AUTOMATIONDIRECT.com

Do-more T1H Series PLC Hardware User Manual

Manual Number: T1H-DM-M

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Notes

Do-more T1H Series PLC User Manual

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Please include the Manual Number and the Manual Issue, both shown below, when communicating with Technical Support regarding this publication.

Manual Number: T1H-DM-M

Issue: 1st Edition, Rev. F

Issue Date: 07/2025

Publication History		
Issue	**Date**	**Description of Changes**
1st Edition	10/13	Original
Rev. A	10/16	Added T1F-16TMST thermistor input module
Rev. B	10/18	Updated EU Directives appendix
Rev. C	08/20	T1H-PBC obsoleted
Rev. D	11/24	Removed Type 1 fonts, added hyperlinks to footer.
Rev. E	01/25	Updated cable USB-RS232 to USB-RS232-1.
Rev. F	07/25	Retired TIF-16TMST thermistor input module

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Notes:

GETTING STARTED

In This Chapter:

Introduction

Purpose of this Manual

Thank you for purchasing from our Do-more PLC family of products. This manual shows you how to install, set up, program, troubleshoot and maintain your Do-more T1H Series PLC. For installation personnel, this manual contains information on power and signal wiring, mounting details and configuration procedures.

This manual can be very helpful as a quick reference guide for those who are experienced in PLCs. For those who may be new to PLCs or our products, reading this manual will give you an understanding of the variety of features available with the Do-more PLC.

Purpose of this Chapter

This chapter will guide you through the basic set up of a Do-more T1H Series PLC. It contains step by step instructions on installing the programming software, installing and configuring your hardware, applying power to the PLC, establishing a communications link, and creating, saving and writing a project to the CPU. Once these steps are completed, your Do-more T1H Series PLC will be running a ladder logic project that you have programmed.

Online Help Files and Other Documentation

Do-more Designer, the Do-more PLC programming software, is available for free download from our website at:

http://www.automationdirect.com

The software includes searchable online help topics covering all aspects of the software, instruction set, module set up and communication.

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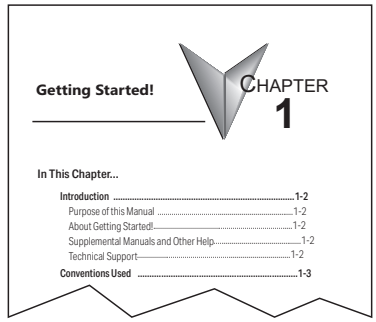
Conventions Used

When you see the "note pad" icon in the left-hand margin, the paragraph to its immediate right will be a special note. Notes represent information that may make your work quicker or more efficient. The word ***NOTE:*** *in boldface will mark the beginning of the text.*

When you see the "exclamation point" icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death in extreme cases. Any warning in this manual should be regarded as critical information that should be read in its entirety. The word WARNING in boldface will mark the beginning of the text.

Key Topics for Each Chapter

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


Getting Started!

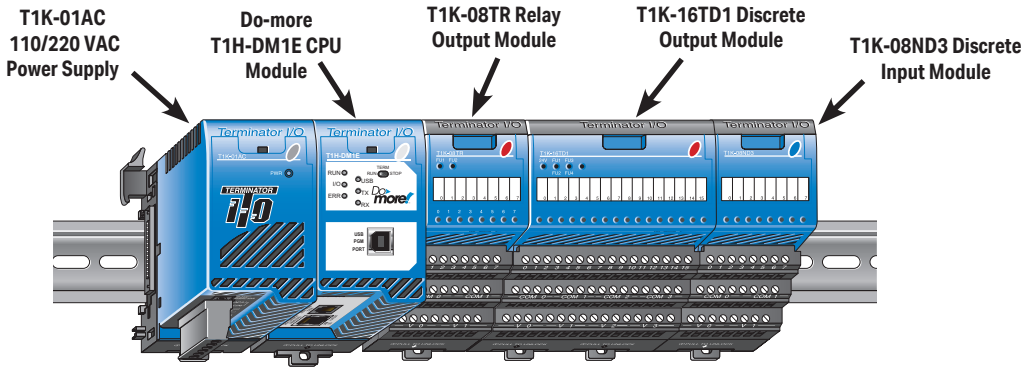
CHAPTER 1

In This Chapter...

Before You Begin

It is recommended that the following items be available to make this short step-by-step introduction to the Do-more T1H Series PLC go smoothly.

Example Do-more T1H Series PLC



PC Running Windows XP, Vista, Windows 7, Windows 8

Not available from Automationdirect.com.

Do-more Designer Programming Software

Download software from our webste at: http://www.automationdirect.com

USB-A to USB-B Programming Cable

You can also use an Ethernet or Serial (D2-DSCBL) cable for programming, but we recommend using a USB cable; just plug it in and it works.

Screwdriver TW-SD-VSL-1

Wire Strippers DN-WS

Hookup Wire

AC Power Cord

Not available from Automationdirect.com.

Do-more T1H Series PLC System Components

The Do-more T1H Series CPU modules were designed for use with the Terminator I/O product line. For those not familiar with Terminator I/O, it is a modular system which combines the functions of terminal blocks and I/O modules for distributed I/O. Each Terminator I/O system contains: a Power Supply, a Base Controller, and one or more I/O Module(s). Now with the addition of the T1H CPU, standing in place of the Base Controller, the Terminator distributed I/O system becomes a complete, highly functional, stand-alone PLC system.

CPU

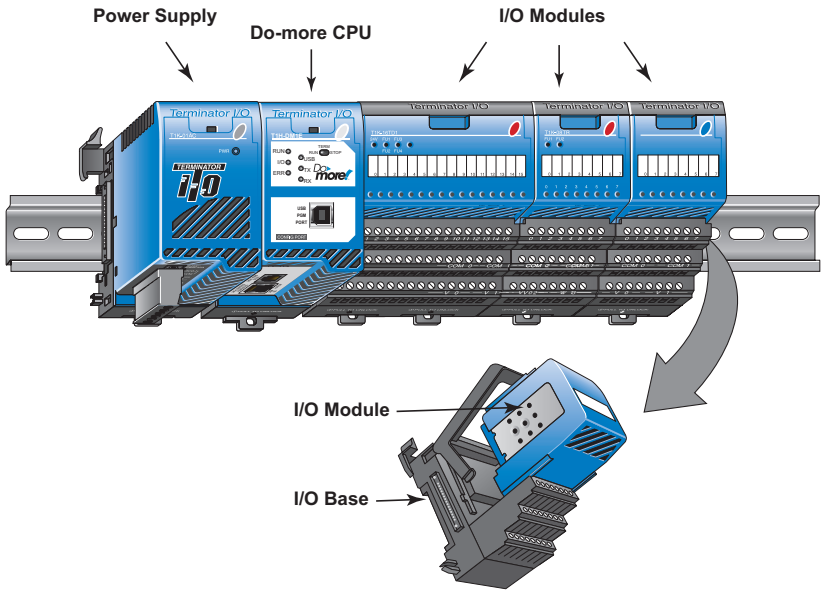
T1H-DM1/T1H-DM1E

Power Supplies

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

I/O Modules

A Terminator I/O module assembly consists of an I/O module and a separate base, as shown below. A complete range of discrete modules which support 12/24 VDC, 110/220 VAC and up to 7A relay outputs is offered. The analog I/O modules provide 12 and 14 bit resolution and several selections of I/O signal ranges (including bipolar). The temperature input modules provide 16 bit resolution with several temperature input range selections.



Do-more Software System Requirements

The Do-more Designer Windows-based programming software works with Windows® XP (Home or Professional, 32-bit), Vista (Home, Basic, Premium, 32 or 64-bit), Windows 7 (Home, Professional, Ultimate, 32 or 64-bit) or Windows 8 (Home, Professional, Enterprise 32 or 64-bit; Windows 8 RT edition is NOT supported).

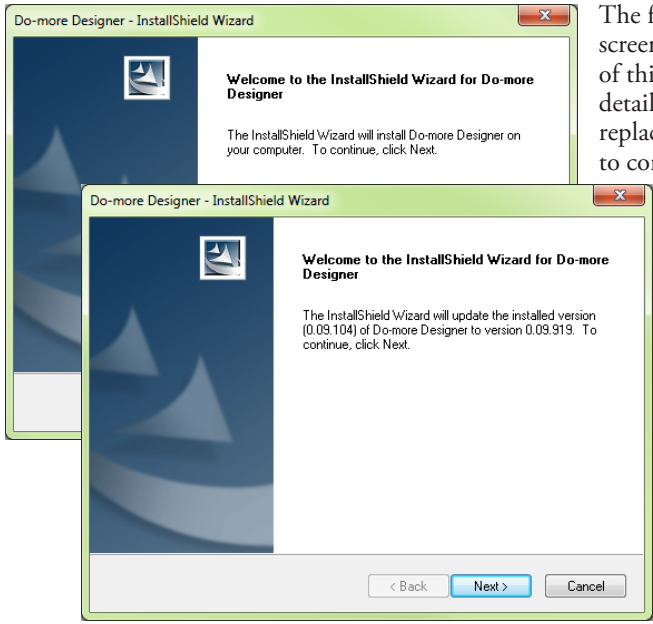
Please check the following requirements when choosing your PC configuration:

- Minimum PC to PLC Connectivity, at least one of the following:
  - USB Port: connects to the CPU with USB-A connector (USB-A to USB-B cable)
  - RS-232 Serial Port: connects to the CPU with RJ-12 connector (RJ-12 to DB9 or RJ-12 to USB-B serial converter cable)
  - Ethernet Port: connects to the CPU (T1H-DM1E) with RJ-45 10Base-T or 100Base-T (Cat5 Patch Cable)
- Hard Disk: 100MB free disk space
- Video Display: 1024x768, 256 colors resolution (1280x720, true color recommended)
- Windows XP, 32-bit:
  - 800MHz, single core CPU (2GHz, multi-core or hyperthreaded recommended)
  - 512MB RAM (2GB recommended)
- Vista, Windows 7 or Windows 8, 32 or 64-bit:
  - 1GHz, single core CPU (2GHz, multi-core recommended)
  - 1GB RAM (3GB recommended)

NOTE: *The PC/Laptop/Ethernet Switch connector at the "opposite end" of the PLC connector will dictate what kind of cable you will need.*

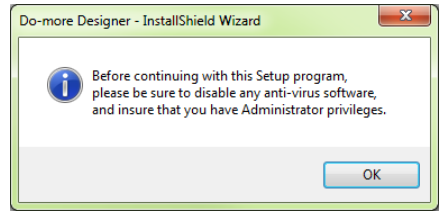
Step 1: Install Do-more Designer Software

Download the Do-more Designer programming software (DM-PGMSW) from our website at **http://automationdirect.com** and launch the install procedure. If you already have Do-more Designer installed, you can just update to version 1.2 or newer to get T1H CPU support.



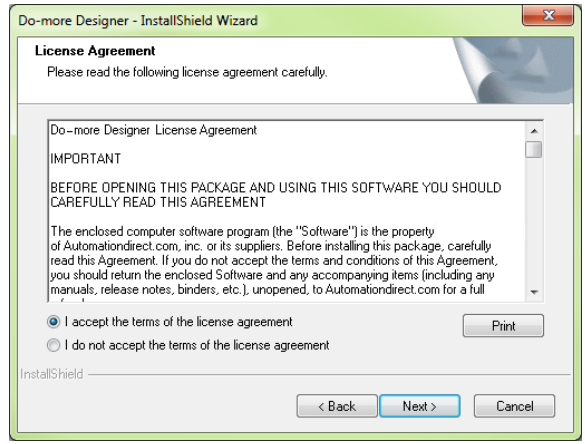
The first screen that opens is the Welcome screen seen here. If there are previous versions of this software already installed, this screen will detail the version number of the software being replaced and the one being installed, click Next to continue.

An alert window will appear requesting that all anti-virus software be disabled and also reminding the user that Administrative restrictions may exist.

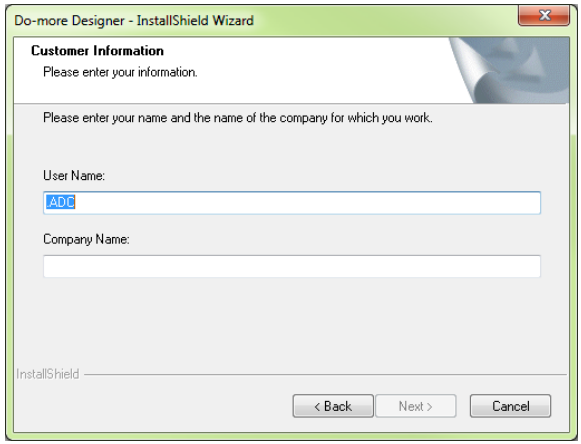


The License Agreement window will be displayed next. Read over the agreement, select "I accept the terms of the license agreement" and click the Next button to continue.

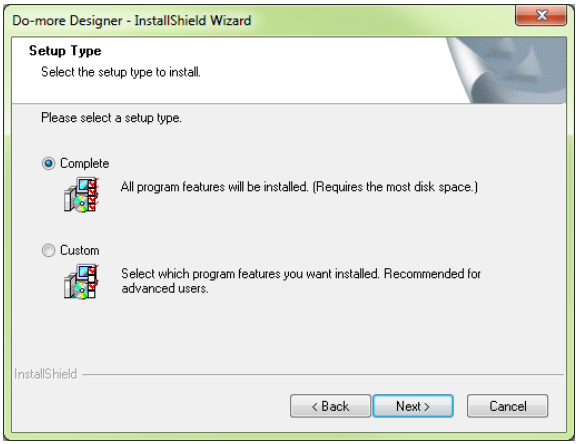
There is also the option to print the license agreement if desired. The print function will print the license agreement to a .pdf file and save it in the location you choose.



Now the software will ask a little about you. Please fill in the information requested on the Customer Information screen and click Next to continue.



At this stage, the software will ask which type of install you would like to perform. The Select Type window seen below gives two options for installation type: Complete and Custom.

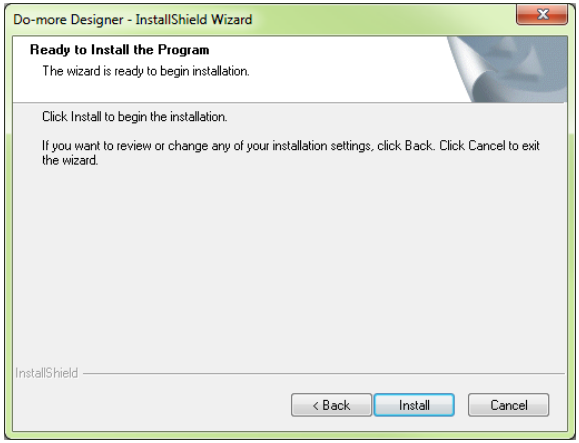


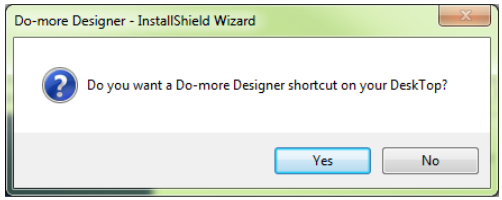
Custom installation allows you to choose which program features to install, whereas Complete installation installs all of the program features available. The Complete installation is selected by default and is recommended for first-time users.

Select the installation type desired and click the Next button to continue.

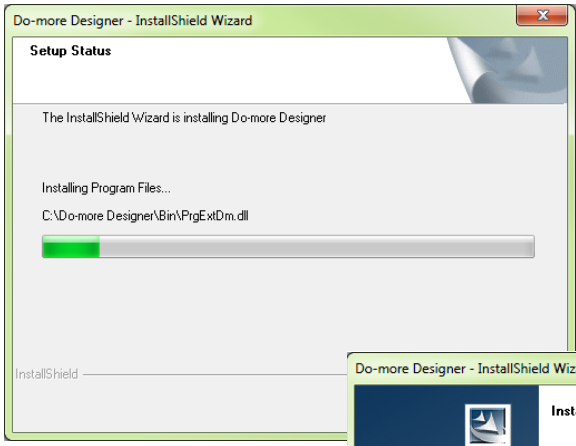
The next screen to appear is the Ready to Install the Program window. This window is an alert window, cautioning you that the program is about to be installed. If there are any changes that need to be made to the install settings do them now before continuing.

To review or change any of the previous installation selections, click the Back button to return to the appropriate window and make the change. If no changes are necessary click the Install button to begin the installation.



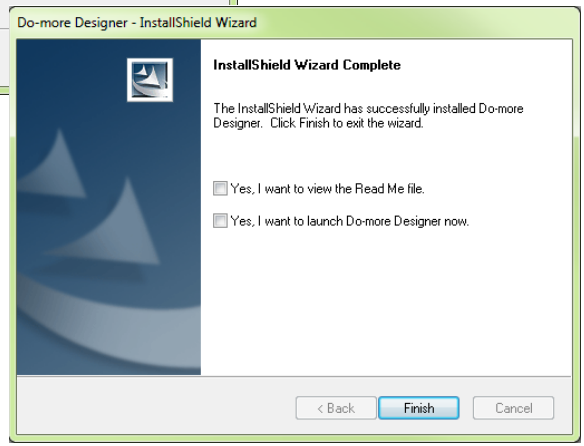


The popup shown here will allow you to choose whether or not to install a shortcut for the software on your PC's desktop. Click Yes or No to continue with the installation.



The software will now install the needed files and folders with the Setup Status window detailing the status of the installation.

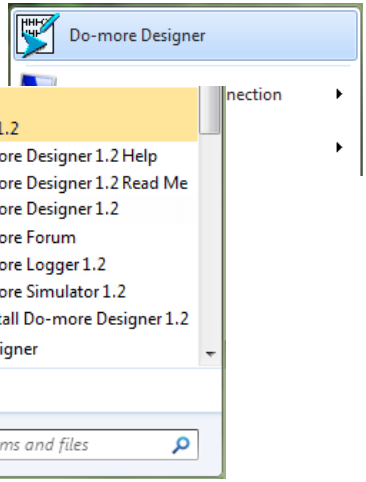
Once the installation has been successfully completed, the window below will open. Your software is now installed and ready to use. The installation wizard can now be closed by clicking the Finish button at the bottom of the window.



Step 2: Launch Do-more Designer Software

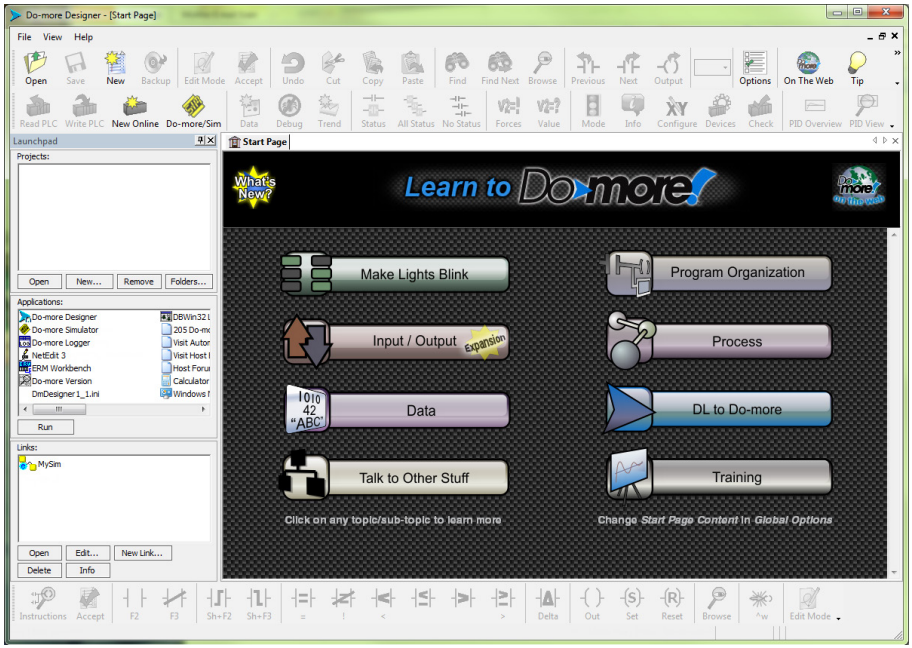
After installing Do-more Designer, launch the software by double clicking the desktop DM icon.

You can also launch the software from the PC's Start menu or All Programs menu. If the software link is not embedded in the Start menu, use the path: Start > All Programs > Do-more > Designer x.x > Do-more Designer x.x to launch the software.



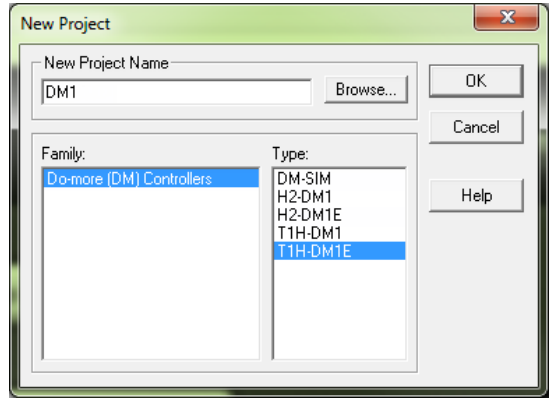
***NOTE:** Software version 1.2 or greater is required.*

The Do-more Designer Software will start up and display the Start Page shown below. This page consists of a Launchpad with quick links to existing projects, software applications and communications links. There is also a section containing shortcuts to important help file topics and the Do-more Designer simulator application.



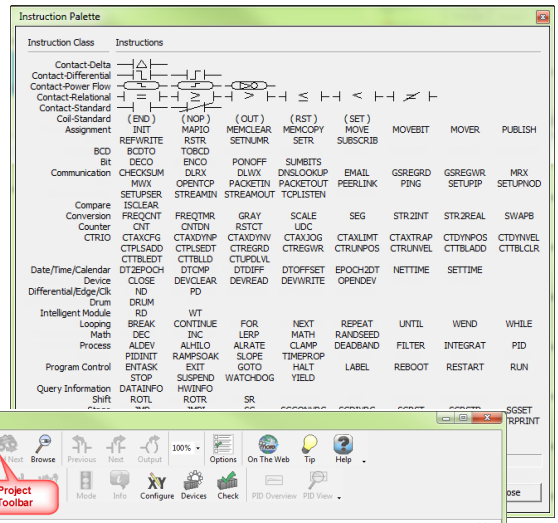
To begin a new project offline select New from the toolbar on the Start Page. The New Project window seen here will open.

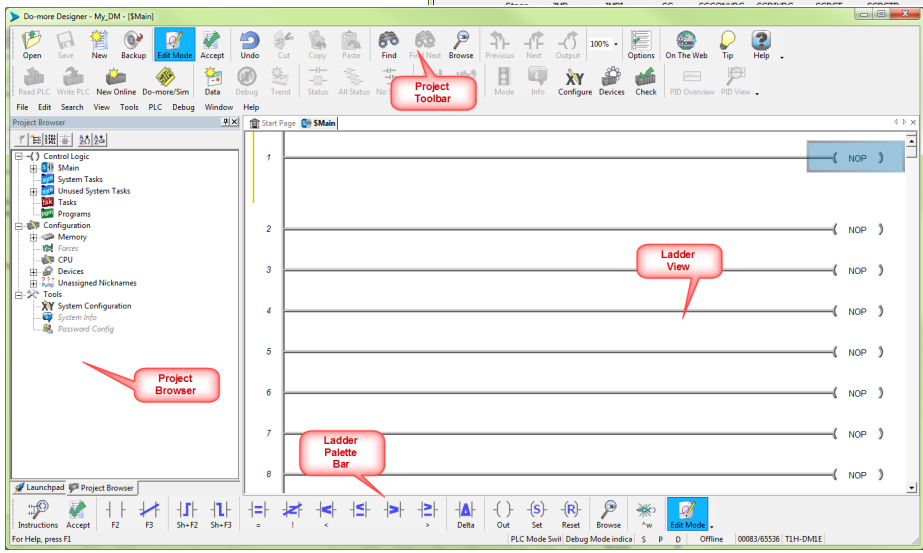
Name the new project and select the type of controller it is intended for. Use the Browse button to choose a different location to store the project or accept the default location. Click OK after your selections have been made to continue. The Main programming window and Instruction Palette shown below will open.



The Instruction Palette lists all of the instructions available for use in your program. A brief explanation of each instruction is provided once the instruction is highlighted and a more detailed explanation is available in the help file.

The Main programming window is divided into menus and toolbars for quick access to configurations, instructions and other needed items used during project development.

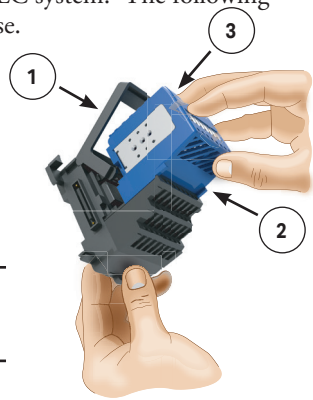




Step 3: Install Hardware

The "Installation and Wiring" chapter of this manual contains detailed information for the installation of components in your Do-more T1H Series PLC system. The following summary explains the basic steps for installing modules in a base.

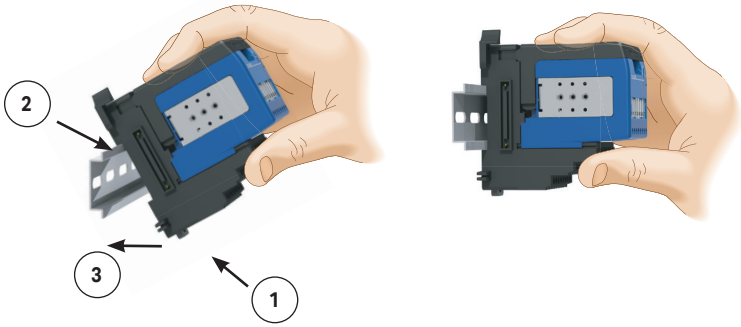
1. First, insert module into base:
   - Pull base arm back to allow space for module to enter base.
   - Align module slides with base track.
   - Press module firmly into base.



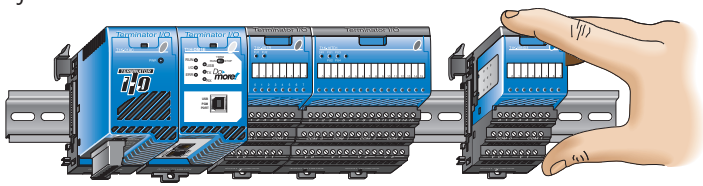
2. Next, mount the components on the DIN Rail:

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

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



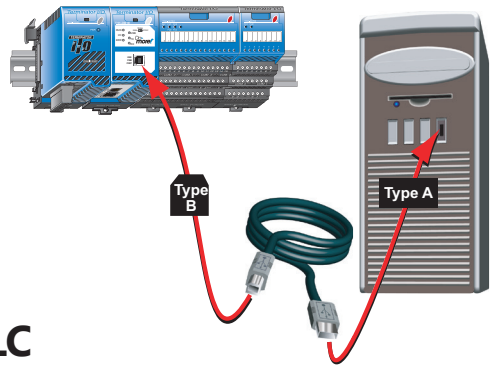
3. Finally, slide the module assembly into position on the DIN Rail:
   - Slide the module assembly on the DIN rail until the clip arm attaches securely to the adjacent module.



NOTE: *One power supply is required in the leftmost component position followed by the CPU. 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.*

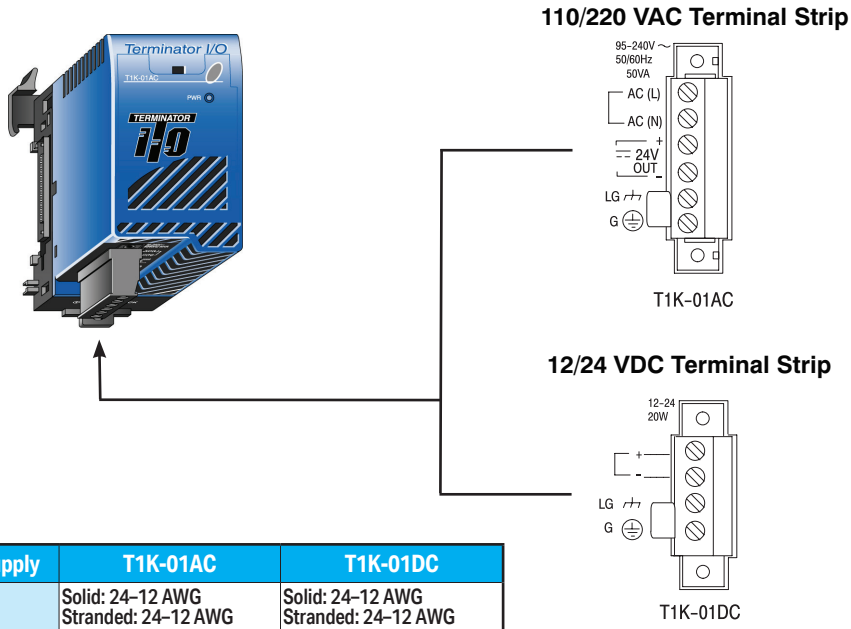
WARNING: Minimize the risk of electrical shock, personal injury, or equipment damage. Always disconnect the system power before installing or removing any system component.

Once all of the modules have been installed, connect the USB cable. Use a standard USB cable with Type A and Type B connectors. (Ethernet and Serial connections are also available, but are not shown for this example.)



Step 4: Apply Power to the PLC

Power is supplied to the Do-more T1H Series PLC through the backplane of the base from the power supply. The following diagram and table show the terminal connections located on Terminator power supplies and their specifications.



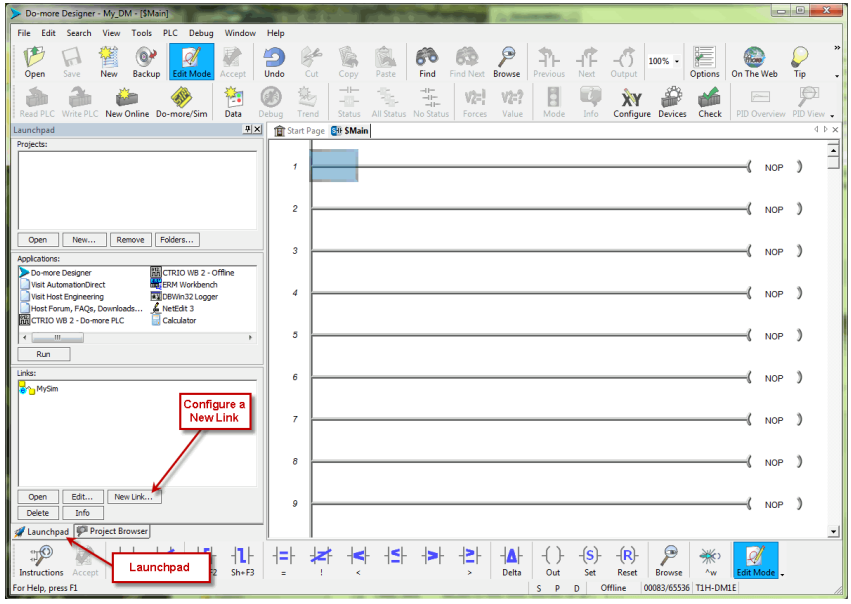
Power Supply	T1K-01AC	T1K-01DC
Wire Size	Solid: 24–12 AWG Stranded: 24–12 AWG	Solid: 24–12 AWG Stranded: 24–12 AWG
Recommended Torque	4.43–5.31 lb·in (0.5–0.6 N·m)	4.43–5.31 lb·in (0.5–0.6 N·m)

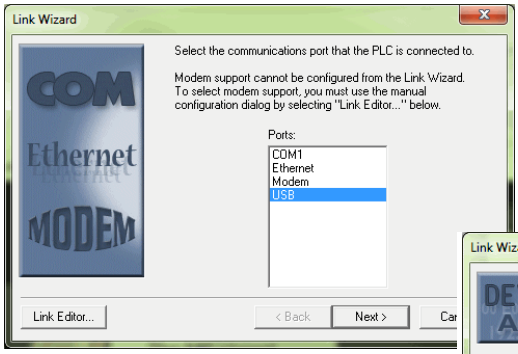
NOTE: *You can connect either a 115VAC or 220VAC supply to the AC terminals.*

Once all of the power wiring has been completed and verified, connect the appropriate voltage source to the power supply and power up the system. The Do-more T1H Series PLC will perform a self evaluation once power is applied. Refer to the "Installation and Wiring" chapter of this manual for more power supply and input wiring information.

Step 5: Establish Communication

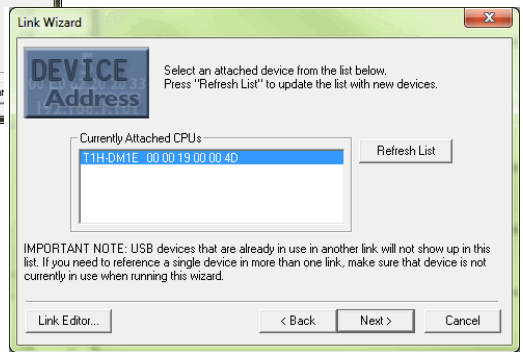
Now that the Do-more T1H Series PLC is powered up, you need to establish a communications link between the PC and the PLC. The Do-more Designer software provides a Link Wizard to assist you with configuring this new communications link. To open the Link Wizard, select the New Link... button in the Links section of the Main Page's Launchpad as shown below.



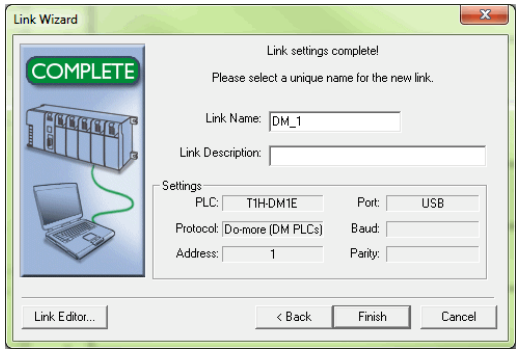


Wizard will first ask you to choose which communications port you will be using. In this example, we will be using a USB connection. Select USB, click Next and the wizard will automatically search for available CPU's on that port.

Choose the CPU that you are programming and select Next. The Do-more Designer software will create a link to that controller.

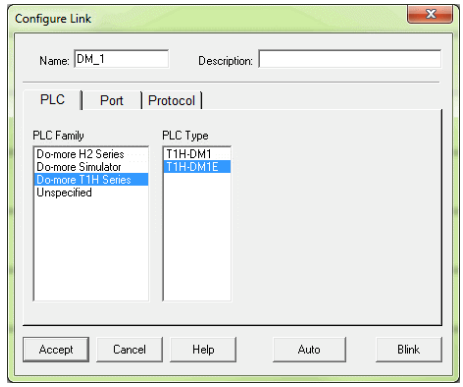


The Link Wizard will now display the saved settings for this link as seen on following page.

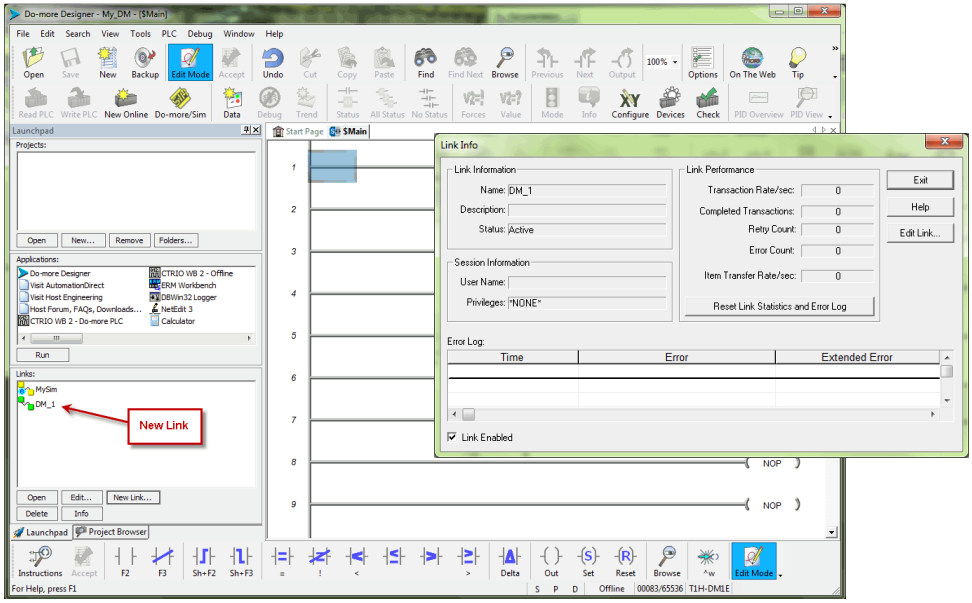


A unique name is required for each link that is created. Name the new link and, if desired, give it a description then select Finish.

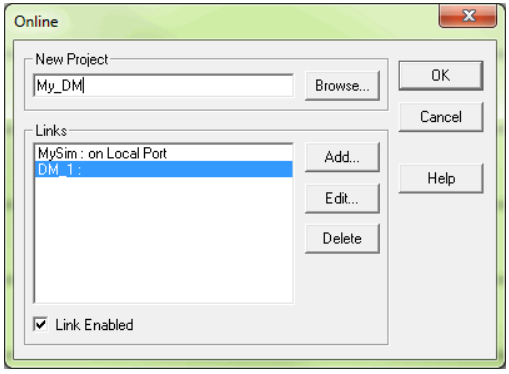
You can also manually configure each link by selecting the Link Editor... button from the lower left corner of the Link Wizard. The Configure Link dialog will open, as seen below, allowing you to select PLC types, port parameters, and protocols.



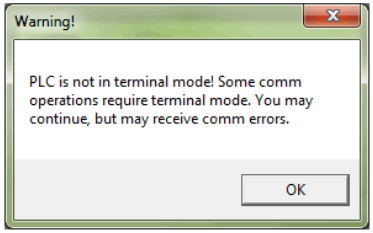
Once you have completed configuring your communications link, either manually with the Link Editor or automatically with the Link Wizard, it will be available to select in the Links section of the Launchpad. There you can edit, enable/disable, delete or view statistics for that link.



Now select the New Online button and the Online dialog box, seen below, will open. From this dialog, you are given available communications links to choose from with options to add, edit disable/enable, or delete links.

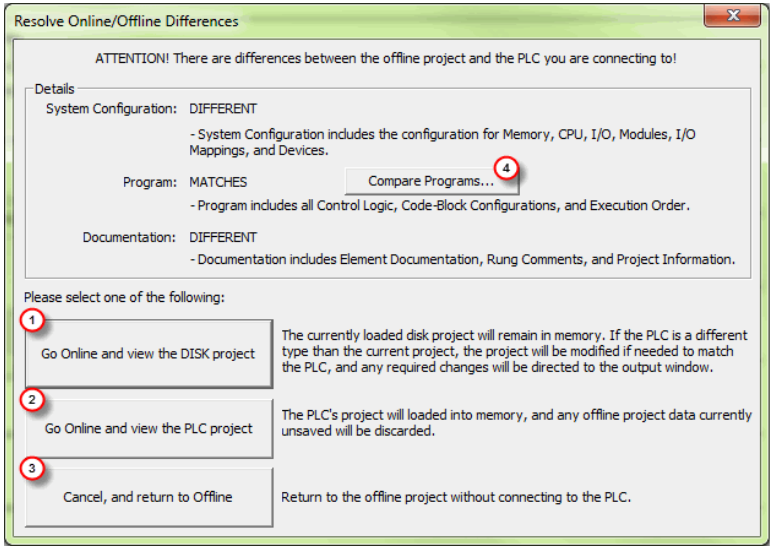


Choose the appropriate link, select OK and the software will connect to the Do-more T1H Series PLC. If the mode selector switch on the CPU module is not in the Term position when connecting, the warning shown below will appear.

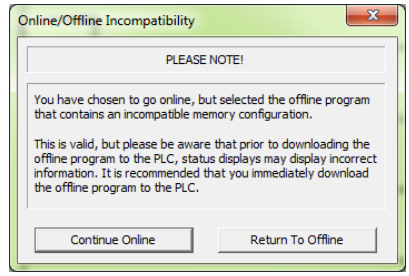


You are allowed to continue if you wish or place the mode selector switch on the CPU module in the Term position to avoid any unintended communication errors.

If you were connecting to the CPU module with a project created offline, you may encounter the message window shown here.

