INSTALLATION, WIRING AND SPECIFICATIONS

CHAPTER 2

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 and/or damage equipment. Do not rely on the automation system alone to provide a safe operating environment. Sufficient emergency circuits should be provided to stop either partially or totally the operation of the PLC or the controlled machine or process. These circuits should be routed outside the PLC in the event of controller failure, so that independent and rapid shutdown is available. Devices, such as "mushroom" switches or end of travel limit switches, should operate motor starter, solenoids, or other devices without being processed by the PLC. These emergency circuits should be designed using simple logic with a minimum number of highly reliable electromechanical components. Every automation application is different, so there may be special requirements for your particular application. Make sure to 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 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.

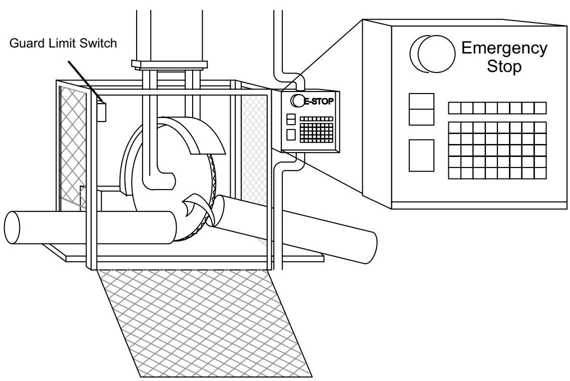
- Emergency stop switch for disconnecting system power
- Mechanical disconnect for output module power
- Orderly system shutdown sequence in the PLC control program

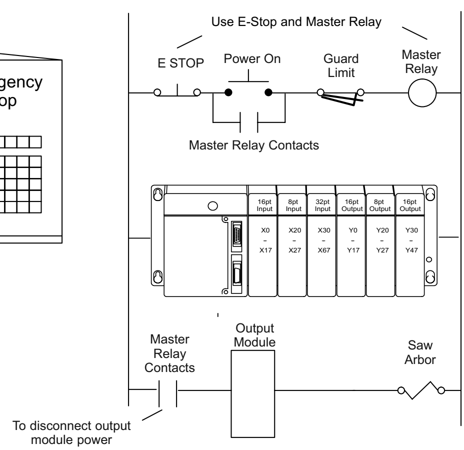
Emergency Stops

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.).





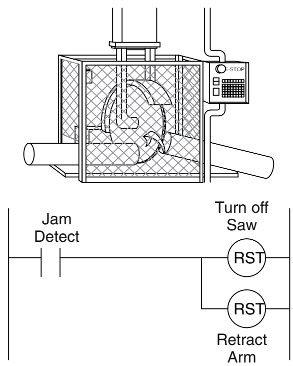
Emergency Power Disconnect

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 “out rush”. 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 are usually things such as jammed parts, etc., that do not pose a risk of personal injury or equipment damage.



WARNING 1: 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.
WARNING 2: This equipment is designed for use in Pollution Degree 2 environments (installed within an enclosure rated at least IP54).
WARNING 3: Transient suppression must be provided to prevent the rated voltage from being exceeded by 140%.

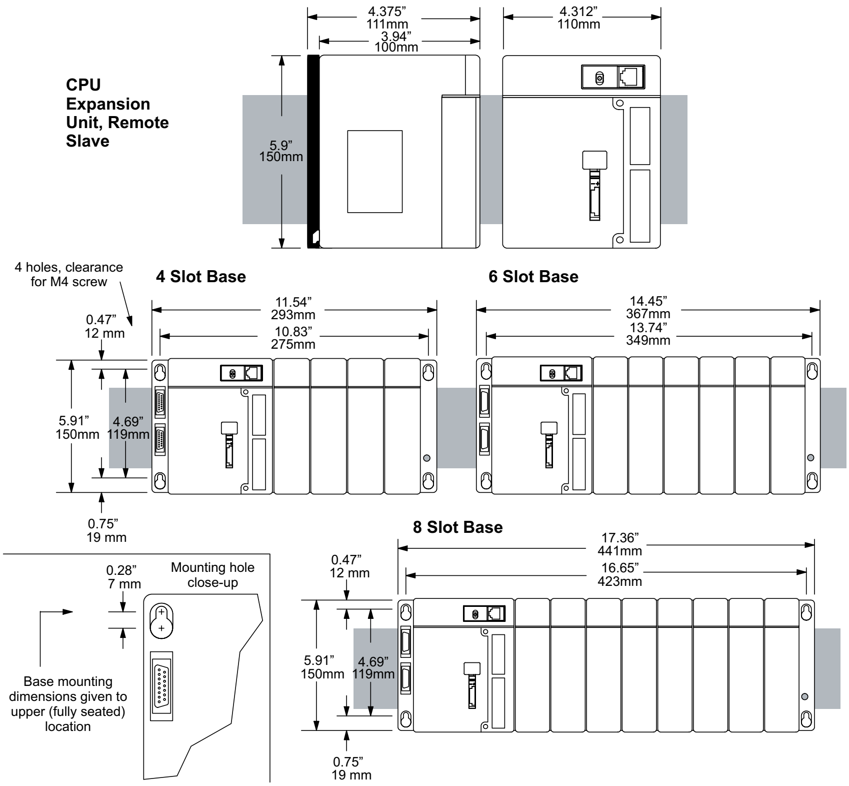
Mounting Guidelines

In addition to the panel layout guidelines, other specifications can affect the installation of a PLC system. Always consider the following:

- Environmental specifications
- Power Supply specifications
- Regulatory Agency Approvals
- Enclosure Selection and Component Dimensions.

Base Dimensions

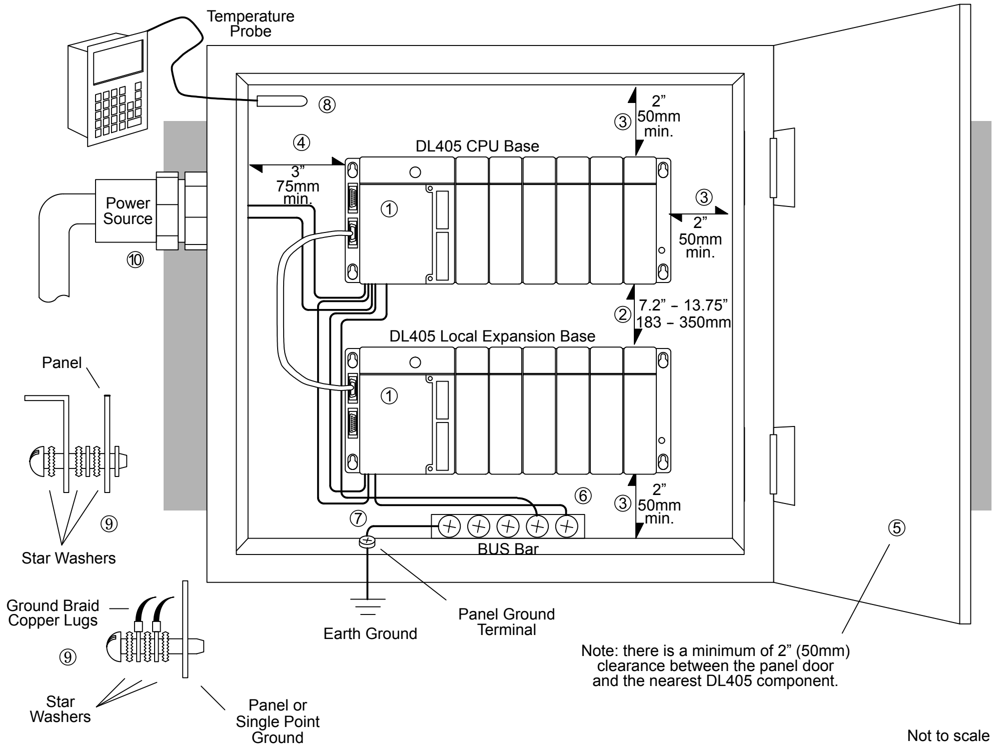
The following diagram shows the outside dimensions and mounting hole locations for the 4-slot, 6-slot, and 8-slot bases. Make sure you follow the installation guidelines to allow proper spacing from other components.



Panel Layout and Clearances

There are many things to consider when designing the panel layout. The following items correspond to the diagram shown on the following page. Note, there may be additional requirements, depending on your application and use of other components in the cabinet.

- The bases must be mounted horizontally to provide proper ventilation.
- There should be a minimum of 7.2″ (183mm) and a maximum of 13.75″ (350mm) between bases.
- A minimum clearance of 2″ (50mm) between the base and the top, bottom and right side of the cabinet should be provided.
- A minimum clearance of 3″ (75mm) between the base and the left side of the cabinet should be provided.
- There must be a minimum of 2″ clearance between the panel door and the nearest DL405 component.
- The ground terminal on the DL405 base 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. A general rule is to achieve a 0.1 ohm of DC resistance between the DL405 base and the single point ground.
- There must be a single point ground (i.e. copper bus bar) for all devices in the panel requiring an earth ground return. The single point of ground must be connected to the panel ground termination. The panel ground termination must be connected to earth ground. For this connection you should use #12 AWG stranded copper wire as a minimum. Minimum wire sizes, color coding, and general safety practices should comply with appropriate electrical codes and standards for your region. A good common ground reference (Earth ground) is essential for proper operation of the DL405. 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.
- Properly evaluate any installations where the ambient temperature may approach the lower or upper limits of the specifications. Place a temperature probe in the panel, close the door and operate the system until the ambient temperature has stabilized. If the ambient temperature is not within the operating specification for the DL405 system, measures such as installing a cooling/heating source must be taken to get the ambient temperature within the DL405 operating specifications.
- 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, coating or corrosion should be removed in the area of contact.
- The DL405 system is designed to be powered by 110 VAC, 220 VAC, or 24 VDC normally available throughout an industrial environment. Isolation transformers and noise suppression devices are not normally necessary, but may be helpful in eliminating/reducing suspect power problems.



Enclosures

Your selection of a proper enclosure is important to ensure safe and proper operation of your DL405 system. Applications of DL405 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

Agency Approvals

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

- UL (Underwriters' Laboratories, Inc.)
- CSA (Canadian Standards Association)
- CUL (Canadian Underwriters' Laboratories, Inc.)

To obtain the most current agency approval information, see the Agency Approval Checklist section on the specific component part number web page.

Environmental Specifications

The following table lists the environmental specifications that generally apply to the DL405 system (CPU, Bases, I/O Modules). The I/O module operation may fluctuate depending on the ambient temperature and your application. Please refer to the appropriate I/O modules specifications for the temperature derating curves applying to specific modules.

Specifications	Rating
Storage Temperature	–4° F to 158° F (–20° C to 70° C)
Ambient Operating Temperature	32° F to 140° F (0° C to 60° C)
Ambient Humidity *	30%–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)
Atmosphere	No corrosive gases

*Equipment will operate below 30% 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

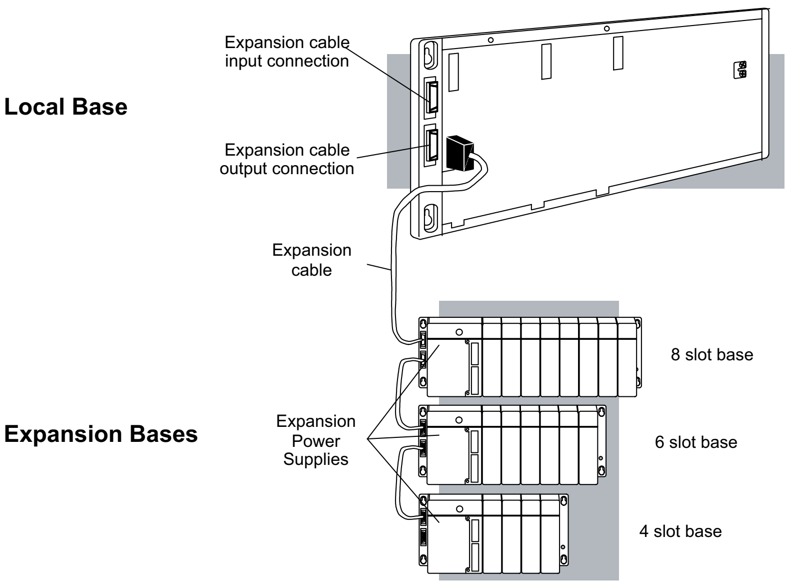
The power source must be capable of supplying voltage and current complying with the base power supply specifications.

