

I/O WIRING AND SPECIFICATIONS



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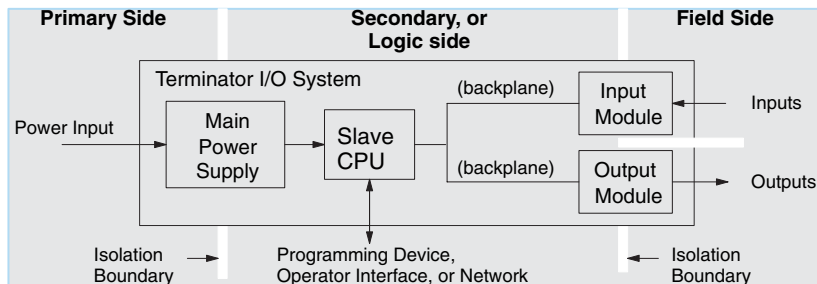
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I/O Wiring Strategies

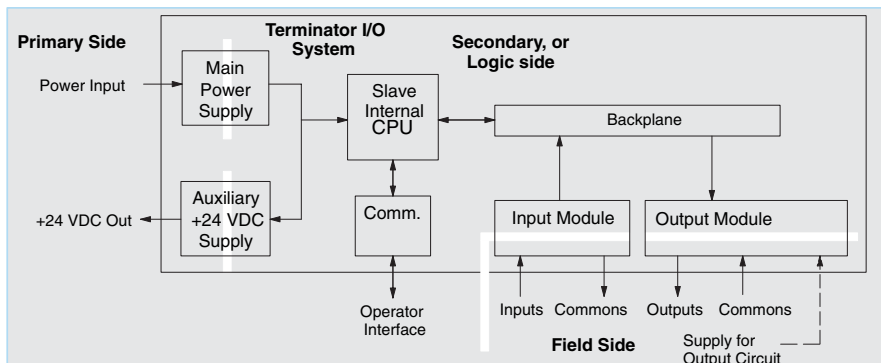
Terminator I/O System Isolation Boundaries

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.



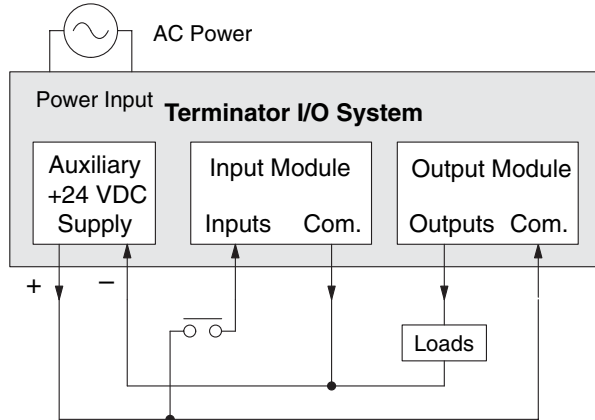
The next figure shows the physical layout of a Terminator I/O system, as viewed from the front. In addition to the basic circuits covered above, AC-powered bases include an auxiliary +24VDC power supply with its own isolation boundary. Since the supply output is isolated from the other three circuits,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



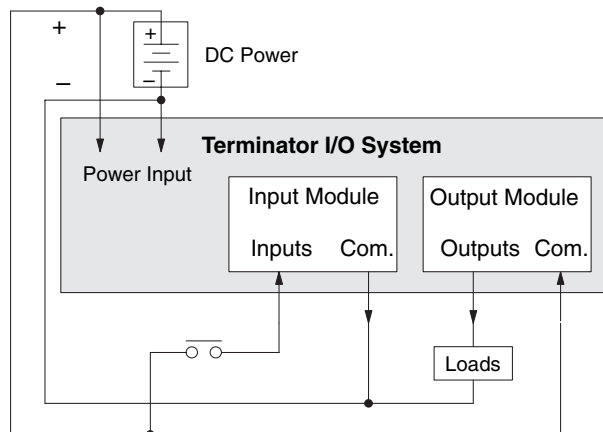
In some cases, using the built-in auxiliary +24VDC supply can result in a cost savings for your control system. It can power combined loads up to 500mA if power budget allows. Be careful not to exceed the current rating of the supply. If you are the system designer for your application, you may be able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



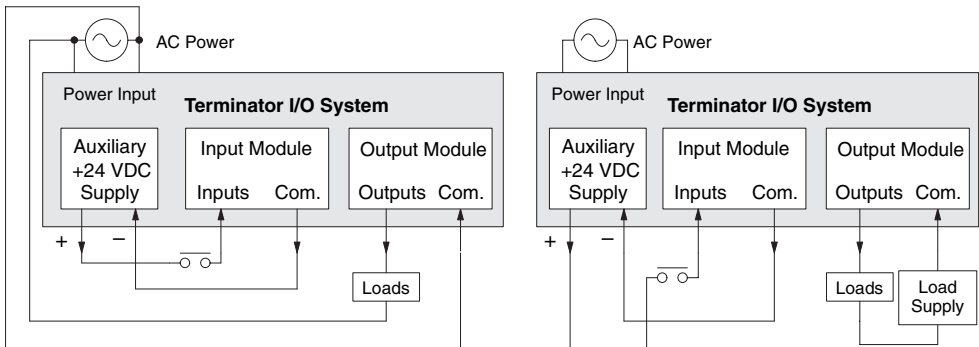
DC-powered units are designed for application environments in which low-voltage DC power is more readily available than AC. These include a wide range of battery-powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this type of application, all input devices 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

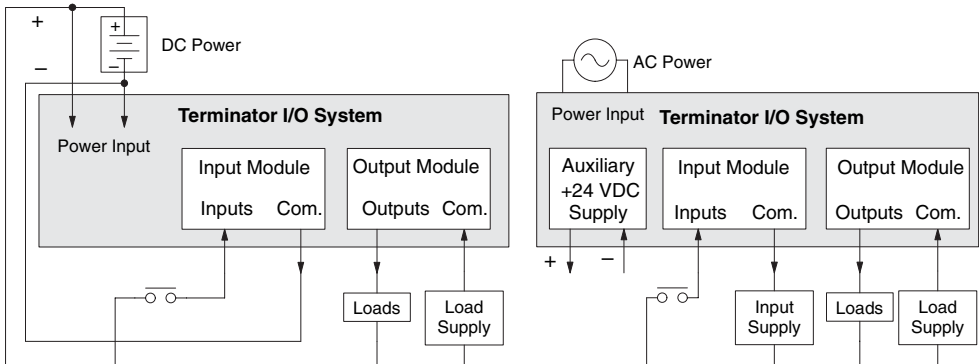
In most applications it will be necessary to power the input devices from one power source, and to power output loads from another source. Loads often require high-energy AC power, while input sensors use low-energy DC. If a machine operator is likely to come in close contact with input wiring, then 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 worse-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

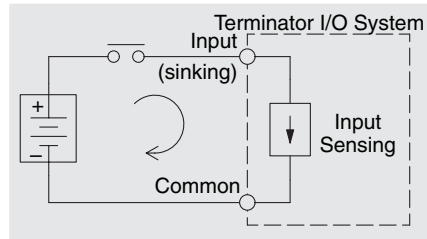
Before going further in the study of wiring strategies, you must have a solid understanding of “sinking” and “sourcing” concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring your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

Sinking = provides a path to supply ground (-)

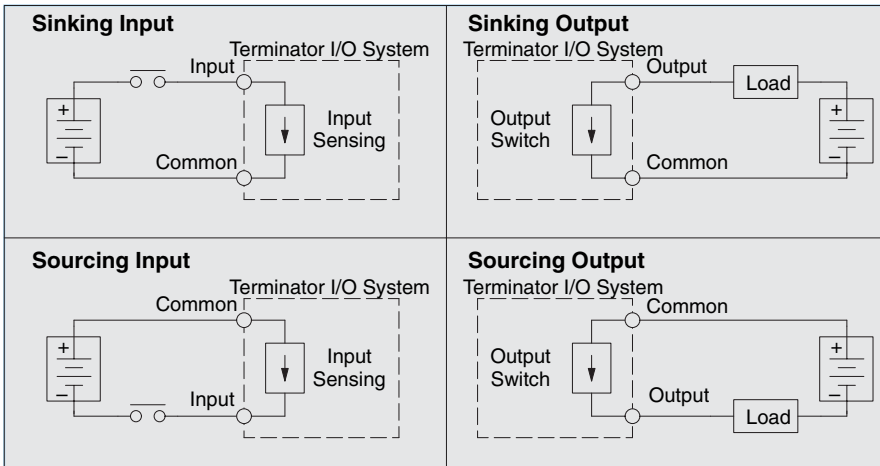
Sourcing = provides a path to supply source (+)

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.

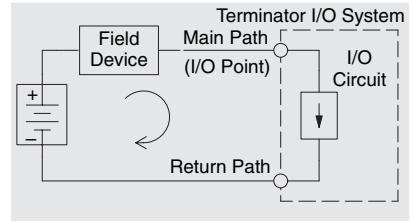


By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types as shown below. The I/O module specifications at the end of this chapter list the input or output type.

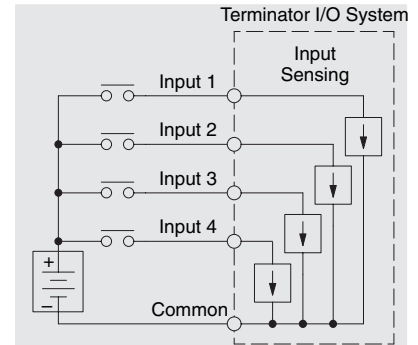


I/O “Common” Terminal Concepts

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..

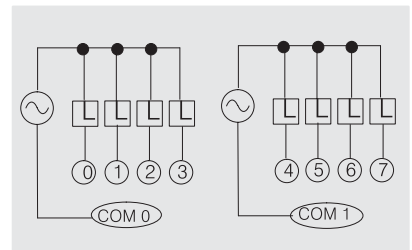


If there was unlimited space and budget for I/O terminals, every I/O point could have two dedicated terminals as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output points are in groups which share the 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.

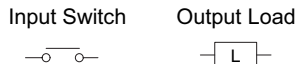
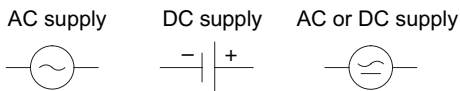


NOTE: In the circuit above, the current in the common path is 4 times any channel's input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons.

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 banks of circuits with four output points in each. The common terminal for each is labeled COM 0 and COM 1, respectively.



In this 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:

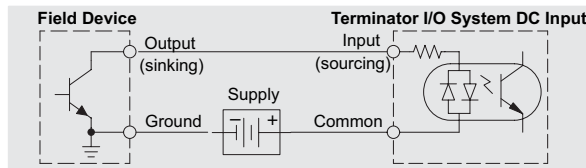


Connecting DC I/O to Solid State Field Devices

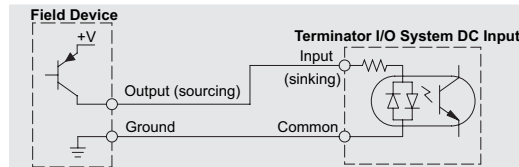
In the previous section on Sourcing and Sinking concepts, the DC I/O circuits were explained to only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *When connecting 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 +24V auxiliary supply or another supply (+12VDC or +24VDC), as long as the input specifications are met.



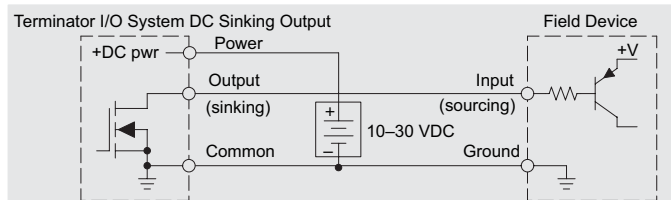
In the next circuit, a field device has an open-emitter PNP transistor output. It sources current to the input point, which sinks the current back to ground. Since the field device is sourcing current, no additional power supply is required.



Solid State Output Loads

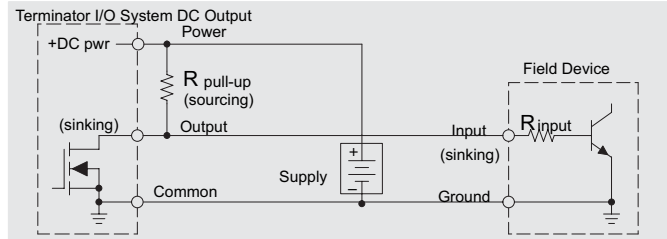
Sometimes an application requires connecting an output point to a solid state input on a device. This type of connection is usually made to carry a low-level control signal, not to send DC power to an actuator.

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.



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, resistor $R_{pull-up}$ is connected from the output to the DC output circuit power input.

Example: Circuit with no Suppression



NOTE 1: DO NOT attempt to drive a heavy load (>25mA) 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.

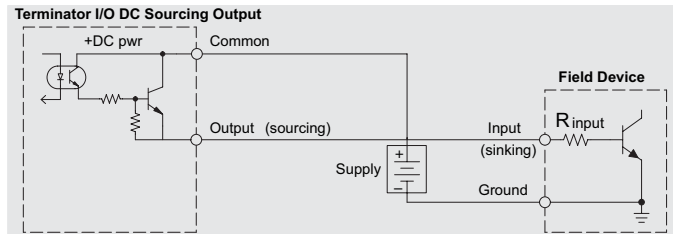
It is important to choose the correct value of $R_{pull-up}$. In order to do so, you need to know the nominal input current to the field device (I_{input}) when the input is energized. If this value is not known, it can be calculated as shown (a typical value is 15mA). Then use I_{input} and the voltage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

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

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

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

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:

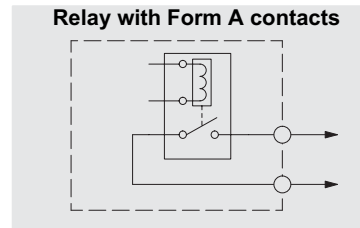
- Loads that require higher currents than the solid-state outputs can deliver
- Cost-sensitive applications
- Some output channels need isolation from other outputs (such as when some loads require different voltages than other loads)

Some applications in which NOT to use relays:

- Loads that require currents under 10mA
- 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 share common relay 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.



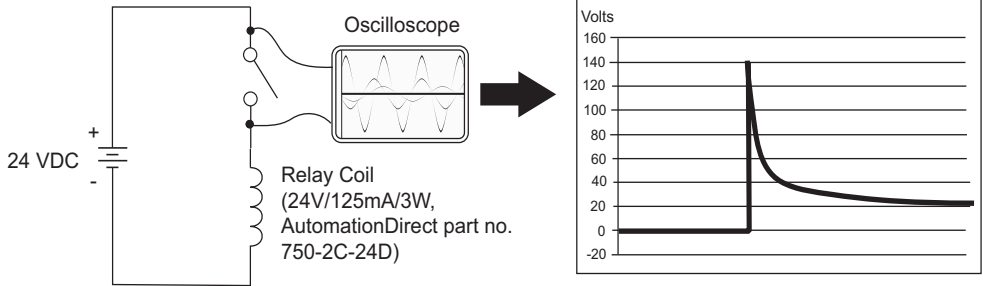
Relay Outputs - Transient Suppression for Inductive Loads in a Control System

The following pages are intended to give a quick overview of the negative effects of transient voltages on a control system and provide some simple advice on how to effectively minimize them. The need for transient suppression is often not apparent to the newcomers in the automation world. Many mysterious errors that can afflict an installation can be traced back to a lack of transient suppression.

What is a Transient Voltage and Why is it Bad?

Inductive loads (devices with a coil) generate transient voltages as they transition from being energized to being de-energized. If not suppressed, the transient can be many times greater than the voltage applied to the coil. These transient voltages can damage PLC outputs or other electronic devices connected to the circuit, and cause unreliable operation of other electronics in the general area. Transients must be managed with suppressors for long component life and reliable operation of the control system.

This example shows a simple circuit with a small 24V/125mA/3W relay. As you can see, when the switch is opened, thereby de-energizing the coil, the transient voltage generated across the switch contacts peaks at 140V.

Example: Circuit with no Suppression

In the same circuit, replacing the relay with a larger 24V/290mA/7W relay will generate a transient voltage exceeding 800V (not shown). Transient voltages like this can cause many problems, including:

- Relay contacts driving the coil may experience arcing, which can pit the contacts and reduce the relay's lifespan.
- Solid state (transistor) outputs driving the coil can be damaged if the transient voltage exceeds the transistor's ratings. In extreme cases, complete failure of the output can occur the very first time a coil is de-energized.
- Input circuits, which might be connected to monitor the coil or the output driver, can also be damaged by the transient voltage.

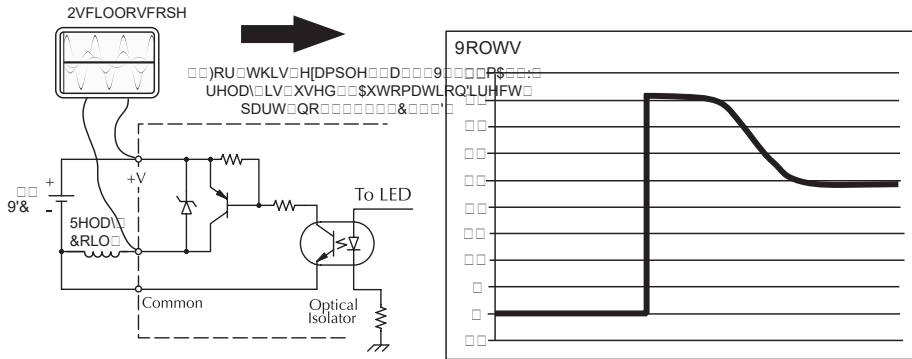
A very destructive side-effect of the arcing across relay contacts is the electromagnetic interference (EMI) it can cause. This occurs because the arcing causes a current surge, which releases RF energy. The entire length of wire between the relay contacts, the coil, and the power source carries the current surge and becomes an antenna that radiates the RF energy. It will readily couple into parallel wiring and may disrupt the PLC and other electronics in the area. This EMI can make an otherwise stable control system behave unpredictably at times.

PLC's Integrated Transient Suppressors

Although the PLC's outputs typically have integrated suppressors to protect against transients, they are not capable of handling them all. It is usually necessary to have some additional transient suppression for an inductive load.

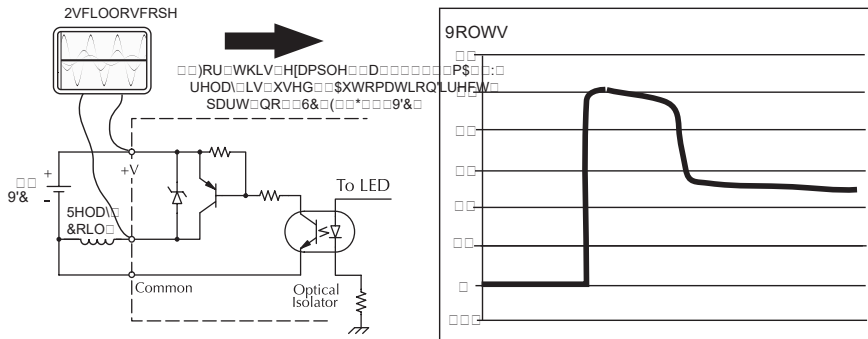
The next example uses the same 24V/125mA/3W relay used earlier. This example measures the PNP transistor output of a D0-06DD2 PLC, which incorporates an integrated Zener diode for transient suppression. Instead of the 140V peak in the first example, the transient voltage here is limited to about 40V by the Zener diode. While the PLC will probably tolerate repeated transients in this range for some time, the 40V is still beyond the module's peak output voltage rating of 30V.

Example: Small Inductive Load with Only Integrated Suppression



The next example uses the same circuit as above, but with a larger 24V/290mA/7W relay, thereby creating a larger inductive load. As you can see, the transient voltage generated is much worse, peaking at over 50V. Driving an inductive load of this size without additional transient suppression is very likely to permanently damage the PLC output.

Example: Larger Inductive Load with Only Integrated Suppression

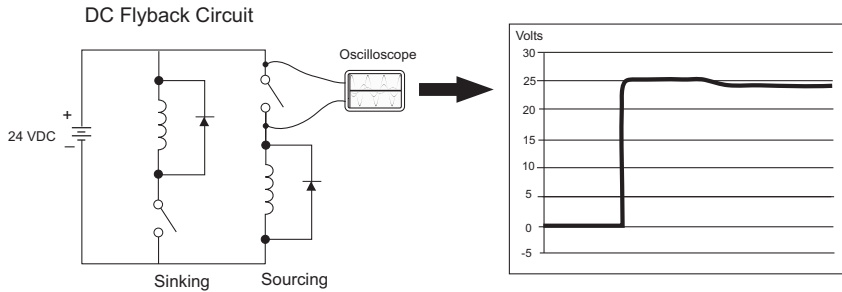


Additional transient suppression should be used in both these examples. If you are unable to measure the transients generated by the connected loads of your control system, using additional transient suppression on all inductive loads would be the safest practice.

Types of Additional Transient Protection

DC Coils:

The most effective protection against transients from a DC coil is a flyback diode. A flyback diode can reduce the transient to roughly 1V over the supply voltage, as shown in this example.



Many AutomationDirect socketed relays and motor starters have add-on flyback diodes that plug or screw into the base, such as the AD-ASMD-250 protection diode module and 784-4C-SKT-1 socket module shown below. If an add-on flyback diode is not available for your inductive load, an easy way to add one is to use AutomationDirect's DN-D10DR-A diode terminal block, a 600VDC power diode mounted in a slim DIN rail housing.

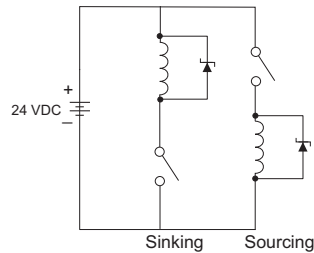


Two more common options for DC coils are Metal Oxide Varistors (MOV) or TVS diodes. These devices should be connected across the driver (PLC output) for best protection as shown below. The optimum voltage rating for the suppressor is the lowest rated voltage available that will NOT conduct at the supply voltage, while allowing a safe margin.

AutomationDirect's ZL-TSD8-24 transorb module is a good choice for 24VDC circuits. It is a bank of 8 uni-directional 30V TVS diodes. Since they are uni-directional, be sure to observe the polarity during installation. MOVs or bi-directional TVS diodes would install at the same location, but have no polarity concerns.



DC MOV or TVS Diode Circuit



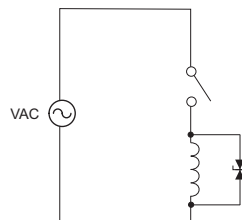
AC Coils:

Two options for AC coils are MOVs or bi-directional TVS diodes. These devices are most effective at protecting the driver from a transient voltage when connected across the driver (PLC output) but are also commonly connected across the coil. The optimum voltage rating for the suppressor is the lowest rated voltage available that will NOT conduct at the supply voltage, while allowing a safe margin.

The AutomationDirect ZL-TSD8-120 transorb module is a good choice for 120VAC circuits. It is a bank of eight bi-directional 180V TVS diodes.



AC MOV or Bi-Directional Diode Circuit



NOTE: Manufacturers of devices with coils frequently offer MOV or TVS diode suppressors as an add-on option which mount conveniently across the coil. Before using them, carefully check the suppressor ratings. Just because the suppressor is made specifically for that part does not mean it will reduce the transient voltages to an acceptable level.

For example, a MOV or TVS diode rated for use on 24–48VDC coils would need to have a high enough voltage rating to NOT conduct at 48V. That suppressor might typically start conducting at roughly 60VDC. If it were mounted across a 24V coil, transients of roughly 84V (if sinking output) or -60V (if sourcing output) could reach the PLC output. Many semiconductor PLC outputs cannot tolerate such levels.

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 to pass 24VDC from a power supply on the preceding base.

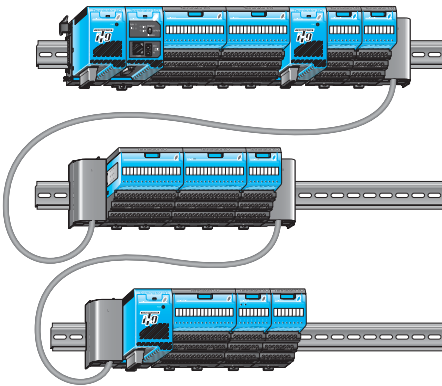


NOTE: *The T1K-05CBL-RR-1 expansion cable with an isolated 24VDC lead was discontinued in 2015 and is no longer available. Some of the following examples show this cable. As an alternative consider using the T1K-10CBL-1 cable as shown in the first example on the following page. See the Multiple Power Supplies / Local Expansion Configurations section in Chapter 2 for more information.*

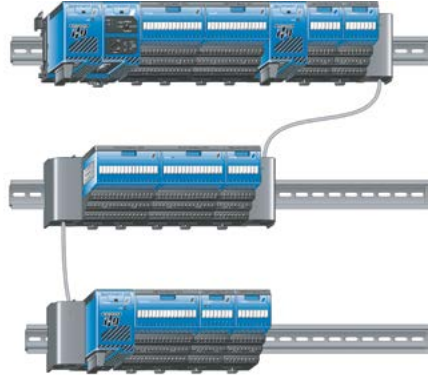
Overview of I/O Expansion Configurations

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 of the example systems shown below.

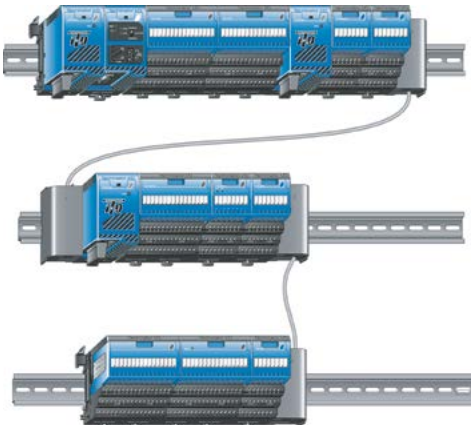
**One expansion cable each;
T1K-10CBL and T1K-10CBL-1**



**One expansion cable each;
T1K-05CBL-RR-1 and T1K-05CBL-LL**



**One expansion cable each;
T1K-10CBL-1 and T1K-05CBL-RR-1**



T1K-05CBL-RR-1 Expansion Cable



Types of Modules Available for the Terminator System

The table below lists the type of modules available for the Terminator by category.

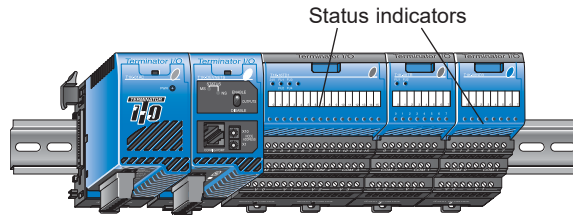
Terminator I/O Module / Unit	Slave System
Base Controller	Only one per slave (node) system. Mount to the right of the first power supply.
Additional Power Supplies	Yes (see Note)
DC Input Modules	Yes
AC Input Modules	Yes
DC Output Modules	Yes
AC Output Modules	Yes
Relay Output Modules	Yes
Analog Modules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

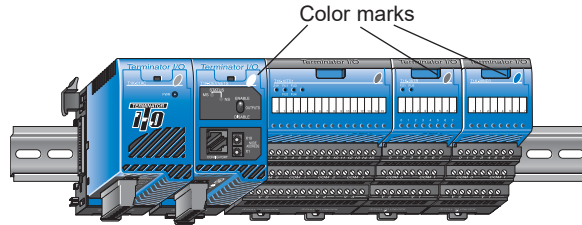
Discrete Module Status Indicators

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 shown in the diagram and table on the following page.



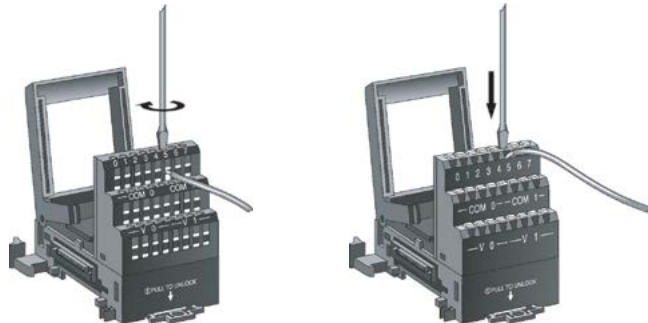
Module Type	Color Code
Power Supply	Green
Base Controller / Specialty	White
Discrete / Analog Input	Blue
Discrete / Analog Output	Red

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.

