



**DL205**  
**Installation and I/O**  
**Manual**

Manual Number D2-INST-M

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# Manual Revisions

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

**Title:** DL205 Installation and I/O Manual

**Manual Number:** D2-INST-M

Edition/Rev	Date	Description of Changes
First Edition	10/98	original issue
Rev A	04/01	added modules
Rev B	06/02	added surge suppression information and modules; updated Appendix A



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# Introduction

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## In This Chapter. . . .

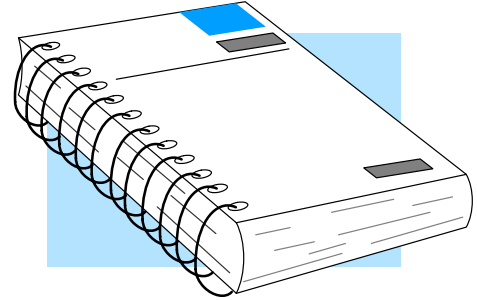
- About This Manual
  - Conventions Used
  - CPU-slot Controllers
  - DL205 System Components
-



## About This Manual

### The Purpose of this Manual

This manual is written for the user of non-traditional CPU-slot controllers or I/O controllers who are also using our DL205 I/O products. This manual shows you how to install and wire the equipment. It provides specifications for input and output modules. It also helps you understand how to interface these products to other devices in a control system.



### Supplemental Manuals

In addition to this manual, you will want to have the appropriate manual for your CPU-slot controller and for the PC-based control software you will be using.

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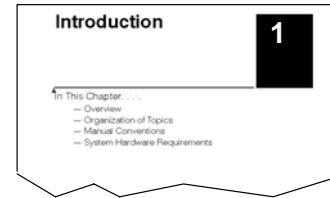
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## Conventions Used

### Key Topics for Each Chapter

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



When you see the “notepad” icon in the left-hand margin, the paragraph to its immediate right will be a **special note**. The word **NOTE:** in boldface will mark the beginning of the text.



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

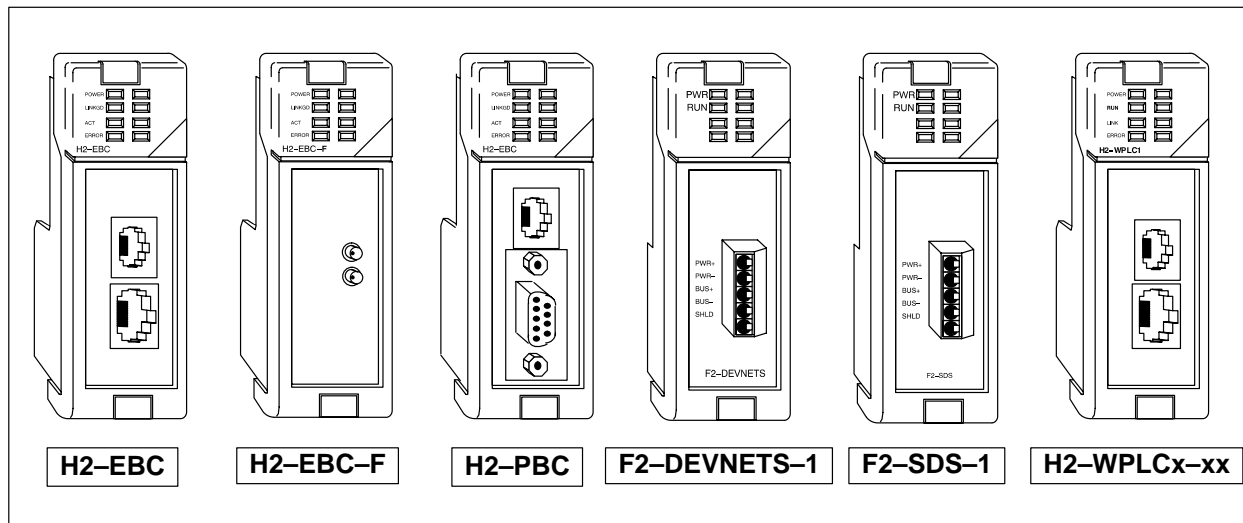
## CPU-slot Controllers

There are currently six “base controllers” or “I/O controllers” available for the DL205. Five of the six require connection to a PC running PC-based Control software. The sixth contains the CPU and operating system onboard the module.

The four controllers currently available are:

- Ethernet Base Controller
  - H2-EBC
  - H2-EBC-F
- Profibus Slave Base Controller
  - H2-PBC
- DeviceNet™ Slave
  - F2-DEVNETS-1
- Smart Distributed System™ Slave
  - F2-SDS-1
- WinPLC
  - H2-WPLCx-xx

Of the controllers listed, only the WinPLC is a stand-alone controller with its control software loaded in non-volatile memory onboard the module.



## DL205 System I/O Components

- Bases** Four base sizes are available: 3 slot, 4 slot, 6 slot, and 9 slot. One slot is for the DL205 Controller/Slave module, the remaining slots are for I/O modules. All bases include a built-in power supply.
- I/O Configuration** The number of I/O points that can be supported is CPU-slot controller dependent.
- I/O Modules** The DL205 has some of the most powerful modules in the industry. A complete range of discrete modules which support 24 VDC, 110/220 VAC and up to 10A relay outputs are offered. The analog modules provide 12 and 16 bit resolution and several selections of input and output signal ranges (including bipolar). At this time, the only specialty module supported is the H2-CTRIO when used with an H2-EBC or H2-WPLCx-xx controller.

# Installation and Power Wiring

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## In This Chapter. . . .

- Safety Guidelines
  - Mounting Guidelines
  - Installing DL205 Bases
  - Installing Components in the Base
  - Base Wiring Guidelines
-

## Safety Guidelines



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

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

### Plan for Safety

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

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

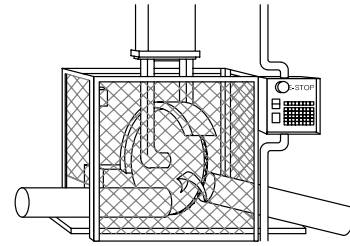
- NEMA — The National Electrical Manufacturers Association, located in Washington, D.C., publishes many different documents that discuss standards for industrial control systems. You can order these publications directly from NEMA. Some of these include:  
*ICS 1, General Standards for Industrial Control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

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

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

### Orderly System Shutdown

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



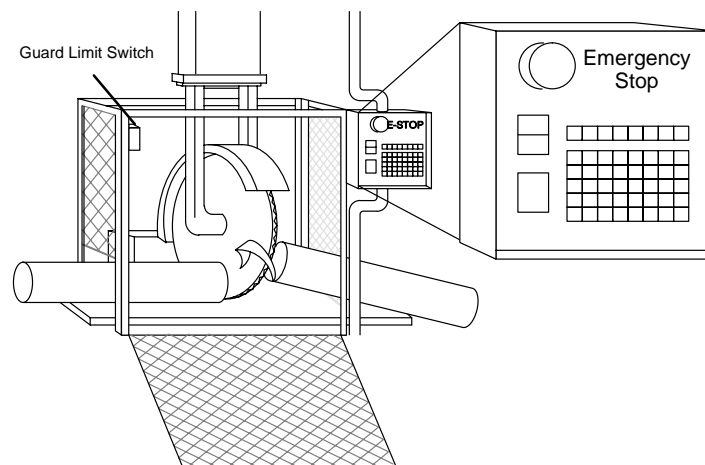
**WARNING:** The control program *must not* be the only form of protection for any problems that may result in a risk of personal injury or equipment damage.

### System Power Disconnect

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

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

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



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

# Mounting Guidelines

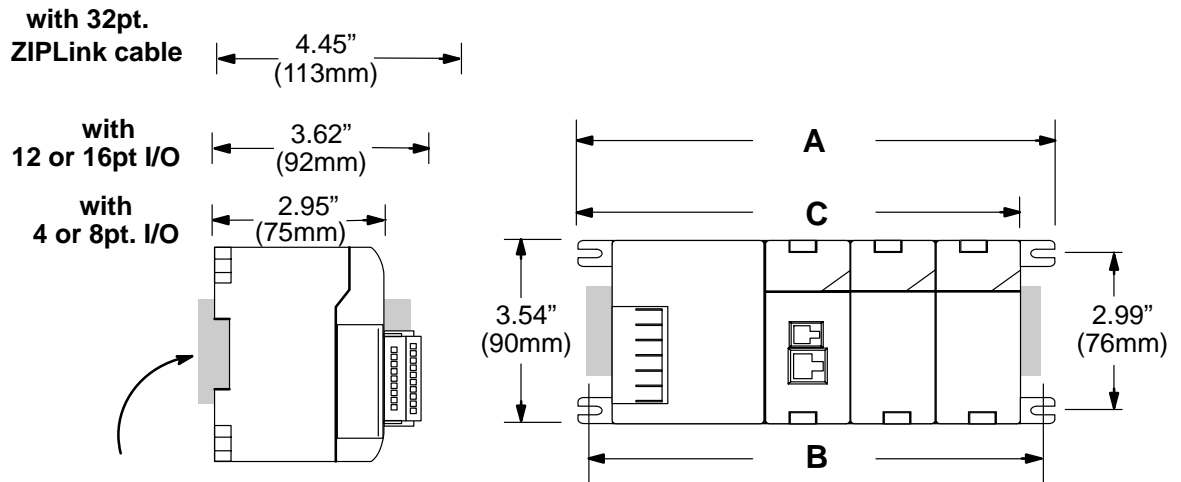
Before installing the DL205 system you will need to know the dimensions for the components. The diagrams on the following pages provide the component dimensions to use in defining your enclosure specifications. Remember to leave room for potential expansion.