Specifications	D4-454	D4-454DC-1
Input Voltage Nominal	120VAC	24VDC
Input Voltage Range	100–120 VAC; 196–240 VAC (+10% -15%)	20–29 VDC
Input Voltage Ripple	N/A	< 10%
Inrush Current, Maximum	20A	10A
Power Consumption, Maximum	50VA	38W
Voltage Withstand (dielectric)	1 min at 1500 VAC between primary, secondary, field ground and run relay	
Insulation Resistance	10MΩ at 500VDC	
Output Voltage auxiliary power supply	20–28 VDC (24V nominal), ripple more than 1V P-P	
Output Current auxiliary power supply	24VDC @ 400mA maximum	

Installing DL405 Bases

Three Sizes of Bases

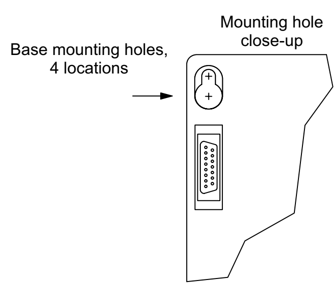
All I/O configurations of the DL405 will use a selection of either 4, 6, or 8 slot base(s). Local and expansion bases can be 4, 6, or 8 slot in size. Local and expansion bases differ only in how they are wired in a system.



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

The CPU/Expansion Unit/Remote Slave must always be installed in the left-most slot in a base. This slot is marked on the base as P/S, CPU. The I/O modules can be installed in any remaining slots. It is not necessary for all slots to be filled for your system to work correctly. You may use filler modules to fill the empty slots in the base.

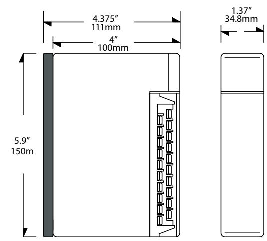
The base is secured to the equipment panel or machine using four M4 screws in the corner locations shown to the right. The mounting cut-outs allow removal of the base after installation, without completely removing the mounting screws. Full mounting template dimensions are given in the previous section on Mounting Guidelines.



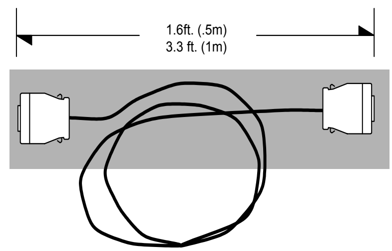
Component Dimensions

Before installing your PLC system you will need to know the dimensions for the components in your system. The diagram on this page provide the component dimensions and should be used to define your enclosure specifications. Remember to leave room for potential expansion. Please see the Product Weights Appendix for the weights for each component.

I/O modules

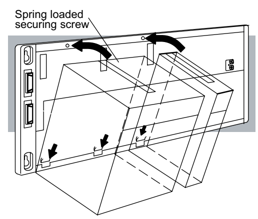


Base Expansion Cable



Installing Components in the Base

- The components have plastic tabs at the bottom and a screw that the top.
- With the device tilted slightly forward, hook the plastic tabs into the notch on the base.
- Then gently push the top of the component back toward the base until it is firmly installed into the base.
- Now tighten the screw at the top of the device to secure it to the base.



WARNING 1: To minimize the potential damage to the CPU/Module rear base connector(s), do not force the module into position. It should glide smoothly into place. If it does not glide smoothly into place, please check the following:
a) Visually inspect the base connector to make sure the mating holes are not blocked.
b) Visually inspect the pins on the rear connector making sure they are not bent or pushed in.
c) Make sure the plastic tabs on the bottom of the CPU/Module are level before tilting the module into position. Damage to the connectors may occur if the above information is not considered.
WARNING 2: To minimize the risk of electrical shock, personal injury or equipment damage, always disconnect the system power before installing or removing any system equipment.

CPU and Expansion Unit Wiring Guidelines

The main power terminal connections are under the front covers of the D4-454 CPUs and DL405 Expansion Units. The list below describes the function of each of the terminal screws. Most of the terminal screws are identical between the CPU and the Expansion unit. If the terminal screw only applies to one of the units it will be noted.

Run Relay - (CPU only) indicates to an external device when the CPU is in Run Mode by contact closure. Its normally-open contacts can also remove power from critical I/O points if CPU comes out of Run Mode.

24VDC Auxiliary Power - can be used to power field devices or I/O modules requiring external power. It supplies up to 400mA of current at 20–28 VDC, ripple less than 1 V P-P. (Not available on DC CPU model.)

Logic Ground - internal ground to the system which can be tied to field devices/ communication ports to unite ground signals.

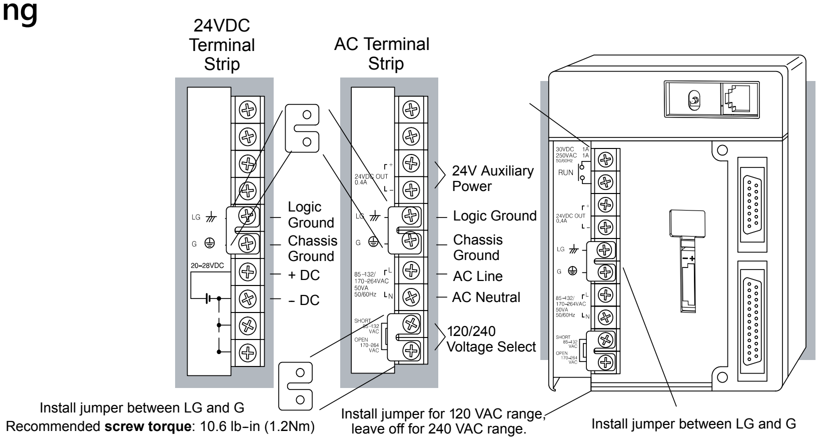
Chassis Ground - where earth ground is connected to the unit.

AC Power - where the line (hot) and the neutral (common) connections are made to the CPU/Expansion Unit. (This is also where the DC power source is connected for the 24VDC CPU. The positive connection is tied to line and the negative connection is tied to ground.

120/240 Voltage Select - a jumper across two of the terminals determines the voltage selection. Install the jumper to select 120VAC input power, and remove the jumper to select 240VAC power input (the jumper is not required for DC-powered CPUs or Expansion Units.)

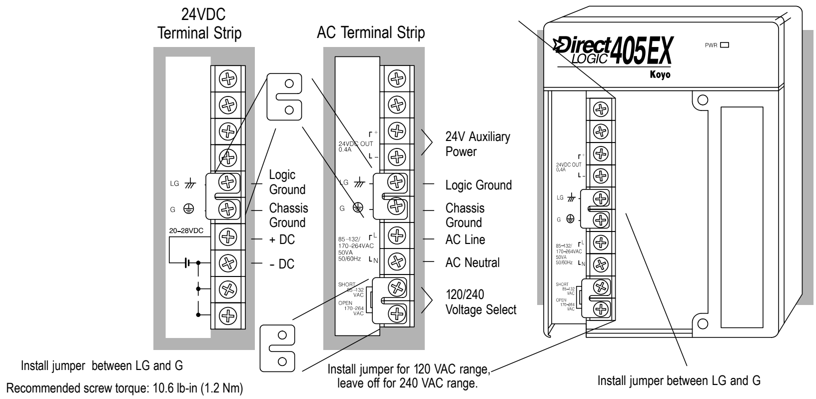
WARNING: Damage will occur to the power supply if 240 VAC is connected to the terminal connections with the 120VAC jumper installed. Once the power wiring is connected, install the protective cover to avoid risk of accidental shock.

CPU Wiring



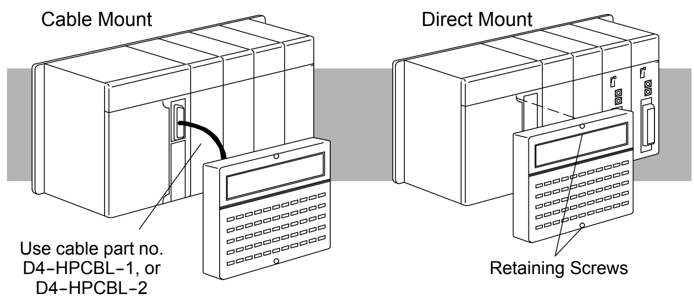
Expansion Unit Wiring

The following diagram details the appropriate connections for each terminal.



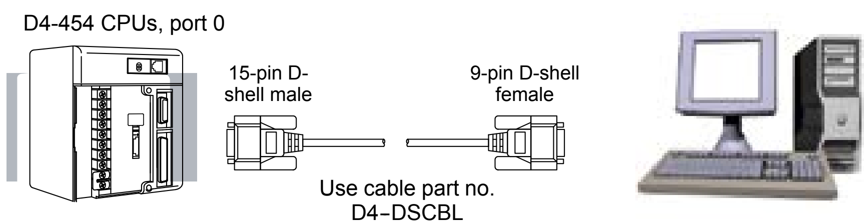
Connecting Programming Devices

You can mount the Handheld directly to Port 0 of the D4-454 CPU (15-Pin D-Shell connector), or you can use a 9ft (3m) or 4.6 ft (1.5 m) cable as shown below.

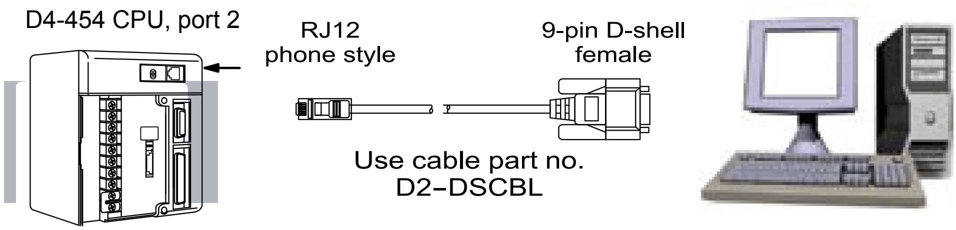


DirectSOFT Programming

The standard port for use in DirectSOFT programming is the 15-pin port 0 on both D4-454 CPUs. The cable shown below is approximately 12 feet (3.6m) long.

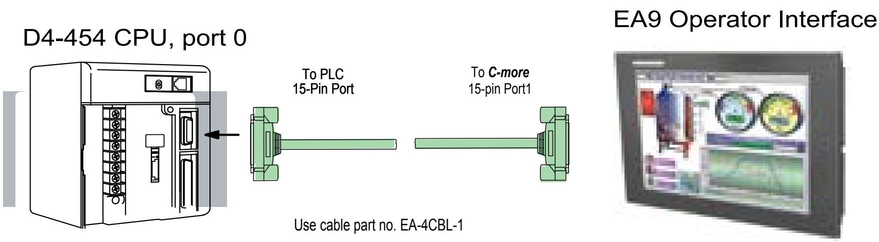


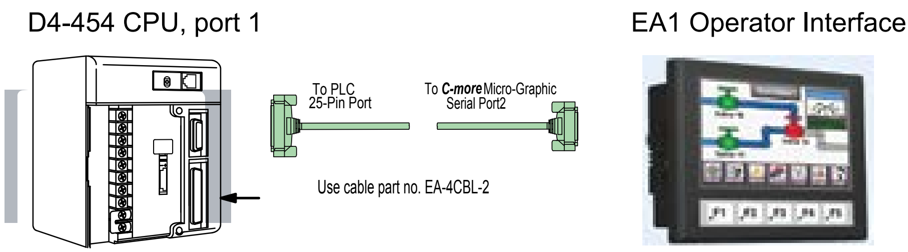
On the D4-454, you may use port 2 instead for DirectSOFT programming. The cable shown below is approximately 12 feet (3.66 m) long.

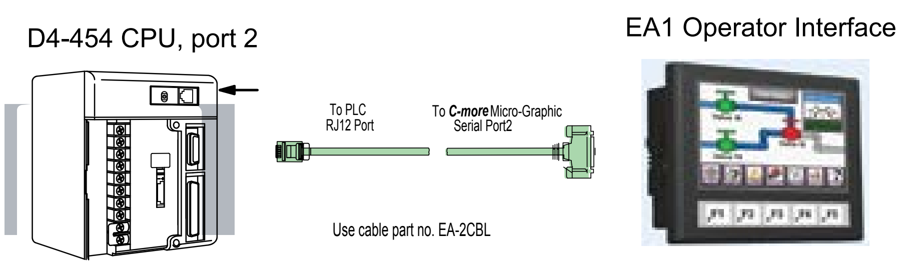


Connecting Operator Interface Devices

It is very common to connect an operator interface to DL405 PLCs. The C-more touch panels provide a graphical interface designed to display graphics and animation, and to exchange data to and from the PLC by means of the touch screen.