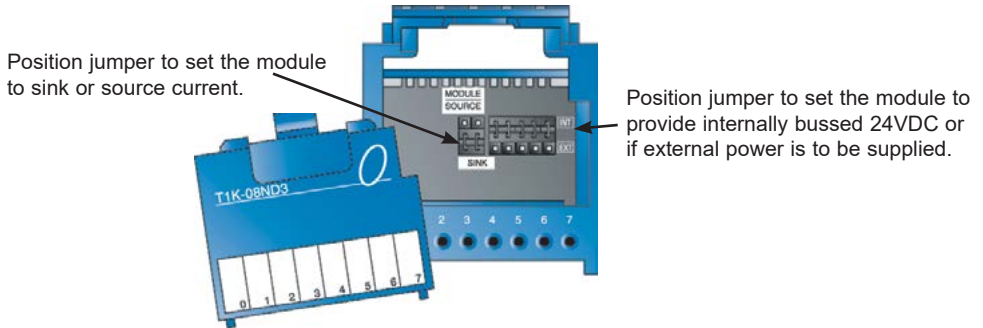


Terminal Type	Screw Type	Spring Clamp
Recommended Torque	1.77–3.54 lb-in (0.2–0.4 N-m)	-
Recommended Screwdriver Blade Size	0.02 in. x 0.125 in. (0.5 mm x 3mm)	Push in on clamp using screwdriver blade size: (0.016 x 0.079 to 0.032 x 0.16) in. (0.4 x 2 to 0.8 x 4) mm
Wire Gauge	Solid conductor: 24–12 AWG Stranded conductor: 24–12 AWG	Solid conductor: 24–14 AWG Stranded conductor: 24–14 AWG (Twist conductors before inserting into gate)

Selecting Internal 24VDC Power Supply

The DC input field devices can be powered from the integrated 24VDC 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 24VDC.

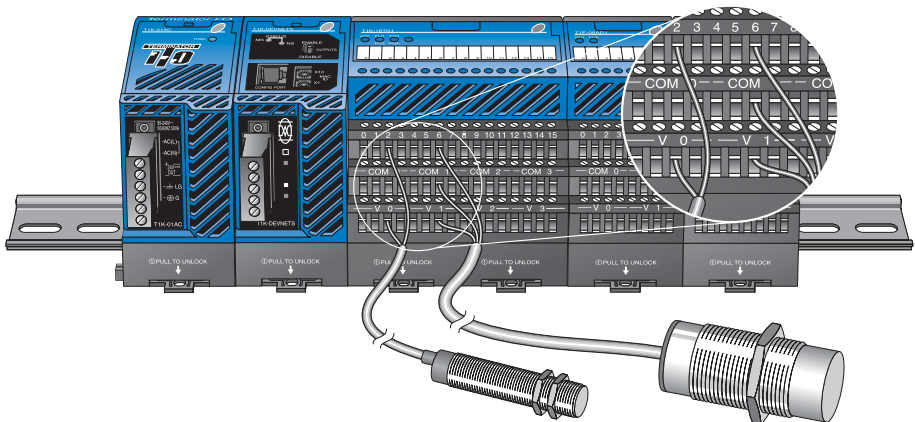
Jumpers located under top cover of T1K-08ND3 and T1K-16ND3



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

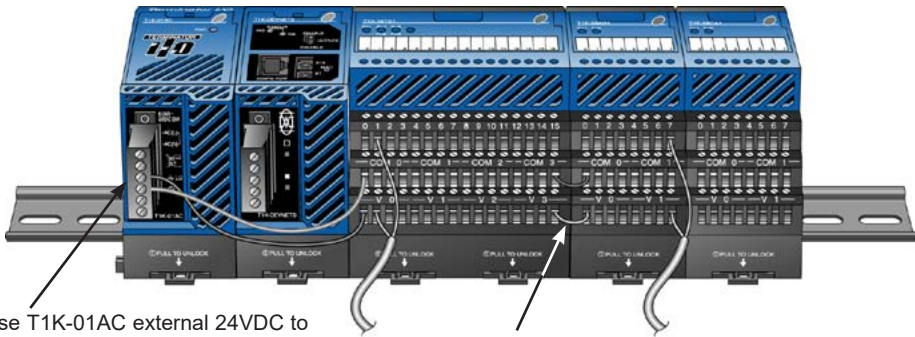
External 24VDC Wiring Options

DC output and analog I/O modules do not have direct access to the internally bussed 24VDC. External user supplied 24VDC power, or auxiliary 24VDC 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 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.

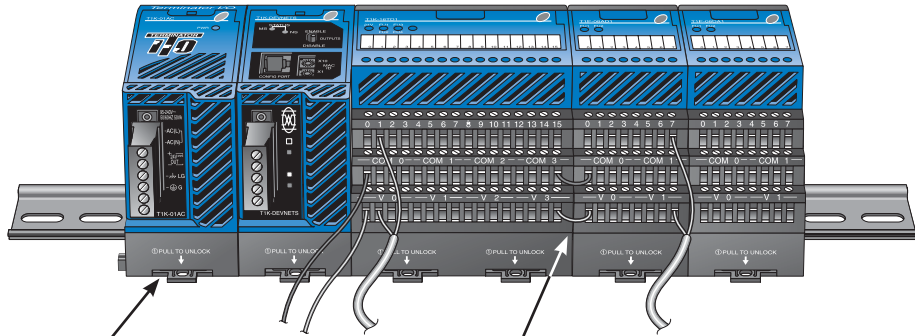
Using T1K-01AC for External 24VDC Power



Use T1K-01AC external 24VDC to create a power bus for 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.

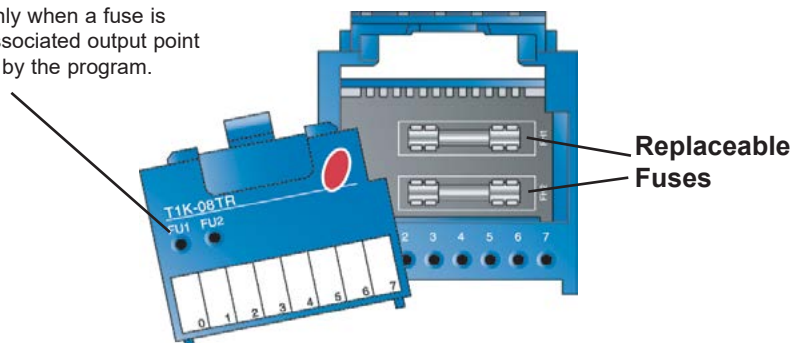
1. There is a limit to the size of wire the terminals can accept. The table below lists the suggested AWG for each module type.
2. Always use a continuous length of wire, do not combine wires to attain a needed length.
3. Use the shortest possible wire length.
4. Use wire trays for routing where possible.
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 blown fuse indicator illuminates only when a fuse is blown and associated output point is turned ON by the program.



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 Base Controllers in the table at right 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*	



* Note: T1H-PBC was discontinued 8/2020; no replacement available.

The table at right shows which modules can or cannot be “Hot Swapped”.

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

Hot Swap: I/O Module Replacement

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.

Outputs Enable / Disable Switch

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.

Check External 24VDC Wiring Before Hot Swapping

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 or DC output module independently to the external power supply.



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

Calculating the Power Budget

Managing the Power Resource

When determining the types and quantity of I/O modules to be used in the Terminator I/O system, it is important to remember there is a limited amount of power available from the power supply. A chart is provided 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 chosen I/O exceeds the maximum power available from the power supply the problem is corrected by simply adding another power supply.

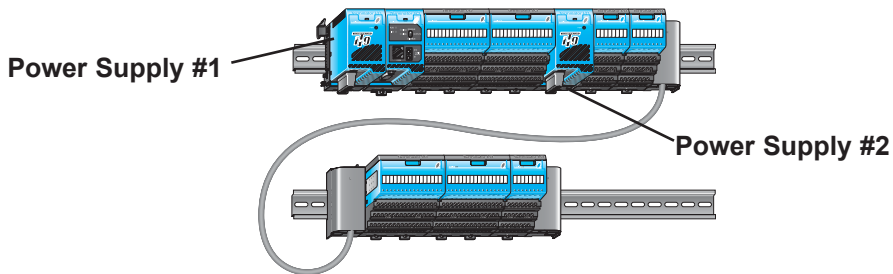


WARNING: It is extremely important to calculate the power budget correctly. If you exceed the power budget, the system may operate in an unpredictable manner which may result in a risk of personal injury or equipment damage.

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	N/A
A max. of 500mA @ 24VDC can be achieved by lowering the 5VDC to 1500mA	1500	500	N/A	N/A	N/A



NOTE: Important about 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.

The 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)
Base Controllers			AC Output Module		
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-MOVBUS	250	0	Relay Output Modules		
T1H-PBC	530	0	T1K-08TR	350	0
DC Input Modules			T1K-16TR	700	0
T1K-08ND3	35	0	T1K-08TRS	400	0
T1K-16ND3	70	0	Analog Input Modules		
AC Input Modules			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)
DC Output Modules			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-16TMST	150	0
T1H-08TDS	200	0	T1F-14THM	60	70 (see note 2)
T1K-16TD1	200	400 (see note 2)	Analog Output Modules		
T1K-16TD2-1	200	0	T1F-08DA-1	75	150 (see note 2)
Combination Analog Modules			T1F-16DA-1	75	150 (see note 2)
T1F-8AD4DA-1	75	60 (see note 2 and 3)	T1F-08DA-2	75	150 (see note 2)
T1F-8AD4DA-2	75	70 (see note 2)	T1F-16DA-2	75	150 (see note 2)
			Specialty Modules and other devices (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

NOTE: Important Power Budget - 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	Part Number	5VDC (mA) Required	24VDC (mA) Required
Power Supplied T1K-01AC (see pg. 3-18)		2000	300
Slave	T1H-EBC100	350	0
Module	T1K-16NA-1	70	0
Module	T1K-16TA	450	0
Other (I/O, etc.)	-	0	0
Maximum power required		870	0
Remaining power available		2000-870 = 1130	300-0 = 300
Power Supply #2	Part Number	5VDC (mA) Required	24VDC (mA) Required
Power Supplied T1K-01AC (see pg. 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.

1. When 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 24VDC 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.
2. Add the current columns starting with the slave and put the total in the row labeled “Maximum power required”.
3. Subtract the row labeled “Maximum power required” from the “Power Supplied”. Place the difference in the row labeled “Remaining Power Available”.
4. 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.

I/O Specification Terms

Inputs or Outputs Per Module

Indicates number of input or output points per module and designates current sinking, current sourcing, or either.

Commons Per Module

Number of commons per module and their electrical characteristics.

Input Voltage Range

The operating voltage range of the input circuit.

Output Voltage Range

The operating voltage range of the output circuit.

Peak Voltage

Maximum voltage allowed for the input circuit.

AC Frequency

AC modules are designed to operate within a specific frequency range.

ON Voltage Level

The voltage level at which the input point will turn ON.

OFF Voltage Level

The voltage level at which the input point will turn OFF.

Input impedance

Input impedance can be used to calculate input current for a particular operating voltage.

Input Current

Typical operating current for an active (ON) input.

Minimum ON Current

The minimum current for the input circuit to operate reliably in the ON state.

Maximum OFF Current

The maximum current for the input circuit to operate reliably in the OFF state.

Minimum Load

The minimum load current for the output circuit to operate properly.

External DC Required

Some output modules require external power for the output circuitry.

ON Voltage Drop

Sometimes called “saturation voltage”, it is the voltage measured from an output point to its common terminal when the output is ON at maximum load.

Maximum Leakage Current

The maximum current a connected maximum load will receive when the output point is OFF.

Maximum Inrush Current

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.

Base Power Required

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 is explained in the power budget section of this manual.

OFF to ON Response

The time the module requires to process an OFF to ON state transition.

ON to OFF Response

The time the module requires to process an ON to OFF state transition.

Terminal Type

Indicates whether the terminal type is a removable or non-removable connector or a terminal.

Status Indicators

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.

Weight

Indicates the weight of the module.

Fuses

Protective devices for an output circuit, which stop current flow when current exceeds the fuse rating. They may be replaceable or non-replaceable, or located externally or internally.

T1K-01AC, T1K-01DC Power Supply

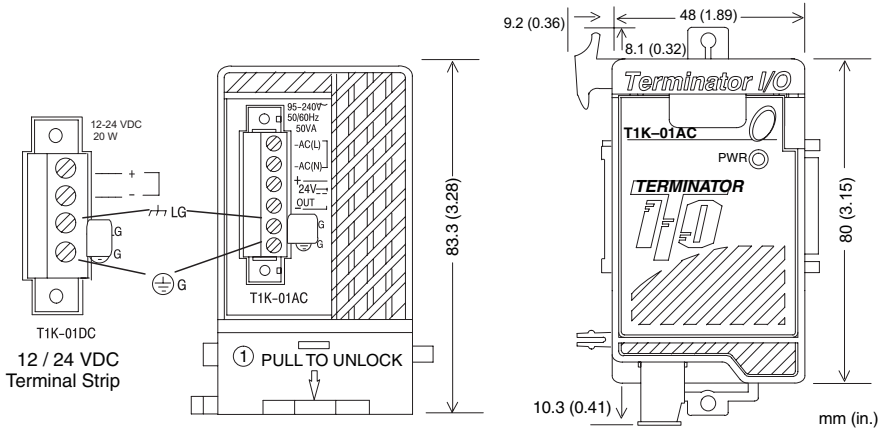
		Specifications	
Specification		T1K-01AC	T1K-01DC
Input Voltage Range		110/220 VAC (85–264 VAC)	12/24 VDC (10.8 - 26.4 VDC)
Input Frequency		50/60 Hz (47–63 Hz)	-
Maximum Power		50VA	20W
Maximum Inrush Current		20A	10A
Insulation Resistance		> 10MΩ @ 500VDC	
Voltage Withstand (Dielectric)		1 min. @ 1500VAC between primary, secondary and field ground	
Auxiliary 24VDC Supply		300mA maximum	-
Output 1: 5VDC Base Power Supplied	Voltage	5.25 VDC (5.00–5.50 VDC)	5.25 VDC (5.00–5.50 VDC)
	Current	a) 2.0 A maximum b) 1.5 A maximum (see note)	2.0 A maximum
	Ripple	5% maximum	5% maximum
Output 2: 24VDC Base Power Supplied	Voltage	24VDC (20.0–28.0 VDC)	-
	Current	a) 300mA maximum b) 500mA maximum (see note)	-
	Ripple	10% maximum	-
Replacement Terminal Block - Phoenix Contact		MVSTBW 2.5/4-ST-5.08 BK	MVSTBW 2.5/6-ST-5.08 BK
Fuse		1 (Primary) not replaceable	



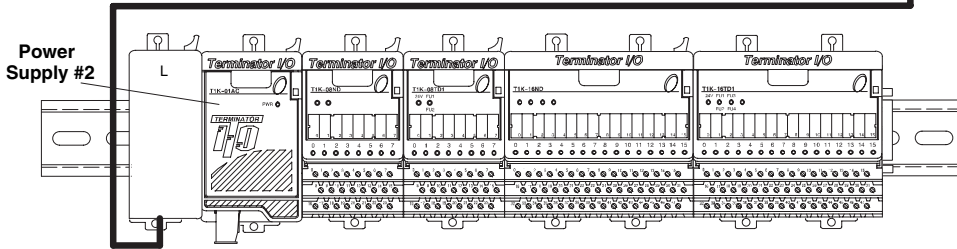
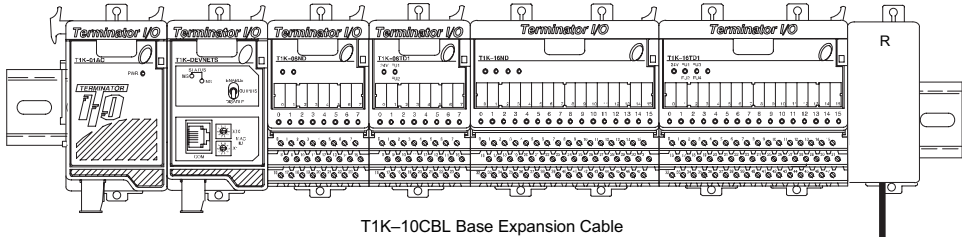
NOTE: 500mA @ 24VDC is achieved by lowering the 5VDC to 1.5 A from 2.0 A.

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 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10MΩ
Noise Immunity	NEMA ICS3-304 Impulse Noise 1μs, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)

Dimensions



Power Supply #1



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

Note 2: Use T1K-01AC 24 VDC 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 5 VDC and 24 VDC.

T1H-EBC Ethernet Base Controller (Obsolete)

Specifications	
Module Type	Ethernet Slave
Communications	10Base-T
Auto-configuring	I/O type/position automatically identified during power-up
Ethernet Protocols	UDP/IP, IDX
Ethernet Port	RJ-45
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 diagnostics 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	RJ-12, RS-232C K-Sequence protocol, ASCII (not functional when used with H2-ERM).
Base Power Requirements	350mA @ 5VDC (EBC); Serial port supports up to 500mA @ 5VDC (Add for power budget consumption).

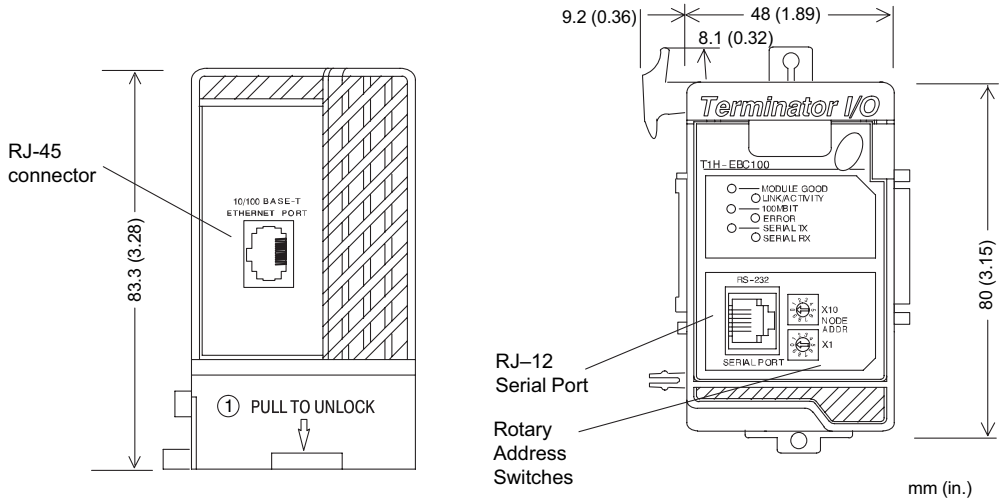
General Specifications	
Installation Requirements	Mounts to the right of the first power supply.
Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Relative Humidity	5% to 95% (Non-condensing)
Environmental Air	No corrosive gases. The level of environmental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

T1H-EBC100 Ethernet Base Controller

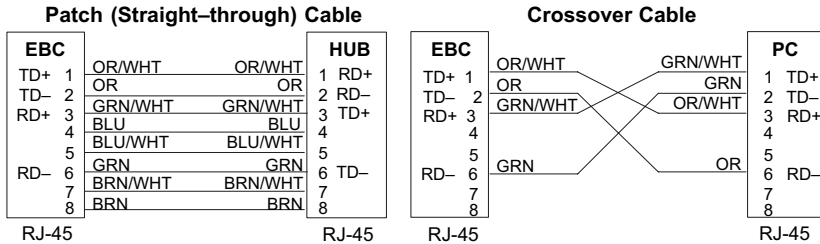
Specifications	
Module Type	Ethernet Slave
Communications	100Base-T Ethernet
Auto-configuring	I/O type/position automatically identified during power-up
IP Configuration	Obtain an IP address from a DHCP Server automatically at power-up (Default); Dedicated IP address using NetEdit3 or HTML configuration.
Ethernet Protocols	UDP/IP, IPX, MODBUS TCP
Ethernet Port	RJ-45
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	100 MBaud or 10 MBaud (auto-detect)
LED Indicators	<p>MODULE GOOD (green): On = module passed diagnostics 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>NOTE: All indicators re-initialize during power-up. For more information consult the T1H-EBC-M User Manual.</p> <p>LINK / ACTIVITY (green): On = Ethernet network activity detected</p> <p>100 MBit (green): On = Ethernet network activity detected at 100 Mbps Off = (With LINK / ACTIVITY On) Ethernet activity is auto-detected at 10 Mbps</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>
Serial Communications Port	RJ-12, RS-232C K-Sequence protocol, ASCII, MODBUS RTU [not functional when used with H2-ERM(100), H4-ERM(100), or H2-DM1(E)].
Base Power Requirement	350mA @ 5VDC (EBC); Serial port supports up to 500mA @ 5VDC (add for power budget consumption).

General Specifications	
Installation Requirements	Mounts to the right of the 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. The level of environmental pollution = 2 (UL 840).
Vibration	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)

Dimensions



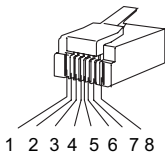
T1K-EBC100 Ethernet Port Pin-out



This diagram illustrates the standard wire positions in the RJ-45 connector. We strongly recommend that you use Category 5 or better, UTP cable.

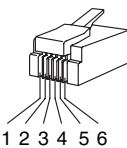
T1K-EBC100 Serial Port Pin-out

10 / 100BaseT



8-pin RJ-45 connector (8P8C)

RJ-12



6-pin RJ-12 connector

Serial Port Pin Descriptions		
Pin	Signal	Definition
1	0V	Power (-) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	5V	Request to send
6	0V	Clear to Send

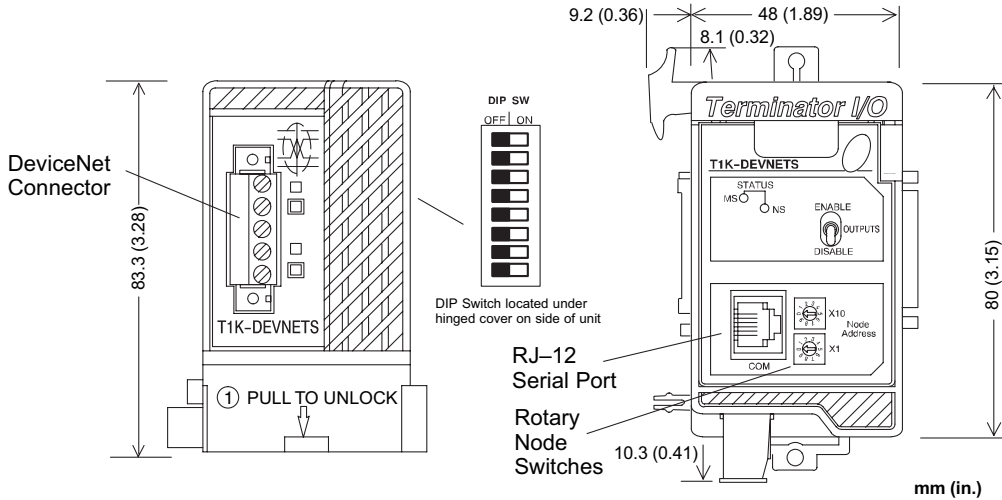
T1K-DEVNETS

Communications Specification	
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 (Maximum cable length)	125000 Baud (1640ft / 500m) 250000 Baud (820ft / 250m) 500000 Baud (328ft / 100m)
Communication Status Indicators	MS: Module Status LED Green: normal device operation Red: unrecoverable controller fault NS: Network Status LED Green: communication link on-line and connected Green flashing: on-line, but not connected Red: critical link or controller failure Red flashing: connection time-out
DeviceNet Power Consumption	45mA @ 11 to 25VDC
Base Power Consumption	190mA @ 5VDC

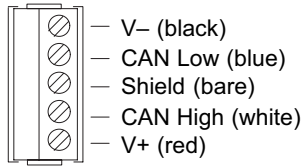
DeviceNet Specifications			
Device Type	Generic	Configuration Consistency	No
Explicit Peer to Peer Message	No	Fault Node Recovery	No
I/O Peer to Peer Message	No	Master Scanner	No
Communication Baud Rate 125K, 250K, 500K	Yes	I/O Slave Message Bit Strobe Polling Cyclic Change of State	No Yes No No

General Specifications	
Installation Requirements	Must mount to the right of the 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% to 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	MIL STD 810C. Method 514.2
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 (170g)

Dimensions

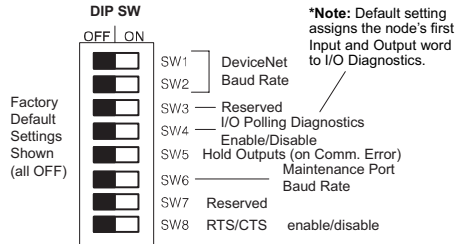


T1K-DEVNETS Serial Port Pin-out

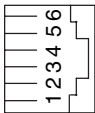


Use Belden Cable 3084A, or equivalent.

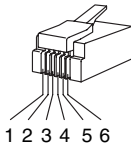
T1K-DEVNETS DIP Switch Settings



Serial Port



RJ-12



Serial Port Pin Descriptions

Pin	Signal	Definition
1	0V	Power (-) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	RTS	Request to send
6	CTS	Clear to Send

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

SW 5 Hold Outputs	
Outputs	SW5
Turn Off	OFF
Hold	ON

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

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

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

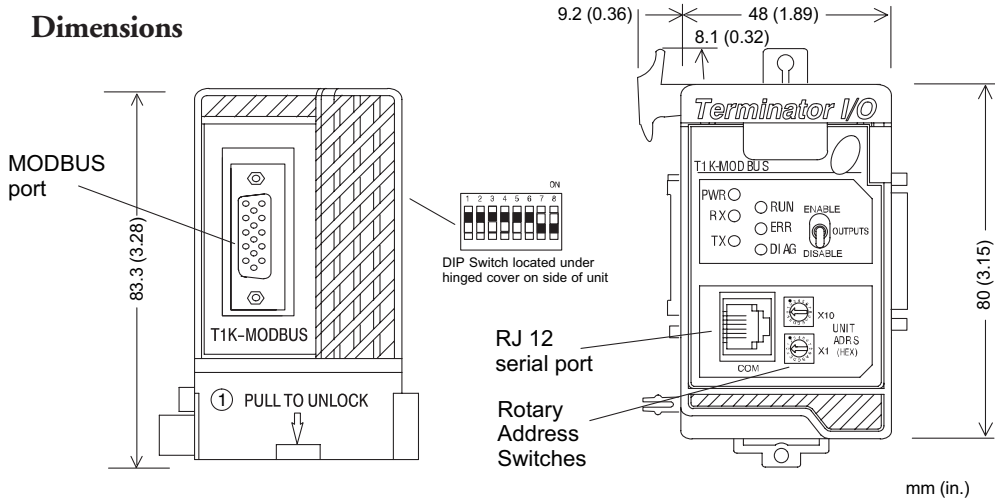
*See Dip SW 4 Note above.