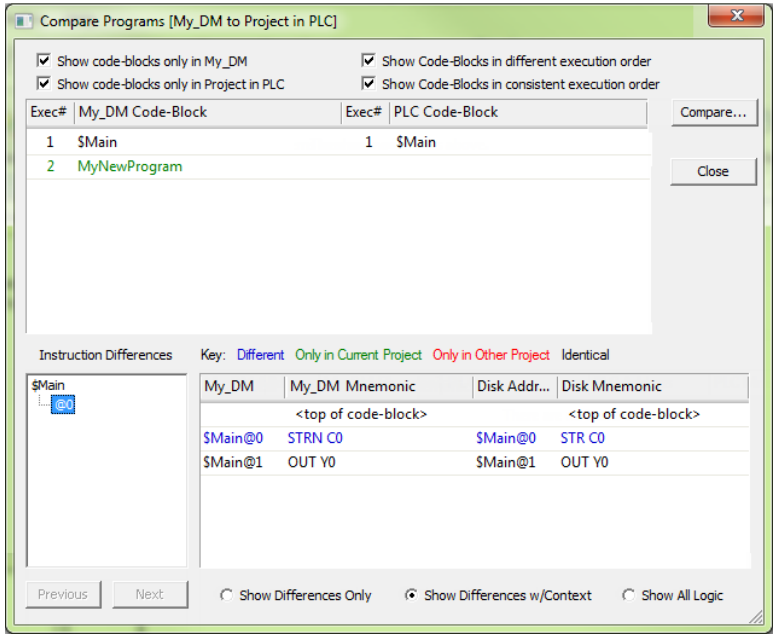


Only with the New Online option does the Do-more T1H Series PLC assume that you are creating a new project from scratch. With any other method, such as PLC > Connect, the software will compare the project in the controller with the offline version you have open. If there are any differences, this warning window will appear detailing the options available for continuing:



- 1. Go Online and view the DISK project - This option will go online with the PLC but display the project from disk. Status displays may show incorrect information. If the memory configuration in the disk-based project contains elements that are incompatible with the memory configuration currently in the Do-more PLC the message box seen here will be displayed.
- 2. Go Online and view the PLC project - The project from the PLC will be opened by Do-more Designer.
- 3. Cancel, and return to Offline - This option will cancel the connection attempt and return to the offline project.
- 4. Compare Programs... - If you are unsure as to why the two projects are different, then this option will do a comparison of the projects and detail the differences found. An example comparison is seen below.

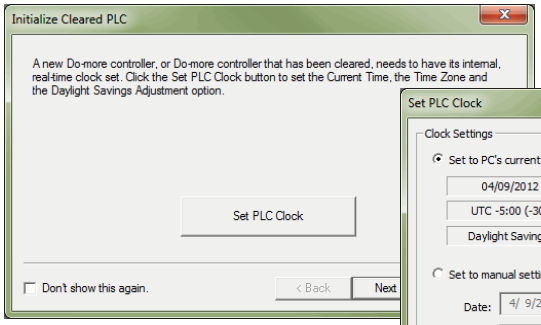
In this example, the PLC project titled My_DM was compared with a project stored on the PC. The report window shown above illustrates the differences found between the two.

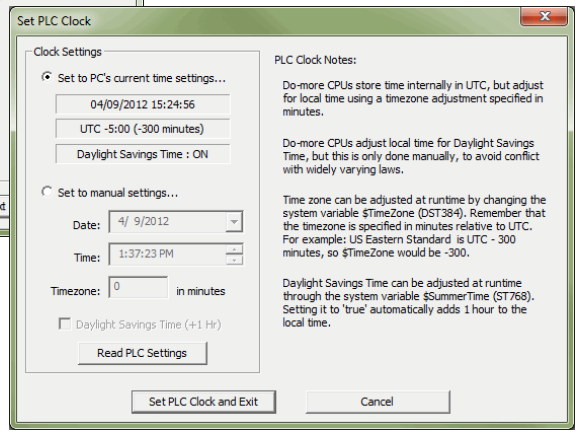


According to the report, the PLC project was different in two areas. First, a new code-block was found only in the PLC project. This new code-block is titled MyNewProgram and is highlighted in green. The green color represents items that exist only in the Current Project (project in PLC) and not in the Other (project in PC). Also, the comparison noted that a normally open contact (STR) was changed to a normally closed contact (STRN) at $Main@0. This item is highlighted in blue which represents items that are different between the PLC Project and the project in the PC.

Other colors used in the comparison are red, which denotes items that exist only in the project on the PC and not in the PLC and black which highlights items that are identical in both projects. There are also numerous checkbox and radio button options available to help you analyze the differences between projects.

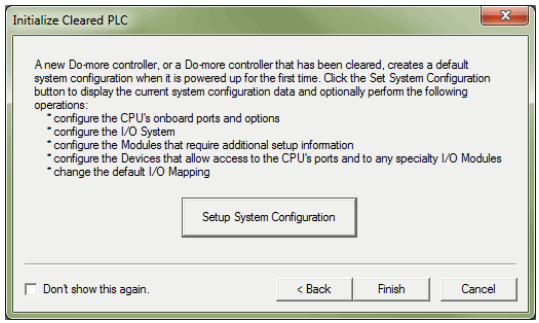
Once you have connected to the CPU either by using the New Online option or using PLC > Connect for offline projects, you may encounter the initialization windows shown here.





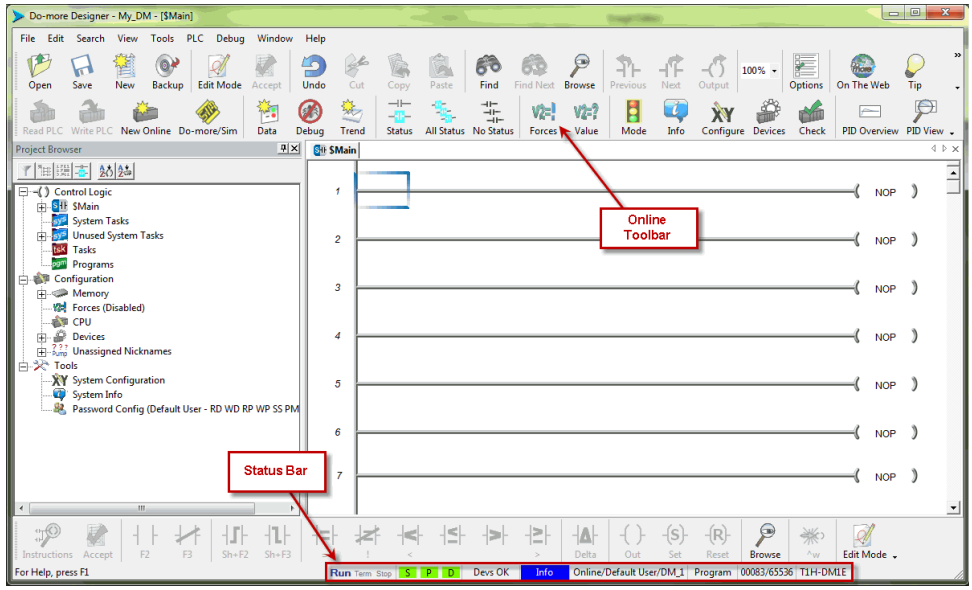
The Set PLC Clock option (above) allows you to set the internal, real-time clock of the PLC.

The Set PLC Clock window (right) has options for Timezones and Daylight Savings Adjustments.



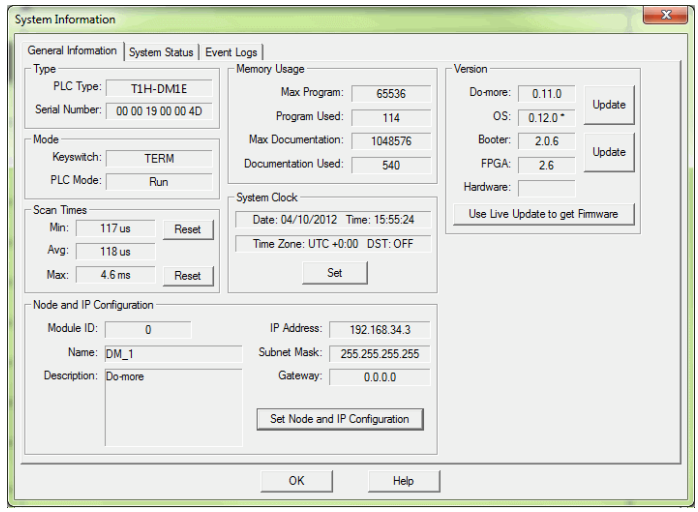
The Setup System Configuration option (left) allows you to configure the parameters of the Do-more T1H Series PLC. I/O module configuration, CPU ports, and I/O mapping profiles are a few of the parameters available in the System Configuration window. Refer to the following section for Hardware Configuration options.

Once all parameters have been configured, the following programming window will open with the online toolbar active.



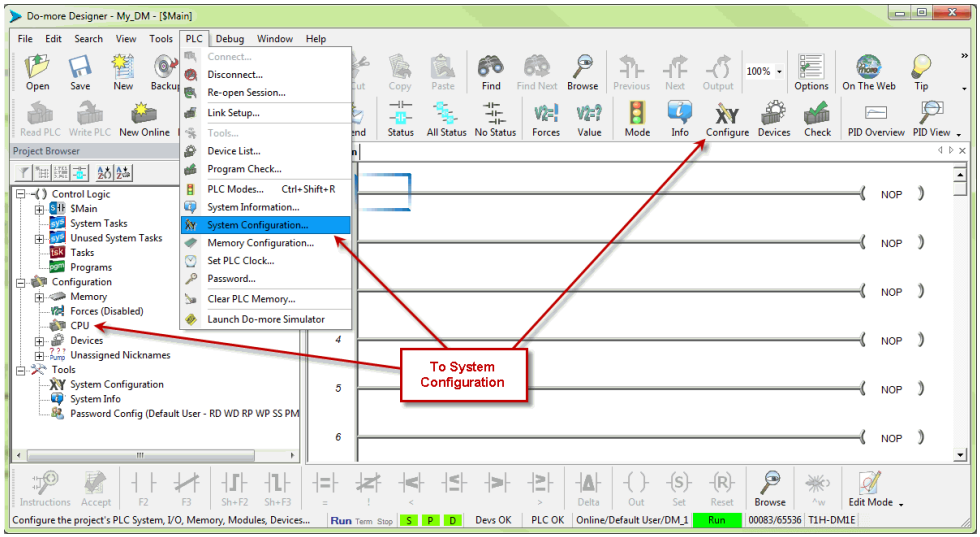
Notice that the status bar indications show PLC type, memory usage, communication status, PLC errors, PLC mode, etc. Hovering your mouse over the status bar will highlight the items that are selectable. If you select one of these items, a new window will open with real-time data and options that are available for that selection.

As an example, the System Information window seen here appears after selecting the Memory Usage indication from the status bar.

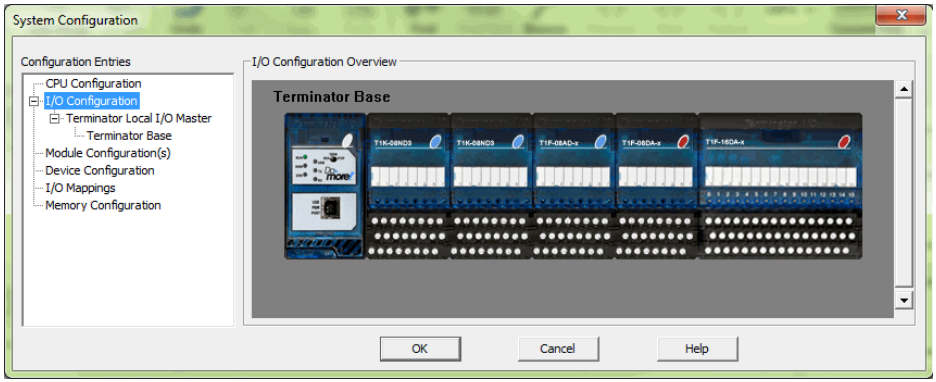


Step 6: Verify Hardware Configuration

Next, you will need to verify the hardware configuration for accuracy. The Do-more T1H Series PLC has an auto discover feature that will automatically detect the I/O modules installed. You can see the results of this search by selecting PLC > System Configuration, double clicking the CPU link under the Configuration tab in the Project Browser, or by clicking the XY Configure icon in the Project Toolbar.

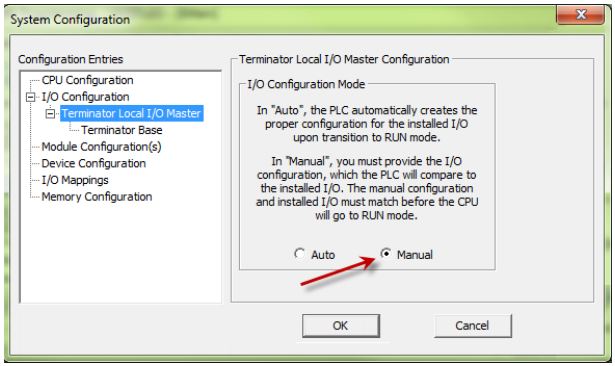


On the left side of the System Configuration window is an index of topics titled Configuration Entries. Click the I/O Configuration tab and you should see an overview of the modules that the software located, similar to the following.



From here you can verify that the software has detected all of the I/O modules that are installed.

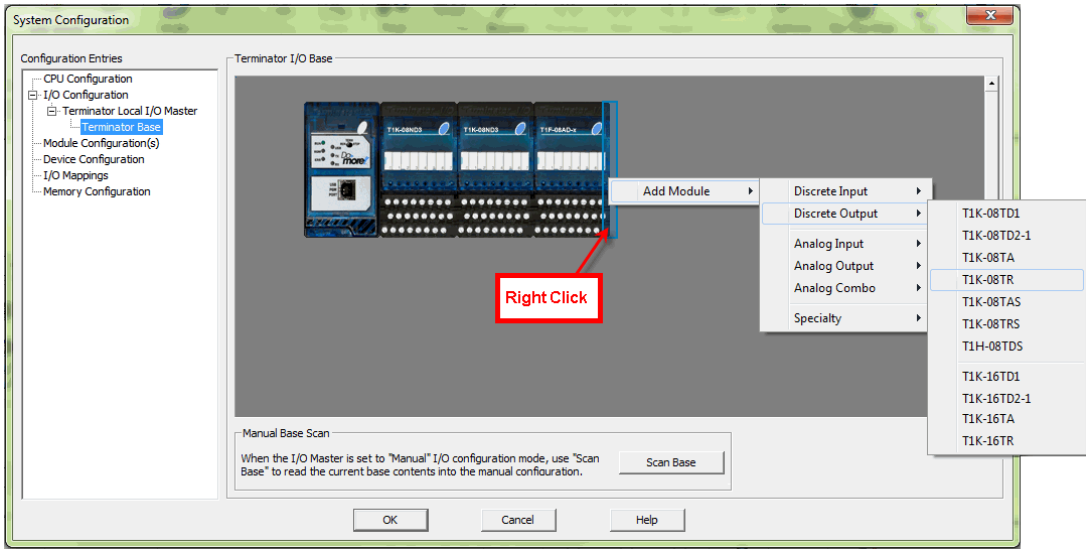
The Do-more T1H Series PLC allows the I/O to be manually configured as well. In order to do so, you must first set the I/O Configuration Mode to manual. Select the Terminator Local I/O Master tab found under the I/O Configuration tab in the Configuration Entries index.



The Terminator Local I/O Master Configuration window shown here will appear. From here select Manual to configure the I/O modules that are installed in the system yourself. It is important to remember that the PLC will compare what you configure with what is installed and they must match for the PLC to work properly.

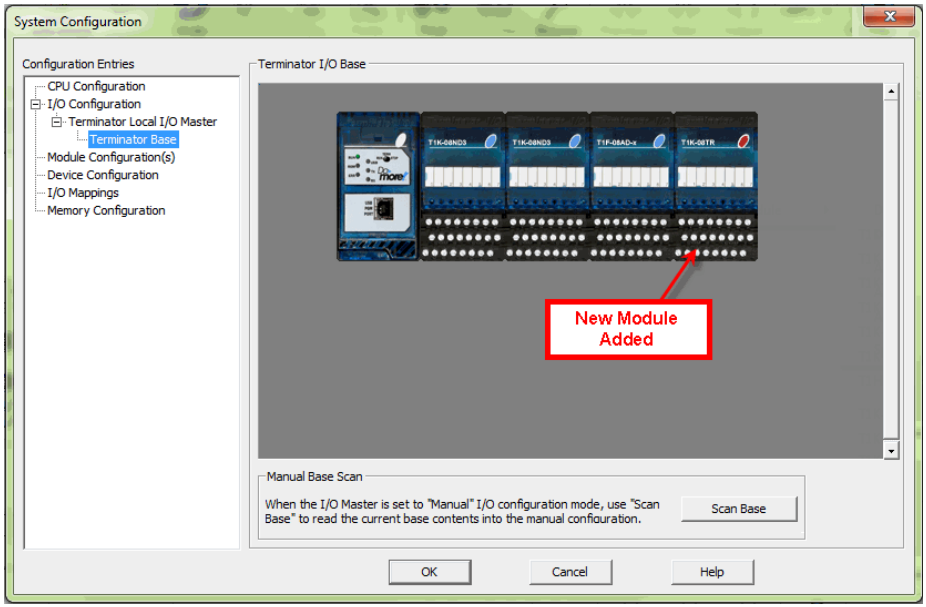
NOTE: *If the manually configured I/O modules do not match the installed I/O modules, the PLC will not go into Run Mode.*

After you have set the configuration mode to Manual, select the Terminator Base tab in the Configuration Entries index. This will take you to the following set up window.

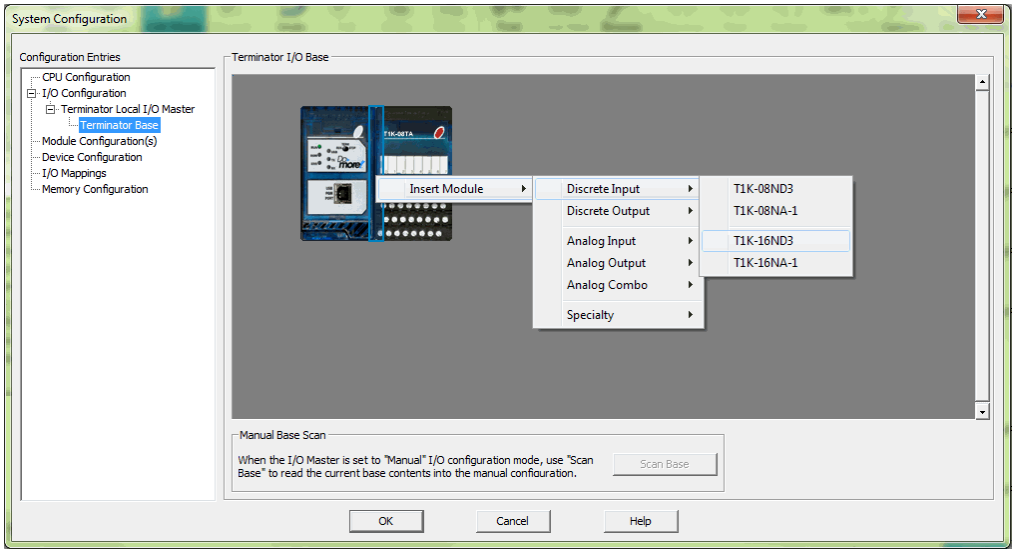


Notice that from this window, you can perform a Manual Scan. When initiated, this scan will poll the available modules connected to the PC and display the I/O found. The results can then be altered as you choose.

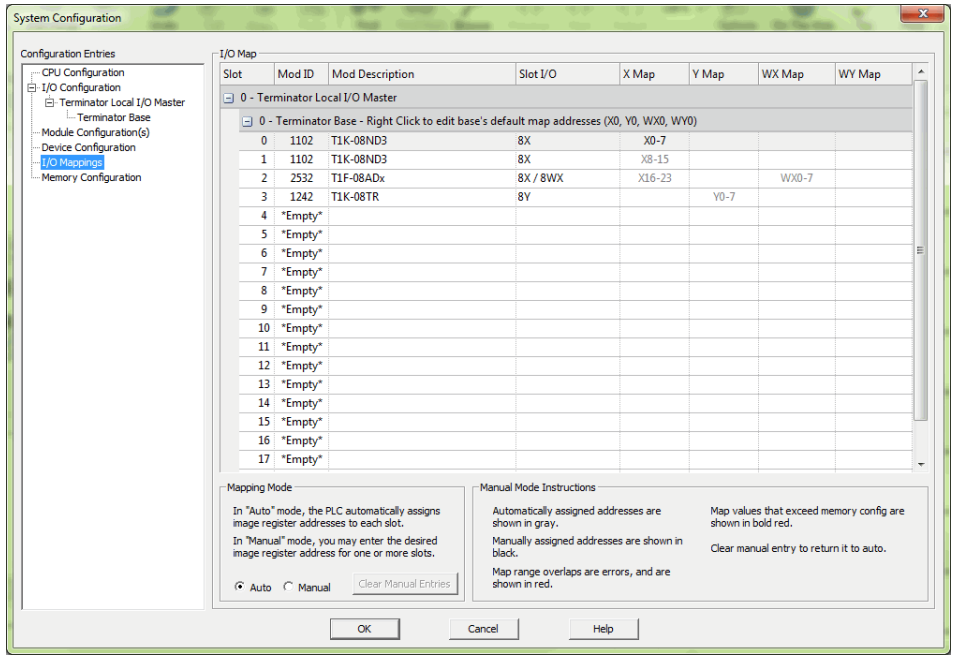
To manually enter your I/O modules into the configuration, right click on the slot the module will reside in, select Add Module and then choose the module from the drop down list. Once you have selected the module, it will appear in the slot that was chosen.



In order to Insert a module manually between two existing modules in the System Configuration Window, you would follow the same steps as mentioned above but instead of selecting 'Add Module' the selection will be 'Insert Module' as seen below.



After the hardware configuration has been verified select the I/O Mappings tab in the Configuration Entries index. This option will display the assigned addresses for the configured modules as seen below.

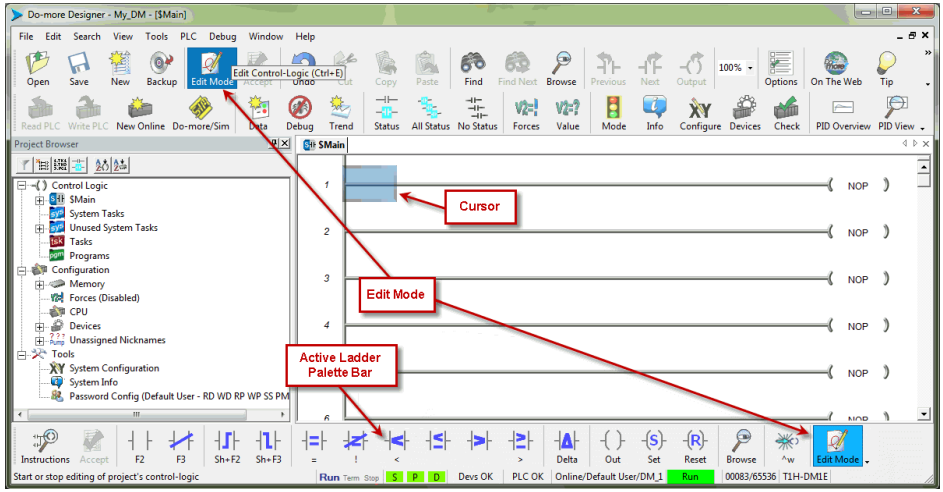


These X (discrete input), Y (discrete output), WX (analog input) and WY (analog output) addresses are automatically assigned by Do-more Designer. You have the option to manually configure these addresses by selecting Manual in the Mapping Mode section at the bottom of the window.

The Manual Mode Instructions section, also found at the bottom of the window, details the various color indications associated with this mode.

Step 7: Create a Ladder Logic Program

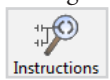
To create a ladder logic program, you must first place the software in Edit Mode. Click the Edit Mode button found in the Project Toolbar or Ladder Palette Bar or use the shortcut Ctrl+E.

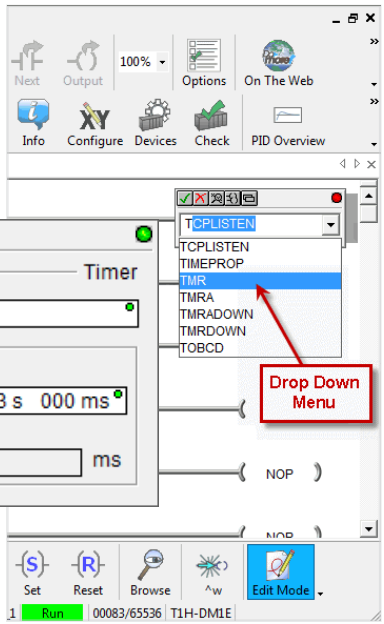


When in Edit Mode, all of the Ladder Palette Bar's options will become active and the cursor in Ladder View will fill in blue. Now, you are ready to begin entering the example ladder logic below.

Rung #1

Place the box cursor in the NOP position on Rung #1. If the Instruction Palette is not open, then click Instructions from the Ladder Palette Bar and select the TMR (Timer) or type a "T" and select TMR from the drop down menu, then press Enter. Once TMR is selected, a Timer dialog box appears.

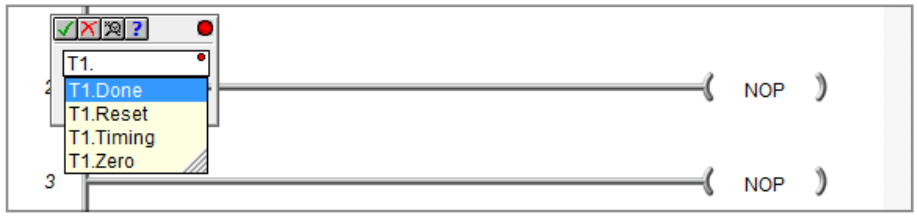




- 1. Set the Timer Struct to T1.
- 2. Enter 03 into the Preset Constant Value for the seconds (s) preset.
- 3. Click the checkmark in the upper left corner to accept.

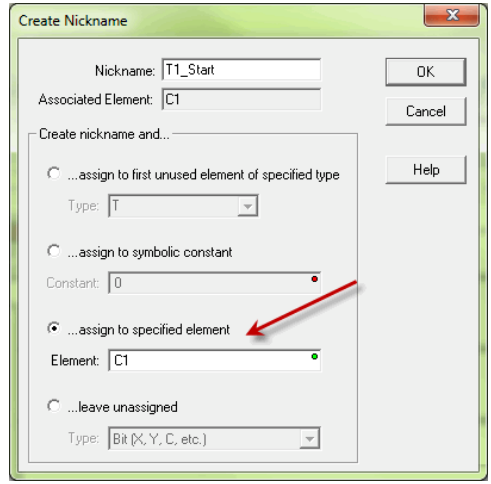
After clicking the checkmark, Rung #1 should show the T1 timer (TMR) instruction with a preset of 3.000 seconds.
A user variable can be assigned to the preset value if needed.

Since a Timer is a structure it has predefined elements associated with it. Elements such as .Acc (accumulated time), .Done (the completion bit) and .Timing (the timer is enabled and timing). Therefore, if "T1." is entered into any contact name the Auto-Complete feature of Do-more Designer will display all applicable bit (boolean) selections available for that structure. Selecting the .Done option, as seen below, will assign this element to the contact and the contact name will be T1.Done.

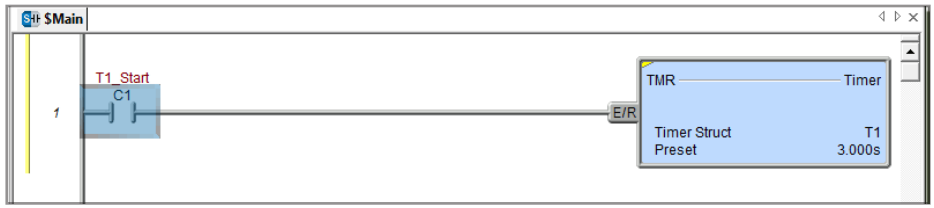


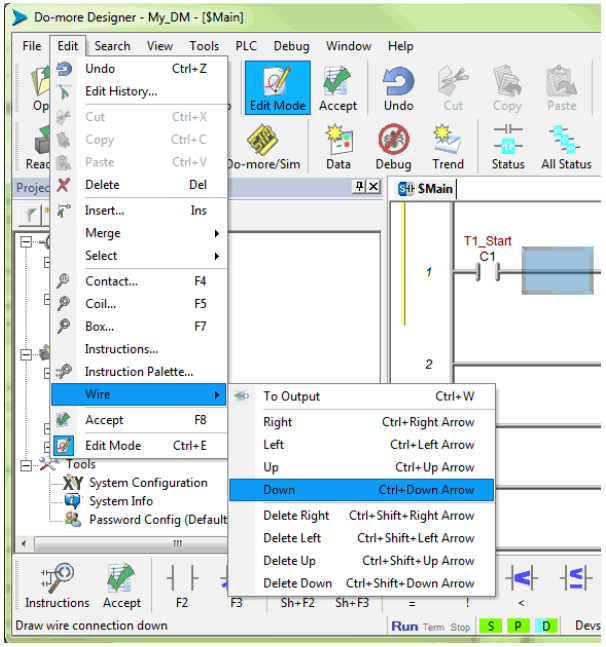
This feature works for all structures including: timers, counters, PID loops and strings. Many system data types such as, $Main and $FirstScan, as well as user-created devices like ECOM, CTRIO, or SERIO modules can also use this feature. See the Do-more Designer Help file for more information on structures.

Now place the box cursor in the leftmost column of Rung #1. Type in a meaningful nickname, such as "T1_Start", and press Enter or select the Normally Open Contact (F2) from the Ladder Palette Bar, enter "T1_Start" for the name and click the checkmark in the upper left corner. Either method will open the Create Nickname dialog seen here. Select the third option to assign the nickname to a specified element, type the desired memory bit for this contact (C1) and select OK.



Rung #1 should now appear as follows:

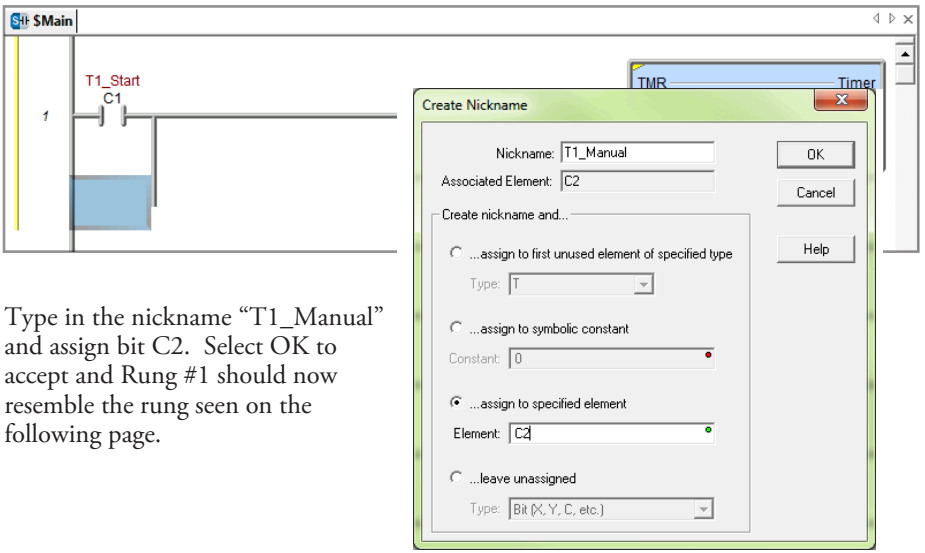




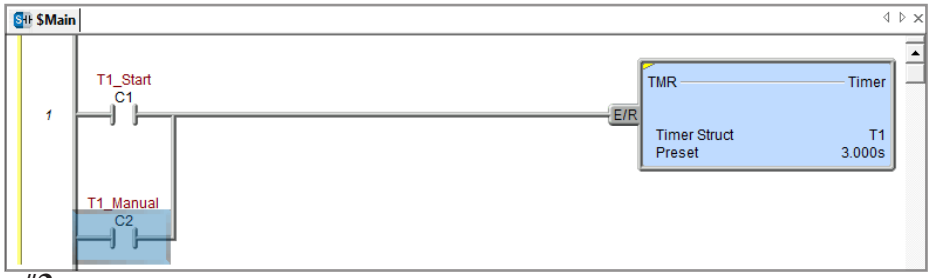
With the cursor in the position to the right of contact T1_Start, you are going to begin drawing a branch circuit. Under the Edit drop down menu, select Wire, then select Down. Notice the shortcuts that are available for wire drawing. The wire that should now appear in your ladder could have also been drawn using the shortcut Ctrl+Down Arrow.

NOTE: *There are also Delete Wire options in the Edit drop down menu that are used to erase any wires not needed.*

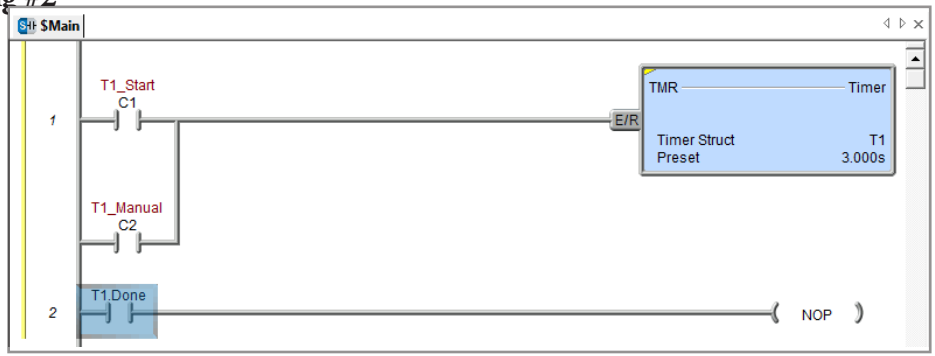
Now place the cursor in the space to the left of the new line and select another normally open contact.



Type in the nickname "T1_Manual" and assign bit C2. Select OK to accept and Rung #1 should now resemble the rung seen on the following page.



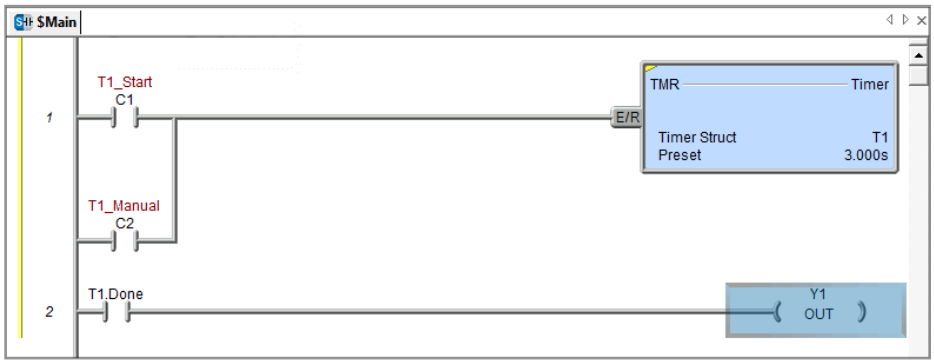
Rung #2



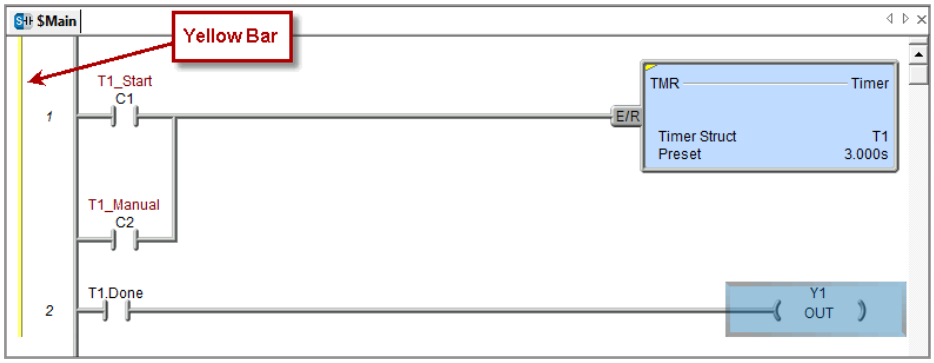
Place a normally open contact in the first position of Rung #2. This contact will be tied to the Done bit of timer T1. Therefore, the name for this contact should be entered as "T1. Done". There should be no Create Nickname dialog as seen with the earlier normally open contacts.

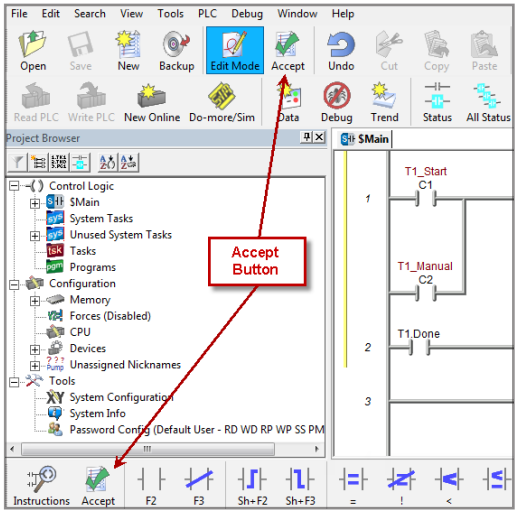
Lastly, you will need to add an Out coil to the end of Rung #2. Place the cursor at the end of the rung and either select Out from the Ladder Palette Bar or just type "OUT" and select the Out instruction from the drop down menu. Next, choose which bit will be tied to this coil. Tie this coil to the physical output Y1 by typing "Y1" and click the check mark.

The ladder program should now look like the following. When either the T1_Start or T1_Manual contact is energized, the timer will begin timing. When it times out, contact T1_Done will energize and the output coil Y1 will turn on. Note that an END instruction is not required.

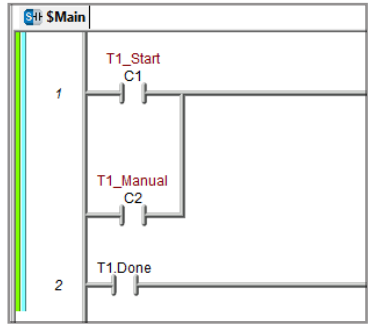


The yellow bar in the margin signifies logic that has not been accepted. So once you have verified your logic, click the Accept button in the Project Toolbar or the Ladder Palette Bar to accept the changes.





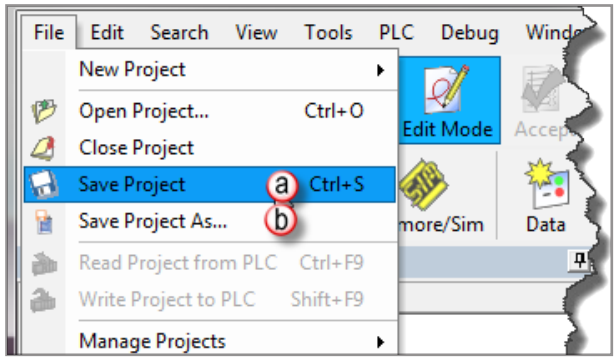
You should now see blue and green bars, shown below, signifying that the logic has not been downloaded to the CPU or saved.



Now exit the Edit mode by clicking the Edit Mode button once again or by pressing ESC on the keyboard.

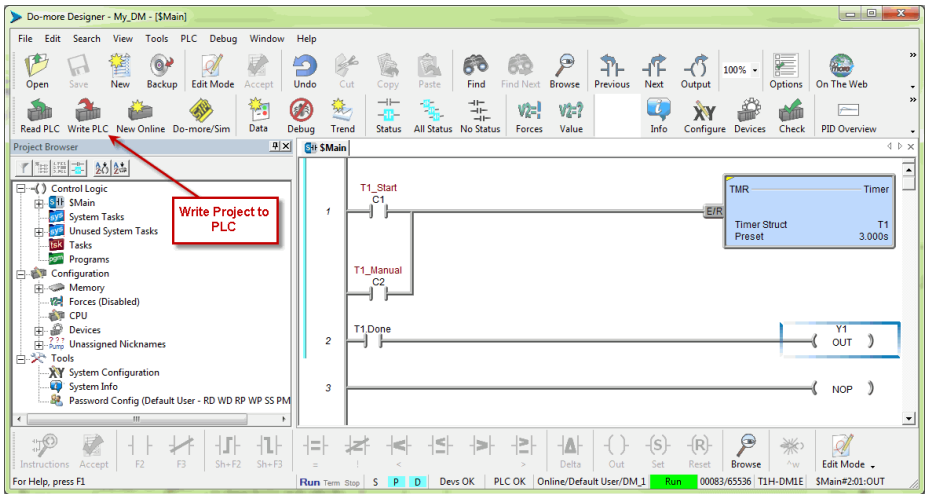
Step 8: Save a Project

Save the project by selecting (a) Save Project (Ctrl+S) from the File drop down menu. Or save the file under a different name or in a different location by selecting the (b) Save Project As... option.