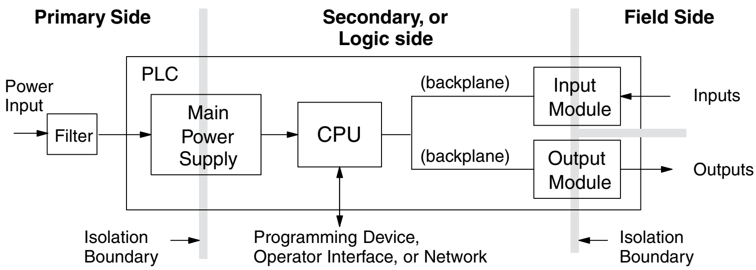


I/O Wiring Strategies

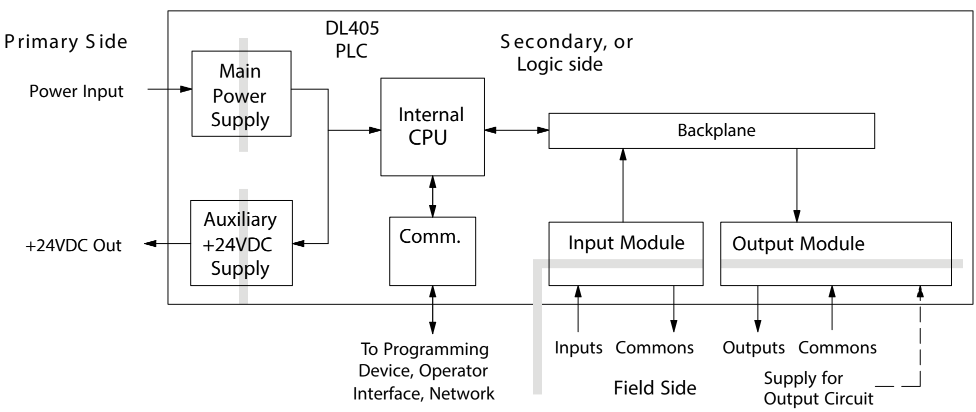
The DL405 PLC system is very flexible and will work in many different wiring configurations. By studying this section before actual installation, you can probably find the best wiring strategy for your application. This will help to lower system cost, wiring errors, and avoid safety problems.

PLC Isolation Boundaries

PLC 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 powerline filter will provide isolation between the power source and the power supply. 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 PLC, 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 DL405 PLC system, as viewed from the front. In addition to the basic circuits covered above, AC- powered CPUs include an auxiliary +24 VDC 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.

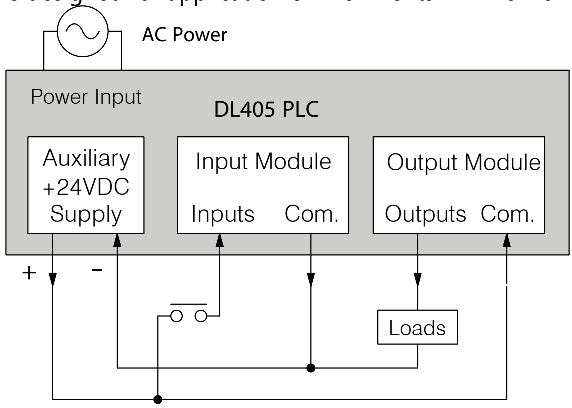


Powering I/O Circuits with the Auxiliary Supply

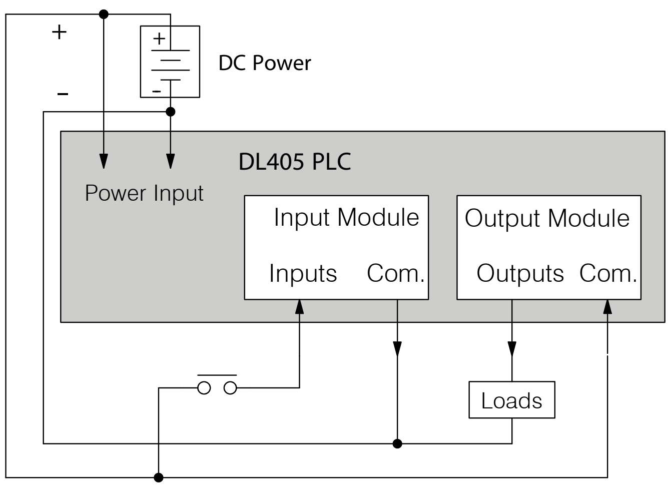
In some cases, using the built-in auxiliary +24VDC supply can result in a cost savings for your control system. It can power combined loads up to 400mA. Be careful not to exceed the current rating of the supply. If you are the system designer for your application, you may be able to select and design in field devices which can use the +24VDC auxiliary supply.

The D4-454 CPU features the 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 (400mA limit).

The D4-454DC-1 is designed for application environments in which low-voltage DC



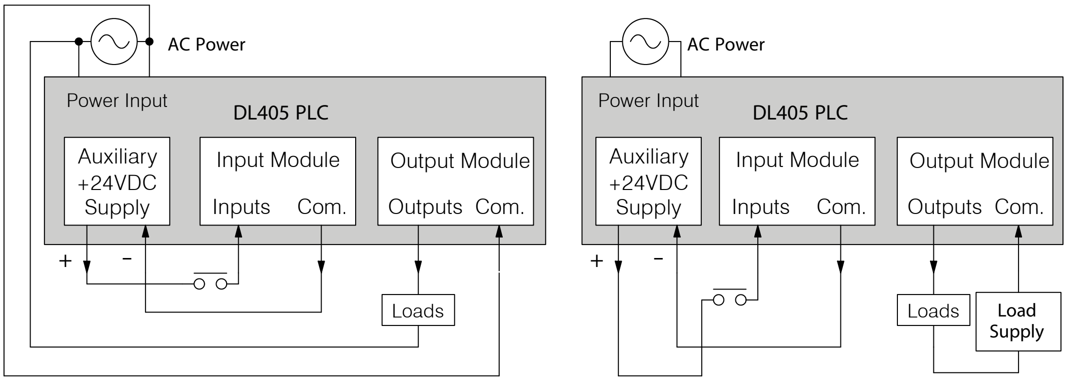
power is more readily available than AC. These include a wide range of battery–powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this application type, all input devices and output loads typically use the same DC power source. Typical wiring for DC-powered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



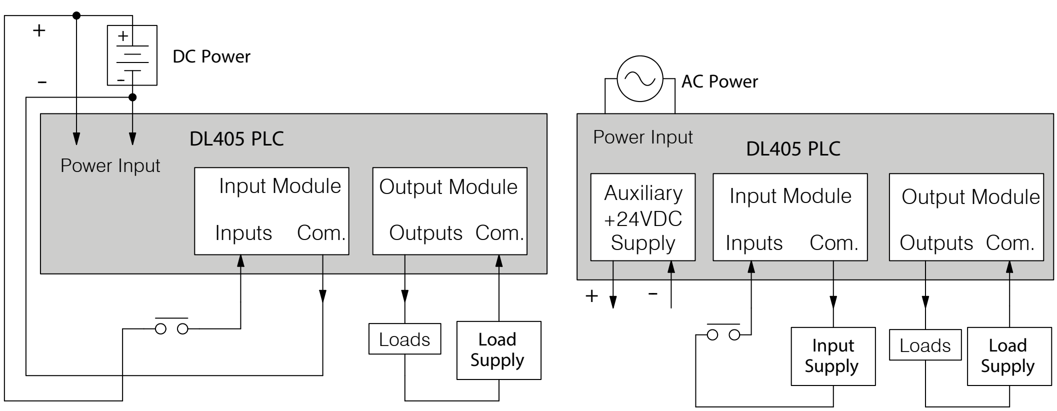
Powering I/O Circuits Using Separate Supplies

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 PLC, 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 PLC supply, then a separate supply must be used as shown to the right in the figure below.



Some applications will use the PLC external power source to also power the input circuit. This typically occurs on DC-powered PLCs, as shown in the drawing below to the left. The inputs share the PLC power source supply, while the outputs have their own separate supply. A worst-case scenario, from a cost and complexity viewpoint, is an application which requires separate power sources for the PLC, 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

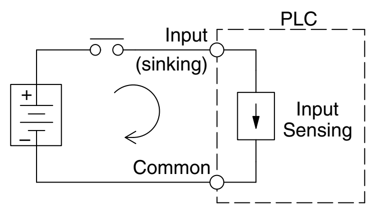
Before going further in the study of wiring strategies, you must have a solid understanding of "sinking" and "sourcing" concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring your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

Sinking = provides a path to supply ground (–)

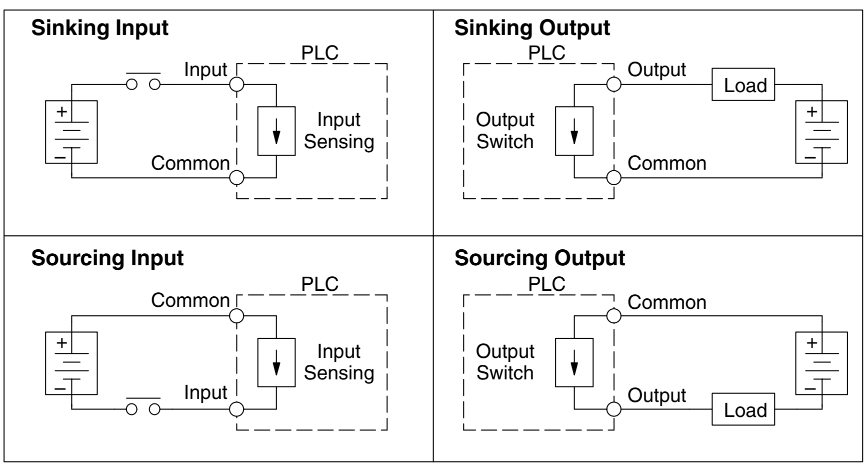
Sourcing = provides a path to supply source (+)

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 only 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 PLC 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.

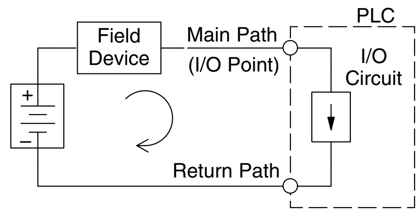


Apply the circuit principle above to the four possible combinations of input/output sinking/sourcing types as shown below. The I/O module specifications at the end of this chapter list the input or output type.

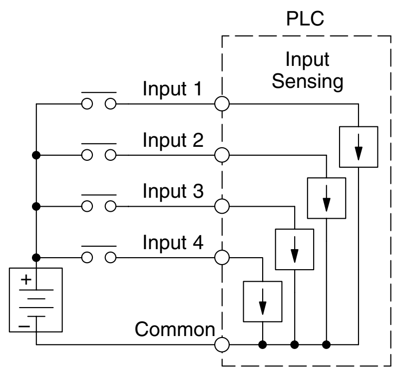


I/O "Common" Terminal Concepts

In order for a PLC 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.

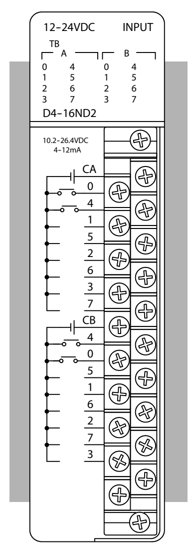


If there was unlimited space and budget for I/O terminals, every I/O point could have two dedicated terminals as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output points on PLCs are in groups which share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

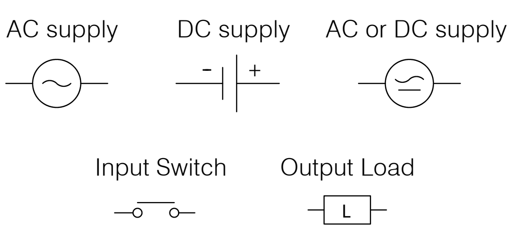


NOTE: *In the circuit above, the current in the common path is 4 times any channel's input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons*

Most DL405 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. There are two circuit banks with eight input points in each. The common terminal for each is labeled "CA" and "CB", respectively.



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

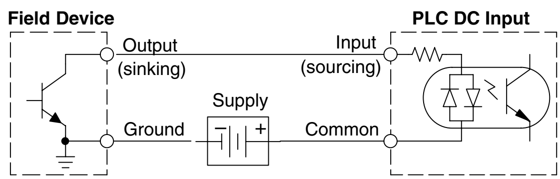


Connecting DC I/O to "Solid State" Field Devices

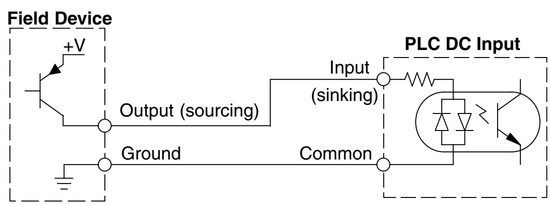
In the previous section on Sourcing and Sinking concepts, the DC I/O circuits were explained to sometimes only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking.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

Solid State Input Sensors

Several DL405 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 PLC 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.

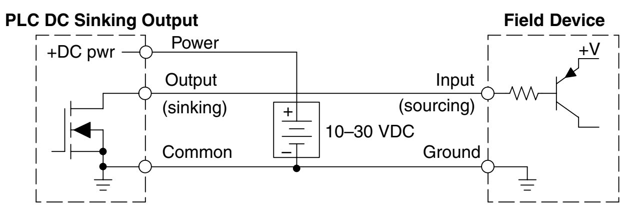


In the next circuit, a field device has an open-collector PNP transistor output. It sources current to the PLC input point, which sinks the current back to ground. Since the field device is sourcing current, no additional power supply is required.
Solid State Output Loads

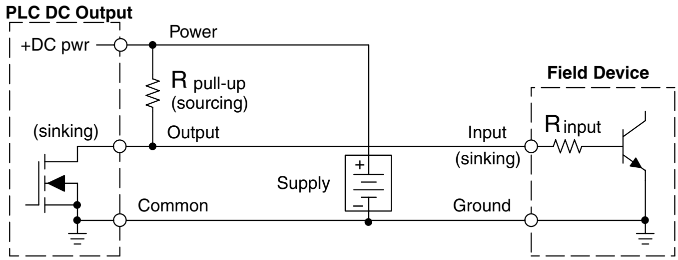


Sometimes an application requires connecting a PLC output point to a solid state input on a device. This type of connection is usually made to carry a low-level control signal, not to send DC power to an actuator.

