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

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.

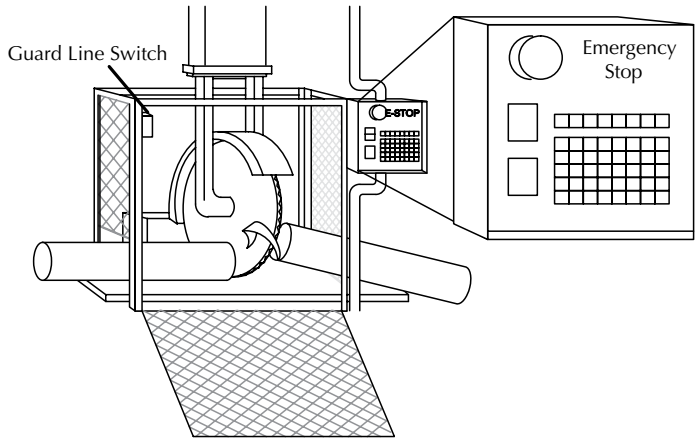
- Emergency stop switch for disconnecting system power
- Mechanical disconnect for output module power
- Orderly system shutdown sequence in the PLC control program

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.).



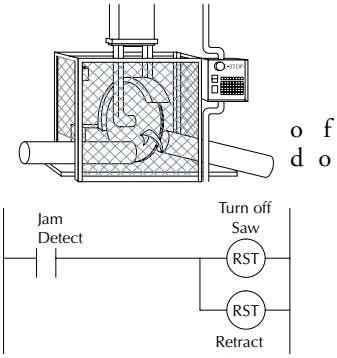
Emergency Power Disconnect

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 ensure 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 are usually 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

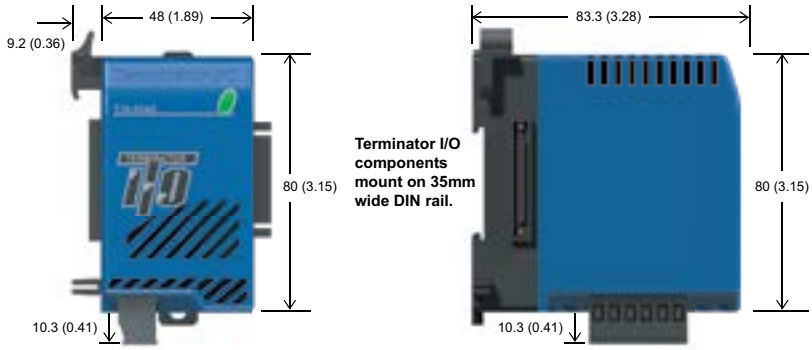
Before installing the Terminator I/O system you will need to know the dimensions of the components. The diagrams on the following pages provide the component dimensions to use in defining your enclosure specifications. Remember to leave room for potential expansion.