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

## Base Dimensions

The following information shows the proper mounting dimensions. The height dimension is the same for all bases. The depth varies depending on your choice of I/O module. The length varies as the number of slots increase. Make sure you have followed the installation guidelines for proper spacing.



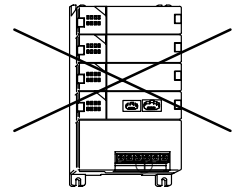
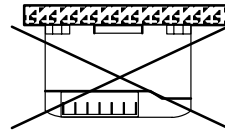
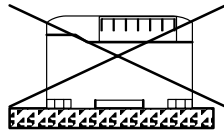
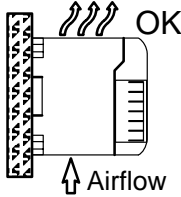
DIN Rail slot. Use rail conforming to DIN EN 50022.

Base	A (Total Width)		B (Mounting Hole)		C (Component Width)	
	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters
3-slot	6.77"	172mm	6.41"	163mm	5.8"	148mm
4-slot	7.99"	203mm	7.63"	194mm	7.04"	179mm
6-slot	10.43"	265mm	10.07"	256mm	9.48"	241mm
9-slot	14.09"	358mm	13.74"	349mm	13.14"	334mm



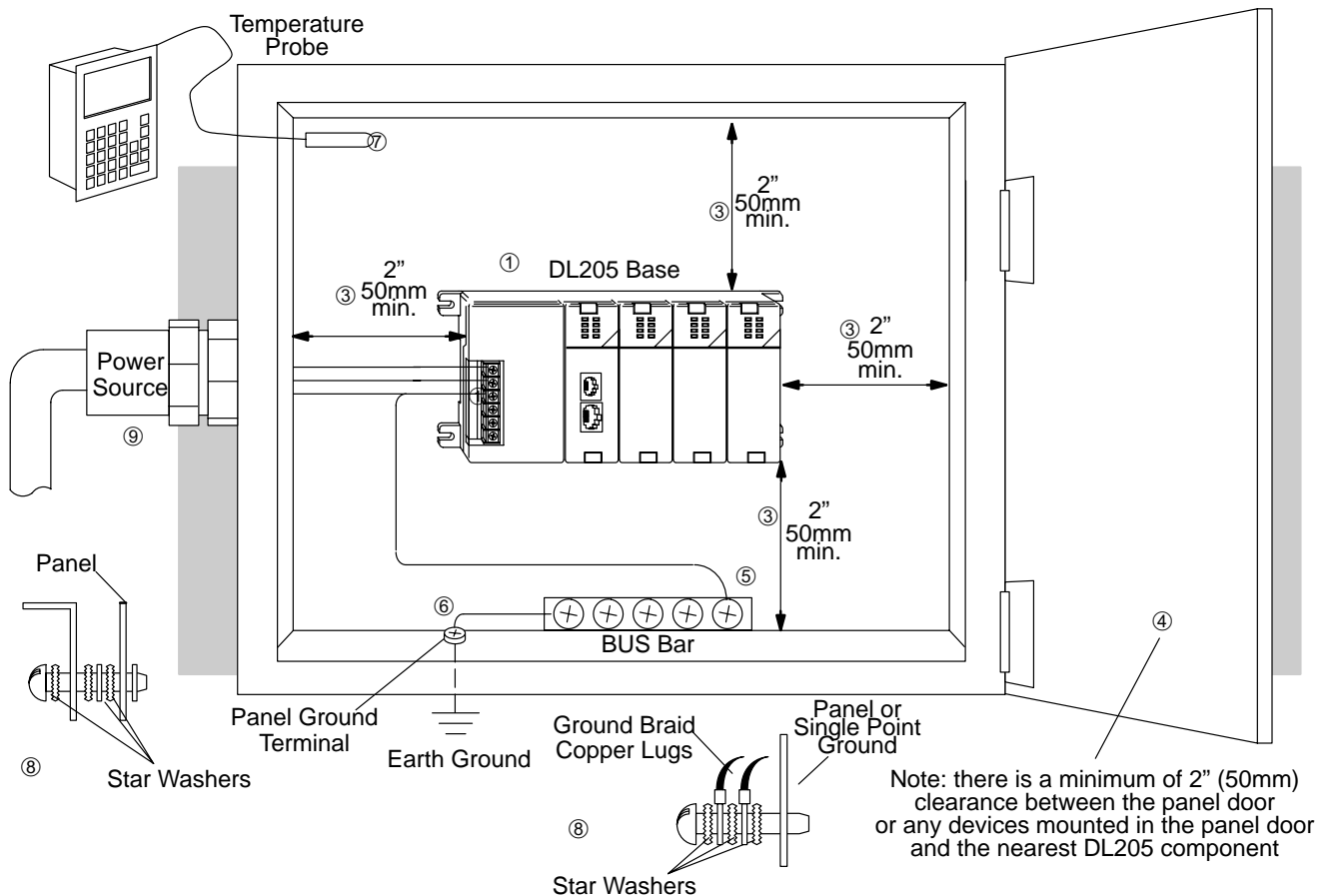
**Panel Mounting and Layout**

It is important to design your panel properly to help ensure the DL205 products operate within their environmental and electrical limits. The system installation should comply with all appropriate electrical codes and standards. It is important the system also conforms to the operating standards for the application to insure proper performance. The diagrams below reference the items in the following list.



1. Mount the bases horizontally to provide proper ventilation.
2. If you place more than one base in a cabinet, there should be a minimum of 7.2" (183mm) between bases.
3. Provide a minimum clearance of 2" (50mm) between the base and all sides of the cabinet. There should also be at least 1.2" (30mm) of clearance between the base and any wiring ducts.
4. There must be a minimum of 2" (50mm) clearance between the panel door and the nearest DL205 component.

**Note:** The cabinet configuration below is not suitable for EU installations. Refer to Appendix A European Union Directives.



Installation and Wiring

5. The ground terminal on the DL205 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. 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 DL205 base and the single point ground.
6. There must be a single point ground (i.e. copper bus bar) for all devices in the panel requiring an earth ground return. The single point of ground must be connected to the panel ground termination.

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

A good common ground reference (Earth ground) is essential for proper operation of the DL205. There are several methods of providing an adequate common ground reference, including:

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

7. Properly evaluate any installations where the ambient temperature may approach the lower or upper limits of the specifications. Place a temperature probe in the panel, close the door and operate the system until the ambient temperature has stabilized. If the ambient temperature is not within the operating specification for the DL205 system, measures such as installing a cooling/heating source must be taken to get the ambient temperature within the DL205 operating specifications.
8. Device mounting bolts and ground braid termination bolts should be #10 copper bolts or equivalent. Tapped holes instead of nut-bolt arrangements should be used whenever possible. To assure good contact on termination areas impediments such as paint, coating or corrosion should be removed in the area of contact.
9. The DL205 system is designed to be powered by 110/220 VAC, 24 VDC, or 125 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 DL205 system. Applications of DL205 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 generally apply to the DL205 bases and I/O modules (Be sure to check the specifications of the CPU-slot controller you are using). I/O module operation may fluctuate depending on the ambient temperature and your application. Please refer to the appropriate I/O module specifications for the temperature derating curves applying to specific modules.

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*	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.

Specification	AC Powered Bases	24 VDC Powered Bases	125 VDC Powered Bases
Part Numbers	D2-03B-1, D2-04B-1, D2-06B-1, D2-09B-1	D2-03BDC1-1, D2-04BDC1-1, D2-06BDC1-1, D2-09BDC1-1	D2-06BDC2-1, D2-09BDC2-1
Input Voltage Range	100-240 VAC +10% -15%	10.2 – 28.8VDC (24VDC) with less than 10% ripple	104-240 VDC +10% -15%
Maximum Inrush Current	30 A	10A	20A
Maximum Power	80 VA	25W	30W
Voltage Withstand (dielectric)	1 minute @ 1500 VAC between primary, secondary, field ground, and run relay		
Insulation Resistance	> 10 M $\Omega$ at 500 VDC		
Auxiliary 24 VDC Output	20-28 VDC, less than 1V p-p 300 mA max.	None	20-28 VDC, less than 1V p-p 300 mA max.
Fusing (internal to base power supply)	non-replaceable 2A @ 250V slow blow fuse; external fus- ing recommended	non-replaceable 3.15A @ 250V slow blow fuse; exter- nal fusing recommended	non-replaceable 2A @ 250V slow blow fuse; external fus- ing recommended

## Agency Approvals

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

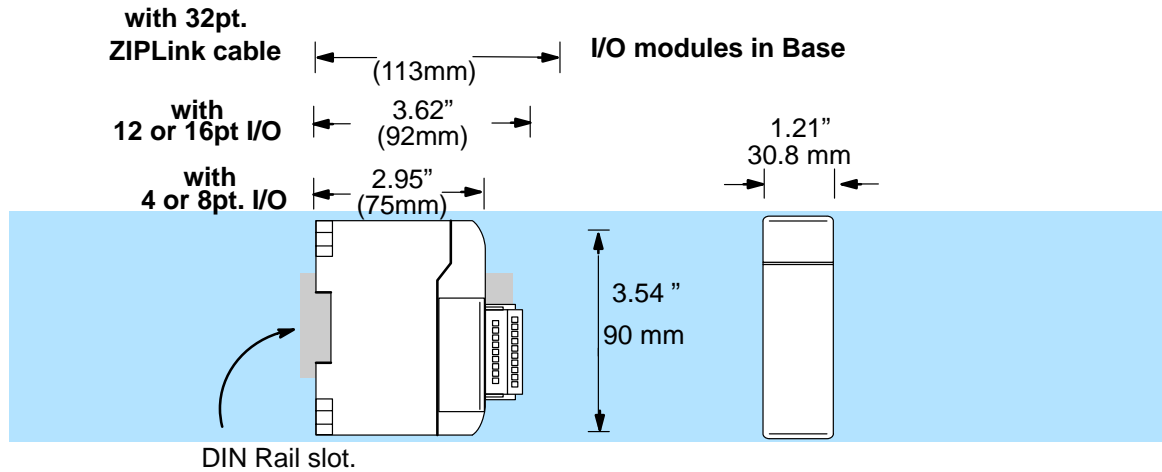
- UL (Underwriters' Laboratories, Inc.)
- CSA (Canadian Standards Association)
- FM (Factory Mutual Research Corporation)
- CUL (Canadian Underwriters' Laboratories, Inc.)