Several of the DL405 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 PLC 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 PLC sinking DC output point is connected to the sinking input of a field device. This is a little tricky, because both the PLC 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 PLC output by using a pull-up resistor. In the circuit below, a Rpull-up is connected from the output to the DC output circuit power input.



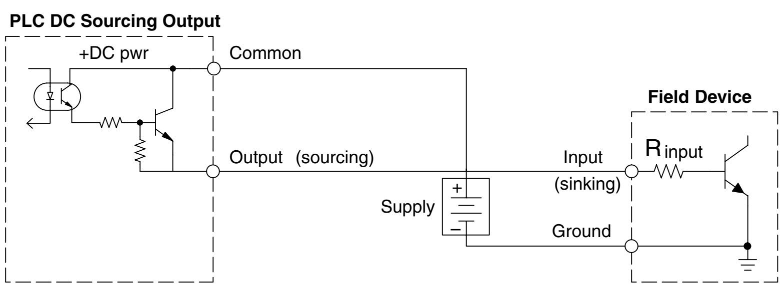
NOTE 1: *DO NOT attempt to drive a heavy load (> 25mA) with this pull-up method.*
NOTE 2: *Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the PLC output is OFF, from a ladder logic 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 Rpull-up. In order to do so, you need to know the nominal input current to the field device (Iinput) when the input is energized. If this value is not known, it can be calculated as shown (a typical value is 15mA). Then use Iinput and the voltage of the external supply to compute Rpull-up. Then calculate the power Ppull-up (in watts), in order to size Rpull-up properly.

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

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

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 DL405 I/O family feature relay outputs: D4–08TR, F4-08TRS-1, F4-08TRS-2, D4-16TR. 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)

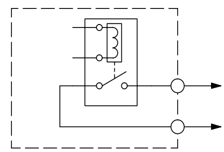
Some applications in which NOT to use relays:

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

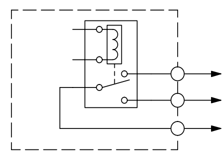
Relay outputs in the DL405 output modules are available in two contact arrangements, shown to the right. The Form A type, or SPST (single pole, single throw) type is normally open and is the simplest to use. The Form C type, or SPDT (single pole, double throw) type has a center contact which moves and a stationary contact on either side. This provides a normally closed contact and a normally open contact.

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

Relay with Form A contacts



Relay with Form C contacts



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

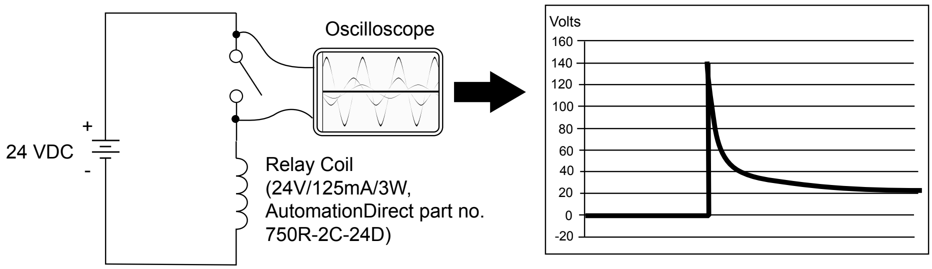
The following pages are intended to give a quick overview of the negative effects of transient voltages on a control system and provide some simple advice on how to effectively minimize them. The need for transient suppression is often not apparent to the newcomers in the automation world. Many mysterious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

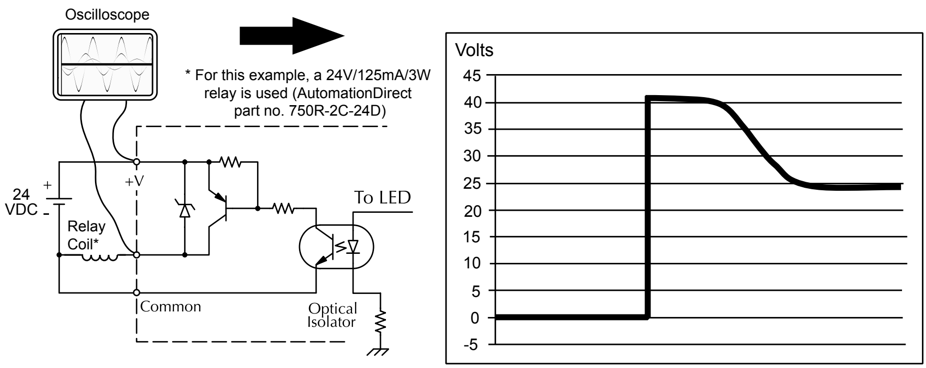
A very destructive side-effect of the arcing across relay contacts is the electromagnetic interference (EMI) it can cause. This occurs because the arcing causes a current surge, which releases RF energy. The entire length of wire between the relay contacts, the coil, and the power source carries the 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.

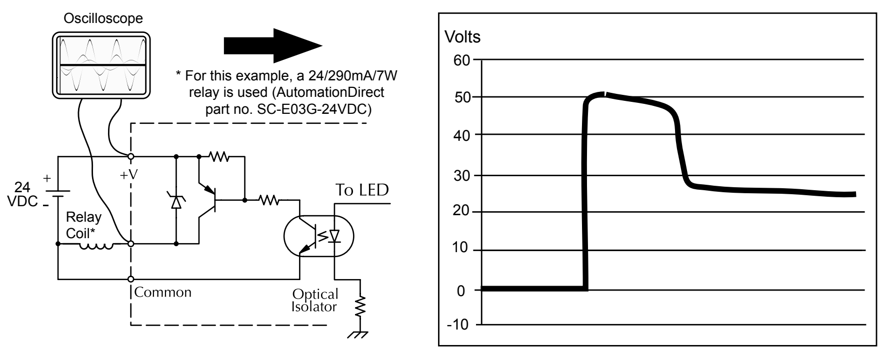
The next example uses the same 24V/125mA/3W relay used earlier. This example measures a PLC PNP transistor output, which incorporates an integrated Zener diode for transient suppression. Instead of the 140V peak in the first example, the transient voltage here is limited to about 40V by the Zener diode. 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

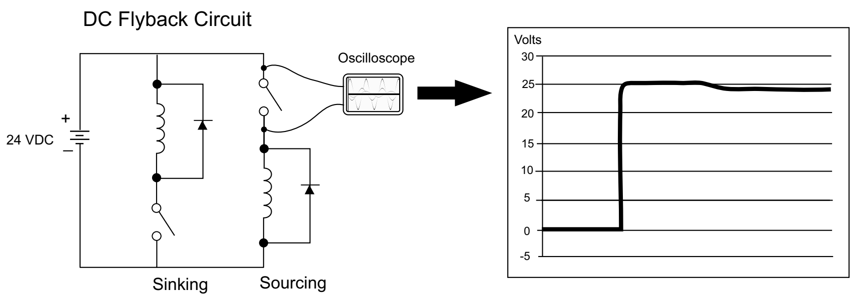


Additional transient suppression should be used in both these examples. If you are unable to measure the transients generated by the connected loads of your control system, using additional transient suppression on all inductive loads would be the safest practice.

Types of Additional Transient Protection

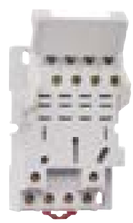
DC Coils:

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

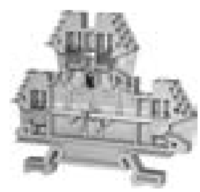


Many AutomationDirect's socketed relays and motor starters have add-on fly back diodes that plug or screw into the base, such as the AD-ASMD-250 protection diode module and 784-4C-SKT-1 socket module shown below. If an add-on fly back diode is not available for your inductive load, an easy way to add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

AD-ASMD-250
Protection Diode Module



784-4C-SKT-1
Relay Socket



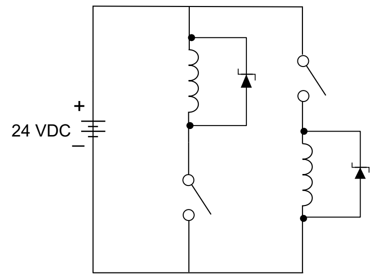
DN-D10DR-A
Diode Terminal Block

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

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

ZL-TSD8-24
Transorb Module

DC MOV or TVS Diode Circuit



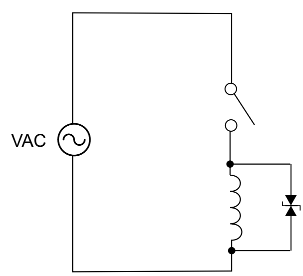
AC Coils:

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 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.

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

ZL-TSD8-120
Transorb Module

AC MOV or Bi-Directional Diode Circuit



NOTE: *Manufacturers of devices with coils frequently offer MOV or TVS diode suppressors as an add-on option which mount conveniently across the coil. Before using them, carefully check the suppressors 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.

I/O Modules Wiring, and Specification

Slot Numbering

The DL405 bases come in 4, 6 or 8 slot sizes with the first slot on the far left dedicated for the CPU or one of the Base Controller Modules. The I/O and Specialty Modules can be placed in any of the remaining slots on the base. The CPU slot is NOT numbered. The first slot to the right of the CPU starts at zero. For example, the slot numbering on an 8 slot base (D4-08B-1) is slot 0 to 7.

Module Placement Restrictions

The following table lists the valid locations for all types of modules in a D4-454 system:

Module/Unit	Local CPU Base	Local Expansion Base	Remote I/O Base
CPUs	CPU Slot Only	–	–
Input Modules	✓	✓	✓
Output Modules	✓	✓	✓
Relay Output Modules	✓	✓	✓
Analog Modules	✓	✓	✓
Local Expansion			
D4-EX	–	✓	–
D4-EXDC	–	✓	–
Communications and Networking			
D4-DCM	✓ (*)	–	–
H4-ECOM100	✓	–	–
F4-MAS-MB	✓	–	–
Remote I/O			
H4-ERM100	✓	–	–
H4-EBC	–	–	✓
D4-RM	✓	–	–
D4-RS	–	–	✓
D4-RSDC	–	–	✓
Motion			
D4-HSC	✓	✓	–
H4-CTRIO	✓	✓	✓
Specialty Modules			
D4-16SIM	✓	✓	✓
F4-16PID	✓	–	–
F4-8MPI	✓	–	–
F4-4LTC	✓	–	–
F4-CP128	✓	–	–
F4-CP128-T	✓	–	–
D4-FILL	✓	✓	✓

(*) When used with H4-ERM100 Ethernet Remote I/O system

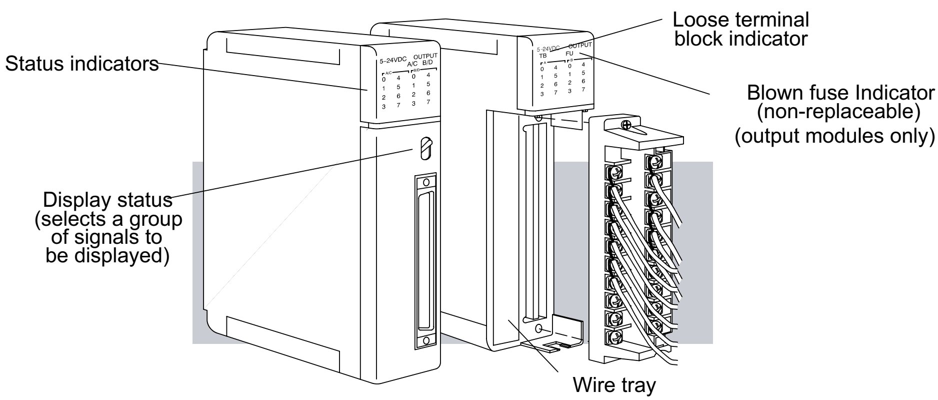
Module Placement

Before wiring the I/O modules in your system to field devices, it's very important to make sure each I/O module is in the right slot and base in the system. Costly wiring errors may be avoided by doing the following:

- Do the power budget calculations for each base to verify the base power supply can power all the modules in the base. Information on how to do this is in Chapter 4, System Design and Configuration.
- Some Specialty I/O modules may only be installed in particular slots (will not function properly, otherwise). Check the corresponding manual before installation and wiring.
- Whenever possible, keep modules with high voltage and current wiring away from sensitive analog modules.

