs should remain open (no connections) for minimum power consumption.

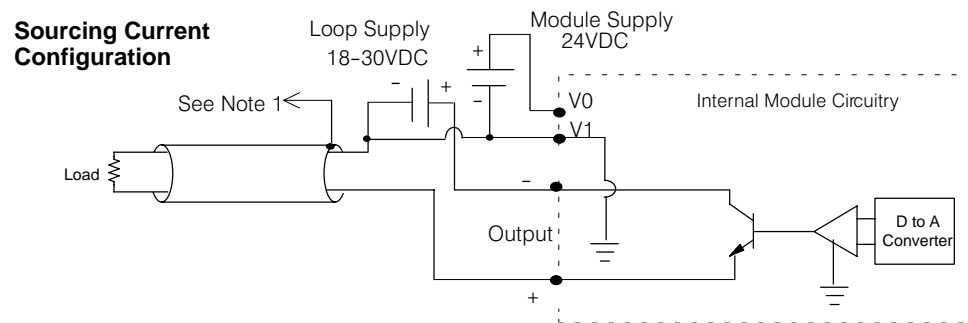
## Output Signal Range



mm (in.)



## Equivalent Output Circuit



## Specifications

### T1F-8AD4DA-2 8 Channel Voltage Analog Input / 4 Channel Voltage Analog Output

#### Input Channel Specifications: Rev A

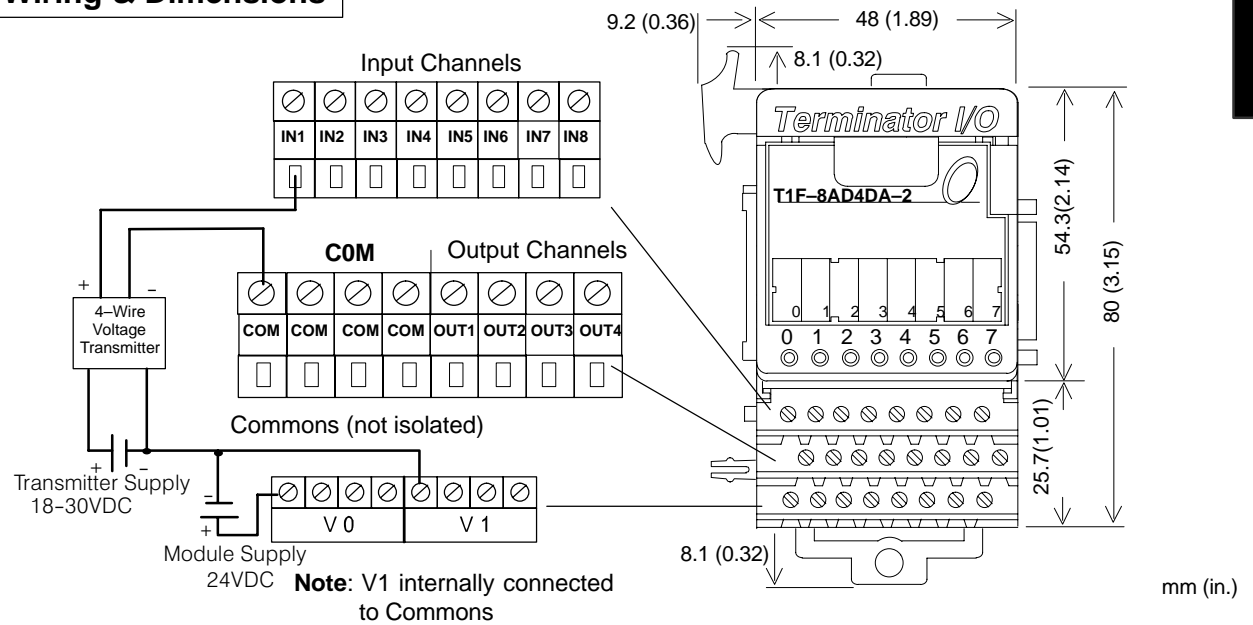
Number of Channels	8, single ended (1 common)
Input Ranges	0-5V, 0-10V, +/- 5V, +/- 10V
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	-3db @ 500Hz, -20db/decade
Input Resistance	200K ohm min.
Absolute Max. Ratings	Fault Protected Input 130V(rms) or 100VDC
Conversion Time	5.5ms per channel
Linearity Error	+ / - 2 count max.
Input Stability	+ / - 1 count
Calibration Full Scale Error	8 counts max.
Calibration Offset Error	2 counts max.
Max. Full Scale Inaccuracy (% of full scale); all errors included	0.08% @ 25°C 0.26% @ 60°C

#### Input Range Resolution:

0 - 5V	0 - 4095 counts
0 - 10V	0 - 8191 counts
+ / - 5V	-4095 to 4095 counts
+ / - 10V	-8192 to 8191 counts

**Note:** Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.

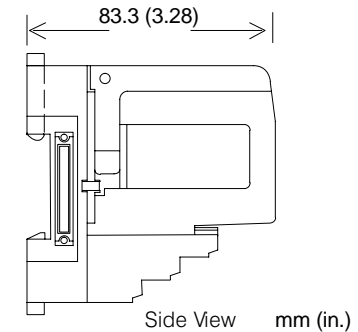
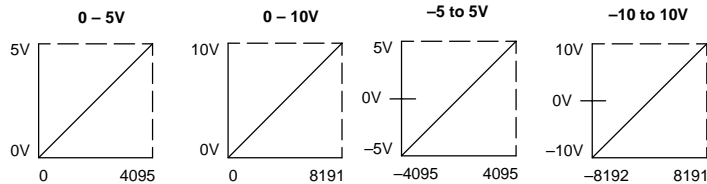
## Wiring & Dimensions



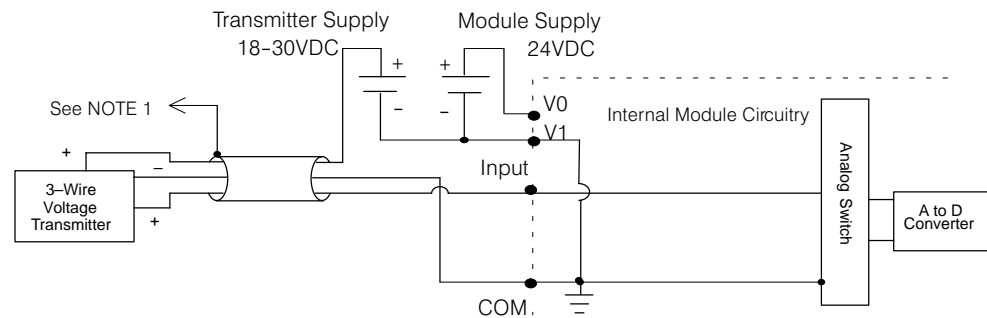
#### NOTES:

- 1: Shields should be grounded at the signal source.
- 2: Unused inputs should be connected to Common (0VDC).
- 3: More than one external power supply can be used, provided all the power supply commons are connected.

#### Input Signal Ranges



#### Equivalent Input Circuit



# Specifications

T1F-8AD4DA-2

## Output Channel Specifications:

Rev A

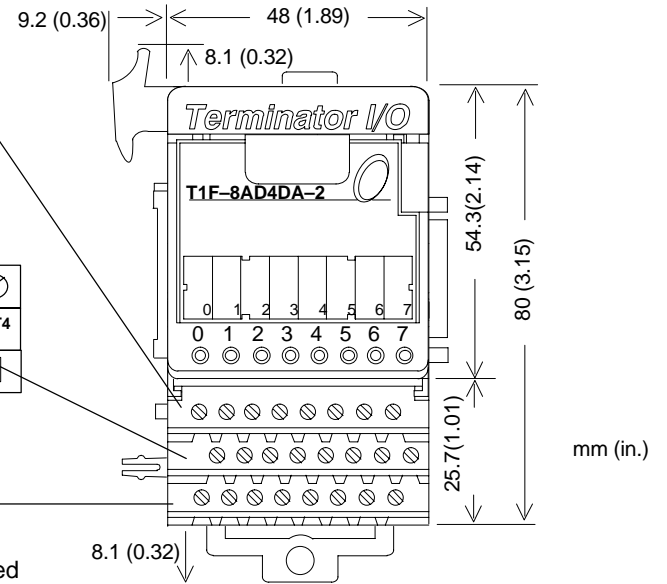
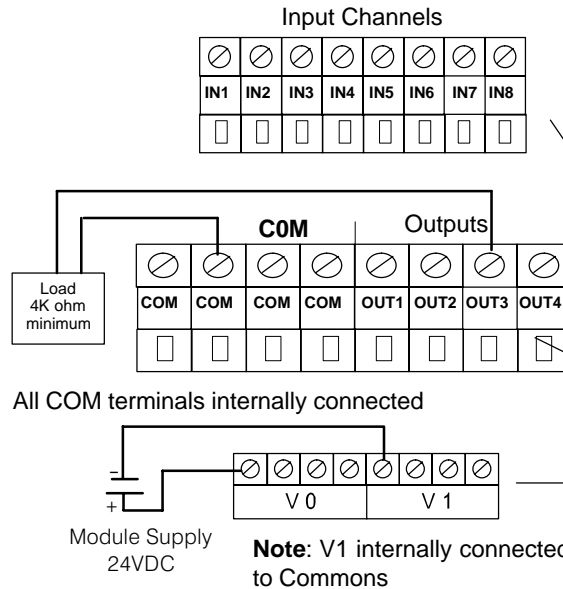
Number of Channels	4
Output Ranges	0-5V, 0-10V, +/- 5V, +/- 10V
Output Type	single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15 VDC
Load Impedance	4K ohm min.
Load Capacitance	0.01uF max.
Linearity Error (end to end)	+ / - 2 count max. + / - 0.050% of full scale max
Conversion Settling Time	300us max. full scale change
Full Scale Calibration Error	+ / - 12 counts max.
Offset Calibration Error	10V ranges: + / - 5 counts max 5V ranges: + / - 9 counts max
Max. Full Scale Inaccuracy (% of full scale); all errors and temp drift included	10V ranges: + / - 0.2% @ 25°C + / - 0.4% @ 60°C 5V ranges: + / - 0.3% @ 25°C + / - 0.5% @ 60°C

## Module General Specifications:

CPU Update Rate	12 channels per scan max.
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Output Points Required	128 discrete pts. or 4 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Module Power Supply	21.6-26.4VDC, 70mA, class 2
External Transmitter Power Supply	18-30VDC, 70mA, class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	+ / - 50 ppm / °C max. full scale
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
weight	136g

# Wiring & Dimensions

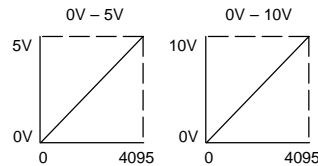
**Note:** The output channels require software setup via the Module Control Byte. Refer to the Memory Map Chapter in the T1K-INST-M Installation and I/O Manual.



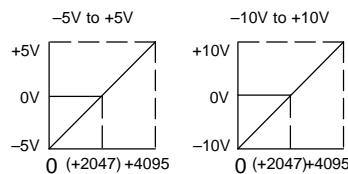
## NOTES:

- 1: Shields should be connected to the 0V terminal of the module or the 0V terminal of the power supply.
- 2: Unused voltage outputs should remain open (no connections) for minimum power consumption.

## Unipolar Ranges



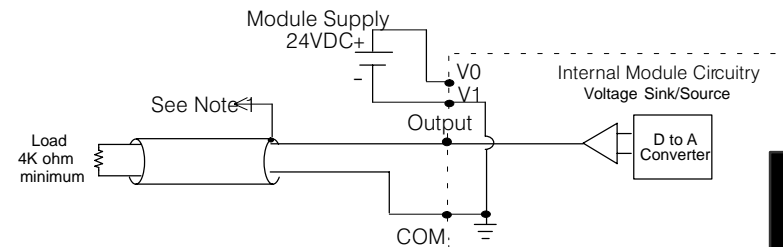
## Bipolar Ranges



## Output Range Resolution:

0 - 5V	0 - 4095
0 to 10V	0 - 4095
+ / - 5V	0 - 4095
+ / - 10V	0 - 4095

## Equivalent Output Circuit





## Specifications

### T1H-CTRIO Counter I/O Module

#### Input Specifications:

Rev B

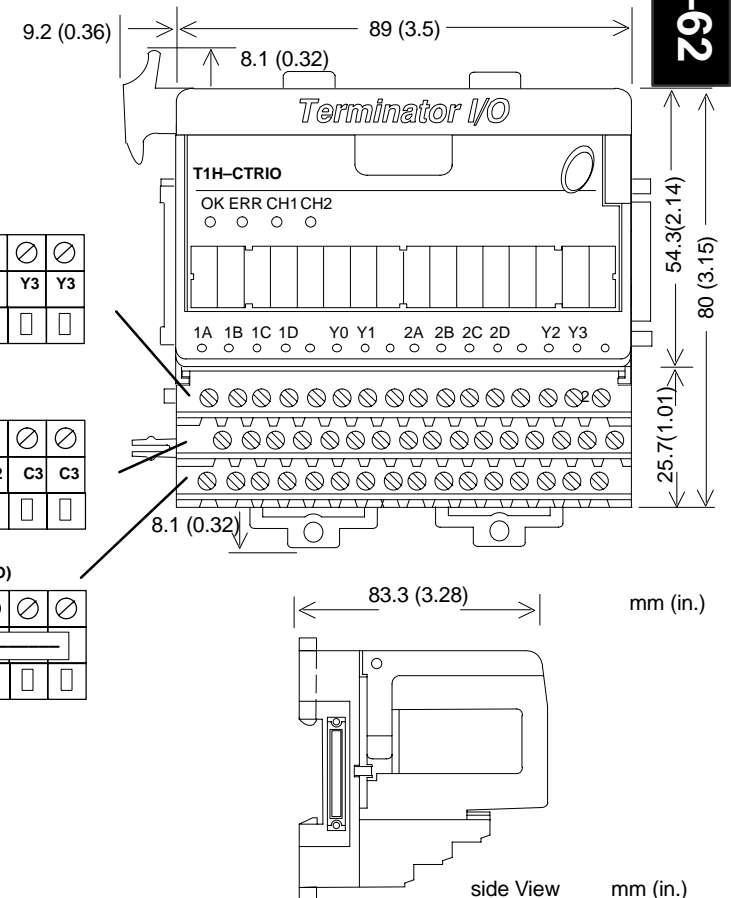
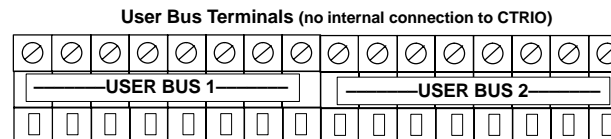
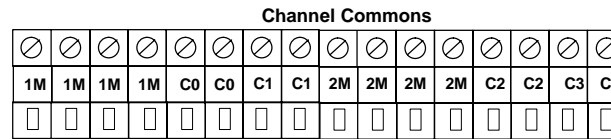
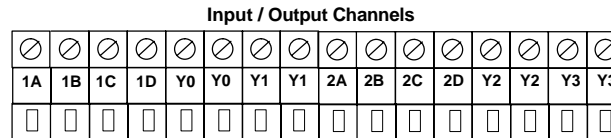
Inputs	8 pts. ( 2 isolated channels / 4 pts. each channel), sink / source, 100K Hz max; See Input Resources Table for available Input Function options
Minimum Pulse Width	5us
Input Voltage Range	9–30VDC
Maximum Voltage	30VDC
Input Voltage Protection	Zener clamped at 33VDC
Rated Input Current	8mA typical, 12mA maximum
Minimum ON Voltage	9.0VDC
Maximum OFF Voltage	2.0VDC
Minimum ON Current	5.0mA @ 9.0VDC
Maximum OFF Current	2.0mA
OFF to ON Response	< 3us
On to OFF Response	< 3us