### Component Dimensions



Before installing your DL205 system you will need to know the dimensions for the components in your system. The diagrams on the following pages provide the component dimensions and should be used to define your enclosure specifications. Remember to leave room for potential expansion.

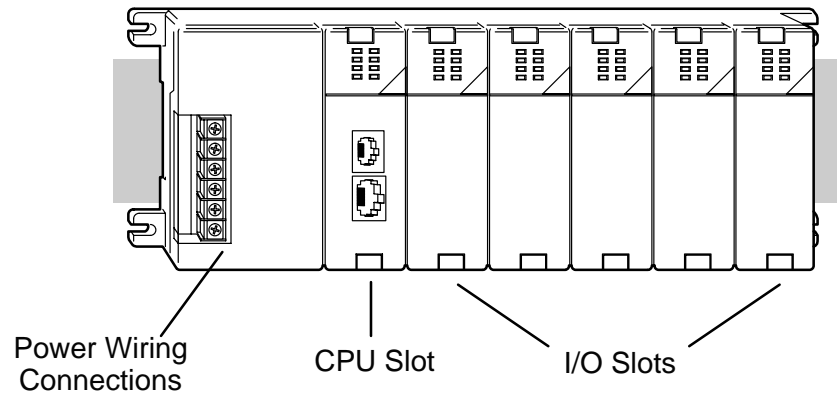
**NOTE:** If you are using other components in your system, make sure you refer to the appropriate manual to determine how those units can affect mounting dimensions.



## Installing DL205 Bases

**Choosing the Base Type** The DL205 system offers four different sizes of bases and three different power supply options.

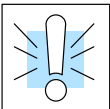
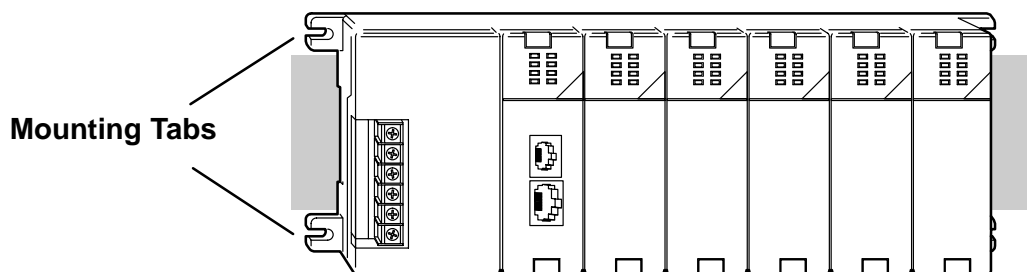
The following diagram shows an example of a 6-slot base.



Your choice of base depends on three things.

- Number of I/O modules required
- Input power requirement (AC or DC power)
- Available power budget

**Mounting the Base** All I/O configurations of the DL205 may use any of the base configurations. The bases are secured to the equipment panel or mounting location using four M4 screws in the corner tabs of the base. The full mounting dimensions are given in the previous section on Mounting Guidelines.



**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.

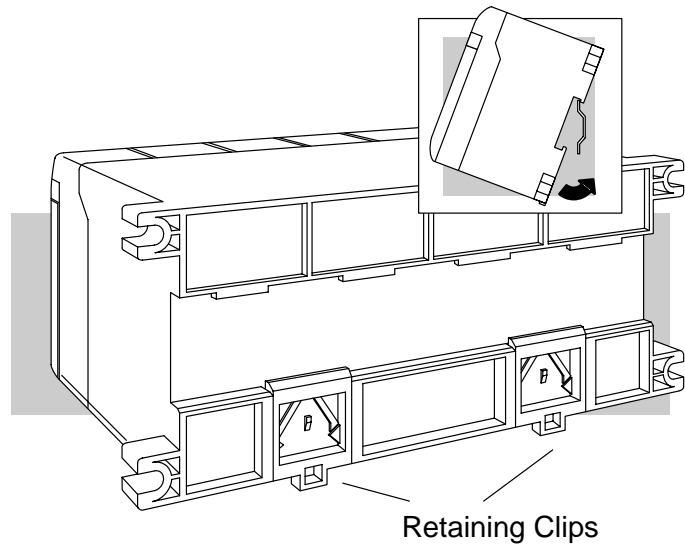
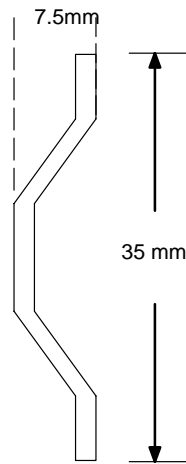
### Using Mounting Rails

The DL205 bases can also be secured to the cabinet by using mounting rails. You should use rails that conform to DIN EN standard 50 022. Refer to our catalog for a complete line of DIN rail and DINnectors, DIN rail mounted apparatus. These rails are approximately 35mm high, with a depth of 7.5mm. If you mount the base on a rail, you should also consider using end brackets on each end of the rail. The end bracket helps keep the base from sliding horizontally along the rail. This helps minimize the possibility of accidentally pulling the wiring loose.

If you examine the bottom of the base, you'll notice two small retaining clips. To secure the base to a DIN rail, place the base onto the rail and gently push up on the retaining clips. The clips lock the base onto the rail.

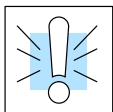
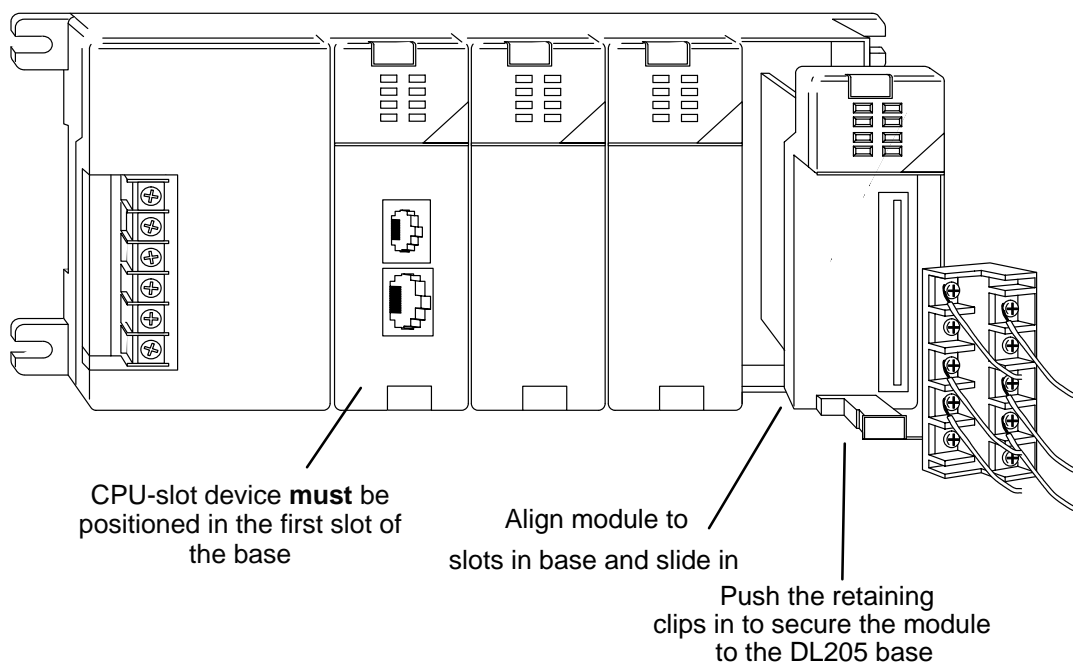
To remove the base, pull down on the retaining clips, lift up on the base slightly, and pull it away from the rail.

DIN Rail Dimensions



## Installing Components in the Base

When inserting components into the base, align the PC board(s) of the module with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the backplane connector. Once the module is inserted into the base, push in the retaining clips (located at the top and bottom of the module) to firmly secure the module to the base.