I/O Module Status Indicators

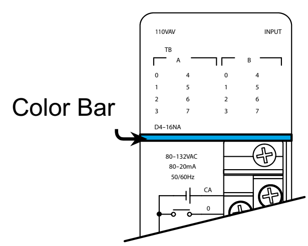
The discrete modules provide LED status indicators to show the status of the I/O points.



Color Coding of I/O Modules

The DL405 family of I/O modules have a color coding scheme to help you quickly identify if a module is either an input module, output module, or a specialty module. This is done through a color bar indicator located on the front of each module. The color scheme is listed below:

Module Type	Color Code
Discrete/Analog Output	Red
Discrete/Analog Input	Blue
Other	White

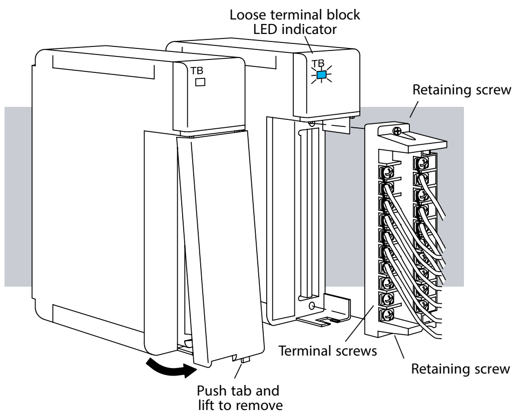


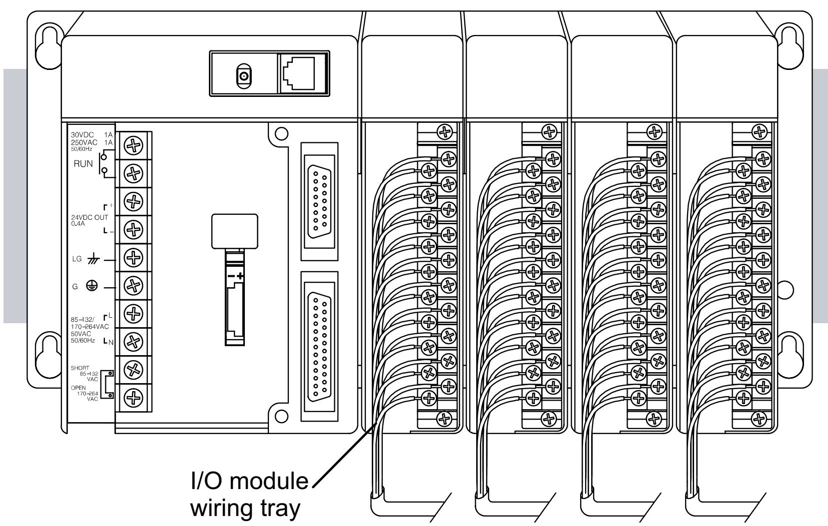
Wiring the Different Module Connectors

You must first remove the front cover of the module prior to wiring. To remove the cover depress the bottom tab of the cover and tilt the cover up to loosen from the module

All DL405 I/O module terminal blocks are removable for your convenience. To remove the terminal block loosen the retaining screws and lift the terminal block away from the module. When you return the terminal block to the module make sure the terminal block is tightly seated. Be sure to tighten the retaining screws. You should also verify the loose terminal block LED is off when system power is applied.

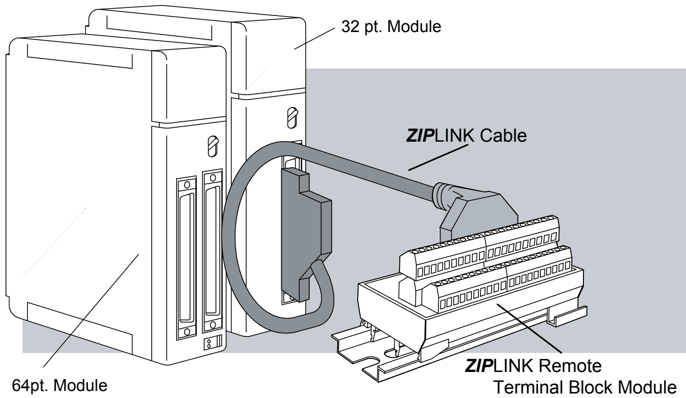
WARNING: For some modules, field device power may still be present on the terminal block even though the PLC system is turned off. To minimize the risk of electrical shock, check all field device power before you remove the connector.





Wiring 32 and 64 Point I/O Modules

The 32-point and 64-point I/O modules use a different style of connector due to the increased number of I/O points. A ZIPLink connection system is shown in the figure below. Another option is to use the D4-IOCBL-1, a 3 meter prewired solder connector and cable with pigtail.



The ZIPLink system offers “plug and play” capability, eliminating the need for traditional wiring. Simply plug one end of the ZIPLink cable into a 32 or 64 point I/O module and the other end into a ZIPLink Remote Terminal Block Module. Please review out online ZIPLink Selection Table to ensure proper module/cable combinations are chosen for your application.

I/O Wiring Checklist

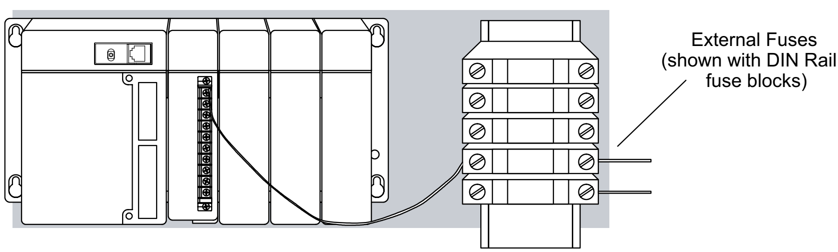
Use the following guidelines when wiring the I/O modules in your system.

Module type	Suggested AWG Range	Suggested Torque
CPU	12AWG	10.63 lb·inch (1.2 N·m)
8 Point	12AWG	7.97 lb·inch (0.9 N·m)
16 Point	14AWG	7.97 lb·inch (0.9 N·m)
32 Point 64 Point	*ZIP*Link Solution Required. Review out online selection table to ensure proper module/cable combinations are chosen. D4-IOCBL-1 (3m pigtail cable with D4-IO3264S)	

NOTE: *Wire Type TFFN or Type MTW is recommended. Other types of wire may be acceptable, but it really depends on the thickness of the wire insulation. If the insulation is too thick and you use all the I/O points, then the plastic terminal cover may not close properly.*

- There is a limit to the size of wire the modules can accept. The table above lists the suggested AWG for each module type. When making terminal connections, follow the suggested torque values.
- Always use a continuous length of wire, do not combine wires to attain a needed length.
- Use the shortest possible wire length.
- Use wire trays for routing where possible.
- Avoid running wires near high energy wiring. Also, avoid running input wiring close to output wiring where possible.
- To minimize voltage drops when wires must run a long distance , consider using multiple wires for the return line.
- Avoid running DC wiring in close proximity to AC wiring where possible.
- Avoid creating sharp bends in the wires.

NOTE: *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. Refer to our catalog for a complete line of DIN rail mounted fuse blocks.*



DL405 Input Module Chart

The following table lists the available DL405 input modules. Specifications begin on the following page.

DL405 Input Module Types	Number of Input Points	DC Current Sink Input	DC Current Source Input	AC Input
D4-16ND2	16	-	✓	-
D4-16ND2F	16	-	✓	-
D4-32ND3-1	32	✓	✓	-
D4-32ND3-2	32	✓	✓	-
D4-64ND2	64	-	✓	-
D4-08NA	8	-	-	✓
D4-16NA	16	-	-	✓
D4-16NE3	16	✓	✓	✓
F4-08NE3S	8	✓	✓	✓
D4-08ND3S	8	✓	✓	-

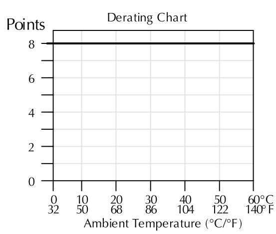
DL405 Output Module Chart

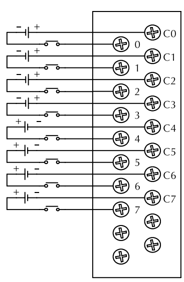
The following table lists the available DL405 output modules. Specifications begin on the following page.

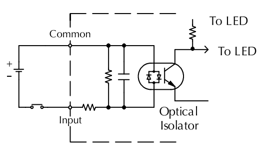
DL405 Output Module Types	Number of Output Points	DC Current Sink Output	DC Current Source Output	AC Output
D4-08TD1	8	✓	-	-
F4-08TD1S	8	✓	-	-
D4-16TD1	16	✓	-	-
D4-16TD2	16	-	✓	-
D4-32TD1	32	✓	-	-
D4-32TD1-1	32	✓	-	-
D4-32TD2	32	-	✓	-
D4-64TD1	64	✓	-	-
D4-08TA	8	-	-	✓
D4-16TA	16	-	-	✓
D4-08TR	8	✓	✓	✓
F4-08TRS-1	8	✓	✓	✓
F4-08TRS-2	8	✓	✓	✓
D4-16TR	16	✓	✓	✓

D4-08ND3S DC Input	
Inputs Per Module	8 (sink/source)
Commons Per Module	8 (isolated)
Input Voltage Range	20–52.8 VDC
Peak Voltage	52.8 VDC
On Voltage Level	> 18V
Off Voltage Level	< 7V
Input Impedance	4.8 kΩ
Input Current	5mA @ 24VDC 10mA @ 48VDC
Minimum On Current	3.5 mA
Maximum Off Current	1.5 mA
Base Power Required 5V	100mA max
OFF to ON Response	3–10 ms
ON to OFF Response	3–12 ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side

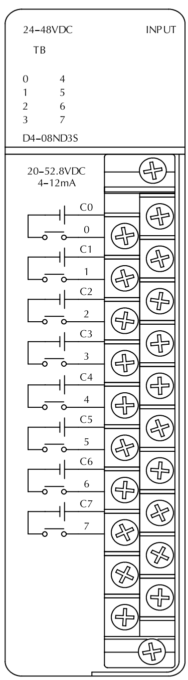
D4-16ND2 DC Input	
Inputs Per Module	16 (current sourcing)
Commons Per Module	2 (isolated)
Input Voltage Range	10.2–26.4 VDC
Peak Voltage	26.4 VDC
On Voltage Level	> 9.5 V
Off Voltage Level	< 4.0 V
Input Impedance	3.2 kΩ @ 12VDC 2.9 kΩ @ 24VDC
Input Current	3.8 mA @ 12VDC 8.3 mA @24VDC
Minimum On Current	3.5 mA
Maximum Off Current	1.5 mA
Base Power Required 5V	150mA max
OFF to ON Response	1–7ms (2.3 typical)
ON to OFF Response	2–12ms (4.6 typical)
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side

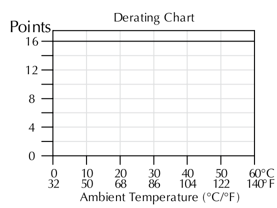


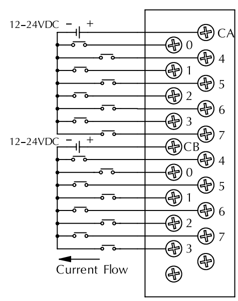


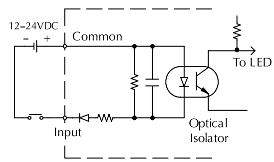


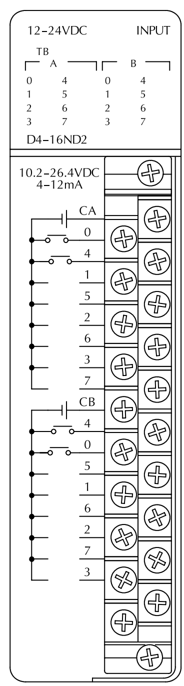
Current sourcing configuration shown





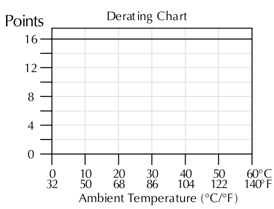


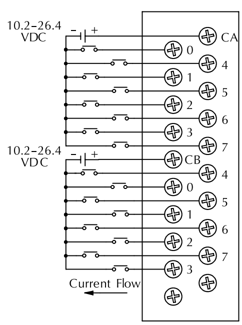


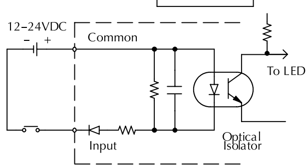


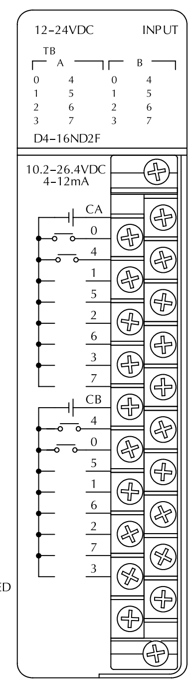
D4-16ND2F DC Input	
Inputs Per Module	16 (current sourcing)
Commons Per Module	2 (isolated)
Input Voltage Range	10.2–26.4 VDC
Peak Voltage	26.4 VDC
On Voltage Level	> 9.5V
Off Voltage Level	< 4.0V
Input Impedance	3.2 kΩ @ 12VDC 2.9 kΩ @ 24VDC
Input Current	3.8 mA @ 12VDC 8.3 mA @ 24VDC
Minimum On Current	3.5 mA
Maximum Off Current	1.5 mA
Base Power Required 5V	150mA max
OFF to ON Response	1ms
ON to OFF Response	1ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side