#### Output Specifications:

Outputs	4 pts., independently isolated, sink/source (FET Outputs); See Output Resources Table for available Output Function options
Voltage Range	5–36VDC
Maximum Voltage	36VDC
Output Clamp Voltage	60VDC
Maximum Load Current	1.0A
Max. Leakage Current	100uA
Inrush Current	5.0A for 20ms
OFF to ON Response	< 3us
ON to OFF Response	< 3us
ON State Voltage Drop	< 0.3V
External Power Supply	for loop power only, not required for internal module function
Overcurrent Protection	15A max
Base Power Required	400mA @ 5VDC
Thermal Shutdown	Tjunction = 150°C
Overtemperature Reset	Tjunction = 130°C
Duty Cycle Range	1% to 99% in 1% increments
Operating Environment	0°C–60°C, Humidity 5 to 95%

## Wiring & Dimensions

**Note:** Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.



3-62

## LED Indicators

### LED Diagnostic Definitions

CH1	Blinks when Channel 1 Function 1 is counting or timing
CH2	Blinks when Channel 2 Function 1 is counting or timing
Y0–Y3	Follows actual output state; ON = output is passing current

### LED Diagnostic Definitions

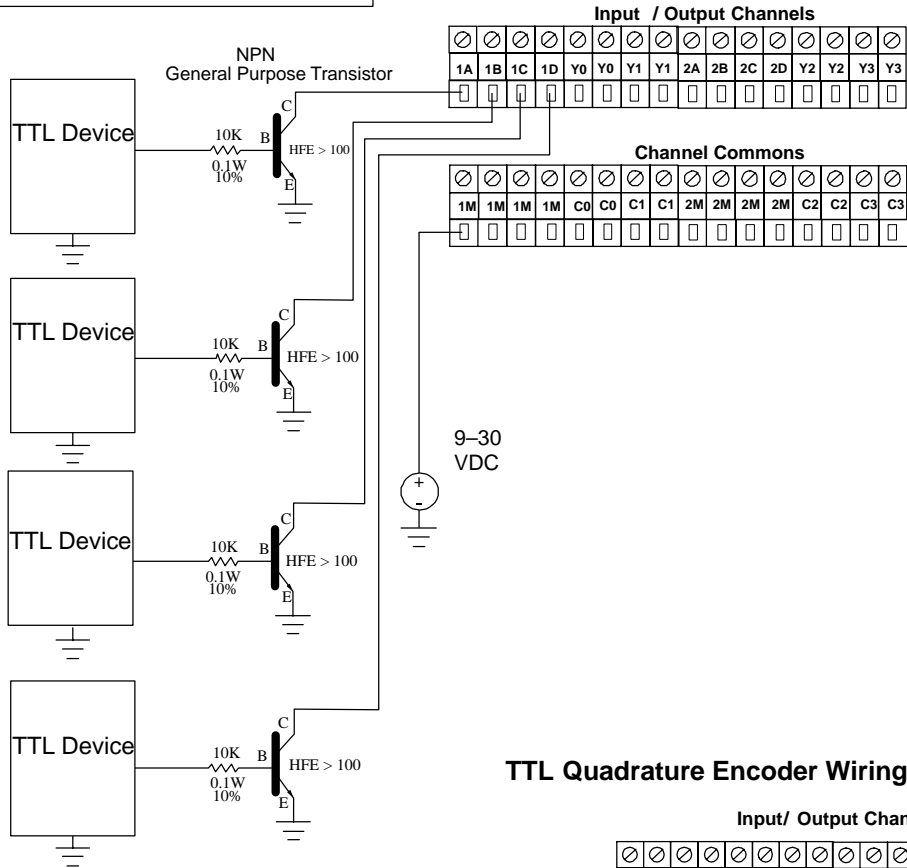
OK	ER	Description
ON	OFF	All is well – Run Mode
ON	ON	Hardware Failure
Blinking	Blinking	Boot Mode – Use for Field OS Upgrades
Blinking	OFF	Program Mode
OFF	Blinking	Module Self –diagnostic Failure
OFF	ON	Module Error due to Watchdog Timeout
OFF	OFF	No Power to Module

### LED Descriptions

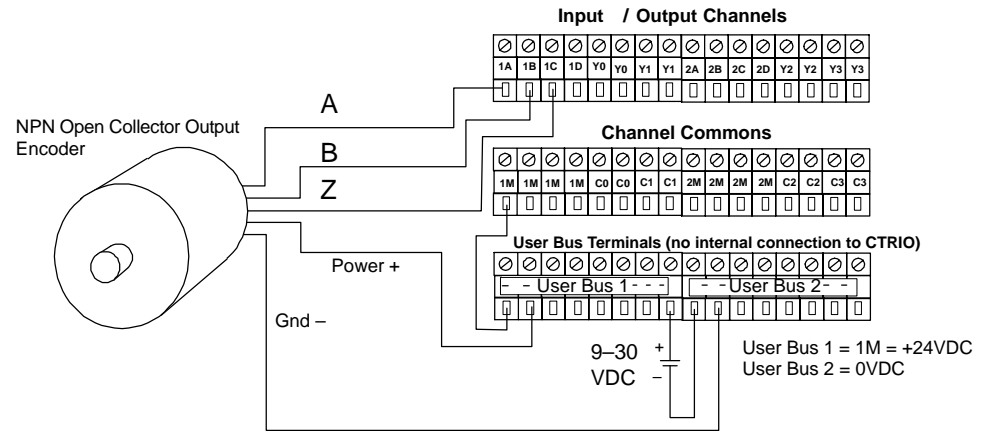
OK	Module OK
ER	User Program Error
CH1	Channel 1 Status
CH2	Channel 2 Status
1A–1D	Channel 1 A–D Status
2A–2D	Channel 2 A–D Status
Y0 – Y3	Output Status

**Input Wiring Diagrams**

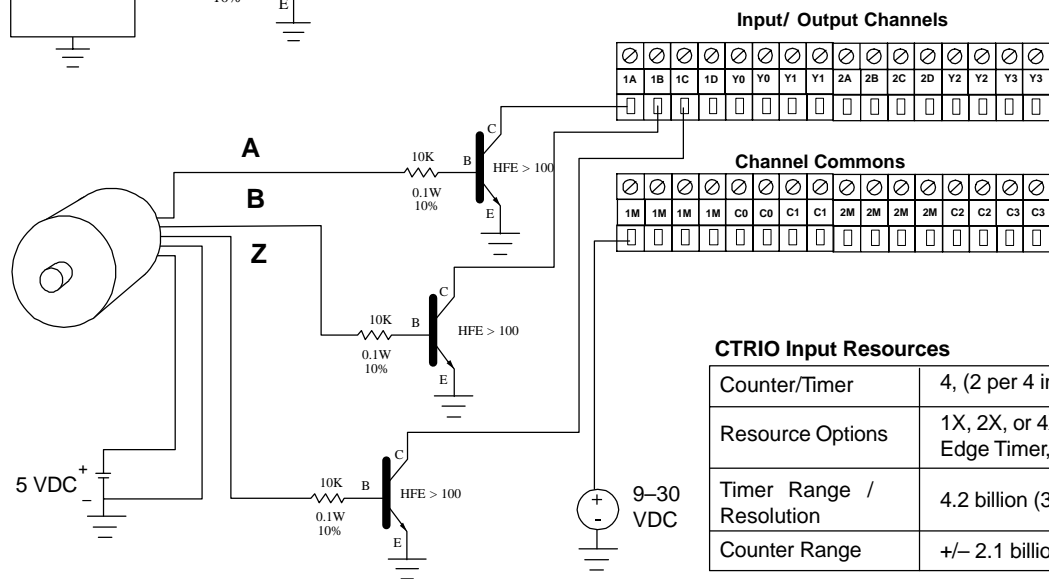
**TTL Input Wiring Example**



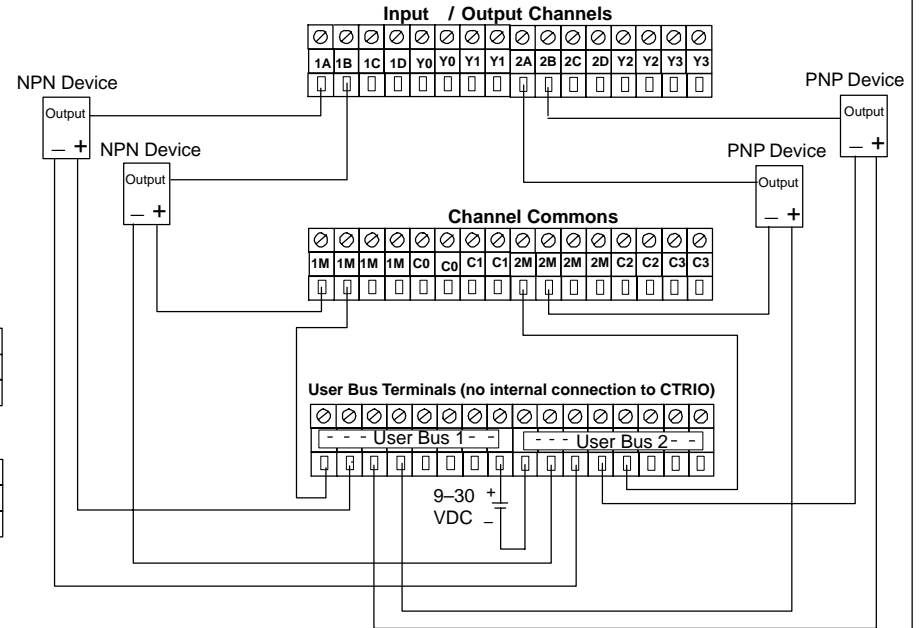
**Quadrature Encoder Wiring Example**



**TTL Quadrature Encoder Wiring Example**



**Input Wiring Example**



**CTRIO Input Resources**

Counter/Timer	4, (2 per 4 input channel group)
Resource Options	1X, 2X, or 4X Quadrature, Up or Down Counter, Edge Timer, Dual Edge Timer, Pulse Catch, Reset, Inhibit, Capture
Timer Range / Resolution	4.2 billion (32 bits); 1us
Counter Range	+/- 2.1 billion (32 bits or 31 bits + sign bit)

User Bus 1 = 1M = +24VDC  
User Bus 2 = 2M = 0VDC

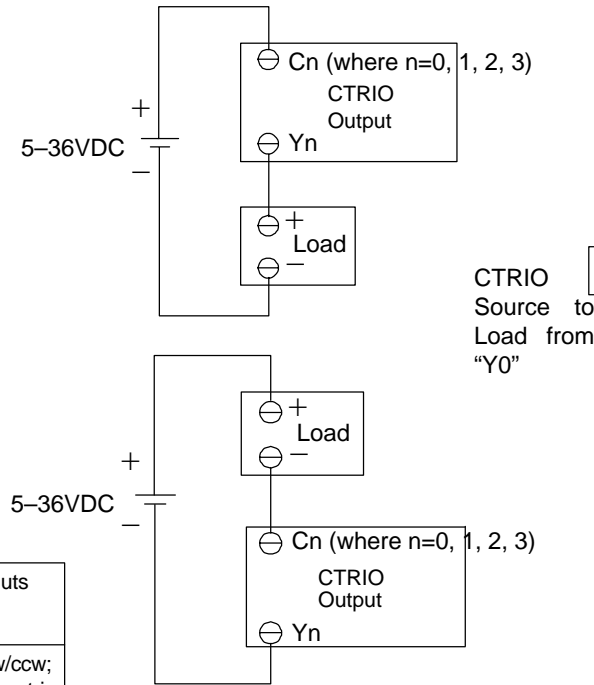
## Output Wiring Diagrams

The module has 4 optically isolated output points (pts. Y0–Y3 with isolated commons C0–C3, respectively). The outputs must be wired so positive current flows into Cn terminal and then out of the Yn terminal.

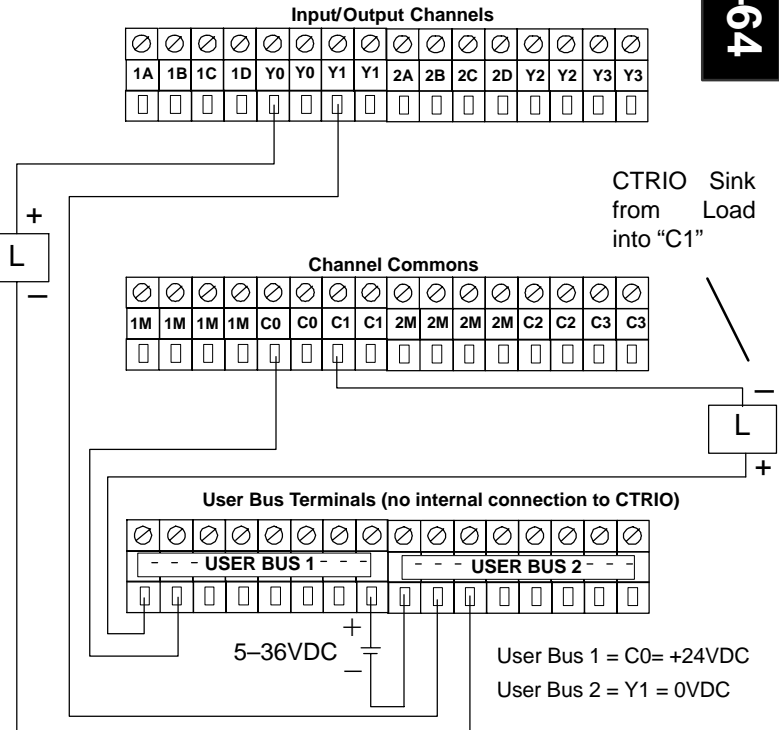
### CTRIO Output Resources

Pulse outputs / Discrete outputs	Pulse outputs: 2 Channels (2 outputs per channel); Discrete outputs: 4 pts.
Resource Options	Pulse Outputs: pulse/direction or cw/ccw; Profiles: Trapezoid, S–Curve, Symmetrical S–Curve, Dynamic Positioning, Dynamic Velocity, Home Search, Velocity mode, Run to limit mode and Run to position mode; Discrete Outputs: 4 configurable for set, reset, pulse on, pulse off, toggle and reset count function (assigned to respond to Timer/Counterfunctions); RawMode: Direct access to output from user program
Target Position Range	+/- 2.1 billion (32 bits or 31 bits + sign bit)

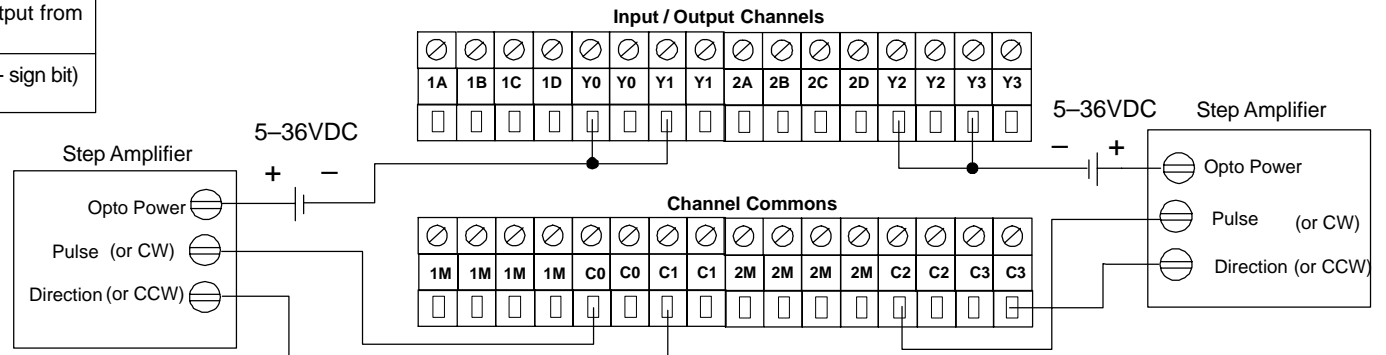
### Output Wiring Schematic



### Output Wiring Example



### Stepper/Servo Drive Wiring Example



The stepper wiring example assumes the Step Amplifier interface to be optocoupler LEDs (common anodes at the "OPTO Power" terminal) with internal current limiting resistors. This is a standard method, but you must consult your stepper amplifier documentation to ensure that this method is applicable.