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

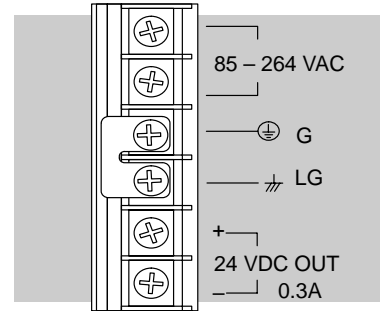
### Base Wiring Guidelines

#### Base Wiring

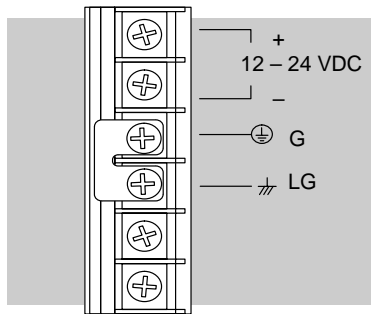
The diagrams show the terminal connections located on the power supply of the DL205 bases. The base terminals can accept up to 16 AWG. You may be able to use larger wiring depending on the type of wire used, but 16 AWG is the recommended size. Do not overtighten the connector screws; recommended torque value is 7.81 pound-inches (0.882 N•m).

**NOTE:** You can connect either a 115 VAC or 220 VAC supply to the AC terminals. Special wiring or jumpers are not required as with some of the other *DirectLOGIC™* products.

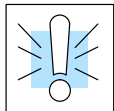
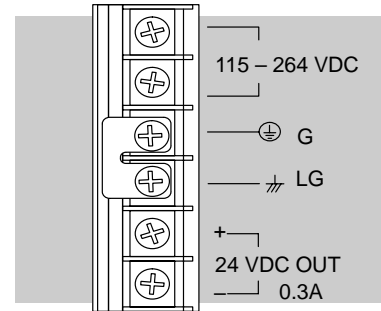
110/220 VAC Base Terminal Strip



12/24 VDC Base Terminal Strip



125 VDC Base Terminal Strip



**WARNING:** Once the power wiring is connected, install the plastic protective cover. When the cover is removed there is a risk of electrical shock if you accidentally touch the wiring or wiring terminals.



# I/O Wiring and Specifications

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In This Chapter. . . .

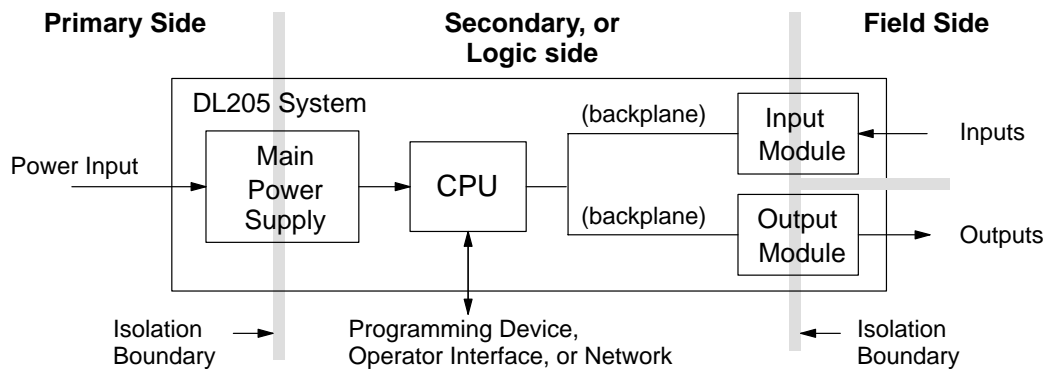
- I/O Wiring Strategies
  - I/O Modules Position, Wiring, and Specifications
  - Glossary of Specification Terms
-

# I/O Wiring Strategies

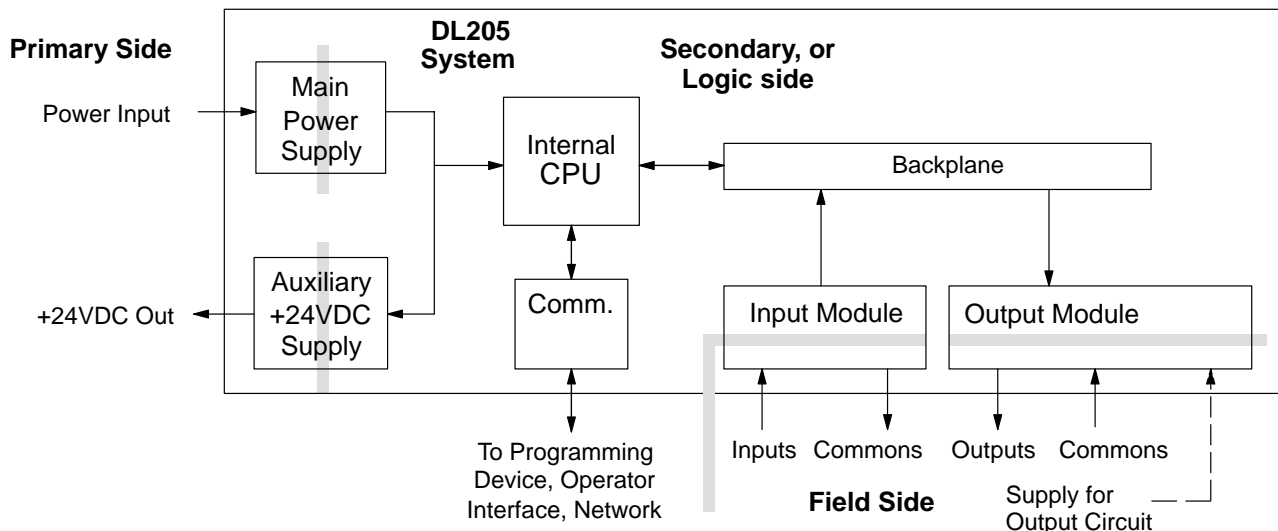
## DL205 System Isolation Boundaries

The DL205 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.

DL205 system circuitry is divided into three main regions separated by isolation boundaries, shown in the drawing below. Electrical isolation provides safety, so that a fault in one area does not damage another. A transformer in the power supply provides magnetic isolation between the primary and secondary sides. Opto-couplers provide optical isolation in Input and Output circuits. This isolates logic circuitry from the field side, where factory machinery connects. Note the discrete inputs are isolated from the discrete outputs, because each is isolated from the logic side. Isolation boundaries protect the operator interface (and the operator) from power input faults or field wiring faults. *When wiring a DL205 system, it is extremely important to avoid making external connections that connect logic side circuits to any other.*



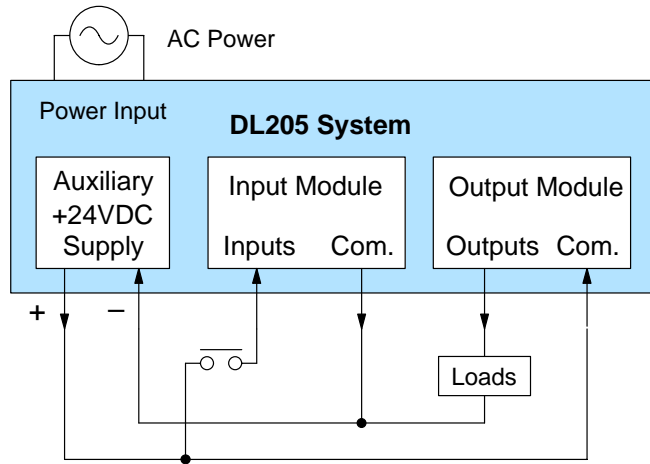
The next figure shows the physical layout of a DL205 system, as viewed from the front. In addition to the basic circuits covered above, AC-powered bases include an auxiliary +24VDC power supply with its own isolation boundary. Since the supply output is isolated from the other three circuits, it can power input and/or output circuits!



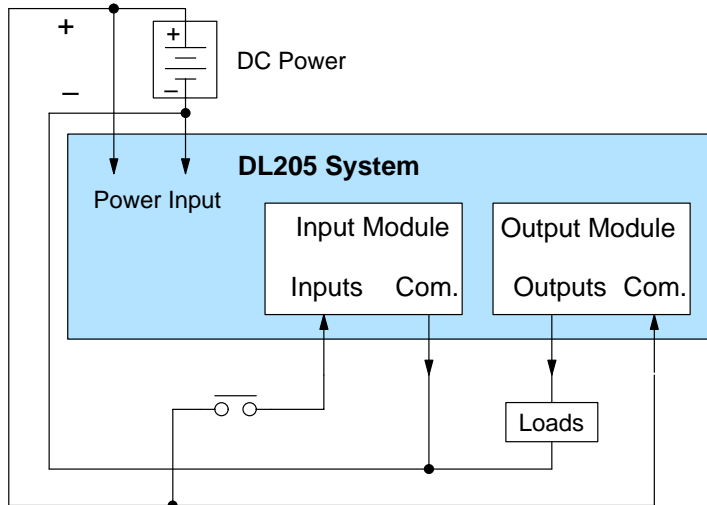
In some cases, using the built-in auxiliary +24VDC supply can result in a cost savings for your control system. It can power combined loads up to 300mA. Be careful not to exceed the current rating of the supply. If you are the system designer for your application, you may be able to select and design in field devices which can use the +24VDC auxiliary supply.

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

All AC powered DL205 bases feature 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.