D4-16 SIM Input Simulator	
Inputs per Module	8 or 16 selectable by internal switch
Base Power Required 5V	150mA max
Terminal Type	None
Status Indicators	Logic Side



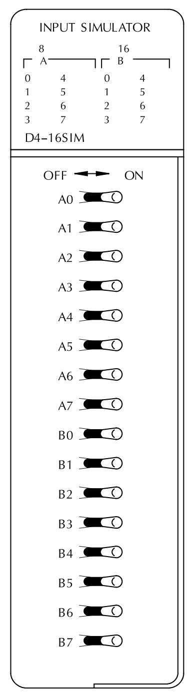






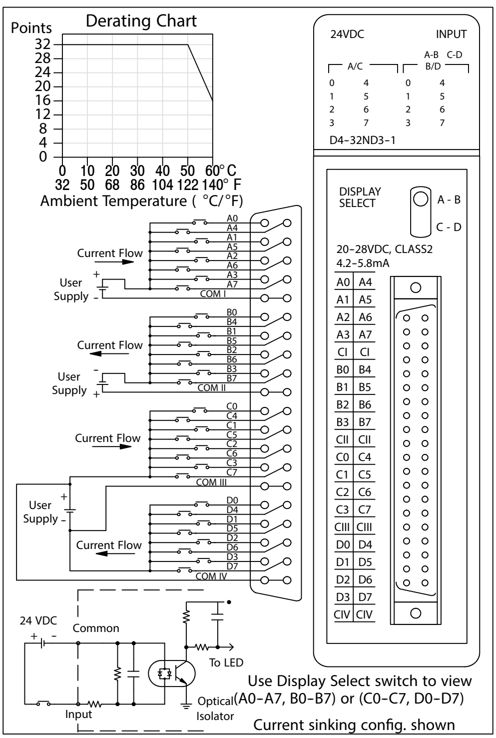
8 or 16 input point selection is located on the back of the module.

Switch position is indicated by the LEDs above the input switches.



D4-32ND3-1 DC Input	
Inputs Per Module	32 (sink/source)
Commons Per Module	4 (isolated)
Input Voltage Range	20–28 VDC
Peak Voltage	30VDC
On Voltage Level	> 19V
Off Voltage Level	< 10V
Input Impedance	4.8 kΩ
Input Current	5mA @ 24VDC
Minimum On Current	3.5 mA
Maximum Off Current	1.6 mA
Base Power Required 5V	150mA max
OFF to ON Response	2–10ms
ON to OFF Response	2–10m
Terminal Type	Connector sold separately *
Status Indicators	Logic Side

* *ZIP*Link prewired cable solution is recommended. See the online *ZIP*Link selector table for more information.

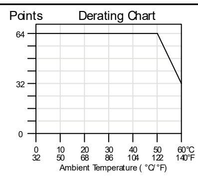


D4-64ND2 DC Input	
Inputs Per Module	64 (current sourcing)
Commons Per Module	8 (isolated)
Input Voltage Range	20–28 VDC
Peak Voltage	30VDC
On Voltage Level	> 20V
Off Voltage Level	< 13V
Input Impedance	4.8 kΩ
Input Current	5mA @ 24VDC
Minimum On Current	3.6 mA
Maximum Off Current	2.6 mA
Base Power Required 5V	300mA max

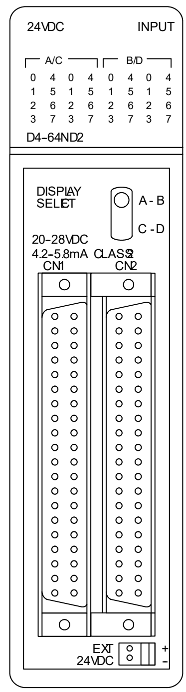
If you are using 64-pt. modules, you cannot install any specialty modules in slots 5, 6, or 7 of the local CPU base.

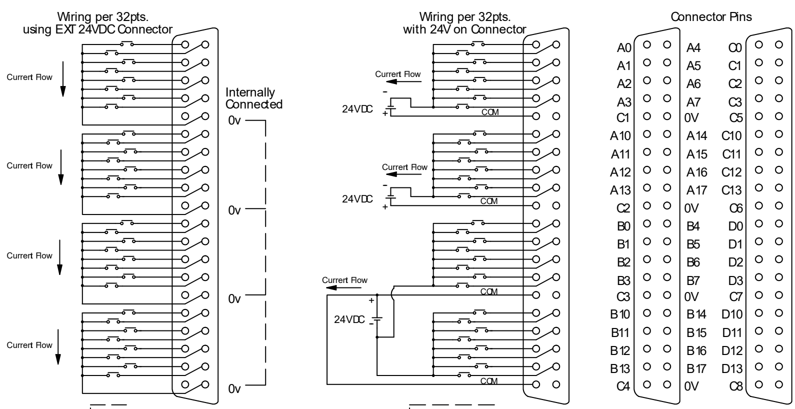
External Power (Optional)	24VDC ± 10%, 320mA max
OFF to ON Response	2 .5 ms (typical)
ON to OFF Response	5ms (typical)
Terminal Type	Connector sold separately *
Status Indicators	Logic Side

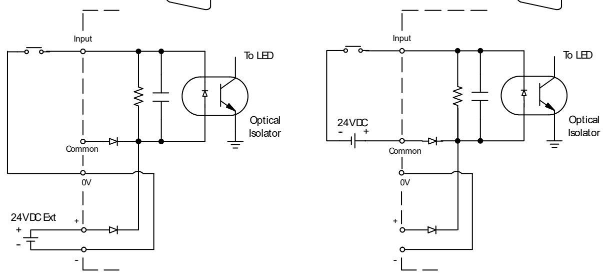
*ZIPLink prewired cable solution is recommended. See the online ZIPLink selector table for more information.



Since there are only 32 LEDs on the module, you can only display the status for 32 points at one time. In the A - B position the status of the first group of 32 input points (A0–A17, B0–B17) are displayed (connector 1). In the C - D position the status of the second group of 32 input points (C0–C17, D0–D17) are displayed (connector 2).



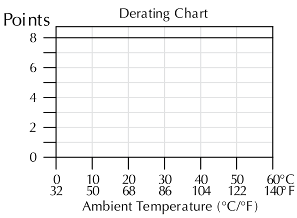


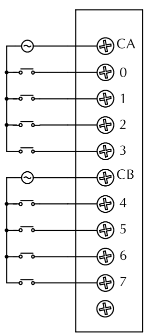


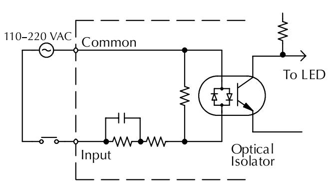
* Module location – this module placement is restricted to the local base on DL430/DL440 systems. It may also be placed in expansion bases in D4-450 and D4-454 system that are using the new (-1) bases.

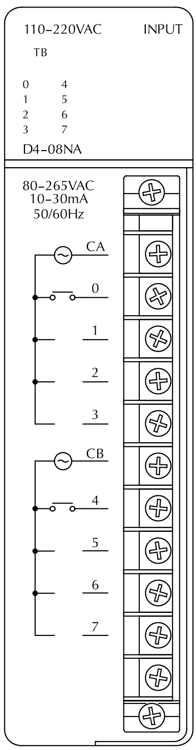
D4-08NA AC Input	
Inputs Per Module	8
Commons Per Module	2 (isolated)
Input Voltage Range	80–265 VAC
Peak Voltage	265VAC
AC Frequency	47–63 Hz
On Voltage Level	> 70V
Off Voltage Level	< 30V
Input Impedance	12kΩ
Input Current	8.5 mA @ 100VAC 20mA @ 230VAC
Minimum On Current	5mA
Maximum Off Current	2mA
Base Power Required 5V	100mA max
OFF to ON Response	5–30 ms
ON to OFF Response	10–50 ms
Terminal Type (Included)	Removable (D4-8IOCON)
Status Indicators	265VAC Logic Side

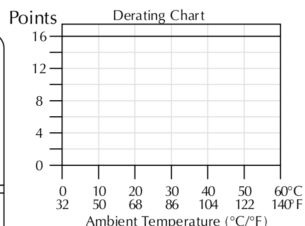
D4-16NA AC Input	
Inputs Per Module	16
Commons Per Module	2 (isolated)
Input Voltage Range	80–132 VAC
Peak Voltage	132VAC
AC Frequency	47–63 Hz
On Voltage Level	> 70V
Off Voltage Level	< 20V
Input Impedance	8kΩ
Input Current	14.5 mA @ 120VAC
Minimum On Current	7mA
Maximum Off Current	2mA
Base Power Required 5V	150mA max
OFF to ON Response	5–30 ms
ON to OFF Response	10–50 ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side

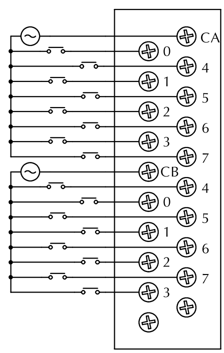


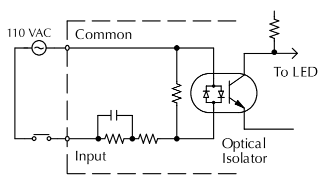


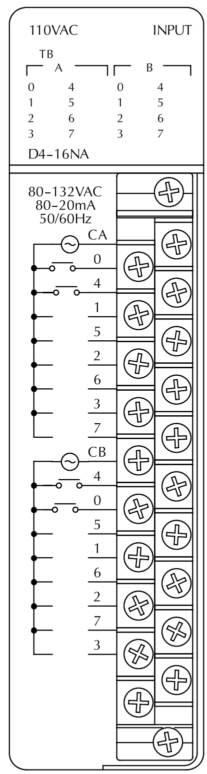






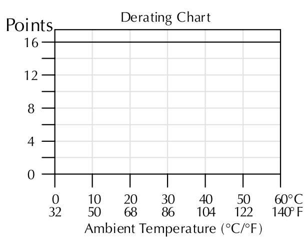


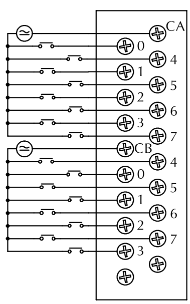


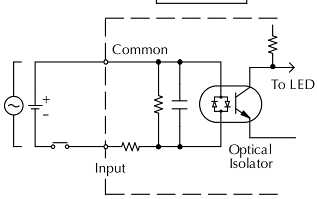


D4-16NE3 AC/DC Input	
Inputs Per Module	16 (sink/source)
Commons Per Module	2 (isolated)
Input Voltage Range	10.2–26.4 VAC/VDC
Peak Voltage	37.5 VAC/VDC
AC Frequency	47–63 Hz
On Voltage Level	> 9.5V
Off Voltage Level	< 3.0V
Input Impedance	3.2 kΩ @ 12V 2.9 kΩ @ 24V
Input Current	3.8 mA @ 12V 8.3 mA @ 24V
Minimum On Current	4mA
Maximum Off Current	1.5 mA
Base Power Required 5V	150mA max
OFF to ON Response	5–40 ms
ON to OFF Response	10–50 ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side

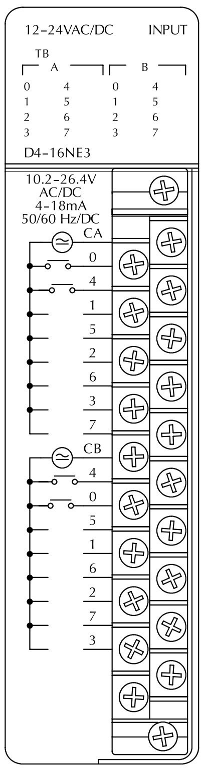
F4-08NE3S AC/DC Input	
Inputs Per Module	8 (sink/source)
Commons Per Module	8 (isolated)
Input Voltage Range	90–150 VAC/VDC
Peak Voltage	350 peak < 1ms
AC Frequency	47–63 Hz
On Voltage Level	> 90 VDC/75 VAC
Off Voltage Level	< 60 VDC/45 VAC
Input Impedance	22kΩ
Input Current	5.5 mA @ 120V
Minimum On Current	4mA
Maximum Off Current	2mA
Base Power Required 5V	90mA max
OFF to ON Response	8ms
ON to OFF Response	15ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side