## Specifications

### T1K-08B(-1) I/O Module Base

Specification	T1K-08B	T1K-08B-1
Terminal Type	screw type	spring clamp type
Recommended Torque	1.77 – 3.54 lb-inch (0.2 – 0.4 Nm)	–
Recommended Screwdriver Blade Size	0.02in.x 0.125in. (0.5mm x 3mm)	push in on clamp using screwdriver blade size: 0.016x0.079 in.to 0.032 x0.16 in. (0.4mmx2mm to 0.8mmx4mm )
Wire Gauge Size	solid conductor: 25–12AWG stranded conductor: 26–12AWG	solid conductor: 25–14AWG stranded conductor: 26–14AWG*
Weight	135g	125g

\*Twist conductors before inserting into gate

### T1K-16B(-1) I/O Module Base

Specification	T1K-16B	T1K-16B-1
Terminal Type	screw type	spring clamp type
Recommended Torque	1.77 – 3.54 lb-inch (0.2 – 0.4 Nm)	–
Recommended Screwdriver Size	0.02in.x 0.125in. (0.5mm x 3mm)	push in on clamp using screwdriver blade size: 0.016x0.079 in.to 0.032 x0.16 in. (0.4mmx2mm to 0.8mmx4mm )
Wire Gauge Size	solid conductor: 25–12AWG stranded conductor: 26–12AWG	solid conductor: 25–14AWG stranded conductor: 26–14AWG*
Weight	220g	210g

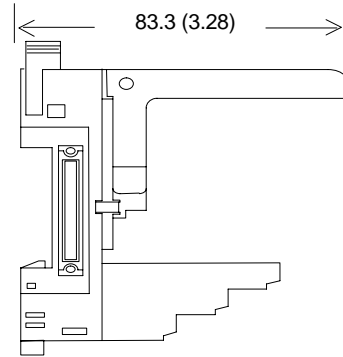
\*Twist conductors before inserting into gate

## Environmental Specifications

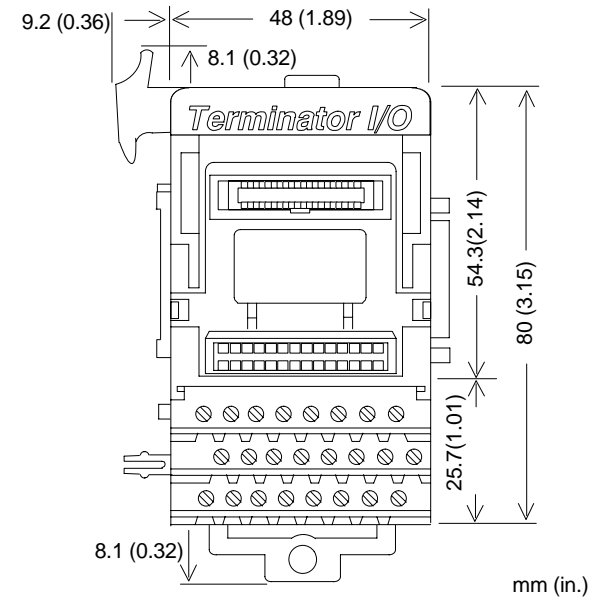
Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	–4°F to 158°F (–20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840)
Vibration Resistance	MIL STD 810C, Method 514.2
Shock Resistance	MIL STD 810C, Method 516.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M ohm
Noise Immunity	NEMA ICS3–304 Impulse Noise 1us, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

## Dimensions

### T1K-08B, T1K-08B-1

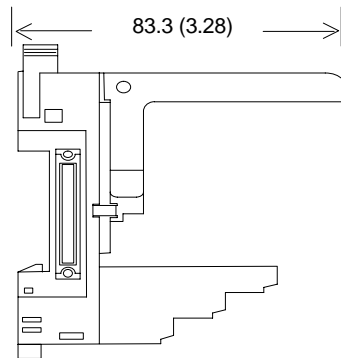


Side View

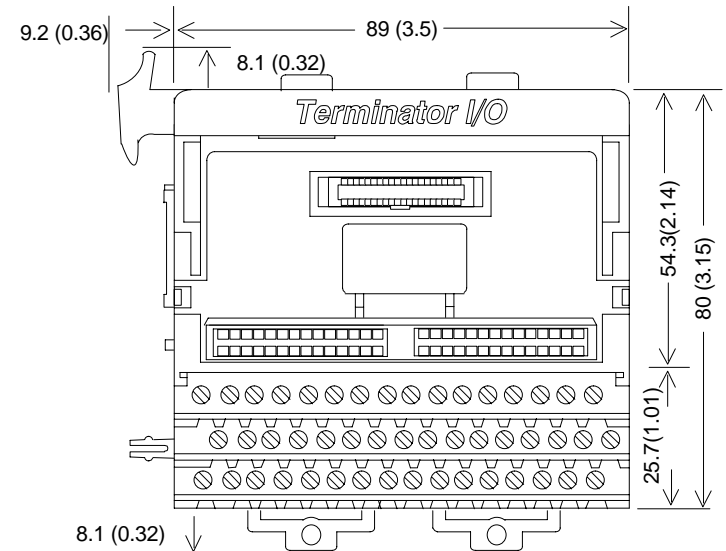


mm (in.)

### T1K-16B, T1K-16B-1



Side View



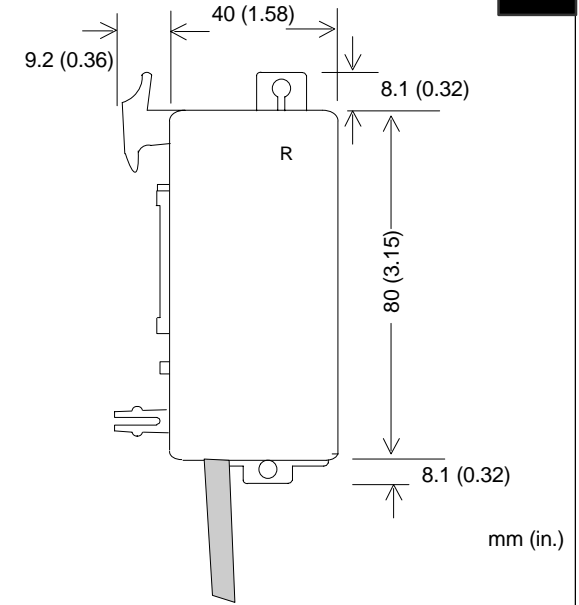
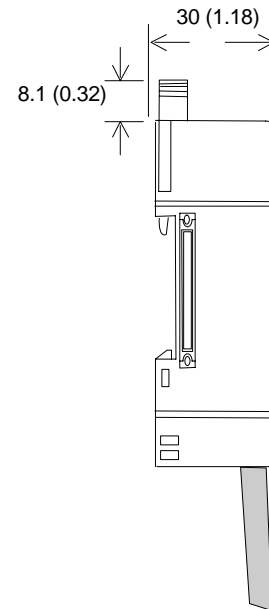
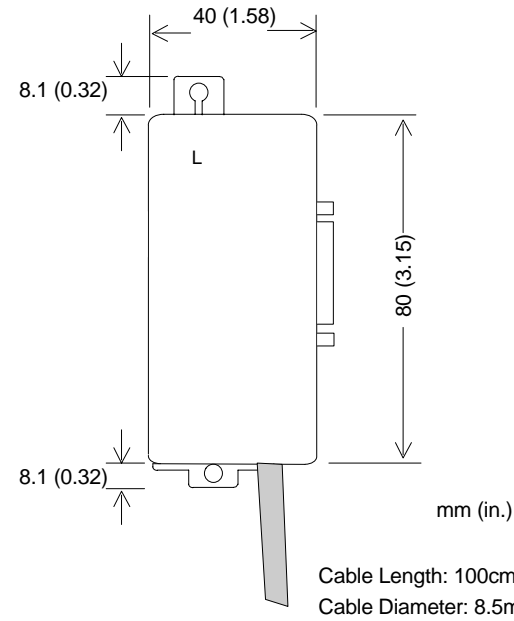
mm (in.)

## Specifications

### T1K-10CBL, T1K-10CBL-1 Expansion Cable

Specification	T1K-10CBL	T1K-10CBL-1
Cable Length	100cm (3.28ft.)	
Cable Diameter	8.5mm	
Shielding	None	
Temperature Range	-25°C to 80°C (-13°F to 176°F)	
Jacket Material	PVC	
<b>Auxiliary 24 VDC Cable</b>	Cable Diameter	2 cables used: 1.42mm each
	Insulation Voltage	2000VAC / 1 minute

## Dimensions



## Specifications

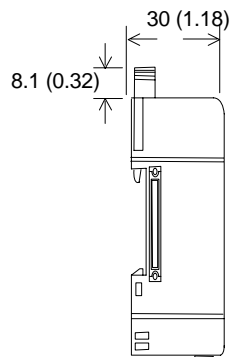
**NOTE:** Please refer to Chapter 2 for application examples using the different types of expansion cables that are available.

### T1K-05CBL-LL(-1) Expansion Cable

Specification	T1K-05CBL-LL	T1K-05CBL-LL-1
Cable Description	Left-to-Left Side Expansion Cable	
Cable Length	50cm (1.64ft.)	
Cable Diameter	8.5mm	
Shielding	None	
Temperature Range	-25°C to 80°C (-13°F to 176°F)	
Jacket Material	PVC	
Auxiliary 24 VDC Cable	Cable Diameter	two 1.42mm cables used in a 6mm sheath
	Insulation Voltage	2000VAC / 1 minute

### T1K-05CBL-RR(-1) Expansion Cable

Specification	T1K-05CBL-RR	T1K-05CBL-RR-1
Cable Description	Right-to-right side expansion cable	
Cable Length	50cm (1.64ft.)	
Cable Diameter	8.5mm	
Shielding	None	
Temperature Range	-25°C to 80°C (-13°F to 176°F)	
Jacket Material	PVC	
Auxiliary 24 VDC Cable	Cable Diameter	two 1.42mm cables used in a 6mm sheath
	Insulation Voltage	2000VAC / 1 minute

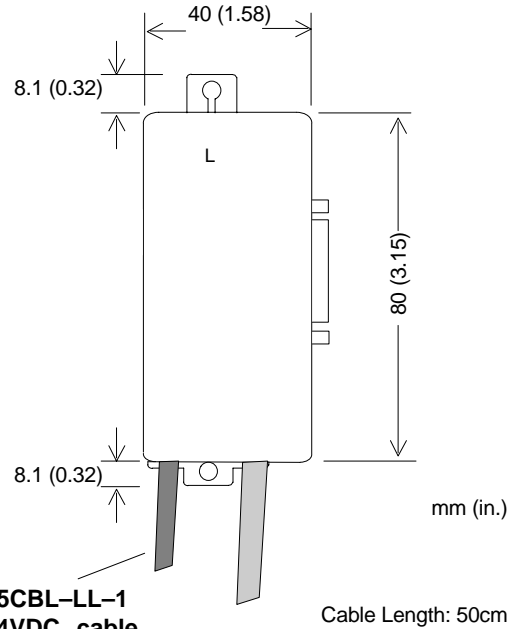


Side View

Cable Length: 50cm

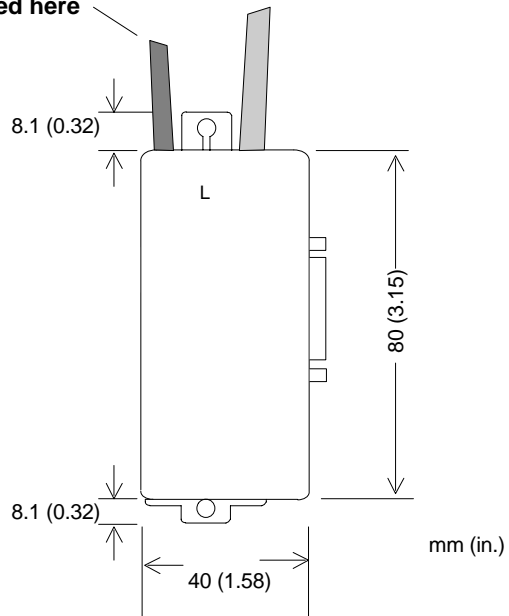
## Dimensions

### T1K-05CBL-LL(-1)



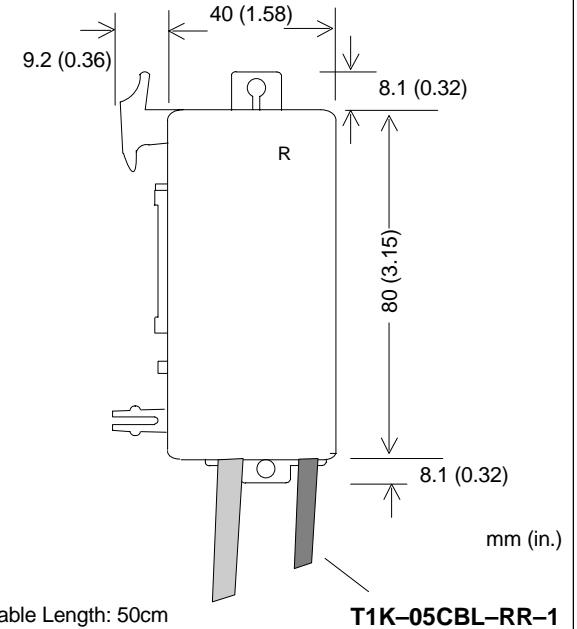
T1K-05CBL-LL-1 has 24VDC cable attached here

Cable Length: 50cm



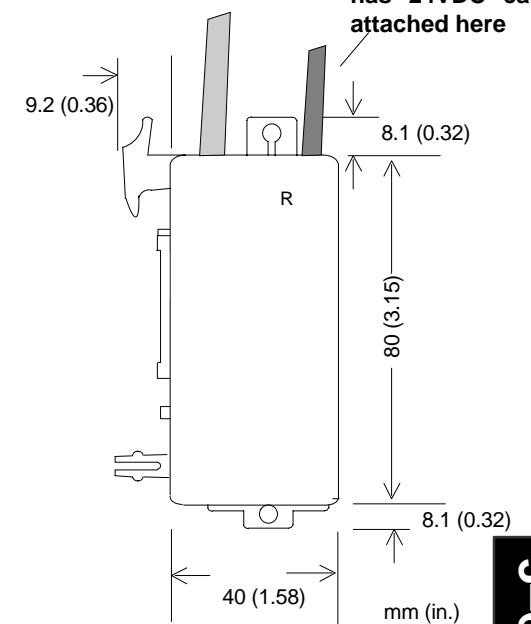
T1K-05CBL-LL-1 has 24VDC cable attached here