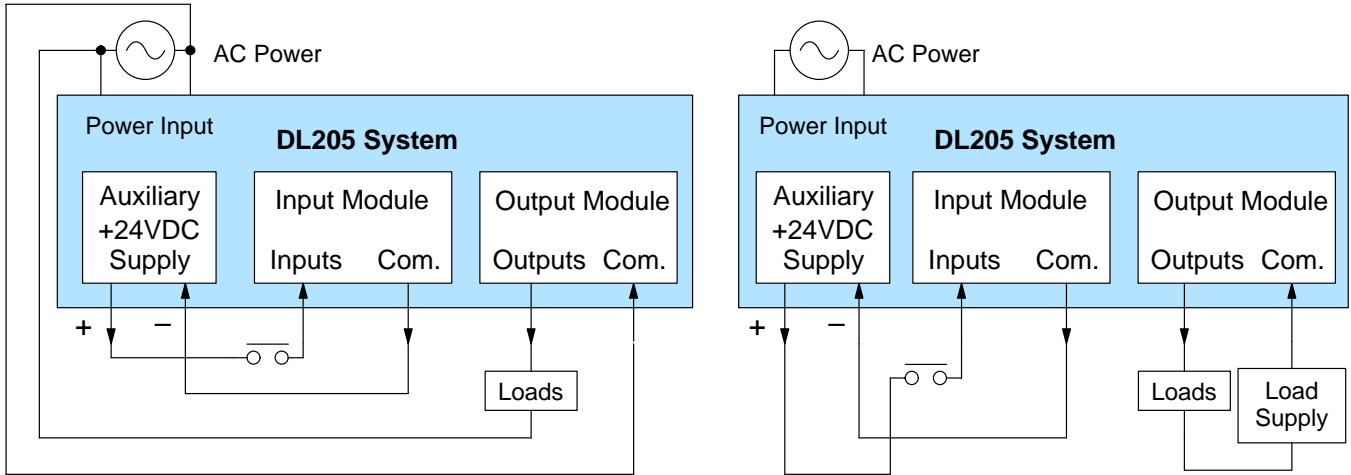
DC-powered DL205 bases are designed for application environments in which low-voltage DC power is more readily available than AC. These include a wide range of battery-powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this type of application, all input devices and output loads typically use the same DC power source. Typical wiring for DC-powered applications is shown in the following diagram.



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

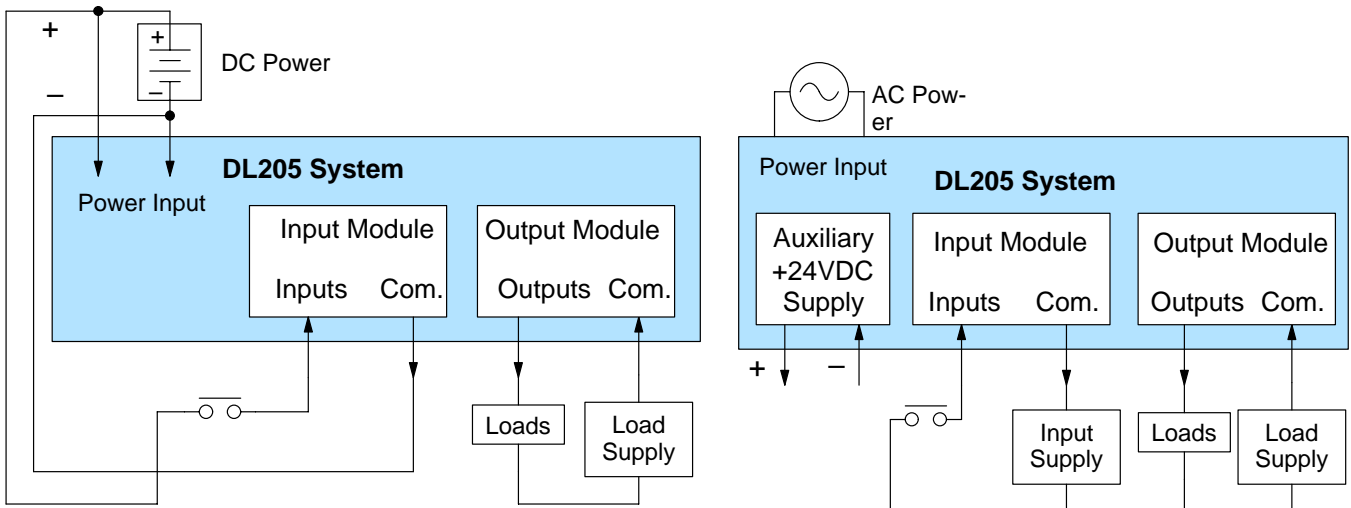
In most applications it will be necessary to power the input devices from one power source, and to power output loads from another source. Loads often require high-energy AC power, while input sensors use low-energy DC. If a machine operator is likely to come in close contact with input wiring, then safety reasons also require isolation from high-energy output circuits. It is most convenient if the loads can use the same power source as the DL205 system, and the input sensors can use the auxiliary supply, as shown to the left in the figure below.

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



Some applications will use the DL205 external power source to also power the input circuit. This typically occurs on DC-powered systems, as shown in the drawing below to the left. The inputs share the system power source supply, while the outputs have their own separate supply.

A worst-case scenario, from a cost and complexity view-point, is an application which requires separate power sources for the DL205 system, input devices, and output loads. The example wiring diagram below on the right shows how this can work, but also the auxiliary supply output is an unused resource. You will want to avoid this situation if possible.



**Sinking / Sourcing Concepts**

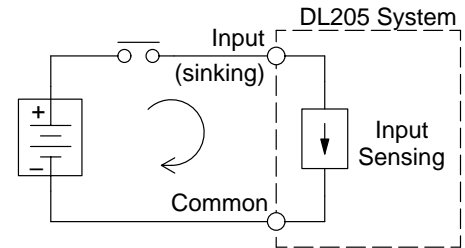
Before going further in the study of wiring strategies, you must have a solid understanding of “*sinking*” and “*sourcing*” concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring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

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

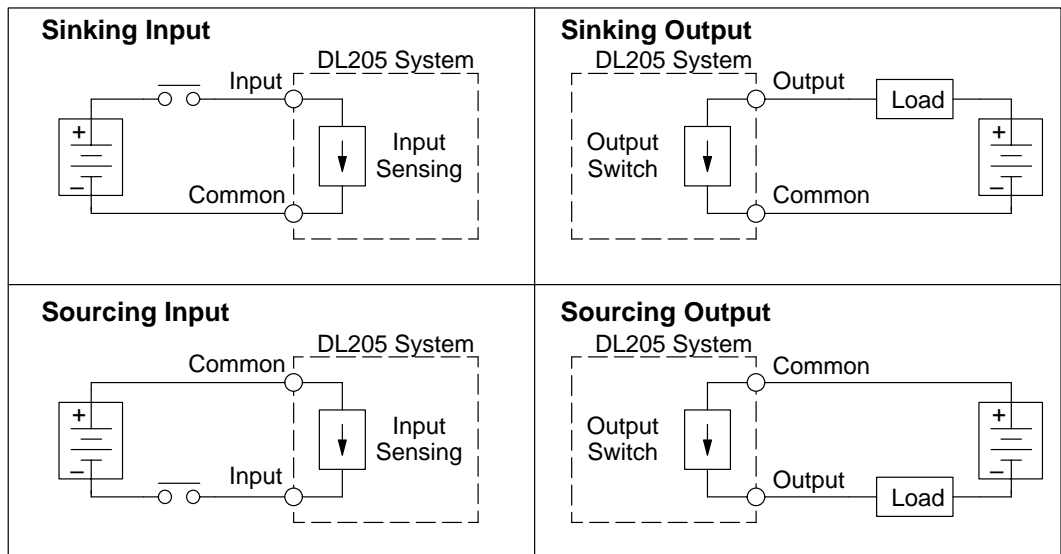
**Sourcing = provides a path to supply source (+)**

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

For example, the figure to the right depicts a “sinking” input. To properly connect the external supply, you will have to connect it so the input *provides a path to ground (-)*. Start at the DL205 system input terminal, follow through the input sensing circuit, exit at the common terminal, and connect the supply (-) to the common terminal. By adding the switch, between the supply (+) and the input, the circuit has been completed. Current flows in the direction of the arrow when the switch is closed.

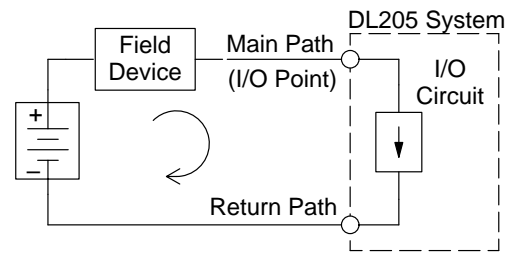


By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types as shown below. The I/O module specifications at the end of this chapter list the input or output type.

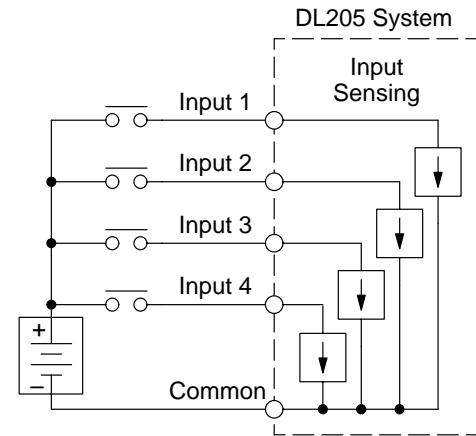


### I/O “Common” Terminal Concepts

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



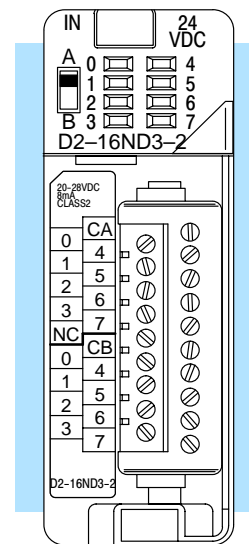
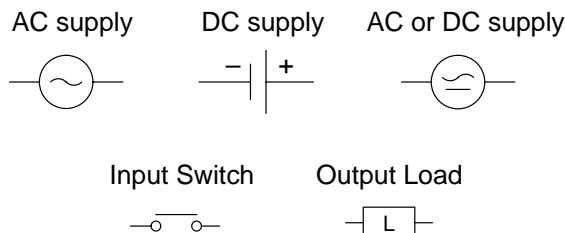
If there was unlimited space and budget for I/O terminals, every I/O point could have two dedicated terminals as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output points are in groups which share the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