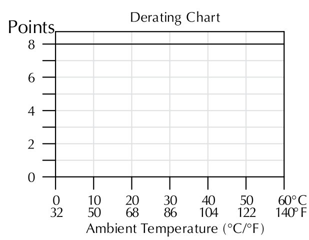


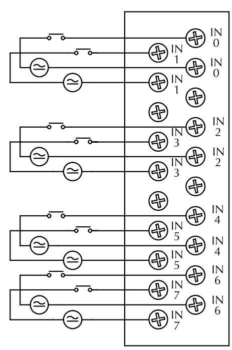


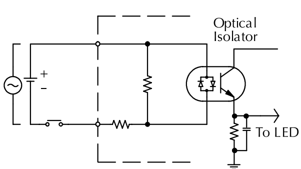


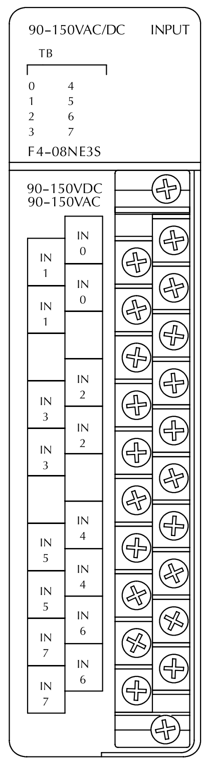
Current sourcing configuration shown



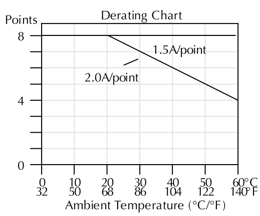


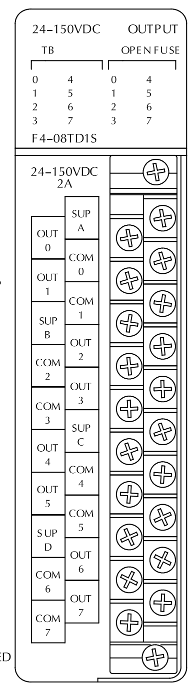


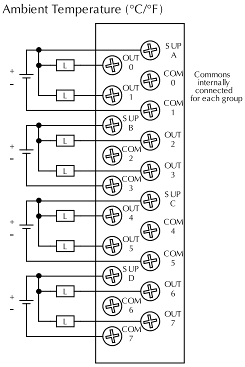


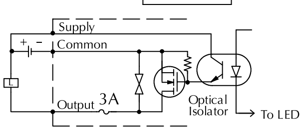


F4-08TD1S DC Output	
Outputs Per Module	8 (current sinking)
Commons Per Module	4 (isolated, 8 terminals)
Operating Voltage	24–150 VDC
Output Type	MOS FET
Peak Voltage	47–63 Hz
On Voltage Drop	0.5 VDC @ 2A
Max Current (resistive)	2A/point 4A/common
Max Leakage Current	5µA
Max Inrush Current	30A for 1ms 19A for 10ms
Minimum Load	N/A
Base Power Required 5V	295mA max
External DC Required	None
OFF to ON Response	25µs
ON to OFF Response	25µs
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side
Fuses	1 (3A) per output (see diagram) Non-replaceable



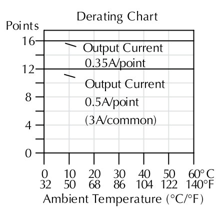


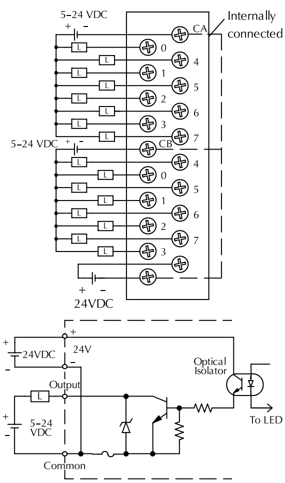


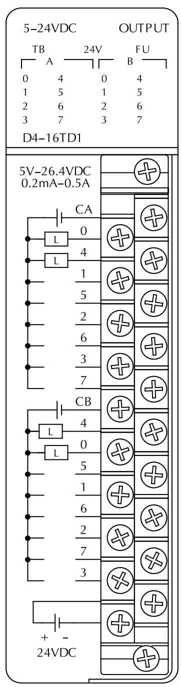


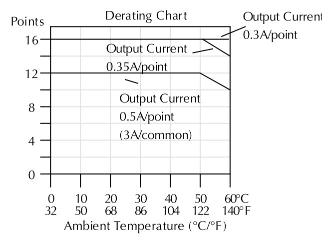
D4-16TD1 DC Output	
Outputs Per Module	16 (current sinking)
Commons Per Module	2 internally connected
Operating Voltage	4.5–26.4 VDC
Output Type	NPN Open Collector
Peak Voltage	40VDC
On Voltage Drop	0.5 VDC @ 0.5 A 0.2 VDC @ 0.1 A
Max Current (resistive)	0.5 A/point 3A/common
Max Leakage Current	0.1 mA @40VDC
Max Inrush Current	2A for 10ms 1A for 100ms
Minimum Load	0.2 mA
Base Power Required 5V	200mA max
External DC Required	24VDC ± 10% @125mA
OFF to ON Response	0.5 ms
ON to OFF Response	0.5 ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side
Fuses	1 (5A) per common Non-replaceable

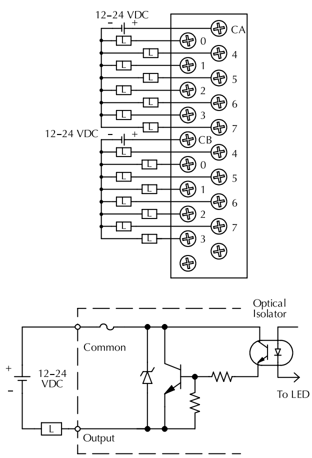
D4-16TD2 DC Output	
Outputs Per Module	16 (current sourcing)
Commons Per Module	2 (isolated)
Operating Voltage	10.2–26.4 VDC
Output Type	NPN Emitter Follower
Peak Voltage	40VDC
On Voltage Drop	1.5 VDC @ 0.5 A
Max Current (resistive)	0.5 A/point 3A/common @ 50°C 2.5 A/common @ 60°C
Max Leakage Current	0.1 mA @40VDC
Max Inrush Current	2A for 10ms 1A for 100ms
Minimum Load	0.2 mA
Base Power Required 5V	200mA max
External DC Required	None
OFF to ON Response	1ms
ON to OFF Response	1ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side
Fuses	1 (5A) per common Non-replaceable

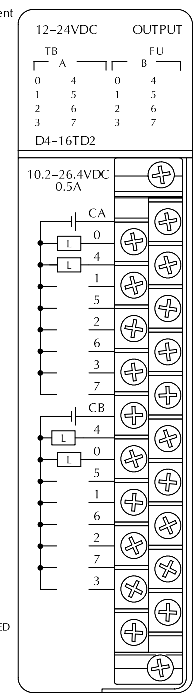










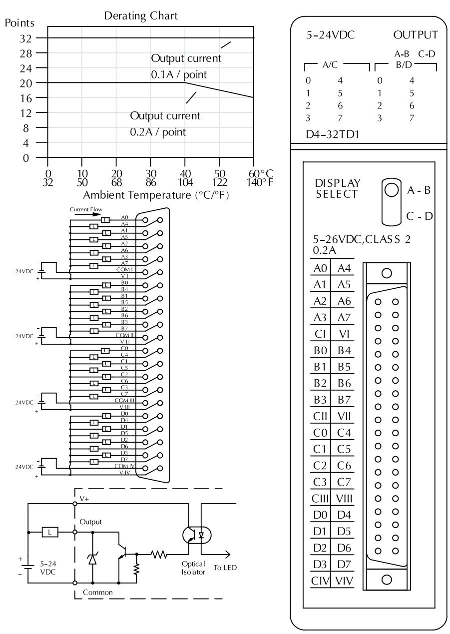


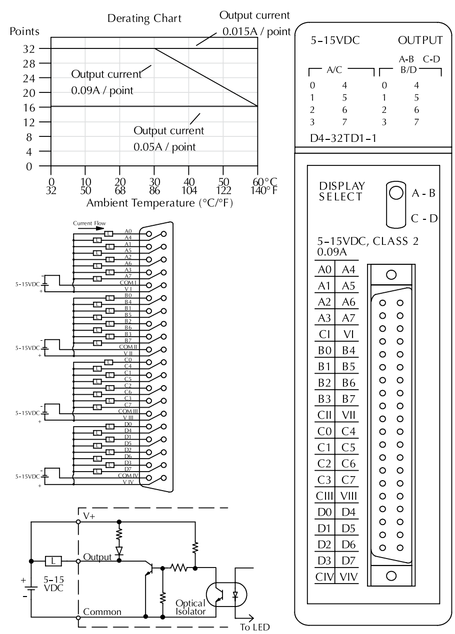
D4-32TD1 DC Output	
Outputs Per Module	32 (current sinking)
Commons Per Module	4 (isolated)
Operating Voltage	4.75–26.4 VDC
Output Type	NPN Open Collector
Peak Voltage	36VDC
On Voltage Drop	0.6 VDC @ 0.2 A
Max Current (resistive)	0.2 A/point 1.6 A/common
Max Leakage Current	0.1m A @ 36VDC
Max Inrush Current	1A for 10ms 0.5 A for 100ms
Minimum Load	0.1 mA
Base Power Required 5V	250mA max
External DC Required	24VDC ± 10%, 140mA max
OFF to ON Response	0.1 ms
ON to OFF Response	0.1 ms
Terminal Type	Connectors sold separately*
Status Indicators	Logic Side
Fuses	None

* ZIPLink prewired cable solution is recommended. See the online ZIPLink selector guide for more information.

D4-32TD1-1 DC Output	
Outputs Per Module	32 (current sinking)
Commons Per Module	4 (isolated)
Operating Voltage	5–15 VDC
Output Type	NPN Open Collector (with pull-up)
Peak Voltage	16.5 VDC
On Voltage Drop	0.4 VDC @ 0.1 A
Max Current (resistive)	0.09 A/point 0.72 A/common 2.88 A/module
Max Leakage Current	0.1 mA @ 16.5 VDC
Max Inrush Current	0.5 A for 10ms 0.2 A for 100ms
Minimum Load	0.15 mA
Base Power Required 5V	250mA max
External DC Required	5–15 VDC ± 10%, 150mA max
OFF to ON Response	0.1 ms
ON to OFF Response	0.1 ms
Terminal Type (Included)	Connectors sold separately*
Status Indicators	Logic Side
Fuses	None

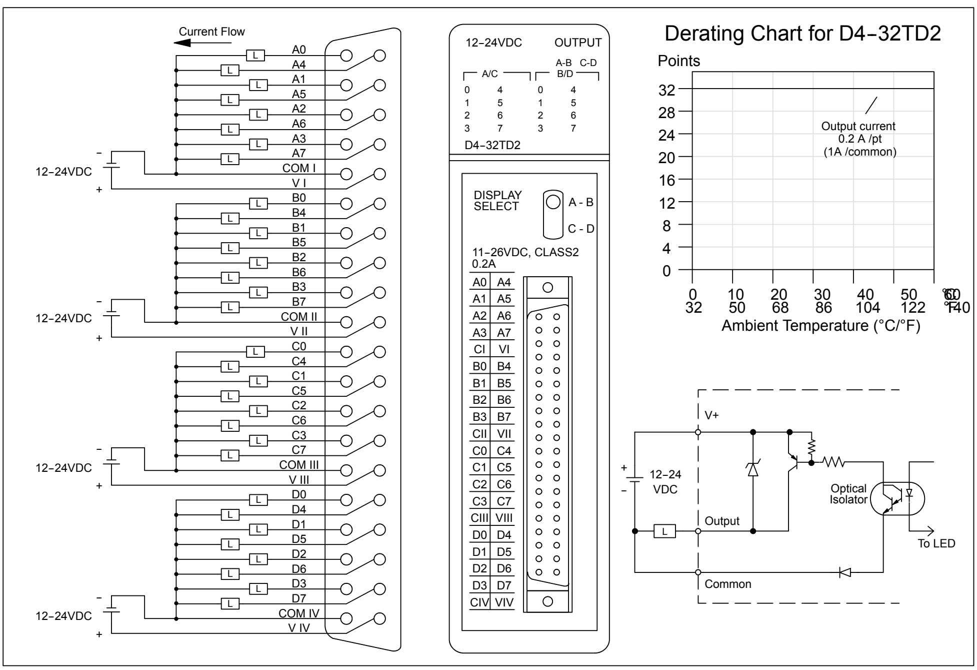
* ZIPLink prewired cable solution is recommended. See the online ZIPLink selector guide for more information.