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

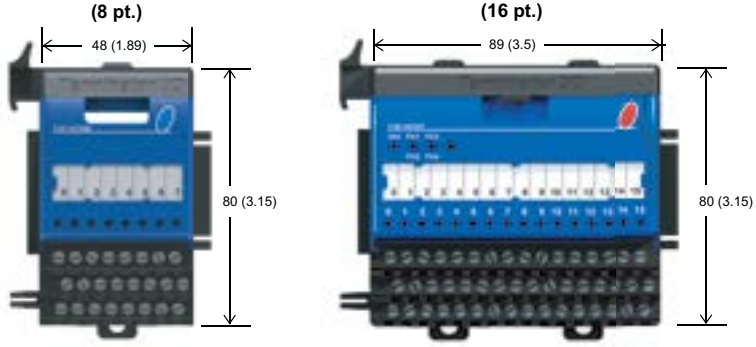
Dimensions

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

Base Controller / Power Supply

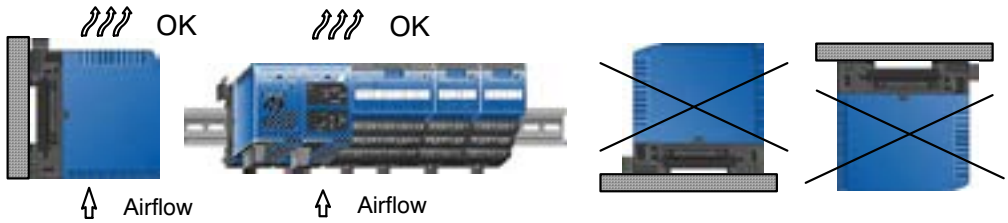


I/O Modules

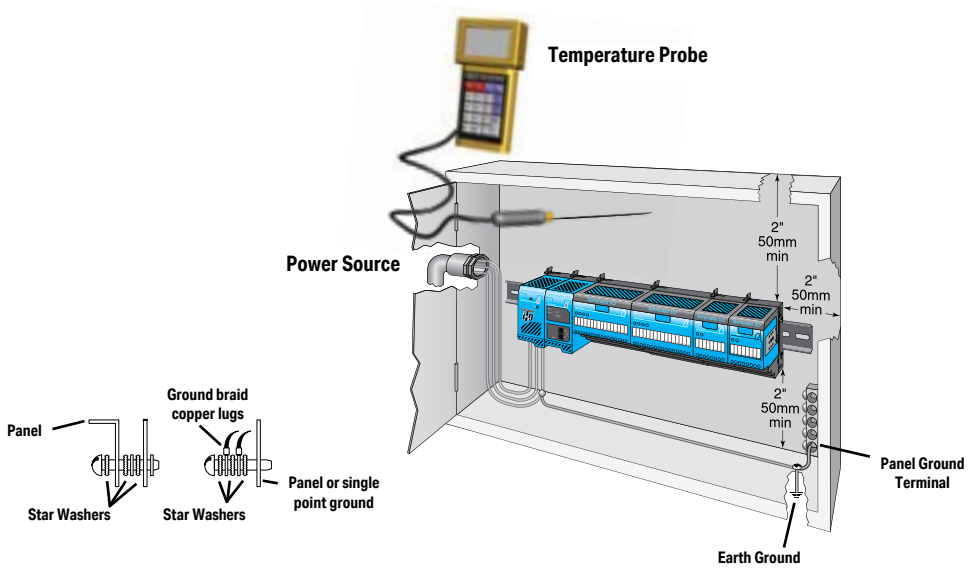


Panel Mounting and Layout

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



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



4. There must be a minimum of 2in. (50mm) clearance between the panel door and the nearest Terminator I/O component.
5. The ground terminal on the Terminator I/O power supply must be connected to a single point ground. Use copper stranded wire to achieve a low impedance. Copper eye lugs should be crimped and soldered to the ends of the stranded wire to ensure good surface contact. Remove anodized finishes and use copper lugs and star washers at termination points. A general rule is to achieve a 0.1 ohm of DC resistance between the Terminator I/O slave and the single point ground.
6. There must be a single point ground (i.e. copper bus bar) for all devices in the panel requiring an earth ground return. The single point of ground must be connected to the panel ground termination. The panel ground termination must be connected to earth ground. For this connection you should use 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 I/O. There are several methods of providing an adequate common ground reference, including: a) Installing a ground rod as close to the panel as possible. b) Connection to incoming power system ground.
7. Properly evaluate any 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 I/O 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 ensure 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 I/O system. Applications of Terminator I/O systems vary and may require additional features. The minimum considerations for enclosures include:

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

Environmental Specifications

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

Specification	Rating
Storage temperature	-4°F to 158°F (-20°C to 70°C)
Ambient operating temperature	32°F to 131°F (0°C to 55°C)
Ambient humidity*	5%–95% relative humidity (non-condensing
Vibration resistance	MIL STD 810C, Method 514.2
Shock resistance	MIL STD 810C, Method 516.2
Noise Immunity	NEMA (ICS3-304) Impulse noise 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 24VDC Output	20–28 VDC, 10% ripple max. 300mA. Max. 500mA @ 24VDC can be achieved if the 5VDC power budget rating of 2000mA is reduced to 1500mA. See power budget section.	None