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

Most DL205 input and output modules group their I/O points into banks that share a common return path. The best indication of I/O common grouping is on the wiring label, such as the one shown to the right. The miniature schematic shows two circuit banks with 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:

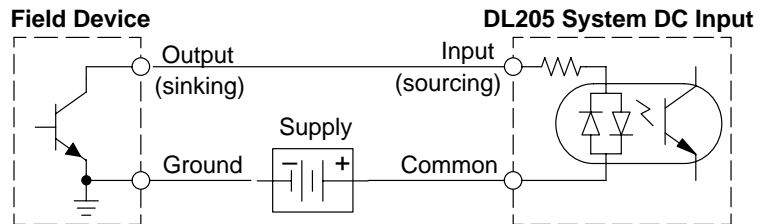


**Connecting DC I/O to “Solid State” Field Devices**

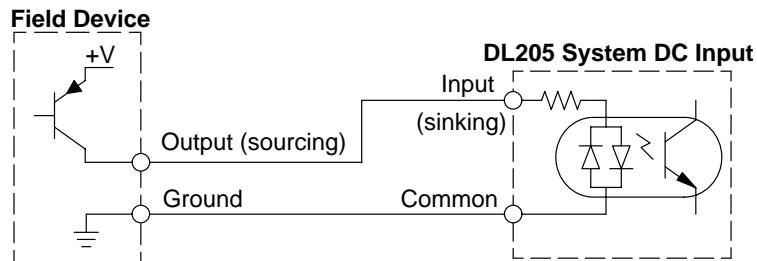
In the previous section on Sourcing and Sinking concepts, the DC I/O circuits were explained to only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *When connecting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

**Solid State Input Sensors**

Several DL205 DC input modules are flexible because they detect current flow in either direction, so they can be wired as either sourcing or sinking. In the following circuit, a field device has an open-collector NPN transistor output. It sinks current from the input point, which sources current. The power supply can be the +24 auxiliary supply or another supply (+12 VDC or +24VDC), as long as the input specifications are met.



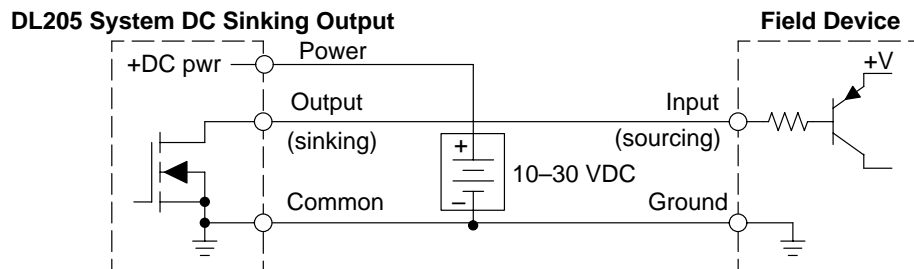
In the next circuit, a field device has an open-emitter PNP transistor output. It sources current to the input point, which sinks the current back to ground. Since the field device is sourcing current, no additional power supply is required.



**Solid State Output Loads**

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

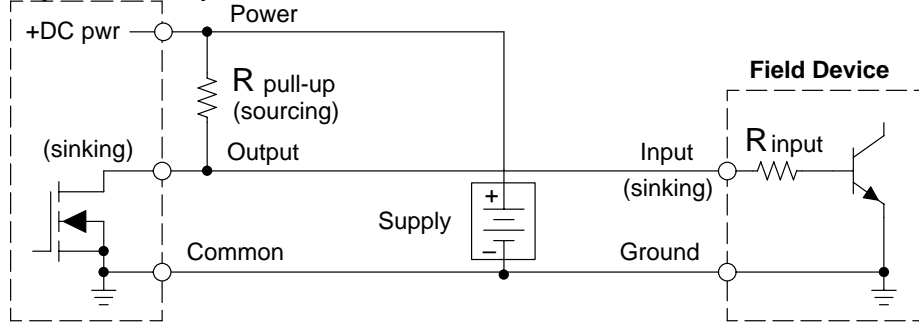
Several of the DL205 DC output modules are the sinking type. This means that each DC output provides a path to ground when it is energized. In the following circuit, the output point sinks current to the output common when energized. It is connected to a sourcing input of a field device input.



I/O Wiring and Specifications

In the next example a sinking DC output point is connected to the sinking input of a field device. This is a little tricky, because both the DL205 system output and field device input are sinking type. Since the circuit must have one sourcing and one sinking device, a sourcing capability needs to be added to the DL205 system output by using a pull-up resistor. In the circuit below, a  $R_{pull-up}$  is connected from the output to the DC output circuit power input.

**DL205 System DC Output**



**NOTE 1:** DO NOT attempt to drive a heavy load (>25 mA) with this pull-up method  
**NOTE 2:** Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the DL205 system output is OFF, from a ladder logic point-of-view. Your ladder program must comprehend this and generate an inverted output. Or, you may choose to cancel the effect of the inversion elsewhere, such as in the field device.

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

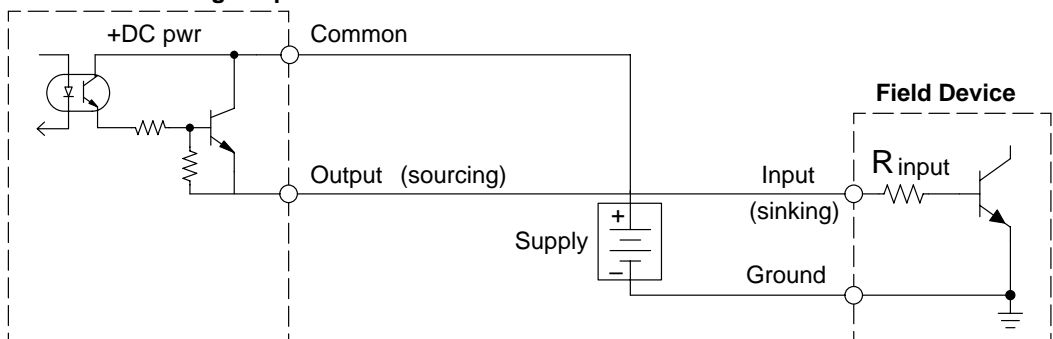
$$I_{input} = \frac{V_{input (turn-on)}}{R_{input}}$$

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

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

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

**DL205 DC Sourcing Output**





## Relay Output Guidelines

Six output modules in the DL205 I/O family feature relay outputs: D2-04TRS, D2-08TR, D2-12TR, D2-08CDR, F2-08TR and F2-08TRS. Relays are best for the following applications:

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

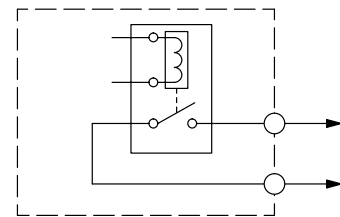
Some applications in which NOT to use relays:

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

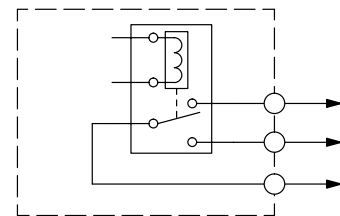
Relay outputs in the DL205 output modules are available in two contact arrangements, shown to the right. The Form A type, or SPST (single pole, single throw) type is normally open and is the simplest to use. The Form C type, or SPDT (single pole, double throw) type has a center contact which moves and 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



## Surge Suppression For Inductive Loads

Inductive load devices (devices with a coil) generate transient voltages when de-energized with a relay contact. When a relay contact is closed it “bounces”, which energizes and de-energizes the coil until the “bouncing” stops. The transient voltages generated are much larger in amplitude than the supply voltage, especially with a DC supply voltage.

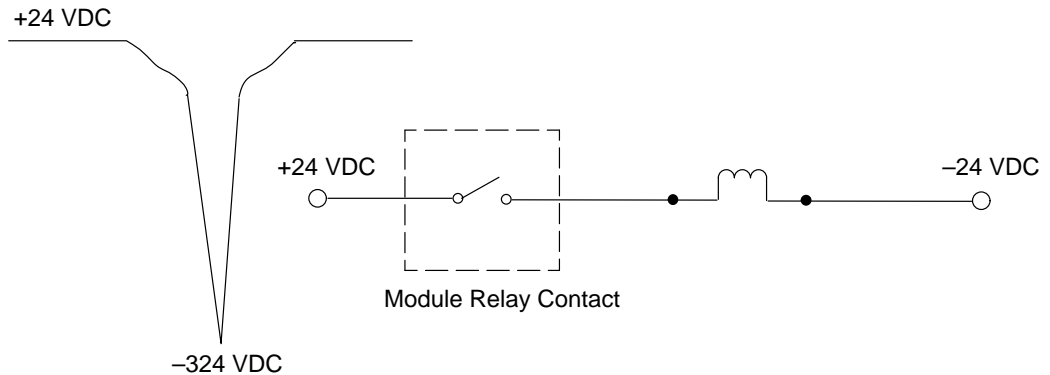
When switching a DC-supplied inductive load the full supply voltage is always present when the relay contact opens (or “bounces”). When switching an AC-supplied inductive load there is one chance in 60 (60 Hz) or 50 (50 Hz) that the relay contact will open (or “bounce”) when the AC sine wave is zero crossing. If the voltage is not zero when the relay contact opens there is energy stored in the inductor that is released when the voltage to the inductor is suddenly removed. This release of energy is the cause of the transient voltages.