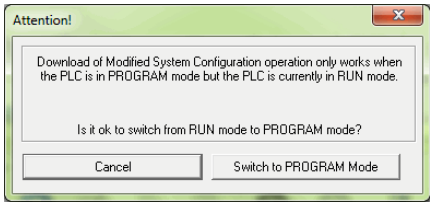


Step 9: Write Project to the Do-more T1H Series PLC

Now that you have created the example ladder logic program, you can write the program to the PLC. To do so, click the Write PLC button in the Project Toolbar.

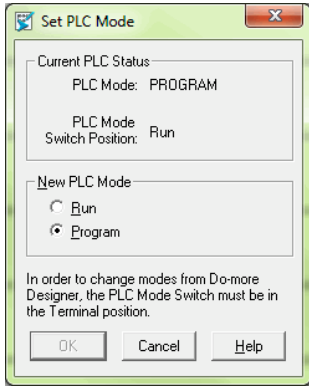


If the Write PLC button is not active, then you must first connect to the PLC to activate the online portion of the Project Toolbar (see the "Establish Communication" section of this chapter). If you have altered the System Configuration, which includes the hardware configuration, in any way, then the PLC must be taken out of Run mode in order to process the download.



The message seen here will appear asking you to verify if this is a good time to do so. Since this is the setup phase of this system, select Switch to Program Mode and continue with the download.

If this system was previously commissioned and in use, then you would need to verify that the process it is controlling can be interrupted at this time before continuing.

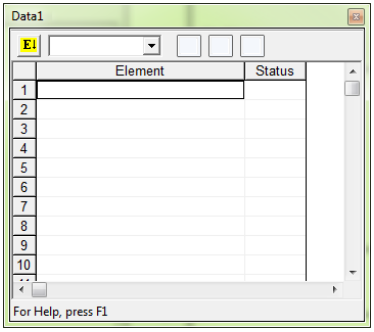


Download the project and once the download is finished, assuming there are no errors, the Do-more T1H Series PLC should return to Run mode. If at any time you need to change the PLC mode, select the Mode icon in the Project Toolbar, click the Mode Status indication in the Status Bar or select PLC > PLC Modes....

The PLC Modes window shown here will open displaying the current mode the PLC is in with options to change it to either Run or Program mode. Click OK to accept the change or Cancel to exit.

Step 10: Testing Project Using Data View

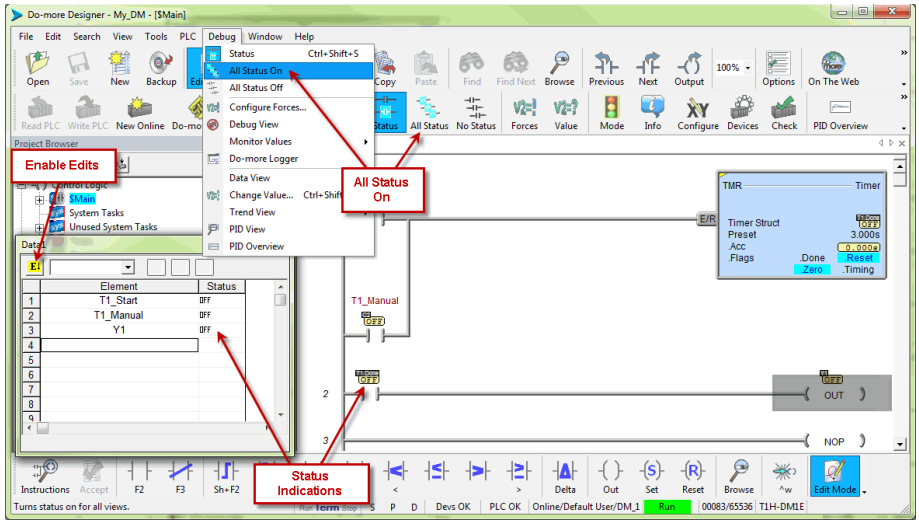
With the project successfully downloaded into the Do-more T1H Series PLC, you can now test the function of the ladder program using the Data View tool. To start, you need to open a new Data window in the software. To do so, click the Data icon in the Project Toolbar, select Debug > Data View > New or press Ctrl+Shift+F3.



The Data View window seen here will open. This window will open in the project browser section of the programming window but it can be relocated anywhere on the screen by clicking the title bar and dragging it to a new location.

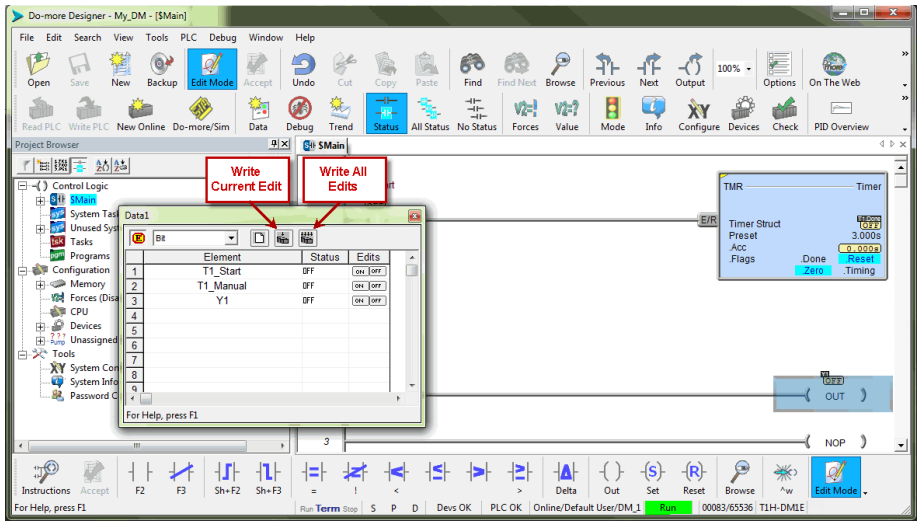
Now enter the elements that you wish to monitor. On line one type “C1” under the Element column and press Enter. You will see the C1 change to the variable name associated with it or T1_Start. On line two type the element “C2” and on line three type “Y1”.

With the ladder elements entered into the Data View window, you now need to activate their status. To do so, click the All Status icon on the Project Toolbar or select Debug > All Status On. The All Status On option will not only activate the status of the Data View window but also the status of the ladder program as seen on the following page.

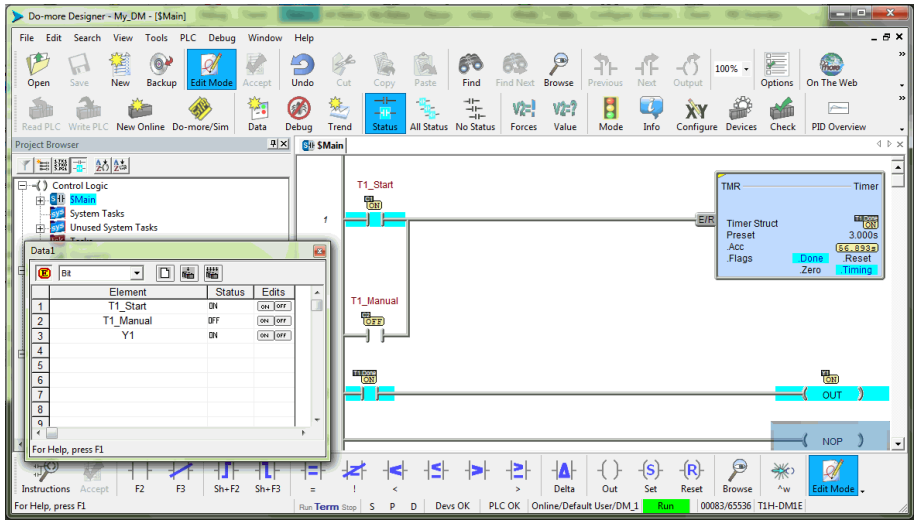


The next step is to enable edits within the Data View window. To do so, click the yellow box with the "E" found in the top left corner of the Data View window, as seen above. The Edits column is now added to the Data View window.

The Edits column allows you to make changes to the current values of the elements listed. T1_Start's current value is OFF. Click the ON button under the Edits column and the Write Current Edit and the Writes All Edits buttons will appear at the top of the window. These buttons will write individual or all edits made in the Data View window to the PLC.



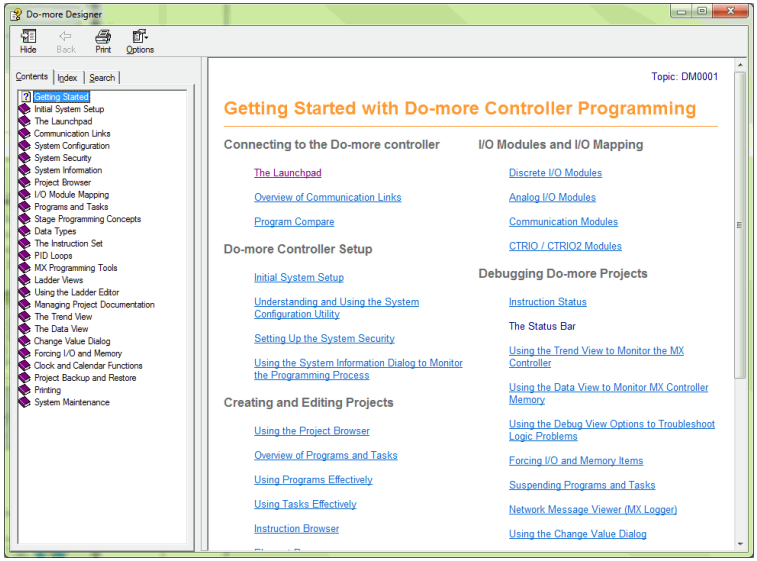
Click the Write Current Edit to PLC button and confirm it. This will write the new value to T1_Start. Once T1_Start changes to an ON state, the timer (T1) will begin to time and quickly reach the preset. As soon as the preset is reached, the done bit, T1.Done, will turn ON causing output Y1 to also turn ON as seen on the following page. Now write an OFF to T1_Start and watch as the timer and Y1 reset.



Congratulations, you have now programmed, downloaded and tested a ladder logic program for the Do-more PLC. Feel free to experiment with a program of your own and don't forget that the software Help file is an essential tool to use when programming your controller.

Accessing the Help File

The software Help file, seen below, is available as a quick reference or detailed guide to the many features and capabilities of the Do-more PLC. To access the Help File select the Help File icon from the Project Toolbar, choose Help from the Help menu drop down or use the shortcut F1.



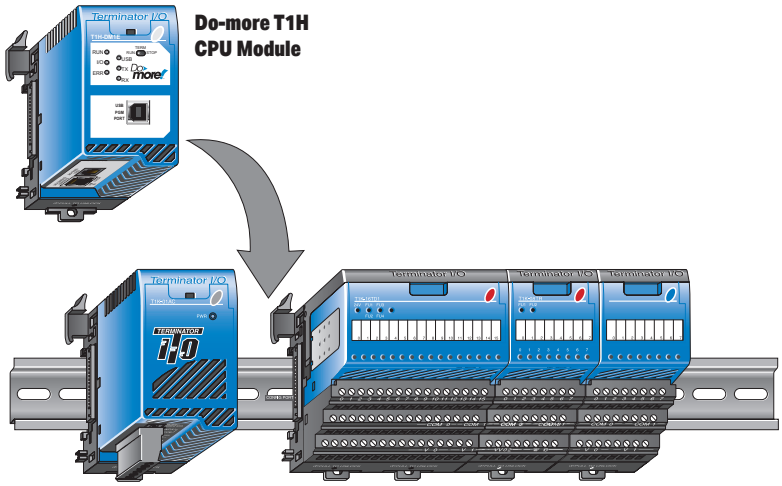
CHAPTER 2

DO-MORE PLC HARDWARE OVERVIEW

In This Chapter:

Do-more T1H Series PLC Overview

The Do-more T1H Series PLC is the latest PLC series released as part of the Do-more PLC family. The Do-more T1H Series PLC combines the modular and space-saving package of our Terminator I/O line with the new Do-more T1H Series CPU module to create a versatile, stand-alone control system. Using Do-more Designer as a foundation, the T1H Series PLC system provides a powerful, flexible instruction set, inside a user friendly programming environment.



Terminator I/O system with Power Supply and I/O modules (Base Controller removed)

The Do-more T1H Series PLC is designed around a new control engine with a new, advanced Do-more Instruction Set for ladder programs. The new Do-more Designer software, with advanced programming and monitoring features, will be used to create your new programs.

Module Compatibility

The following table shows which Terminator I/O product line components are supported by the Do-more T1H-DM1 and T1H-DM1E CPUs.

Module Compatibility Table					
Module	**Part Number**	**Status**	**Module**	**Part Number**	**Status**
Base Units	T1K-08B	✓	*Analog I/O Modules*	T1F-08AD-1	✓
	T1K-08B-1	✓		T1F-08AD-2	✓
	T1K-16B	✓		T1F-16AD-1	✓
	T1K-16B-1	✓		T1F-16AD-2	✓
Discrete I/O Modules	T1K-08ND3	✓		T1F-16RTD	✓
	T1K-16ND3	✓		T1F-16TMST	✓
	T1K-08NA-1	✓		T1F-14THM	✓
	T1K-16NA-1	✓		T1F-08DA-1	✓
	T1K-08TD1	✓		T1F-08DA-2	✓
	T1K-16TD1	✓		T1F-16DA-1	✓
	T1K-08TD2-1	✓		T1F-16DA-2	✓
	T1K-16TD2-1	✓		T1F-8AD4DA-1	✓
	T1H-08TDS	✓		T1F-8AD4DA-2	✓
	T1K-08TA	✓	*Specialty Modules*	T1H-CTRIO	✓
	T1K-16TA	✓			
	T1K-08TAS	✓			
	T1K-08TR	✓			
	T1K-16TR	✓			
	T1K-08TRS	✓			

✓ = Supported

Communications

The Do-more T1H Series PLC supports many communication protocols. The following table shows which CPU module communications port supports each protocol.

Protocols	CPU Modules		
	T1H-DM1 / T1H-DM1E		T1H-DM1E
	USB Port	RS-232 Serial Port	Ethernet Port
Do-more Designer Programming	Yes	Yes	Yes
Modbus/RTU Client (Master)		Yes	
Modbus/RTU Server (Slave)		Yes	
Modbus/TCP Client (Master)			Yes
Modbus/TCP Server (Slave)			Yes
DirectLOGIC RX/WX Client (Master)			Yes
DirectLOGIC RX/WX Server (Slave)			Yes
K-Sequence Server (Slave)		Yes	
DirectNET Server (Slave)			
HEI Ethernet I/O Master			Yes
SMTP (EMail) Client w/Authentication			Yes
Simple Network Time Protocol (SNTP) Client			Yes
Do-more/PEERLINK			Yes
Do-more Time Synchronization Protocol (Client, Server, Alternate Client)			Yes
Do-more Logger/UDP			Yes
Serial ad-hoc ASCII/Binary Programatic Control		Yes	
UDP ad-hoc Programmatic Control			Yes
TCP Client Programmatic Control			Yes
TCP Server Programmatic Control			Yes

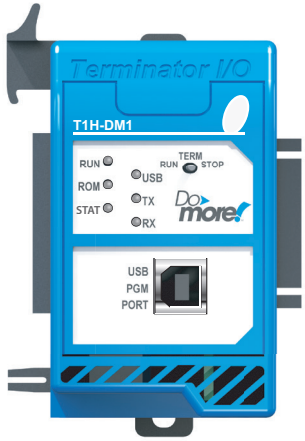
Blank = Not Supported

SPECIFICATIONS - CPU MODULES

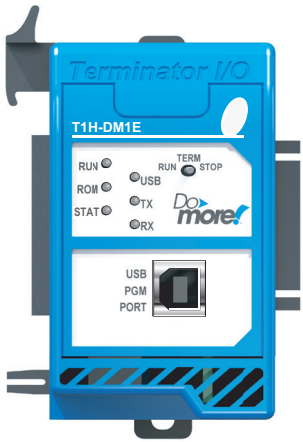
In This Chapter:

CPU Specifications

CPU General Specifications		
Feature	**T1H-DM1**	**T1H-DM1E**
Total Memory (bytes)	262,144 bytes	
Ladder Memory (instruction words)	65,536 instruction words	
V-Memory (words)	Configurable up to 65536 (4096 default)	
Non-volatile V Memory (words)	Configurable up to 65536 (4096 default)	
D-memory (DWORDs)	Configurable up to 65536 (4096 default)	
Non-volatile D Memory (DWORDs)	Configurable up to 65536 (4096 default)	
R-memory (REAL DWORDs)	Configurable up to 65536 (4096 default)	
Non-volatile R Memory (REAL DWORDs)	Configurable up to 65536 (4096 default)	
Boolean execution	50µs	
Stage Programming	Yes	
Number of Stages	128 per Program code-block; number of code-blocks configurable to memory limit	
Handheld Programmer	No	
Programming Software for Windows	FREE Do-more Designer	
Built-In communications ports	USB, RS-232	USB, RS-232, Ethernet (10/100 Base-T)
Program Memory	Flash ROM	
Total I/O points available	X, Y, each configurable up to 65536 (2048 default); WX, WY (analog in/out) each configurable up to 65536 (256 default)	
Max Number of Local I/O Modules	16	
Local I/O points available	256	
Ethernet I/O Discrete points	131,072	
Ethernet I/O Analog I/O Channels	32,768	
Max Number of Ethernet slaves per PLC	16	
I/O points on Ethernet I/O	32,768	
Discrete I/O Module Point Density	8/16	
Number of instructions available	>160	>170
Control relays	Configurable up to 65536 (2048 default)	
Special relays (system defined)	1024	
Special registers (system defined)	512	
Timers	Configurable up to 65536 (256 default)	
Counters	Configurable up to 65536 (256 default)	
System Date/Time structures	8	



T1H-DM1



T1H-DM1E

CPU General Specifications (continued)		
Feature	**T1H-DM1**	**T1H-DM1E**
User Date/Time structures	Configurable up to 65536 (32 default)	
ASCII String/Byte buffer structures	Configurable up to memory limit (192 default)	
Modbus Client memory	Yes, configurable up to memory limit, default 1024 input bits, 1024 coil bits, 2048 input registers, 2048 holding registers	
DL Classic Client memory	Up to memory limit, default 512 X, 512 Y, 512 C, 2048 V	
Immediate I/O	No	
Interrupt input (hardware / timed)	No	
Subroutines	Program and Task code-blocks, up to memory limit	
Drum Timers	Yes, up to memory limit	
Table Instructions	Yes	
Loops	FOR/NEXT, WHILE/WEND, REPEAT/UNTIL loops	
Math	>60 operators and functions: Integer, Floating Point, Trigonometric, Statistical, Logical, Bitwise, Timing	
ASCII	Yes, IN/OUT, Serial, Ethernet TCP and UDP; 11 output script commands	
PID Loop Control, Built In	Yes, configurable to memory limit (over 2,000)	
Time of Day Clock/Calendar	Yes	
Run Time Edits	Yes	
Supports True Force	Yes	
Internal Diagnostics	Yes	
Password security	Multi-user, credentialed, session-based security	
System error log	Yes	
User error log	Yes	
Battery backup	Yes (Battery included)	

Do-more Designer V1.2 or newer must be used with these Do-more T1H CPU modules.

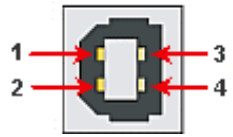
Communications Ports Specifications

Port 1 Specifications (USB)

USB Port: This port has a USB Type B female connector and requires a USB Type A-B cable.

- Do-more programming protocol only

USB Type B Slave Input Specifications	
Description	Standard USB 2.0 Slave input for programming and online monitoring only, with built-in surge protection. Not compatible with older full speed USB devices.
Cables (ADC part #)	USB Type A to USB Type B: USB-CBL-AB3 (3ft) USB-CBL-AB6 (6ft) USB-CBL-AB10 (10ft) USB-CBL-AB15 (15ft)



USB Port 1		
1	5V	Bus Voltage Sense
2	D-	Data -
3	D+	Data +
4	0V	Ground

Port 2 Specifications (Serial)

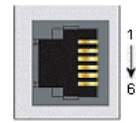
RS-232 Port: Serial RS-232 multipurpose communications port:

- Full-duplex
- 1024B buffer
- RJ-12 connector

RJ-12 style connector used for:

- Do-more programming protocol
- Modbus RTU Master connections
- Modbus RTU Slave connections
- ASCII Incoming and Outgoing communications
- Custom Protocol Incoming and Outgoing communications

RS-232 Specifications	
Description	Non-isolated, full duplex RS-232 DTE port used for programming, online monitoring or can connect the CPU as an ASCII or Modbus RTU master or slave to a peripheral device. Includes ESD and built-in surge protection.
Communications	1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 Baud
+5V Cable Power Source	220mA maximum at 5V, ±5%. Reverse polarity and overload protected.
Maximum Output Load (TXD/RTS)	3kΩ, 1,000pf
Minimum Output Voltage Swing	±5V
Output Short Circuit Protection	±15mA
Cable Options	D2-DSCBL USB-RS232-1 with D2-DSCBL FA-CABKIT FA-ISOCON for converting RS-232 to isolated RS-422/485 EA-MG-PGM-CBL



6-pin RJ12 Female Modular Connector

RS-232 Port 2		
1	0V	Power (-) connection (GND)
2	5V	Power (+) connection (220mA max)
3	RXD	Receive Data (RS-232)
4	TXD	Transmit Data (RS-232)
5	RTS	Request to Send (RS-232)
6	CTS	Clear to Send (RS-232)

Port 3 Specifications (Ethernet)

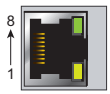
Ethernet Port: Programming and Modbus TCP Client/Server port with 10/100 Base-T Ethernet RJ45 connector.

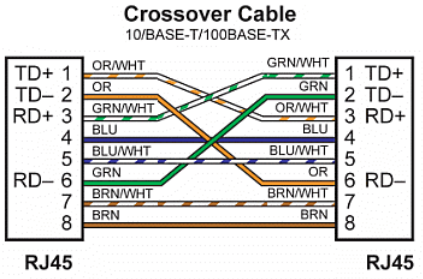
RJ-45 style connector used for:

- Do-more programming protocol
- Modbus TCP Client connections (Modbus requests sent from the CPU)
- Modbus TCP Server connections (Modbus requests received by the CPU)
- Ethernet I/O Master

Ethernet Specifications	
Description	Standard transformer isolated Ethernet port with built-in surge protection for programming, online monitoring, Modbus/TCP client/server connections (fixed IP or DHCP) and Ethernet I/O capabilities.
Transfer Rate	10/100 Mbps
Cables	Use a Patch (Point to Point) cable when a switch or hub is used. Use a Crossover cable when a switch or hub is not used.

NOTE: *The Ethernet port can support all the functions listed above at the same time. However, it is important to consider the implications to network traffic and network topology. Since there is just one Ethernet port available, it will not be possible to use multiple functions and have an isolated network for Ethernet I/O, as is recommended. Utilize the adjustable poll rates of Ethernet I/O and Modbus TCP Clients (if auto-polling) to limit the impact on your network.*





8-pin RJ45 Connector (8P8C)

NOTE: *The above diagram illustrates the standard wire positions in the RJ45 connector. It is recommended that all 10/100 Base-T cables be Category 5, UTP cables.*

Ethernet I/O

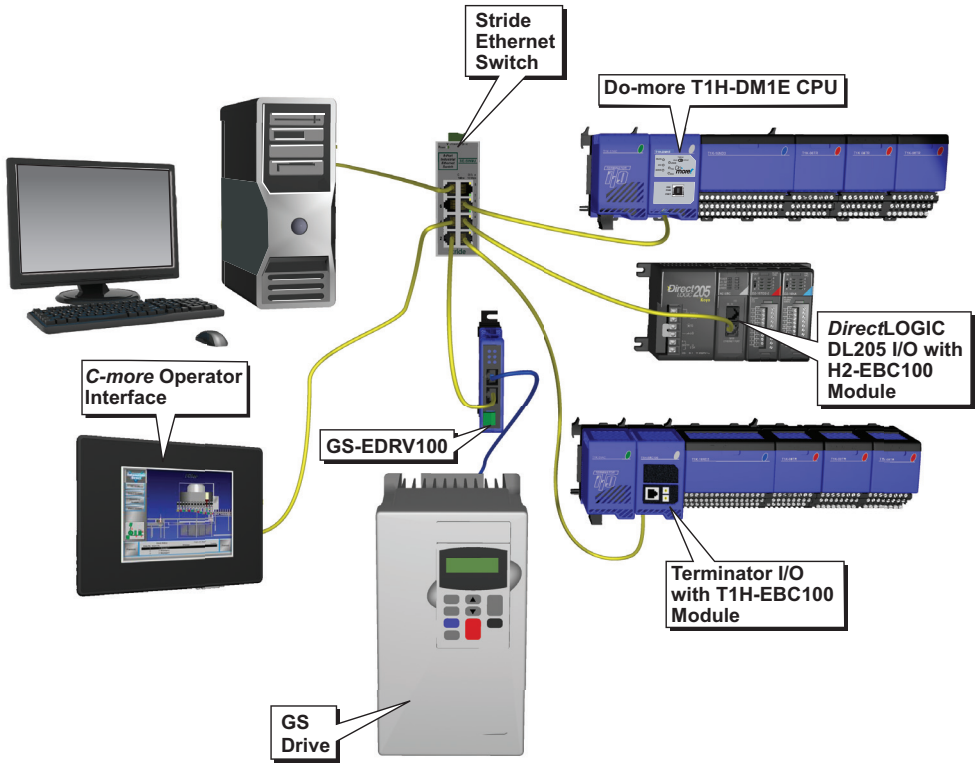
The T1H-DM1E CPU's built-in Ethernet port can be configured as an Ethernet I/O master. The Ethernet I/O feature allows expansion beyond the local chassis to slave I/O using the onboard high-speed Ethernet link.

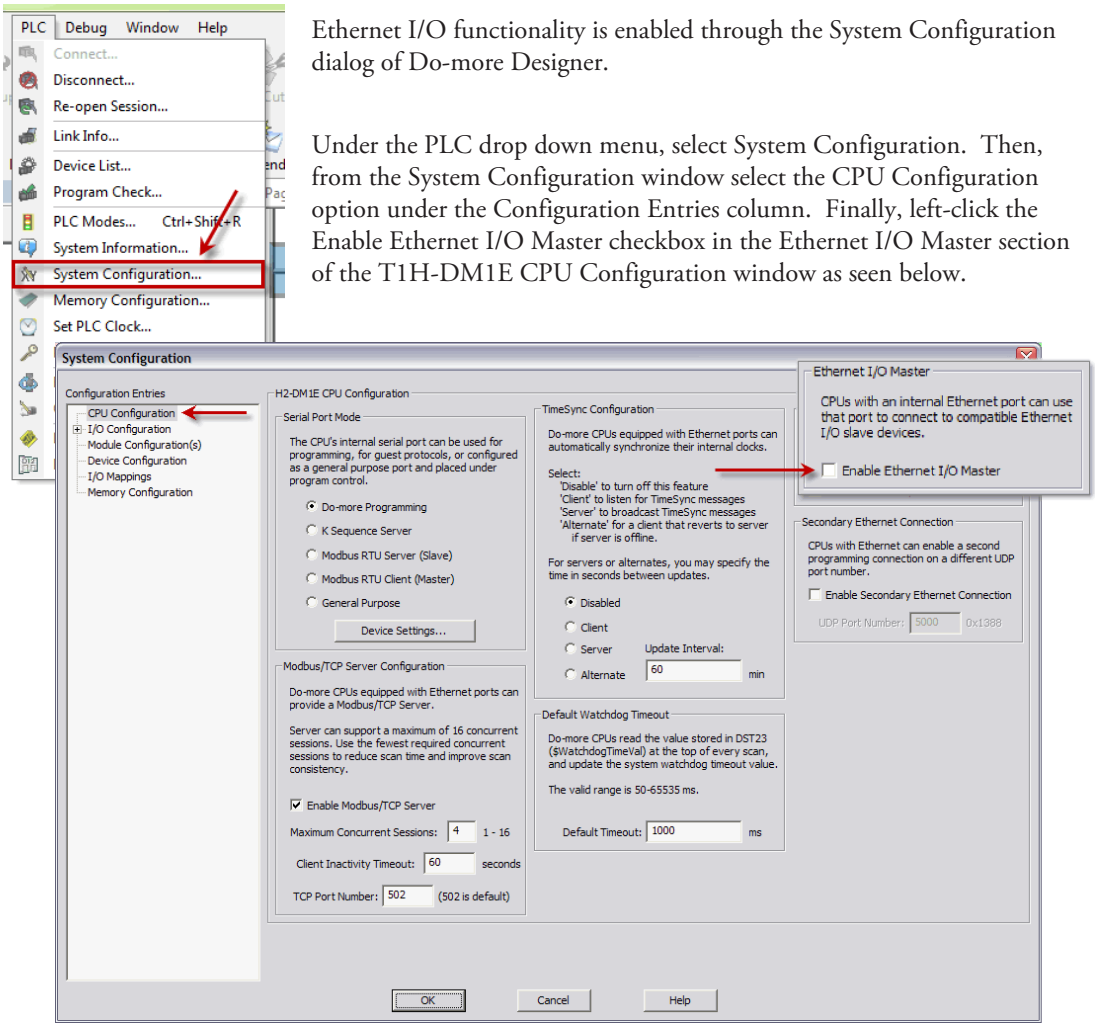
The onboard Ethernet port can support up to 16 slave devices. The slave I/O modules supported are:

- H2-EBC100
- 1H-EBC100 (Terminator I/O)
- GS-EDRV100 (GS Drives)

The Ethernet I/O network uses Category 5 UTP cables for cable runs up to 100 meters (328 ft.) with extended distances achieved through Ethernet switches.

Ethernet I/O Example





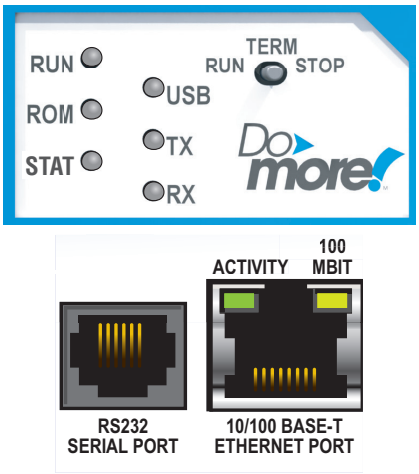
Ethernet I/O functionality is enabled through the System Configuration dialog of Do-more Designer.

Under the PLC drop down menu, select System Configuration. Then, from the System Configuration window select the CPU Configuration option under the Configuration Entries column. Finally, left-click the Enable Ethernet I/O Master checkbox in the Ethernet I/O Master section of the T1H-DM1E CPU Configuration window as seen below.

For more information on the setup, use and options available with Ethernet I/O, refer to the Ethernet I/O Master section of Do-more Designer Help File topic DMD0247.

Status Indicators

Do-more T1H CPU modules have multi-color LEDs that are used to visually provide operational status to the user.



LED Indicators		
Indicator	**Status**	**Description**
RUN	Green	CPU is in RUN Mode
	Yellow	Forces are Active
ROM	Yellow	CPU is updating Non-volatile Memory
STAT*	Red*	CPU Fatal Error
	Yellow	Low Battery
	Green	Status OK (good)
USB	Green	USB Receive Activity
	Yellow	USB Transmit Activity
TX	Green	RS-232 Transmit Activity
RX	Green	RS-232 Receive Activity
ACTIVITY	Green	Ethernet Port Activity
100 MBIT	Yellow	Ethernet Port communicating at 100 MBIT Rate

** See Do-more software manual to further investigate what type of error has occurred.*

In addition to the individual definition of each LED, there are times when the controllers will use combinations of the LED ON/OFF state and colors to convey status information. The following combinations use some or all of the LEDs:

- STAT LED is blinking RED for (15 seconds) - Do-more Designer can blink the STAT LED for 15 seconds to verify that a communication link is targeting the correct controller.
- All six (6) of the LEDs are ON and the color of each LED is GREEN - indicates the operating system has started running.
- All six (6) of the LEDs are cycling through RED and GREEN, in a circular 'chase' pattern - indicates the operating system is initializing.
- The left-most three (3) LEDs are cycling through RED and GREEN, in a 'bouncing ball' pattern - indicates the controller is running only the boot loader and is NOT going to load and run the operating system. The most likely cause is having DIP switch #1 in the ON position.
- All six (6) of the LEDs are ON and the color of each LED is RED - indicates the hardware watchdog timer has expired because the controller's operating system has stopped running.

Mode Switch Functions	
Mode Switch Position	**CPU Action**
RUN (Run Program)	CPU is forced into RUN Mode if no errors are encountered.
TERM (Terminal)	RUN, PROGRAM and the DEBUG modes are available. In this mode, the mode of operation can be changed through the Do-more Designer Software.
STOP (Stop Program)	CPU is forced into STOP Mode.

Mode Switch Functions

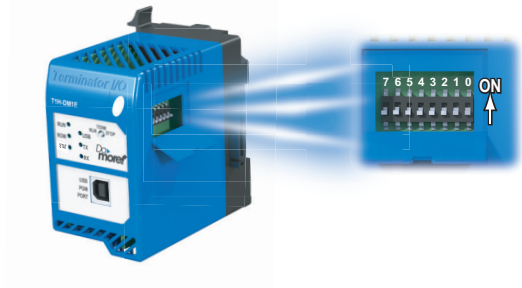
As mentioned in the previous table, the CPU mode can also be changed through the programming software if the mode switch is placed in the TERM position. In this position, the CPU can be changed remotely between the Run and Program modes. For more information on changing CPU modes through the software, see the "Step 9: Write Project to the Do-more PLC" section of Chapter1 "Getting Started".

When power is applied to the system, the controller will go through it's power-up sequence then either stay in Program mode if the mode switch is in the STOP position, or attempt to go to Run mode if the mode switch is in the RUN position.

If the mode switch is in the TERM position, the controller will return to the last operational mode before power was lost. For example, if the controller was in Run mode when power was lost, when power is restored and the mode switch is in the TERM position, the controller will attempt to return to Run mode.

DIP Switch Specifications

Do-more controller's circuit board has a block of DIP switches that are used to perform various debug and reset operations. The DIP switch settings are only read when the system is first powered up. Changing the settings of the DIP switches requires that the system containing the controller be powered down and the CPU removed. The DIP switches can then be changed as required. The DIP switch block is located on the right side of the CPU under a small cover. Once the switches have been set, the CPU can then be reinstalled in the system and powered back up.



DIP Switch Settings		
Switch Number	**Switch Position**	**Function**
0	ON	Load the last copy of the operating system.
1	ON	Do not load an Operating System, stay in the Booter.
2	ON	Disable the hardware watchdog timer - the hardware watchdog is always enabled, but this switch allows the user to override the ability of the Force Watchdog Error (WATCHDOG) and Debug Mode to generate a Watchdog condition.
3	ON	Disable ability to update the firmware and/or gate array.
4	ON	Reserved
5	ON	
6	ON	
7	ON	Reset the TCP/IP Network Settings to factory default values - Must be used with DIP #1
All 8	ON	Clears everything from the controller (see details in the following pages)

The default position for all of the DIP switches is OFF. The table below describes the position and function associated with each DIP switch.

Do-more T1H controllers make use of combinations of DIP switch settings and the Mode switch on the front of the controller to perform two reset functions. These reset functions can only be performed when the controller is in the boot loader.

The following sequence describes the steps necessary to perform one of the reset operations. This combination of DIP switch settings and mode switch manipulation is purposely complex to prevent these reset operations from being accidentally executed.

Clear only the Network Settings

This reset function will clear ONLY the Network settings, which consists of the Module ID, Module Name, Module Description, IP Address, Subnet Mask and Gateway Address.

1. Begin by powering down the controller.
2. Remove the controller from the base and record the location of the DIP switches (so they can be set back to their original position after the manual reset is finished).
3. Next set ONLY DIP #1 and #7 ON to perform the Clear Only the Network Settings operation, make sure all other DIP switches are OFF.
4. Reinstall the controller in the base.
5. Set the controller mode switch to TERM (the center location) and power up the controller.
6. At this point the LEFT bank of 3 LEDs should be blinking the 'stay in the boot loader sequence', that is, they should be blinking in sequence, from top to bottom then back to the top, alternating between red and green.
7. Move the controller mode switch to RUN (to the left).
8. Move the controller mode switch to TERM (to the center).
9. Move the controller mode switch to RUN (to the left).
10. Move the controller mode switch to TERM (to the center).
11. Move the controller mode switch to STOP (to the right).
12. Move the controller mode switch to TERM (to the center) - the LEFT bank of 3 LEDs should now be ON.

NOTE: *If you want to terminate the reset at this point you can do so by moving switch to RUN instead of STOP or powering down the controller.*

- Move the controller mode switch to STOP (to the right) - the RIGHT bank of 3 LEDs should now be ON.

NOTE: *If you want to terminate the manual reset at this point you can only do so by powering down the controller.*

1. Move the controller mode switch to TERM (to the center) - the LEFT bank LEDs begin flashing the power up sequence, and the ROM led should briefly be ON indicating that the data in the ROM is being rewritten. The LEDs will then begin flashing the 'staying in boot loader' sequence indicating the reset is complete.
2. Power down the controller.
3. Remove the controller from the base and return the DIP switches to their original positions.
4. Set the controller mode switch to TERM (in the center location).

Clear All

This reset function will clear everything from the controller, this includes the Network Settings as described previously, and the System Configuration, Memory Configuration, all control logic, all Documentation, and all of the User Accounts and Passwords.

1. Begin by powering down the controller.
2. Remove the controller from the base and record the location of the DIP switches (so they can be set back to their original position after the manual reset is finished).
3. Next set all eight of the DIP switches ON to perform the Clear All operation.
4. Reinstall the controller in the base.
5. Set the controller mode switch to TERM (the center location) and power up the controller.
6. At this point the LEFT bank of 3 LEDs should be blinking the 'stay in the boot loader sequence', that is, they should be blinking in sequence, from top to bottom then back to the top, alternating between red and green.
7. Move the controller mode switch to RUN (to the left).
8. Move the controller mode switch to TERM (to the center).
9. Move the controller mode switch to RUN (to the left).
10. Move the controller mode switch to TERM (to the center).
11. Move the controller mode switch to STOP (to the right).
12. Move the controller mode switch to TERM (to the center) - the LEFT bank of 3 LEDs should now be ON.

***NOTE:** If you want to terminate the reset at this point you can do so by moving switch to RUN instead of STOP or powering down the controller.*

- Move the controller mode switch to STOP (to the right) - the RIGHT bank of 3 LEDs should now be ON.

***NOTE:** If you want to terminate the manual reset at this point you can only do so by powering down the controller.*

1. Move the controller mode switch to TERM (to the center) - the LEFT bank LEDs begin flashing the power up sequence, and the ROM led should briefly be ON indicating that the data in the ROM is being rewritten. The LEDs will then begin flashing the 'staying in boot loader' sequence indicating the reset is complete.
2. Power down the controller.
3. Remove the controller from the base and return the DIP switches to their original positions.
4. Set the controller mode switch to TERM (in the center location).

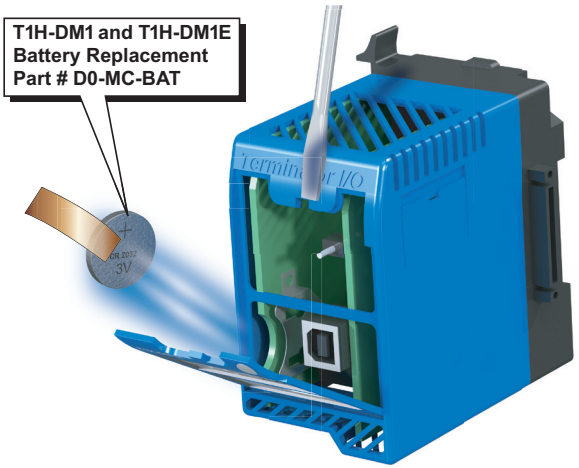
Battery Replacement

All Do-more controllers have an onboard battery that maintains the contents of the retentive memory any time the power to the controller is lost. The battery has an expected lifespan of three years; after which the battery will need to be replaced. The battery is a standard CR2032, coin cell battery. AutomationDirect part number: D0-MC-BAT.

When the controller detects that the battery voltage is too low, and needs to be replaced, the ERR LED will be YELLOW. When Do-more Designer is online with the controller, the system-defined location $BatteryLow will be ON as well.