T1K-MODBUS Base Controller

Specifications	
Communication Protocol	MODBUS RTU (Slave)
MODBUS Connector	15-pin female D-shell
MODBUS Port Type	RS-232C, RS-422 / 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, 4800, 9600, 19200, 38400) Baud 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, 2.5 s, 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 the right of the first power supply in a slave system.
Base Power Requirements	250mA @ 5VDC
Communication Port (RJ-12 Serial Port)	RJ-12, RS-232C Use to configure MODBUS port using MODBUS Setup Tool Utility or use to upgrade firmware Baud rate: 9600, 19,200 Baud (set with Dip Switch 6) Fixed settings: 8 data bits, 1 start bit, parity Odd

General Specifications	
Installation Requirements	Must mount to the right of the 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% to 95% relative humidity (Non-condensing)
Voltage Withstand	1500VAC, 1 minute (15-pin connector internal)
Insulation Resistance	500VDC, 10MΩ
Vibration Resistance	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA (ICS3-304) Impulse Noise 1μs, 1000V FCC class A RFI (145MHz, 435MHz)
Atmosphere	No corrosive gases Environmental Pollution Level 2
Weight	6.0 oz (170g)

Dimensions



T1K-MODBUS DIP Switch Settings

MODBUS Port Pin-out		
Pin		Signal Definition
1	5 V	5VDC
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)

SW 1-3 MODBUS Port Baud Rates			
Baud Rate	SW 1	SW 2	SW 3
300	OFF	OFF	OFF
600	ON	OFF	OFF
1200	OFF	ON	OFF
2400	ON	ON	OFF
4800	OFF	OFF	ON
9600	ON	OFF	ON
19200	OFF	ON	ON
38400	ON	ON	ON

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

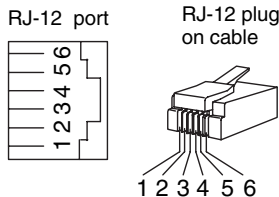
SW 7 MODBUS RTU Addressing Mode	
Mode	SW7
584/984	OFF
DirectLogic	ON

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

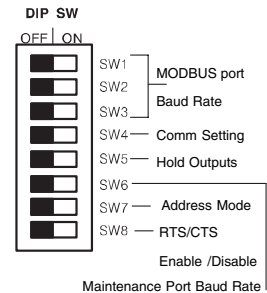
SW 8 RTS / CTS Enable / Disable	
RTS / CTS	SW8
Disable	OFF
Enable	ON

SW 5 Hold Output	
Outputs	SW5
Turn Off	OFF
Hold	ON

Serial Port Pin-out	
Pin	Signal
1	0V
2	+5V
3	RXD
4	TXD
5	RTS
6	CTS



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

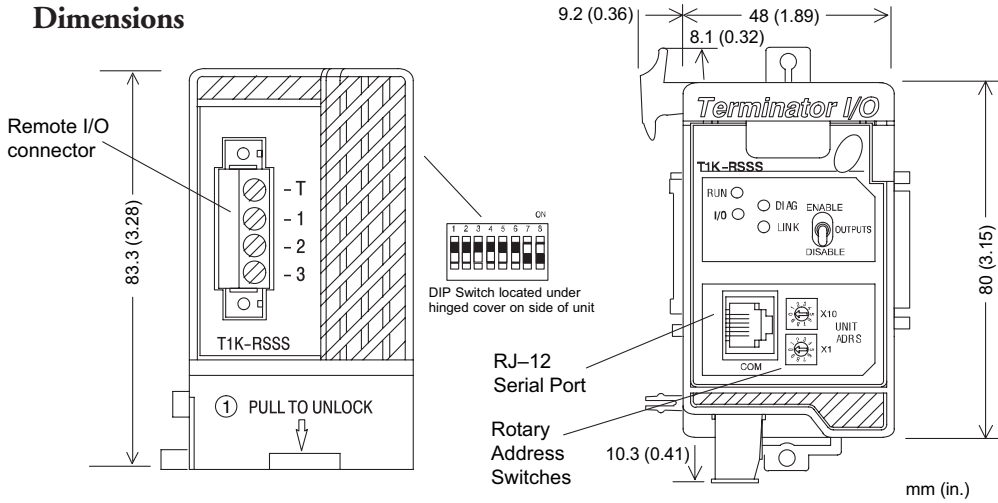


T1K-RSSS Remote I/O Base Controller

Specification				
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	Check PLC CPU / remote Master module remote I/O specifications			
Baud Rate / Communication Distance (set by DIP switches)	Baud Rate	Distance	Baud Rate	Distance
	19200	1200m	19200	1.2km
	38400	1200m	38400	1.2km
	153600	600m		
	307200	300m		
	614400	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			
Communication Port (active in SM-NET only)	RJ-12, RS-232C (K-Sequence) Dip switch selectable: Baud rate: 4800–38400 bps * 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 the right of the first power supply in a slave.
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. The level of environmental pollution = 2 (UL 840).
Vibration	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)

Dimensions



T1K-RSSS DIP Switch Settings

SW 1 Mode	
OFF	SM-NET
ON	RM-NET

Baud Rate	SW 2, 3, 4 Baud Rates		
	SW 1	SW 2	SW 3
19200	OFF	OFF	OFF
38400	ON	OFF	OFF
153600	OFF	ON	OFF
307200	ON	ON	OFF
614400	OFF	OFF	ON

Baud rates above 38.4 kbps are for SM-NET only.

SW 5 Output Default	
Outputs	SW5
Clear	OFF
Hold	ON

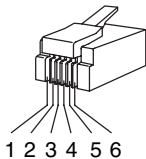
SW 6 Serial Port Parity	
Odd	OFF
None	ON
SM-NET only	

SW 7-8 Serial Port Baud Rate		
Baud Rate	SW7	SW8
4800	ON	OFF
9600	OFF	OFF
19200	OFF	ON
38400	ON	ON

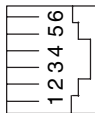
Port Active in SM-NET only
Use 9600, odd parity for Operator Interface

T1K-RSSS Serial Port Pin-out

RJ-12 plug on cable



RJ-12 socket on T1K-RSSS



Serial Port Pin Descriptions		
Pin	Signal	Definition
1	0V	Power (-) connection (GND)
2	5V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	5V	Request to send
6	0V	Clear to Send

T1H-PBC Profibus Base Controller

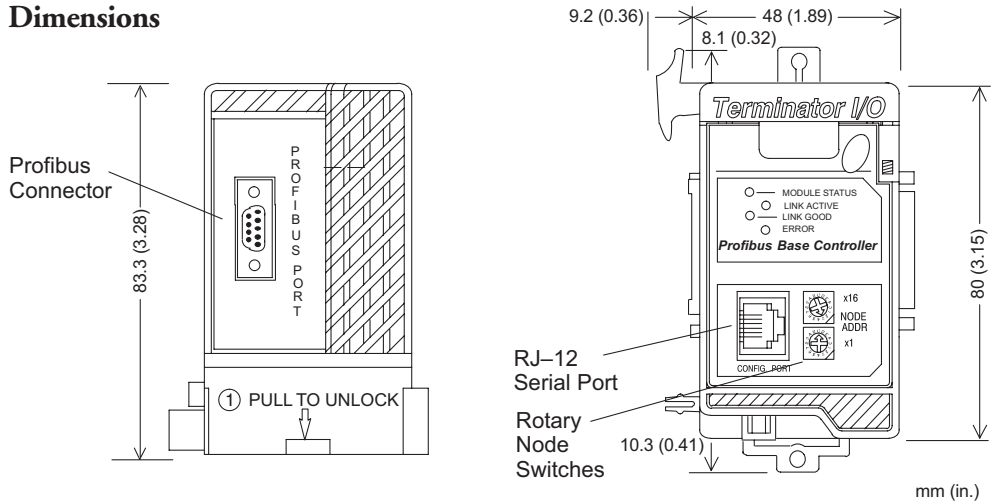


* Note: T1H-PBC was discontinued 08/2020; no replacement available.

Specifications	
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 or software (0 used by Master)
Segment Distance	100 meters (328 feet) to 1200 meters (3270 feet)
Baud Rate	Selectable from 9.6 kbps to 12 Mbps
LED Indicators	STATUS (Module): ON = module power-up check passed ACTIVE (Link): ON = Network is active OFF = Network is not active TOKEN (Holding): ON = 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	RJ-12, RS-232C K-Sequence protocol, ASCII (not functional when used with H2-ERM).
Base Power Requirements	350mA @ 5VDC (EBC); Serial port supports up to 500mA @ 5VDC (add for power budget consumption).

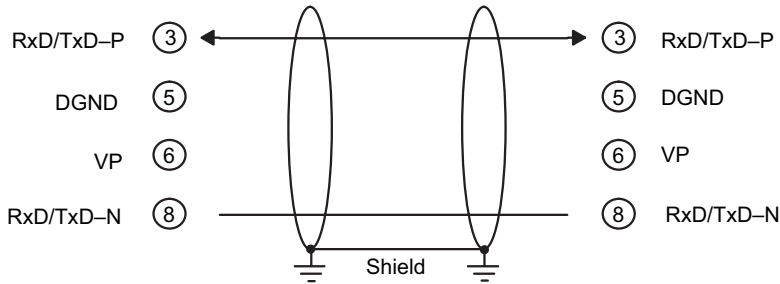
General Specifications	
Installation Requirements	Must mount to the right of the first power supply.
Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Relative Humidity	5% to 95% (Non-condensing)
Environmental Air	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration	MIL STD 810C. Method 514.2
Shock	MIL STD 810C. Method 514.2
Noise Immunity	NEMA (ICS3-304) Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Manufacturer	Host Automation Products

Dimensions



* Note: T1H-PBC was discontinued 08/2020; no replacement available.

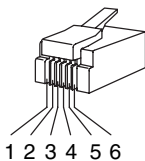
T1H-PBC Port Pin-out



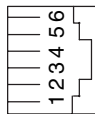
Use Belden Profibus 3079A Cable or Siemens 6XV1 830 0AH10

Serial (Config) Port

(Use for firmware upgrades only)



RJ-12 plug
on cable

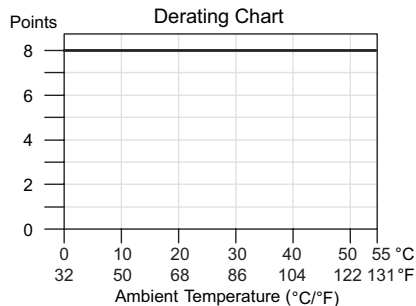


Serial Port Pin Descriptions		
Pin	Signal	Definition
1	0 V	Power (-) connection (GND)
2	5 V	Power (+) connection
3	RXD	Receive Data (RS-232C)
4	TXD	Transmit Data (RS-232C)
5	RTS	Request to send
6	CTS	Clear to Send

T1K-08ND3 DC Input

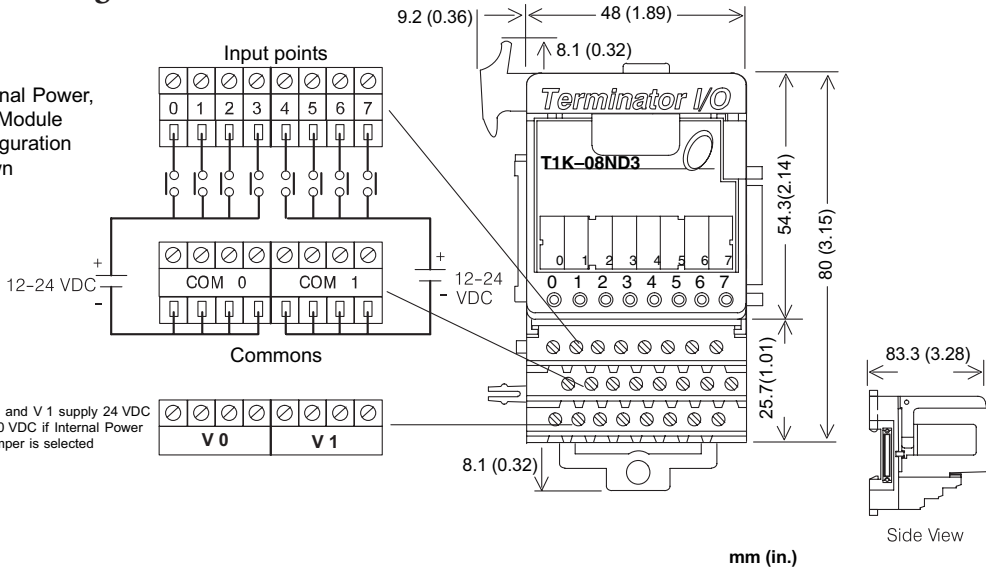
Specifications	
Inputs Per Module	8 (sink / source)
Commons Per Module	Ext. power: 2, isolated (4 pts. / com.) Int. power: 2, all 8 pts. internally connected
Operating Voltage	12–24 VDC
Input Voltage Range	10.8–26.4 VDC min. / max.
Peak Voltage	30VDC
Input Current (Typical)	4mA @ 12VDC, 8.5mA @ 24VDC
Input Impedance	2.8 K Ω
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Min. ON Current	4mA
Max. OFF Current	0.5 mA
OFF to ON Response	2–8 m., Typical: 4ms
ON to OFF Response	2–8 ms, Typical: 4ms
Base Power Requirements	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 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M Ω
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A



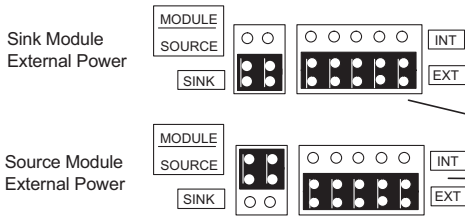
Wiring & Dimensions

Note:
External Power,
Sink Module
Configuration
Shown

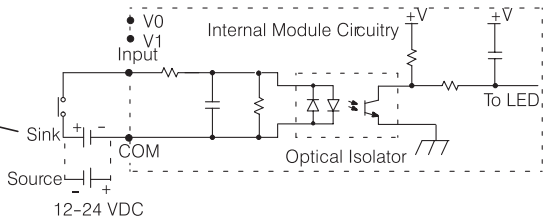


Jumper Selection

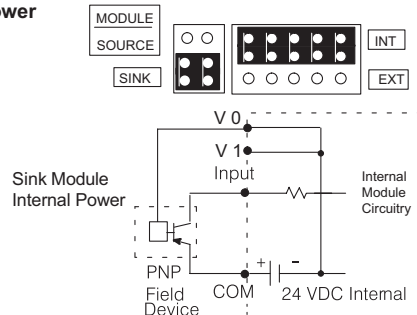
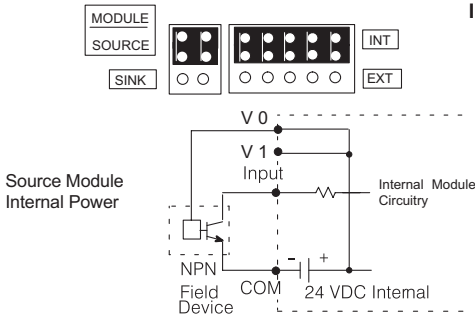
External Power



Equivalent Input Circuit



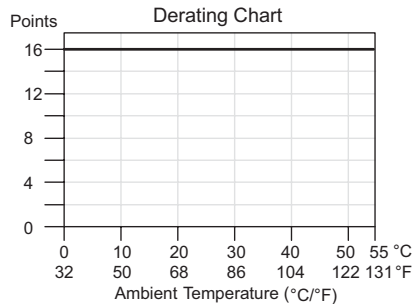
Internal Power



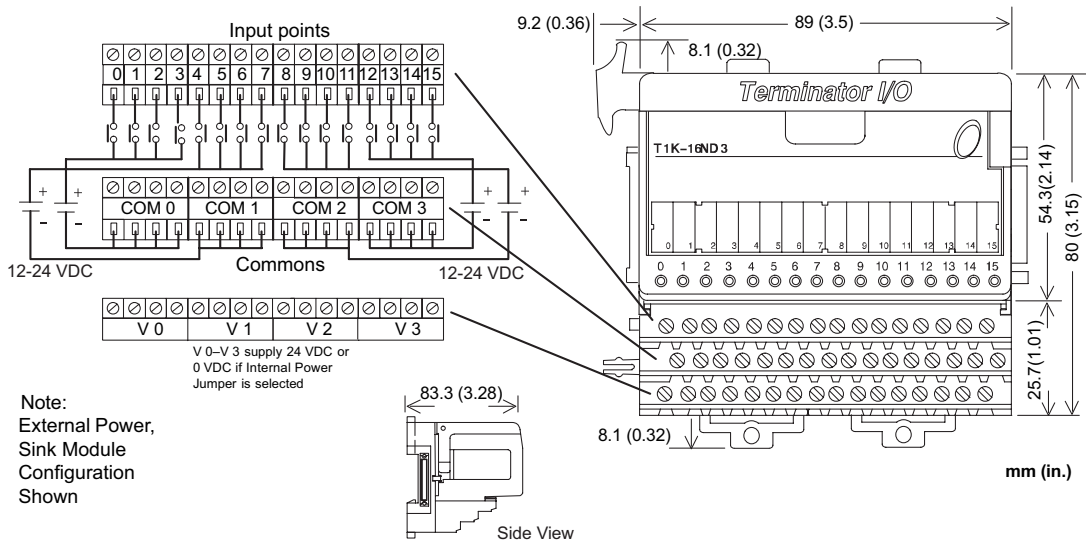
T1K-16ND3 DC Input

Specifications	
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	12–24 VDC
Input Voltage Range	10.8–26.4 VDC min. / max.
Peak Voltage	30VDC
Input Current (Typical)	4mA @ 12VDC, 8.5 mA @ 24VDC
Input Impedance	2.8 k Ω
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Min. ON Current	4mA
Max. OFF Current	0.5 mA
OFF to ON Response	2–8 ms, Typical: 4ms
ON to OFF Response	2–8 ms, Typical: 4ms
Base Power Requirements	70mA @ 5VDC
Status Indicators	Logic Side
Weight	160g

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 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M Ω
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

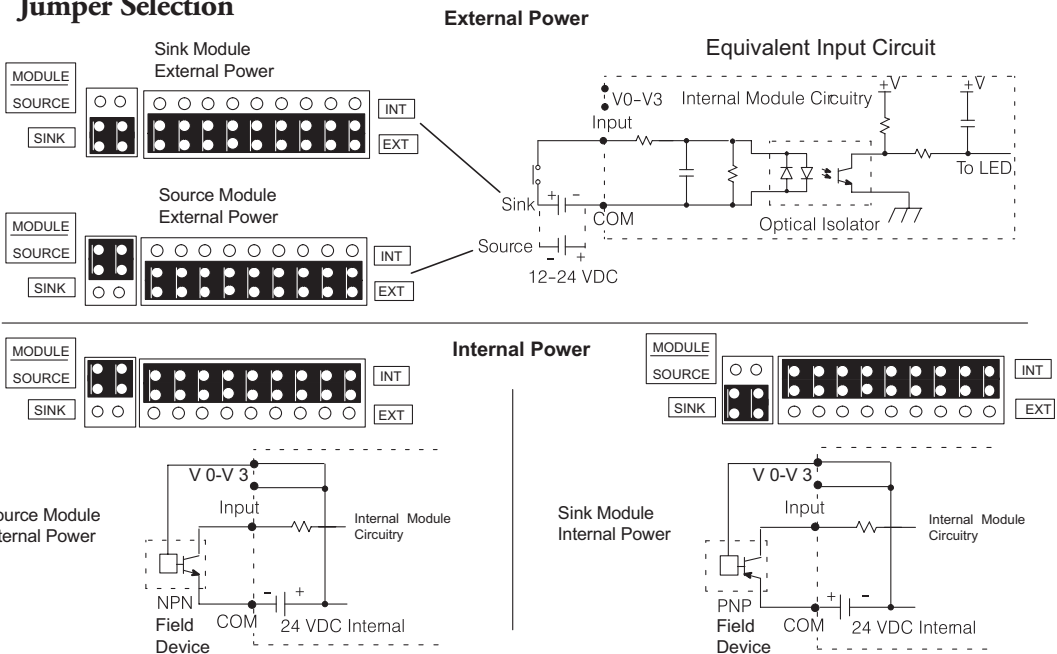


Wiring & Dimensions



NOTE: When using external power, the module can be wired to either sink current or source current regardless of the module sink/source jumper position. When using internal power, the sink/source jumpers determine the module configuration.

Jumper Selection

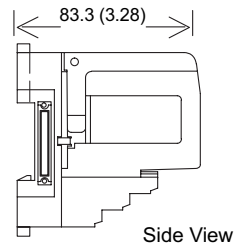
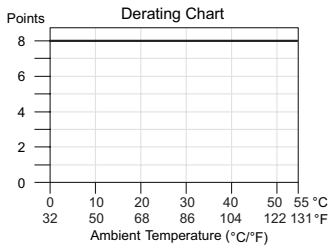
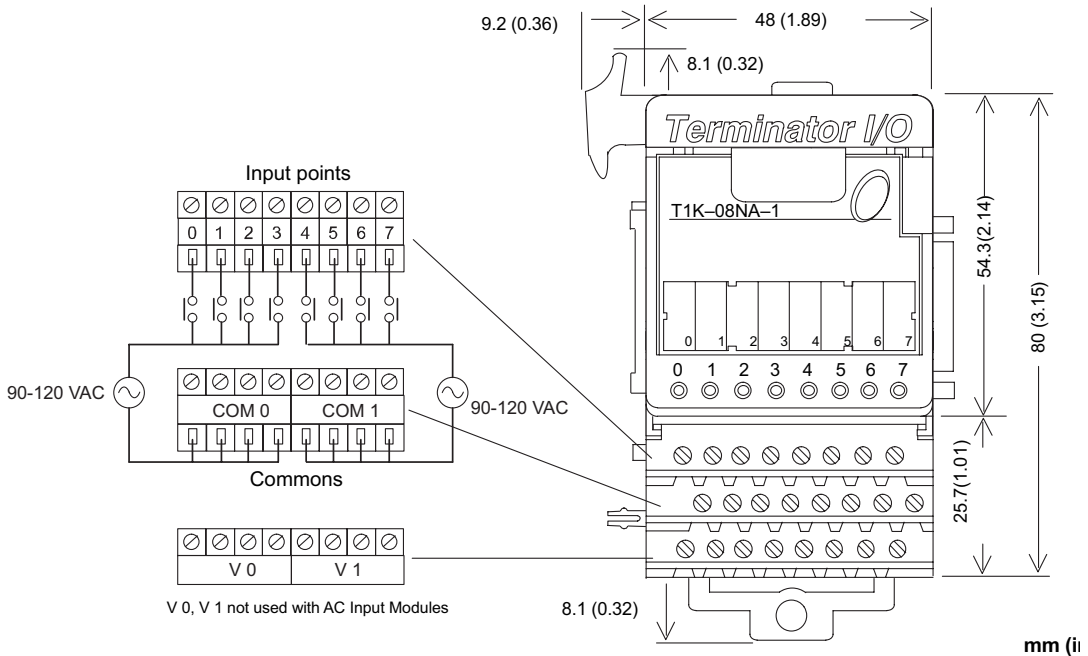


T1K-08NA-1 AC Input

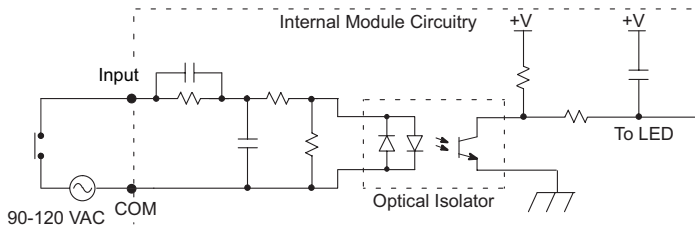
Specifications	
Inputs Per Module	8
Commons Per Module	2, 4 pts. / com (isolated)
Operating Voltage	90–120 VAC, 47–63 Hz
Input Voltage Range	80–132 VAC, 47–63 Hz min. / max.
Input Current	8mA @ 100VAC (50Hz) 10mA @ 100VAC (60Hz) 12mA @ 132VAC (50Hz) 15mA @ 132VAC (60Hz)
Input Impedance	14k Ω @ 50Hz, 12k Ω @ 60Hz
ON Current / Voltage	> 6mA @ 75VAC
OFF Current / Voltage	< 2.0 mA @ 20VAC
OFF to ON Response	< 40ms
ON to OFF Response	< 40ms
Base Power Requirements	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 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M Ω
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

Wiring & Dimensions



Equivalent Input Circuit

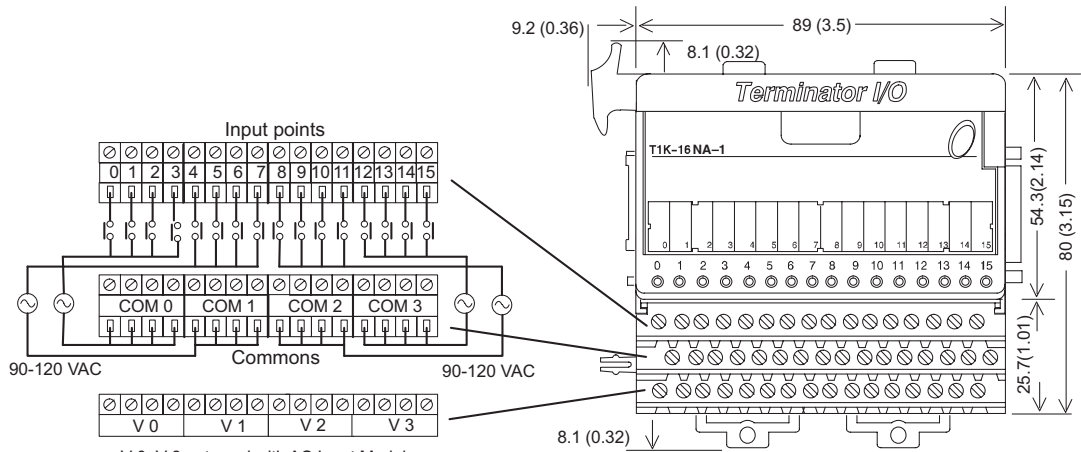


T1K-16NA-1 AC Input

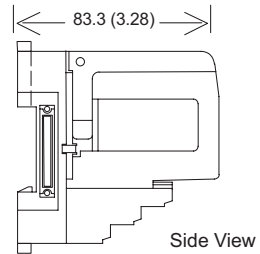
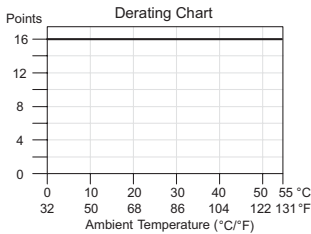
Specifications	
Inputs Per Module	16
Commons Per Module	4, 4 pts. / com (isolated)
Operating Voltage	90–120 VAC, 47–63 Hz
Input Voltage Range	80–132 VAC, 47–63 Hz min. / max.
Input Current	8mA @ 100VAC (50Hz) 10mA @ 100VAC (60Hz) 12mA @ 132VAC (50Hz) 15mA @ 132VAC (60Hz)
Input Impedance	14k Ω @ 50Hz, 12k Ω @ 60Hz
ON Current / Voltage	> 6mA @ 75VAC
OFF Current / Voltage	< 2.0 mA @ 20VAC
OFF to ON Response	< 40ms
ON to OFF Response	< 40ms
Base Power Requirements	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 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M Ω
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

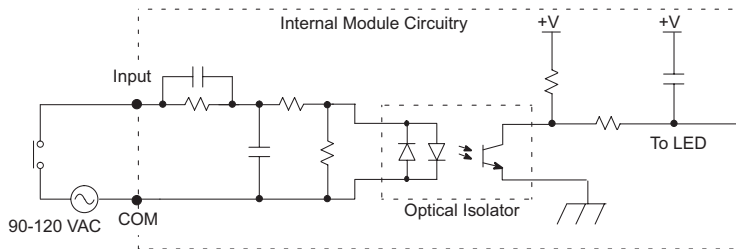
Wiring & Dimensions



mm (in.)