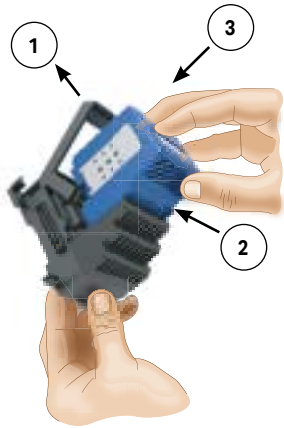
Agency Approvals

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

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

Assembling the Components

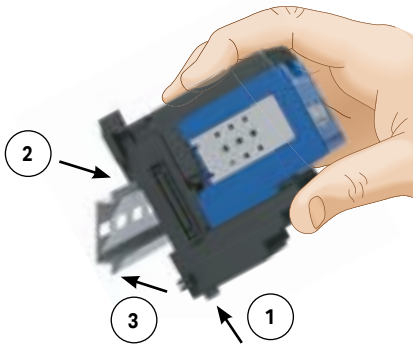
Assembling the I/O Modules and Bases

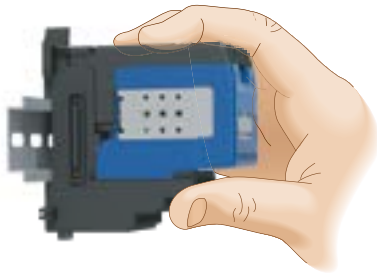


INSERT MODULE INTO BASE

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

Mounting the Components on DIN Rail





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

INSTALL ON DIN RAIL

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

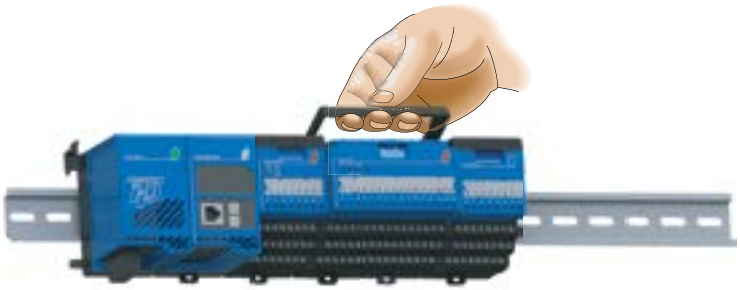
Connecting the Components on the DIN Rail

SLIDE ASSEMBLY INTO POSITION ON 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 base controller. Additional power supplies should be added between I/O modules as necessary to meet power budget requirements (see ch 3, page 3-18). Each power supply powers the modules to its right, but is interrupted by the next power supply.*

Removing I/O Modules from the Base



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

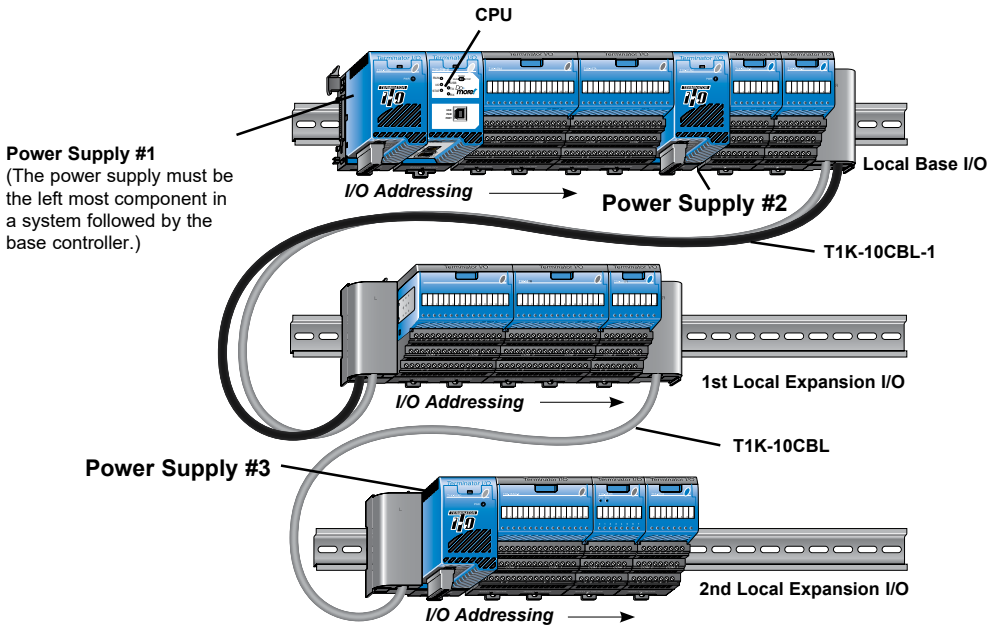
To remove a module assembly from the DIN rail, lift the clip arm up and slide the module assembly away from the adjacent module. Pull the locking tab down (out) and lift the assembly off the DIN rail. Refer to the "I/O Module Hot Swap Feature" section in Chapter 3 to remove an I/O module with Terminator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

Multiple Power Supplies / Local Expansion Configurations

Multiple Power Supply Configuration

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

Expansion cables are available in two configurations: one that 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.