NOTE: *Make sure to have a current copy of the Do-more Designer project saved to Disk before performing this operation.*

1. Power down the system containing the controller.
2. Remove the controller from the system.
3. Pry open the front cover and remove the battery from it's holder that is located in the lower left corner. The battery is removed by pushing on the back of the battery to begin sliding it out of the holder, then pulling it the rest of the way out by the front edge of the battery. Make note of how the battery is aligned in the holder.



NOTE: *The controller has an onboard capacitor that will maintain the retentive memory contents while the battery is being replaced. This capacitor has a two-hour runtime (minimum), which should be more than enough to replace the battery.*

1. Insert the new battery into the holder, making sure the alignment is correct, and close the cover.
2. Reinstall the controller in the system.
3. Power up the system containing the controller.
4. Verify that the ERR LED is not YELLOW and the system-defined location $BatteryLow will be OFF.

Specifications - Terminal Bases and Power Supplies

In This Chapter:

T1K-08B(-1) I/O Terminal 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 stranded conductors before inserting into gate.

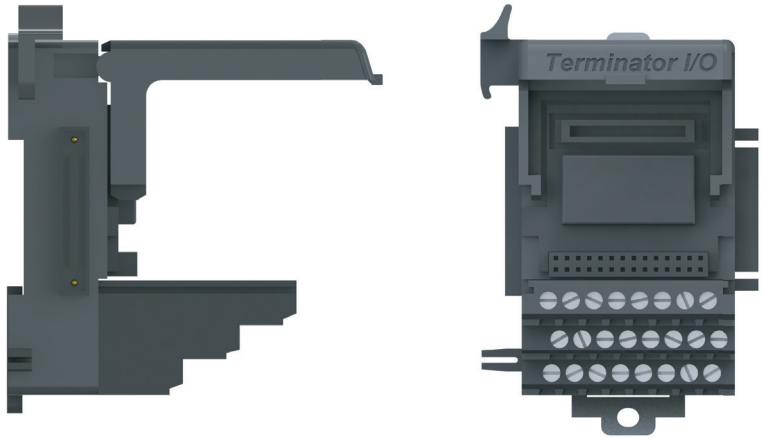
T1K-16B(-1) I/O Terminal Base

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

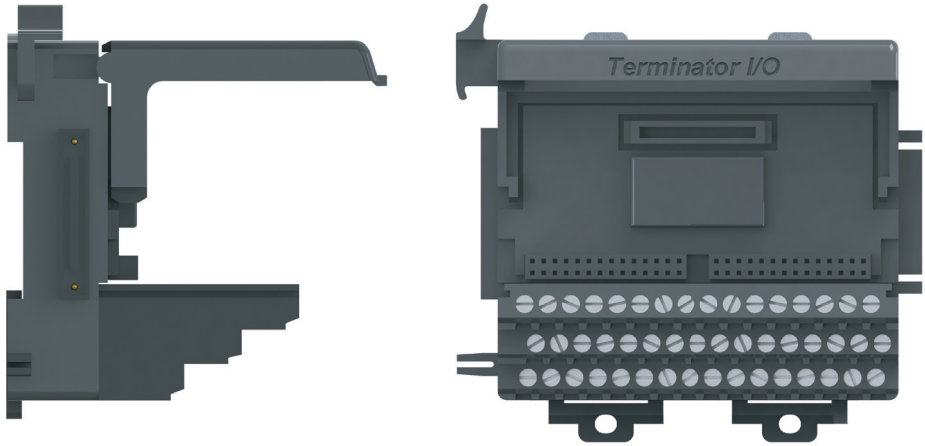
*Twist conductors before inserting into gate.

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 1ms, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)
Agency Approvals	UL E185989, CE, FCC class A

T1K-08B, T1K-08B-1



T1K-16B, T1K-16B-1

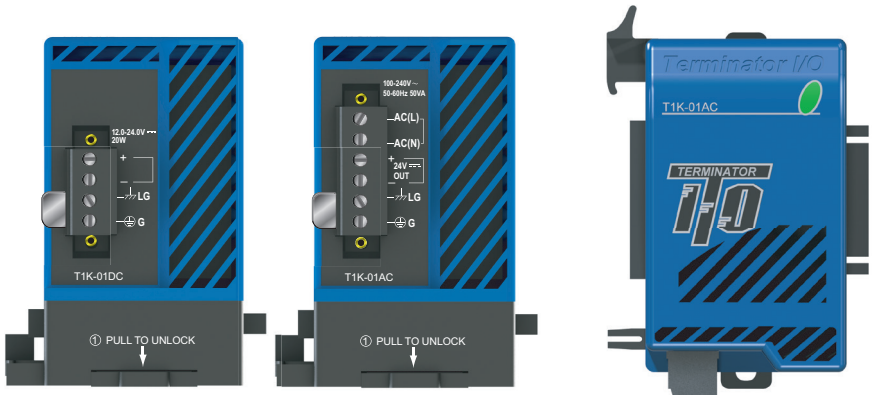


T1K-01AC, T1K-01DC Power Supply

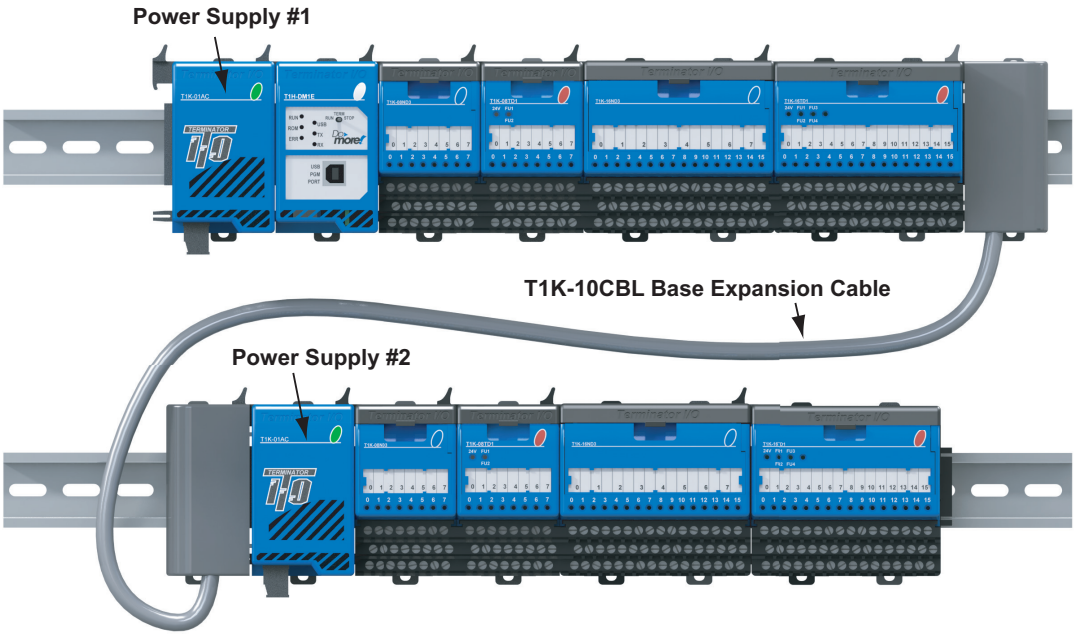
Specifications			
Specification		**T1K-01AC**	**T1K-01DC**
Input Voltage Range		110/220 VAC (85–264 VAC)	12/24 VDC (10.8–26.4 VDC)
Input Frequency		50/60 Hz (47–63 Hz)	-
Maximum Power		50VA	20W
Maximum Inrush Current		20A	10A
Insulation Resistance		>10MΩ@ 500VDC	
Voltage Withstand (Dielectric)		1 min. @ 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° to 131°F (0°C to 55°)
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 1ms, 1000V FCC class A RFI (144MHz, 430MHz 10W, 10cm)



T1K-01DC **T1K-01AC**



Note: Use the T1K–01AC 24VDC auxiliary supply or an external user supply for modules that require an external 24VDC.

Important Power Budget Note: For each power supply in a system make sure the current required by the CPU and I/O modules does not exceed the current supplied at both 5VDC and 24VDC (if using the 24VDC auxiliary supply).

Calculating the Power Budget

Managing the Power Resource

When determining the types and quantity of I/O modules to be used in the Do-more T1H Series PLC 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 .

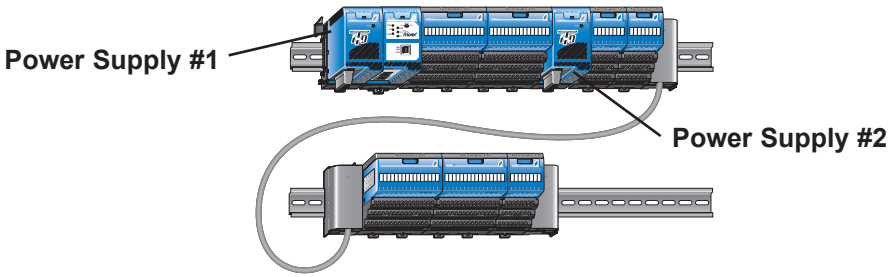
WARNING: It is extremely important to calculate the power budget correctly. If you exceed the power budget, the system may operate in an unpredictable manner which may result in a risk of personal injury or equipment damage.

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	-
T1K-01AC (see Note)	1500	500			

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



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: *Power Supply #1 powers the CPU module and the two I/O modules to its right. Power Supply #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 Do-more T1H PLC 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.

Terminator Module Power Consumption					
Module	***5VDC (mA)***	***24VDC (mA)***	***Module***	***5VDC (mA)***	***24VDC (mA)***
CPU Modules			***Analog Input Modules***		
T1H-DM1	250	0	T1F-08AD-1	75	50 (see note 1)
T1H-DM1E	275	0	T1F-16AD-1	75	50 (see note 1)
DC Input Modules			T1F-08AD-2	75	50 (see note 1)
T1K-08ND3	35	0	T1F-16AD-2	75	50 (see note 1)
T1K-16ND3	70	0	T1F-16RTD	150	0
-	-	-	T1F-16TMST	150	0
AC Input Modules			T1F-14THM	60	70 (see note 1)
T1K-08NA-1	35	0	***Analog Output Modules***		
T1K-16NA-1	70	0	T1F-08DA-1	75	150 (see note 1)
DC Output Modules			T1F-16DA-1	75	150 (see note 1)
T1K-08TD1	100	200 (see note 1)			
T1K-08TD2-1	100	0	T1F-08DA-2	75	150 (see note 1)
T1H-08TDS	200	0			
T1K-16TD1	200	400 (see note 1)	T1F-16DA-2	75	150 (see note 1)
T1K-16TD2-1	200	0			
AC Output Modules			***Combination Analog Modules***		
T1K-08TA	250	0	T1F-8AD4DA-1	75	60 (see note 1 and 2)
T1K-16TA	450	0			
T1K-08TAS	300	0	T1F-8AD4DA-2	75	70 (see note 1)
Relay Output Modules					
T1K-08TR	350	0	***Specialty Module and other devices***		
T1K-16TR	700	0	T1H- CTRIO	400	0
T1K-08TRS	400	0			

Note 1: Use T1K-01AC 24VDC auxiliary supply or external user supply.

Note 2: 60mA plus 20mA per output loop.

NOTE: Important Power Budget - *For each power supply in a system, make sure the current required by the CPU module 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 a Do-more T1H Series PLC system.

PLC			
Power Supply #1	***Part Number***	***5VDC (mA) Required***	***24VDC (mA) Required***
Power Supplied T1K-01AC		**2000**	**300**
CPU	T1H-DM1E	275	0
Module	T1K-16NA-1	70	0
Module	T1K-16TA	450	0
Maximum power required		**795**	**0**
Remaining power available		**2000-795 = 1205**	**300-0 = 300**
Power Supply #2	***Part Number***	***5VDC (mA) Required***	***24VDC (mA) Required***
Power Supplied T1K-01AC		**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
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 if the 24VDC current requirement exceeds the T1K-01AC 24VDC auxiliary supply.

1. Fill in the information for the CPU, 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 CPU 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 configuration.

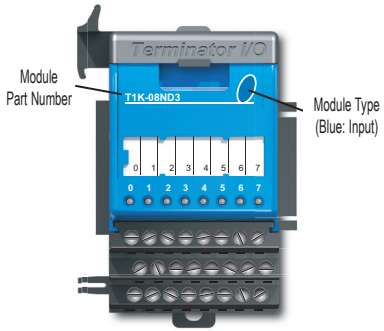
SPECIFICATIONS - DISCRETE I/O MODULES

In This Chapter:

Discrete I/O Modules Overview

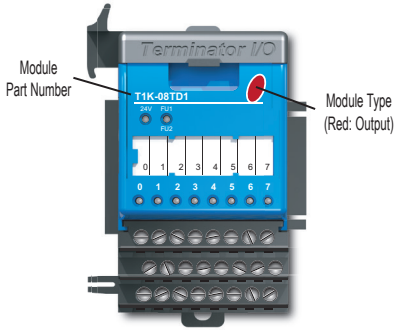
There are 15 discrete I/O modules available. The specifications and wiring diagrams for these modules are found in this chapter. Each discrete I/O module is identified as an "Input" or "Output" module using the color coding scheme shown below. A blue dot on the front panel signifies an Input module and a red dot signifies an Output module.

Discrete Input Modules



Discrete Input Modules			
Part Number	Number of Inputs	Description	See Page
T1K-08ND3	8	Sinking/Sourcing DC Input	5-4
T1K-16ND3	16	Sinking/Sourcing DC Input	5-6
T1K-08NA-1	8	AC Input	5-8
T1K-16NA-1	16	AC Input	5-9

Discrete Output Modules

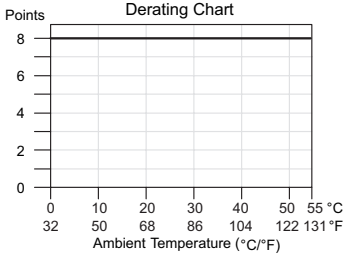


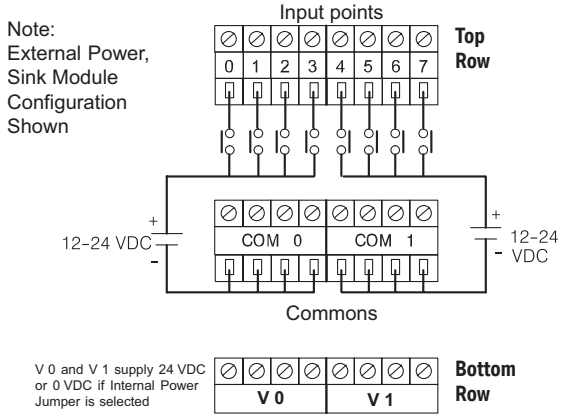
Discrete Output Modules			
Part Number	Number of Outputs	Description	See Page
T1K-08TD1	8	Sinking DC Output	5-10
T1K-16TD1	16	Sinking DC Output	5-11
T1K-08TD2-1	8	Sourcing DC Output	5-12
T1K-16TD2-1	16	Sourcing DC Output	5-13
T1H-08TDS	8	Isolated Sinking/Sourcing DC Output	5-14
T1K-08TA	8	AC Output	5-15
T1K-16TA	16	AC Output	5-16
T1K-08TAS	8	Isolated AC Output	5-17
T1K-08TR	8	Relay Output	5-18
T1K-16TR	16	Relay Output	5-19
T1K-08TRS	8	Isolated Relay Output	5-20

WARNING: The T1H Series PLC does not support any Hot-Swap features.

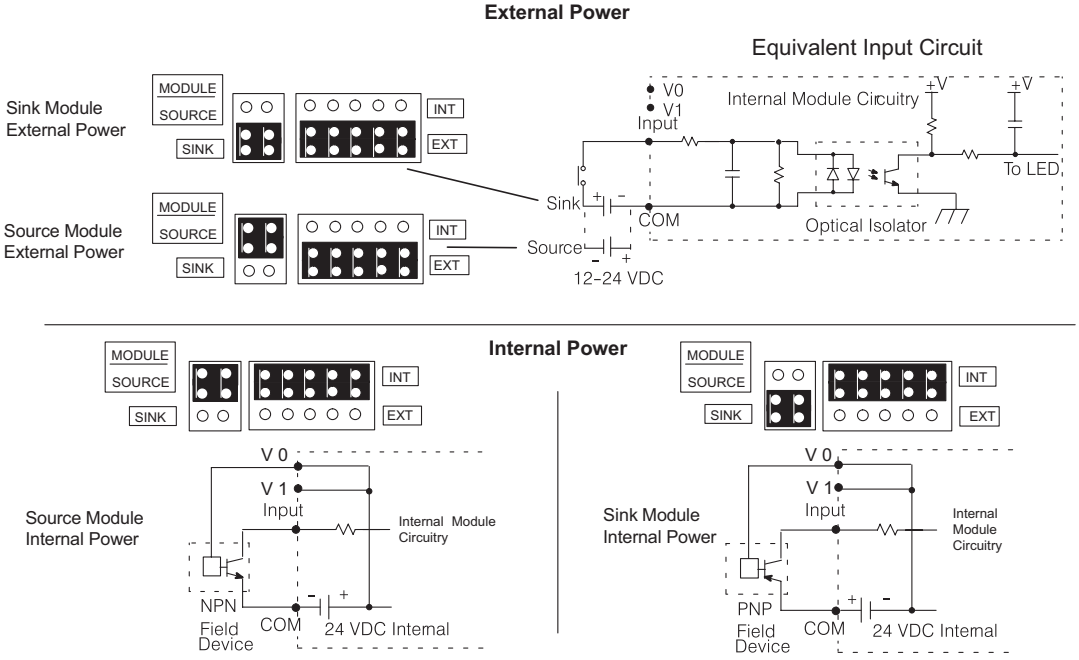
T1K-08ND3 - DC Input

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, 8.5 mA @ 24VDC
Input Impedance	2.8 kΩ
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	35mA @ 5VDC
Status Indicators	Logic Side
Weight	70g



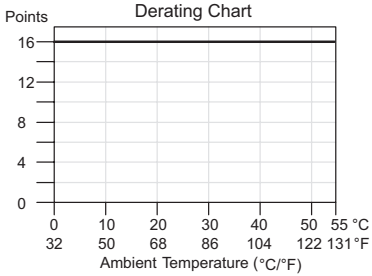


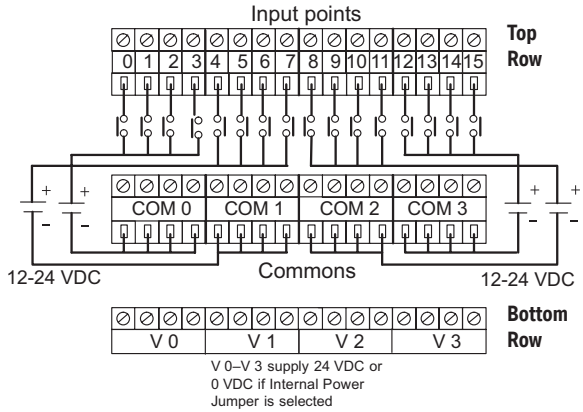
Jumper Selection



T1K-16ND3 - DC Input

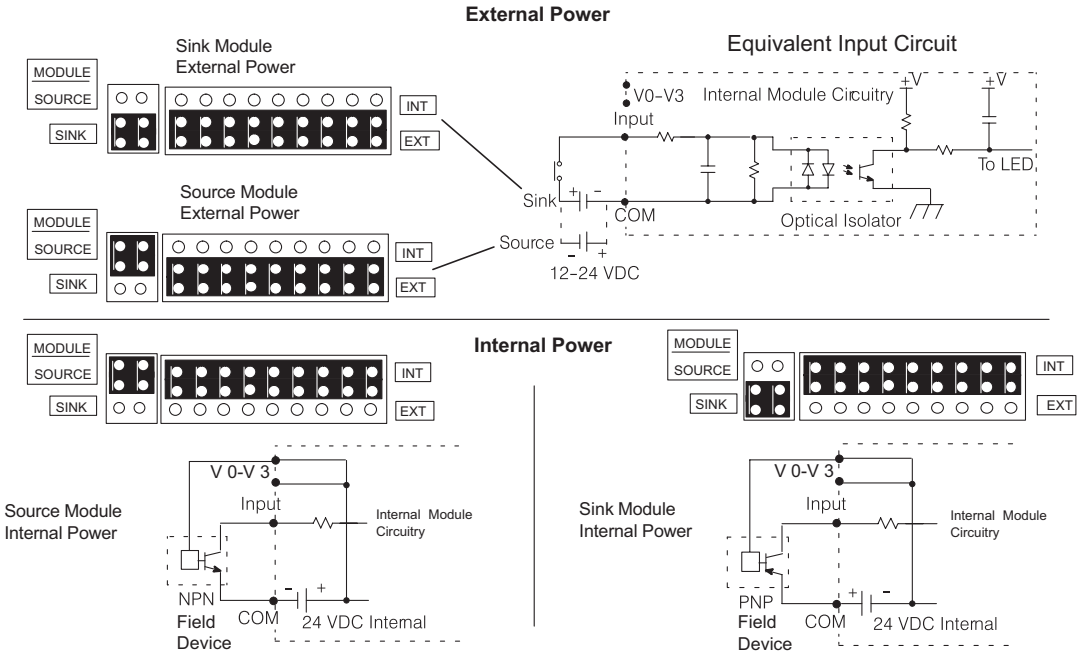
Specifications	
Inputs Per Module	16 (sink / source)
Commons Per Module	Ext. power: 4, isolated (4 pts. / com.) Int. power: 4, all 16 pts. internally connected
Operating Voltage	12–24 VDC
Input Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	30VDC
Input Current (Typical)	4mA @ 12VDC, 8.5 mA @ 24VDC
Input Impedance	2.8 kΩ
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





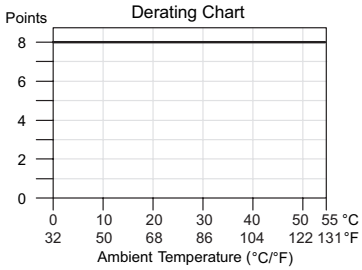
NOTE: *When using external power, the module can be wired to either sink current or source current regardless of the module's sink/source jumper position. When using internal power, the sink/source jumpers determine the module's configuration."*

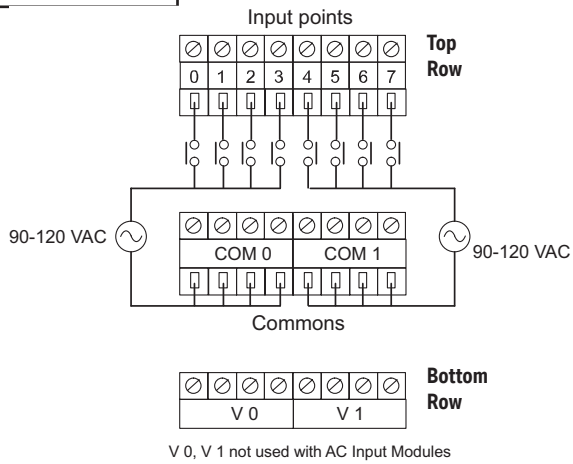
Jumper Selection



T1K-08NA-1 - AC Input

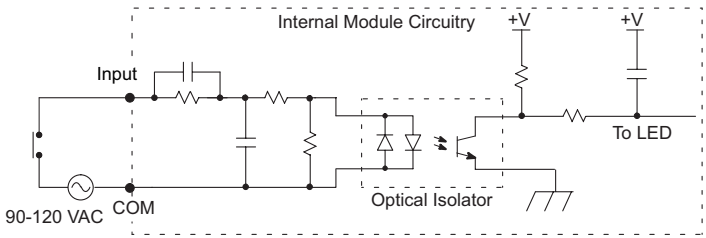
Specifications	
Inputs Per Module	8
Commons Per Module	2, 4 pts. / com. (Isolated)
Operating Voltage	90–120 VAC, 47–63 Hz
Input Voltage Range	80–132 VAC, 47–63 Hz min. / max.
Input Current	8mA @ 100VAC (50Hz) 10mA @ 100VAC (60Hz) 12mA @ 132VAC (50Hz) 15mA @ 132VAC (60Hz)
Input Impedance	14kΩ @ 50Hz, 12kΩ @ 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





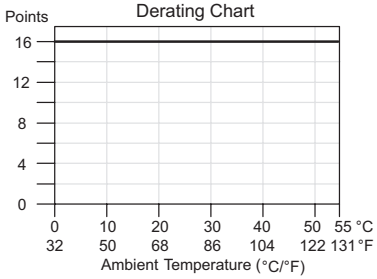
V 0, V 1 not used with AC Input Modules

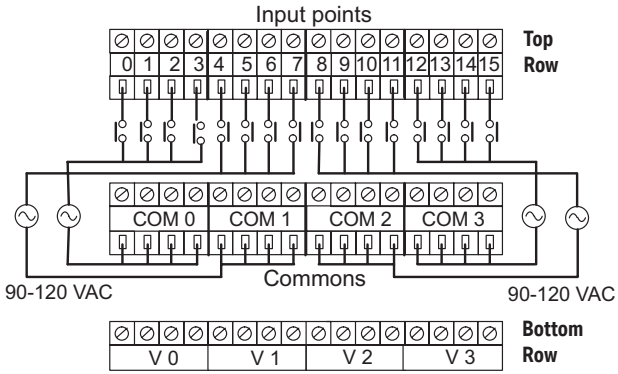
Equivalent Input Circuit



T1K-16NA-1 - AC Input

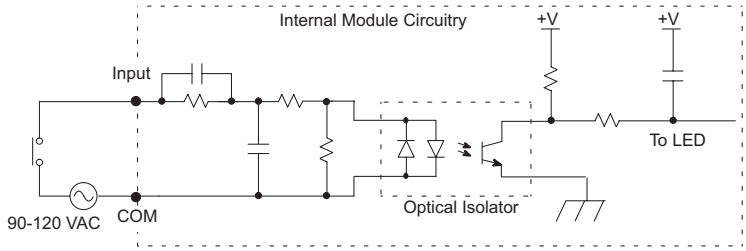
Specifications	
Inputs Per Module	16
Commons Per Module	4, 4 pts. / com. (Isolated)
Operating Voltage	90–120 VAC, 47–63 Hz
Input Voltage Range	80–132 VAC, 47–63 Hz min. / max.
Input Current	8mA @ 100VAC (50Hz) 10mA @ 100VAC (60Hz) 12mA @ 132VAC (50Hz) 15mA @ 132VAC (60Hz)
Input Impedance	14kΩ @ 50Hz, 12kΩ @ 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





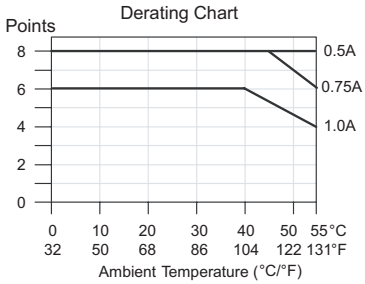
V 0–V 3 not used with AC Input Modules

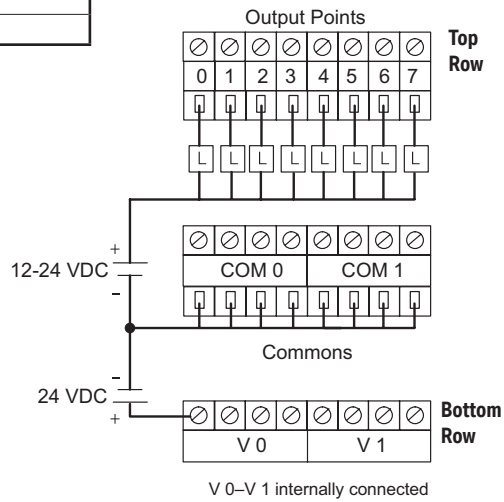
Equivalent Input Circuit



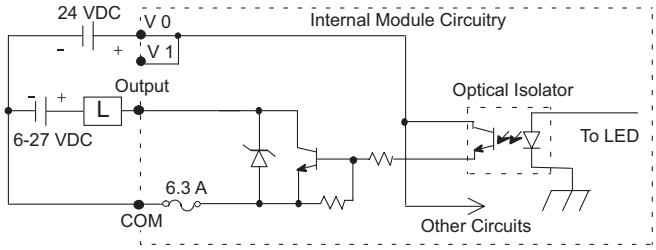
T1K-08TD1 - DC Output

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	15µA @ 30VDC
ON Voltage Drop	0.3 VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10µs
ON to OFF Response	< 60µs
Base Power Requirements	100mA @ 5VDC
External Power Required	200mA max. @ 20–28 VDC
Status Indicators	Logic Side
Error Status Indicators (LEDs)	24V 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



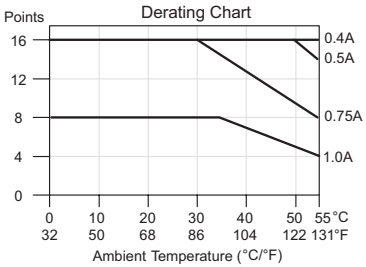


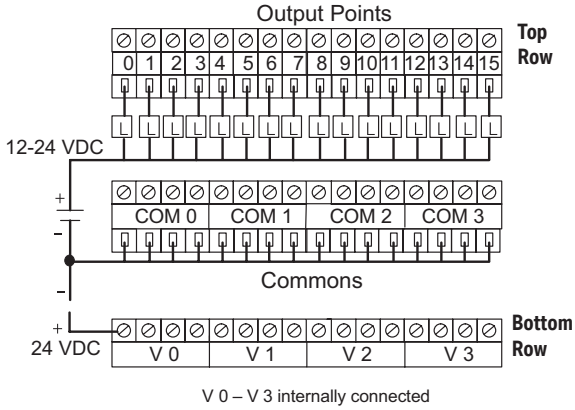
Equivalent Output Circuit

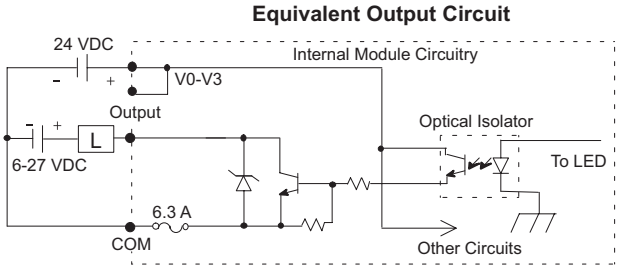


T1K-16TD1 - DC Output

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	15µA @ 30VDC
ON Voltage Drop	0.3 VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10µs
ON to OFF Response	< 60µs
Base Power Requirements	200mA @ 5VDC
External Power Required	400mA max. @ 20–28 VDC
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) T1K-FUSE-1	4, (6.3 A, 250V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	140g

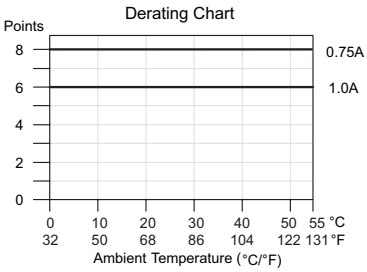


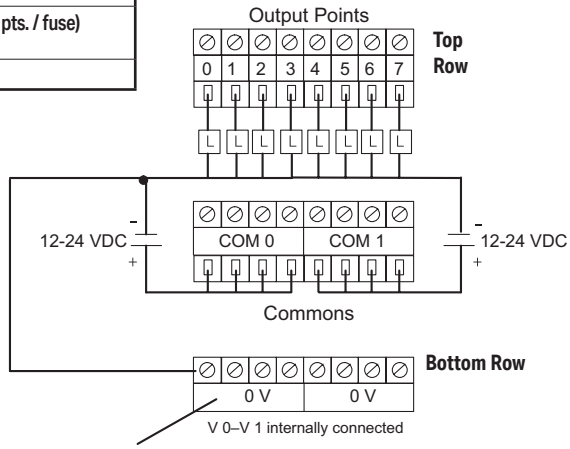




T1K-08TD2-1 - DC Output

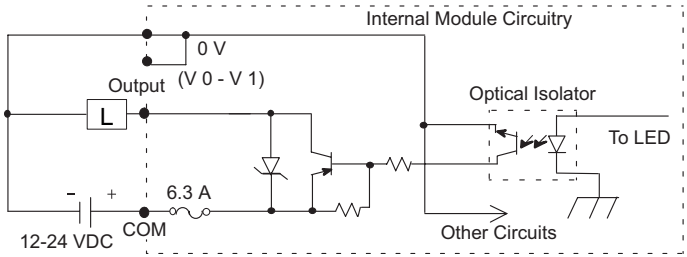
Specifications	
Outputs Per Module	8 (source)
Commons Per Module	2 internally connected
Operating Voltage Range	12–24 VDC
Output Voltage Range	10.8 - 26.4 VDC min. / max.
Peak Voltage	50VDC
Max. Load Current	1A / pt., 4A / common
Max. Leakage Current	15µA @ 26.4 VDC
ON Voltage Drop	1.2 VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	< 10µs
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) T1K-FUSE-1	2, (6.3 A, 250V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	100g





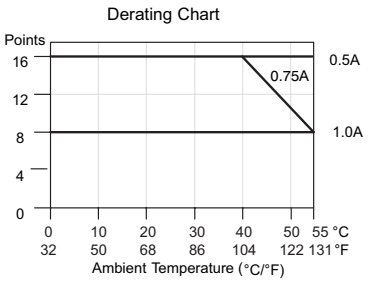
Note: Apply the 0 V label that comes with the I/O module to I/O base terminal points V 0–V 1 to properly identify the 0 VDC terminal points.

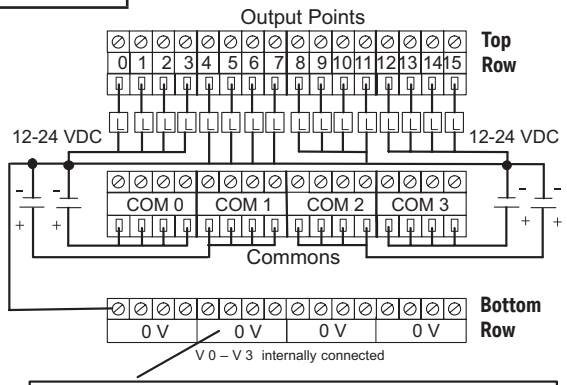
Equivalent Output Circuit



T1K-16TD2-1 - DC Output

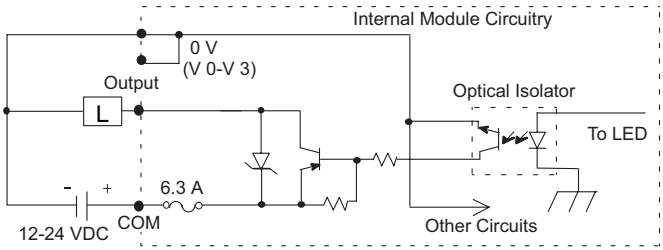
Specifications	
Outputs Per Module	16 (source)
Commons Per Module	4 internally connected
Operating Voltage Range	12–24 VDC
Output Voltage Range	10.8–26.4 VDC min. / max.
Peak Voltage	50VDC
Max. Load Current	1A / pt., 4A / common (Subject to derating)
Max. Leakage Current	15µA @ 26.4 VDC
ON Voltage Drop	1.2 VDC @ 1.0 A
Max. Inrush Current	2A for 100ms
OFF to ON Response	<10µs
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, 250 V / common), (4 pts. / fuse) NQ3 - 6.3 SOC corp.
Weight	140g





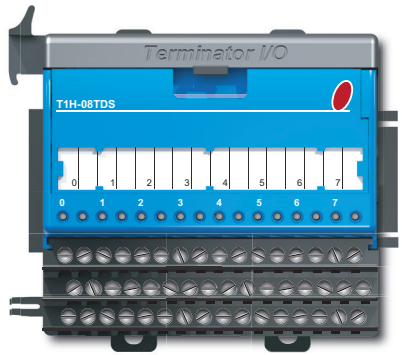
Note: Apply the 0 V label that comes with the I / O module to I / O base terminal points V 0–V 3 to properly identify the 0 VDC terminal points.

Equivalent Output Circuit



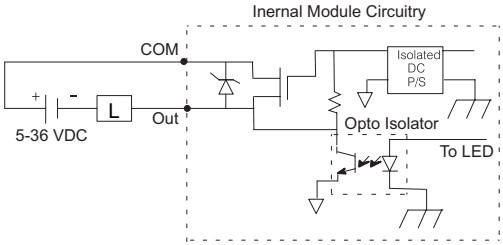
T1H-08TDS - Isolated DC Output

Specifications	
Outputs Per Module	8 (sink / source)
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	75µA
Max. ON State Voltage Drop	0.3 VDC @ 2.0 A, 0.15 V @ 1A
Inrush Current	5A for 20ms
OFF to ON Response	< 3µs
ON to OFF Response	< 100µs
Base Power Requirements	200mA max.
Thermal Shutdown	Between T-junction = 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

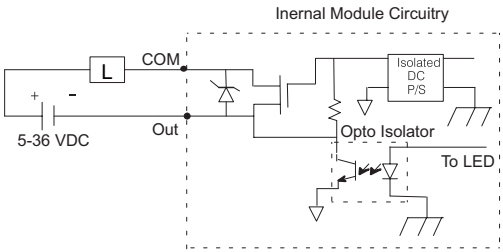


Equivalent Output Circuit

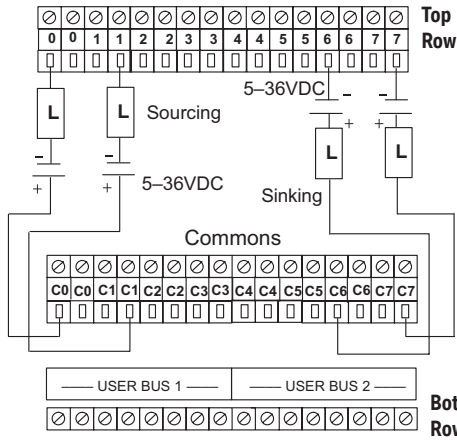
Sourcing (High Side Switching)



Sinking (Low Side Switching)



Output Points

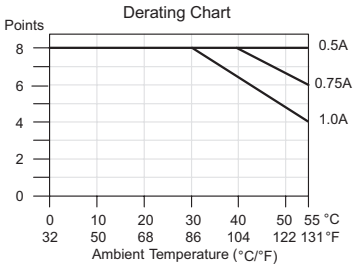


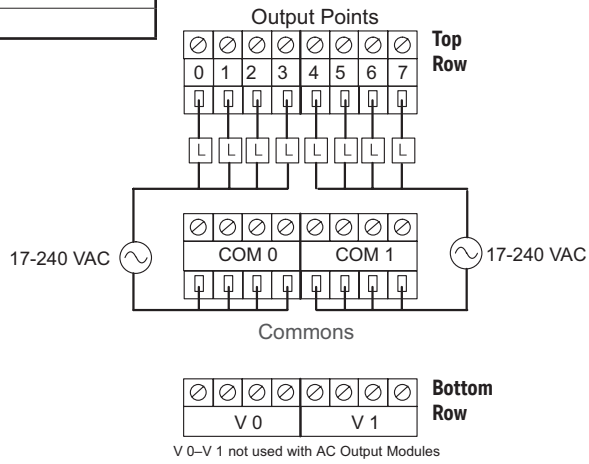
No connection: The 8 User Bus 1 terminals are bussed together. The 8 User Bus 2 terminals are also bussed together.