### T1K-05CBL-RR(-1)



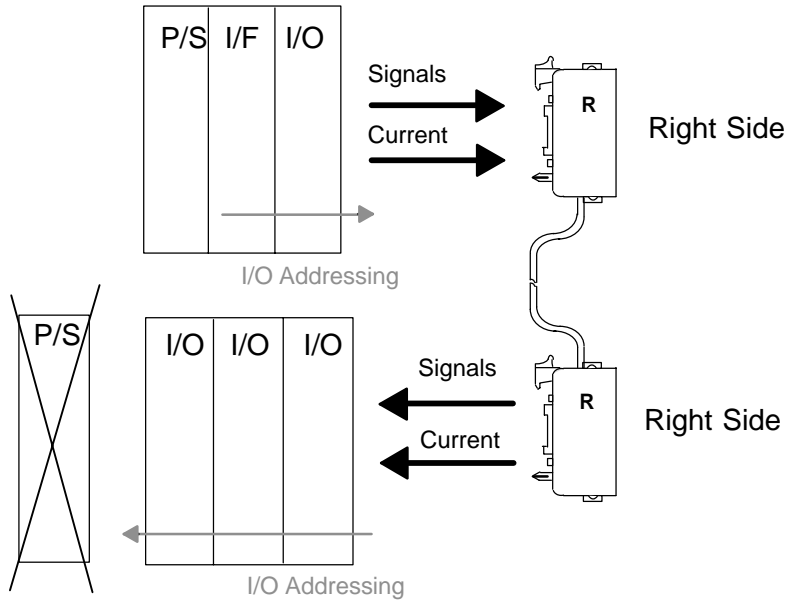
T1K-05CBL-RR-1 has 24VDC cable attached here

Cable Length: 50cm



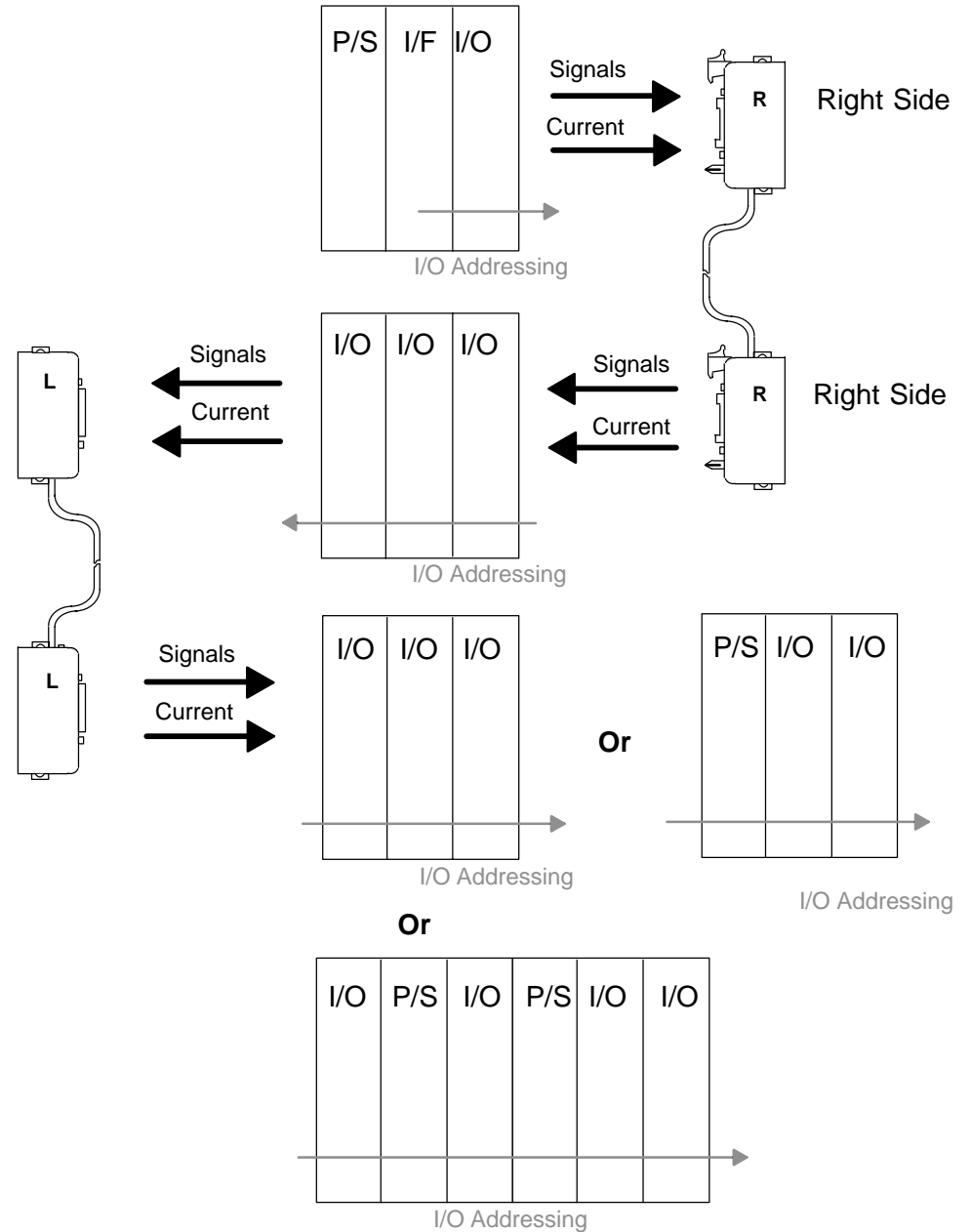
T1K-05CBL-RR-1 has 24VDC cable attached here

This is an example using the T1K-05CBL-RR(T1K-05CBLRR-1) cable. It is always connected from the right side to the right side.



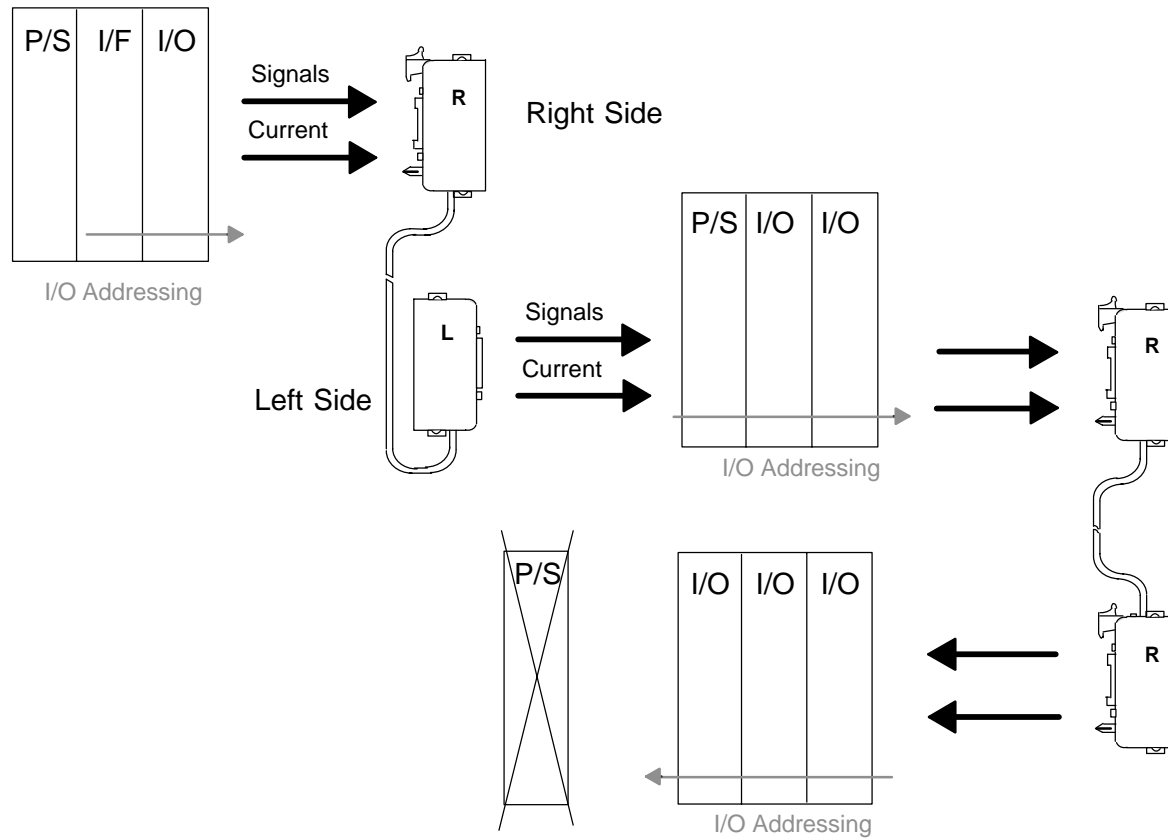
Note: Do not put a power supply (P/S) on the expansion row in this example.

When another expansion row is added to the example on the left, a T1K-05CBL-LL(T1K-05LL-1) cable is used. It is always connected from the left side to the left side, but it is never used as the first cable.



Note: Another P/S can be put on the expansion row that is connected through the T1K-05CBL-LL cable.

In this example, a T1K-10CBL is used to connect the local base I/O to an expansion row that has a power supply (P/S) installed in the first position on the row. The next expansion row, without a P/S, is connected using a T1K-05CBL-RR-1 cable.



Note: Do not put a power supply (P/S) on the last expansion row in this example.



# I/O Memory Map and Analog Module Resolution

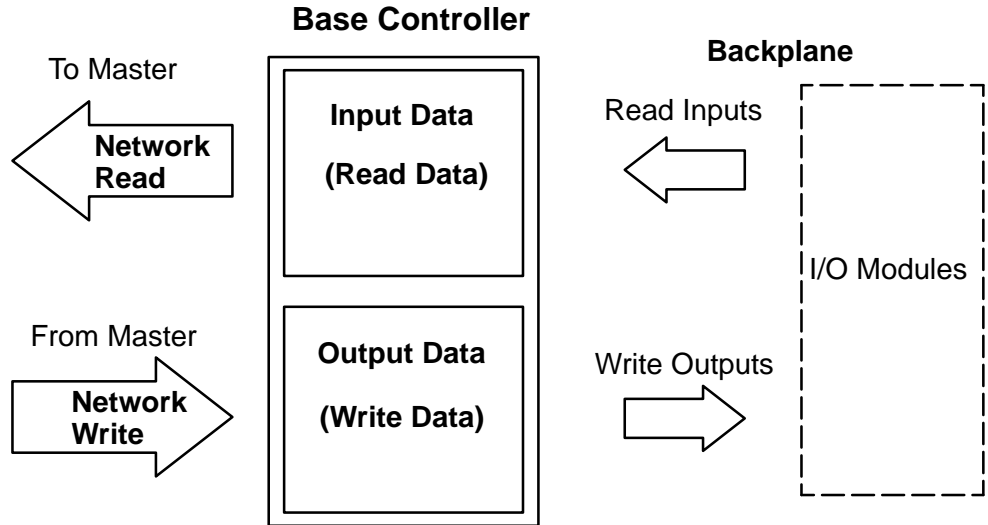
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In This Chapter. . . .

- Master/Slave Communications
  - Terminator I/O Backplane Communications
  - Discrete Input Module Memory Map
  - Discrete Output Module Memory Map
  - Discrete Output Module Status Byte
  - Analog Input Module Memory Map
  - Analog Input Module Resolution
  - Analog Output Module Memory Map
  - Analog Output Module Control Byte
  - Analog Output Module Resolution
-

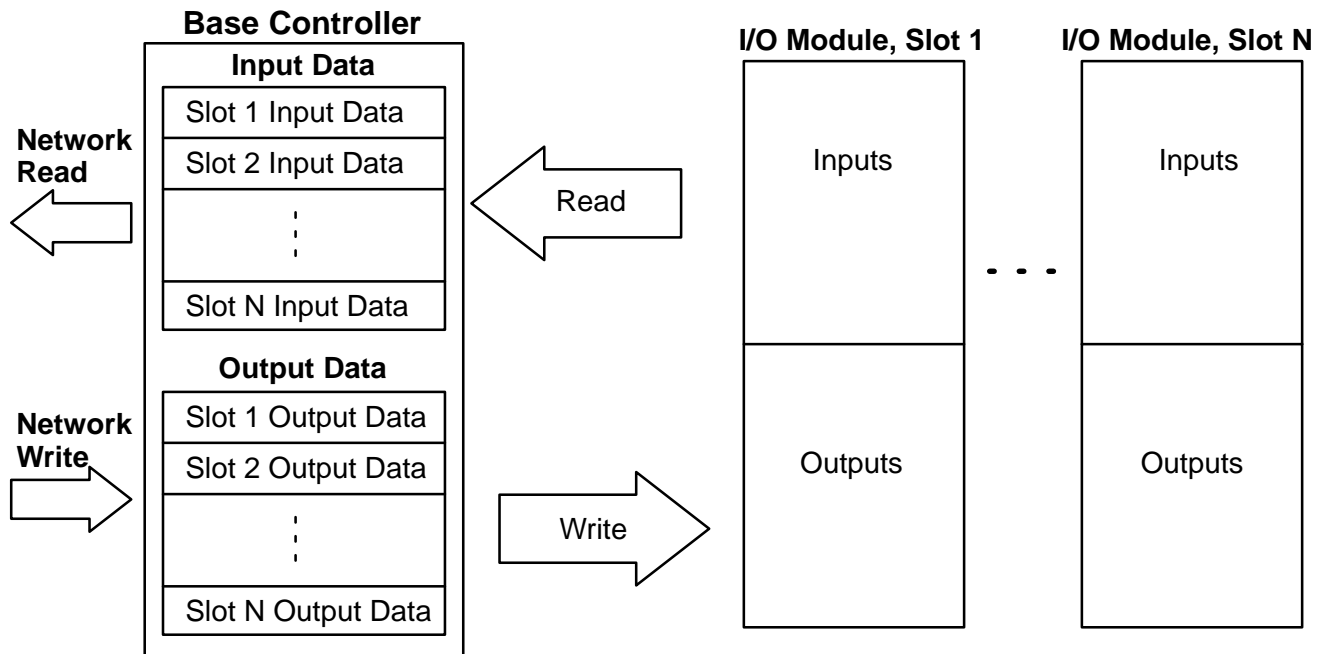
## Master/Slave Communications

The base controller (slave) communicates with the master by sending Input Data and receiving Output Data. The base controller *reads* Inputs from I/O Modules and *writes* Outputs to I/O Modules.



## Terminator I/O Backplane Communications

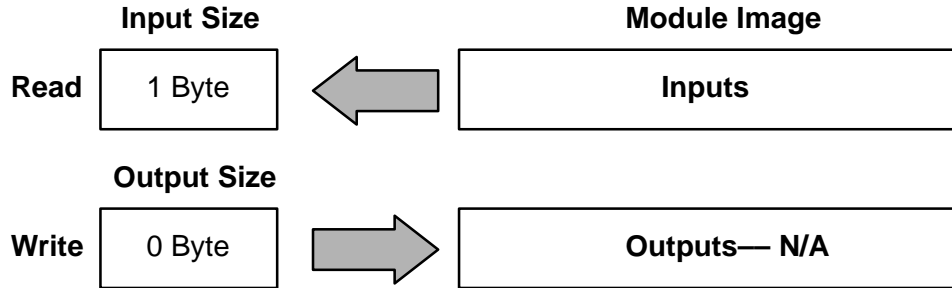
The base controller communicates with its I/O modules over the backplane. The I/O is mapped in consecutive order as shown.