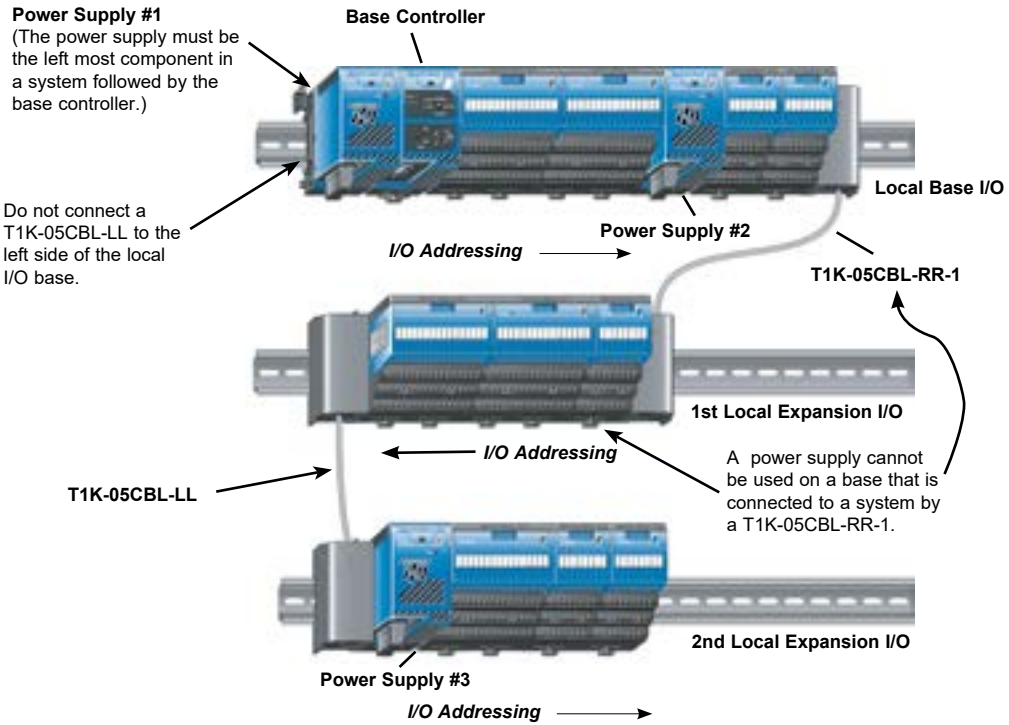


Example Using T1K-10CBL and T1K-10CBL-1 Expansion Cables

System shown above: The first power supply powers the base controller and the two I/O modules to its right. The second power supply powers the 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 serves as an example only, your power budget requirements will vary depending on the I/O modules used.

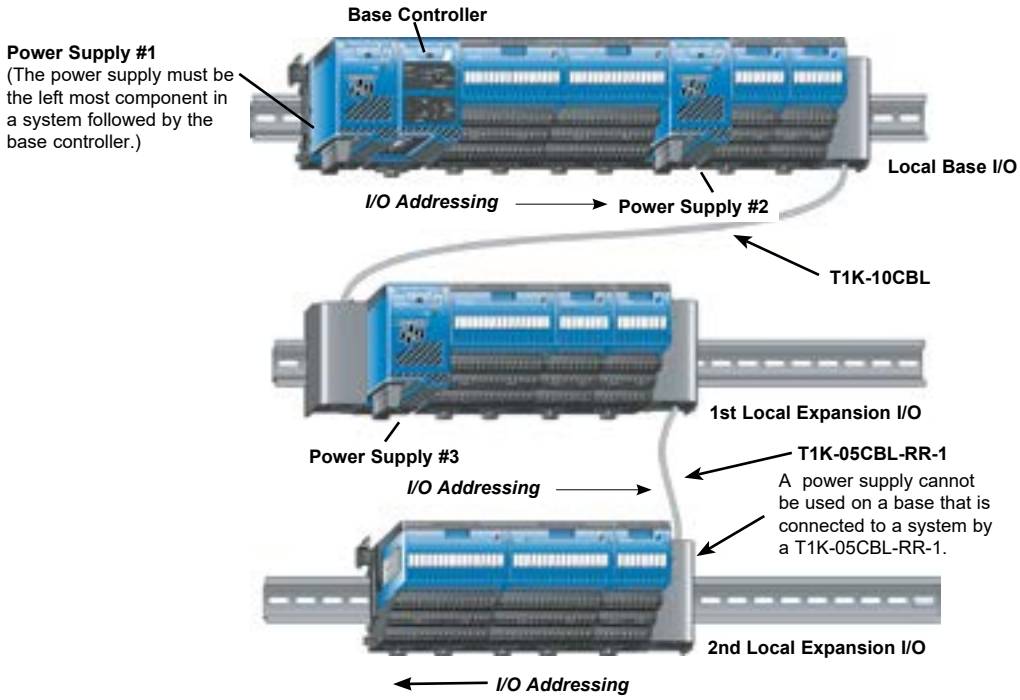
Example Using T1K-05CBL-RR-1 and T1K-05CBL-LL Expansion Cables