Equivalent Input Circuit

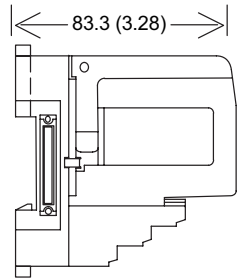
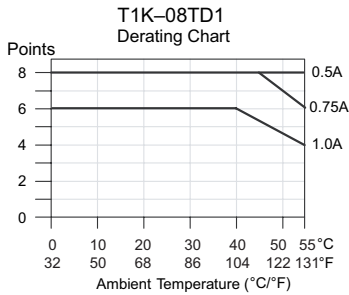
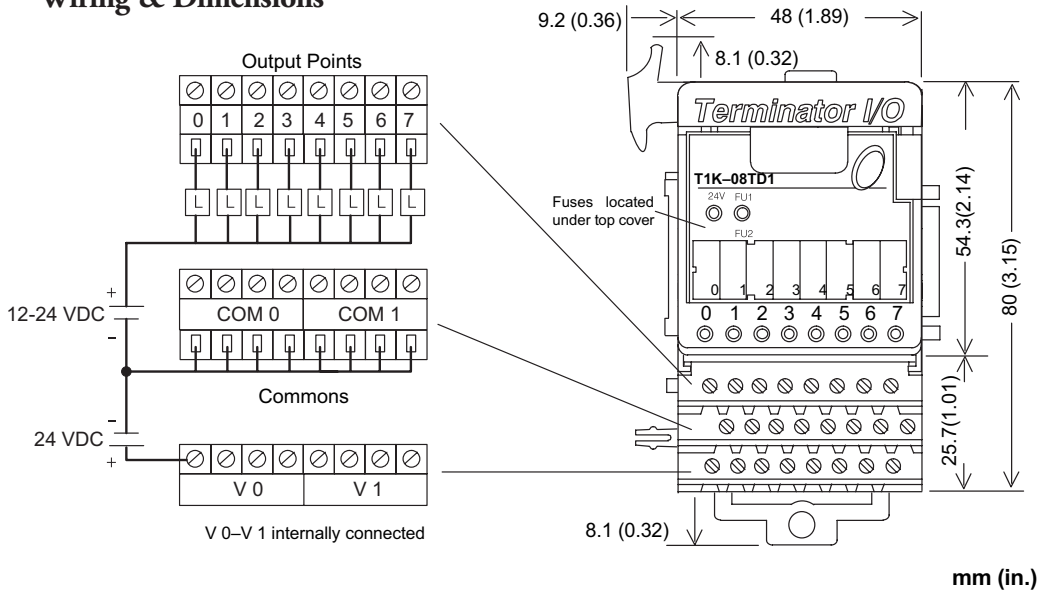


T1K-08TD1 DC Output

Specifications	
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	50VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15 μ A @ 30VDC
ON Voltage Drop	0.3 VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10 μ s
ON to OFF Response	< 60 μ s
Base Power Requirements	100mA @ 5VDC
External Power Required	200mA max. @ 20–28 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	24 V ON = low external power FU1 / FU2 ON = fuse 1 or fuse 2 blown
Fuses (User Replaceable) T1K-FUSE-1	2, (6.3 A, 250V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	85g

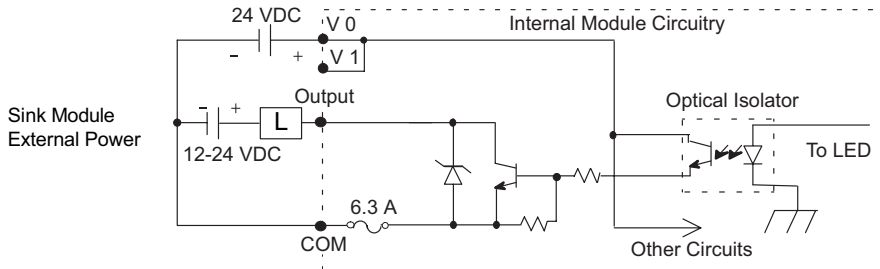
Environmental Specifications	
Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions



Side View

Equivalent Output Circuit

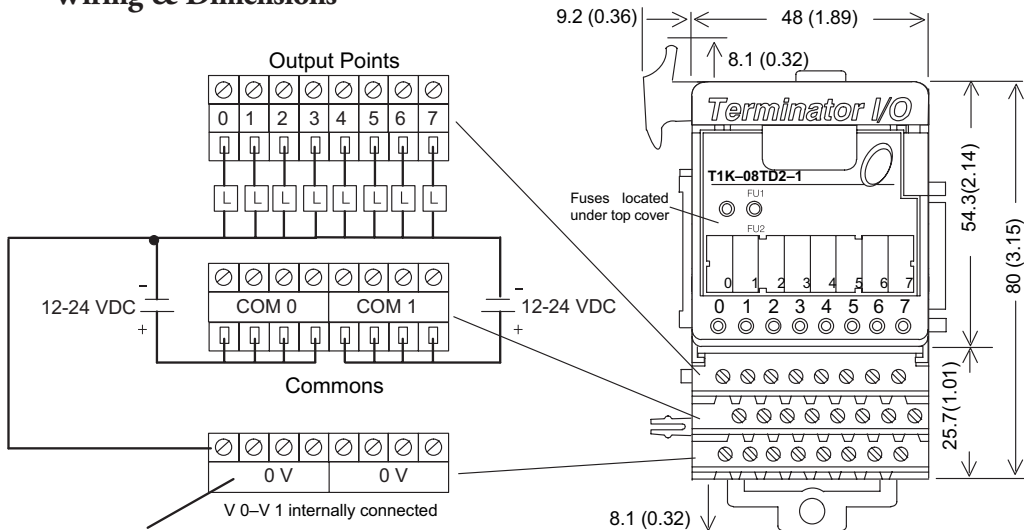


T1K-08TD2-1 DC Output

Specifications	
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	50VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15 μ A @ 26.4 VDC
ON Voltage Drop	1.2 VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10 μ s
ON to OFF Response	< 0.5 ms
Base Power Requirements	100mA @ 5VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or fuse 2 blown
Fuses (User Replaceable)	2, (6.3 A, 250V / common), (4 pts. / fuse)
T1K-FUSE-1	NQ3 - 6.3 SOC corp.
Weight	100g

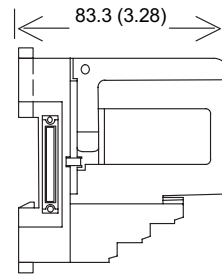
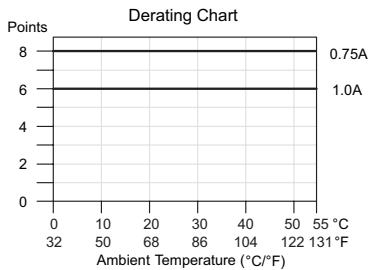
Environmental Specifications	
Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions



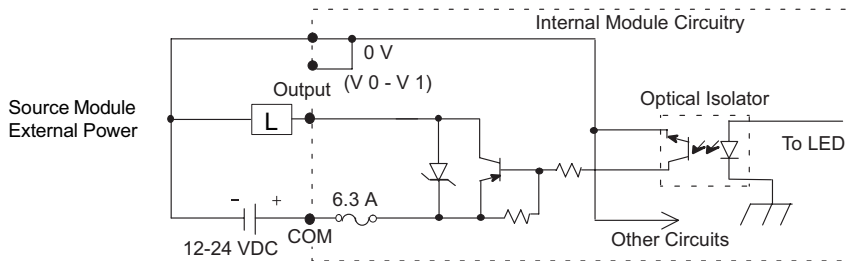
Note: Apply the 0 V label that comes with the I/O module to I/O base terminal points V 0-V 1 to properly identify the 0 VDC terminal points.

mm (in.)



Side View

Equivalent Output Circuit



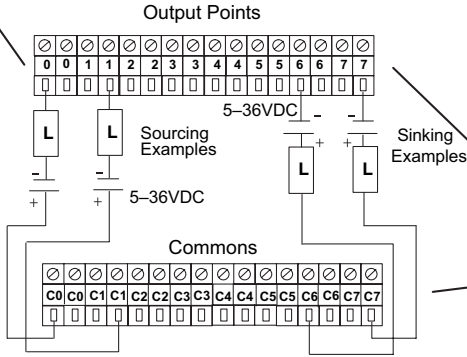
T1H-08TDS Isolated DC Output

Specifications	
Outputs Per Module	8 (isolated, sink / sourcing)
Commons Per Module	8 (isolated)
Operating Voltage Range	5–36 VDC
Max. Voltage	36VDC
Output Clamp Voltage	40VDC
Max. Load Current	2A / pt., 16A / module, 32°F to 140°F (0°C to 60°C)
Electronic Over Current Protection	Output trips at 6A min., 12A max.
Max. Load Voltage	36VDC
Max. Leakage Current	75 μ A
Max. ON State Voltage Drop	0.3 VDC @ 2.0 A, 0.15 V @ 1A
Inrush Current	5A for 20ms
OFF to ON Response	< 3 μ s
ON to OFF Response	< 100 μ s
Base Power Requirements	200mA max.
Thermal Shutdown	Between Tjunction = 302°F to 374°F (150°C to 190°C)
Over Temperature Reset	Thermal shutdown temp. minus 5°F (15°C)
Status Indicators	Logic Side
Weight	93.6 g

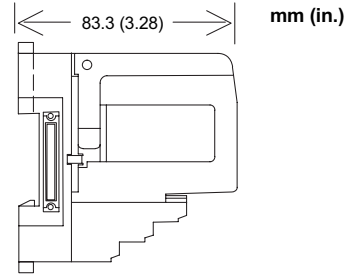
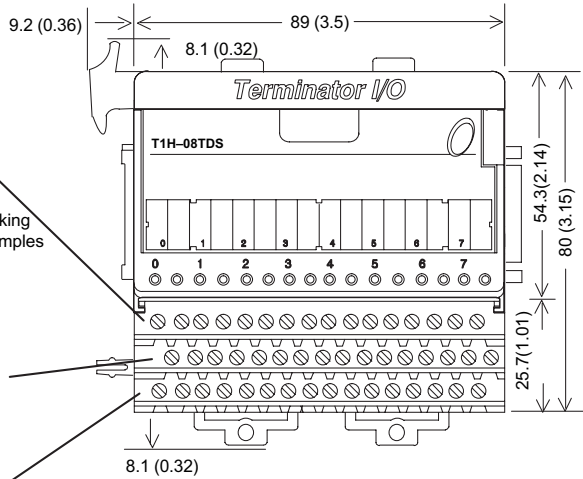
Environmental Specifications	
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M Ω
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 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.

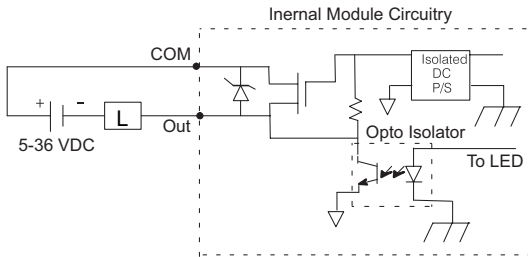


No connection: The 8 User Bus 1 terminals are bussed together. The 8 User Bus 2 terminals are also bussed together.

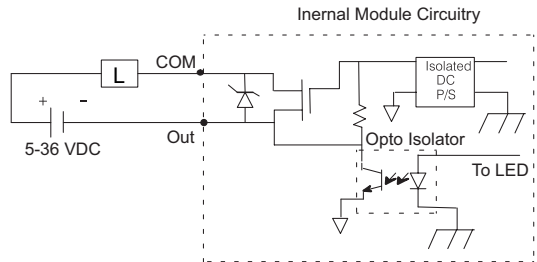


Equivalent Output Circuit

Sourcing (High Side Switching)



Sinking (Low Side Switching)



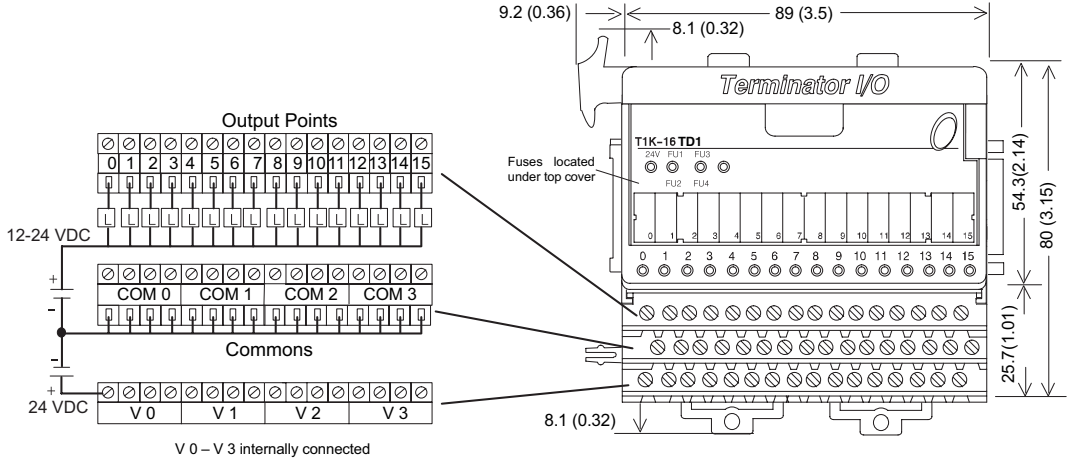
Side View

T1K-16TD1 DC Output

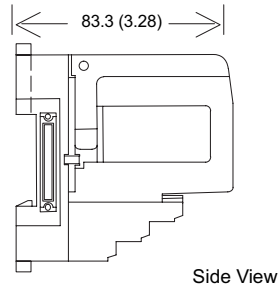
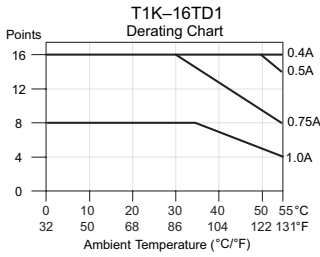
Specifications	
Outputs Per Module	16 (sink)
Commons Per Module	4 internally connected
Operating Voltage Range	6–27 VDC
Output Voltage Range	5–30 VDC min. / max.
Peak Voltage	50VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15 μ A @ 30VDC
ON Voltage Drop	0.3 VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10 μ s
ON to OFF Response	< 60 μ s
Base Power Requirements	200mA @ 5VDC
External Power Required	400mA max. @ 20–28VDC
Status Indicators	Logic Side
Error Status Indicators (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, (6.3 A, 250V / common), (4 pts. / fuse)
T1K-FUSE-1	NQ3 - 6.3 SOC corp.
Weight	140g

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 84D).
Vibration Resistance	MIL STD 810C. Method 514.2
Shock Resistance	MIL STD 810C. Method 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M Ω
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

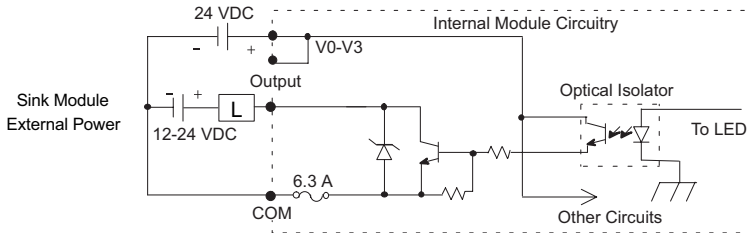
Wiring & Dimensions



mm (in.)



Equivalent Output Circuit

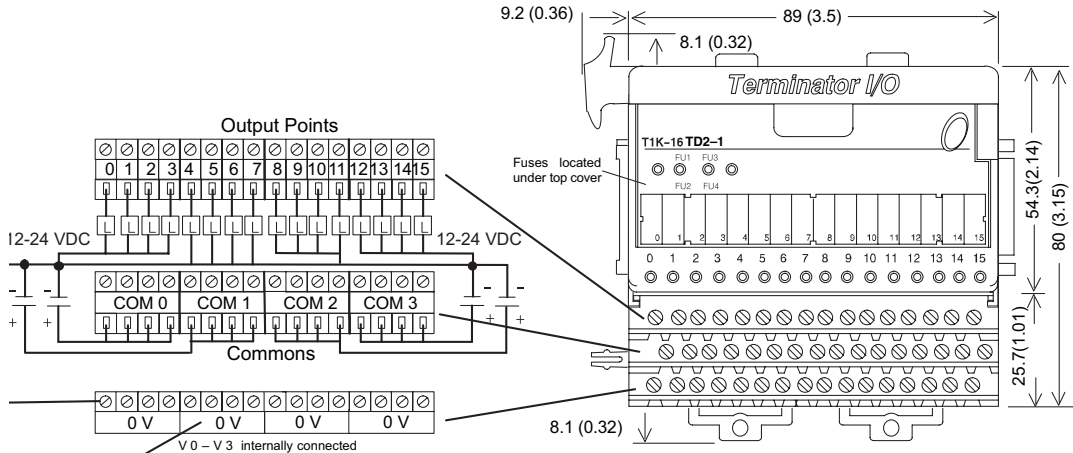


T1K-16TD2-1 DC Output

Specifications	
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 min. / max.
Peak Voltage	50VDC
Max. Load Current	1A / pt., 4A / common (subject to derating)
Max. Leakage Current	15 μ A @ 26.4VDC
ON Voltage Drop	1.2VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10 μ s
ON to OFF Response	< 0.5 ms
Base Power Requirements	200mA @ 5VDC
Status Indicators	Logic Side
Error Status Indicators (LEDS)	FU1 / FU2 ON = fuse 1 or 2 blown FU3 / FU4 ON = fuse 3 or 4 blown
Fuses (User Replaceable) T1K-FUSE-1	4, (6.3 A, 250V / common), (4pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	140g

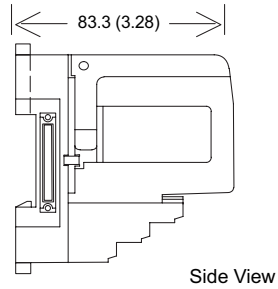
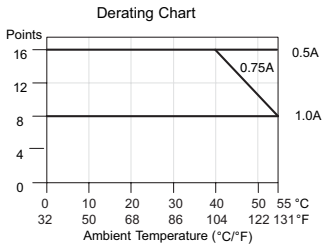
Environmental Specifications	
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions

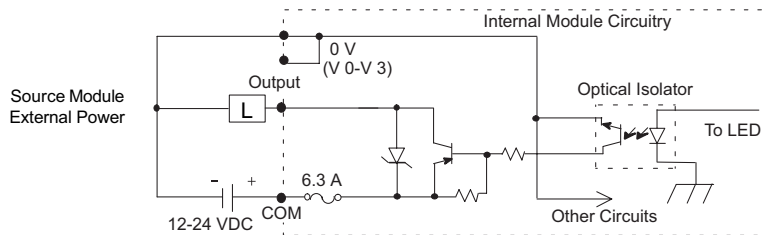


mm (in.)

Note: Apply the 0 V label that comes with the I/O module to I/O base terminal points V 0-V 3 to properly identify the 0 VDC terminal points.



Equivalent Output Circuit

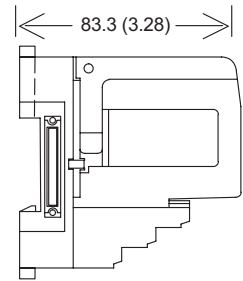
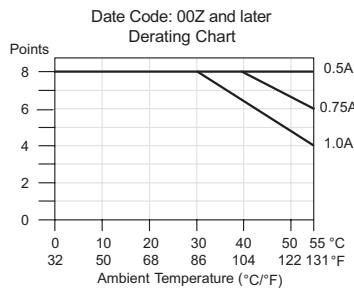
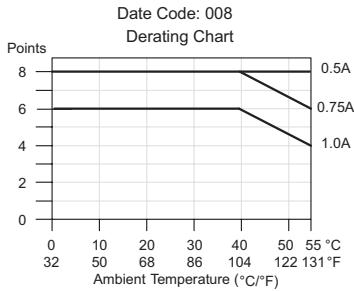
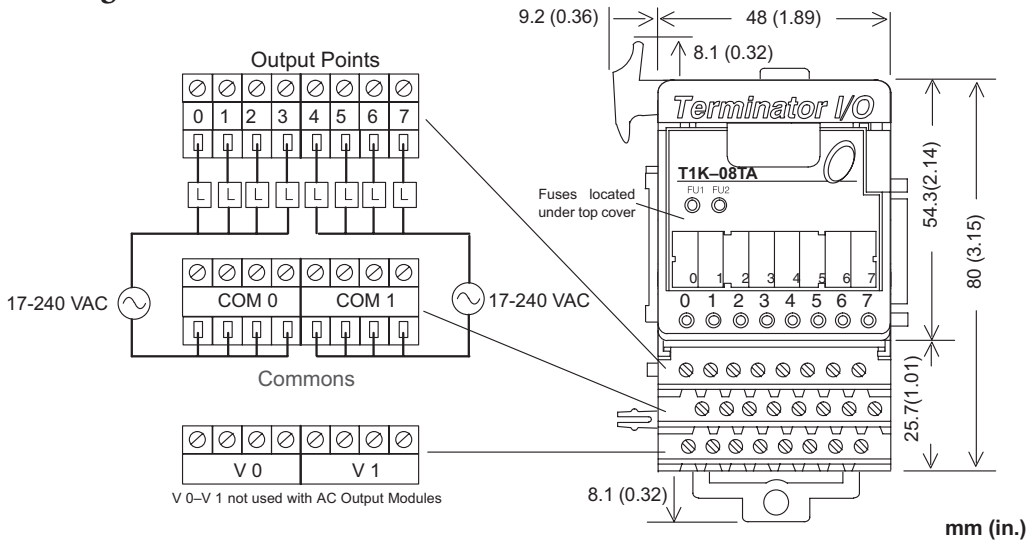


T1K-08TA AC Output

Specifications	
Outputs Per Module	8
Commons Per Module	2, 4 pts. / common (isolated)
Operating Voltage Range	17–240 VAC (47–63 Hz)
Output Voltage Range	15–264 VAC (47–63 Hz) min. / max.
Max. Load Current	1A / pt., 4A / common (subject to derating)
ON Voltage Drop	1.5 VAC @ > 50mA, 4.0 VAC @ < 50mA
Max. Leakage Current	4mA @ 264VAC
Max. Inrush Current	10A for 10ms
Min. Load	10mA
OFF to ON Response	< 1ms
ON to OFF Response	< 1ms + 1/2 cycle
Base Power Requirements	250mA @ 5VDC
Status Indicators	Logic Side
Error Status Indicators (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 20mm type
Weight	140g

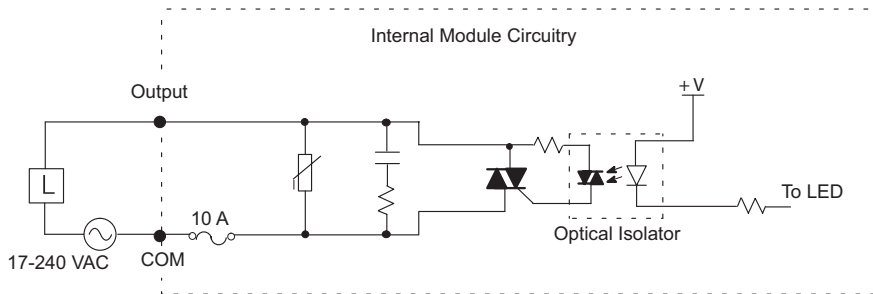
Environmental Specifications	
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions



Side View

Equivalent Output Circuit

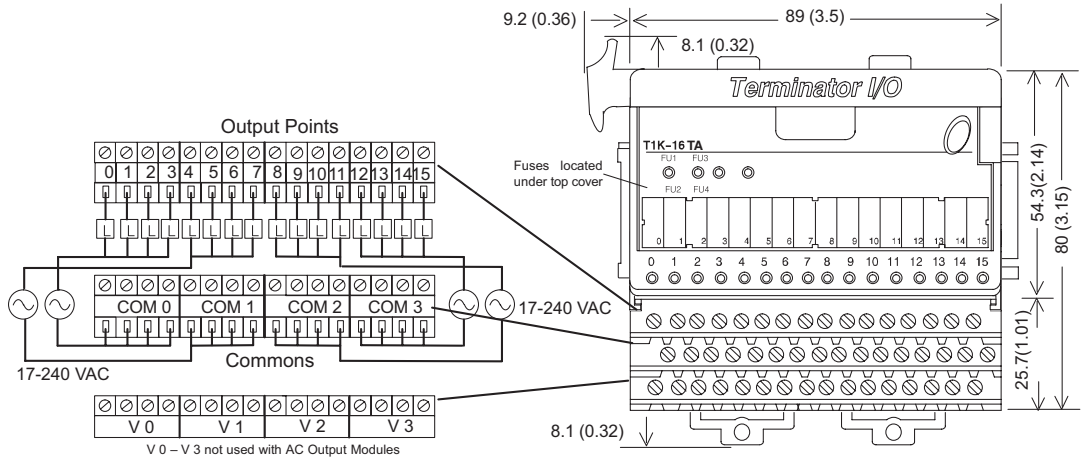


T1K-16TA AC Output

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

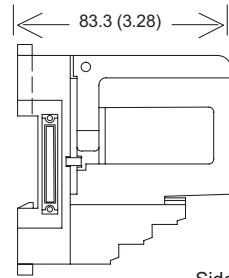
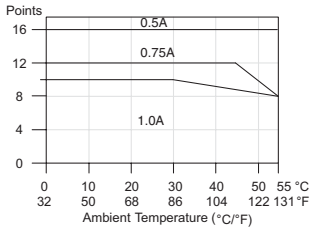
Environmental Specifications	
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions



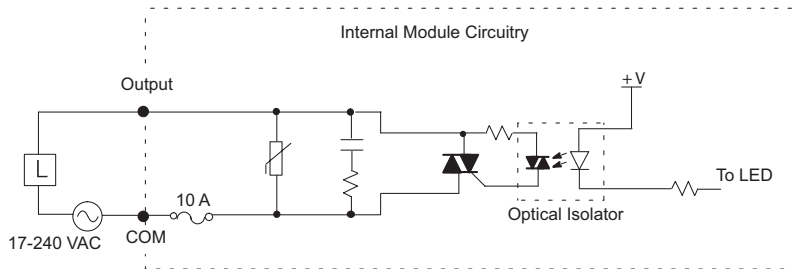
mm (in.)

Date Code: 012 and Later
Derating Chart



Side View

Equivalent Output Circuit



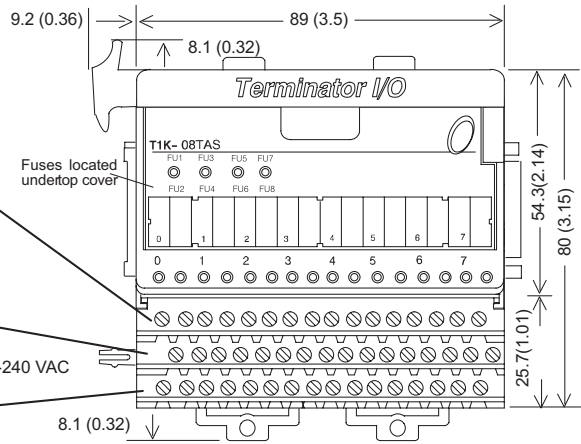
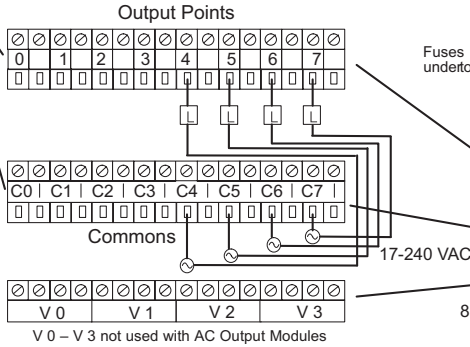
T1K-08TAS AC Output

Specifications	
Outputs Per Module	8
Commons Per Module	8, 1pt. / common (isolated)
Operating Voltage Range	17–40 VAC (47–63 Hz)
Output Voltage Range	15–264 VAC (47–63 Hz) min. / max.
Max. Load Current	2A / pt. common (subject to derating)
ON Voltage Drop	1.5 VAC @ > 50mA, 4.0 VAC @ < 50mA
Max. Leakage Current	4mA @ 264VAC
Max. Inrush Current	10A for 10ms
Min. Load	10mA
OFF to ON Response	<1ms
ON to OFF Response	<1ms + 1/2 cycle
Base Power Requirements	300mA @ 5VDC
Status Indicators	Logic Side
Error Status Indicators (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), (1pt. / fuse) NQ3-10 SOC Corp.
Weight	190g

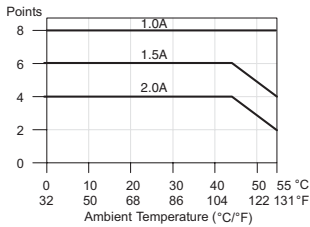
Environmental Specifications	
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions

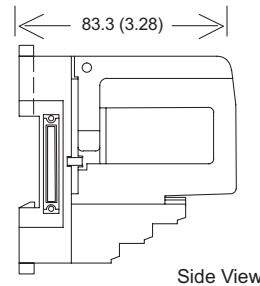
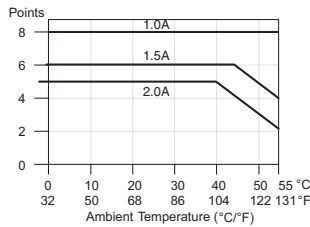
Note: Apply the labels that come with the I/O module to the I/O base to properly identify the terminal points.



**Date Code: 008
Derating Chart**

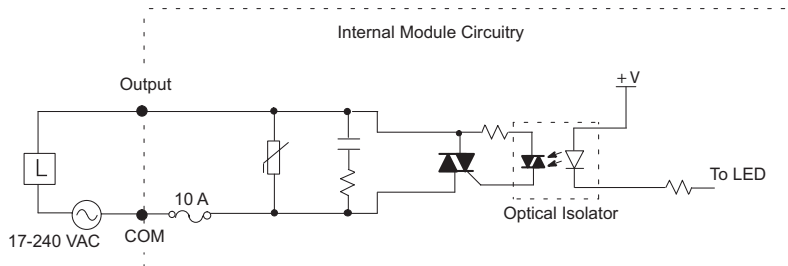


**Date Code: 012 and later
Derating Chart**



mm (in.)