D4-32TD2 DC Output	
Outputs Per Module	32 (current sourcing)
Commons Per Module	4 (isolated)
Operating Voltage	10.8–26.4 VDC
Output Type	PNP Open Collector
Peak Voltage	30VDC
On Voltage Drop	0.6 VDC @ 0.2 A
Max Current (resistive)	0.2A/point 1A/common 4/module
Max Leakage Current	0.01 mA @ 26.4 VDC
Max Inrush Current	500mA for 10ms
Minimum Load	0.2 mA
Base Power Required 5V	350mA max
External DC Required	10.8–26.4 VDC 1A/common including load
OFF to ON Response	0.2 ms
ON to OFF Response	0.2 ms
Terminal Type	Connectors sold separately*
Status Indicators	Logic Side
Fuses	None

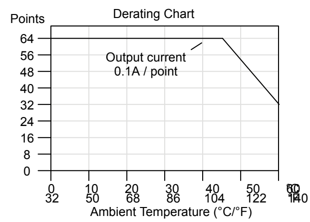
* ZIPLink prewired cable solution is recommended. See the online ZIPLink selector guide for more information.



D4-64TD1 DC Output	
Inputs Per Module	64 (current sinking)
Commons Per Module	8 (non-isolated)
Operating Voltage	4.75–28 VDC
Output Type	NPN Open Collector
Peak Voltage	36VDC
On Voltage Drop	0.6 VDC @0.1A
Max Current (Resistive)	0.1A/point 1A/common 7A per module total
Max Leakage Current	0.01mA @ 36VDC
Max Inrush Current	1A for 1ms, 700mA for 100ms
Minimum Load	0.1 mA

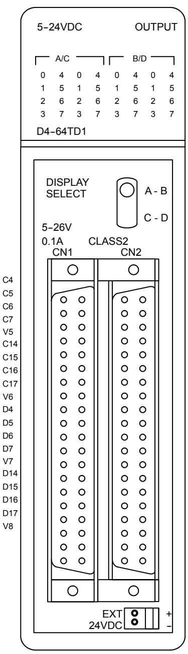
Base Power Required 5V	800mA max
External DC Required	24VDC ± 10%, (850mA per common) 7A total max
OFF to ON Response	0.1 ms
ON to OFF Response	0.2 ms
Terminal Type	Connector sold separately *
Status Indicators	Logic Side
Fuses	None

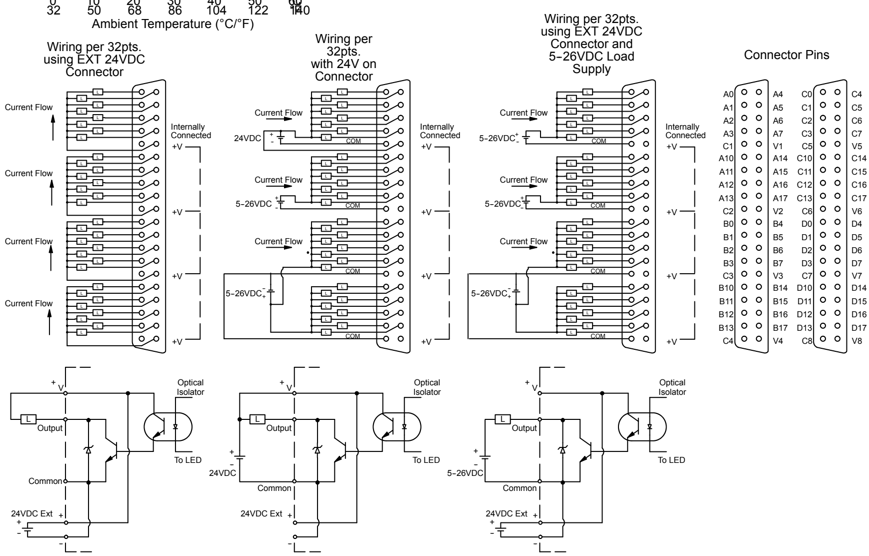
*ZIPLink prewired cable solution is recommended. See the online ZIPLink selector table for more information.



Only 32 status points can be displayed at one time on the front of the module. In the A - B position the status of the first group of 32 output points (A0–A17, B0–B17) are displayed (connector 1). In the C - D position the status of the second group of 32 output points (C0–C17, D0–D17) are displayed (connector 2).

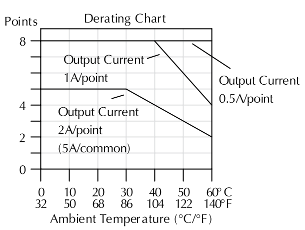
* Module location – this module placement is restricted to the local base on DL430/DL440 systems. It may also be placed in expansion bases in D4-450 and D4-454 systems that are using the new (–1) bases.

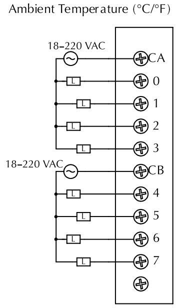


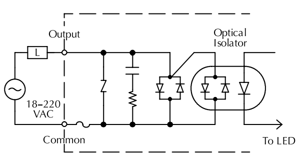


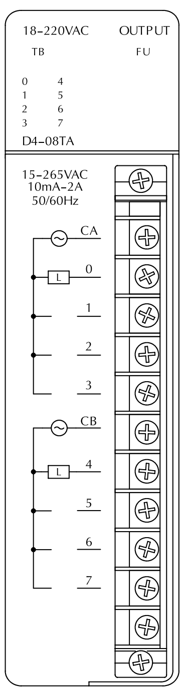
D4-08TA AC Output	
Outputs Per Module	8
Commons Per Module	2 (isolated)
Operating Voltage	15–265 VAC
Output Type	SSR Triac
Peak Voltage	265VAC
AC Frequency	47–63 Hz
On Voltage Drop	1.5 VAC @ 2A
Max Current	2A/point 5A/common @ 30°C 2A/common @ 60°C
Max Leakage Current	5mA @ 265VAC
Max Inrush Current	30mA for 10ms 10A for 100ms
Minimum Load	10mA
Base Power Required 5V	250mA max
OFF to ON Response	1ms
ON to OFF Response	1ms + 1/2 cycle
Terminal Type (Included)	Removable (D4-8IOCON)
Status Indicators	Logic Side
Fuses	1 (8A) per common, non-replaceable

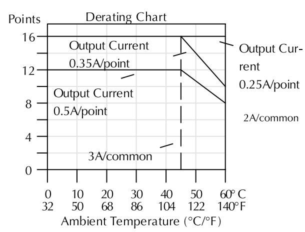
D4-08TA AC Output	
Outputs Per Module	16
Commons Per Module	2 (isolated)
Operating Voltage	15–265VAC
Output Type	SSR Triac
Peak Voltage	265VAC
AC Frequency	47–63 Hz
On Voltage Drop	1.5 VAC @ 0.5 A
Max Current	0.5 A/point 3A/common @ 45°C 2A/common @ 60°C
Max Leakage Current	4mA @ 265VAC
Max Inrush Current	15A for 10ms 10A for 100ms
Minimum Load	10mA
Base Power Required 5V	450mA max
OFF to ON Response	1ms
ON to OFF Response	1ms + 1/2 cycle
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side
Fuses	1 (5A) per common, non-replaceable

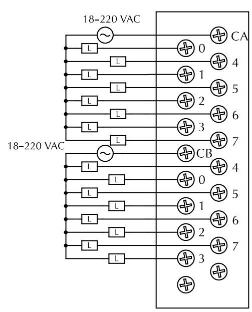


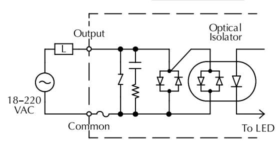


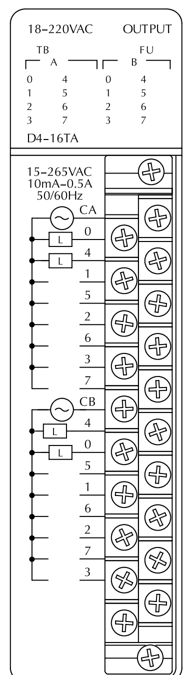










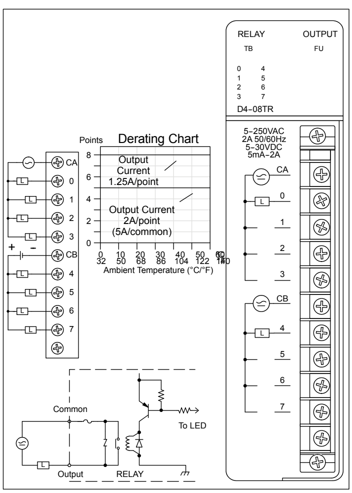


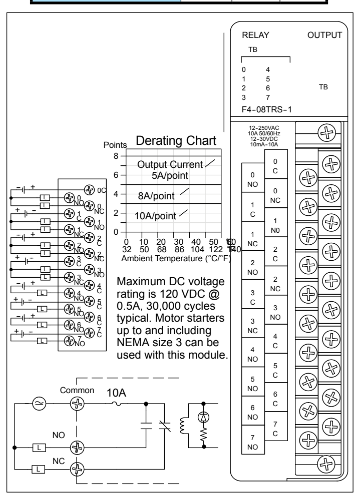
D4-08TR Relay Output	
Outputs Per Module	8 relays
Commons Per Module	2 (isolated)
Operating Voltage	5–30VDC / 5–250VAC
Output Type	Form A (SPST-N.O.)
Peak Voltage	30VDC / 256VAC
AC Frequency	47–63 Hz
On Voltage Drop	N/A
Max Current	2A/point 5A/common
Max Leakage Current	0.1 mA @ 265VAC
Max Inrush Current	2A
Minimum Load	5mA
Base Power Required 5V	550mA max
External DC Required	None
OFF to ON Response	12ms
ON to OFF Response	12ms
Terminal Type (Included)	Removable (D4-8IOCON)
Status Indicators	Logic Side
Fuses	1 (8A) per common Non-replaceable

F4-08TRS-1 Relay Output	
Outputs Per Module	8 relays
Commons Per Module	8 (isolated)
Operating Voltage	12–30 VDC / 12–125 VAC *125–250 VAC
Output Type	4 Form C (SPST) 4, Form A (SPST N.O.)
Peak Voltage	30VDC / 250VAC @ 10A
AC Frequency	47–63 Hz
On Voltage Drop	N/A
Max Current	10A/point; 40A/module
Max Leakage Current	N/A
Max Inrush Current	10A
Minimum Load	100mA @ 12VDC
Base Power Required 5V	575mA max
External DC Required	None
OFF to ON Response	7ms
ON to OFF Response	9ms
Terminal Type (Included)	Removable (D4-8IOCON)
Status Indicators	Logic Side
Fuses	1 (10A) per common Non-replaceable

Typical Relay Life (Operations)			
Maximum Resistive or Inductive Inrush Load Current	Operating Voltage		
	30 VDC	120 VAC	250 VAC
2A Resistive	100K	300K	200K
2A Inductive	100K	300K	60K
0.5 A Resistive	800K	1M	800K
0.5 A Inductive	300K	300K	200K

Typical Relay Life (Operations)			
Maximum Resistive or Inductive Inrush Load Current	Operating Voltage		
	28 VDC	120 VAC	250 VAC
1/4 HP	–	25K	–
10A	50K	50K	–
5A	200K	100K	–
3A	325K	125K	50K
0.05 A	>50M	–	–





F4-08TRS-2 Relay Output	
Outputs Per Module	8 relays
Commons Per Module	8 (isolated)
Operating Voltage	12–30 VDC / 12–250 VAC
Output Type	4 Form C (SPST) 4, Form A (SPST N.O.)
Peak Voltage	30VDC 250VAC @ 5A
AC Frequency	47–63 Hz
On Voltage Drop	N/A
Max Current (Resistive)	5A/point 40A/module
Max Leakage Current	N/A
Max Inrush Current	10A
Minimum Load	5mA
Base Power Required 5V	1000mA max, 60mA/point
External DC Required	None
OFF to ON Response	7ms
ON to OFF Response	9ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side
Fuses	1 (10A 250V) per common User-replaceable part # D4-FUSE-2

D4-16TR Relay Output	
Outputs Per Module	16 relays
Commons Per Module	2 (isolated)
Operating Voltage	5–30 VDC / 5–250 VAC
Output Type	Form A (SPST N.O.)
Peak Voltage	30VDC / 250VAC
AC Frequency	47–63 Hz
On Voltage Drop	N/A
Max Current (Resistive)	1A/point 5A/common
Max Leakage Current	0.1 mA @ 265VAC
Max Inrush Current	4A
Minimum Load	5mA
Base Power Required 5V	1000mA max, 60mA/point
External DC Required	None
OFF to ON Response	10ms
ON to OFF Response	10ms
Terminal Type (Included)	Removable (D4-16IOCON)
Status Indicators	Logic Side
Fuses	1 (18) per common Non-replaceable

Typical Relay Life (Operations)			
Maximum Resistive or Inductive Inrush Load Current	Operating Voltage		
	28 VDC	120 VAC	2450 VAC
5A	200K	100K	–
3A	325K	125K	50K
0.05 A	>50M	–	–

Typical Relay Life (Operations)			
Maximum Resistive or Inductive Inrush Load Current	Operating Voltage		
	30 VDC	120 VAC	250 VAC
1A Resistive	>1M	500K	300K
1A Inductive	400K	200K	100K
0.5 A Resistive	>2M	800K	500K
0.5 A Inductive	>1M	300K	200K