When inductive load devices (motors, motor starters, interposing relays, solenoids, valves, etc.) are controlled with relay contacts, it is recommended that a surge suppression device be connected directly across the coil of the field device. If the inductive device has plug-type connectors, the suppression device can be installed on the terminal block of the relay output.

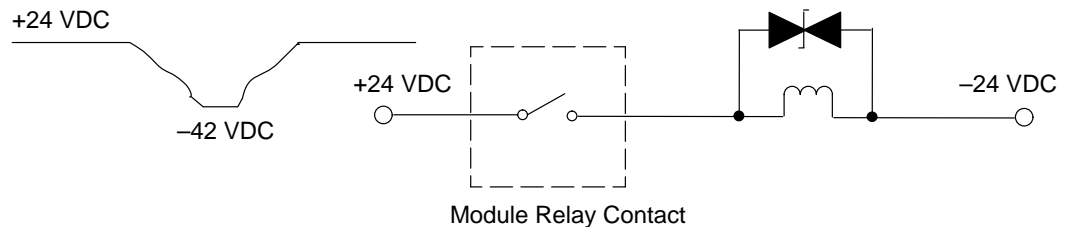
**Transient Voltage Suppressors (TVS or transorb)** provide the best surge and transient suppression of AC and DC powered coils, providing the fastest response with the smallest overshoot.

**Metal Oxide Varistors (MOV)** provide the next best surge and transient suppression of AC and DC powered coils.

For example, the waveform in the figure below shows the energy released when opening a contact switching a 24 VDC solenoid. Notice the large voltage spike.



This figure shows the same circuit with a transorb (TVS) across the coil. Notice that the voltage spike is significantly reduced.



Use the following table to help select a TVS or MOV suppressor for your application based on the inductive load voltage.

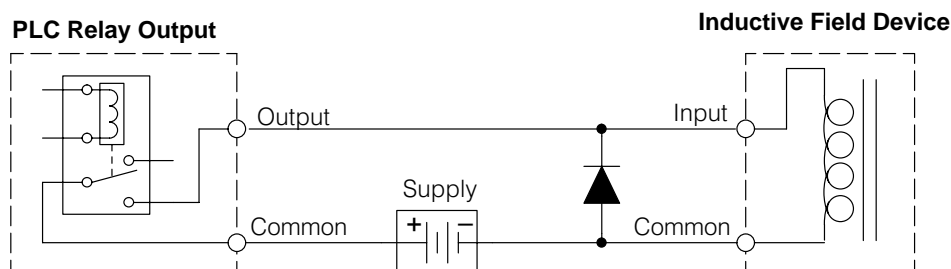
Vendor / Catalog	Type (TVS, MOV, Diode)	Inductive Load Voltage	Part Number
AutomationDirect	8 channel TVS	24 VDC	ZL-TD8-24
AutomationDirect	8 channel TVS	110 VAC	ZL-TD8-120
General Instrument	TVS	110/120 VAC	P6KE180CAGICT-ND
Transient Voltage Suppressors, LiteOn	TVS	220/240 VAC	P6KE350CA
Diodes; from DigiKey	TVS	12/24 VDC or VAC	P6K30CAGICT-ND
Catalog; Phone: 1-800-344-4539	Diode	12/24 VDC or VAC	1N4004CT-ND
Harris Metal Oxide Varistors; from Newark	MOV	110/120 VAC	V150LA20C
Catalog; Phone: 1-800-463-9275	MOV	220/240 VAC	V250LA20C

### Prolonging Relay Contact Life

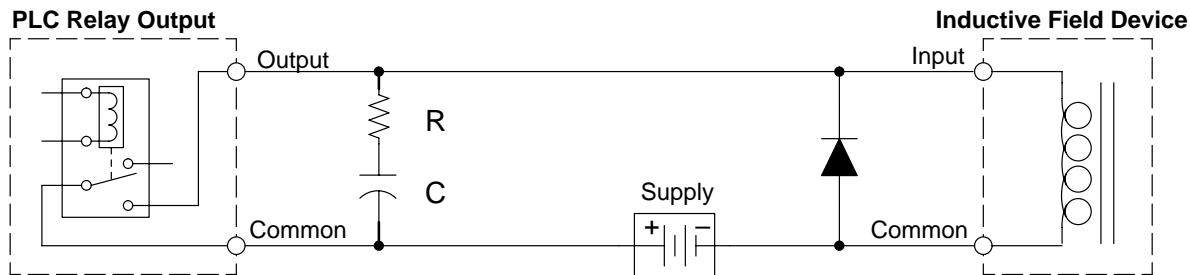
Relay contacts wear according to the amount of relay switching, amount of spark created at the time of open or closure, and presence of airborne contaminants. There are some steps you can take to help prolong the life of relay contacts, such as switching the relay on or off only when it is necessary, and if possible, switching the load on or off at a time when it will draw the least current. Also, take measures to suppress inductive voltage spikes from inductive DC loads such as contactors and solenoids.

For inductive loads in DC circuits we recommend using a suppression diode as shown in the following diagram (DO NOT use this circuit with an AC power supply). When the load is energized the diode is reverse-biased (high impedance). When the load is turned off, energy stored in its coil is released in the form of a negative-going voltage spike. At this moment the diode is forward-biased (low impedance) and shunts the energy to ground. This protects the relay contacts from the high voltage arc that would occur just as the contacts are opening.

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



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



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

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

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

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

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

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

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

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

Now, finding the values of R and C,:

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

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

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

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

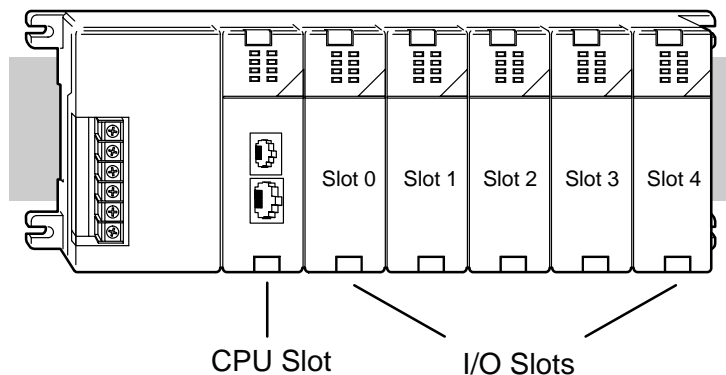
For best results, follow these guidelines in using a noise suppression diode:

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

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

### Slot Numbering

The DL205 bases each provide different numbers of slots for use with the I/O modules. You may notice the bases refer to 3-slot, 4-slot, etc. One of the slots is dedicated to the CPU-slot controller, so you always have one less I/O slot. For example, you have five I/O slots with a 6-slot base. The I/O slots are numbered 0 – 4. The “CPU” slot always contains a CPU-slot controller and is not numbered.



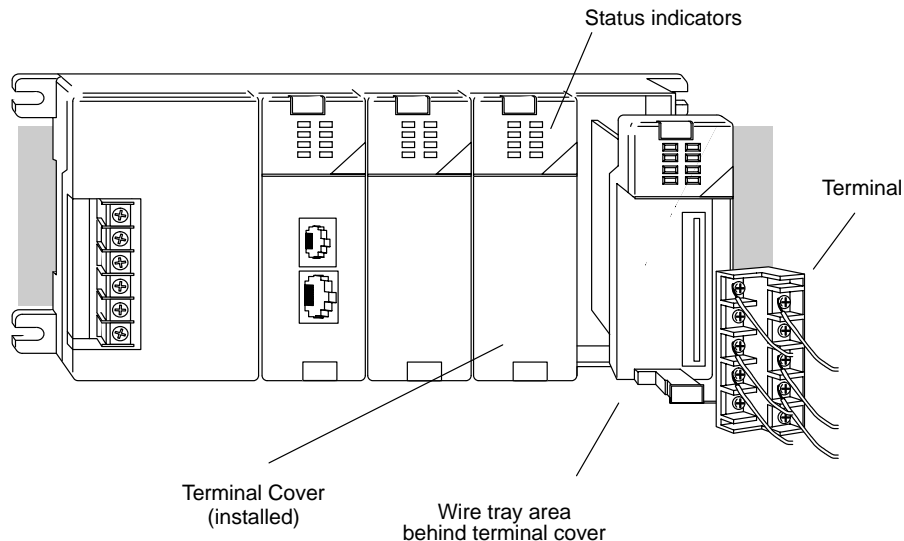
### Module Placement Restrictions

The most commonly used I/O modules for the DL205 system (AC, DC, Relay and Analog) can be used in any slot. The following table lists the valid locations for all types of modules in a DL205 system.

Module/Unit	Local CPU Base Slot #
CPU-slot Controller	CPU Slot Only
DC Input Modules	Any slot
AC Input Modules	Any slot
DC Output Modules	Any slot
AC Output Modules	Any slot
Relay Output Modules	Any slot
Analog I/O Modules	Any slot
H2-CTRIO Module	Any slot in H2-EBC or H2-WPLCx-xx system

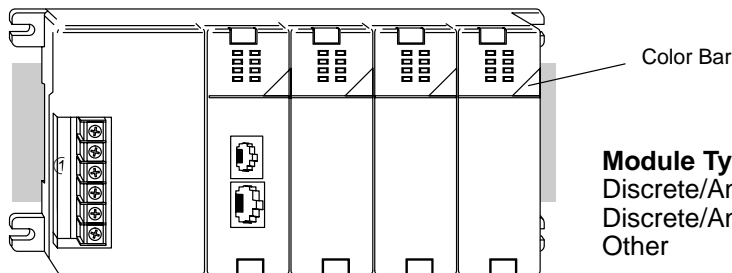
**Discrete Input Module Status Indicators**

The discrete modules provide LED status indicators to show the status of the input points.