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

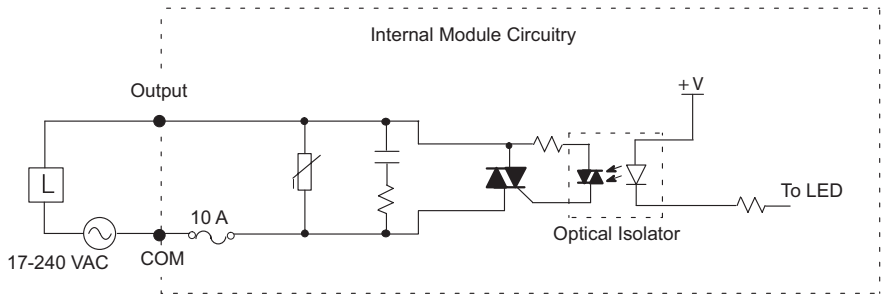
T1K-08TA - AC Output

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 @ 5 VDC
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 20 mm type
Weight	140g



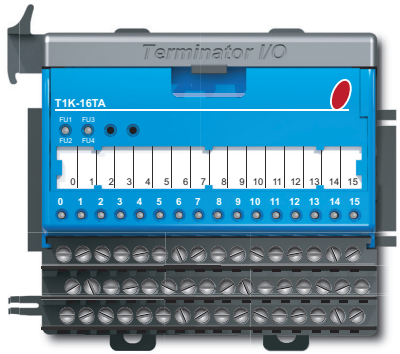


Equivalent Output Circuit

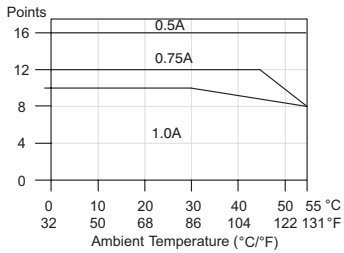


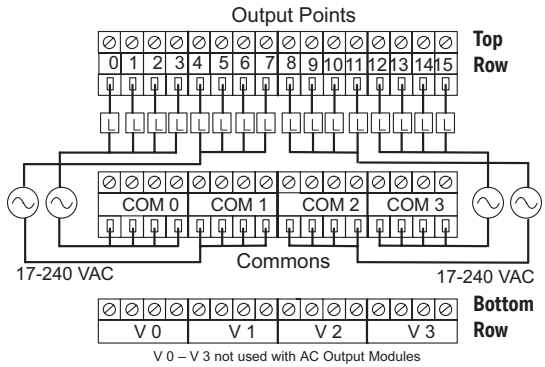
T1K-16TA - AC Output

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) T1K-FUSE-2	4, (10A, 250V / common), (4 pts. / fuse) 5 x 20 mm type
Weight	190g

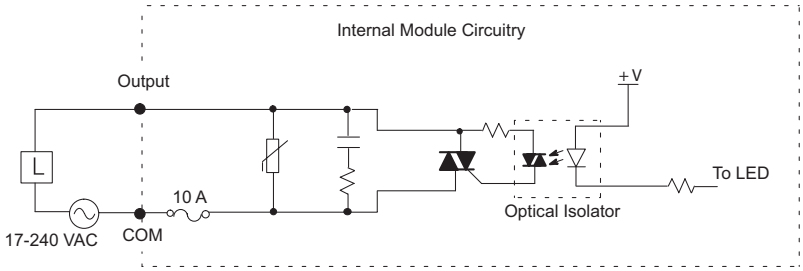


Derating Chart





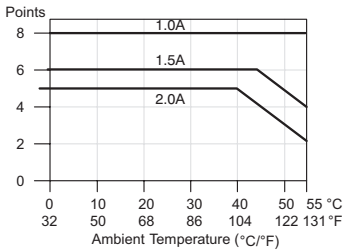
Equivalent Output Circuit

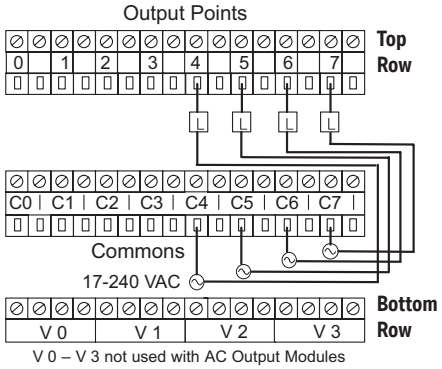


T1K-08TAS - Isolated AC Output

Specifications	
Outputs Per Module	8
Commons Per Module	8, 1 pt. / 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	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), (1 pt. / fuse) NQ3-10 SOC Corp.
Weight	190g

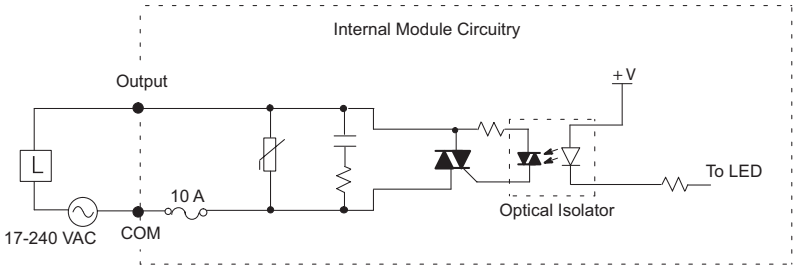
Derating Chart





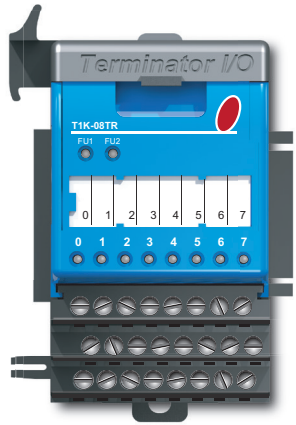
Note: Apply the labels that come with the I/O module to the I/O base to properly identify the terminal points.

Equivalent Output Circuit

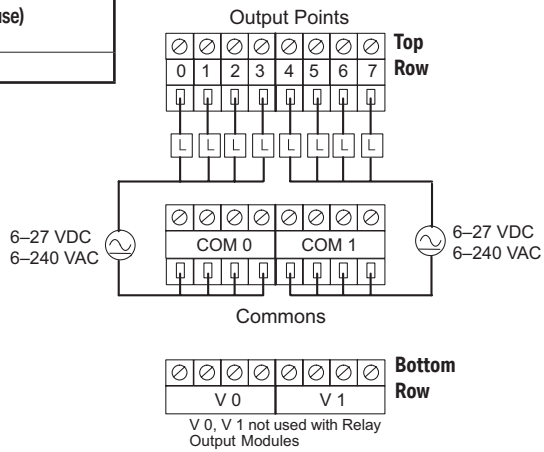


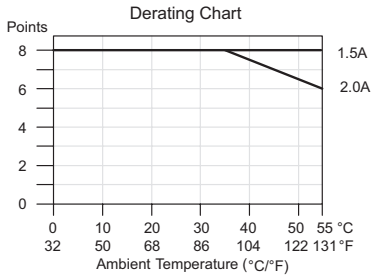
T1K-08TR - Relay Output

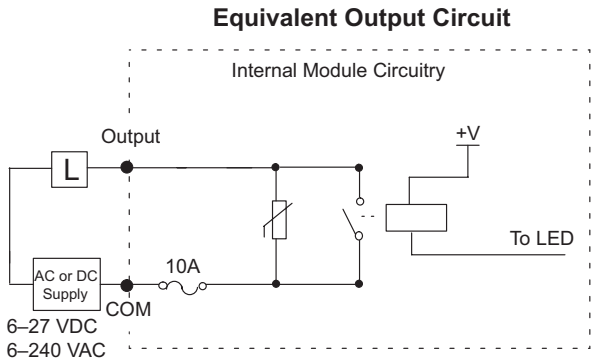
Specifications	
Outputs Per Module	8
Output Type	Relay Form A (SPST) normally open
Commons Per Module	2, 4 pts. / common (Isolated)
Operating Voltage Range	6–240 VAC (47–63 Hz), 6–27 VDC
Output Voltage Range	5–264 VAC (47–63 Hz) min. / max. 5–30 VDC min / max
Max. Load Current	2A / pt., 8A / common
Max. Leakage Current	0.1 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	350mA @ 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 20 mm type
Weight	110g



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



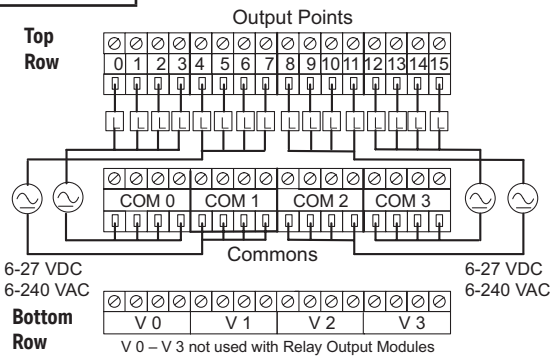




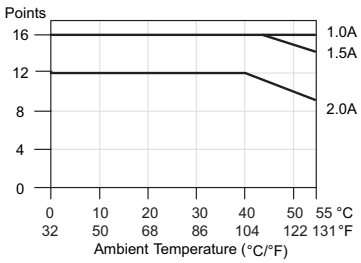
T1K-16TR - Relay Output

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 20 mm type
Weight	200g

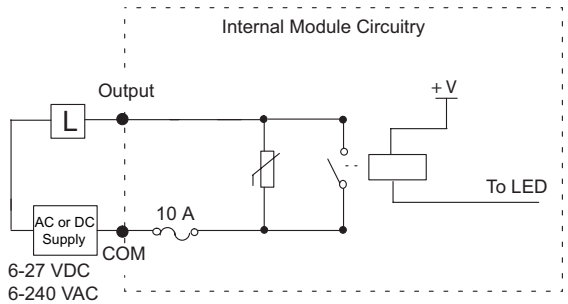
Typical Relay Life (Operations) at Room Temperature		
Voltage & Type of Load	Load Current	
	1 A	2 A
24VDC Resistive	500K	250K
24VDC Solenoid	100K	50K
110VAC Resistive	500K	250K
110VAC Resistive	200K	100K
220VAC Resistive	350K	200K
220VAC Resistive	100K	50K



Derating Chart

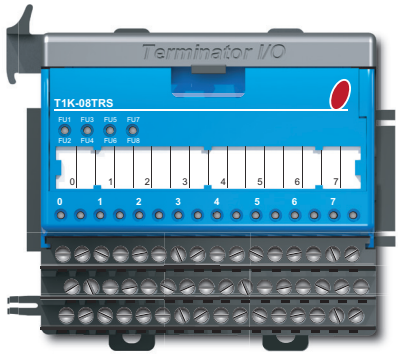


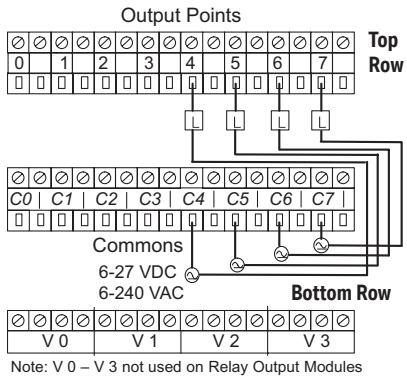
Equivalent Output Circuit



T1K-08TRS - Isolated 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 fuse 2 blown FU3 / FU4 ON = fuse 3 or fuse 4 blown FU5 / FU6 ON = fuse 5 or fuse 6 blown FU7 / FU8 ON = fuse 7 or fuse 8 blown
Fuses (User Replaceable) T1K-FUSE-3	8 (10A, 250V / common), (1 pt. / fuse) NQ3-10 SOC Corp.
Weight	185g

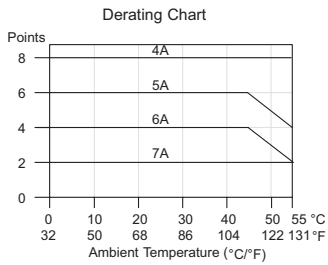




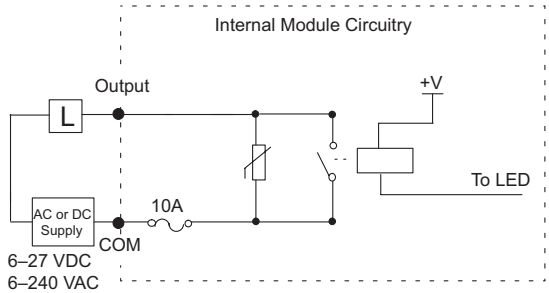
Note: Apply the labels that come with the I/O module to the I / O base to properly identify the terminal points.

Typical Relay Life (Operations) at Room Temperature				
Voltage & Type of Load	Load Current			
	1 A	2 A	5 A	7 A
24VDC Resistive	1000K	500K	200K	100K
24VDC Solenoid	300K	100K	*	*
110VAC Resistive	1000K	500K	200K	100K
110VAC Resistive	300K	100K	*	*
220VAC Resistive	500K	250K	125K	60K
220VAC Resistive	300K	100K	*	*

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



Equivalent Output Circuit



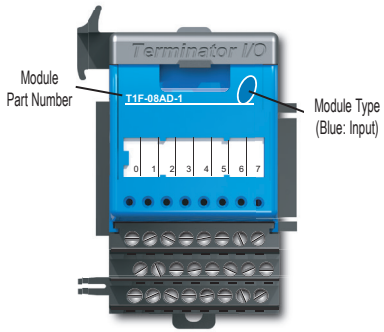
SPECIFICATIONS - ANALOG I/O MODULES

In This Chapter:

Analog I/O Modules Overview

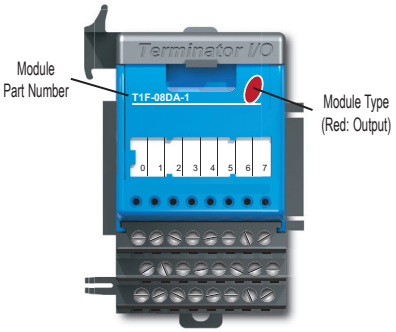
There are 13 analog I/O modules available. The specifications and wiring diagrams for these modules are found in this chapter. Each analog I/O module is identified as an "Input", "Output" or "Input/Output" module using the color coding scheme shown below. A blue dot on the front panel signifies an Input module, a red dot signifies an Output module and a white dot signifies an Input/Output module.

Analog Input Modules



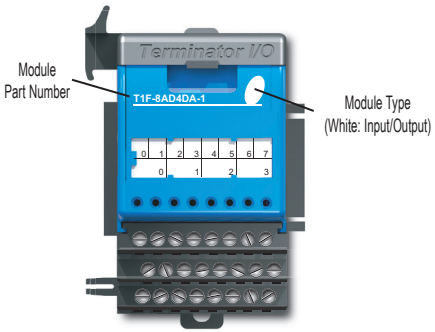
Analog Input Modules			
Part Number	Number of Channels	Description	See Page
T1F-08AD-1	8	Analog Current Input	6-6
T1F-08AD-2	8	Analog Voltage Input	6-7
T1F-16AD-1	16	Analog Current Input	6-8
T1F-16AD-2	16	Analog Voltage Input	6-9
T1F-16RTD	16	RTD	6-10
T1F-16TMST	16	Thermistor	6-12
T1F-14THM	14	Thermocouple	6-14

Analog Output Modules



Analog Output Modules			
Part Number	Number of Channels	Description	See Page
T1F-08DA-1	8	Analog Current Output	6-17
T1F-08DA-2	8	Analog Voltage Output	6-18
T1F-16DA-1	16	Analog Current Output	6-19
T1F-16DA-2	16	Analog Voltage Output	6-20

Analog Input/Output Module



Analog Input/Output Modules			
Part Number	Number of Channels	Description	See Page
T1F-8AD4DA-1	8/4	Analog Current Input/Output	6-21
T1F-8AD4DA-2	8/4	Analog Voltage Input/Output	6-23

Analog I/O Modules Overview- continued

WARNING: The T1H Series PLC does not support any Hot-Swap features.

How to Access the Analog I/O Modules

With the Do-more PLC, the WX and WY memory addresses are assigned to exchange analog data with the analog I/O modules (WX = Analog input data, WY = Analog output data). X addresses are assigned to analog input modules and Y addresses are assigned to configure analog output modules.

The following table shows how many X, Y, WX and WY addresses are assigned to each analog I/O module type.

Analog I/O Module Addressing					
Part Number	Module ID	X	WX	Y	WY
T1F-08AD-1	0x2532	8*	8	-	-
T1F-08AD-2	0x2532	8*	8	-	-
T1F-16AD-1	0x2533	16*	16	-	-
T1F-16AD-2	0x2533	16*	16	-	-
T1F-08DA-1	0x2628	-	-	8	8
T1F-08DA-2	0x2628	-	-	8	8
T1F-16DA-1	0x262C	-	-	8	16
T1F-16DA-2	0x262C	-	-	8	16
T1F-8AD4DA-1	0x2736	8*	8	8	4
T1F-8AD4DA-2	0x2736	8*	8	8	4
T1F-16RTD	0x2573	16**	16	-	-
T1F-16TMST	0x2573	16**	16	-	-
T1F-14THM (see Note 1)	0x2573	16**	16	-	-

*** X addresses assigned to this module are not used.**
**** X addresses assigned to this module indicate a broken transmitter.**

NOTE 1: *This module can be configured to operate in unipolar mode which generates a range of values from 0 to 65535 (instead of -32768 to 32767). Use the ":U"(unsigned) cast operator to get the proper representation of the data when using a module that is configured for unipolar. For example: WX0:U, WX1:U.*

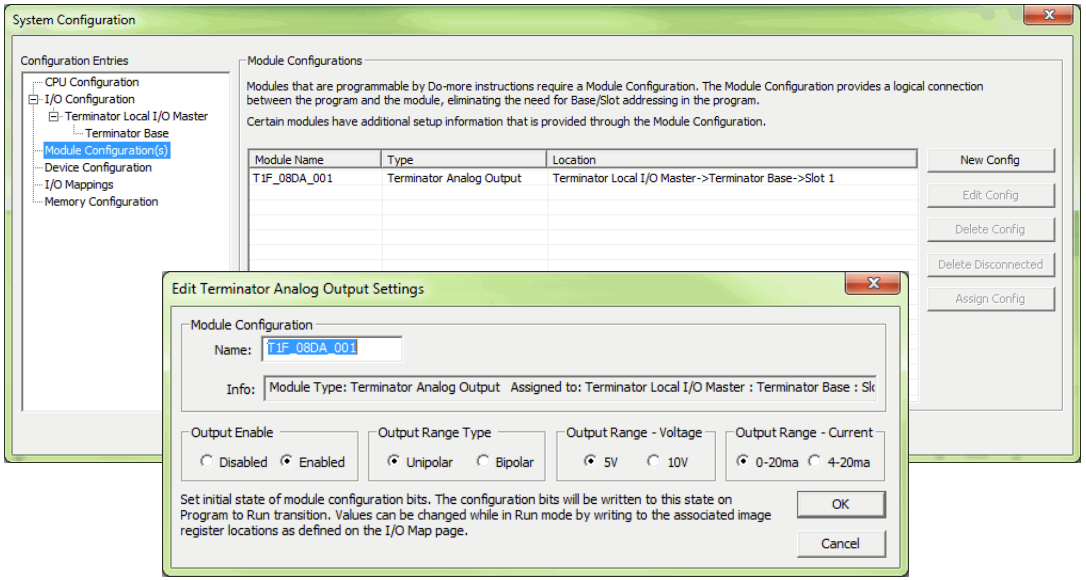
Analog I/O Modules Overview- continued

Module Control Byte

Analog output modules have a Module Control Byte that is used to configure some options for the outputs. In the module addressing, this byte shows up as eight Discrete Output (Y) Bits.

- Y0 = Outputs Enabled
- Y(0+1) = Unipolar/Bipolar
- Y(0+2) = 5V/10V Range
- Y(0+3) = 0–20mA/4–20mA
- Y((0+4) through (0+7)) = Reserved

When an analog output module is added to a Do-more project, a Module Configuration with default Module Control Byte values is created. Its settings can be changed under Module Configuration by double-clicking the Module Name or by selecting the New Config or Edit Config buttons on the right hand side.

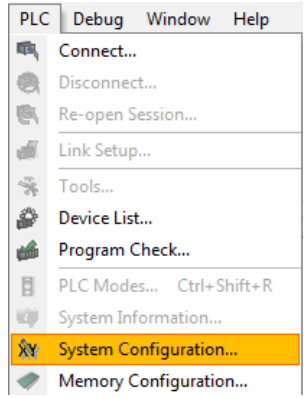


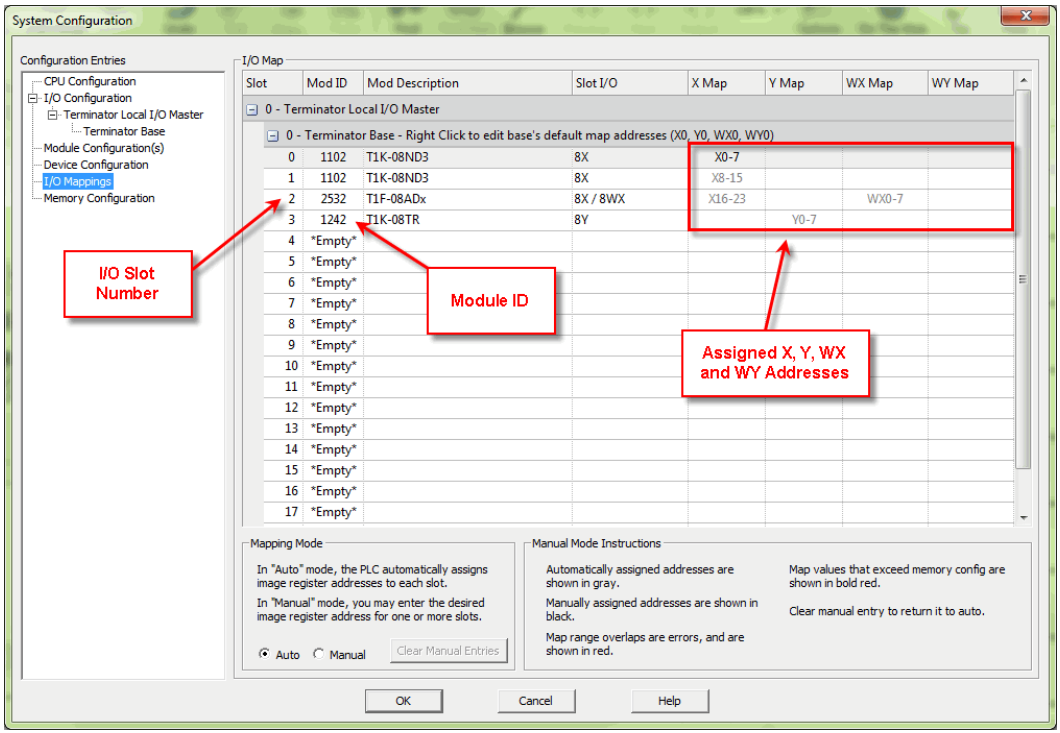
The Do-more T1H Series CPU will write the settings from the Module Configuration into the modules before going to Run mode. The Y Bits can optionally be used to change the Module Control Byte setting within the program.

Analog I/O Modules Overview- continued

You can check which X, Y, WX and WY addresses are assigned to each analog I/O module in the I/O Mapping tab of the System Configuration window, as shown below.

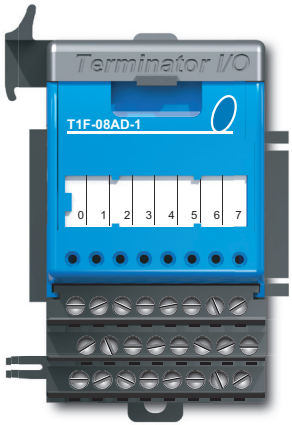
Select the pull-down menu PLC > System Configuration to open the System Configuration window and click the I/O Mapping tab.



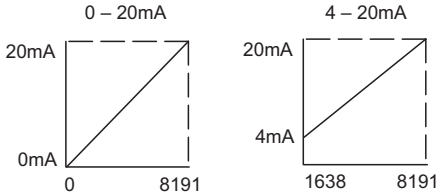


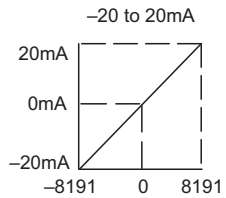
T1F-08AD-1 - 8 Channel Analog Current Input

Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0–20mA, 4–20mA, -20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Module Addressing	8 input bits (X-not used); 8 input words (WX)
Frequency Response	-3db @ 500Hz, -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
CPU Update Rate	1 channel per scan
Base Power Required	75mA @ 5VDC
External Module Power Supply Req.	18–30 VDC, 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



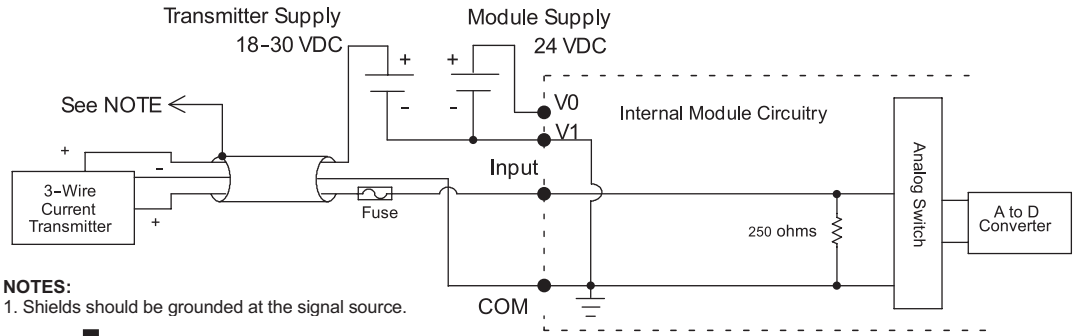
Input Range/Resolution





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

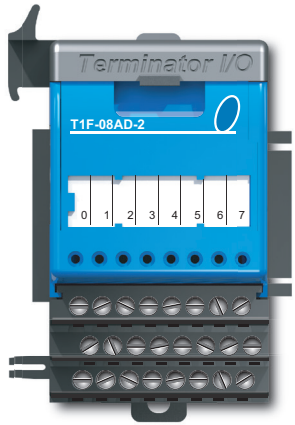
Equivalent Input Circuit



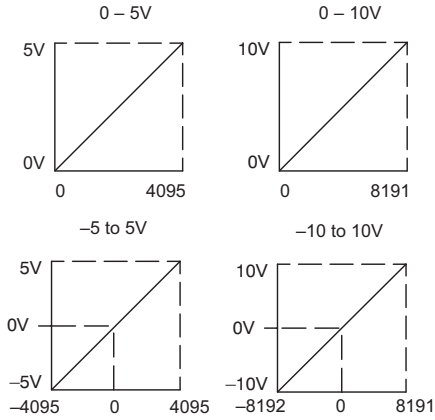
NOTES:
1. Shields should be grounded at the signal source.

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

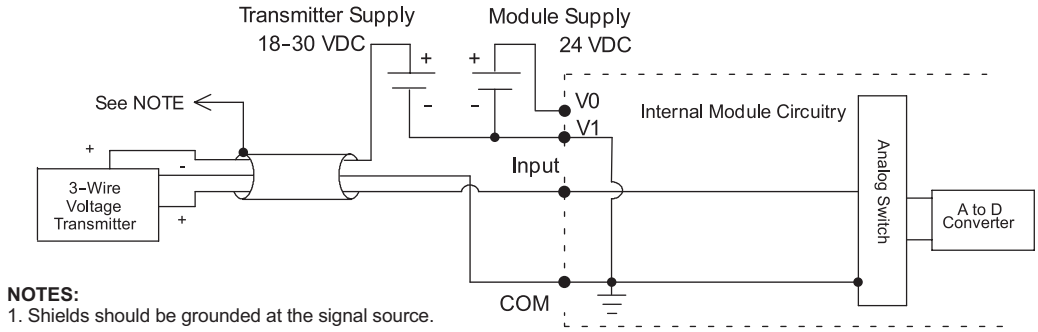
Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0–5 V, 0–10 V, ±5V, ±10V
Resolution	14 bit (13 bit plus sign bit)
Module Addressing	8 input bits (X-not used); 8 input words (WX)
Frequency Response	-3db @ 500Hz, -20db / decade
Input Resistance	200kΩ min.
Absolute Maximum Ratings	Fault Protected Input, 130V (rms)/ 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
CPU Update Rate	1 channel per scan
Base Power Required	75mA @ 5VDC
External Module Power Supply Req.	18–30 VDC, 50mA, class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	±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



Equivalent Input Circuit

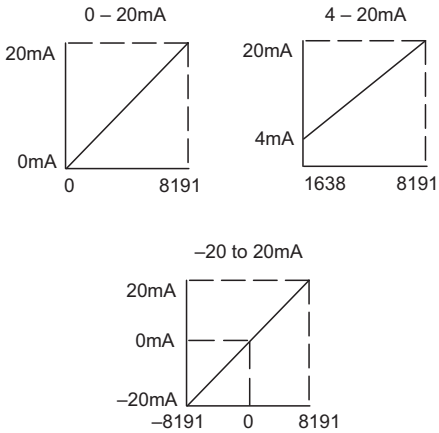


NOTES:
1. Shields should be grounded at the signal source.

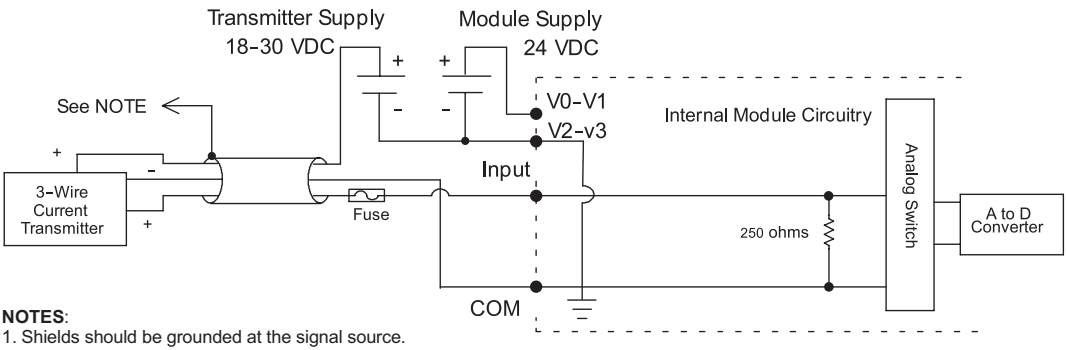
T1F-16AD-1 - 16 Channel Analog Current Input

Specifications	
Number of Channels	16, single ended (1 common)
Input Ranges	0–20mA, 4–0mA, -20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Module Addressing	16 input bits (X-not used); 16 input words (WX)
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
CPU Update Rate	1 channel per scan
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



Equivalent Input Circuit

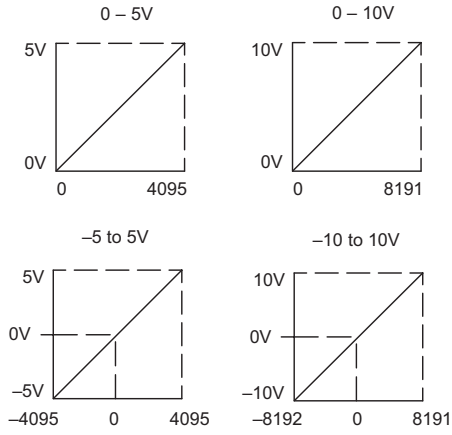


NOTES:
1. Shields should be grounded at the signal source.

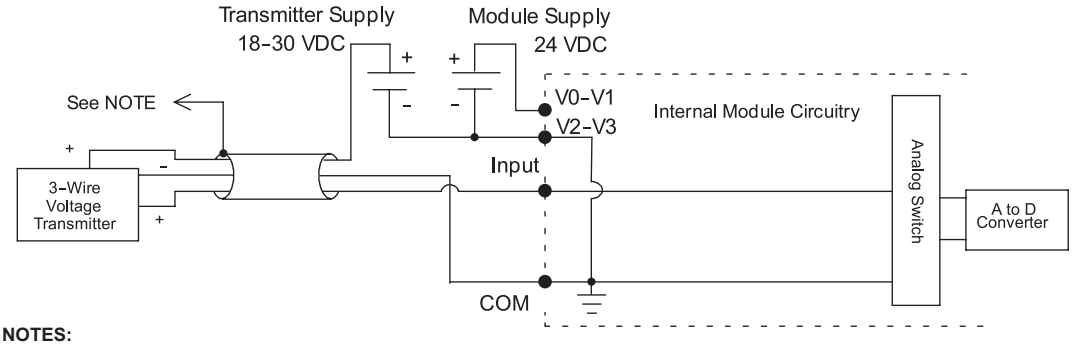
T1F-16AD-2 - 16 Channel Analog Voltage Input

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)
Module Addressing	16 input bits (X-not used); 16 input words (WX)
Frequency Response	-3db @ 500Hz, -20db / decade
Input Resistance	200kΩ min.
Absolute Maximum Ratings	Fault Protected Input, 130V (rms)/ 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
CPU Update Rate	1 channel per scan
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



Equivalent Input Circuit



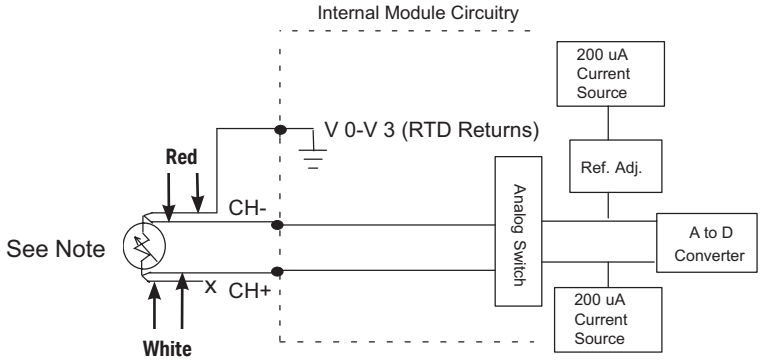
NOTES:
1. Shields should be grounded at the signal source.

T1F-16RTD - 16 Channel RTD Input

Specifications	
Number of Channels	16
Resolution	±0.1°C or °F
Module Addressing	16 input bits (X-broken transmitter); 16 input words (WX)
Common Mode Range	0–5 VDC
Notch Filter	> 50db notches @ 50/60Hz; f - 3db = 13.1 Hz
Absolute Max. Ratings	±50VDC
Converter Type	Charge balancing, 24-bit
Sampling Rate	140ms / channel
CPU Update Rate	1 channel per scan
Base Power Required	150mA @ 5VDC
Operating Temperature	0 to 60°C (32 to 140°F)
Temperature Drift	25ppm / °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 Ω	-200 to 850°C (-328 to 1562°F)
Pt1000 Ω	-200 to 595°C (-328 to 1103°F)
jPt100 Ω	-38 to 450°C (-36 to 842°F)
Type CU - 10 / 25	-200 to 260°C (-328 to 500°F)
120 Ω Nickel	-80 to 260°C (-112 to 500°F)

Equivalent Input Circuit



NOTES:

1. If an RTD sensor has four wires, the plus sense wire should be left unconnected as shown.

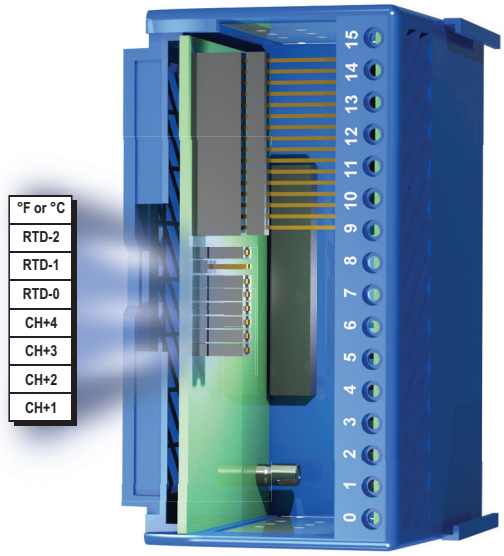
T1F-16RTD - 16 Channel RTD Input - continued

Setting Module Jumpers

Select Number of Channels

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

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

Select Temperature Units

Temperature Unit	Jumper
	°F or °C
°F	X
°C	

X = Jumper Installed
Blank Space = Jumper Removed

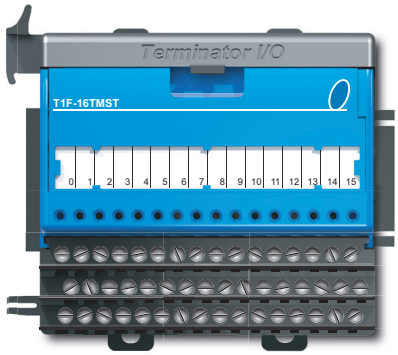
T1F-16TMST - 16 Channel Thermistor Input (Retired 07/25)

Specifications	
Number of Channels	16
Resolution	+ / - 0.1º C or ºF
Input Impedence	> 1MΩ
Common Mode Range	0 - 5 VDC
Absolute Max. Ratings	+ / - 50 VDC
Converter Type	Charge balancing, 24 - bit
Sampling Rate	140 ms / 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	150 mA @ 5 VDC
Operating Temperature	0º to 60º C (32º to 140º F)
Storage Temperature	-20º to 70º C (-4º to 158º F)
Temperature Drift	25 ppm / ºC (max.)
Maximum Inaccuracy [1]	+ / - 1ºC
Excitation Current	10 µA
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	168 g

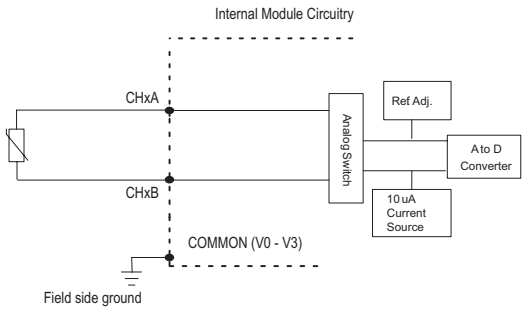
[1] "Accuracy" pertains to module only and does not include tolerances of thermistor element, wiring resistance, etc. For example, 22 gauge wire is 0.016Ω per foot, so 200 feet of wire adds 3.2Ω.

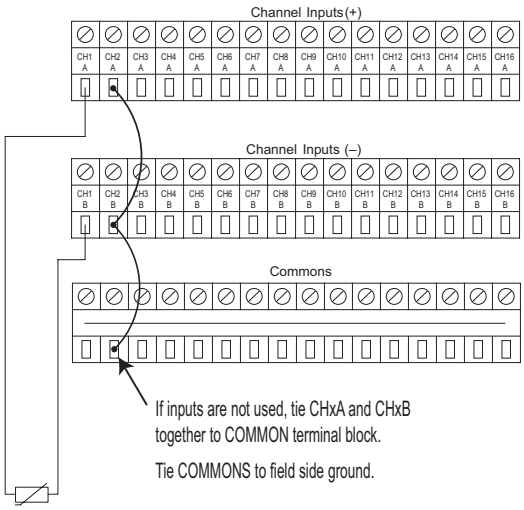
[2] Meets EMC & Safety Requirements

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



Equivalent Input Circuit





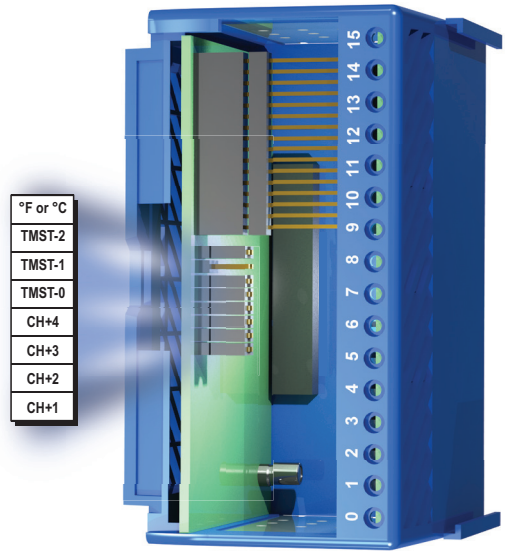
T1F-16TMST - 16 Channel Thermistor Input - continued

Setting Module Jumpers

Select Number of Channels

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

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

Select Temperature Units

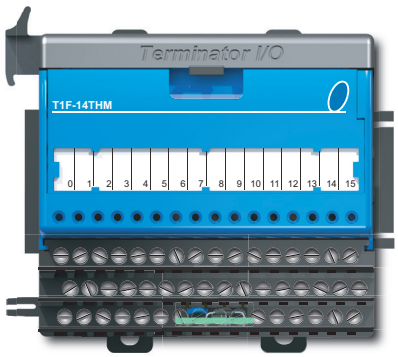
Temperature Unit	Jumper
	°F or °C
°F	X
°C	

X = Jumper Installed
Blank Space = Jumper Removed

T1F-14THM - 14 Channel Thermocouple Input

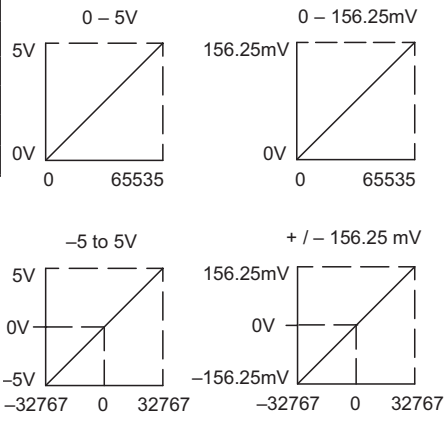
Specifications	
Use with I/O Module Base	T1K-16B screw type terminal base only
Number of Channels	14, differential
Common Mode Range	±5VDC
Module Addressing	16 input bits (X-broken transmitter); 16 input words (WX)
Common Mode Rejection	90db min. @ DC, 150db min . @ 50/60Hz
Input Impedance	1MΩ
Absolute Max. Ratings	Fault Protected Input ±50VDC
CPU Update Rate	1 channel per scan
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 to 760°C (-310 to 1400°F) Type E -210 to 1000°C (-346 to 1832°F) Type K -150 to 1372°C (-238 to 2502°F) Type R 65 to 1768°C (149 to 3214°F) Type S 65 to 1768°C (149 to 3214°F) Type T -230 to 400°C (-382 to 752°F) Type B 529 to 1820°C (984 to 3308°F) Type N -70 to 1300°C (-94 to 2372°F) Type C 65 to 2320°C (149 to 4208°F)
Display Resolution	±0.1°C or ±0.1°F
Cold Junction Compensation	Automatic (CJC Part #: T1F-CJC)
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

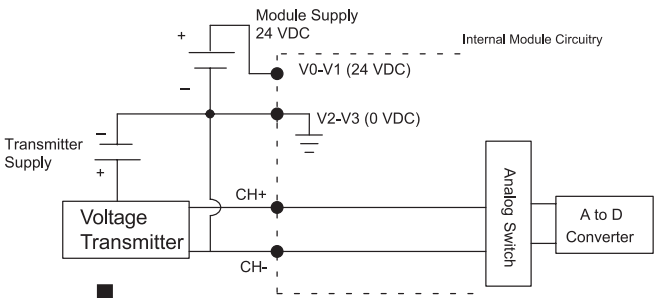


Voltage Specifications	
Input Voltage Ranges	0–5 V, 0–156.25 mV ±5V, ±156.25 mV
Resolution	16 bit (1 in 65535)
Full Scale Calibration Error (Offset Error Included)	±13 counts typical ±33 counts maximum
Offset Calibration Error	±1 count max. @ 0V input
Linearity Error (End to End)	±1 count maximum
Maximum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

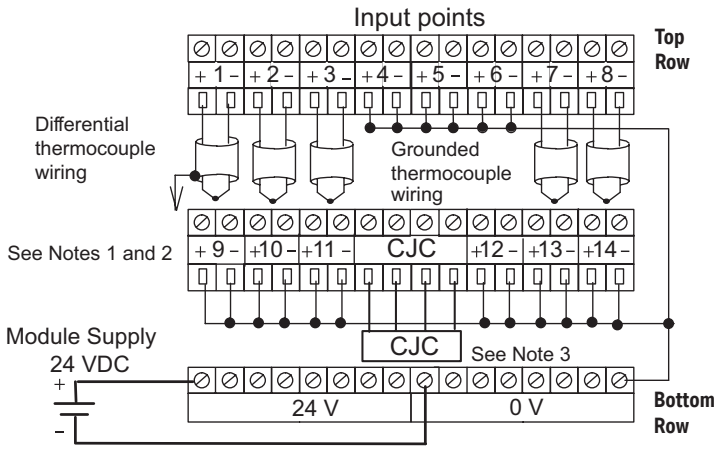
Input Range/Resolution



Equivalent Input Circuit



T1F-14THM 14 Channel Thermocouple Input, continued



NOTES:

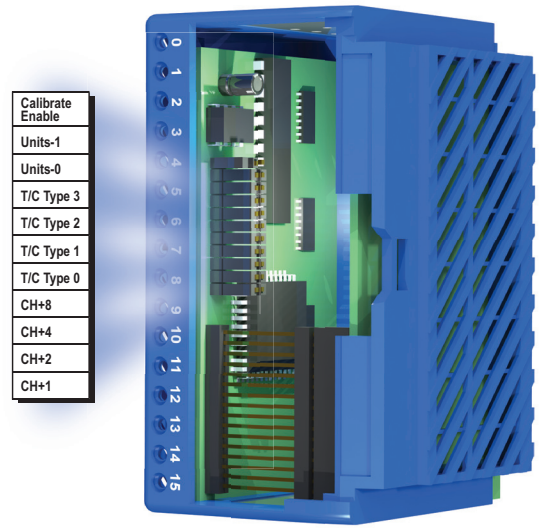
1. Shields should be grounded at the signal source.
2. Unused inputs should be connected to Common (0 VDC).
3. The Cold Junction Compensation (part #: T1F–CJC) temperature sense unit that comes with the module must be installed into the I/O base terminals to perform CJC of the thermocouple inputs.