Equivalent Output Circuit

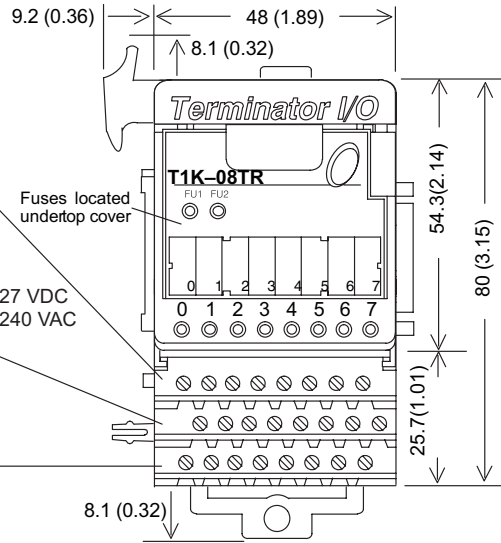
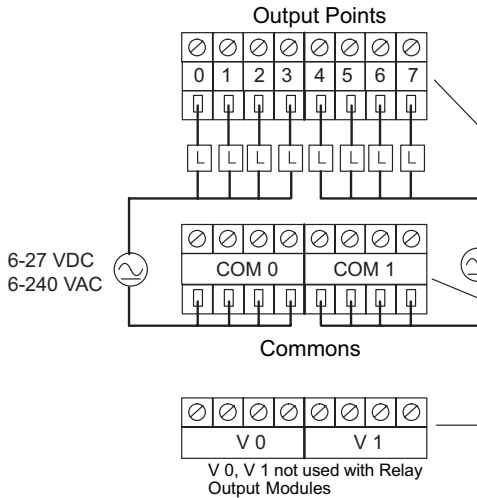


T1K-08TR Relay Output

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

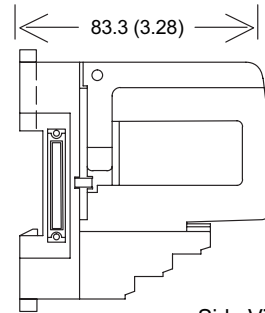
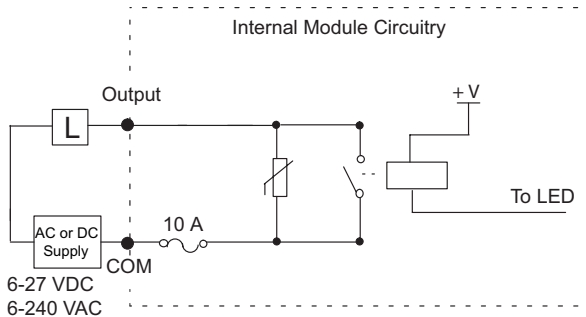
Environmental Specifications	
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions



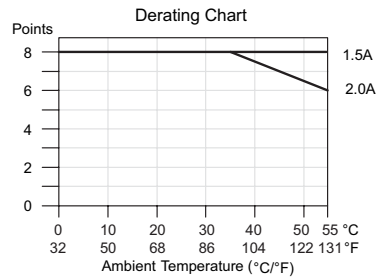
mm (in.)

Equivalent Output Circuit



Side View

Typical Relay Life (Operations) at Room Temperature		
Voltage & Type of Load	Load Current	
	1 A	2 A
24VDC Resistive	500 K	250 K
24VDC Solenoid	100 K	50 K
110VAC Resistive	500 K	250 K
110VAC Resistive	200 K	100 K
220VAC Resistive	350 K	200 K
220VAC Resistive	100 K	50 K

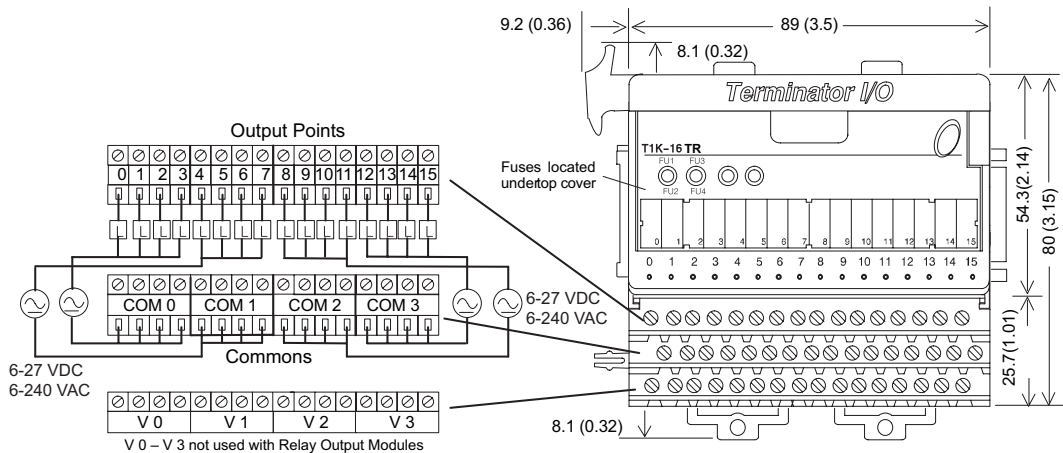


T1K-16TR Relay Output

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

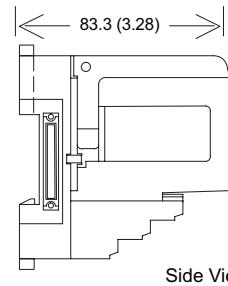
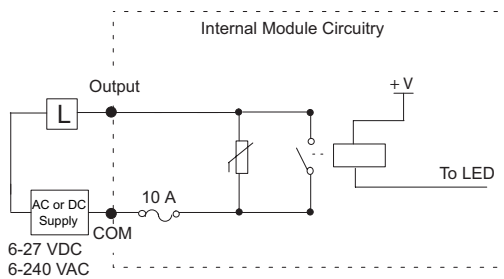
Environmental Specifications	
Ambient Operating Temperature	32°F to 140°F (0°C to 60°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Wiring & Dimensions



mm (in.)

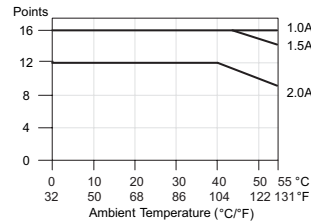
Equivalent Output Circuit



Side View

Typical Relay Life (Operations) at Room Temperature		
Voltage & Type of Load	Load Current	
	1 A	2 A
24VDC Resistive	500 K	250 K
24VDC Solenoid	100 K	50 K
110VAC Resistive	500 K	250 K
110VAC Resistive	200 K	100 K
220VAC Resistive	350 K	200 K
220VAC Resistive	100 K	50 K

Date Code: 012* and later
Derating Chart



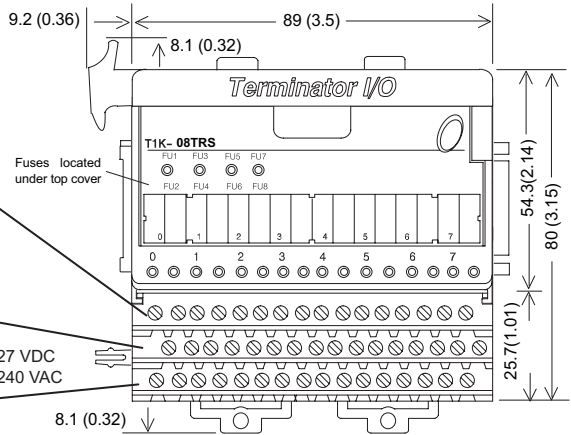
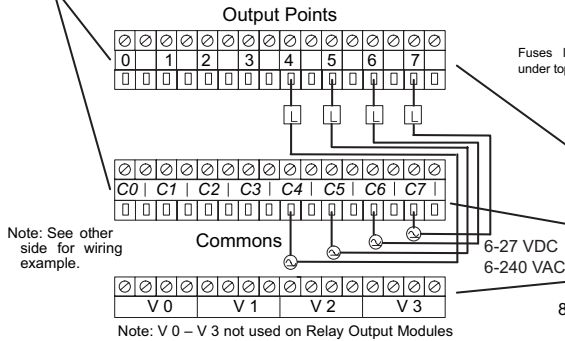
T1K-08TRS Relay Output

Specifications	
Outputs Per Module	8
Output Type	Relay Form A (SPST) normally open
Commons Per Module	8, 1pt. / common (isolated)
Operating Voltage Range	6–240 VAC (47–63 Hz), 6–27 VDC
Output Voltage Range	5–264 VAC (47–63 Hz) min. / max. 5–30 VDC min. / max.
Max. Load Current	7A / pt. common (subject to derating)
Max. Leakage Current	0.1 mA @ 264VAC
Max. Inrush Current	8A for 10ms
Min. Load	5mA @ 5VDC
OFF to ON Response	< 15ms
ON to OFF Response	< 10ms
Base Power Requirements	400mA @ 5VDC
Status Indicators	Logic Side
Error Status Indicators (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), (1pt. / fuse) NQ3-10 SOC Corp.
Weight	185g

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 514.2
Voltage Withstand	1500VAC, 1 minute
Insulation Resistance	500VDC, 10M Ω
Noise Immunity	NEMA ICS3-304 Impulse Noise 1 μ s, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL, CE, FCC class A

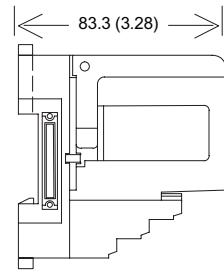
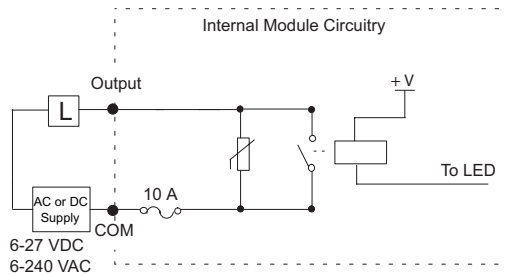
Wiring & Dimensions

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



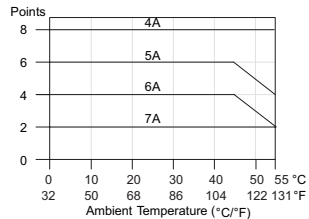
Side View

Typical Relay Life (Operations) at Room Temperature

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

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

Derating Chart

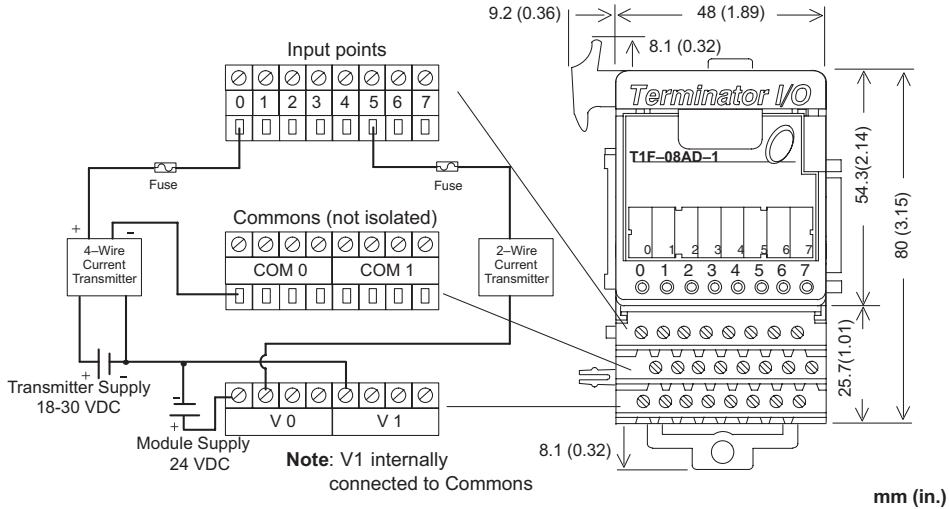


T1F-08AD-1 8-Channel Current Analog Input

Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0–20 mA, 4–20mA, - 20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3db @ 500 Hz, - 20db / decade
Input Resistance	250Ω
Absolute Maximum Ratings	8V max. Input
Conversion Time (Default: Normal Mode)	Normal Mode: 5ms per channel Fast Mode: 0.5 ms per channel (Fast Mode supported in module hardware version B or later, and only when using this analog module with the T1H-EBC(100) or T1H-PBC control module)
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 Module Power Supply Req.	18–30VDC, 50mA, class 2
Recommended Fuse	0.032 A @ 5VDC, 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	±50ppm / °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

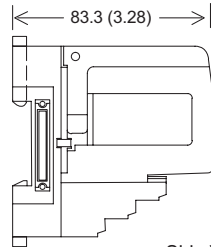
Input Range Resolution	
-20 to 20mA	-8192 to 8191 counts
0–20 mA	0–8191 counts
4–20 mA	1638–8191 counts

Wiring & Dimensions



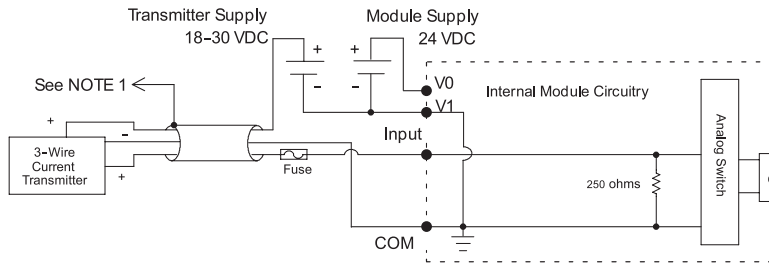
NOTES:

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, 0.032 A 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 4–20 mA output.

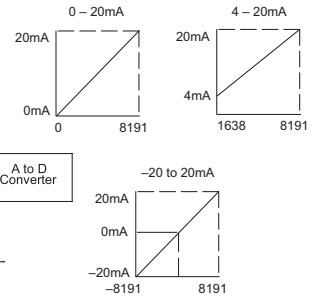


Side View

Equivalent Input Circuit



Input Signal Ranges

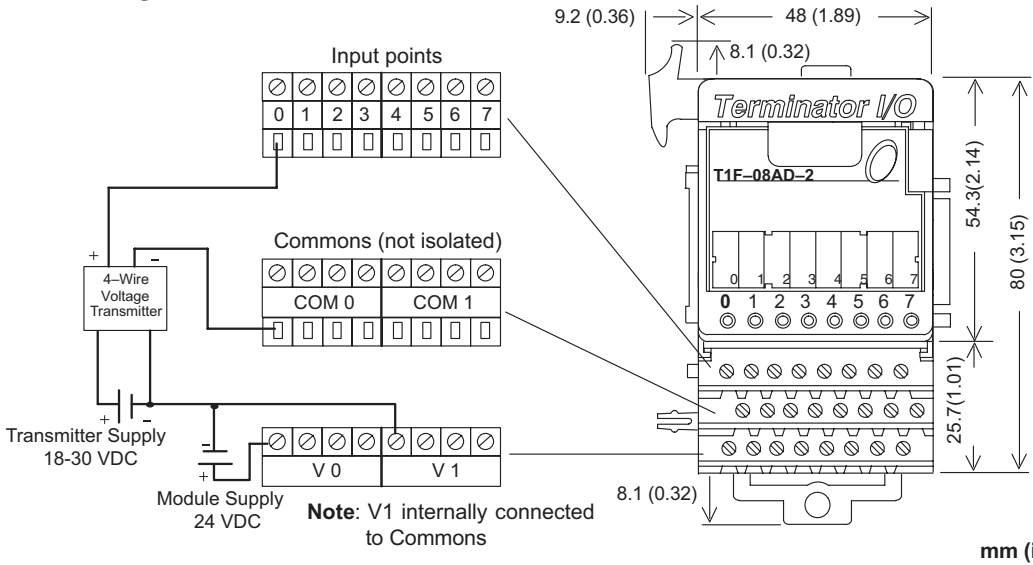


T1F-08AD-2 8-Channel Voltage Analog Input

Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0–5 V, 0–10 V, $\pm 5V$, $\pm 10V$
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3db @ 500Hz, - 20db / decade
Input Resistance	200k Ω min.
Absolute Maximum Ratings	Fault Protected Input, 130V (rms) or 100VDC
Conversion Time (Default: Normal Mode)	Normal Mode: 5ms per channel Fast Mode: 0.5 ms per channel (Fast Mode supported in module hardware version B or later, and only when using this analog module with the T1H-EBC(100) or T1H-PBC control module)
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 Module Power Supply Req.	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	136g

Input Range Resolution	
0–5 V	0–4095 counts
0–10 V	0–8191 counts
$\pm 5V$	- 4095 to 4095 counts
$\pm 10V$	-8192 to 8191 counts

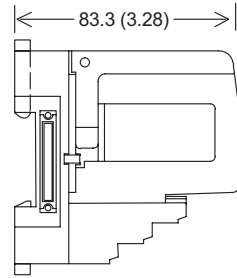
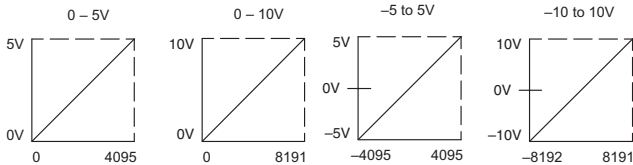
Wiring & Dimensions



NOTES:

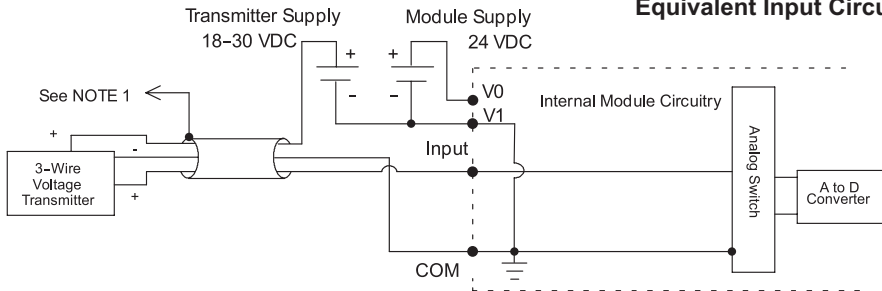
1. Shields should be grounded at the signal source.
2. Unused inputs should be connected to Common (0 VDC).
3. More than one external power supply can be used, provided all the power supply commons are connected.

Input Signal Ranges



Side View

Equivalent Input Circuit

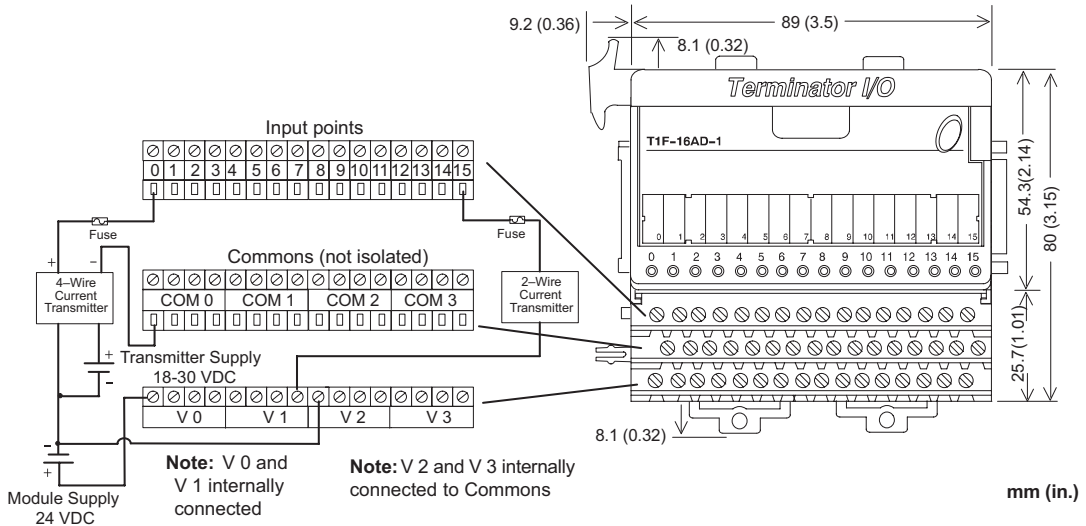


T1F-16AD-1 16-Channel Current Analog Input

Specifications	
Number of Channels	16, single ended (1 common)
Input Ranges	0–20 mA, 4–20 mA, - 20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3db @ 500Hz, - 20db / decade
Input Resistance	250Ω
Absolute Maximum 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 Module Power Supply Req.	18–30 VDC, 50mA, class 2
Recommended Fuse	0.032 A @ 5VDC
Operating Temperature	0°to 60°C (32°to 140°F)
Storage Temperature	- 20°to 70°C (- 4°to 158°F)
Accuracy vs. Temperature	±50ppm / °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

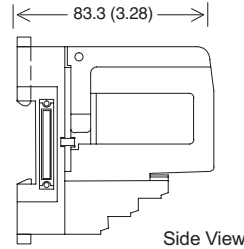
Input Range Resolution	
-20 to 20mA	-8192 to 8191 counts
0–20 mA	0–8191 counts
4–20 mA	1638–8191 counts

Wiring & Dimensions

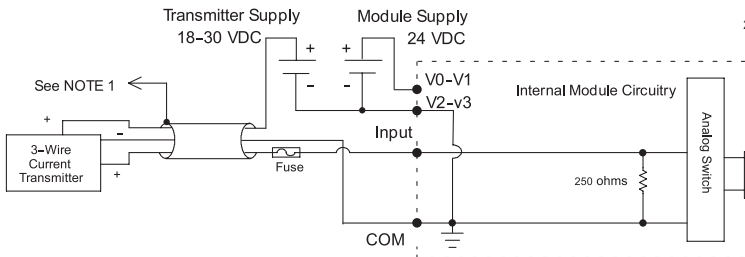


NOTES:

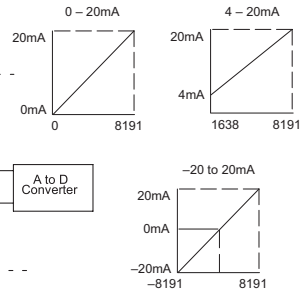
1. Shields should be grounded at the signal source.
2. More than one external power supply can be used, provided all the power supply commons are connected.
3. A Series 217, 0.032 A fast-acting fuse is recommended for 4–20 mA current loops.
4. If the power supply common of an external power supply is not connected to the 0 V 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 4–20 mA output.



Equivalent Input Circuit



Input Signal Ranges

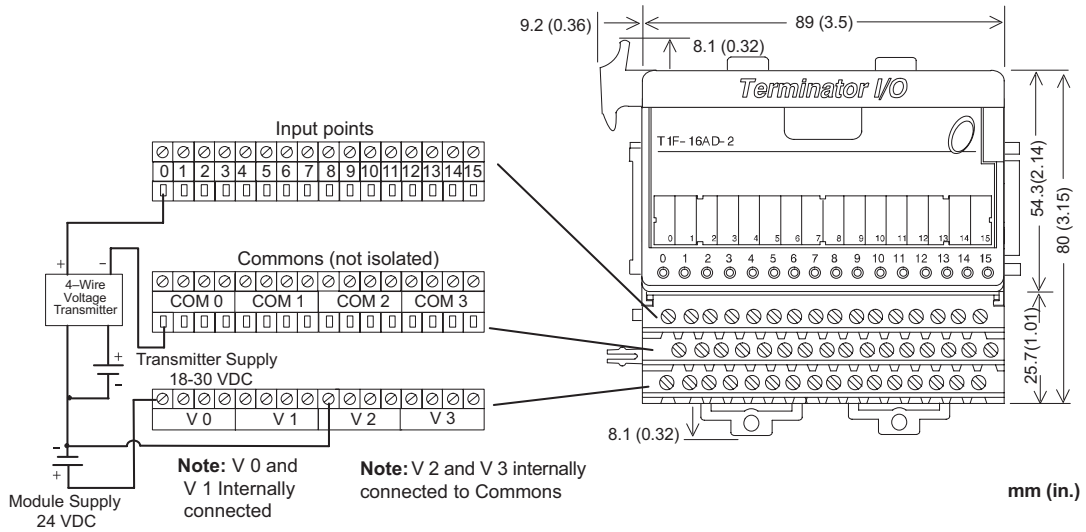


T1F-16AD-2 16-Channel Voltage Analog Input

Specifications	
Number of Channels	16, single ended (1 common)
Input Ranges	0–5 V, 0–10 V, ±5V, ±10V
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	- 3db @ 500Hz, - 20db / decade
Input Resistance	200kΩ min.
Absolute Maximum 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 Module Power Supply Req.	21.6–26.4 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	±50ppm / °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	160g

Input Range Resolution	
0–5 V	0–4095 counts
0–10 V	0–8191 counts
±5V	- 4095 to 4095 counts
±10V	-8192 to 8191 counts

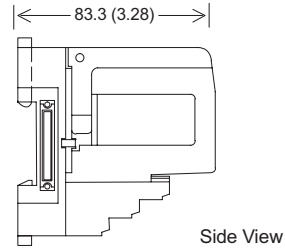
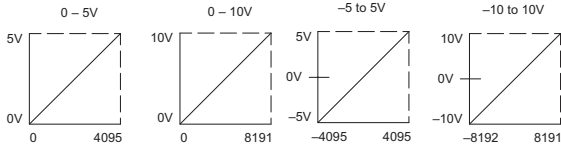
Wiring & Dimensions



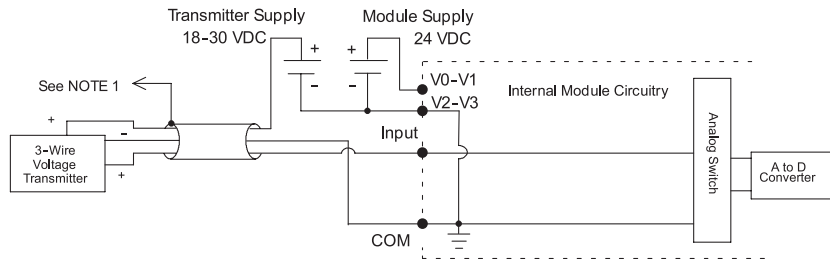
NOTES:

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

Input Signal Ranges



Equivalent Input Circuit



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

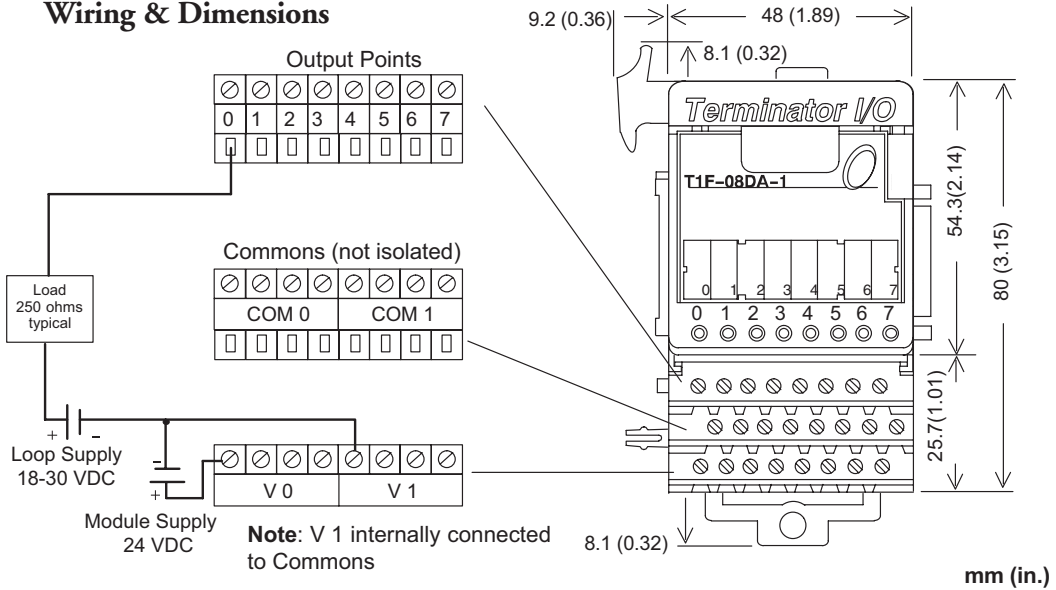
Specifications	
Number of Channels	8
Output Ranges	0–20 mA, 4–20 mA
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Max. Loop Supply	30VDC
Peak Output Voltage	30VDC
Load Impedance	0 Ω min.
Max. Load (ohm) / Power Supply	620 / 18V, 910 / 24V, 1200 / 30V
Min. Load (ohm) / Power Supply*	0 / 24V, 350 / 30V @ 40°C 250 / 24V, 600 / 30V @ 60°C
Linearity Error (end to end)	± 2 counts max. $\pm 0.05\%$ of full scale max.
Conversion Settling Time	400 μ s max. full scale change
Full Scale Calibration Error	± 12 counts max.
Offset Calibration Error	0–20 mA: ± 5 counts max. 4–20 mA: ± 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 Module Power Supply Req.	21.6–26.4 VDC, 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 Ω on the output circuit. Smaller loads will damage the analog output circuit.



NOTE: This module requires software setup via the Module Control Byte. Refer to Chapter 4 in this manual.

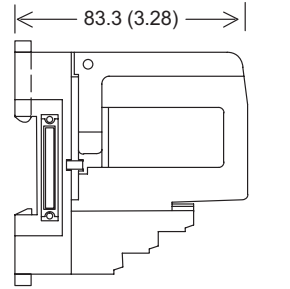
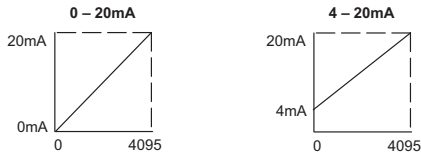
Wiring & Dimensions



NOTES:

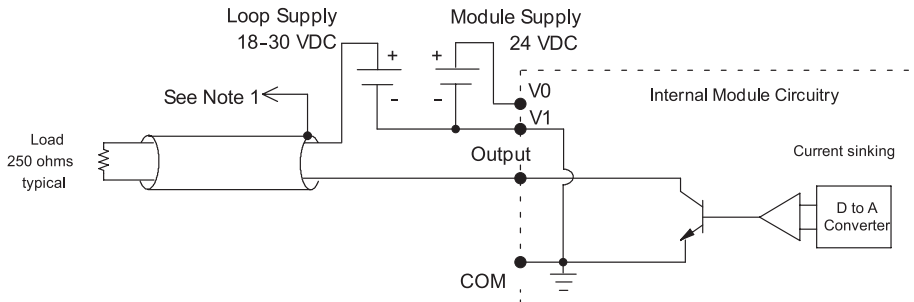
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.
2. Unused current outputs should remain open (no connections) for minimum power consumption.