# Discrete Input Module Memory Map

## 8-Point Discrete Input Modules (T1K-08NA-1 and T1K-08ND3)

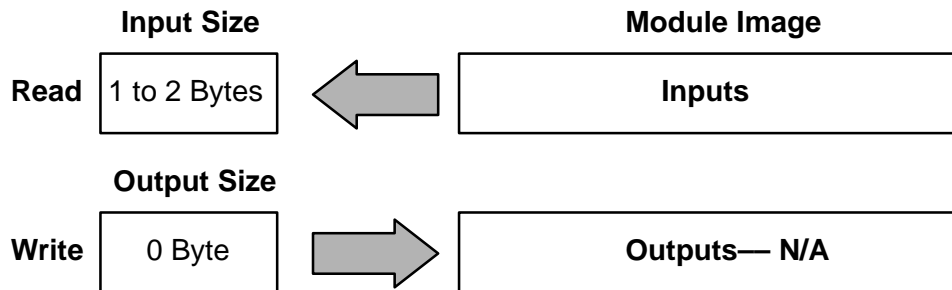
### Image Table Mapping



Memory Map of 8-Point Discrete Input Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	X7	X6	X5	X4	X3	X2	X1	X0	Read Byte 1
Not Used									Write Byte 1

## 16-Point Discrete Input Modules (T1K-16NA-1 and T1K-16ND3)

### Image Table Mapping

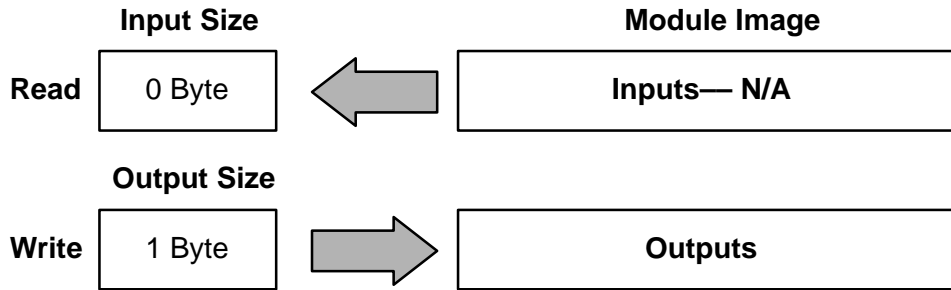


Memory Map of 16-Point Discrete Input Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	X7	X6	X5	X4	X3	X2	X1	X0	Read Byte 1
	X17	X16	X15	X14	X13	X12	X11	X10	Read Byte 2
Not Used									Write Byte 1

# Discrete Output Module Memory Map

## 8-Point Discrete Output Modules (T1K-08TA(S), T1K-08TD1, T1K-08TD2-1 and T1K-08TR(S))

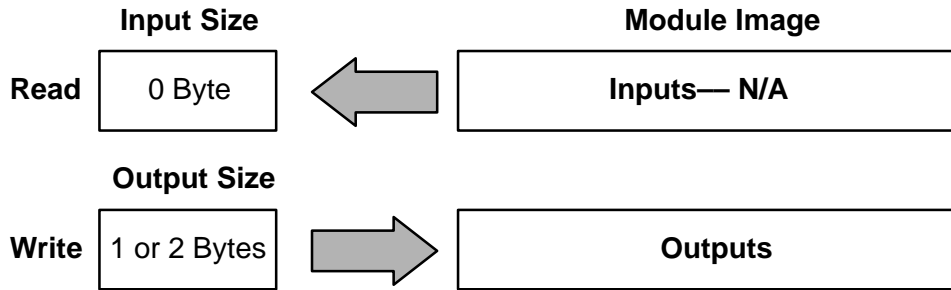
### Image Table Mapping



Memory Map of 8-Point Discrete Output Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
Not Used									Read Byte 1
	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	Write Byte 1

## 16-Point Discrete Output Modules (T1K-16TA, T1K-16TD1, T1K-16TD2-1 and T1K-16TR)

### Image Table Mapping

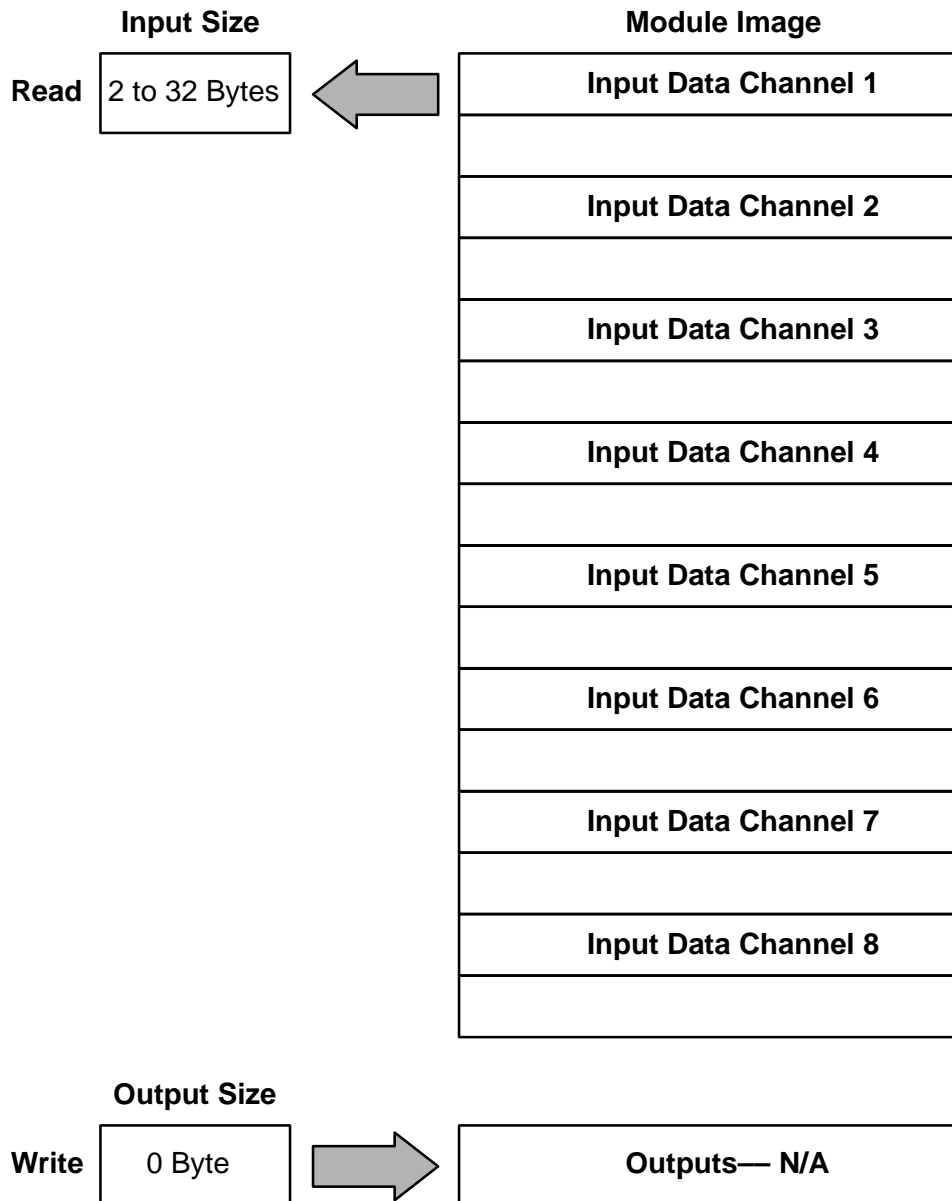


Memory Map of 16-Point Discrete Input Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
Not Used									Read Byte 1
	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	Write Byte 1
	Y17	Y16	Y15	Y14	Y13	Y12	Y11	Y10	Write Byte 2

# Analog Input Module Memory Map

## 8-Channel Analog Input Module (T1F-08AD-x)

### Image Table Mapping

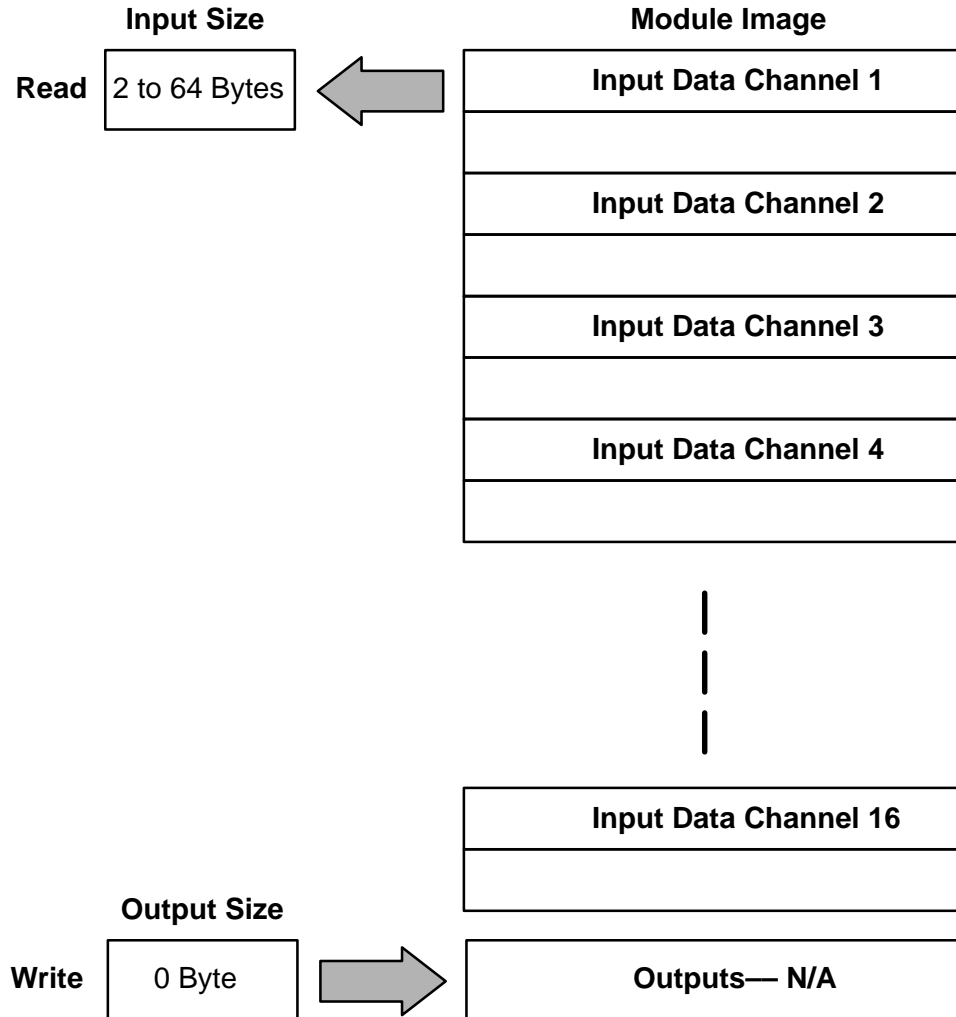


Memory Map of 8-Channel Analog Input Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Read Byte 1
	Analog Value Channel 1								Read Byte 2
	not used								Byte3
	reserved for future use								Byte4
	Analog Value Channel 2								Read Byte 5
	Analog Value Channel 2								Read Byte 6
	not used								Byte7
	reserved for future use								Byte8
	Analog Value Channel 3								Read Byte 9
	Analog Value Channel 3								Read Byte 10
	not used								Byte11
	reserved for future use								Byte12
	Analog Value Channel 4								Read Byte 13
	Analog Value Channel 4								Read Byte 14
	not used								Byte15
	reserved for future use								Byte16
	Analog Value Channel 5								Read Byte 17
	Analog Value Channel 5								Read Byte 18
	not used								Byte19
	reserved for future use								Byte20
	Analog Value Channel 6								Read Byte 21
	Analog Value Channel 6								Read Byte 22
	not used								Byte23
	reserved for future use								Byte24
	Analog Value Channel 7								Read Byte 25
	Analog Value Channel 7								Read Byte 26
	not used								Byte27
	reserved for future use								Byte28
	Analog Value Channel 8								Read Byte 29
	Analog Value Channel 8								Read Byte 30
	not used								Byte31
	reserved for future use								Byte32
	Not Used								Write Byte 1

### 16-Channel Analog Input Module (T1F-16AD-x, T1F-16RTD and T1F-14THM)

**NOTE:** Eventhough the T1F-14THM only has 14 channels, the module consumes 16 channels of memory (16 double words). The first 14 channels are used for input data.

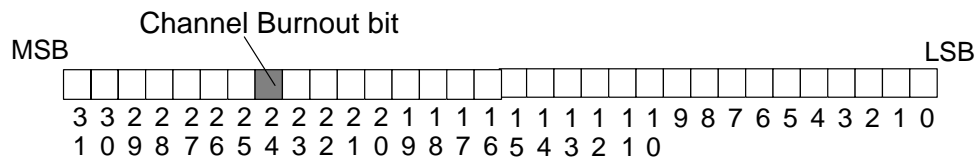
#### Image Table Mapping



I/O Memory Map and Analog Module Resolution

**T1F-14THM and T1F-16RTD Channel Burnout Bit**

**NOTE:** The T1F-14THM can be configured for Magnitude plus sign bit or 2's complement data format. The T1F-16RTD processes negative temperatures in 2's Complement format only. See the Module Data Sheets in chapter 3 for configuration information.



Memory Map of 16-Channel Analog Input Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Read Byte 1
	Analog Value Channel 1								Read Byte 2
	not used								Byte3
	reserved for future use								Byte4
	Analog Value Channel 2								Read Byte 5
	Analog Value Channel 2								Read Byte 6
	not used								Byte7
	reserved for future use								Byte8
	Analog Value Channel 3								Read Byte 9
	Analog Value Channel 3								Read Byte 10
	not used								Byte11
	reserved for future use								Byte12
	Analog Value Channel 4								Read Byte 13
	Analog Value Channel 4								Read Byte 14
	not used								Byte15
	reserved for future use								Byte16
	Analog Value Channel 5								Read Byte 17
	Analog Value Channel 5								Read Byte 18
	not used								Byte19
	reserved for future use								Byte20
	Analog Value Channel 6								Read Byte 21
	Analog Value Channel 6								Read Byte 22
	not used								Byte23
	reserved for future use								Byte24
	Analog Value Channel 7								Read Byte 25
	Analog Value Channel 7								Read Byte 26
	not used								Byte27
	reserved for future use								Byte28
	Analog Value Channel 8								Read Byte 29
	Analog Value Channel 8								Read Byte 30
	not used								Byte31
	reserved for future use								Byte32



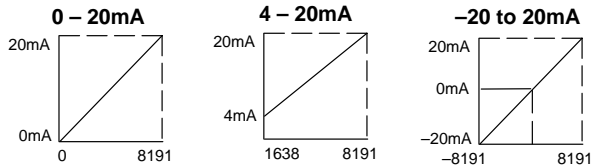
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 9								Read Byte 33
	Analog Value Channel 9								Read Byte 34
	not used								Byte35
	reserved for future use								Byte36
	Analog Value Channel 10								Read Byte 37
	Analog Value Channel 10								Read Byte 38
	not used								Byte39
	reserved for future use								Byte40
	Analog Value Channel 11								Read Byte 41
	Analog Value Channel 11								Read Byte 42
	not used								Byte43
	reserved for future use								Byte44
	Analog Value Channel 12								Read Byte 45
	Analog Value Channel 12								Read Byte 46
	not used								Byte47
	reserved for future use								Byte48
	Analog Value Channel 13								Read Byte 49
	Analog Value Channel 13								Read Byte 50
	not used								Byte51
	reserved for future use								Byte52
	Analog Value Channel 14								Read Byte 53
	Analog Value Channel 14								Read Byte 54
	not used								Byte55
	reserved for future use								Byte56
	Analog Value Channel 15								Read Byte 57
	Analog Value Channel 15								Read Byte 58
	not used								Byte59
	reserved for future use								Byte60
	Analog Value Channel 16								Read Byte 61
	Analog Value Channel 16								Read Byte 62
	not used								Byte63
	reserved for future use								Byte64
	Not Used								Write Byte 1

## Analog Input Module Resolution

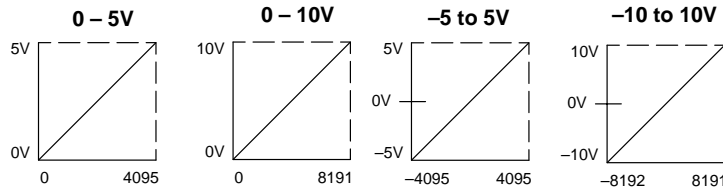
### Input Module Resolution

Since the module has 13-bit resolution, the analog signal is converted into 8192 counts ranging from 0-8191 ( $2^{13}$ ). For example, with a 0 to 10V scale, a 0V signal would be 0, and a 10V signal would be 8191. This is equivalent to a binary value of 0000 0000 0000 to 0001 1111 1111 1111, or 000 to 1FFF hexadecimal. The following diagram shows how this relates to each signal range.