Setting Module Jumpers (See Notes 1 and 2)

Select Number of Channels

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	X

X = Jumper Installed
Blank Space = Jumper Removed



T1F-14THM - 14 Channel Thermocouple Input - continued

Select Input Type

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	
0–156.25 mV			X	
±156.25 mV	X	X		

X = Jumper Installed
Blank Space = Jumper Removed

Select the Conversion Units

(See Notes 3 and 4)

Jumper	Thermocouple Conversion Units	
	2's Complement	
	°F	°C
Units-0	X	
Units-1		

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

X = Jumper Installed
Blank Space = Jumper Removed

NOTE 1: *This module can be configured to operate in unipolar mode which generates a range of values from 0 to 65535 (instead of -32768 to 32767). Use the ":U"(unsigned) cast operator to get the proper representation of the data when using a module that is configured for unipolar. For example: WX0:U, WX1:U.*

NOTE 2: *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 5 V 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-).*

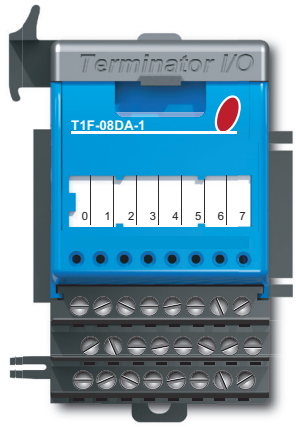
NOTE 3: *All thermocouple types are converted into a direct temperature reading with one implied decimal place. Negative temperatures are represented in 2's complement format. 2's complement data format is required to correctly display bipolar data on some operator interfaces.*

NOTE 4: *The bipolar voltage input ranges may be converted to a 16–bit 2's complement value.*

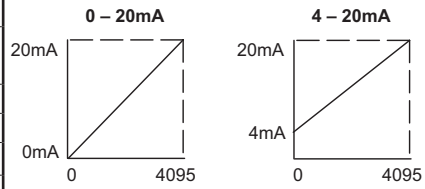
T1F-08DA-1 - 8 Channel Analog Current Output

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)
Module Addressing	8 output bits (Y-control byte); 8 output words (WY)
Max. Loop Supply	30VDC
Peak Output Voltage	30VDC
Load Impedance	0Ω min.
Max. Load (ohm) / Power Supply	620Ω/ 18V, 910Ω/ 24V, 1200Ω/ 30V
*Min. Load (ohm) / Power Supply**	0Ω/ 24V, 350Ω/ 30V @ 40°C 250Ω/ 24V, 600Ω/ 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	0–20 mA: ±5 counts max. 4–20 mA: ±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
CPU Update Rate	1 channel per scan
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

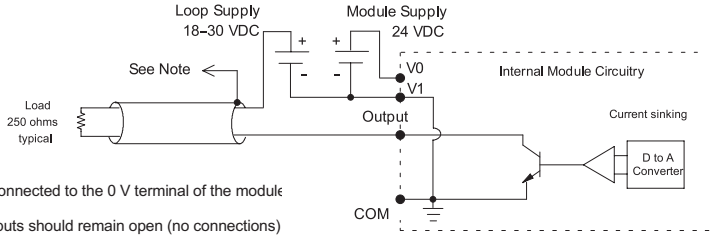
**Max. allowable output power dissipation. For example, at 60 °C and 24VDC, there must be a load of at least 250Ω on the output circuit. Smaller loads will damage the analog output circuit.*



Output Range/Resolution



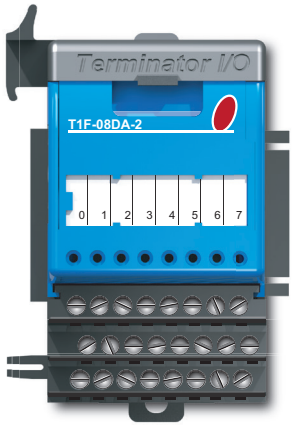
Equivalent Output Circuit



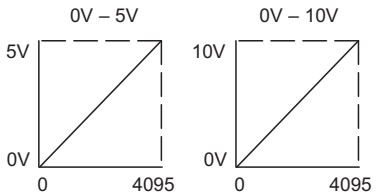
NOTES:
1. Shields should be connected to the 0 V terminal of the module the power supply.
2. Unused current outputs should remain open (no connections)

T1F-08DA-2 - 8 Channel Analog Voltage Output

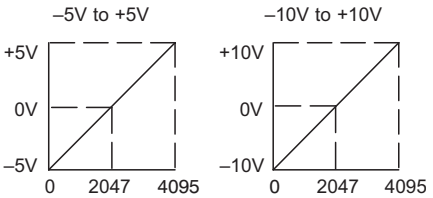
Specifications	
Number of Channels	8
Output Ranges	0–5 V, 0–10 V, ±5V, ±10V
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Module Addressing	8 output bits (Y-control byte); 8 output words (WY)
Peak Output Voltage	15VDC
Load Impedance	4kΩ min.
Load Capacitance	0.01 µF max.
Linearity Error (end to end)	±2 counts max. ±0.05% of full scale max.
Conversion Settling Time	100µs 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	±50ppm / °C, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors and temp drift included	10V ranges: ±0.2% @ 25°C ±0.4% @ 60°C 5V ranges: ±0.3% @ 25°C ±0.5% @ 60°C
CPU Update Rate	1 channel per scan
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



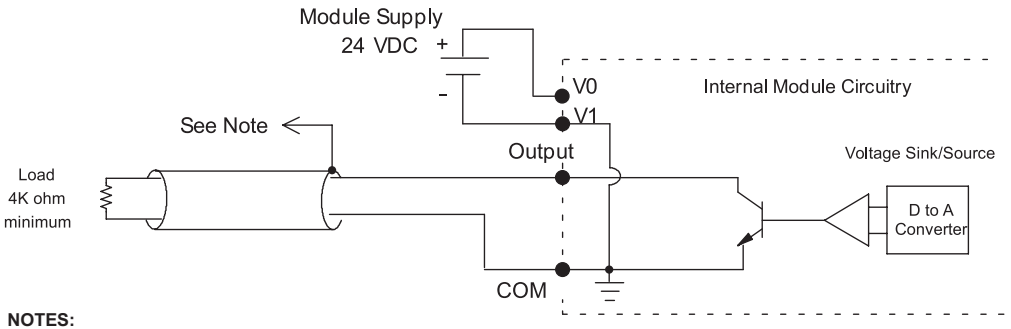
Unipolar Range/Resolution



Bipolar Range/Resolution



Equivalent Output Circuit

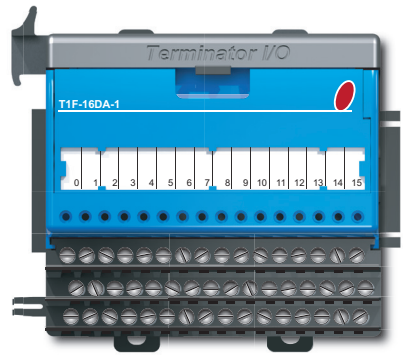


NOTES:
1. Shields should be connected to the 0 V terminal of the module ot the 0 V terminal of the power supply.

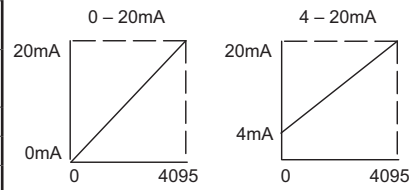
T1F-16DA-1 - 16 Channel Analog Current Output

Specifications	
Number of Channels	16
Output Ranges	0–20mA, 4–20mA
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Module Addressing	8 output bits (Y-control byte); 16 output words (WY)
Max. Loop Supply	30VDC
Peak Output Voltage	30VDC
Max. Load (ohm) / Power Supply	620Ω/ 18V, 910Ω/ 24V, 1200Ω/ 30V
*Min. Load (ohm) / Power Supply**	0Ω/ 24V, 350Ω / 30V @ 40°C 250Ω / 24V, 600Ω / 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
CPU Update Rate	1 channel per scan
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

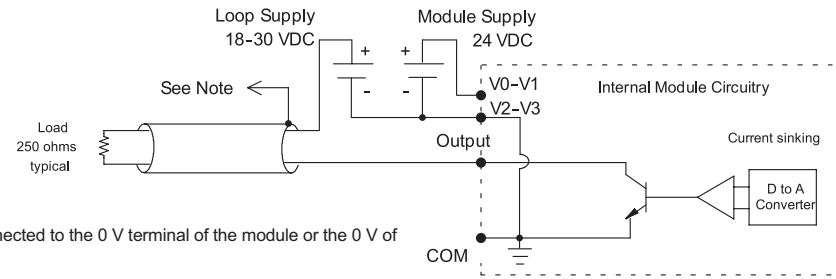
**Max. allowable output power dissipation. For example, at 60°C and 24VDC, there must be a load of at least 250Ω on the output circuit. Smaller loads will damage the analog output circuit.*



Output Range/Resolution



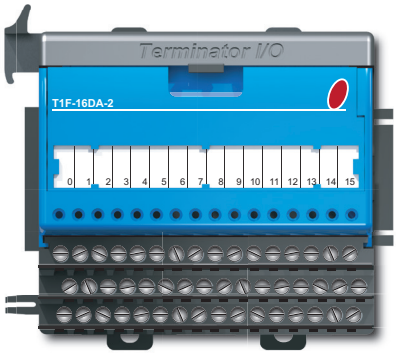
Equivalent Output Circuit



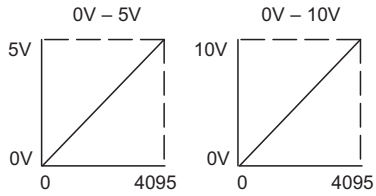
NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.

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

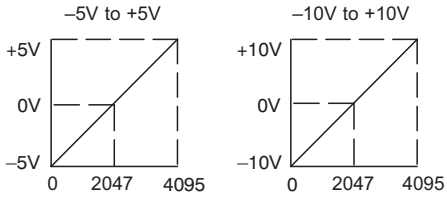
Specifications	
Number of Channels	16
Output Ranges	0–5 V, 0–10 V, ±5V, ±10V
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Module Addressing	8 output bits (Y-control byte); 16 output words (WY)
Peak Output Voltage	15VDC
Load Impedance	4kΩ min.
Load Capacitance	0.01 µF max.
Linearity Error (end to end)	±2 counts max. ±0.05% of full scale max.
Conversion Settling Time	100µs 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	±50ppm/ °C, full scale calibration change
Max. Full Scale Inaccuracy (% of full scale) all errors and temp drift included	10V ranges: ±0.2% @ 25°C ±0.4% @ 60°C 5V ranges: ±0.3% @ 25°C ±0.5% @ 60°C
CPU Update Rate	1 channel per scan
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



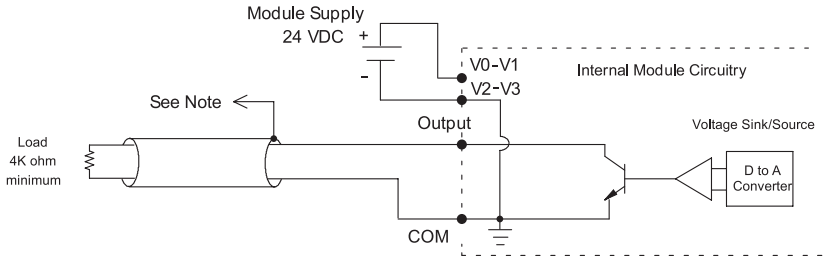
Unipolar Range/Resolution



Bipolar Range/Resolution



Equivalent Output Circuit

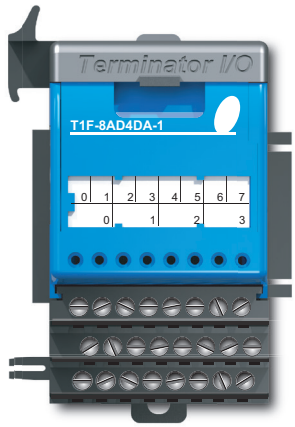


NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.

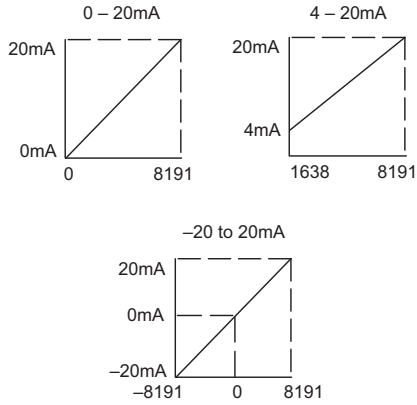
T1F-8AD4DA-1 - 8 Channel Analog Current Input / 4 Channel Analog Current Output

Module General Specifications	
CPU Update Rate	1 channel per scan
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

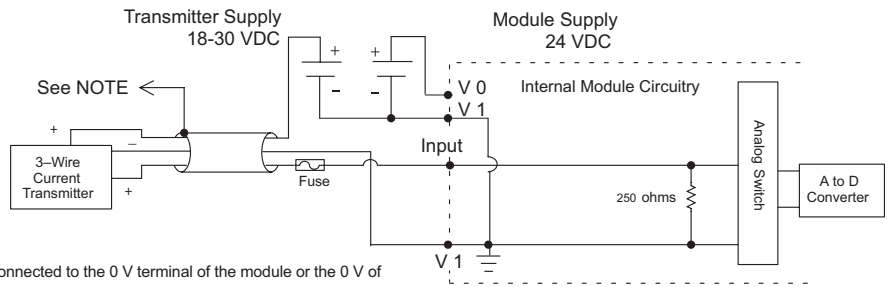
Input Channel Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0–20mA, 4–20mA, - 20 to 20mA
Resolution	14 bit (13 bit plus sign bit)
Module Addressing	8 input bits (X-not used); 8 input words (WX)
Frequency Response Input active low-pass filter	-3db @ 100Hz, -20db/ decade
Input 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



Equivalent Input Circuit



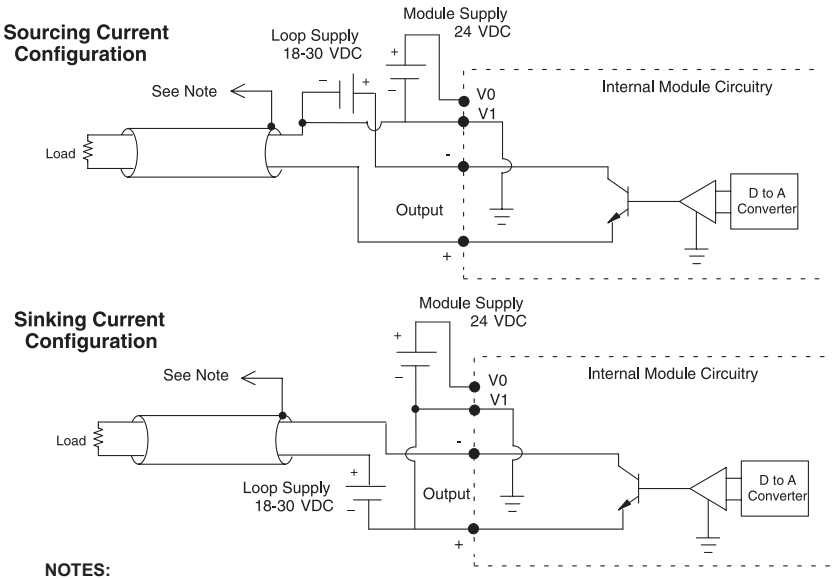
NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.

T1F-8AD4DA-1 - continued

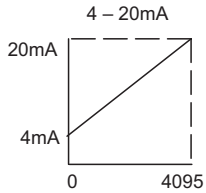
Output Channel Specifications	
Number of Channels	4, sink/source; individually configured by wiring
Output Range	4–20mA
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Module Addressing	8 output bits (Y-control byte); 4 output words (WY)
Maximum Loop Supply	30VDC
Source Load (ohms) / 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)	600Ω / 18V, 900Ω / 24V, 1200Ω / 30V

Output Channel Specifications	
Linearity Error (end to end)	±2 count maximum ±0.050% of full scale maximum
Conversion Settling Time	400µs 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. @ 400Ω load ±18 counts max. @ 250Ω load ±12 counts max. @ 125Ω load
Offset Calibration Error	SINK: ±6 counts max. @ any load SOURCE: ±10 counts max. @ 400Ω load ±8 counts max. @ 250Ω load ±6 counts max. @ 125Ω 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: 400Ω load 0.63% @ 25°C 400Ω load 0.83% @ 60°C 250Ω load 0.44% @ 25°C 250Ω load 0.64% @ 60°C 125Ω load 0.30% @ 25°C 125Ω load 0.50% @ 60°C

Equivalent Output Circuit



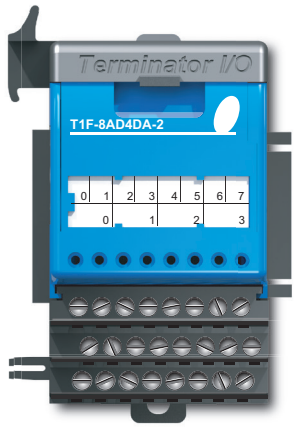
Output Range/Resolution



NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.

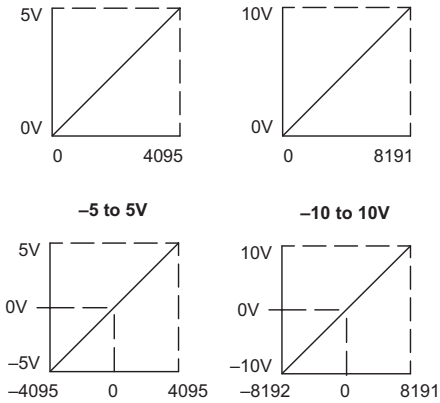
T1F-8AD4DA-2 - 8 Channel Analog Voltage Input / 4 Channel Analog Voltage Output

Module General Specifications	
CPU Update Rate	1 channel per scan
Base Power Required	75mA @ 5VDC
External Module Power Supply	21.6–26.4 VDC, 70mA, class 2
Operating Temperature	0 to 60°C (32 to 140°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Accuracy vs. Temperature	±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

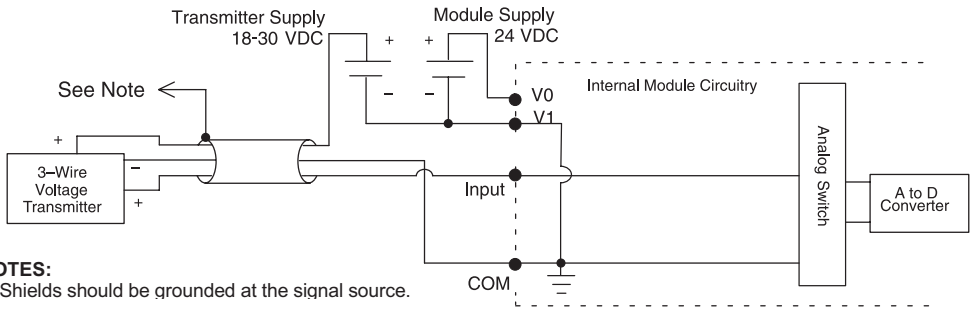


Input Channel Specifications	
Number of Channels	8, single ended (1 common)
Input Ranges	0–5 V, 0–10 V, ±5V, ±10V
Resolution	14 bit (13 bit plus sign bit)
Module Addressing	8 input bits (X-not used); 8 input words (WX)
Frequency Response	-3db @ 500Hz, - 20db / decade
Input Resistance	200kΩ min.
Absolute 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
External Transmitter Power Supply	18–30 VDC, 70mA, class 2

Input Range/Resolution



Equivalent Input Circuit

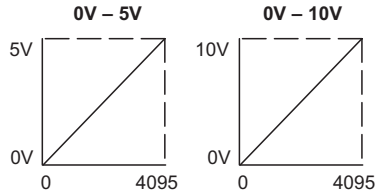


NOTES:
1. Shields should be grounded at the signal source.

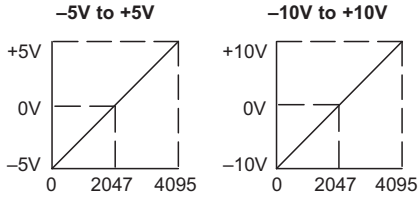
T1F-8AD4DA-2 - continued

Output Channel Specifications	
Number of Channels	4
Output Ranges	0–5 V, 0–10 V, ±5V, ±10V
Output Type	Single ended, 1 common
Resolution	12 bit (1 in 4096)
Module Addressing	8 output bits (Y-control byte); 4 output words (WY)
Peak Output Voltage	15VDC
Load Impedance	4kΩ minimum
Load Capacitance	0.01 µF maximum
Linearity Error (end to end)	±2 count maximum ±0.050% of full scale maximum
Conversion Settling Time	300µs maximum full scale change
Full Scale Calibration Error	±12 counts maximum
Accuracy vs. Temperature	±50ppm/ °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: ±0.2% @ 25°C ±0.4% @ 60°C 5V ranges: ±0.3% @ 25°C ±0.5% @ 60°C
CPU Update Rate	1 channel per scan

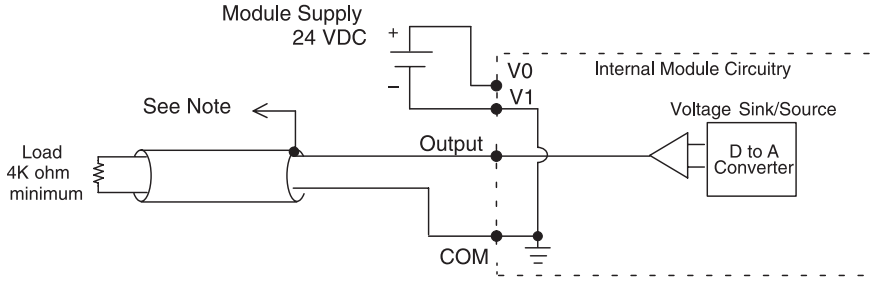
Unipolar Range/Resolution



Bipolar Range/Resolution



Equivalent Output Circuit



NOTES:
1. Shields should be connected to the 0 V terminal of the module or the 0 V of the power supply.

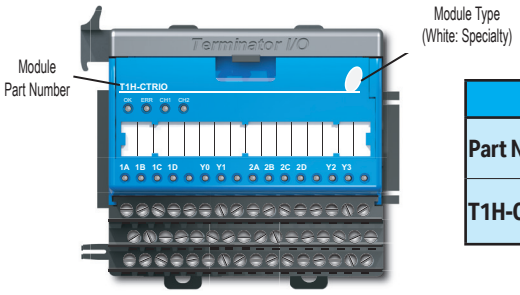
SPECIFICATIONS - SPECIALTY I/O MODULES

In This Chapter:

Specialty Modules Overview

Each specialty module is identified with a white bar across the front panel as seen below. The module's front panel is also equipped with LED status indicators. These indicators show the module health and I/O status. Currently the T1H-CTRIO is the only Specialty Module available to use with the Do-more T1H CPU's.

Specialty Modules



Specialty Modules		
Part Number	**Description**	**See Page**
T1H-CTRIO	High Speed Counter Interface Module	7-3

WARNING: The T1H Series PLC does not support any Hot-Swap features.

T1H-CTRIO

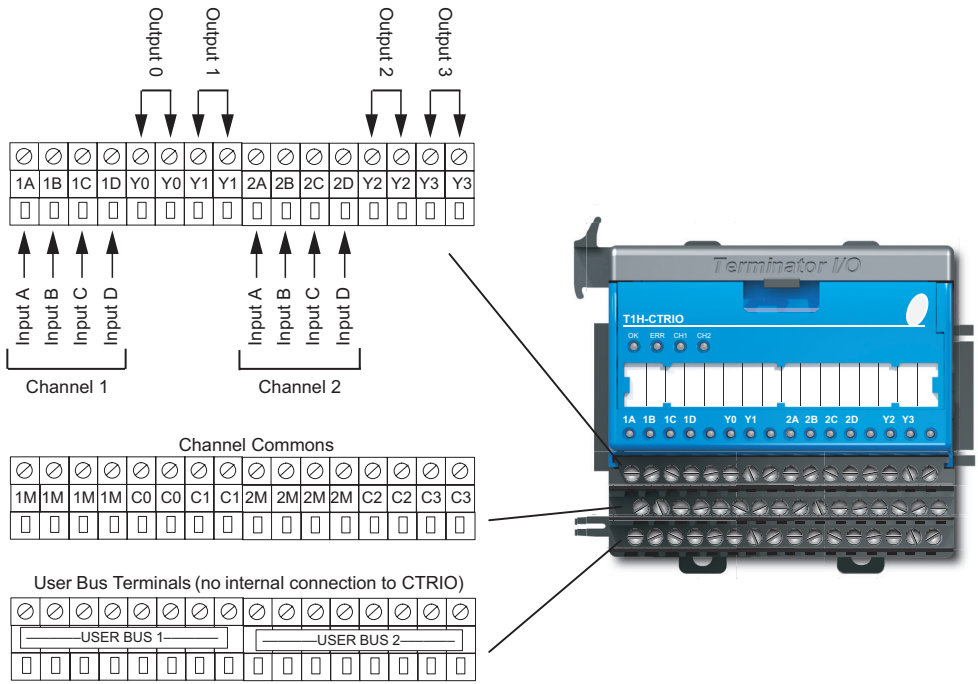
T1H-CTRIO Overview

The T1H-CTRIO Counter I/O (CTRIO) module is designed to accept high-speed pulse input signals for counting or timing applications. This module provides high-speed pulse output signals for servo/stepper motor control, monitoring and alarming as well as other discrete control functions.

The T1H-CTRIO module offers greater flexibility for applications which call for precise counting or timing based on input events or for high-speed control output applications. The CTRIO module can also be used for applications that call for a combination of both high-speed input and high-speed output control functions.

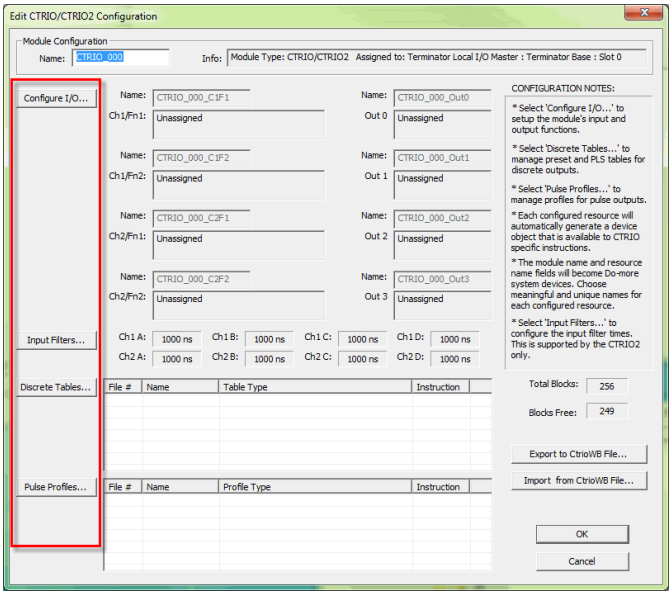
The T1H-CTRIO module has its own internal microprocessor and operates asynchronously with respect to the CPU. Therefore, the response time of the on-board outputs is based on the module's scan time, not the CPU's scan time (unless the CPU is controlling the outputs directly).

T1H-CTRIO Terminal Block Layout

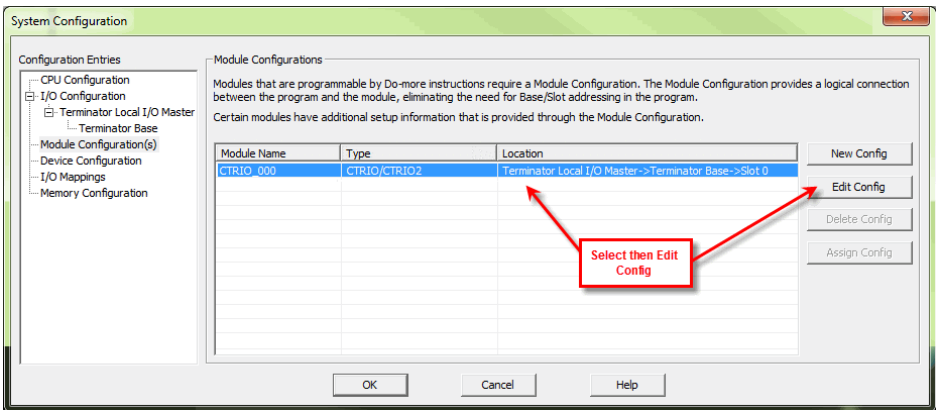


T1H-CTRIO Configuration

The module configuration of the T1H-CTRIO is done from within the Edit CTRIO/ CTRIO2 Configuration window seen below. The Configure I/O..., Input Filters..., Discrete Tables... and Pulse Profiles... buttons in the left hand column allow you to configure the input and output functions of the selected module. Refer to the Do-more Designer Help File for more information on configuration options.



The above window can be accessed once the T1H-CTRIO module is added to the I/O configuration either manually or automatically. See the Verify Hardware Configuration section of the Getting Started chapter for more information on setting up the I/O configuration. With the module added, select the Module Configuration(s) entry from the System Configuration page. Then choose the desired module and select Edit Config.



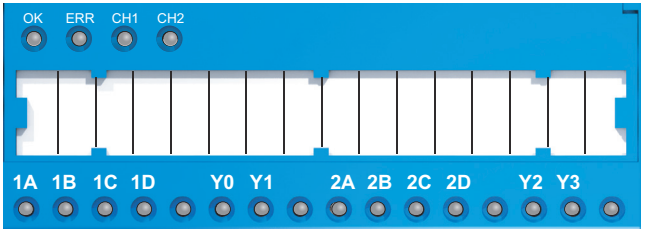
T1H-CTRIO Specifications

General Specifications	
Discrete I/O Points Used	None (I/O map directly in T1H-DM1/E data structure)
Base Power Required	400mA @ 5VDC
Isolation	2500V I/O to Logic, 1000V among Input Channels and All Outputs

Input Specifications	
Input	8 pts. sink / source
Maximum Input Frequency	100kHz
Minimum Pulse Width	5µsec
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	Less than 3.0 µsec
ON to OFF Response	Less than 3.0 µsec

Output Specifications	
Outputs	4 pts., (sink/source), independently isolated
Pulse Outputs	2 channels, 20Hz to 25kHz Pulse/Direction or CW/CCW
Minimum Pulse Width	5µsec
Output Voltage Range	5–36 VDC
Maximum Output Voltage	36VDC
Maximum Load Current	1.0 A
Maximum Leakage Current	100µA
Inrush Current	5.0 A for 20ms
ON State V Drop	0.3 VDC or less
Overcurrent Protection	15A maximum
OFF to ON Response	Less than 3.0 µsec
ON to OFF Response	Less than 3.0 µsec

T1H-CTRIO LED Indicators

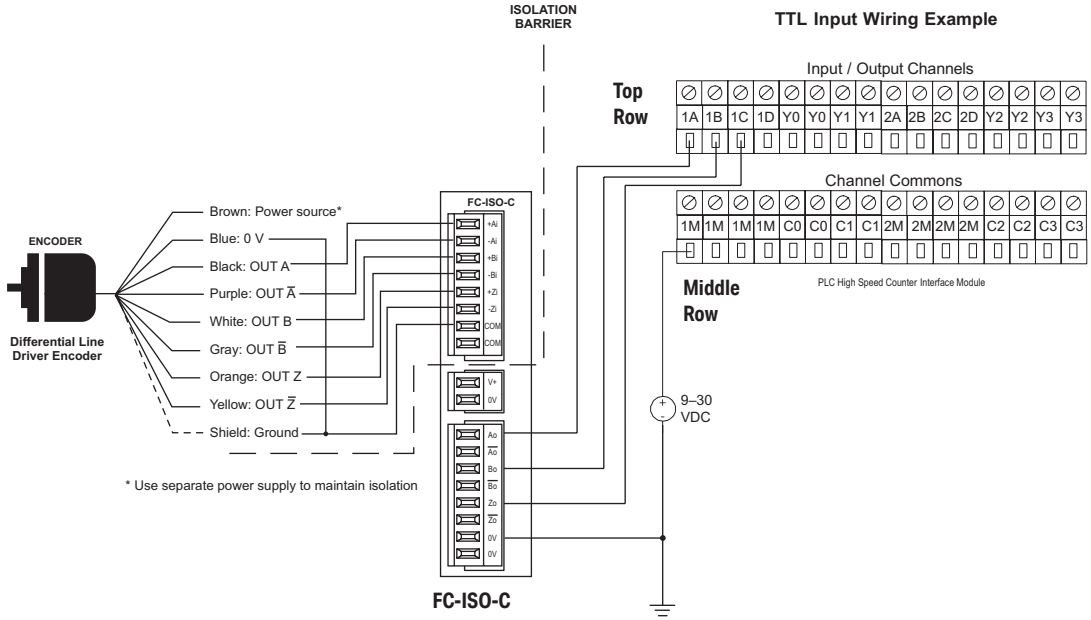


LED Descriptions	
OK	Module OK
ERR	User Program Error
CH1	Channel 1 Status
CH2	Channel 2 Status
1A–1D	Channel 1 A-D Status
2A–2D	Channel 2 A-D Status
Y0–Y3	Output Status

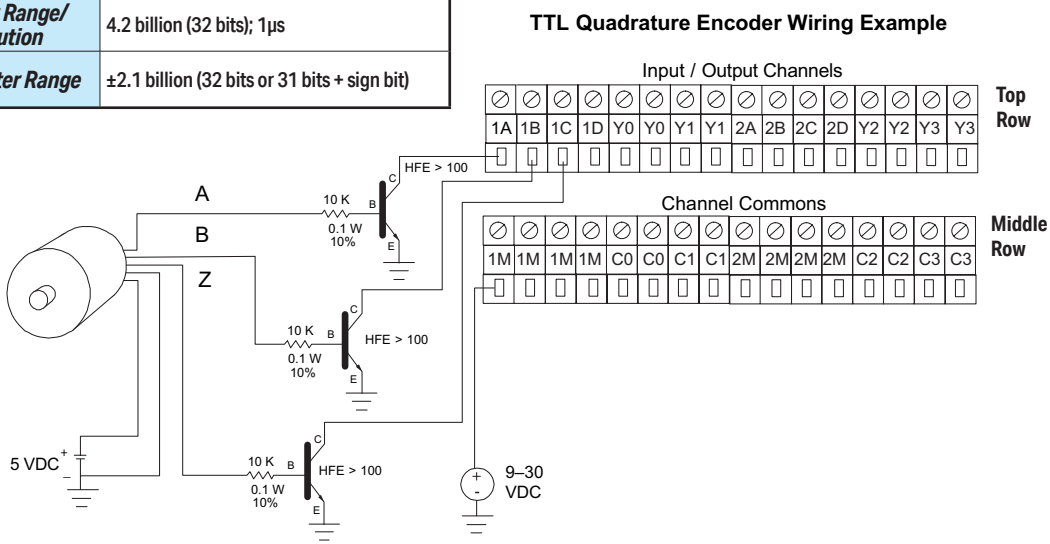
LED Diagnostic Definitions		
OK	**ERR**	**Description**
ON	OFF	All is well - Run Mode
ON	ON	Hardware Failure
Blinking	Blinking	Boot Mode - Use for Field OS Upgrades
Blinking	OFF	Program Mode
OFF	Blinking	Module Self - diagnostic Failure
OFF	ON	Module Error due to Watchdog Timeout
OFF	OFF	No Power to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

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

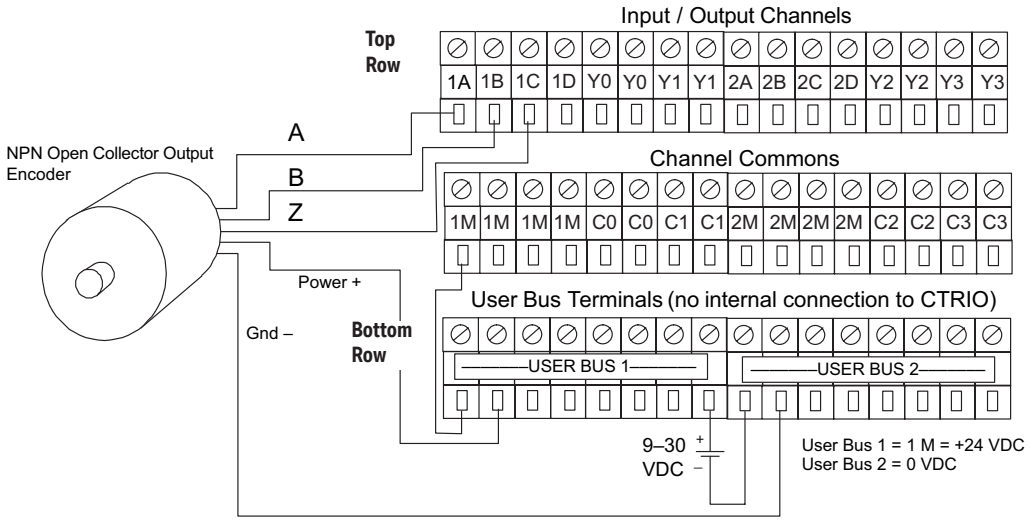


CTRIO Input Resources	
Counter/Timer	4, (2 per 4 input channel group)
Resource Options	1X, 2X, or 4X Quadrature, Up or Down Counter, Edge Timer, Dual Edge Timer, Pulse Catch, Reset, Inhibit, Capture
Timer Range/ Resolution	4.2 billion (32 bits); 1µs
Counter Range	±2.1 billion (32 bits or 31 bits + sign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