Output Signal Ranges



Side View

Equivalent Output Circuit



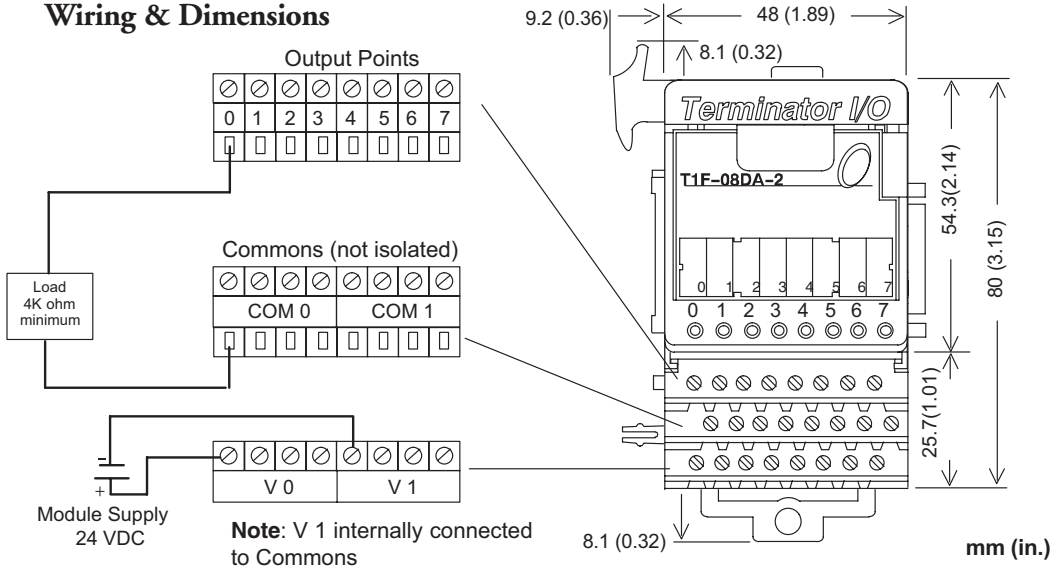
T1F-08DA-2 8-Channel Analog Output

Specifications	
Number of Channels	8
Output Ranges	0–5 V, 0–10 V, $\pm 5V$, $\pm 10V$
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15VDC
Load Impedance	4k Ω min.
Load Capacitance	0.01 μF max.
Linearity Error (end to end)	± 2 counts max. $\pm 0.05\%$ of full scale max.
Conversion Settling Time	100 μs 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 / $^{\circ}C$, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors and temp drift included	10V ranges: $\pm 0.2\%$ @ 25 $^{\circ}C$ $\pm 0.4\%$ @ 60 $^{\circ}C$ 5V ranges: $\pm 0.3\%$ @ 25 $^{\circ}C$ $\pm 0.5\%$ @ 60 $^{\circ}C$
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 Module Power Supply Req.	21.6 - 26.4VDC, 150mA, class 2
Operating Temperature	0 $^{\circ}$ to 60 $^{\circ}C$ (32 $^{\circ}$ to 140 $^{\circ}F$)
Storage Temperature	- 20 $^{\circ}$ to 70 $^{\circ}C$ (- 4 $^{\circ}$ to 158 $^{\circ}F$)
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 Chapter 4 in this manual.

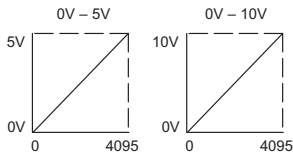
Wiring & Dimensions



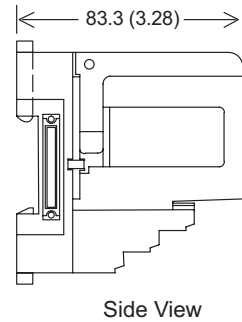
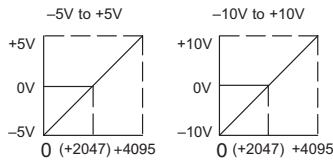
NOTES:

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

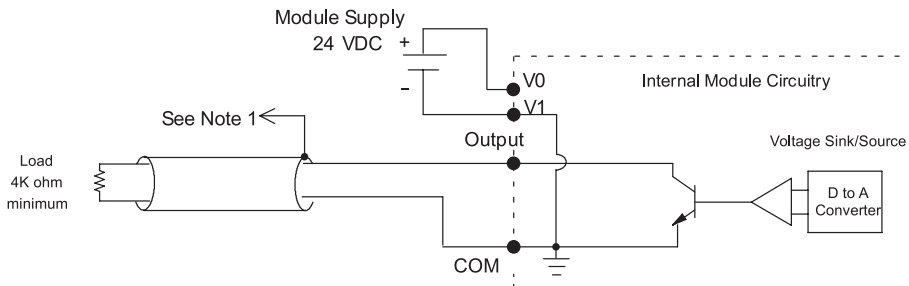
Unipolar Ranges



Bipolar Ranges



Equivalent Output Circuit



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

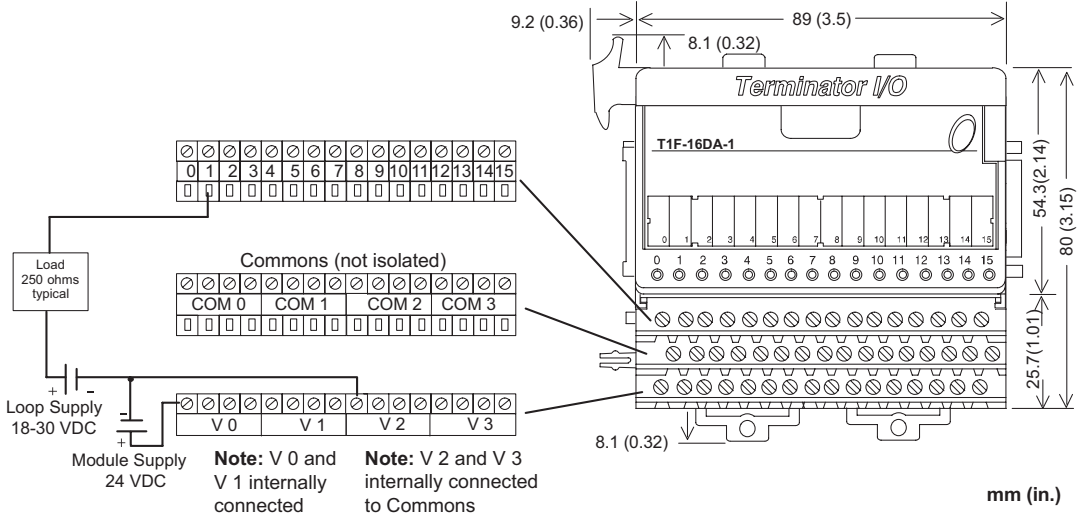
Specifications	
Number of Channels	16
Output Ranges	0–20 mA, 4–20 mA
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Max. Loop Supply	30VDC
Peak Output Voltage	30VDC
Max. Load (ohm) / Power Supply	620 / 18V, 910 / 24V, 1200 / 30V
Min. Load (ohm) / Power Supply*	0 / 24V, 350 / 30 V @ 40°C 250 / 24V, 600 / 30V @ 60°C
Linearity Error (end to end)	±2 counts max. ±0.05% of full scale max.
Conversion Settling Time	400µs 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	±50ppm / °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 Module Power Supply Req.	21.6–26.4 VDC, 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 250Ω on the output circuit. Smaller loads will damage the analog output circuit.



NOTE: This module requires software setup via the Module Control Byte. Refer to Chapter 4 in this manual.

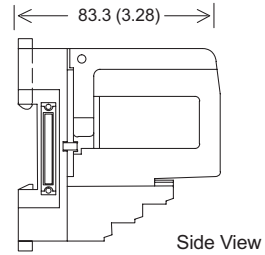
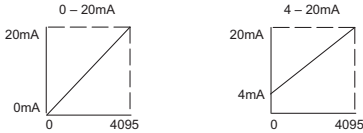
Wiring & Dimensions



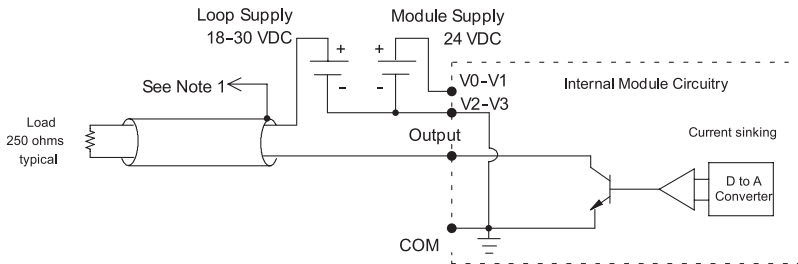
NOTES:

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

Output Signal Ranges



Equivalent Output Circuit



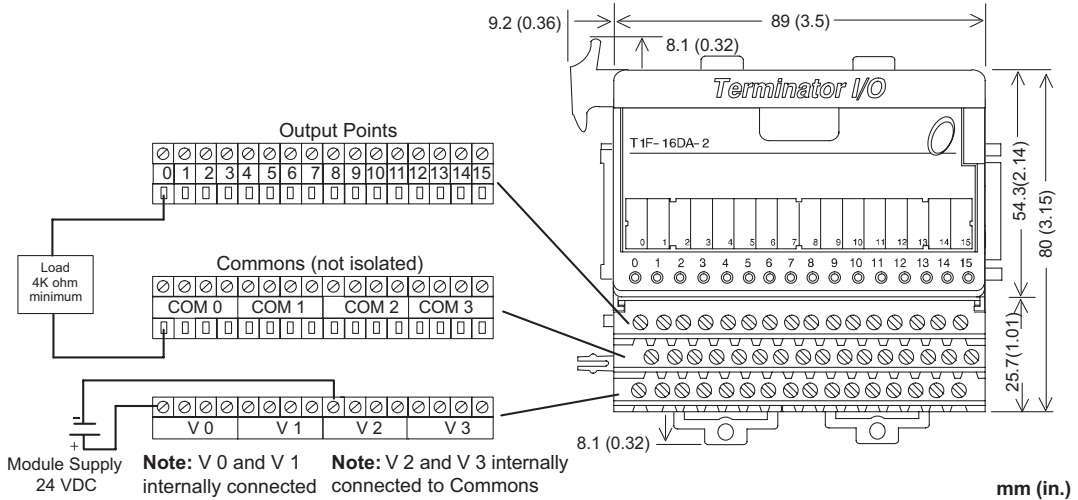
T1F-16DA-2 16-Channel Voltage Analog Output

Specifications	
Number of Channels	16
Output Ranges	0–5 V, 0–10 V, $\pm 5V$, $\pm 10V$
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15VDC
Load Impedance	4k Ω min.
Load Capacitance	0.01 μF max.
Linearity Error (end to end)	± 2 counts max. $\pm 0.05\%$ of full scale max.
Conversion Settling Time	100 μs 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 / $^{\circ}C$, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors and temp drift included	10V ranges: $\pm 0.2\%$ @ 25 $^{\circ}C$ $\pm 0.4\%$ @ 60 $^{\circ}C$ 5V ranges: $\pm 0.3\%$ @ 25 $^{\circ}C$ $\pm 0.5\%$ @ 60 $^{\circ}C$
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 Module Power Supply Req.	21.6–26.4VDC, 150mA, class 2
Operating Temperature	0 $^{\circ}$ to 60 $^{\circ}C$ (32 $^{\circ}$ to 140 $^{\circ}F$)
Storage Temperature	- 20 $^{\circ}$ to 70 $^{\circ}C$ (- 4 $^{\circ}$ to 158 $^{\circ}F$)
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 Chapter 4 in this manual.

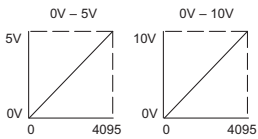
Wiring & Dimensions



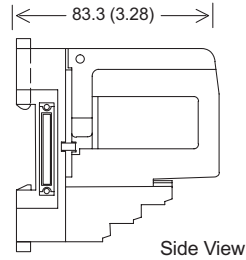
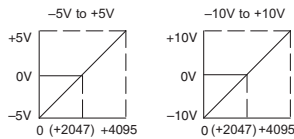
NOTES:

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

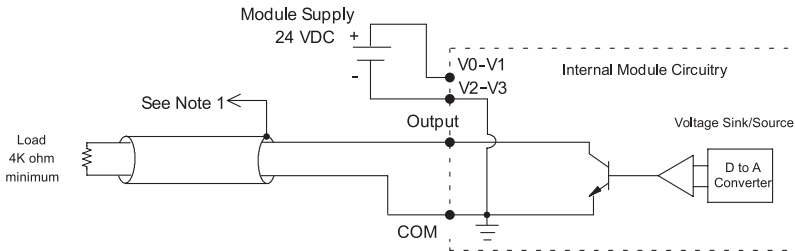
Unipolar Ranges



Bipolar Ranges



Equivalent Output Circuit



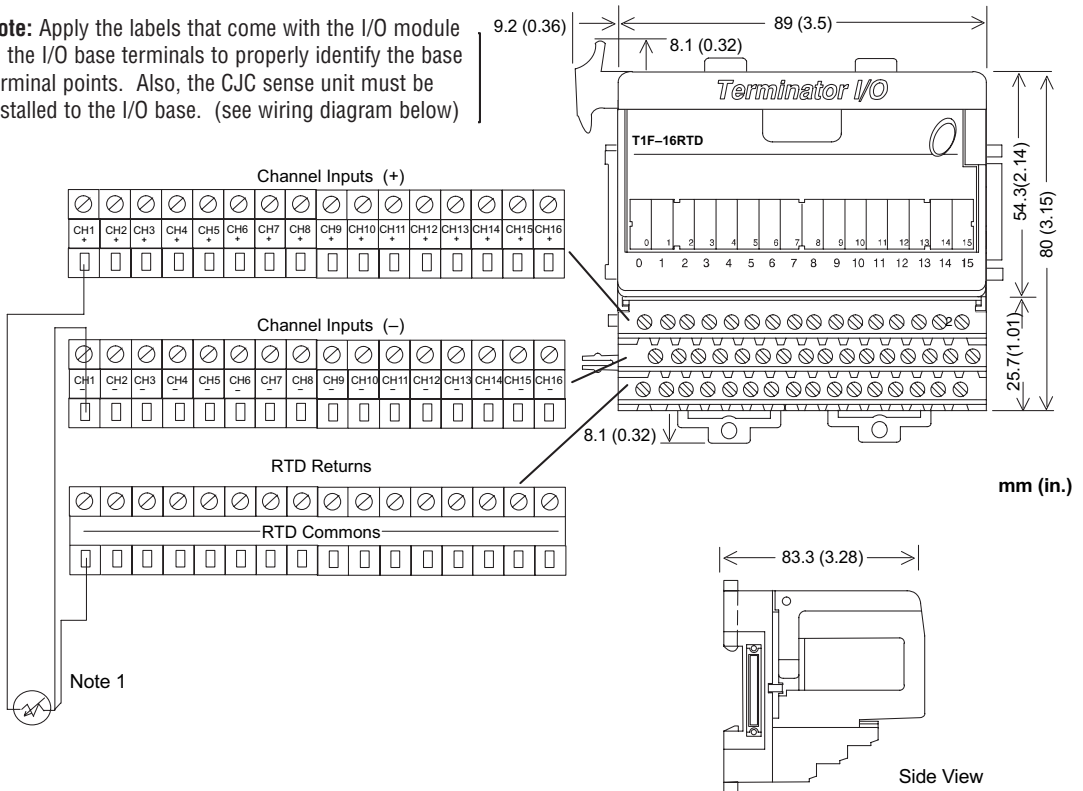
T1F-16RTD RTD Input Module

Specifications	
Number of Channels	16
Resolution	±0.1°C or °F
Common Mode Range	0–5 VDC
Notch Filter	> 50 db notches @ 50/60 Hz; f - 3db = 13.1 Hz
Absolute Max. Ratings	±50VDC
Converter Type	Charge balancing, 24 - bit
Sampling Rate	140ms / channel
Master Update Rate	16 channels per scan
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)
Temperature Drift	25 ppm / °C (max.)
Maximum Inaccuracy	±1°C
RTD Excitation Current	200µA
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	
RTD Type	Range
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)

Wiring & Dimensions

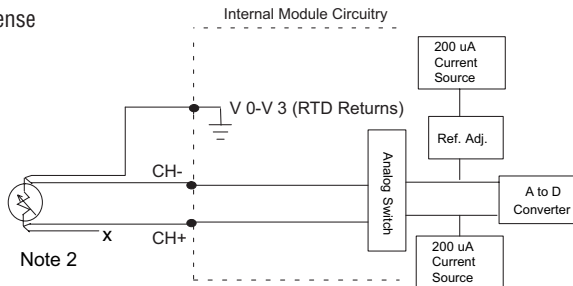
Note: Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points. Also, the CJC sense unit must be be installed to the I/O base. (see wiring diagram below)



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



T1F-16RTD continued

Setting Module Jumpers

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

Select Input Type (see Note 2)

RTD Input	Jumper		
	RTD-0	RTD-1	RTD-2
Pt100Ω	X	X	
Pt1000Ω			X
jPt100Ω		X	
Type CU-10Ω			
Type CU-25Ω	X		
120Ω Nickel	X		X

X = Jumper Installed

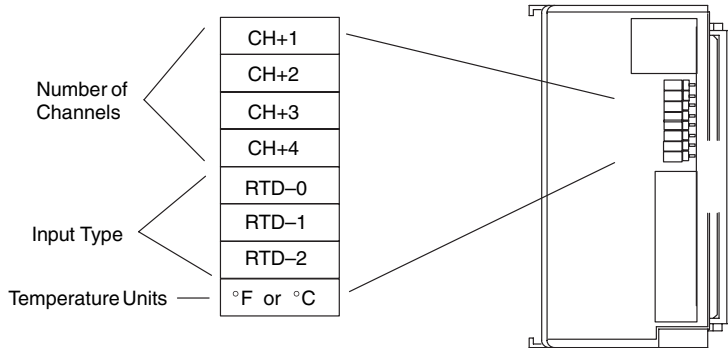
Blank Space = Jumper Removed

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 for your application.

NOTE 2: The module comes from the factory with the input Type jumpers selected for Pt100Ω operation. Use the table to determine the proper settings for your application.



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

The data format for each of the 16 RTD input channels consists of 32 bits. Only one bit is used in bits D31–D16 (bit 24) as shown below.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	B0	-	-	-	-	-	-	-	-

Bit 24, designated as B0, is the channel burn out bit:

- 1 = channel RTD sensor burn out or RTD is disconnected from either input terminal
- 0 = channel is okay.

The remaining bits (–) are not used and are all equal to 0.

D15–D0, shown below, contains the temperature data with D15 being 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.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

T1F-16TMST Thermistor Input Module

Specifications	
Number of Channels	16
Resolution	±0.1°C or °F
Input Impedance	> 1MΩ
Common Mode Range	0–5 VDC
Absolute Max. Ratings	±50VDC
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°C to 60°C (32°F to 140°F)
Storage Temperature	-20°C to 70°C (-4°F to 158°F)
Temperature Drift	25ppm / °C (max.)
Maximum Inaccuracy ¹	±1°C
Excitation Current	10μA
Electrical Isolation	1500VDC field wire to backplane
Relative Humidity	5 to 95% (non-condensing)
Environmental Air	No corrosive gases permitted
Vibration	IEC 60068-2-6 (Test FC)
Shock	IEC 60068-2-27 (Test Ea)
Noise Immunity	EN61131-2:2007 ²
Recommended Cable	AutomationDirect P/N: PLTC3-18-1S-XXX Belden 8761 or equivalent
Weight	168g

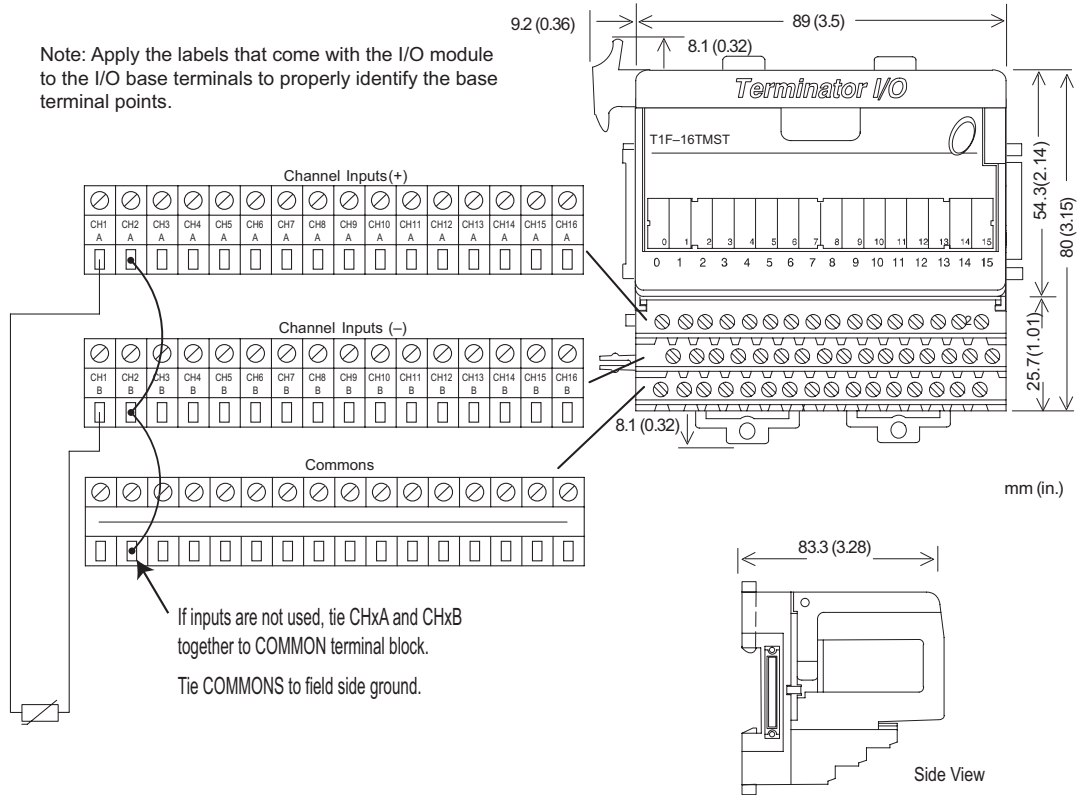
¹ "Accuracy" pertains to module only and does not include tolerances of thermistor element, wiring resistance, etc. For example, 22 gauge wire is 0.016 Ω per foot, so 200 feet of wire adds 3.2 Ω.

² Meets EMC & Safety Requirements

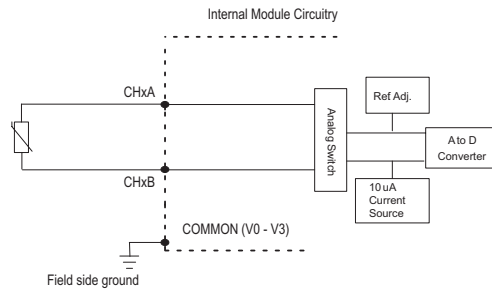
Thermistor Input Ranges	
Input Ranges	Range
10K-AN (Type 3)	-40°C to 150°C (-40°F to 300°F)
10K-CP (Type 2)	-40°C to 150°C (-40°F to 300°F)
5K	-40°C to 150°C (-40°F to 300°F)
3K	-40°C to 150°C (-40°F to 300°F)
2252	-40°C to 150°C (-40°F to 300°F)
1.8K	-40°C to 150°C (-40°F to 300°F)

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.



Equivalent Input Circuit



T1F-16TMST continued

Setting Module Jumpers

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

Select Input Type (see Note 2)

Thermistor Input	Jumper		
	TMST-0	TMST-1	TMST-2
10K-AN (Type 3)			
10K-CP (Type 2)	X		
5K		X	
3K	X	X	
2252			X
1.8K	X		X
Future use		X	X
Future use	X	X	X

X = Jumper Installed

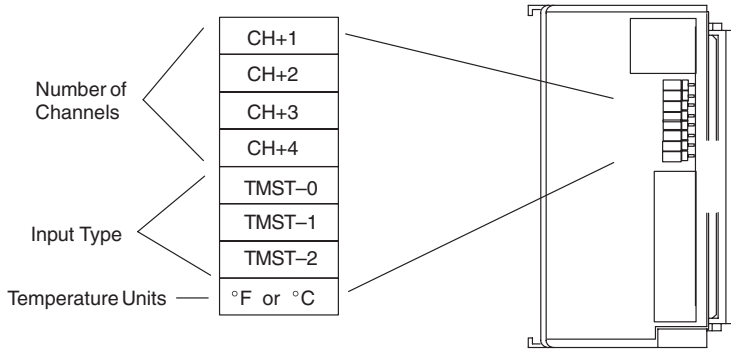
Blank Space = Jumper Removed



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 for your application.

NOTE 2: The module comes from the factory with the Input Type jumpers selected for 10K-AN operation. Use the table to determine the proper settings for your application.

**Jumpers Located Under
Module Top Cover**



Select Temperature Units

Temperature Units	Jumper
°F	X
°C	

X = Jumper Installed,
Blank Space = Jumper Removed

T1F-TMST Data Format

The data format for each of the 16 TMST input channels consists of 32 bits. Only one bit is used in bits D31–D16 (bit 24) as shown below.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	B0	-	-	-	-	-	-	-	-

Bit 24, designated as B0, is the channel burn out bit:

1 = channel thermistor sensor burn out or thermistor is disconnected from either input terminal

0 = channel is okay.

The remaining bits (–) are not used and are all equal to 0.

D15–D0, shown below, contains the temperature data with D15 being 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.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

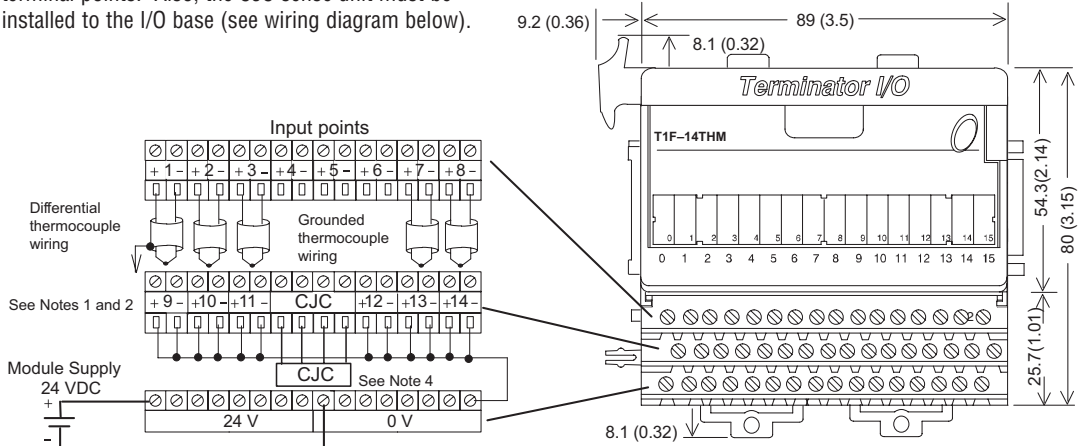
T1F-14THM 14-Channel Thermocouple Input

Specifications	
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	1MΩ
Absolute Max. Ratings	Fault Protected Input ±50VDC
Master Update Rate	14 channels per scan maximum
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 Required	24VDC ±5%, 70mA, class 2
Operating Temperature	0° to 60°C (-4° to 158°F)
Storage Temperature	-20° to 70°C (32° to 140°F)
Accuracy vs. Temperature	±5ppm / °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°C to 760°C (-310°F to 1400°F)
	Type E -210°C to 1000°C (-346°F to 1832°F)
	Type K -150°C to 1372°C (-238°F to 2502°F)
	Type R 65°C to 1768°C (149°F to 3214°F)
	Type S 65°C to 1768°C (149°F to 3214°F)
	Type T -230°C to 400°C (-382°F to 752°F)
	Type B 529°C to 1820°C (984°F to 3308°F)
	Type N -70°C to 1300°C (-94°F to 2372°F)
	Type C 65°C to 2320°C (149°F to 4208°F)
	Type J -190°C to 760°C (-310°F to 1400°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 typical, ±1°C repeatability
Linearity Error	±0.05°C maximum, ±0.01°C typical
Maximum Inaccuracy	±3°C

Wiring & Dimensions

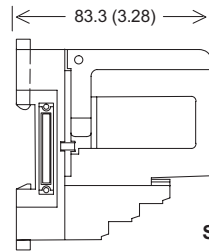
Note: Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points. Also, the CJC sense unit must be installed to the I/O base (see wiring diagram below).