### Current Input Module Resolution



### Voltage Input Module Resolution

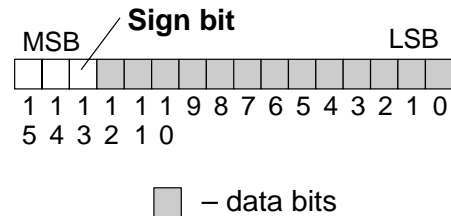


**NOTE:** The 0 – 5V and –5 to 5V range resolution is 4095, however, if the range is exceeded to 5.5V, for example, the digital input reading will reflect the correct value up to 10V (8191).  
The 4 – 20mA range is 1638 to 8191. If the input current signal level falls below 4mA, the correct value will be read down to 0mA.

### Channel Data Bits

The first thirteen bits represent the analog data in binary format. The fourteenth bit is the data sign bit.

Bit	Value	Bit	Value
0	1	7	128
1	2	8	256
2	4	9	512
3	8	10	1024
4	16	11	2048
5	32	12	4096
6	64	13	<b>Sign Bit</b>



**NOTE:** Each Analog channel uses 4 bytes. The first and second byte contain the analog data. The third and fourth byte are not used at this time.

Each count can also be expressed in terms of the signal level by using the equation shown. The following table shows the smallest signal levels that will result in a change in the data value for each signal range.

$$\text{SmallestDetectableChange} = \frac{H - L}{\text{Resolution}}$$

H = high limit of the signal range

L = low limit of the signal range

Range	Signal Span (H - L)	Divide By	Smallest Detectable Change
± 10V	20 V	16383	1.22 mV
± 5V	10 V	8191	1.22 mV
0 to 5V	5 V	4095	1.22 mV
0 to 10V	10 V	8191	1.22 mV
0 to 20mA	20 mA	8191	2.44 μA
4 to 20mA	16 mA	(8191-1638)	2.44 μA
± 20mA	40 mA	16383	2.44 μA

### Analog and Digital Value Conversions

Sometimes it is helpful to be able to quickly convert between the signal levels and the digital values. This is especially useful during machine startup or troubleshooting. The following table provides formulas to make this conversion easier.

Range	If you know the digital value ...	If you know the signal level ...
-10V to + 10V	$A = \frac{20D}{8191} - 10$	$D = \frac{8191}{20}(A + 10)$
-5V to + 5V	$A = \frac{10D}{4095} - 5$	$D = \frac{4095}{10}(A + 5)$
0 to 5V	$A = \frac{5D}{4095}$	$D = \frac{4095}{5}(A)$
0 to 10V	$A = \frac{10D}{8191}$	$D = \frac{8191}{10}(A)$
0 to 20mA	$A = \frac{20D}{8191}$	$D = \frac{4095}{4}(A)$
4 to 20mA	$A = \frac{16D}{6553}$	$D = \frac{6553}{16}(A)$
-20 mA to + 20mA	$A = \frac{40D}{8191} - 20$	$D = \frac{8191}{40}(A + 20)$

For example, if you are using the -10V to +10V range and you have measured the signal at 6V, you would use the following formula to determine the digital value that should be stored in the V-memory location that contains the data.

$$D = \frac{8191}{20}(A + 10)$$

$$D = \frac{8191}{20}(6V + 10)$$

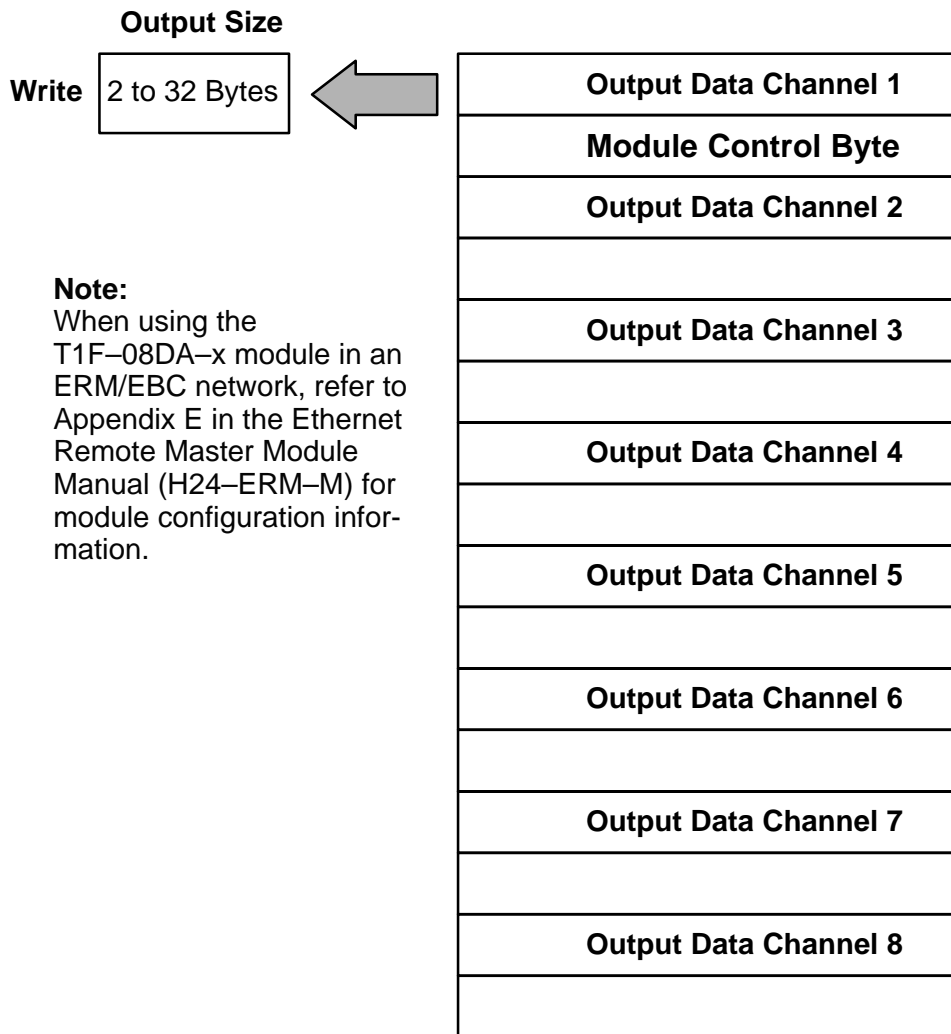
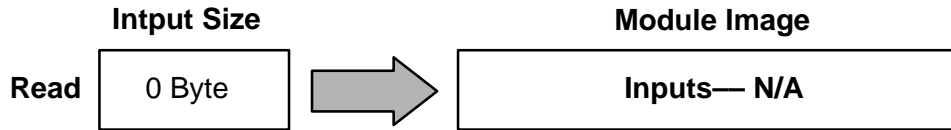
$$D = (409.55) (16)$$

$$D = 6552$$

# Analog Output Module Memory Map

## 8-Channel Analog Output Module (T1F-08DA-x)

### Image Table Mapping

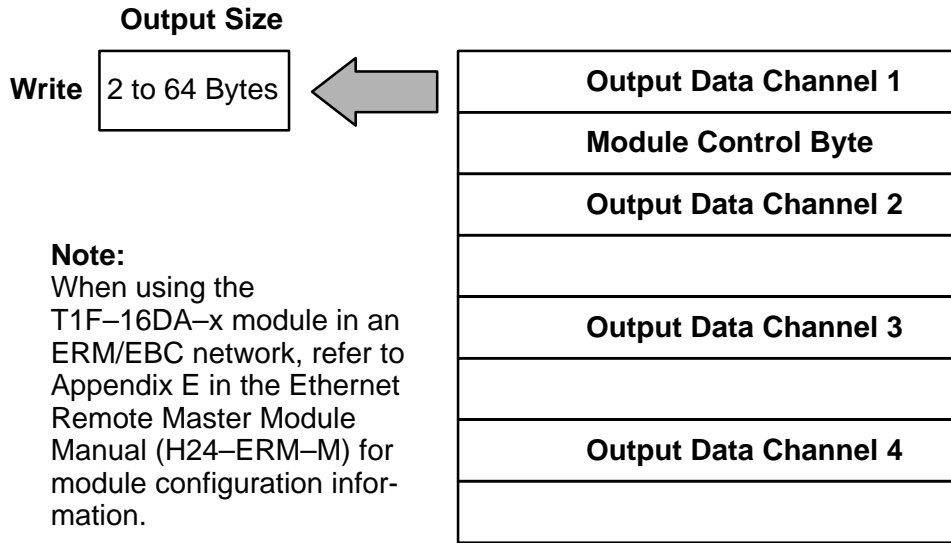
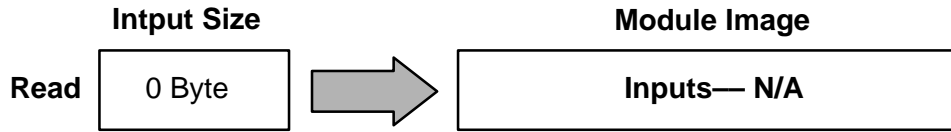


**Note:**  
When using the T1F-08DA-x module in an ERM/EBC network, refer to Appendix E in the Ethernet Remote Master Module Manual (H24-ERM-M) for module configuration information.

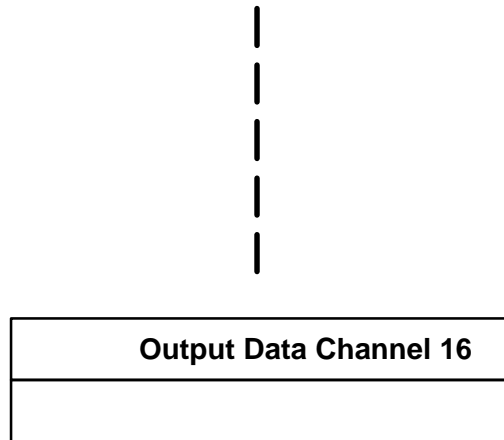
Memory Map of 8-Channel Analog Output Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Not Used								Read Byte 1
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	not used								Byte3
	<b>Module Control Byte</b>								Write Byte 4
	Analog Value Channel 2								Write Byte 5
	Analog Value Channel 2								Write Byte 6
	not used								Byte7
	reserved for future use								Byte8
	Analog Value Channel 3								Write Byte 9
	Analog Value Channel 3								Write Byte 10
	not used								Byte11
	reserved for future use								Byte12
	Analog Value Channel 4								Write Byte 13
	Analog Value Channel 4								Write Byte 14
	not used								Byte15
	reserved for future use								Byte16
	Analog Value Channel 5								Write Byte 17
	Analog Value Channel 5								Write Byte 18
	used not								Byte19
	reserved for future use								Byte20
	Analog Value Channel 6								Write Byte 21
	Analog Value Channel 6								Write Byte 22
	not used								Byte23
	reserved for future use								Byte24
	Analog Value Channel 7								Write Byte 25
	Analog Value Channel 7								Write Byte 26
	not used								Byte27
	reserved for future use								Byte28
	Analog Value Channel 8								Write Byte 29
	Analog Value Channel 8								Write Byte 30
	not used								Byte31
	reserved for future use								Byte32

### 16-Channel Analog Output Module (T1F-16DA-x)

#### Image Table Mapping



**Note:**  
When using the T1F-16DA-x module in an ERM/EBC network, refer to Appendix E in the Ethernet Remote Master Module Manual (H24-ERM-M) for module configuration information.



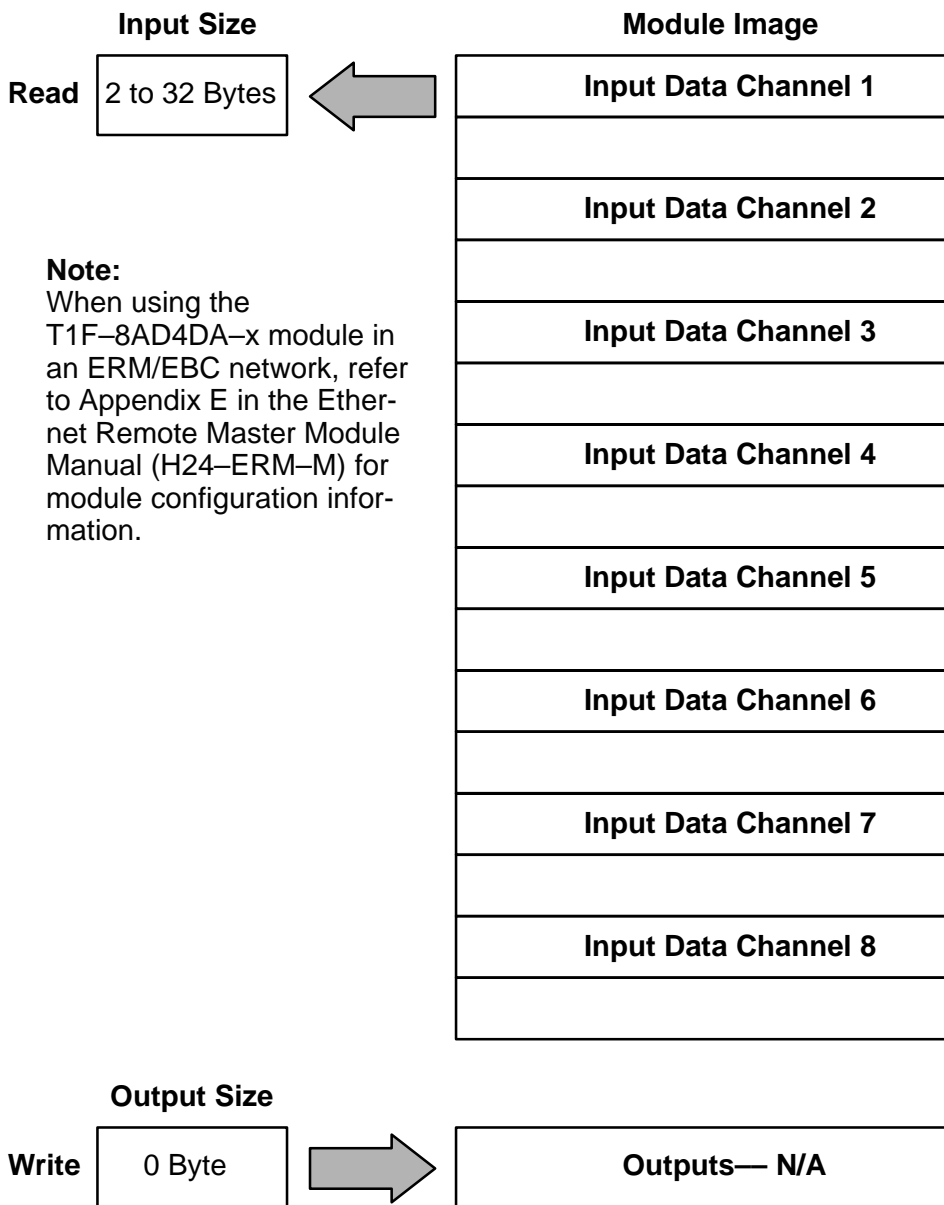
Memory Map of 16-Channel Analog Output Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Not Used								Read Byte 1
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	not used								Byte3
	<b>Module Control Byte</b>								Write Byte 4
	Analog Value Channel 2								Write Byte 5
	Analog Value Channel 2								Write Byte 6
	not used								Byte7
	reserved for future use								Byte8
	Analog Value Channel 3								Write Byte 9
	Analog Value Channel 3								Write Byte 10
	not used								Byte11
	reserved for future use								Byte12
	Analog Value Channel 4								Write Byte 13
	Analog Value Channel 4								Write Byte 14
	not used								Byte15
	reserved for future use								Byte16
	Analog Value Channel 5								Write Byte 17
	Analog Value Channel 5								Write Byte 18
	not used								Byte19
	reserved for future use								Byte20
	Analog Value Channel 6								Write Byte 21
	Analog Value Channel 6								Write Byte 22
	not used								Byte23
	reserved for future use								Byte24
	Analog Value Channel 7								Write Byte 25
	Analog Value Channel 7								Write Byte 26
	not used								Byte27
	reserved for future use								Byte28
	Analog Value Channel 8								Write Byte 29
	Analog Value Channel 8								Write Byte 30
	not used								Byte31
	reserved for future use								Byte32

Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 9								Write Byte 33
	Analog Value Channel 9								Write Byte 34
	not used								Byte35
	reserved for future use								Byte36
	Analog Value Channel 10								Write Byte 37
	Analog Value Channel 10								Write Byte 38
	not used								Byte39
	reserved for future use								Byte40
	Analog Value Channel 11								Write Byte 41
	Analog Value Channel 11								Write Byte 42
	not used								Byte43
	reserved for future use								Byte44
	Analog Value Channel 12								Write Byte 45
	Analog Value Channel 12								Write Byte 46
	not used								Byte47
	reserved for future use								Byte48
	Analog Value Channel 13								Write Byte 49
	Analog Value Channel 13								Write Byte 50
	not used								Byte51
	reserved for future use								Byte52
	Analog Value Channel 14								Write Byte 53
	Analog Value Channel 14								Write Byte 54
	not used								Byte55
	reserved for future use								Byte56
	Analog Value Channel 15								Write Byte 57
	Analog Value Channel 15								Write Byte 58
	not used								Byte59
	reserved for future use								Byte60
	Analog Value Channel 16								Write Byte 61
	Analog Value Channel 16								Write Byte 62
	not used								Byte63
	reserved for future use								Byte64



### 8-Channel Analog Input / 4-Channel Analog Output Module (T1F-8AD4DA-x)

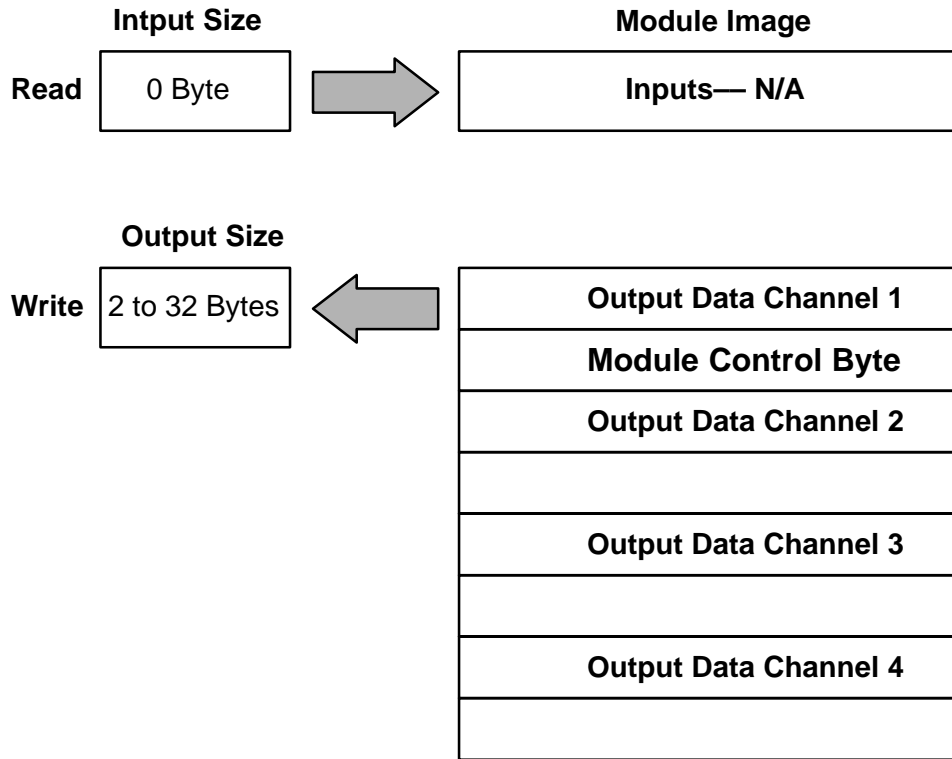
#### Input Image Table Mapping



**Note:**  
When using the T1F-8AD4DA-x module in an ERM/EBC network, refer to Appendix E in the Ethernet Remote Master Module Manual (H24-ERM-M) for module configuration information.

**8-Channel Analog Input /  
4-Channel Analog Output Module  
(T1F-8AD4DA-x)**

**Output Image Table Mapping**



Memory Map of the 8 Analog Input Channels of the T1F-8AD4DA-x									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Read Byte 1
	Analog Value Channel 1								Read Byte 2
	not used								Byte3
	reserved for future use								Byte4
	Analog Value Channel 2								Read Byte 5
	Analog Value Channel 2								Read Byte 6
	not used								Byte7
	reserved for future use								Byte8
	Analog Value Channel 3								Read Byte 9
	Analog Value Channel 3								Read Byte 10
	not used								Byte11
	reserved for future use								Byte12
	Analog Value Channel 4								Read Byte 13
	Analog Value Channel 4								Read Byte 14
	not used								Byte15
	reserved for future use								Byte16
	Analog Value Channel 5								Read Byte 17
	Analog Value Channel 5								Read Byte 18
	not used								Byte19
	reserved for future use								Byte20
	Analog Value Channel 6								Read Byte 21
	Analog Value Channel 6								Read Byte 22
	not used								Byte23
	reserved for future use								Byte24
	Analog Value Channel 7								Read Byte 25
	Analog Value Channel 7								Read Byte 26
	not used								Byte27
	reserved for future use								Byte28
	Analog Value Channel 8								Read Byte 29
	Analog Value Channel 8								Read Byte 30
	not used								Byte31
	reserved for future use								Byte32
	Not Used								Write Byte 1

Memory Map of the 4 Analog Output Channels of the T1F-8AD4DA-x									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Not Used								Read Byte 1
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	not used								Byte3
	<b>Module Control Byte</b>								Write Byte 4
	Analog Value Channel 2								Write Byte 5
	Analog Value Channel 2								Write Byte 6
	not used								Byte7
	reserved for future use								Byte8
	Analog Value Channel 3								Write Byte 9
	Analog Value Channel 3								Write Byte 10
	not used								Byte11
	reserved for future use								Byte12
	Analog Value Channel 4								Write Byte 13
	Analog Value Channel 4								Write Byte 14
	not used								Byte15
	reserved for future use								Byte16

## Analog Output Module Control Byte

Channel 1 Memory Map of 8&16-Channel Analog Output Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	not used								Byte3
	<b>Module Control Byte</b>								Write Byte 4

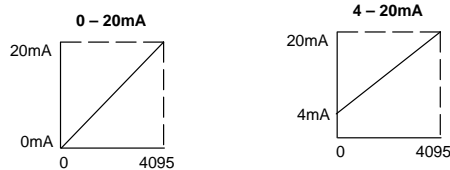
Module Control Byte of 8&16-Channel Analog Output Module									
Decimal Bit	31	30	29	28	27	26	25	24	Read/Write
Octal Bit	37	36	35	34	33	32	31	30	
Bit 24	<b>Outputs Enable</b> 0 = All outputs OFF 1 = All outputs Enabled								Write
Bit 25	<b>Unipolar / Bipolar</b> 0 = Unipolar selected 1 = Bipolar selected								Write
Bit 26	<b>5V / 10V Range</b> 0 = 5V range 1 = 10V range								Write
Bit 27	<b>0 – 20mA / 4–20mA Range</b> 0 = 0 – 20mA range 1 = 4 – 20mA range								Write
Bit 28 – 31	Reserved for system use								–

# Analog Output Module Resolution

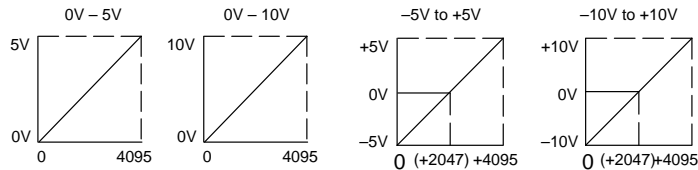
## Output Module Resolution

Since the module has 12-bit resolution, the analog signal is converted into 4096 counts ranging from 0-4095 ( $2^{12}$ ). For example, with a 0 to 10V scale, a 0V signal would be 0, and a 10V signal would be 4095. This is equivalent to a binary value of 0000 0000 0000 to 1111 1111 1111, or 000 to FFF hexadecimal. The following diagram shows how this relates to each signal range.

### Current Output Module Resolution



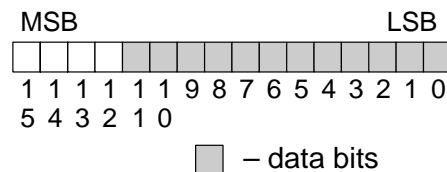
### Voltage Output Module Resolution



## Channel Data Bits

The first twelve bits represent the analog data in binary format.

Bit	Value	Bit	Value
0	1	6	64
1	2	7	128
2	4	8	256
3	8	9	512
4	16	10	1024
5	32	11	2048



**NOTE:** Each Analog channel uses 4 bytes. The first and second byte contain the analog data. The third and fourth byte are not used at this time.

Each count can also be expressed in terms of the signal level by using the equation shown. The following table shows the smallest signal levels that will result in a change in the data value for each signal range.

$$\text{SmallestDetectableChange} = \frac{H - L}{\text{Resolution}}$$

H = high limit of the signal range

L = low limit of the signal range

Range	Signal Span (H - L)	Divide By	Smallest Detectable Change
± 10V	20 V	4095	4.88 mV
± 5V	10 V	4095	2.44 mV
0 to 5V	5 V	4095	1.22 mV
0 to 10V	10 V	4095	2.44 mV
0 to 20mA	20 mA	4095	4.88 μA
4 to 20mA	16 mA	4095	3.91 μA

### Analog and Digital Value Conversions

Sometimes it is helpful to be able to quickly convert between the voltage or current signal levels and the digital values. This is especially helpful during machine startup or troubleshooting. The following table provides formulas to make this conversion easier.

Range	If you know the digital value ...	If you know the analog signal level ...
0 to 5V	$A = \frac{5D}{4095}$	$D = \frac{4095}{5} (A)$
0 to 10V	$A = \frac{10D}{4095}$	$D = \frac{4095}{10} (A)$
± 5V	$A = \frac{10D}{4095} - 5$	$D = \frac{4095}{10} (A + 5)$
± 10V	$A = \frac{20D}{4095} - 10$	$D = \frac{4095}{20} (A + 10)$
0 to 20mA	$A = \frac{20D}{4095}$	$D = \frac{4095}{20} (A)$
4 to 20mA	$A = \frac{16D}{4095} + 4$	$D = \frac{4095}{16} (A - 4)$

For example, if you are using the -10 to +10V range and you know you need a 6V signal level, you would use the following formula to determine the digital value that should be stored in the V-memory location that contains the data.

$$D = \frac{4095}{20} (A + 10)$$

$$D = \frac{4095}{20} (6V + 10)$$

$$D = (204.75) (16)$$

$$D = 3276$$

# European Union Directives (CE)

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In This Appendix. . . .

- European Union (EU) Directives
  - Basic EMC Installation Guidelines
-



## European Union (EU) Directives



**NOTE:** The information contained in this section is intended as a guideline and is based on our interpretation of the various standards and requirements. Since the actual standards are issued by other parties and in some cases Governmental agencies, the requirements can change over time without advance warning or notice. Changes or additions to the standards can possibly invalidate any part of the information provided in this section.

This area of certification and approval is absolutely vital to anyone who wants to do business in Europe. One of the key tasks that faced the EU member countries and the European Economic Area (EEA) was the requirement to harmonize several similar yet distinct standards together into one common standard for all members. The primary purpose of a harmonized standard was to make it easier to sell and transport goods between the various countries and to maintain a safe working and living environment. The Directives that resulted from this merging of standards are now legal requirements for doing business in Europe. Products that meet these Directives are required to have a CE mark to signify compliance.

**Member Countries** Currently, the members of the EU are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Iceland, Liechtenstein, and Norway together with the EU members make up the European Economic Area (EEA) and all are covered by the Directives.

**Applicable Directives** There are several Directives that apply to our products. Directives may be amended, or added, as required.

- **Electromagnetic Compatibility Directive (EMC)** — this Directive attempts to ensure that devices, equipment, and systems have the ability to function satisfactorily in their electromagnetic environment without introducing intolerable electromagnetic disturbance to anything in that environment.
- **Machinery Safety Directive** — this Directive covers the safety aspects of the equipment, installation, etc. There are several areas involved, including testing standards covering both electrical noise immunity and noise generation.
- **Low Voltage Directive** — this Directive is safety related and covers electrical equipment that has voltage ranges of 50–1000VAC and/or 75–1500VDC.
- **Battery Directive** — this Directive covers the production, recycling, and disposal of batteries.

**Compliance** Certain standards within each Directive already require mandatory compliance, such as the EMC Directive, which has gained the most attention, and the Low Voltage Directive.

Ultimately, we are all responsible for our various pieces of the puzzle. As manufacturers, we must test our products and document any test results and/or installation procedures that are necessary to comply with the Directives. As a machine builder, you are responsible for installing the products in a manner which will ensure compliance is maintained. You are also responsible for testing any combinations of products that may (or may not) comply with the Directives when used together.

The end user of the products must comply with any Directives that may cover maintenance, disposal, etc. of equipment or various components. *Although we strive to provide the best assistance available, it is impossible for us to test all possible configurations of our products with respect to any specific Directive. Because of this, it is ultimately your responsibility to ensure that your machinery (as a whole) complies with these Directives and to keep up with applicable Directives and/or practices that are required for compliance. **CE conformity will be impaired if the recommended installation guidelines are not met.***

Currently, the DL05, DL06, DL205, DL305, DL405 and Terminator I/O systems manufactured by Koyo Electronics Industries, FACTS Engineering or Host Engineering, when properly installed and used, conform to the Electromagnetic Compatibility (EMC) and Low Voltage Directive requirements of the following standards.

- **EMC Directive Standards Relevant to PLCs and Terminator I/O**
    - EN50081-1 Generic immunity standard for residential, commercial, \_\_\_\_\_ and light industry (DL05 only at this time)
    - EN50081-2 Generic emission standard for industrial environment.
    - EN50082-1 Generic immunity standard for residential, commercial, \_\_\_\_\_ and light industry
    - EN50082-2 Generic immunity standard for industrial environment.
  - **Low Voltage Directive Standards Applicable to PLCs and Terminator I/O**
    - EN61010-1 Safety requirements for electrical equipment for \_\_\_\_\_ measurement, control, and laboratory use.
  - **Product Specific Standard for PLCs and Terminator I/O**
    - EN61131-2 Programmable controllers, equipment requirements and tests. This standard replaces the above generic standards for immunity and safety. However, the generic emissions standards must still be used in conjunction with the following standards:
      - EN 61000-3-2—Harmonics
      - EN 61000-3-2—Fluctuations
- Automationdirect.com** is currently in the process of changing their testing procedures from the generic standards to the product specific standard, so that all new products will be tested to standard EN61131-2. Check our catalog or website for updated information.