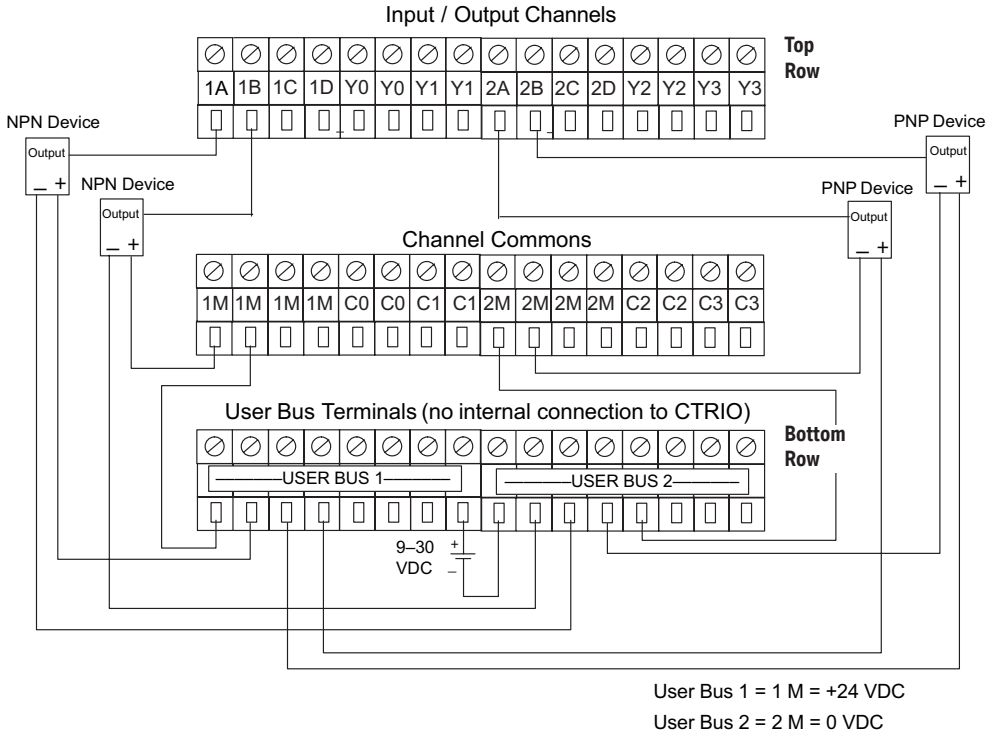


T1H-CTRIO Input Wiring Diagrams

Quadrature Encoder Wiring Example

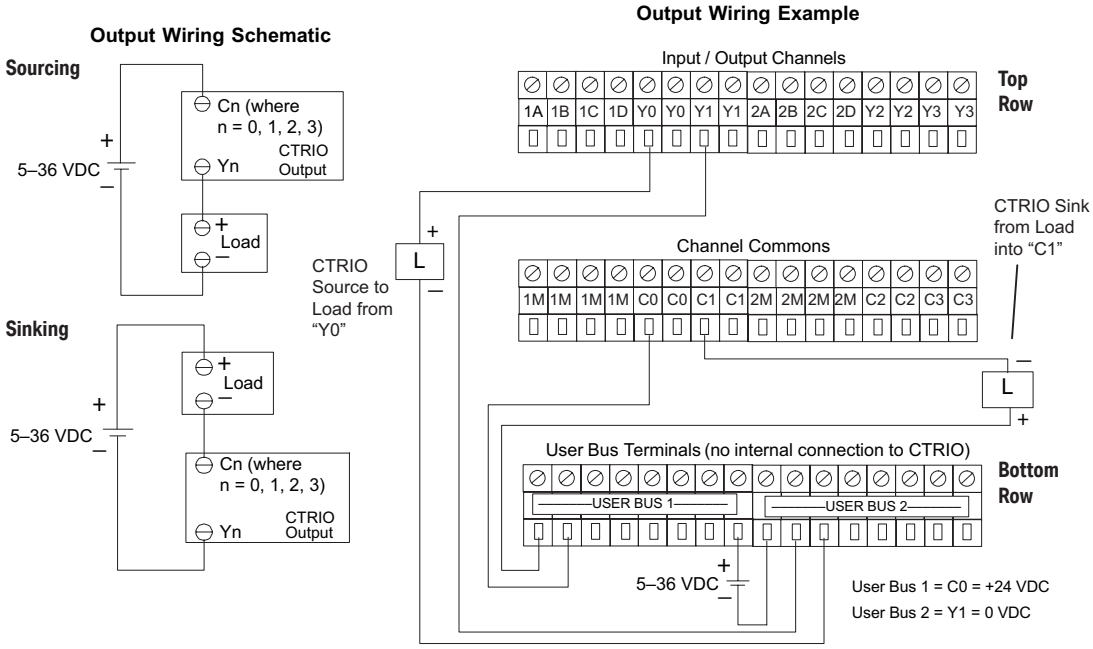


Input Wiring Example



T1H-CTRIO Output Wiring Diagrams

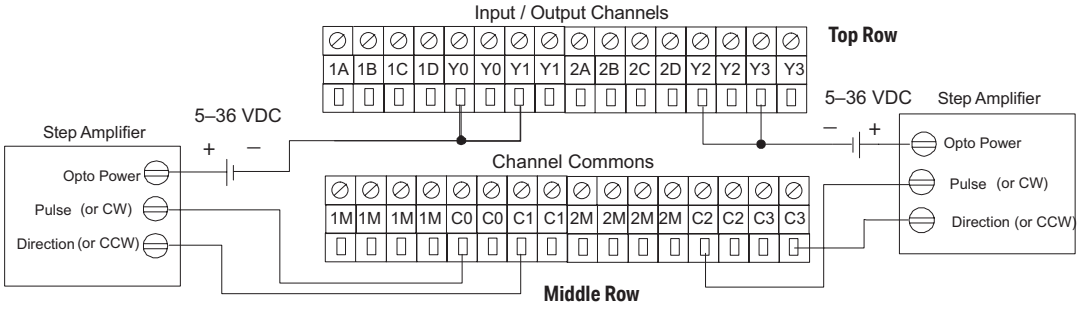
The module has 4 optically isolated output points (pts. Y0–Y3 with isolated commons C0–C3, respectively). The outputs must be wired so positive current flows into Cn terminal and then out of the Yn terminal.



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)

INSTALLATION AND WIRING

In This Chapter:

Safety Guidelines

NOTE: *Products with CE marks perform their required functions safely and adhere to relevant standards as specified by CE directives provided they are used according to their intended purpose and that the instructions in this manual are adhered to. The protection provided by the equipment may be impaired if this equipment is used in a manner not specified in this manual. A listing of our international affiliates is available on our Web site: http://www.automationdirect.com*

WARNING: Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system planning and installation. Automation systems can fail and may result in situations that can cause serious injury to personnel or damage to equipment. Do not rely on the automation system alone to provide a safe operating environment. You should use external electromechanical devices, such as relays or limit switches, that are independent of the PLC application to provide protection for any part of the system that may cause personal injury or damage. Every automation application is different, so there may be special requirements for your particular application. Make sure you follow all national, state, and local government requirements for the proper installation and use of your equipment.

Plan for Safety

The best way to provide a safe operating environment is to make personnel and equipment safety part of the planning process. You should examine every aspect of the system to determine which areas are critical to operator or machine safety. If you are not familiar with PLC system installation practices, or your company does not have established installation guidelines, you should obtain additional information from the following sources.

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

Three Levels of Protection

The publications mentioned provide many ideas and requirements for system safety. At a minimum, you should follow these regulations. Also, you should use the following techniques, which provide three levels of system control.

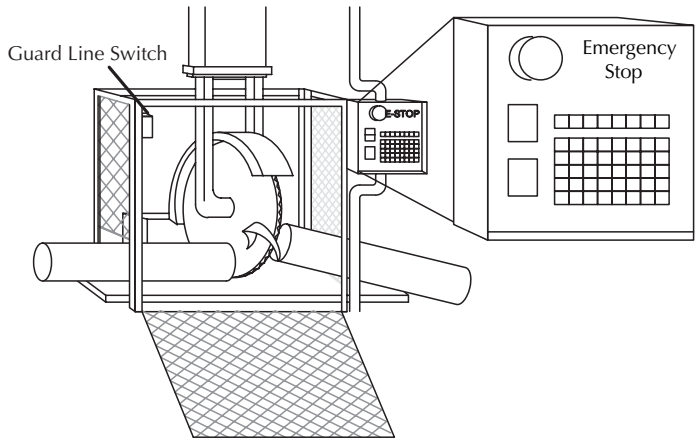
- Emergency stop switch for disconnecting system power
- Mechanical disconnect for output module power
- Orderly system shutdown sequence in the PLC control program

Emergency Stops

It is recommended that emergency stop circuits be incorporated into the system for every machine controlled by a PLC. For maximum safety in a PLC system, these circuits must not be wired into the controller, but should be hardwired external to the PLC. The emergency stop switches should be easily accessed by the operator and are generally wired into a master control relay (MCR) or a safety control relay (SCR) that will remove power from the PLC I/O system in an emergency.

MCRs and SCRs provide a convenient means for removing power from the I/O system during an emergency situation. By de-energizing an MCR (or SCR) coil, power to the input (optional) and output devices is removed. This event occurs when any emergency stop switch opens. However, the PLC continues to receive power and operate even though all its inputs and outputs are disabled.

The MCR circuit could be extended by placing a PLC fault relay (closed during normal PLC operation) in series with any other emergency stop conditions. This would cause the MCR circuit to drop the PLC I/O power in case of a PLC failure (memory error, I/O communications error, etc.).



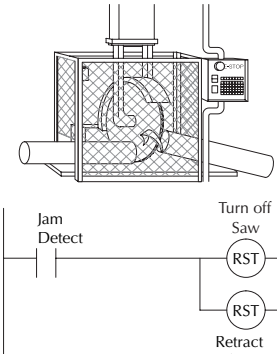
Emergency Power Disconnect

A properly rated emergency power disconnect should be used to power the PLC controlled system as a means of removing the power from the entire control system. It may be necessary to install a capacitor across the disconnect to protect against a condition known as "outrush". This condition occurs when the output TRIACs are turned off by powering off the disconnect, thus causing the energy stored in the inductive loads to seek the shortest distance to ground, which is often through the TRIACs.

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

Orderly System Shutdown

Ideally, the first level of fault detection is the PLC control program, which can identify machine problems. Certain shutdown sequences should be performed. The types of problems usually found are things such as jammed parts, etc. that do not pose a risk of personal injury or equipment damage.



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

Class 1, Division 2, Zone 2 Approval

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

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

WARNING: Explosion Hazard! Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

WARNING: All models used with connector accessories must use R/C (ECBT2) mating plug for all applicable models. All mating plugs shall have suitable ratings for device.

WARNING: This equipment is designed for use in Pollution Degree 2 environments (installed within an enclosure rated at least IP54).

WARNING: Transient suppression must be provided to prevent the rated voltage from being exceeded by 140%.

Mounting Guidelines

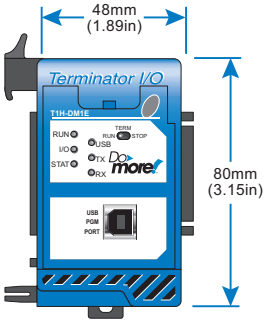
Before installing the Terminator system you will need to know the dimensions of the components. The diagrams on the following pages provide the component dimensions to use in defining your enclosure specifications. Remember to leave room for potential expansion.

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

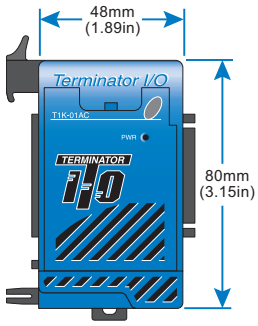
Dimensions

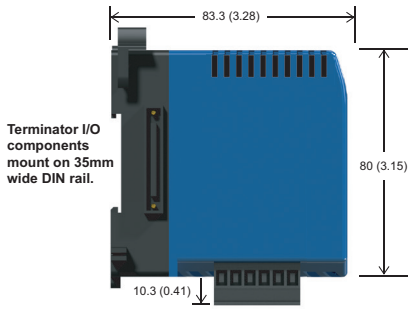
The following diagrams show the, CPU, base controller, power supply and I/O module dimensions. Terminator components mount on 35mm wide DIN rail.

CPU

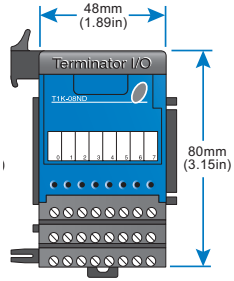


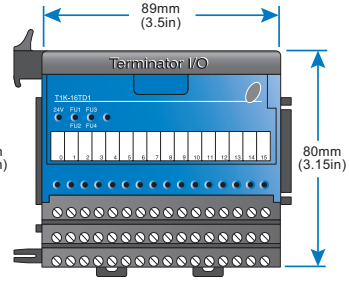
Base Controller/Power Supply

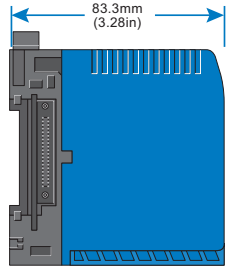




I/O Modules



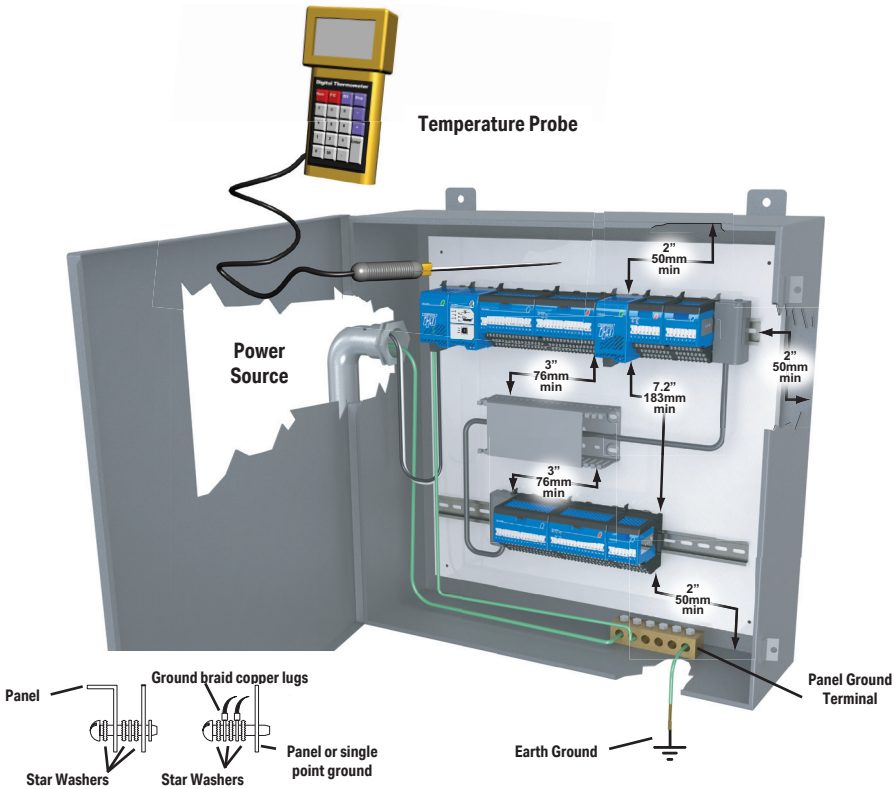




Panel Mounting and Layout

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

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



4. There must be a minimum of 2" (50mm) clearance between the panel door and the nearest Terminator component.
5. The ground terminal on the Terminator power supply must be connected to a single point ground. Use copper stranded wire to achieve a low impedance. Copper eye lugs should be crimped and soldered to the ends of the stranded wire to ensure good surface contact. Remove anodized finishes and use copper lugs and star washers at termination points. A general rule is to achieve a 0.1 ohm of DC resistance between the Terminator I/O slave and the single point ground.
6. There must be a single point ground (i.e. copper bus bar) for all devices in the panel requiring an earth ground return. The single point of ground must be connected to the panel ground termination. The panel ground termination must be connected to earth ground. For this connection you should use 12AWG stranded copper wire as a minimum. Minimum wire sizes, color coding, and general safety practices should comply with appropriate electrical codes and standards for your region. A good common ground reference (earth ground) is essential for proper operation of the Terminator system. There are several methods of providing an adequate common ground reference, including: a) Installing a ground rod as close to the panel as possible. b) Connection to incoming power system ground.
7. Properly evaluate any installation where the ambient temperature may approach the lower or upper limits of the specifications. Place a temperature probe in the panel, close the door and operate the system until the ambient temperature has stabilized. If the ambient temperature is not within the operating specification for the Terminator system, measure points in the panel in consideration for installing a cooling/heating source to provide the ambient temperature to meet the Terminator I/O operating specifications.
8. Device mounting bolts and ground braid termination bolts should be #10 copper bolts or equivalent. Tapped holes instead of nut-bolt arrangements should be used whenever possible. To assure good contact on termination areas impediments such as, paint, other coating or corrosion should be removed in the area of contact.
9. The system is designed to be powered by 110/220 VAC or 24VDC normally available throughout an industrial environment. Isolation transformers and noise suppression devices are not normally necessary, but may be helpful in eliminating/reducing suspect power problems.

Enclosures

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

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

Environmental Specifications

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

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

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

Power

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

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

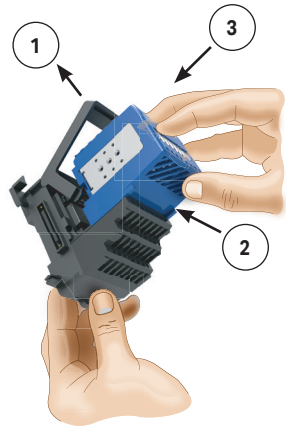
Agency Approvals

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

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

Assembling the Components

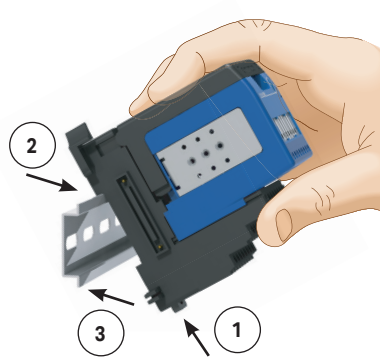
Assembling the I/O Modules and Bases

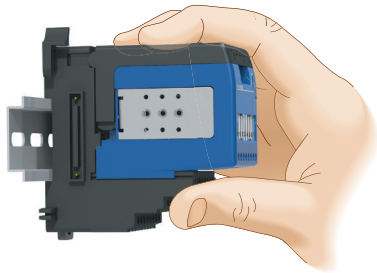


INSERT MODULE INTO BASE

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

Mounting the Components on DIN Rail





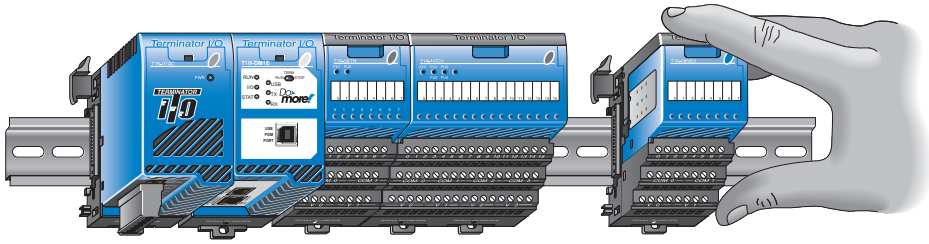
NOTE: *Do not force the module on the DIN rail. Due to slight size variations in different manufacturers' DIN rail, it may be necessary to first unlatch the locking tab, rotate the module into place, then latch the locking tab.*

INSTALL ON DIN RAIL

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

Connecting the Components on the DIN Rail

SLIDE ASSEMBLY INTO POSITION ON THE DIN RAIL

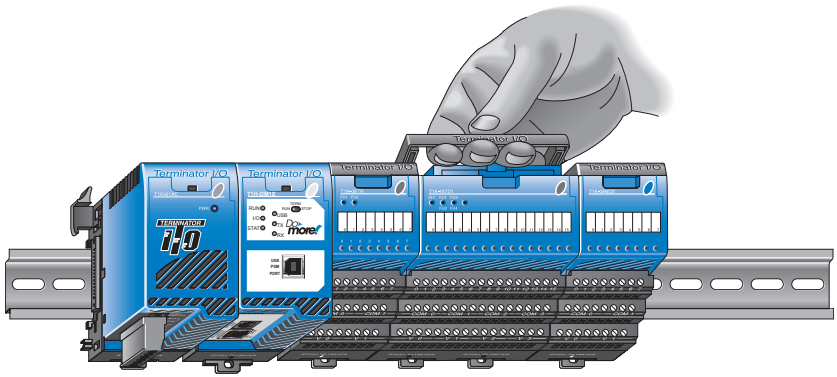


Slide the module assembly on the DIN rail until the clip arm attaches securely to the adjacent module.

NOTE: *One power supply is required in the leftmost component position followed by the CPU. 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.*

Removing I/O Modules from the Base

To remove a module from the base, grip the center of the base arm and rotate outward



releasing the module. Lift the module from the base.

To remove a module assembly from the DIN rail, lift the clip arm up and slide the module assembly away from the adjacent module. Pull the locking tab down (out) and lift the assembly off the DIN rail.

WARNING: The T1H Series PLC does not support any Hot-Swap features.

Multiple Power Supplies / Local Expansion Configurations

Multiple Power Supply Configuration

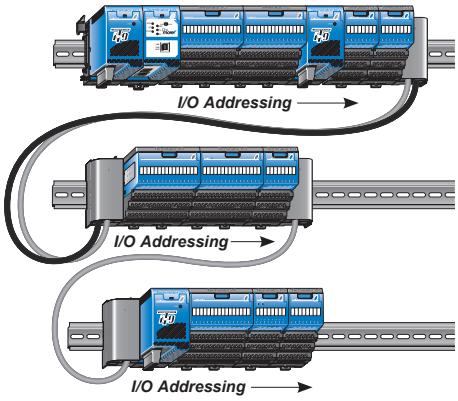
It is possible to have multiple power supplies in a single slave (node) system to meet power budget requirements. **One power supply is required in the leftmost component position followed by the CPU.** Additional power supplies should be added between I/O modules as necessary to meet power budget requirements. 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 allows 24VDC base power to pass and one that does not (both cables pass the 5VDC base power). The ("-1") version of the expansion cables pass 24VDC on an isolated wire. Any local expansion DC input modules configured for "internal power" (current sourcing) must either have a power supply preceding it on the same base or have a ("-1") version cable pass 24VDC from a power supply on the preceding base.

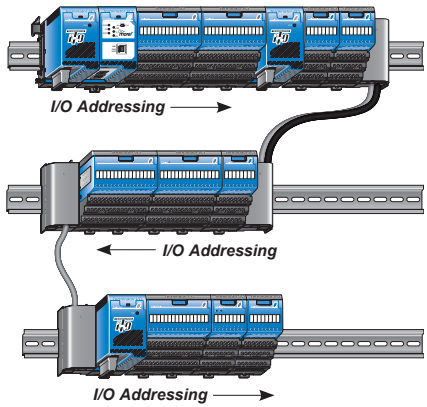
Overview of I/O Expansion Configurations

There are several expansion I/O system configurations that can be created by using the local expansion cables. There are some restrictions on where power supplies can be placed in the system when using the T1K-05CBL-RR-1 expansion base cable.

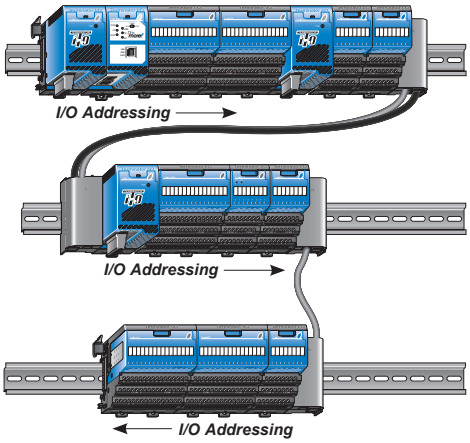
One expansion cable each; T1K-10CBL-1 and T1K-10CBL



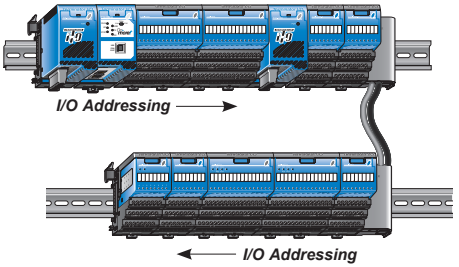
One expansion cable each; T1K-05CBL-RR-1 and T1K-05CBL-LL



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

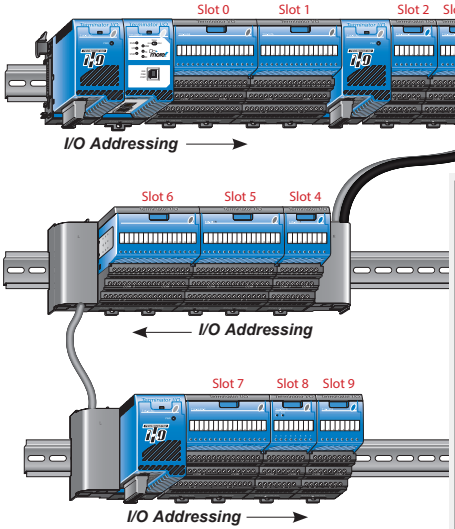


T1K-05CBL-RR-1 Expansion Cable

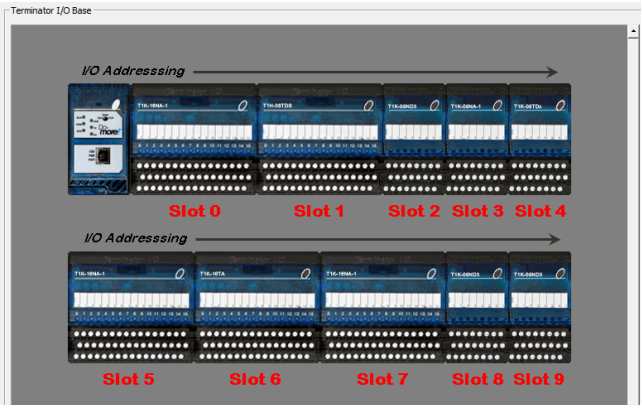


NOTE: *When an expansion cable connects the right side of two units together (RR in the cable part number), note that the I/O addressing of the downstream I/O is numbered right to left instead of left to right. However, the CPU detects modules in sequence from the nearest to the furthest and is unaware of the presence of expansion cables and extra power supplies. The display in Do-more Designer will reflect that. Do-more Designer only shows units left to right, in order (see below). The display in Do-more Designer is not intended to represent the physical layout, just the layout as the I/O is addressed.*

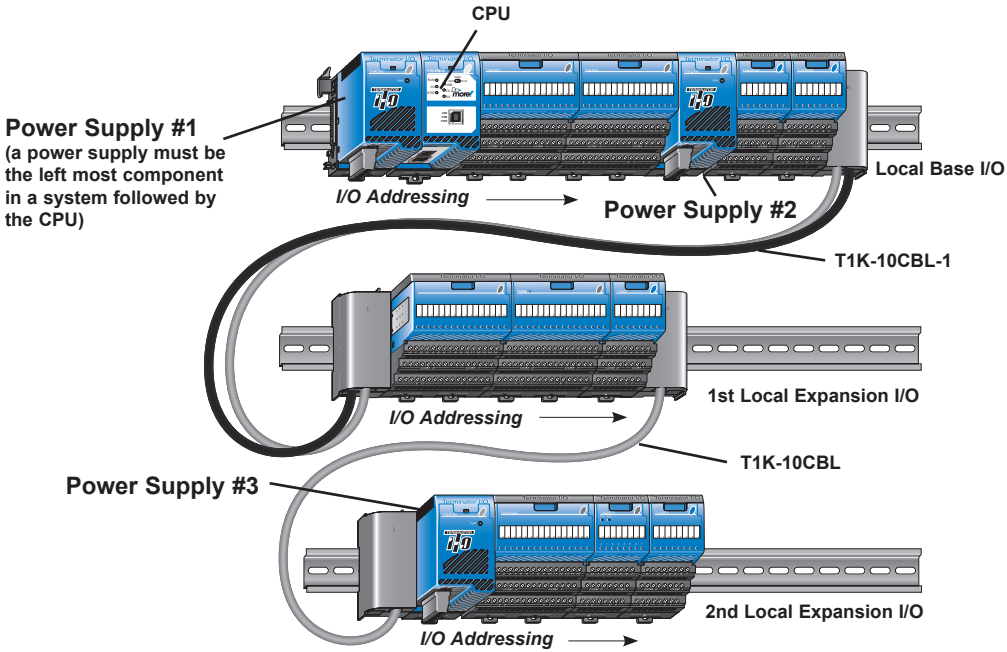
Physical Layout



Layout represented in Do-more Designer

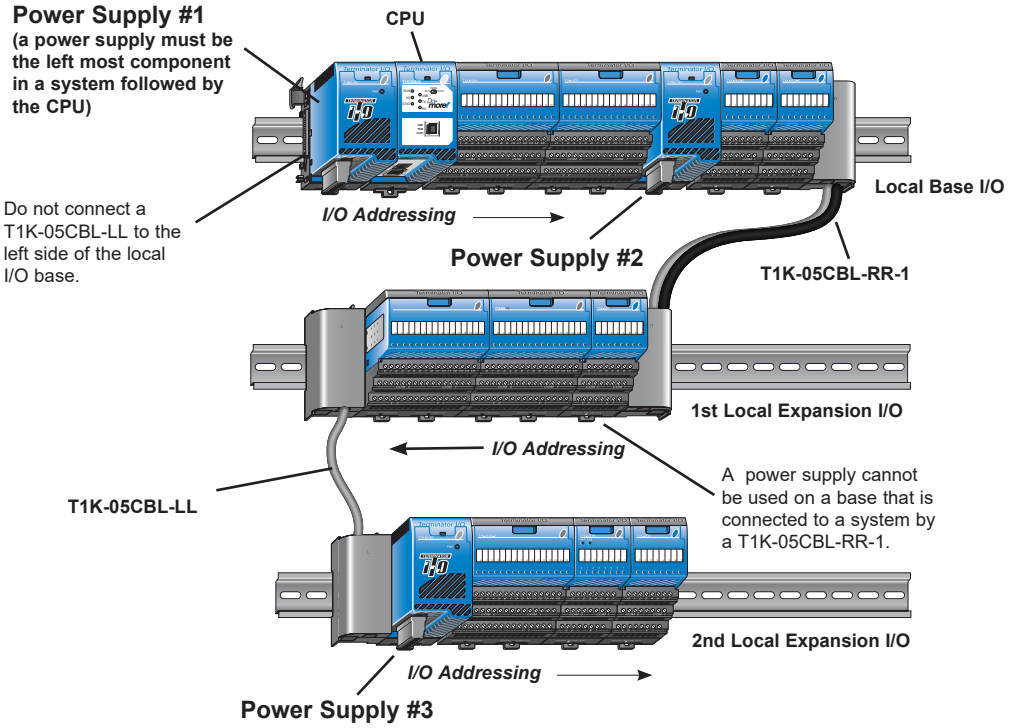


Example Using T1K-10CBL-1 and T1K-10CBL Expansion Cables



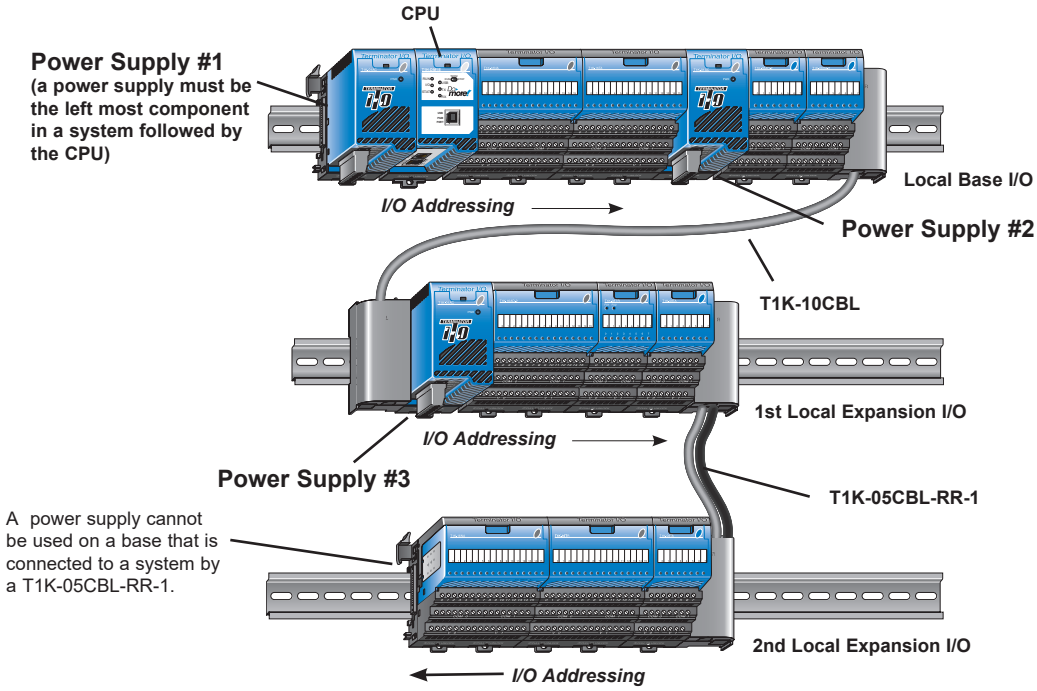
System shown above: The first power supply powers the CPU and the two I/O modules to its right. The second power supply powers the two modules to its right and the three I/O modules on the first local expansion base. Power Supply #3 powers the three I/O modules to its right on the second local expansion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

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



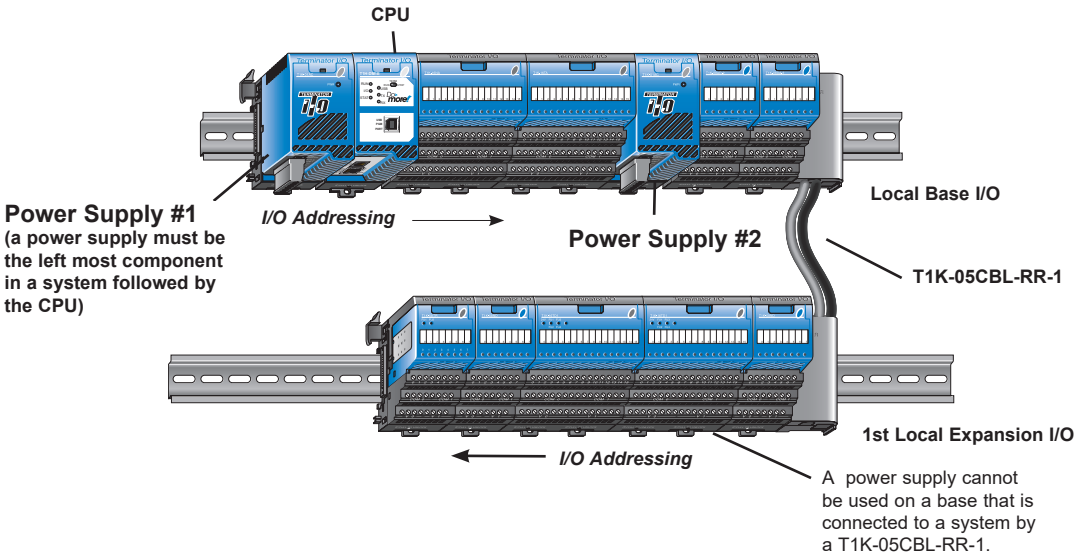
System shown above: The first power supply powers the CPU and the two I/O modules to its right. The second power supply powers the two modules to its right and the three I/O modules on the first local expansion base. When a T1K-05CBL-RR-1 is used, the expansion I/O assignments are from right to left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

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



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

Example Using T1K-05CBL-RR-1 Expansion Cables

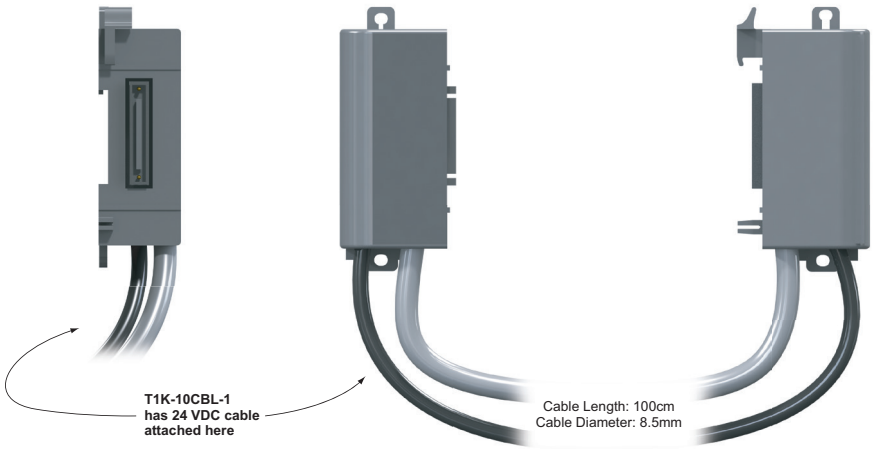


System shown above: The first power supply powers the CPU and the two I/O modules to its right. The second power supply powers the two modules to its right and the five I/O modules on the first local expansion base. When a T1K-05CBL-RR-1 is used, the expansion I/O assignments are from right to left (reversed).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

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

T1K-10CBL(-1)



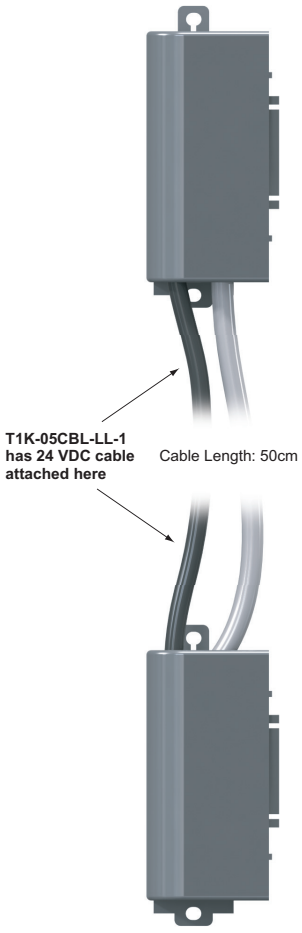
T1K-5CBL-LL(-1) Expansion Cable Specifications

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

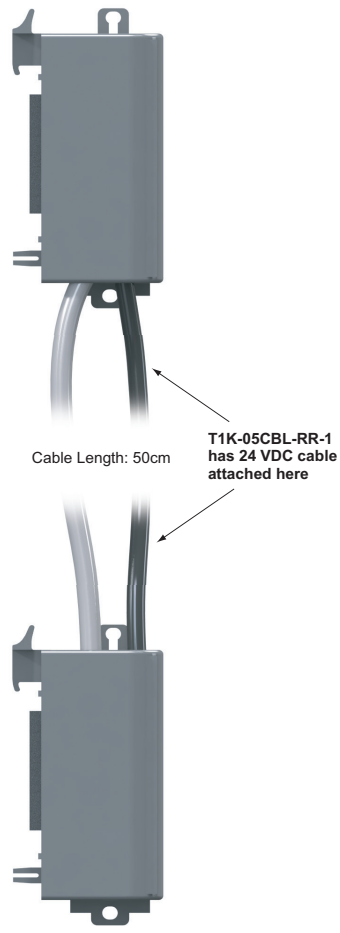
T1K-5CBL-RR(-1) Expansion Cable Specifications

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	-	Two 1.42 mm cables used in a 6mm sheath
	Insulation Voltage	-	2000VAC / 1 minute

T1K-5CBL-LL(-1)



T1K-5CBL-RR(-1)



Wiring Guidelines

Power Wiring

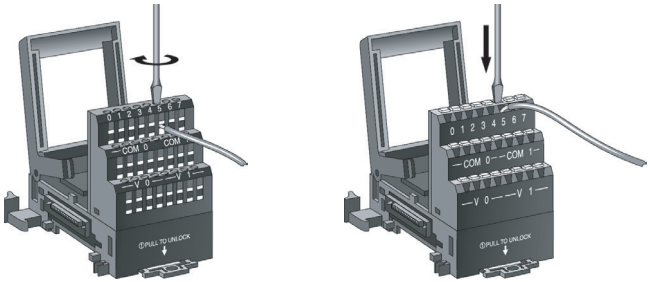
The diagram below shows the terminal connections located on the Terminator AC and DC power supplies. The table below shows the wire size and recommended torque for the power supply screw terminals.