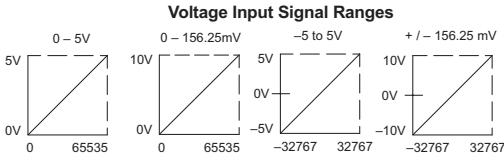
NOTES:

1. Shields should be grounded at the signal source.
2. Unused inputs should be connected to Common (0 VDC).
3. When using 0–156 mV and 5 V ranges, connect (-) or 0 V 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.

mm (in.)

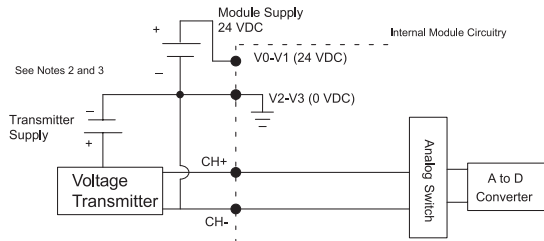


Side View



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

Equivalent Input Circuit



T1F-14THM continued

Setting Module Jumpers

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	
0-5 V		X	X	
±5V	X		X	
0-156 mV			X	
±156mV	X	X		

Select the Conversion Units

Jumper	Thermocouple Conversion Units (See Note 4)			
	Magnitude °F	Plus Sign °C	2's Complement !F !C	
Units-0	X		X	
Units-1	X	X		

Jumper	Voltage Conversion Units (See Note 5)	
	Magnitude Plus Sign	2's Complement
Units-0	X	X
Units-1	X	

X = Jumper Installed
Blank Space = Jumper Removed

Select Input Type (see Note 3)

T1F-THM Data Format

The data format for each of the 14 thermocouple input channels consists of 32 bits (shown here split into two groups of 16 bits). Only one bit is used in bits D31–D16 (bit 24) as shown below.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	B0	-	-	-	-	-	-	-	-

Bit 24, designated as B0, is the channel burn out bit:

1 = channel thermocouple sensor burn out or thermocouple is disconnected from either input terminal

0 = channel is okay.

The remaining bits are not used and are all equal to 0 (-).

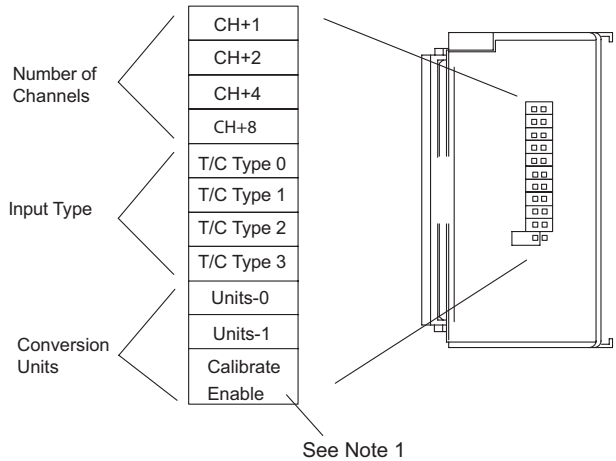
D15 to D0, shown below, contains the 16-bit temperature data with D15 being the most significant bit (MSB). See Notes 4 and 5.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Select Number of Channels (see Note 2)

Number of Channels	Jumper			
	CH+1	CH+2	CH+4	CH+8
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

Jumpers Located Under Module Top Cover



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.

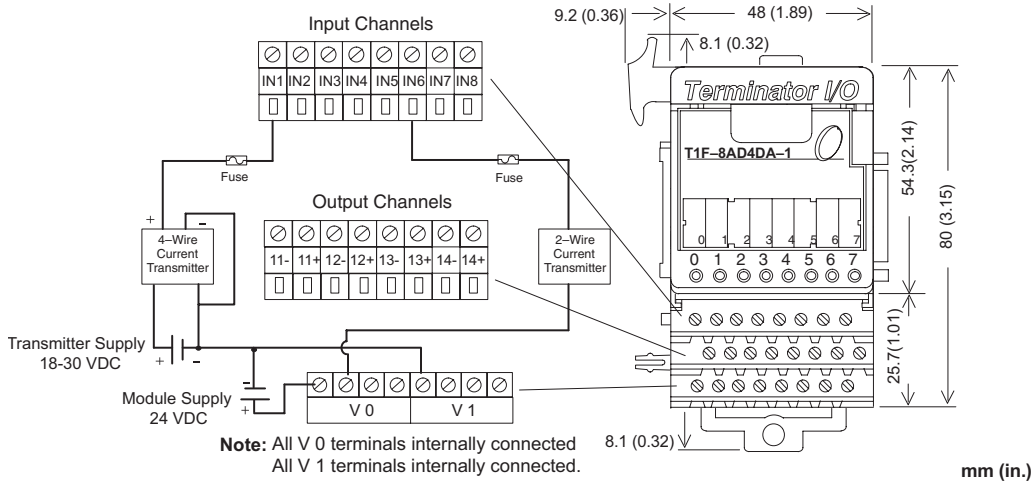
T1F-8AD4DA-1 8-Channel Current Analog Input / 4-Channel Current Analog Output

Input Channel Specifications	
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	0–20 mA, 4–20 mA, -20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Frequency Response Input active low-pass filter	- 3db @ 100Hz, - 20db / decade
Input Resistance	250Ω
Absolute Maximum 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
Recommended Fuse	0.032 A, Series 217 Fast Acting

Input Range Resolution	
-20 to 20mA	-8192 to 8191 counts
0–20 mA	0–8191 counts
4–20 mA	1638–8191 counts

Module General Specifications	
CPU Update Rate	12 channels per scan maximum
Base Power Required	75mA @ 5VDC
External Module Power Supply	21.6–26.4 VDC, 50mA, class 2 (plus 20mA per channel loop)
Operating Temperature	0° to 60°C (32° to 140°F)
Storage Temperature	- 20° to 70°C (- 4° to 158°F)
Accuracy vs. Temperature	±50ppm / °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

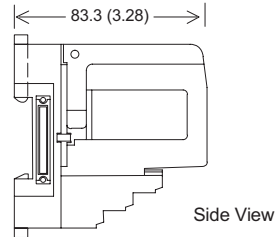
Input Wiring & Dimensions



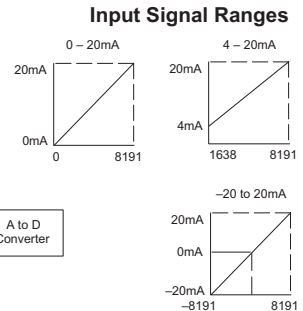
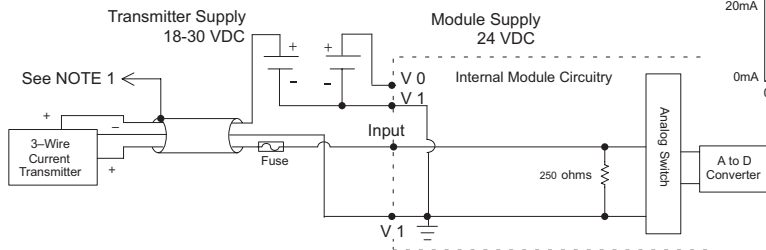
NOTE: Apply the labels that come with the I/O module to the I/O base terminals to properly identify the base terminal points.

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, 0.032 A 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 4–20 mA output.



Equivalent Input Circuit



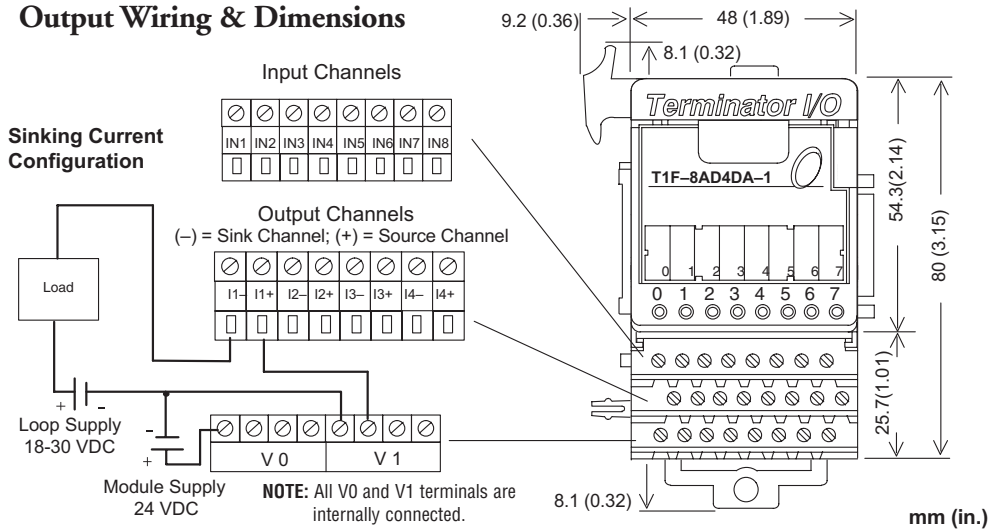
T1F-8AD4DA-1

Output Channel Specifications	
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 Range	4–20 mA
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Maximum Loop Supply	30VDC
Source Load (ohms) / Loop Power Supply	0–400 Ω / 18–30 V
Sink Load (ohm) / Loop Power Supply	0–600 Ω / 18V, 0–900 Ω / 24V, 0–1200 Ω / 30V
Total Load (Sink plus Source)	600 Ω / 18V, 900 Ω / 24V, 1200 Ω / 30V
Linearity Error (end to end)	± 2 count maximum $\pm 0.050\%$ of full scale maximum
Conversion Settling Time	400 μ s maximum 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 Ω load ± 18 counts max. @ 250 Ω load ± 12 counts max. @ 125 Ω load
Offset Calibration Error	SINK: ± 6 counts max. @ any load SOURCE: ± 10 counts max. @ 400 Ω load ± 8 counts max. @ 250 Ω load ± 6 counts max. @ 125 Ω 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 Ω load 0.63% @ 25°C 400 Ω load 0.83% @ 60°C 250 Ω load 0.44% @ 25°C 250 Ω load 0.64% @ 60°C 125 Ω load 0.30% @ 25°C 125 Ω load 0.50% @ 60°C

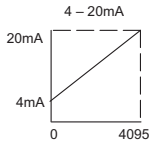


NOTE: This module requires software setup via the Module Control Byte. Refer to Chapter 4.

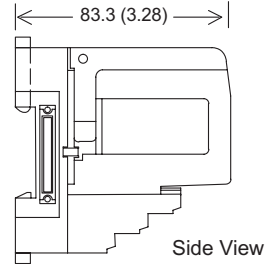
Output Wiring & Dimensions



Output Signal Range NOTES:

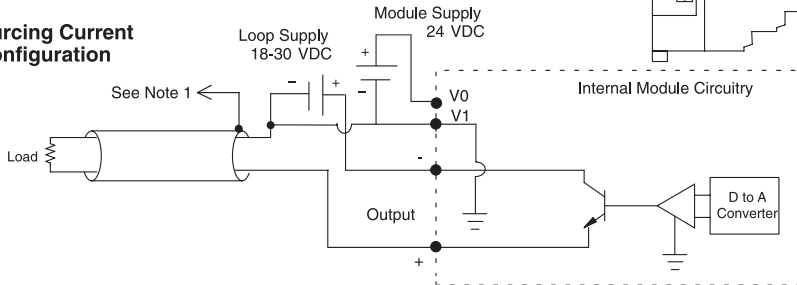


1. Shields should be connected to the 0V terminal of the module or the 0V of the power supply.
2. Unused current outputs should remain open (no connections) for minimum power consumption.

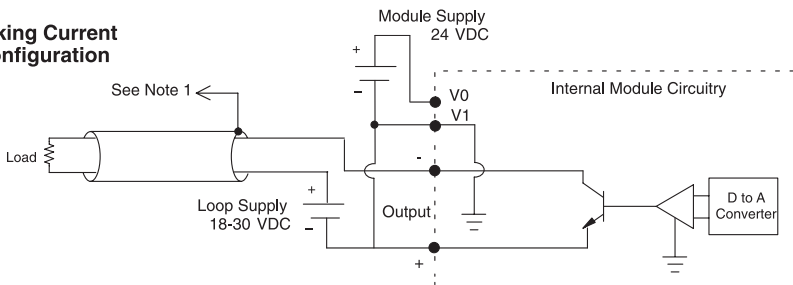


Equivalent Output Circuit

Sourcing Current Configuration



Sinking Current Configuration



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

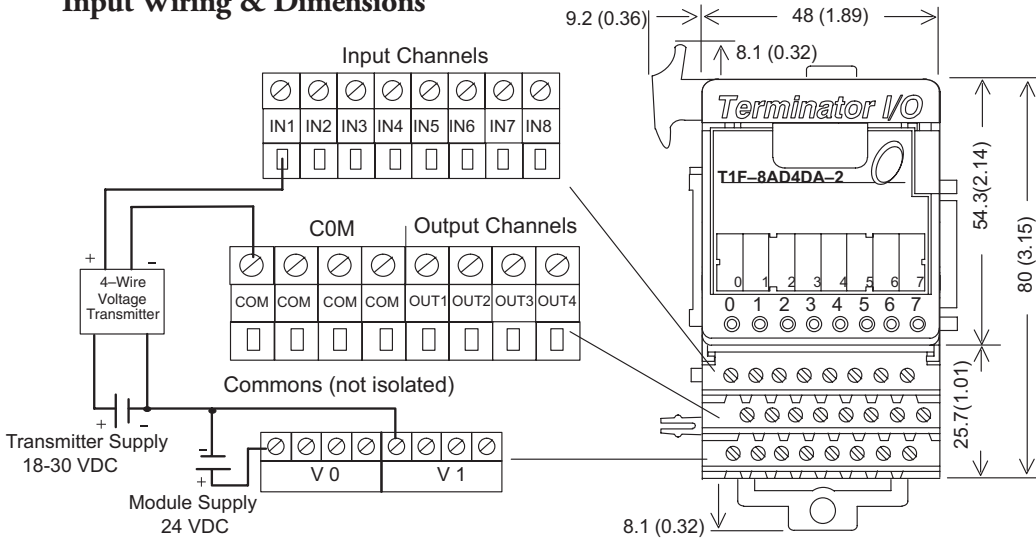
Input Channel Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0–5 V, 0–10 V, $\pm 5V$, $\pm 10V$
Resolution	14 bit (13 bit plus sign bit)
Frequency Response	-3db @ 500Hz, -20db / decade
Input Resistance	200k Ω min.
Absolute Maximum Ratings	Fault Protected Input, 130V (rms) or 100VDC
Conversion Time	5.5 ms 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 maximum
Input Points Required	256 discrete pts. or 8 dwords (d (double) word = 32 bit word) Network Interface dependent
Base Power Required	75mA @ 5VDC
External Module Power Supply	21.6–26.4 VDC, 70mA, class 2
External Transmitter Power Supply	18–30 VDC, 70mA, class 2

Input Range Resolution	
0–5 V	0–4095 counts
0–10 V	0–8191 counts
$\pm 5V$	- 4095 to 4095 counts
$\pm 10V$	- 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.

Input Wiring & Dimensions

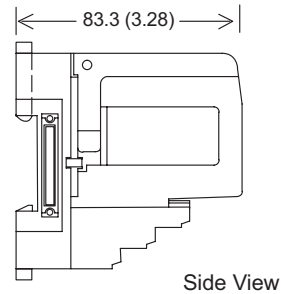
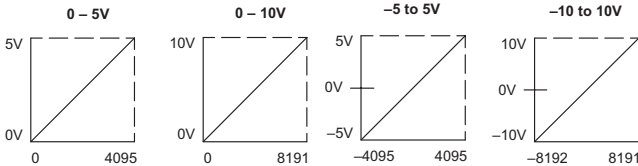


mm (in.)

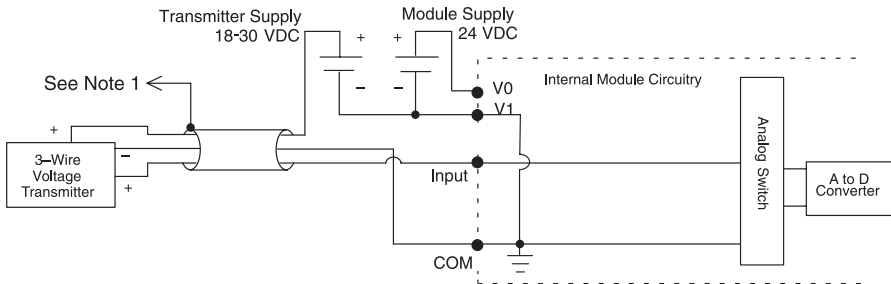
NOTES:

1. V1 terminals are internally connected to Commons.
2. Shields should be grounded at the signal source.
3. Unused inputs should be connected to Common (0VDC).
4. More than one external power supply can be used, provided all the power supply commons are connected.

Input Signal Ranges



Equivalent Input Circuit

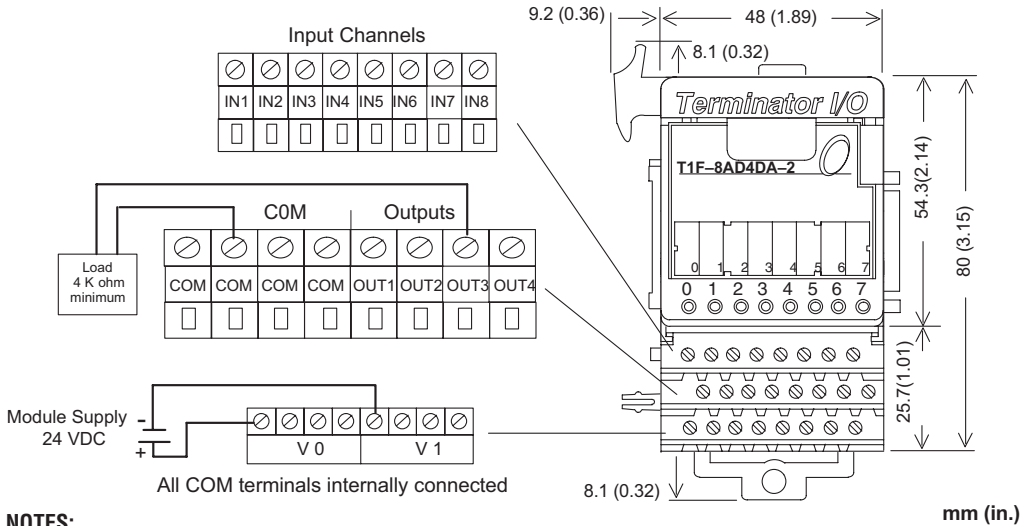


T1F-8AD4DA-2

Output Channel Specifications	
Number of Channels	4
Output Ranges	0–5 V, 0–10 V, $\pm 5V$, $\pm 10V$
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Peak Output Voltage	15VDC
Load Impedance	4k Ω minimum
Load Capacitance	0.01 μF maximum
Linearity Error (end to end)	± 2 count maximum $\pm 0.050\%$ of full scale maximum
Conversion Settling Time	300 μs maximum full scale change
Full Scale Calibration Error	± 12 counts maximum
Accuracy vs. Temperature	± 50 ppm/ $^{\circ}C$; full scale calibration change
Offset Calibration Error	10V ranges: ± 5 counts 5V ranges: ± 9 counts
Max. Full Scale Inaccuracy (% of full scale); all errors and temperature drift included	10V ranges: $\pm 0.2\%$ @ 25 $^{\circ}C$ $\pm 0.4\%$ @ 60 $^{\circ}C$ 5V ranges: $\pm 0.3\%$ @ 25 $^{\circ}C$ $\pm 0.5\%$ @ 60 $^{\circ}C$
Master Update Rate	4 channels per scan max.
Output Points Required	128 discrete pts. or 4 Dwords (32-bit words) (Network Interface Dependent)

Module General Specifications	
Operating Temperature	0 $^{\circ}$ to 60 $^{\circ}C$ (32 $^{\circ}$ to 140 $^{\circ}F$)
Storage Temperature	-20 $^{\circ}$ to 70 $^{\circ}C$ (-4 $^{\circ}$ to 158 $^{\circ}F$)
Accuracy vs. Temperature	± 50 ppm / $^{\circ}C$ 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

Output Wiring & Dimensions



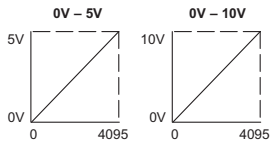
NOTES:

1. V1 terminals are internally connected.
2. Shields should be connected to the 0V terminal of the module at the 0V terminal of the power supply.
3. Unused voltage outputs should remain open (no connections) for minimum power consumption.

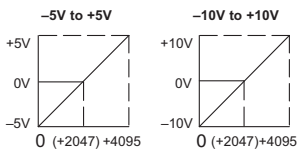
Output Range Resolution:

0 – 5V	0 – 4095
0 to 10V	0 – 4095
± 5V	0 – 4095
±10V	0 – 4095

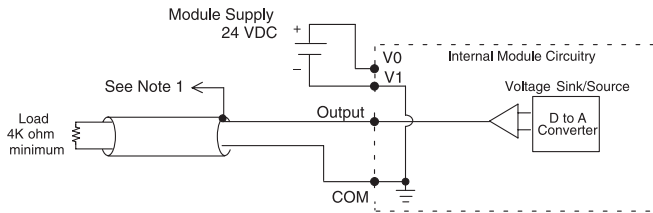
Unipolar Ranges



Bipolar Ranges



Equivalent Output Circuit



NOTE: The output channels require software setup via the Module Control Byte. Refer to Chapter 4.

T1H-CTRIO Counter I/O Module

Input Specifications	
Input	8 pts. (2 isolated channels / 4 pts. each channel), sink / source, 100kHz maximum; See Input Resources Table for available Input Function options.
Minimum Pulse Width	5 μ s
Input Voltage Range	9–30 VDC
Maximum Voltage	30VDC
Input Voltage Protection	Zener clamped at 33VDC
Rated Input Current	8mA typical, 12mA maximum
Minimum ON Voltage	9.0 VDC
Maximum OFF Voltage	2.0 VDC
Minimum ON Current	5.0 mA @ 9.0 VDC
Maximum OFF Current	2.0 mA
OFF to ON Response	< 3.0 μ s
ON to OFF Response	< 3.0 μ s

Output Specifications	
Outputs	4 pts., independently isolated, sink / source (FET Outputs); See Output Resources Table for available Output Function options.
Voltage Range	5–36 VDC
Maximum Voltage	36VDC
Output Clamp Voltage	60VDC
Maximum Load Current	1.0 A
Maximum Leakage Current	100 μ A
Inrush Current	5.0 A for 20ms
OFF to ON Response	< 3.0 μ s
ON to OFF Response	< 3.0 μ s
ON State Voltage Drop	< 0.3 V
External Power Supply	For loop power only, is not required for internal module function.
Overcurrent Protection	15A maximum
Base Power Required	400mA @ 5VDC
Thermal Shutdown	T _{junction} = 150°C
Overtemperature Reset	T _{junction} = 130°C
Duty Cycle Range	1% to 99% in 1% increments
Configurable Presets	a) Each output can be assigned one preset, or b) Each output can be assigned one table of presets, one table can contain max. 128 presets, max. predefined tables = 255
a) single	
b) multiple	

General Specifications	
Module Type	Intelligent
Modules Per Base	Limited only by power consumption
I/O Points Used	None, I/O map directly in PLC V-memory or PC control access
Field Wiring Connector	Standard removable terminal block
Internal Power Consumption	400mA Max at +5V from Base Power Supply, Maximum of 6 Watts (All I/O in ON State at Max Voltage/Current)
Operating Environment	32°F to 140°F (0°C to 60°C), Humidity (non-condensing) 5% to 95%
Isolation	2500V I/O to Logic, 1000V among Input Channels and All Outputs

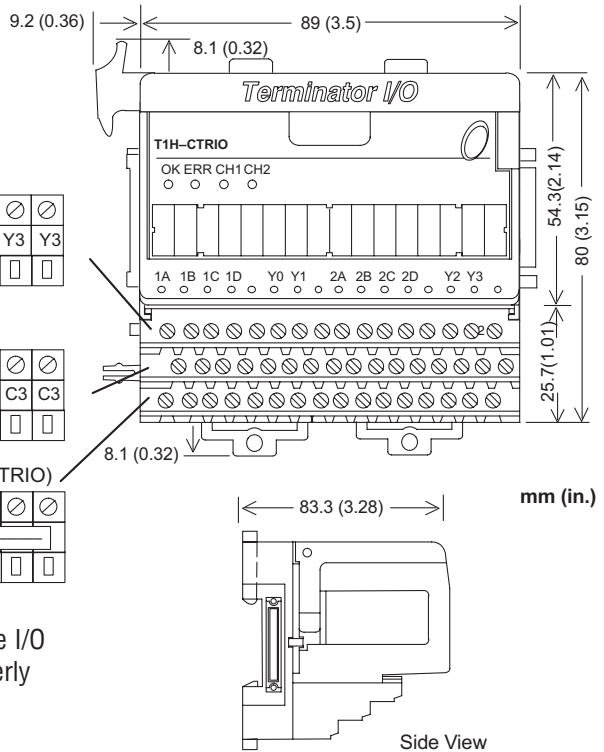
Wiring & Dimensions

Input / Output Channels															
1A	1B	1C	1D	Y0	Y0	Y1	Y1	2A	2B	2C	2D	Y2	Y2	Y3	Y3
□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□

Channel Commons															
1M	1M	1M	1M	C0	C0	C1	C1	2M	2M	2M	2M	C2	C2	C3	C3
□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□

User Bus Terminals (no internal connection to CTRLIO)															
□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
USER BUS 1							USER BUS 2								
□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□

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



LED Indicators

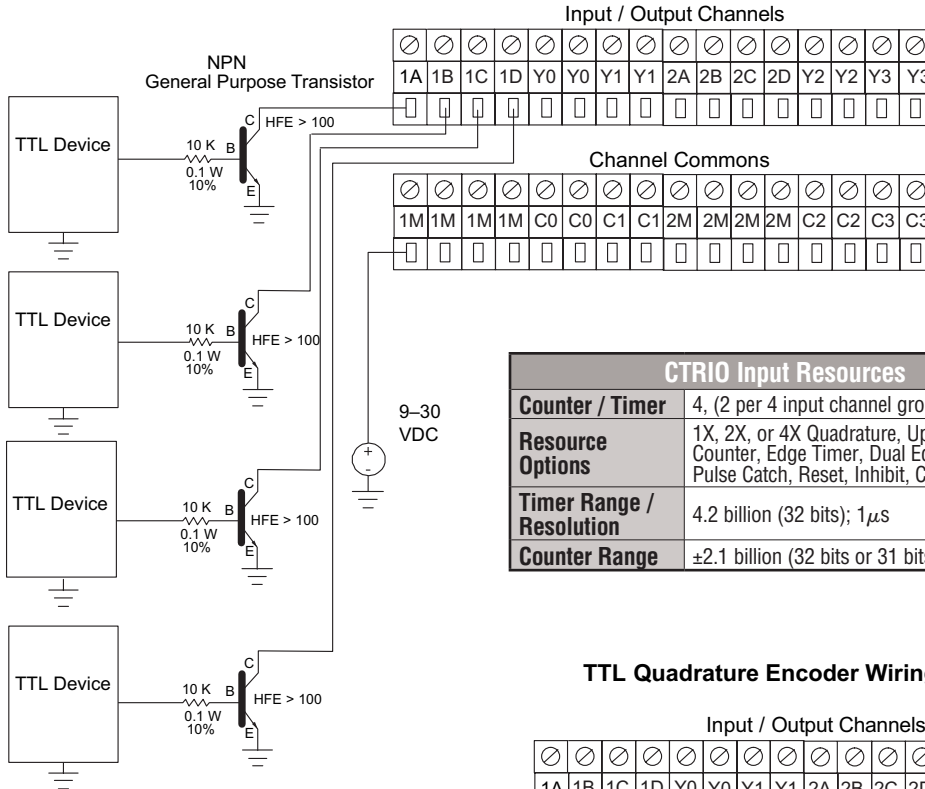
LED Diagnostic Definitions		
OK	ERR	Description
ON	OFF	All is well - Run Mode
ON	ON	Hardware Failure
Blinking	Blinking	Boot Mode - Use for Field OS Upgrades
Blinking	OFF	Program Mode
OFF	Blinking	Module Self - diagnostic Failure
OFF	ON	Module Error due to Watchdog Timeout
OFF	OFF	No Power to Module

LED Descriptions	
OK	Module OK
ERR	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

More LED Diagnostics 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.