### Special Installation Manual

The installation requirements to comply with the requirements of the Machinery Directive, EMC Directive and Low Voltage Directive are slightly more complex than the normal installation requirements found in the United States. To help with this, we have published a special manual which you can download from our website: [www.automationdirect.com](http://www.automationdirect.com)

- **DA-EU-M** – EU Installation Manual that covers special installation requirements to meet the EU Directive requirements. Download this manual to obtain the most up-to-date information.

### Other Sources of Information

Although the EMC Directive gets the most attention, other basic Directives, such as the Machinery Directive and the Low Voltage Directive, also place restrictions on the control panel builder. Because of these additional requirements it is recommended that the following publications be purchased and used as guidelines:

- BSI publication TH 42073: February 1996 – covers the safety and electrical aspects of the Machinery Directive
- EN 60204-1:1992 – General electrical requirements for machinery, including Low Voltage and EMC considerations

- IEC 1000-5-2: EMC earthing and cabling requirements
- IEC 1000-5-1: EMC general considerations

It may be possible for you to obtain this information locally; however, the official source of applicable Directives and related standards is:

**The Office for Official Publications of the European Communities**  
L-2985 Luxembourg; quickest contact is via the World Wide Web at  
[www.euro-op.eu.int](http://www.euro-op.eu.int)

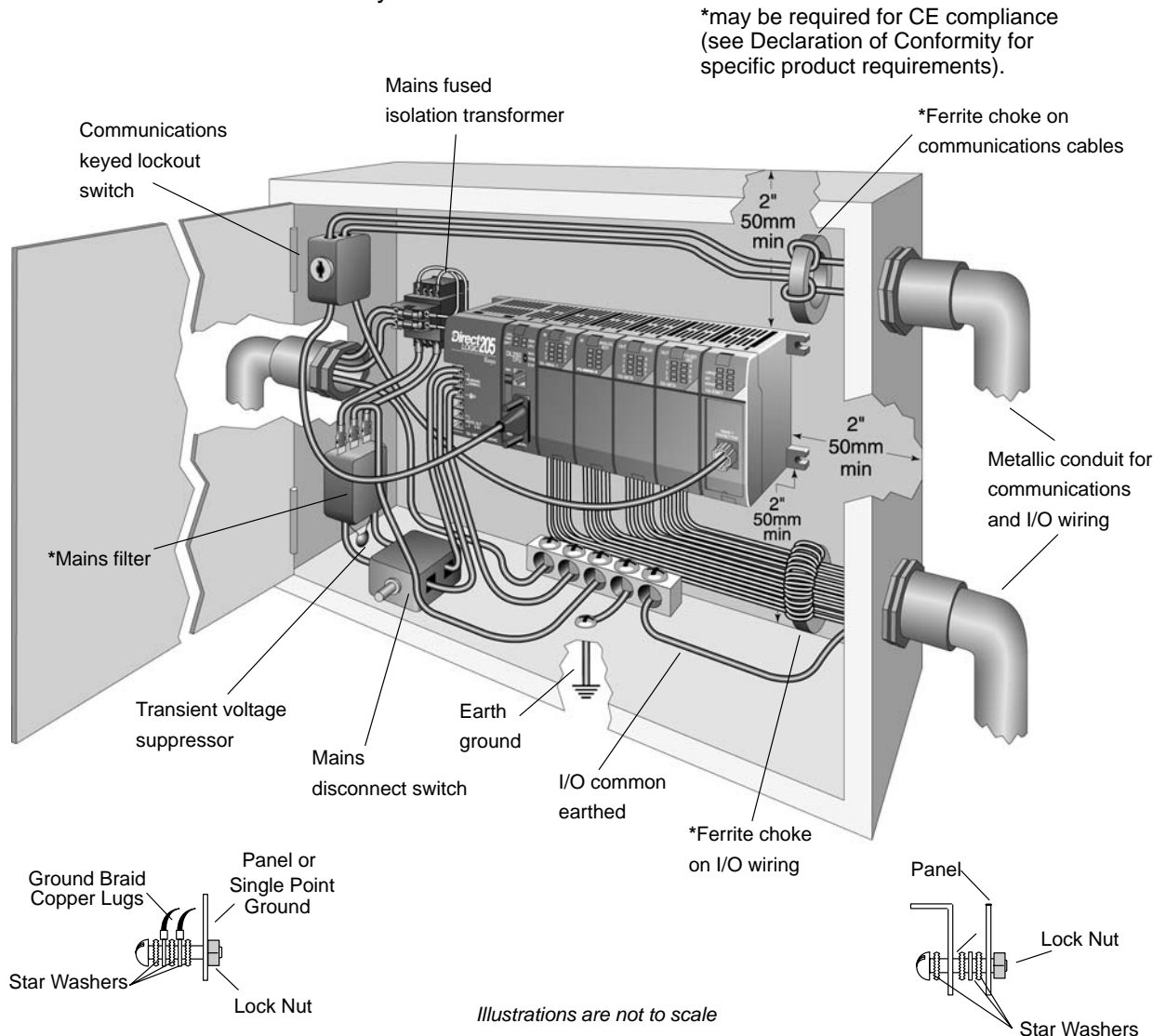
Another source is:

**Global Engineering Documents**  
[www.global.ihs.com](http://www.global.ihs.com)

## Basic EMC Installation Guidelines

### Enclosures

The following diagram illustrates good engineering practices supporting the requirements of the Machinery and Low Voltage Directives. House all control equipment in an industry standard lockable steel enclosure and use metallic conduit for wire runs and cables. The diagram applies to all **DirectLOGIC** PLC systems and Terminator I/O systems.



**Electrostatic Discharge (ESD)**

We specify in all declarations of conformity that our products are installed inside an industrial enclosure using metallic conduit for external wire runs; therefore, we test the products in a typical enclosure. However, we would like to point out that although our products operate normally in the presence of ESD, this is only the case when mounted within an enclosed industrial control cabinet. When the cabinet is open during installation or maintenance, the equipment and or programs may be at risk of damage from ESD carried by personnel.

We therefore recommend that all personnel take necessary precautions to avoid the risk of transferring static electricity to components inside the control cabinet. If necessary, clear warnings and instructions should be provided on the cabinet exterior, such as recommending the use of earth straps or similar devices, or the powering off of equipment inside the enclosure.

**Suppression and Fusing**

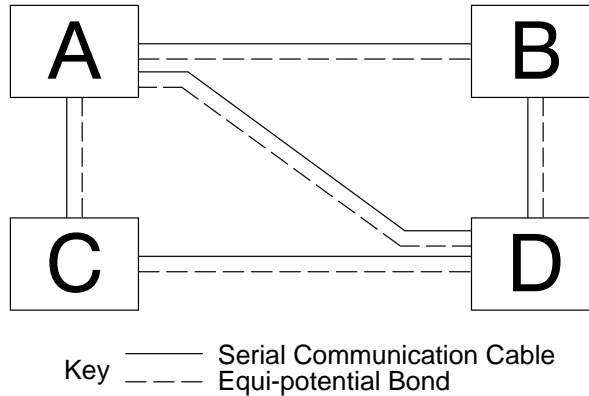
In order to comply with the fire risk requirements of the Low Voltage and Machinery Directive electrical standards EN 61010-1, and EN 60204-1, by limiting the power into “unlimited” mains circuits with power leads reversed, it is necessary to fuse both AC and DC supply inputs. You should also install a transient voltage suppressor across the power input connections of the PLC or Terminator I/O. Choose a suppressor such as a metal oxide varistor, with a rating of 275VAC working voltage for 230V nominal supplies (150VAC working voltage for 115V supplies) and high energy capacity (eg. 140 joules).

Transient suppressors must be protected by fuses and the capacity of the transient suppressor must be greater than the blow characteristics of the fuses or circuit breakers to avoid a fire risk. A recommended AC supply input arrangement for Koyo PLCs and Terminator I/O systems is to use twin 3 amp TT fused terminals with fuse blown indication, such as DINnectors DN-F10L terminals, or twin circuit breakers, wired to a Schaffner FN2010 filter or equivalent, with high energy transient suppressor soldered directly across the output terminals of the filter. PLC and Terminator I/O system inputs should also be protected from voltage impulses by deriving their power from the same fused, filtered, and surge-suppressed supply.

## Internal Enclosure Grounding

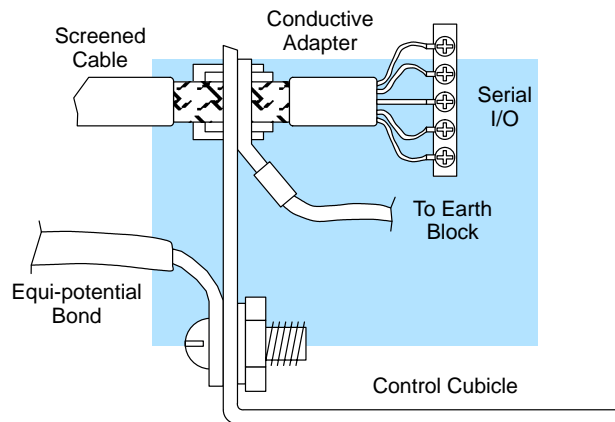
A heavy-duty star earth terminal block should be provided in every cubicle for the connection of all earth ground straps, protective earth ground connections, mains filter earth ground wires, and mechanical assembly earth ground connections. This should be installed to comply with safety and EMC requirements, local standards, and the requirements found in IEC 1000-5-2. The Machinery Directive also requires that the common terminals of PLC or Terminator I/O input modules, and common supply side of loads driven from PLC or Terminator I/O output modules should be connected to the protective earth ground terminal.

## Equi-potential Grounding



Adequate site earth grounding must be provided for equipment containing modern electronic circuitry. The use of isolated earth electrodes for electronic systems is forbidden in some countries. Make sure you check any requirements for your particular destination. IEC 1000-5-2 covers equi-potential bonding of earth grids adequately, but special attention should be given to apparatus and control cubicles that contain I/O devices, remote I/O racks, or have inter-system communications with the primary PLC or Terminator I/O system enclosure. An equi-potential bond wire must be provided alongside all serial communications cables, and to any separate items of the plant which contain I/O devices connected to the PLC or Terminator I/O system. The diagram shows an example of four physical locations connected by a communications cable.

## Communications and Shielded Cables



Good quality 24 AWG minimum twisted-pair shielded cables, with overall foil and braid shields are recommended for analog cabling and communications cabling outside of the PLC or Terminator I/O enclosure.

To date it has been a common practice to only provide an earth ground for one end of the cable shield in order to minimize the risk of noise caused by earth ground loop currents between apparatus. The procedure of only grounding one end, which primarily originated as a result of trying to reduce hum in audio systems, is no longer applicable to the complex industrial environment. Shielded cables are also efficient emitters of RF noise from the PLC or Terminator I/O system, and can interact in a parasitic manner in networks and between multiple sources of interference.

The recommendation is to use shielded cables as electrostatic “pipes” between apparatus and systems, and to run heavy gauge equi-potential bond wires alongside all shielded cables. When a shielded cable runs through the metallic wall of an enclosure or machine, it is recommended in IEC 1000-5-2 that the shield should be connected over its full perimeter to the wall, preferably using a conducting adapter, and not via a pigtail wire connection to an earth ground bolt. Shields must be connected to every enclosure wall or machine cover that they pass through.



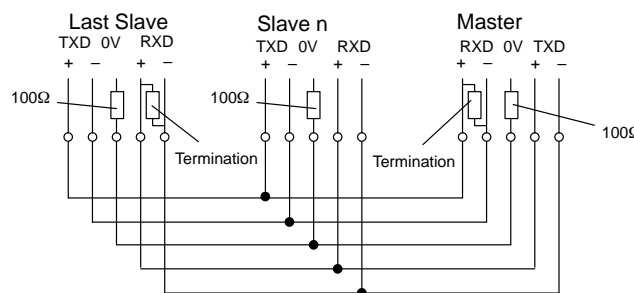
### Analog and RS232 Cables

**NOTE:** Cables, whether shielded or not MUST be enclosed within earthed metal conduit or other metallic trunking when outside the PLC or Terminator I/O enclosure.

Providing an earth ground for both ends of the shield for analog circuits provides the perfect electrical environment for the twisted pair cable as the loop consists of signal and return, in a perfectly balanced circuit arrangement, with connection to the common of the input circuitry made at the module terminals. RS232 cables are handled in the same way.

### Multidrop Cables

RS422 twin twisted pair, and RS485 single twisted pair cables also require a 0V link, which has often been provided in the past by the cable shield. It is now recommended that you use triple twisted pair cabling for RS422 links, and twin twisted pair cable for RS485 links. This is because the extra pair can be used as the 0V inter-system link. With loop DC power supplies earth grounded in both systems, earth loops are created in this manner via the inter-system 0v link. The installation guides encourage earth loops, which are maintained at a low impedance by using heavy equi-potential bond wires. **To account for non-European installations using single-end earth grounds, and sites with far from ideal earth ground characteristics, we recommend the addition of 100 ohm resistors at each 0V link connection in network and communications cables.**



### Shielded Cables within Enclosures

When you run cables between PLC or Terminator I/O items within an enclosure which also contains susceptible electronic equipment from other manufacturers, remember that these cables may be a source of RF emissions. There are ways to minimize this risk. Standard data cables connecting PLCs, Terminator I/O or operator interfaces should be routed well away from other equipment and their associated cabling. You can make special serial cables where the cable shield is connected to the enclosure's earth ground at both ends, the same way as external cables are connected.

**Network Isolation**

For safety reasons, it is a specific requirement of the Machinery Directive that a keyswitch must be provided that isolates any network input signal during maintenance, so that remote commands cannot be received that could result in the operation of the machinery. The FA-ISONET does not have a keyswitch. Use a keylock and switch on your enclosure which when open removes power from the FA-ISONET. To avoid the introduction of noise into the system, any keyswitch assembly should be housed in its own earth grounded steel box and the integrity of the shielded cable must be maintained.

Again, for further information on EU directives we recommend that you get a copy of our EU Installation Manual (DA-EU-M). Also, if you are connected to the World Wide Web, you can check the EU Commission's official site at: <http://eur-op.eu.int/>

**Items Specific to Terminator I/O**

- This equipment must be properly installed while adhering to the guidelines of the PLC or Terminator I/O installation manual DA-EU-M, and is suitable for EN 61010-1 installation categories 1 or 2.
- The rating between all circuits in this product are rated as **basic insulation only**, as appropriate for single fault conditions.
- The protection provided by the equipment may be impaired if the equipment is used in a manner not specified by the manufacturer.
- It is the responsibility of the system designer to earth one side of all control and power circuits, and to earth the braid of screened cables.
- Input power cables must be externally fused and have an externally mounted switch or circuit breaker, preferably mounted near the Terminator I/O system.
- When needed, carefully clean the outside plastic case of Terminator I/O components using a dry cloth.
- Only use replacement parts supplied by **Automationdirect.com** or its agents.
- Cables, whether shielded or not **MUST** be enclosed within earthed metal conduit or other metallic trunking when outside the Terminator I/O enclosure.
- This is a Class A product and it may cause radio interference in certain environments. The user may need to provide shielding, or other measures to eliminate the interference.