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

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.

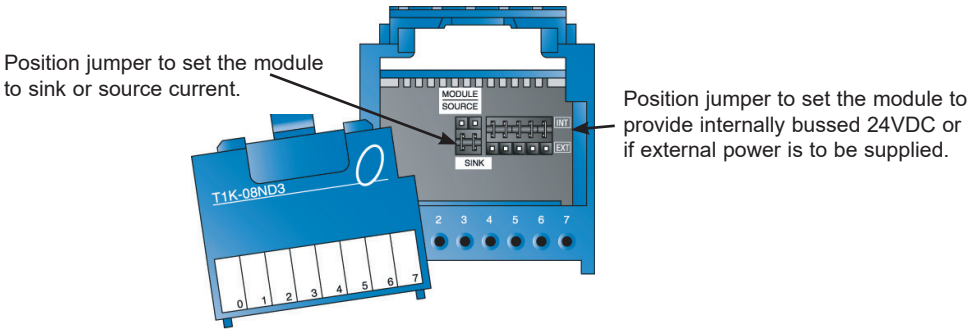


Terminal Type	Screw Type	Spring Clamp
Recommended Torque	1.77–3.54 lb·in (0.2–0.4 N·m)	N/A
Recommended Screwdriver Blade Size	0.02 in. x 0.125 in. (0.5 mm x 3mm)	Push in on clamp using screwdriver blade size: (0.016 x 0.079 to 0.032 x 0.16) in. (0.4 x 2 to 0 .8 x 4) mm
Wire Gauge	Solid conductor: 24–12 AWG Stranded conductor: 24–12 AWG	Solid conductor: 24–14 AWG Stranded conductor: 24–14 AWG (Twist stranded conductors before inserting into gate)

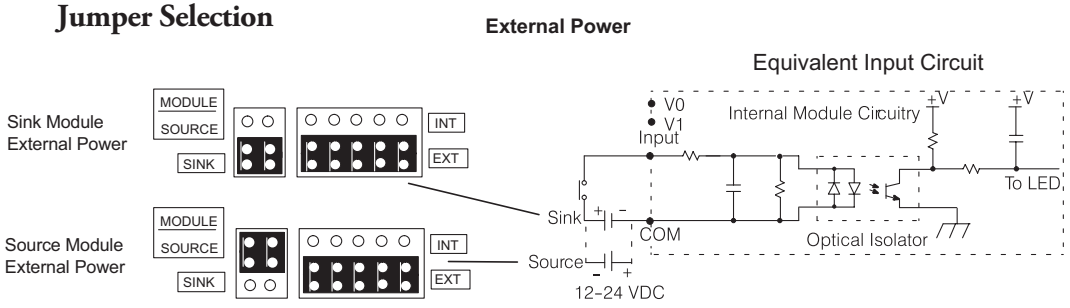
Selecting Internal 24 VDC Power Supply

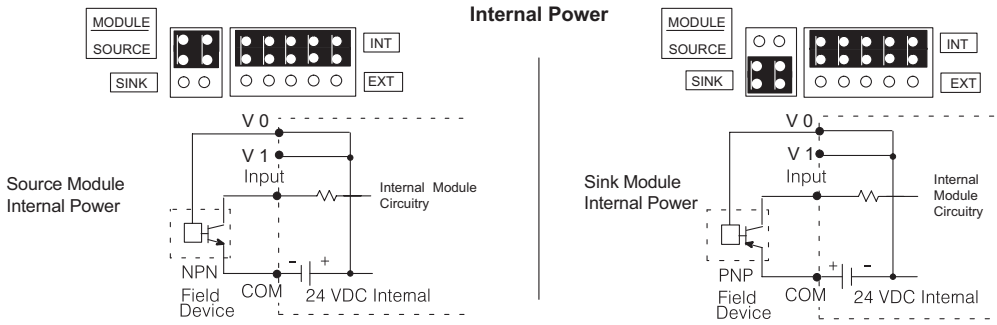
The DC input field devices can be powered from the integrated 24VDC power supply from the power supply bus. The T1K-08ND3 and T1K-16ND3 DC input modules have jumpers for selecting internal 24VDC power supply available for 2 and 3-wire field devices. The analog I/O and DC output modules do not have direct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

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



Jumper Selection

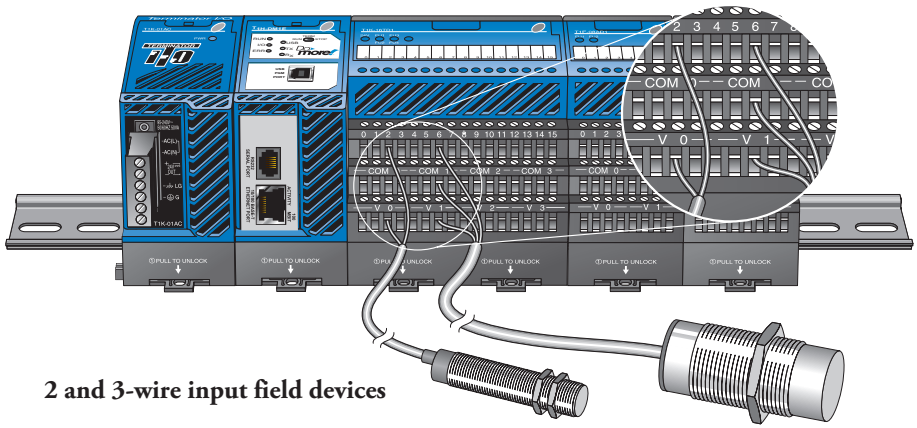




Using Internal 24VDC Base Power

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)



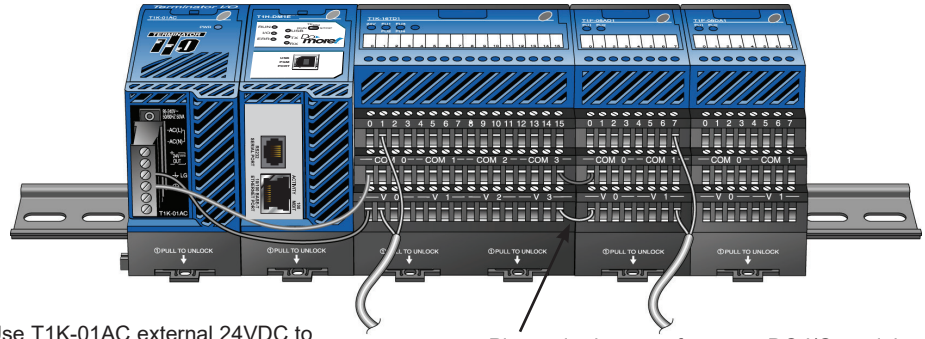
2 and 3-wire input field devices

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's power budget.

WARNING: The T1H Series PLC does not support any Hot-Swap features.

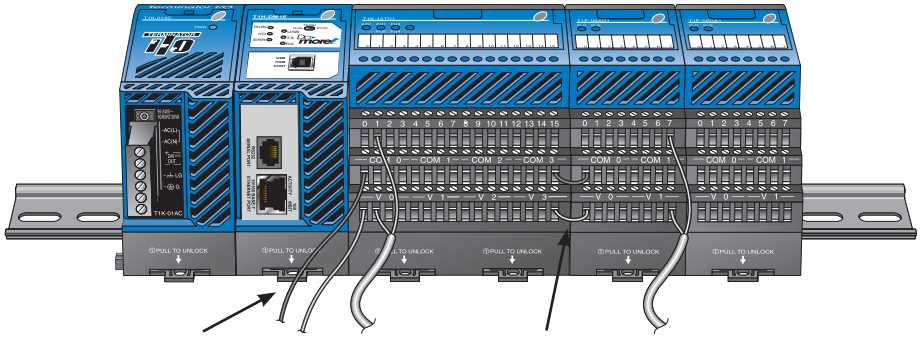
Using T1K-01AC for External 24VDC Power



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.

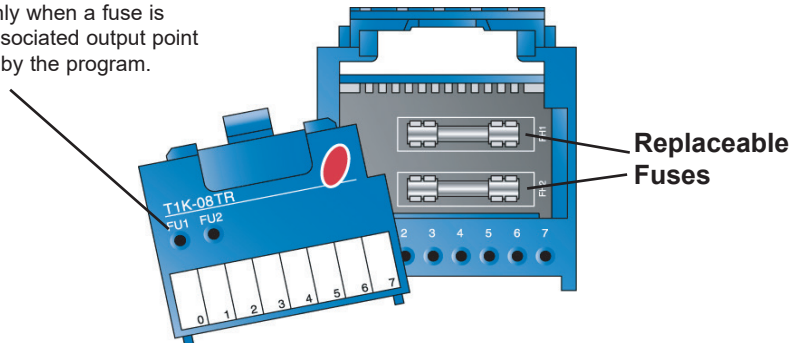
1. There is a limit to the size of wire the terminals can accept. The table on page 8-20 lists the suggested nominal AWG for each terminal base type.
2. Always use a continuous length of wire, do not combine wires to attain a needed length.
3. Use the shortest possible wire length.
4. Use wire trays 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 in Chapter 5. Be sure to remove system power before attempting to remove the I/O module from its base.

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.

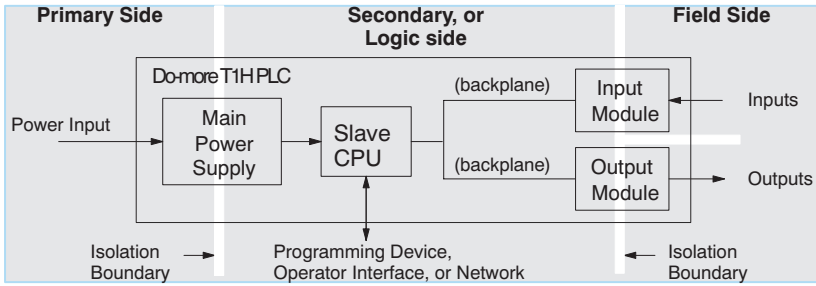


I/O Wiring Strategies

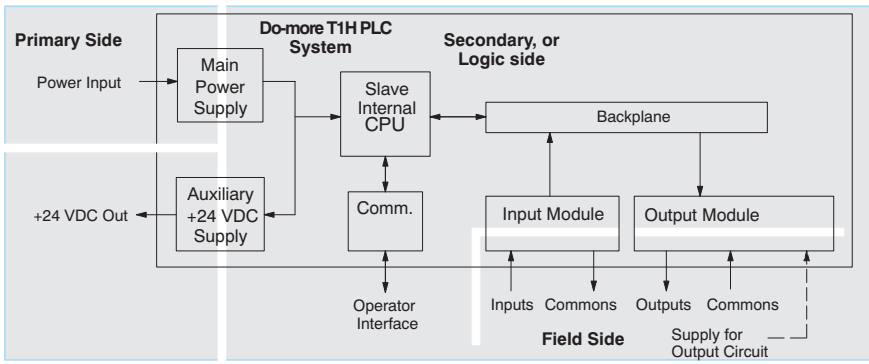
Terminator System Isolation Boundaries

The Terminator 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 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.



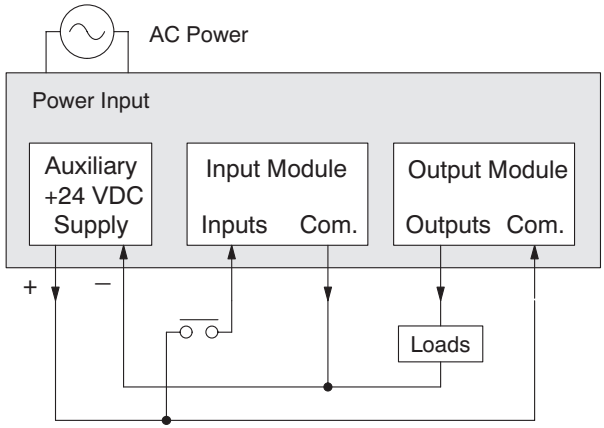
The next figure shows the physical layout of a Terminator system, as viewed from the front. In addition to the basic circuits covered above, AC-powered bases include an auxiliary +24VDC power supply with its own isolation boundary. Since the supply output is isolated from the other three circuits, it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



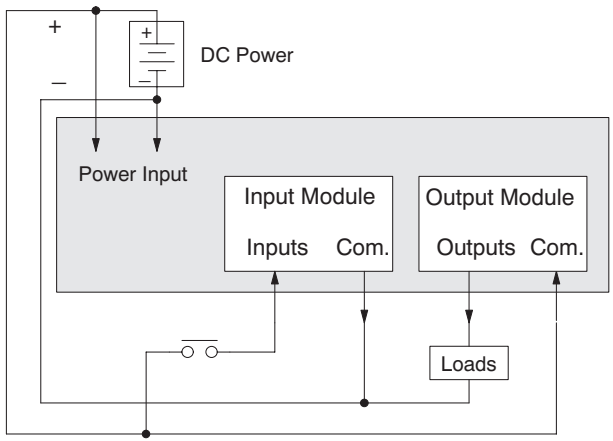
In some cases, using the built-in auxiliary +24VDC supply can result in a cost savings for your control system. It can power combined loads up to 500mA if power budget allows. Be careful not to exceed the current rating of the supply. If you are the system designer for your application, you may be able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



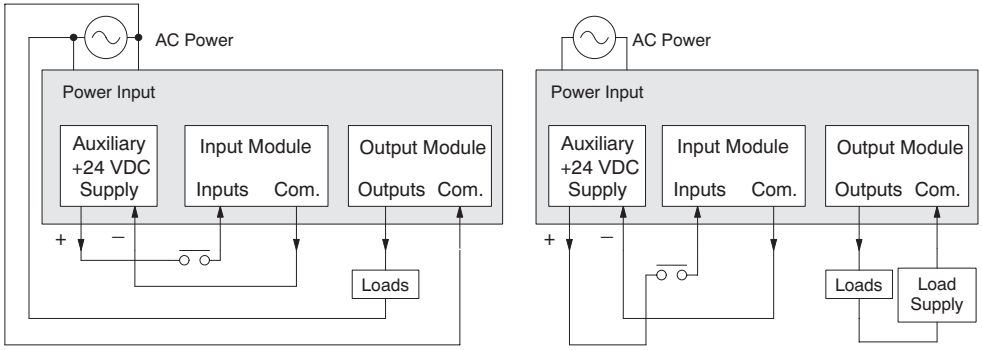
DC-powered units are designed for application environments in which low-voltage DC power is more readily available than AC. These include a wide range of battery-powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this type of application, all input devices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

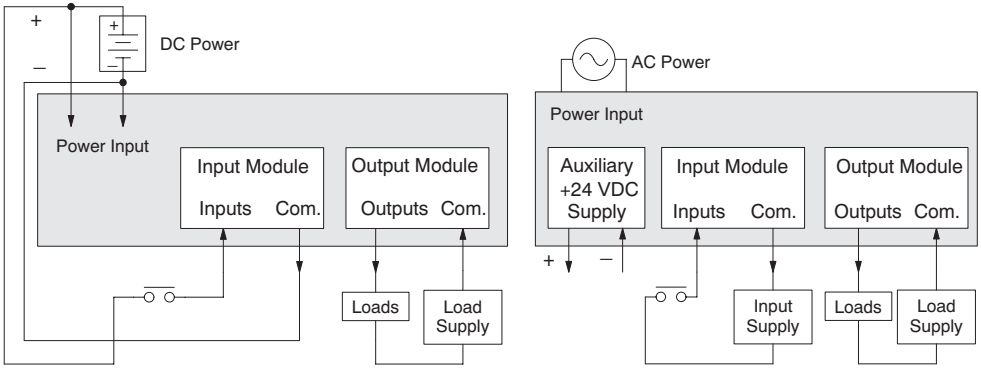
In most applications it will be necessary to power the input devices from one power source, and to power output loads from another source. Loads often require high-energy AC power, while input sensors use low-energy DC. If a machine operator is likely to come in close contact with input wiring, then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

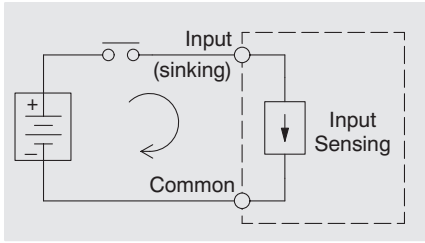
Before going further in the study of wiring strategies, you must have a solid understanding of "*sinking*" and "*sourcing*" concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring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

Sinking = provides a path to supply ground (-)

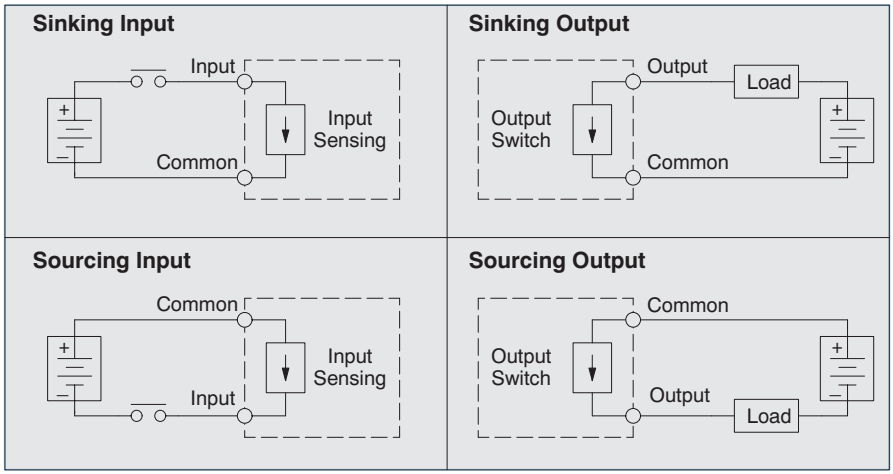
Sourcing = provides a path to supply source (+)

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.

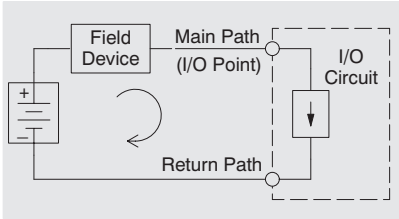


By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types as shown below. The I/O module specifications at the end of this chapter list the input or output type.

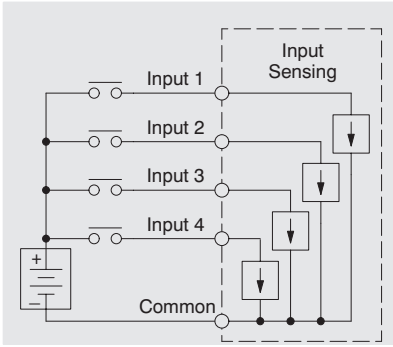


I/O "Common" Terminal Concepts

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..

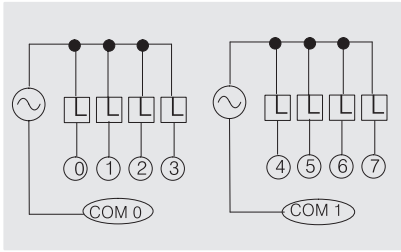


If there was unlimited space and budget for I/O terminals, every I/O point could have two dedicated terminals as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output points are in groups which share the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

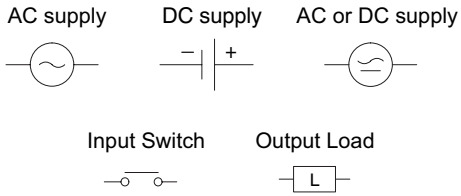


NOTE: *In the circuit above, the current in the common path is 4 times any channel's input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons.*

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:

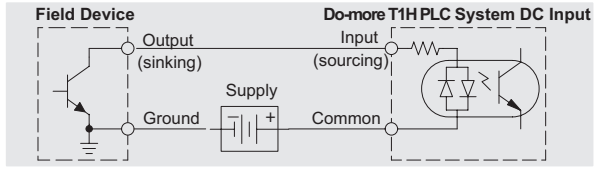


Connecting DC I/O to Solid State Field Devices

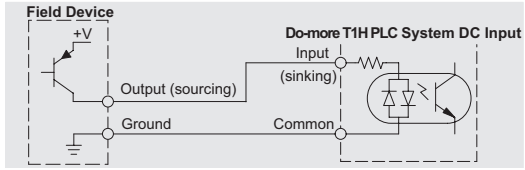
In the previous section on Sourcing and Sinking concepts, the DC I/O circuits were explained to only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *When connecting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



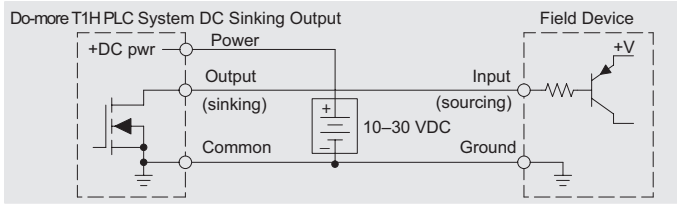
In the next circuit, a field device has an open-emitter PNP transistor output. It sources current to the input point, which sinks the current back to ground. Since the field device is sourcing current, no additional power supply is required.



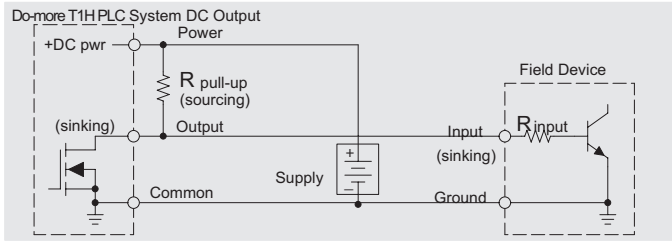
Solid State Output Loads

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



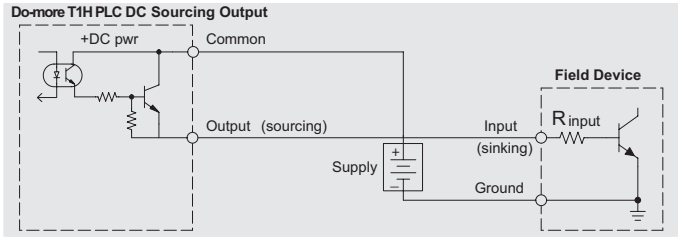
***NOTE 1**: DO NOT attempt to drive a heavy load (>25mA) with this pull-up method.*
***NOTE 2**: Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the Terminator I/O system output is 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 15 mA). Then use I input and the voltage of the external supply to compute $R_{pull\text{-}up}$. Then calculate the power $P_{pull\text{-}up}$ (in watts), in order to size $R_{pull\text{-}up}$ properly.

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

$$R_{pull\text{-}up} = \frac{V_{supply} - 0.7}{I_{input}} - R_{input} \qquad P_{pull\text{-}up} = \frac{V_{supply}^2}{R_{pullup}}$$

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



Relay Output Guidelines

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

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

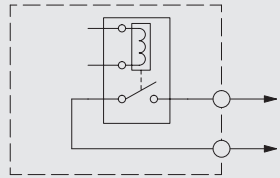
Some applications in which NOT to use relays:

- Loads that require currents under 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 with Form A contacts



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

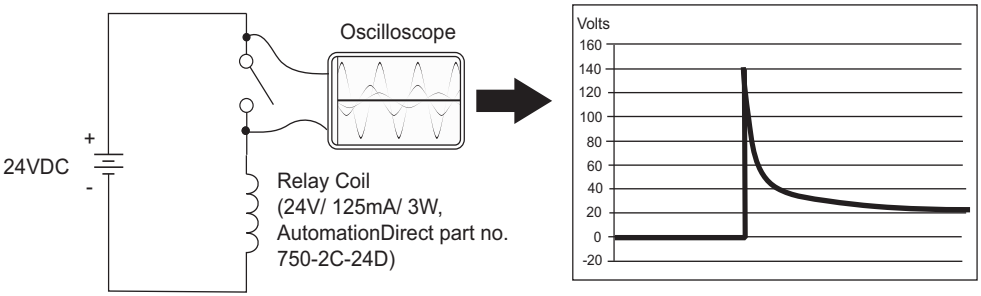
The following pages are intended to give a quick overview of the negative effects of transient voltages on a control system and provide some simple advice on how to effectively minimize them. The need for transient suppression is often not apparent to the newcomers in the automation world. Many mysterious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

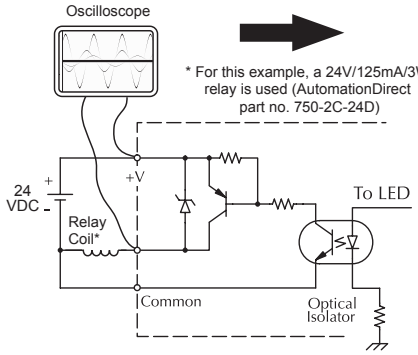
PLC's Integrated Transient Suppressors

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.

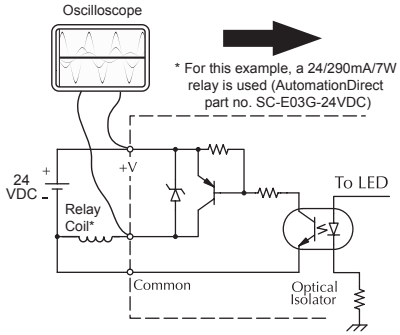
Example: Small Inductive Load with Only Integrated Suppression

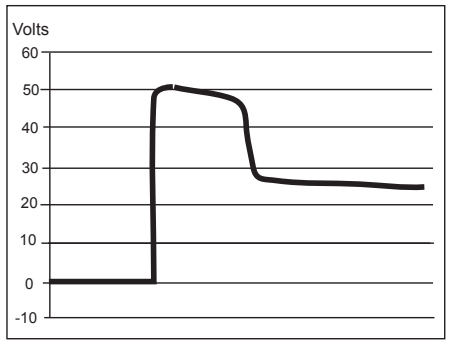
The next example uses the same circuit as above, but with a larger 24V/ 290mA/ 7W relay, thereby creating a larger inductive load. As you can see, the transient voltage generated is much worse, peaking at over 50V. Driving an inductive load of this size without additional transient suppression is very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

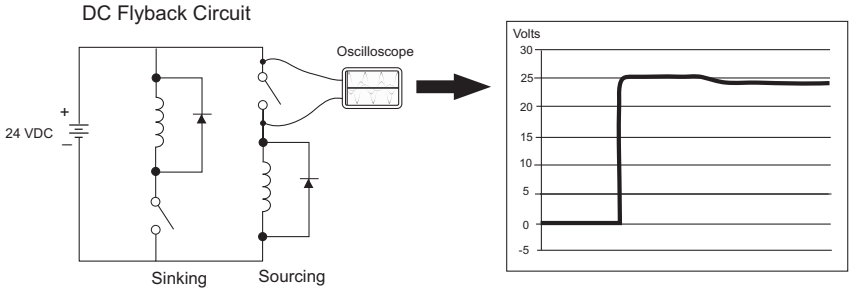




Types of Additional Transient Protection

DC Coils:

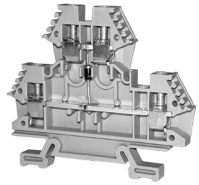
The most effective protection against transients from a DC coil is a flyback diode. A flyback diode can reduce the transient to roughly 1V over the supply voltage, as shown in this example.



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 an AutomationDirect DN-D10DR-A diode terminal block, a 600VDC power diode mounted in a slim DIN rail housing.

AD-ASMD-250
Protection Diode Module

784-4C-SKT-1
Relay Socket

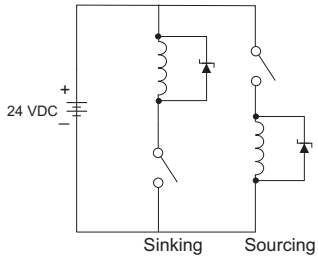


DN-D10DR-A
Diode Terminal Block

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.

An AutomationDirect 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.

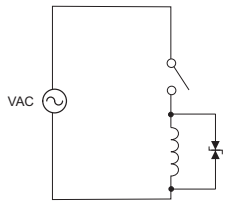
DC MOV or TVS Diode Circuit



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.

AC MOV or Bi-Directional Diode Circuit



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

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 24–48 VDC 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.

EUROPEAN UNION DIRECTIVES (CE)

In This Appendix:

European Union (EU) Directives

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

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

Member Countries

As of January 1, 2015, the members of the EU are Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and United Kingdom. Iceland, Liechtenstein, and Norway together with the EU members make up the European Economic Area (EEA) and all are covered by the Directives.

Applicable Directives

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

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

Compliance

Certain standards within each Directive already require mandatory compliance. The EMC Directive, which has gained the most attention, became mandatory as of January 1, 1996. The Low Voltage Directive became mandatory as of January 1, 1997.

Ultimately, we are all responsible for our various pieces of the puzzle. As manufacturers, we must test our products and document any test results and/or installation procedures that are necessary to comply with the Directives. As an end user, you are responsible for installing the products applying "good engineering practices" and in a manner which will ensure compliance is maintained.

You are also responsible for testing any combinations of products that may (or may not) comply with the Directives when used together. The end user of the products must comply with any Directives that may cover maintenance, disposal, etc. of equipment or various components. *Although we strive to provide the best assistance available, it is impossible for us to test all possible configurations of our products with respect to any specific Directive. Because of this, it is ultimately your responsibility to ensure that your machinery (as a whole) complies with these Directives and to keep up with applicable Directives and/or practices that are required for compliance.*

PLC systems manufactured by Koyo Electronics Industries, FACTS Engineering or HOST Engineering, when properly installed and used, conform to the Electromagnetic Compatibility (EMC), Low Voltage Directive, and Machinery Directive requirements of the following standards.

- **EMC Directive Standards Relevant to PLCs**
  EN50081–1 Generic emission standard for residential, commercial, and light industry
  EN50081–2 Generic emission standard for industrial environment.
  EN50082–1 Generic immunity standard for residential, commercial, and light industry
  EN50082–2 Generic immunity standard for industrial environment.
- **Low Voltage Directive Standards Applicable to PLCs**
  EN61010–1 Safety requirements for electrical equipment for measurement, control, and laboratory use.
- **Product Specific Standard for PLCs**
  EN61131–2 Programmable controllers, equipment requirements and tests. This standard replaces the above generic standards for immunity and safety. However, the generic emissions standards must still be used in conjunction with the following standards:
  -EN 61000-3-2 Harmonics
  -EN 61000-3-2 Fluctuations
- **Warning on Electrostatic Discharge (ESD)**
  We recommend that all personnel take necessary precautions to avoid the risk of transferring
  static charges to inside the control cabinet, and clear warnings and instructions should be
  provided on the cabinet exterior. Such precautions may include, the use of earth straps, similar
  devices or the powering off of the equipment inside the enclosure before the door is opened.
- **Warning on Radio Interference (RFI)**
  This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

General Safety

- External switches, circuit breaker or external fusing, are required for these devices.
- The switch or circuit breaker should be mounted near the PLC equipment.

Other Sources of Information

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

- BSI publication BS TH 42073: November 2000 – covers the safety and electrical aspects of the Machinery Directive
- EN 60204–1:2006 – Safety of Machinery; General electrical requirements for machinery, including Low Voltage and EMC considerations
- IEC 61000–5–2: EMC earthing and cabling requirements
- IEC 61000–5–1: EMC general considerations

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

Publications Office
2, rue Mercier
2985 Luxembourg
LUXEMBOURG

Quickest contact is via the web at:
http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards.

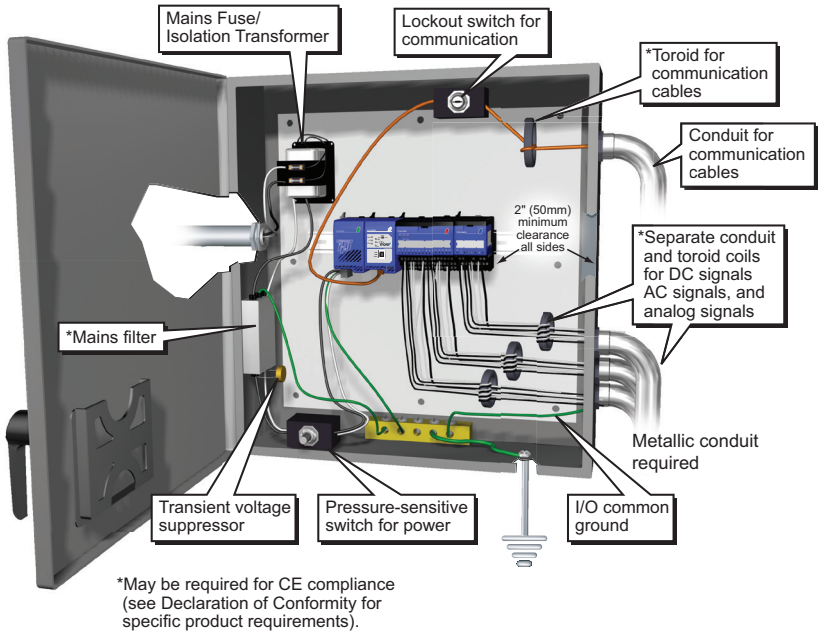
The 'Blue Guide' on the implementation of EU product rules 2016:

http://ec.europa.eu/DocsRoom/documents/18027/

Basic EMC Installation Guidelines

Enclosures

The simplest way to meet the safety requirements of the Machinery and Low Voltage Directives is to house all control equipment in an industry standard lockable steel enclosure. This normally has an added benefit because it will also help ensure that the EMC characteristics are well within the requirements of the EMC Directive. Although the RF emissions from the PLC equipment, when measured in the open air, are well below the EMC Directive limits, certain configurations can increase emission levels. Holes in the enclosure, for the passage of cables or to mount operator interfaces, will often increase emissions.



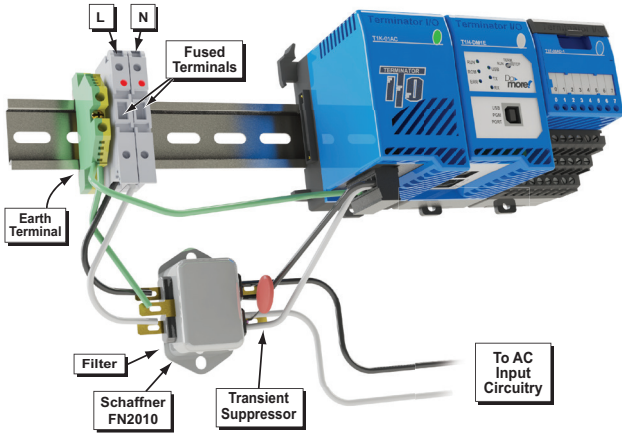
Electrostatic Discharge (ESD)

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

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

AC Mains Filters

The AC powered base power supplies require extra mains filtering to comply with the EMC Directive on conducted RF emissions. All PLC equipment has been tested with filters from Schaffner, which reduce emissions levels if the filters are properly grounded (earth ground). A filter with a current rating suitable to supply all PLC power supplies and AC input modules should be selected. We suggest the FN2080 for Do-more systems.



NOTE: *Very few mains filters can reduce problem emissions to negligible levels. In some cases, filters may increase conducted emissions if not properly matched to the problem emissions.*

Suppression and Fusing

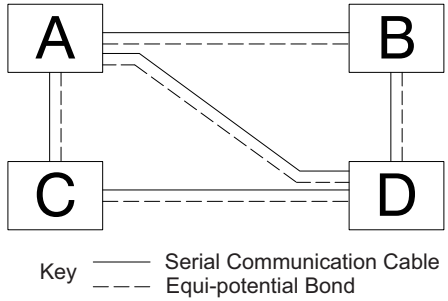
In order to comply with the fire risk requirements of the Low Voltage and Machinery Directive electrical standards (EN 61010–1 and EN 60204–1), by limiting the power into "unlimited" mains circuits with power leads reversed, it is necessary to fuse both AC and DC supply inputs. You should also install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

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

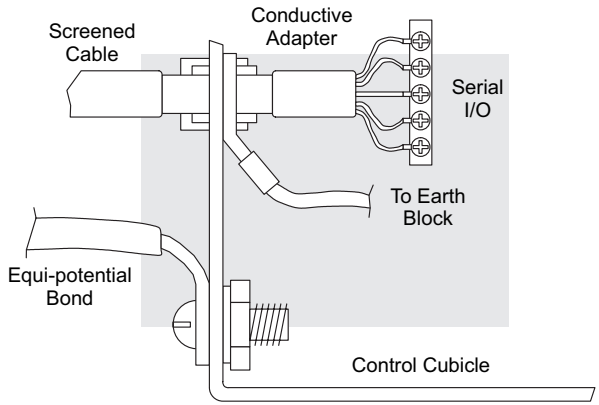
Internal Enclosure Grounding

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

Equi–potential Grounding



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



Communications and Shielded Cables

Good quality 24AWG minimum twisted-pair shielded cables, with overall foil and braid shields are recommended for analog cabling and communications cabling outside of the PLC enclosure. To date it has been a common practice to only provide an earth ground for one end of the cable shield in order to minimize the risk of noise caused by earth ground loop currents between apparatus. The procedure of only grounding one end, which primarily originated as a result of trying to reduce hum in audio systems, is no longer applicable to the complex industrial environment. Shielded cables are also efficient emitters of RF noise from the PLC system, and can interact in a parasitic manner in networks and between multiple sources of interference.

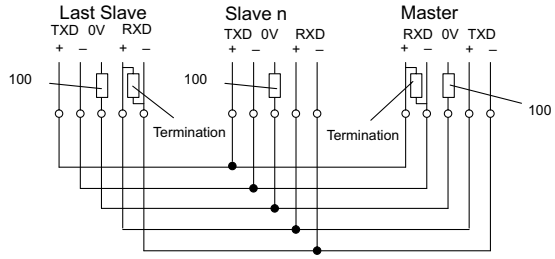
The recommendation is to use shielded cables as electrostatic "pipes" between apparatus and systems, and to run heavy gauge equipotential bond wires alongside all shielded cables. When a shielded cable runs through the metallic wall of an enclosure or machine, it is recommended in IEC 1000–5–2 that the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

Analog and RS232 Cables

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

Multi-drop Cables

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



Shielded Cables within Enclosures

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

Analog Modules and RF Interference

All AutomationDirect products are tested to withstand field strength levels up to 10V/m, which is the maximum required by the relevant EU standards. While all products pass this test, analog modules will typically exhibit deviations of their readings. This is quite normal, however, systems designers should be aware of this and plan accordingly.

When assembling a control system using analog modules, these issues must be adhered to and should be integrated into the system design. This is the responsibility of the system builder/ commissioner.

Network Isolation

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

Again, for further information on EU directives we recommend that you check the EU Commission's official site at:
http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards.

DC Powered Versions

Due to slightly higher emissions radiated by the DC powered versions of the Do-more T1H Series PLC, and the differing emissions performance for different DC supply voltages, the following stipulations must be met:

- The PLC must be housed within a metallic enclosure with a minimum amount of orifices.
- I/O and communications cabling exiting the cabinet must be contained within metallic conduit/trunking.

Items Specific to the Do-more T1H Series PLC

- The rating between all circuits in this product are rated as basic insulation only, as appropriate for single fault conditions.
- There is no isolation offered between the PLC and the analog inputs of this product.
- It is the responsibility of the system designer to earth one side of all control and power circuits, and to earth the braid of screened cables.
- This equipment must be properly installed while adhering to the guidelines of the installation manual DA–EU–M (available for download at AutomationDirect Technical Support Manuals), and the installation standards IEC 1000–5–1, IEC 1000–5–2 and IEC 1131–4.
- It is a requirement that all PLC equipment must be housed in a protective steel enclosure, which limits access to operators by a lock and power breaker. If access is required by operators or untrained personnel, the equipment must be installed inside an internal cover or secondary enclosure. A warning label must be used on the front door of the installation cabinet as follows:
  Warning: Exposed terminals and hazardous voltages inside.
- It should be noted that the safety requirements of the machinery directive standard EN60204–1 state that all equipment power circuits must be wired through isolation transformers or isolating power supplies, and that one side of all AC or DC control circuits must be earthed.
- Both power input connections to the PLC must be separately fused using 3 amp T-type anti–surge fuses, and a transient suppressor fitted to limit supply overvoltages.
- If the user is made aware by notice in the documentation that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.