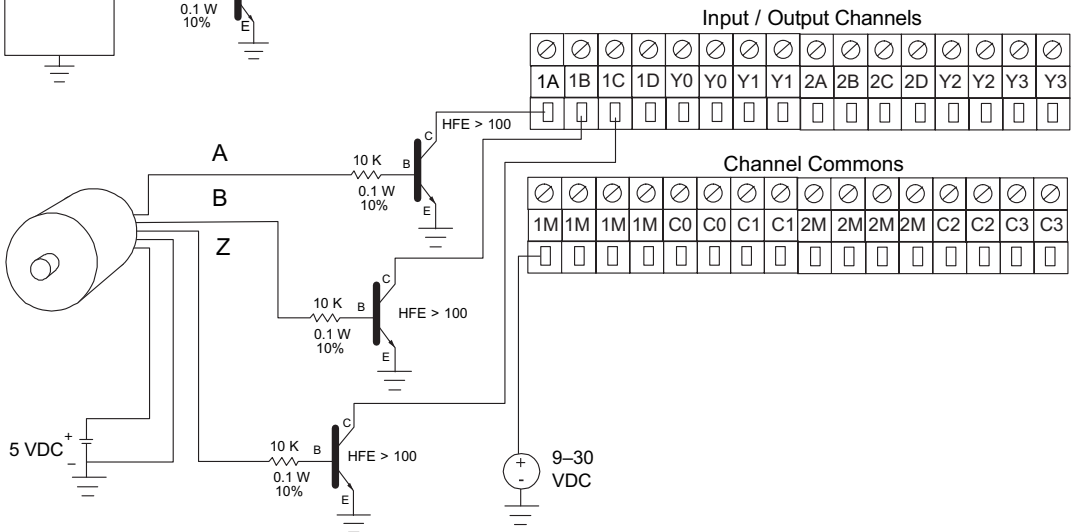
T1H-CTRIO Input Wiring Diagrams

TTL Input Wiring Example



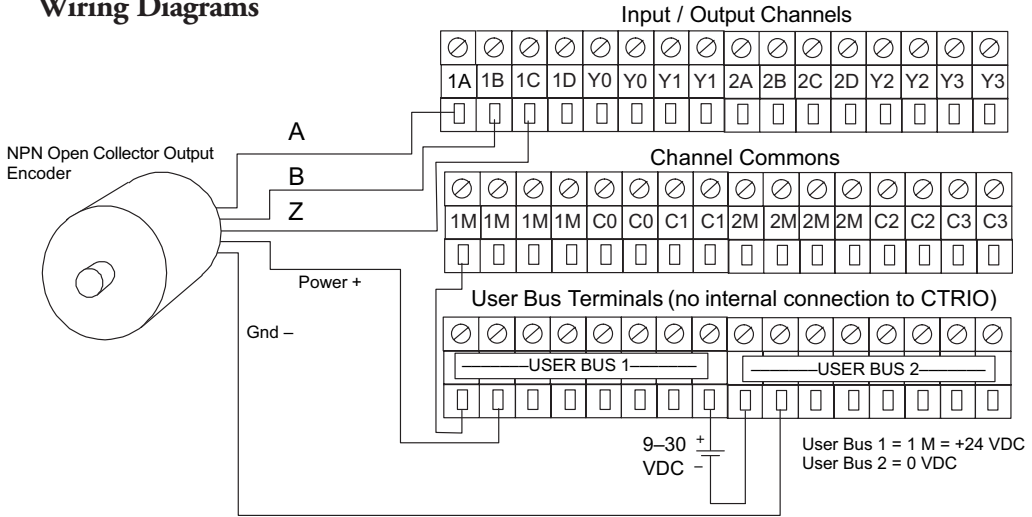
CTRIO Input Resources	
Counter / Timer	4, (2 per 4 input channel group)
Resource Options	1X, 2X, or 4X Quadrature, Up or Down Counter, Edge Timer, Dual Edge Timer, Pulse Catch, Reset, Inhibit, Capture
Timer Range / Resolution	4.2 billion (32 bits); 1μs
Counter Range	±2.1 billion (32 bits or 31 bits +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

TTL Quadrature Encoder Wiring Example

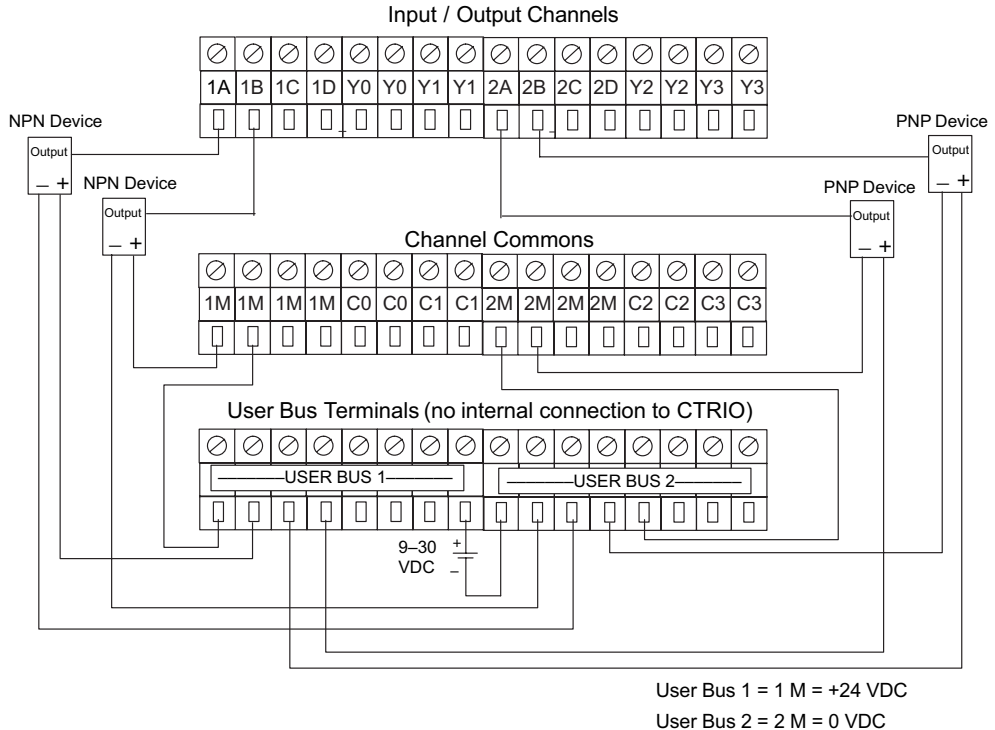


T1H-CTRIO Input Wiring Diagrams

Quadrature Encoder Wiring Example

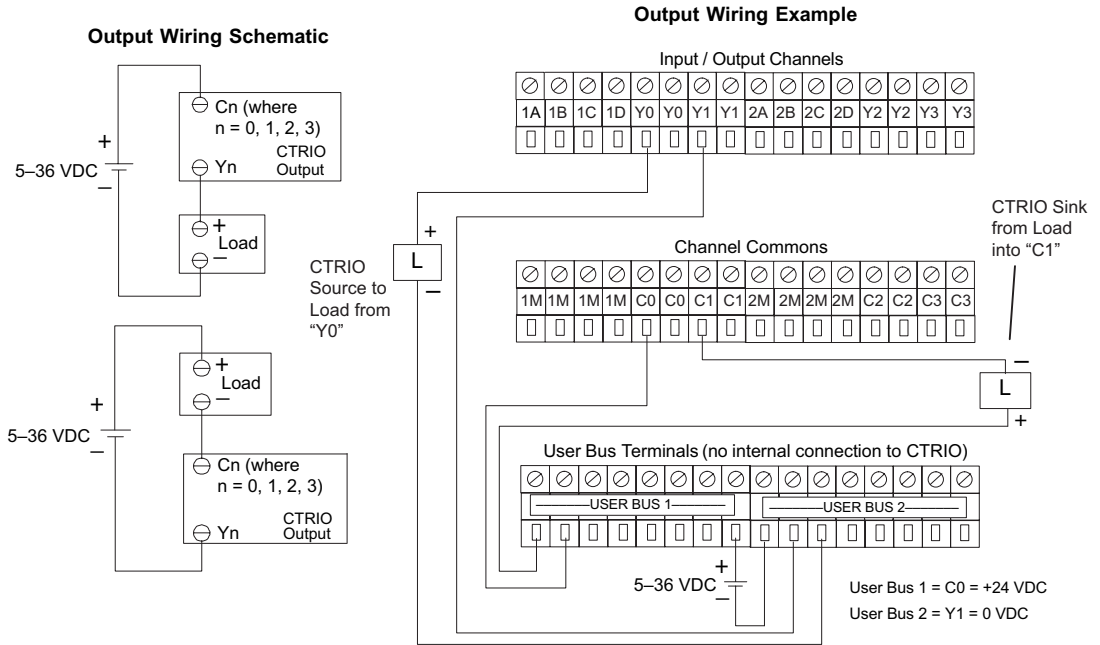


Input Wiring Example



T1H-CTRIO Output Wiring Diagrams

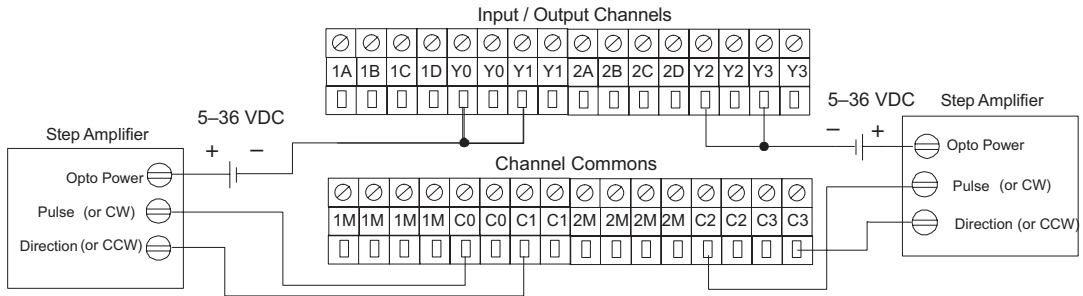
The module has 4 optically isolated output points (Pts. Y0–Y3 with isolated commons C0–C3, respectively). The outputs must be wired so positive current flows into Cn terminal and then out of the Yn terminal.



T1H-CTRIO Output Wiring Diagrams

The stepper wiring example assumes the Step Amplifier interface to be opto-coupler 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.

Stepper / Servo Drive Wiring Example



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 / Counter functions). Raw Mode: Direct access to output from user program.
Target Position Range	±2.1 billion (32 bits or 31 bits + sign bit)

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

Specifications		
Specification	T1K-08B	T1K-08B-1
Terminal Type	Screw type	Spring clamp type
Recommended Torque	1.77–3.54 lb-in (0.2–0.4 N·m)	N/A
Recommended Screwdriver Blade Size	0.02 in. X 0.125 in. (0.5 mm X 3.0 mm)	Push in on clamp using screwdriver blade size: 0.016 X 0.79 in. to 0.032 X 0.16 in. (0.4 mm X 2mm to 0.8 mm X 4mm)
Wire Gauge Size	Solid conductor: 25–12 AWG Stranded conductor: 26–12 AWG*	Solid conductor: 25–14 AWG Stranded conductor: 26–14 AWG*
Weight	135g	125g

*Twist conductors before inserting into gate.

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

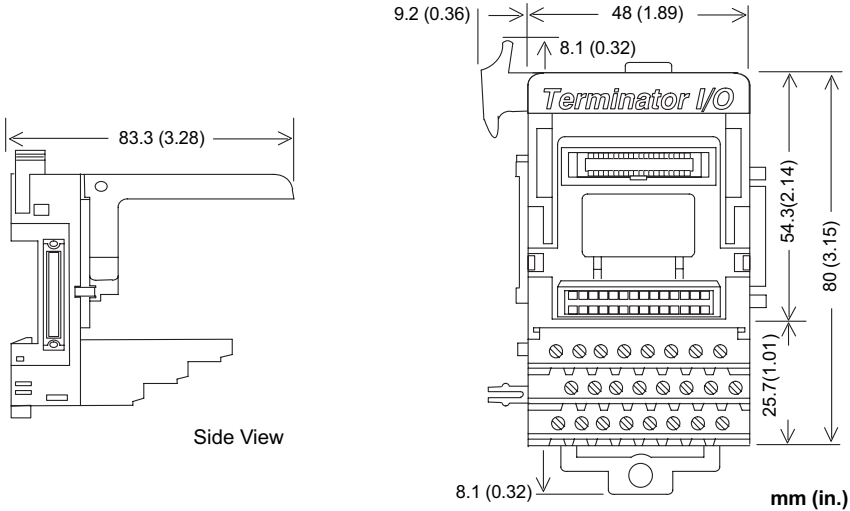
Specifications		
Specification	T1K-16B	T1K-16B-1
Terminal Type	Screw type	Spring clamp type
Recommended Torque	1.77–3.54 lb-in (0.2–0.4 N·m)	N/A
Recommended Screwdriver Blade Size	0.02 in. X 0.125 in. (0.5 mm X 3.0 mm)	Push in on clamp using screwdriver blade size: 0.016 X 0.79 in. to 0.032 X 0.16 in. (0.4 mm X 2mm to 0.8 mm X 4mm)
Wire Gauge Size	Solid conductor: 25–12 AWG Stranded conductor: 26–12 AWG*	Solid conductor: 25–14 AWG Stranded conductor: 26–14 AWG*
Weight	220g	210g

*Twist conductors before inserting into gate.

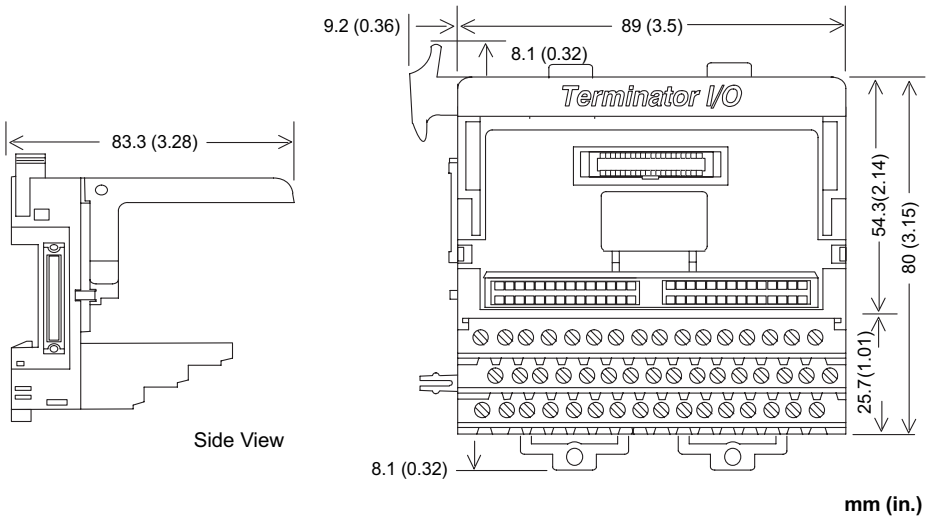
Environmental Specifications	
Ambient Operating Temperature	32°F to 131°F (0°C to 55°C)
Storage Temperature	-4°F to 158°F (-20°C to 70°C)
Ambient Humidity	5% to 95% (Non-condensing)
Atmosphere	No corrosive gases. The level of environmental pollution = 2 (UL 840).
Vibration Resistance	MIL STD 810C. Method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

Dimensions

T1K-08B, T1K-08B-1



T1K-16B, T1K-16B-1

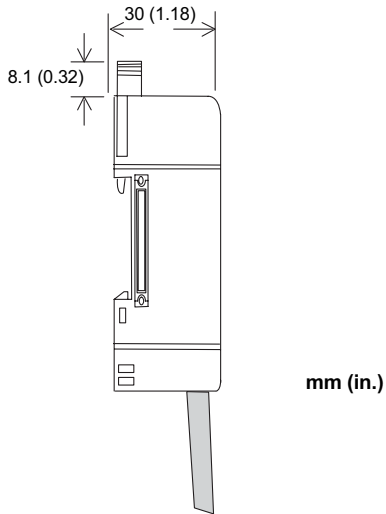
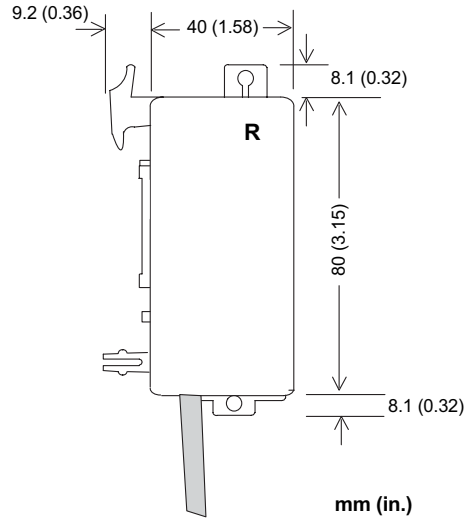
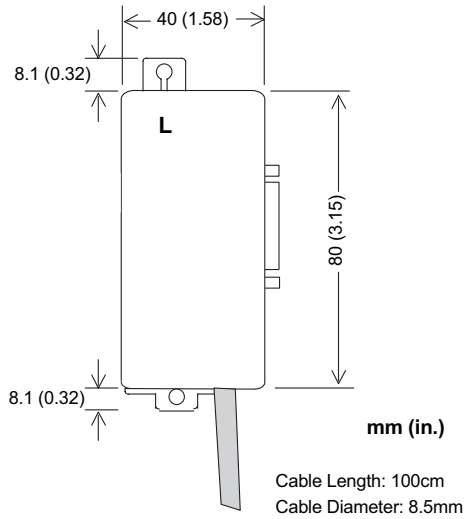


T1K-10CBL, T1K-10CBL-1 Expansion Cable

Specifications

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

Dimensions



T1K-5CBL-LL(-1) Expansion Cable

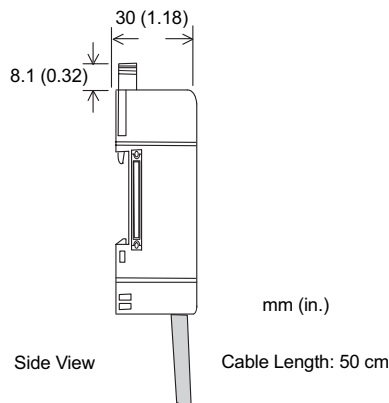
Specifications			
Specification		T1K-05CBL-LL	T1K-05CBL-1-LL-1
Cable Description		Left-to-left Side Expansion Cable	
Cable Length		50cm (1.64 ft.)	
Cable Diameter		8.5 mm	
Shielding		None	
Temperature Range		-25°C to 80°C (-13°F to 176°F)	
Jacket Material		PVC	
Auxiliary 24VDC Cable	Cable Diameter	N/A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

T1K-5CBL-RR(-1) Expansion Cable

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

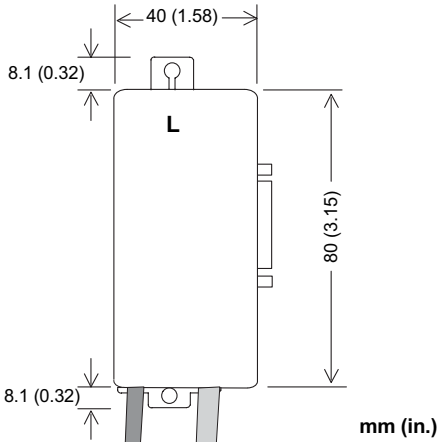


NOTE: Please refer to Chapter 2 for application examples using the different types of expansion cables that are available.



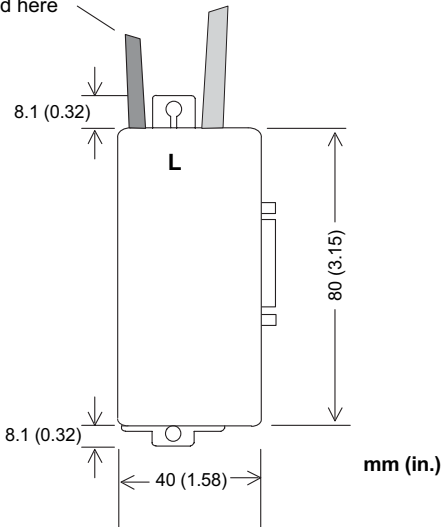
Dimensions

T1K-05CBL-LL(-1)

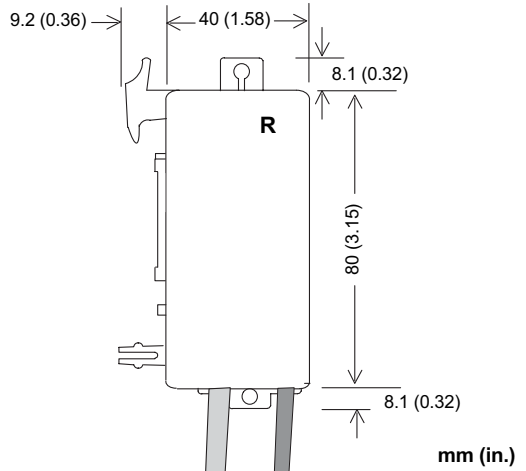


T1K-05CBL-LL-1 has 24 VDC cable attached here

Cable Length: 50 cm

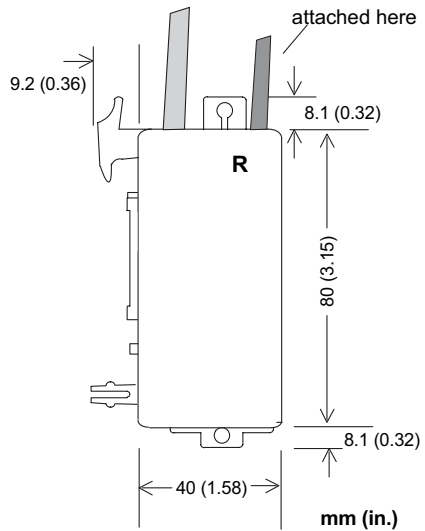


T1K-05CBL-RR(-1)



Cable Length: 50 cm

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

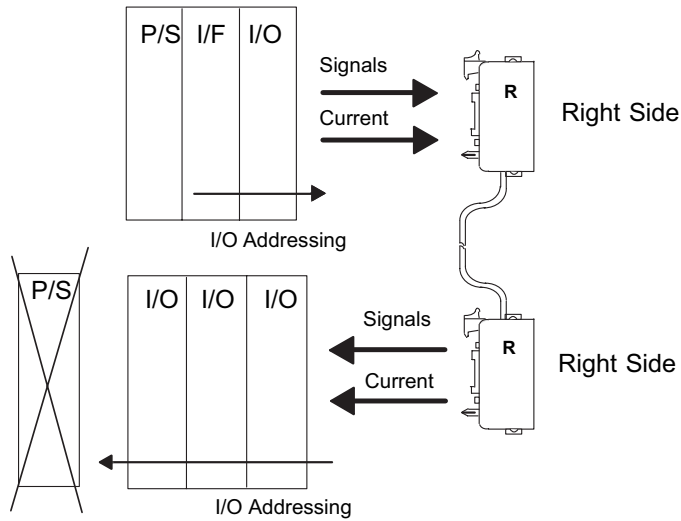


Cable Connection Examples



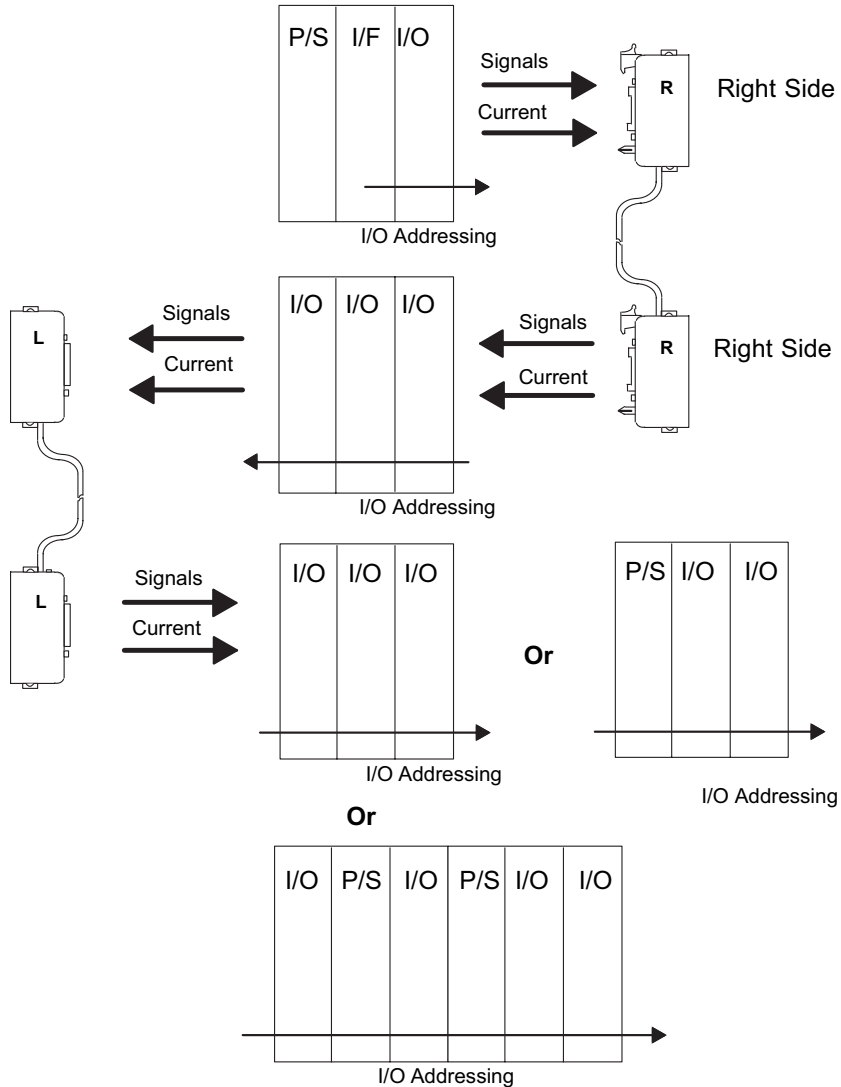
This is an example using the T1K-05CBL-RR (T1K-05CBL-RR-1) cable. It is always connected from the right side to the right side.

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



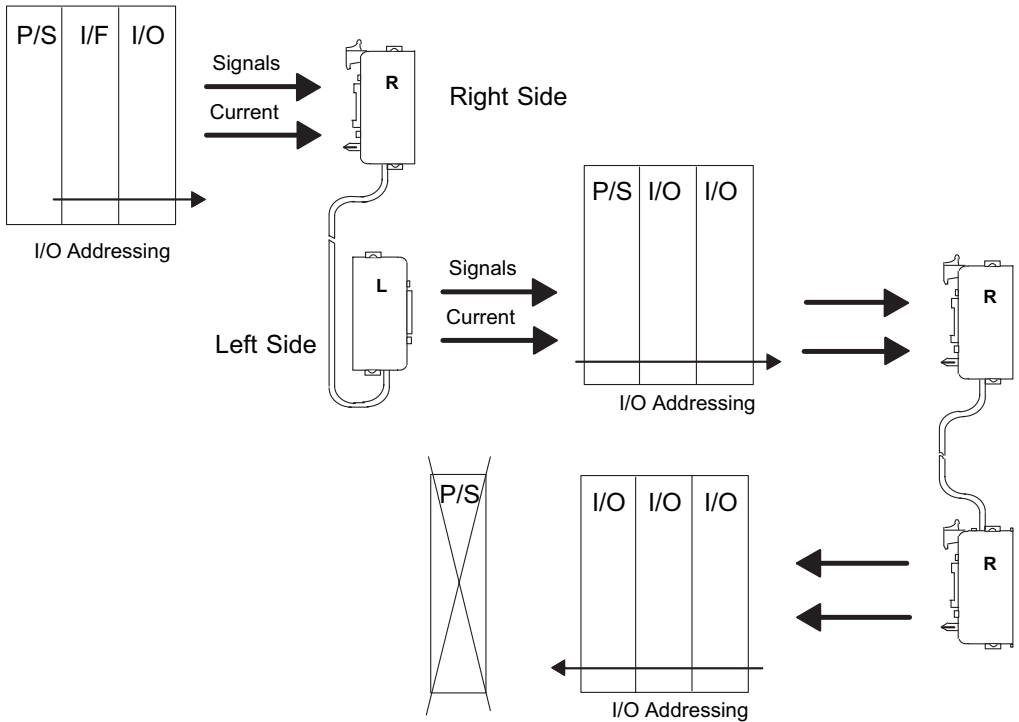
Chapter 3: I/O Wiring and Specifications

When another expansion row is added to the example on the left, a T1K-05CBL-LL (T1K-05CBL-LL-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 cable 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.