NOTE: *The T1K-05CBL-RR-1 expansion cable with an isolated 24VDC lead was discontinued in 2015 and is no longer available. The following examples show this cable. As an alternative, consider using the T1K-10CBL(-1) cables as shown in the example on the preceding page.*



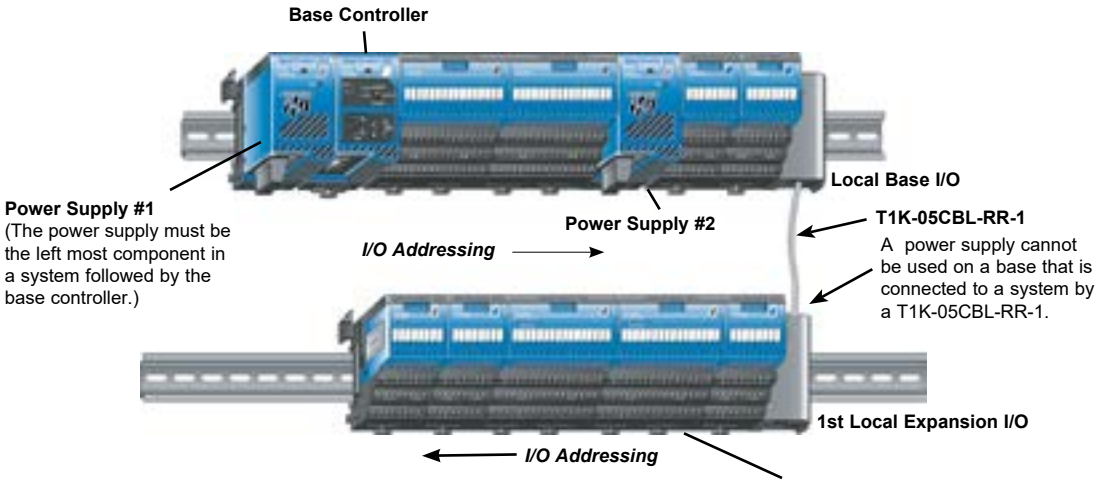
System shown above: The first power supply powers the base controller and the two I/O modules to its right. The second power supply powers the two modules to its right and the three I/O modules on the first local expansion base. When a T1K-05CBL-RR-1 is used, the expansion I/O assignments are from right 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 serves as an example only, your power budget requirements will 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 base controller 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 serves as an example only, your power budget requirements will vary depending on the I/O modules used.

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



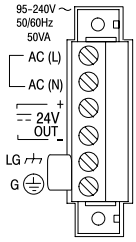
System shown above: The first power supply powers the base controller and the two I/O modules to its right. The second power supply powers the two modules to its right and the five I/O modules on the first local expansion base. When a T1K-05CBL-RR-1 is used, the expansion I/O assignments are from right 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 serves as an example only, your power budget requirements will vary depending on the I/O modules used.

Power Supply Wiring Guidelines

Power Wiring

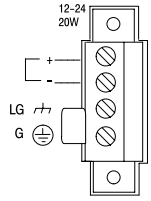
The diagram below shows the terminal connections located on the Terminator I/O AC and DC power supplies. The table below shows the wire size and the recommended power supply terminal screw torque.

110/220 VAC Terminal Strip



T1K-01AC

12/24 VDC Terminal Strip



T1K-01DC

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)