**Color Coding of I/O Modules**

The DL205 family of I/O modules have a color coding scheme to help you quickly identify if the module as 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:



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

I/O Wiring and Specifications

### Wiring the Different Module Connectors

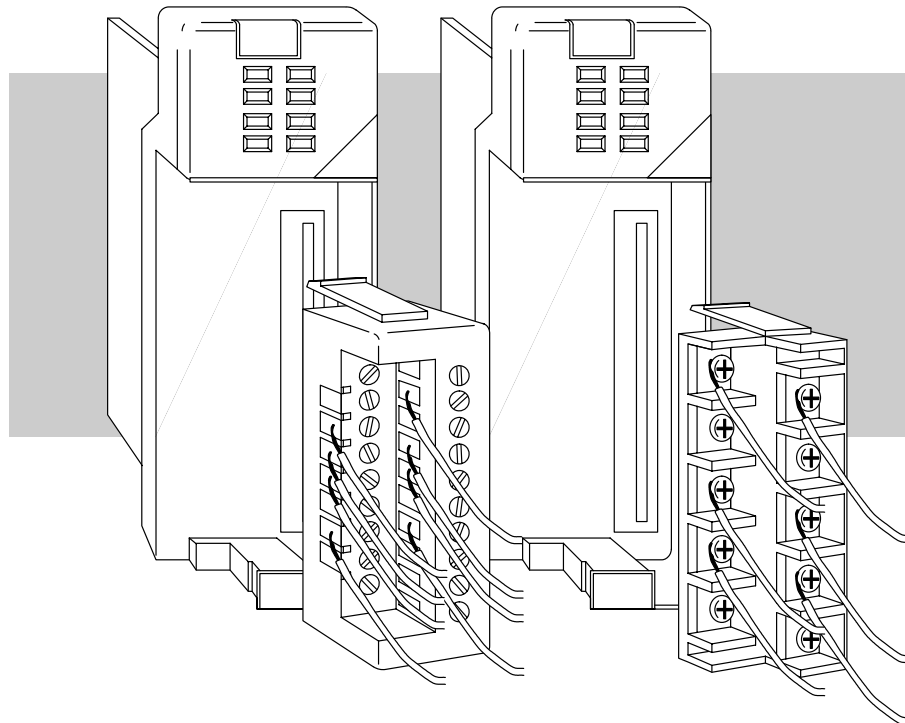
There are two types of module connectors for the DL205 I/O. Some modules have normal screw terminal connectors. Other modules have connectors with recessed screws. The recessed screws help minimize the risk of someone accidentally touching active wiring.

Both types of connectors can be easily removed. If you examine the connectors closely, you'll notice there are squeeze tabs on the top and bottom. To remove the terminal block, press the squeeze tabs and pull the terminal block away from the module.

We also have DIN rail mounted terminal blocks, DINnectors (refer to our catalog for a complete listing of all available products). The DINnectors come with special pre-assembled cables with the I/O connectors installed and wired.



**WARNING:** For some modules, field device power may still be present on the terminal block even though the DL205 system is turned off. To minimize the risk of electrical shock, check all field device power *before* you remove the connector.





## I/O Wiring Checklist

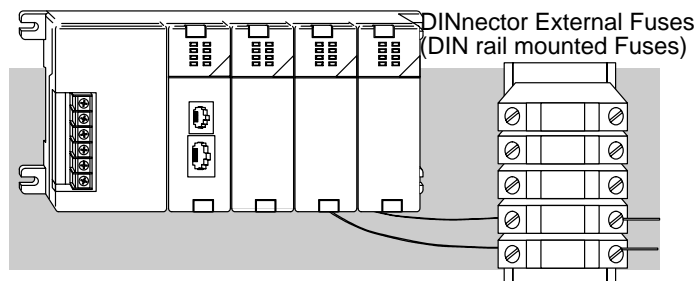
Use the following guidelines when wiring the I/O modules in your system.

1. There is a limit to the size of wire the modules can accept. The table below lists the **suggested** AWG for each module type. When making terminal connections, follow the suggested torque values.

Module type	Suggested AWG Range	Suggested Torque
4 point	16* – 24 AWG	7.81 lb-inch (0.882 N•m)
8 point	16* – 24 AWG	7.81 lb-inch (0.882 N•m)
12 point	16* – 24 AWG	2.65 lb-in (0.3 N•m)
16 point	16* – 24 AWG	2.65 lb-in (0.3 N•m)

**\*NOTE: 16 AWG Type TFFN or Type MTW is recommended.** Other types of 16 AWG may be acceptable, but it really depends on the thickness and stiffness of the wire insulation. **If the insulation is too thick or stiff and a majority of the module's I/O points are used, then the plastic terminal cover may not close properly or the connector may pull away from the module. This applies especially for high temperature thermoplastics such as THHN.**

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



**NOTE:** For modules which have soldered or non-replaceable fuses, we recommend you return your module to us and let us replace your blown fuse(s) since disassembling the module will void your warranty.

## Glossary of Specification Terms

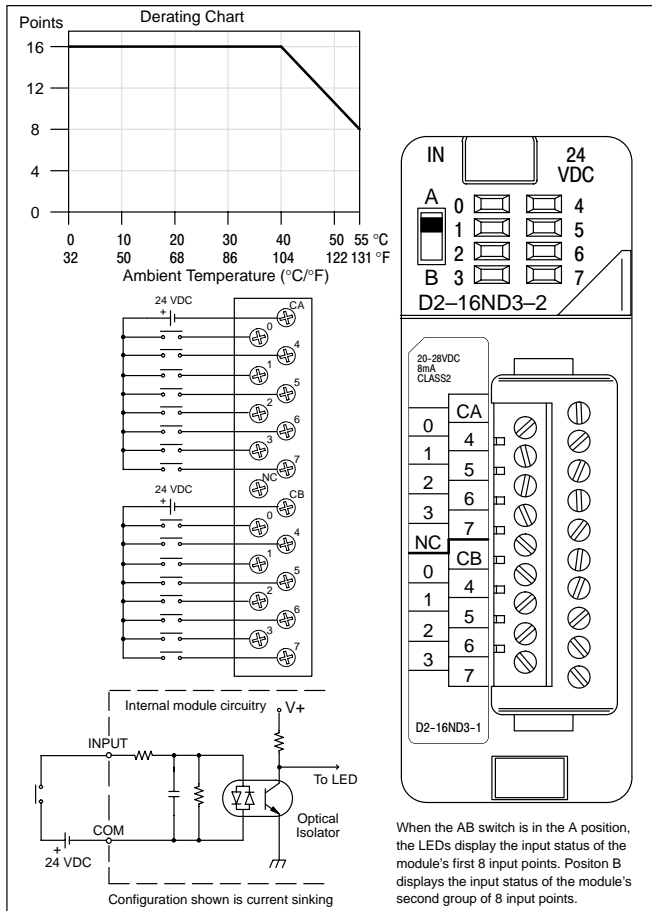
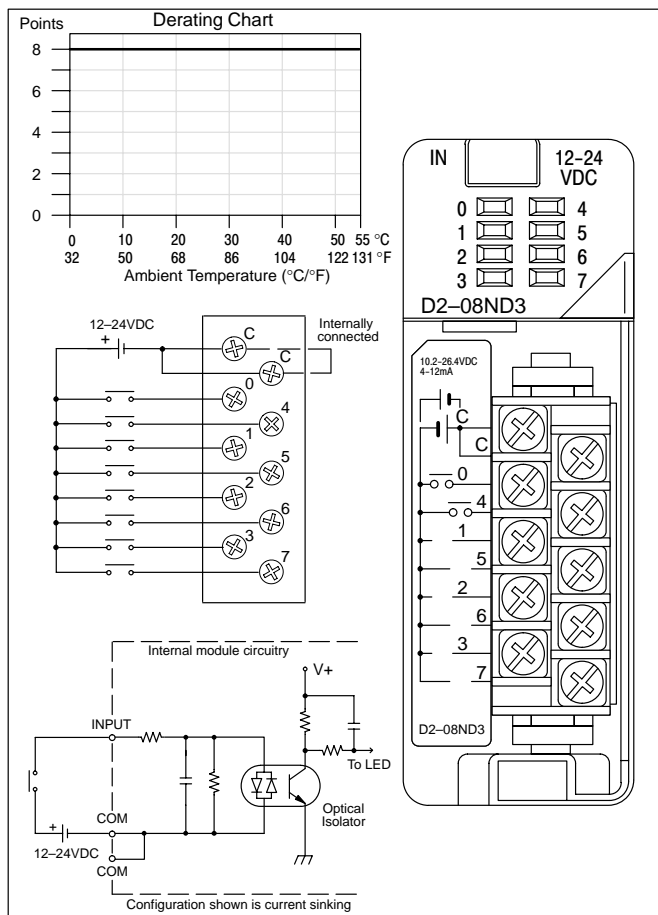
<b>Inputs or Outputs Per Module</b>	Indicates number of input or output points per module and designates current sinking, current sourcing, or either.
<b>Commons / Module</b>	Number of commons per module and their electrical characteristics.
<b>Input Volt. Range</b>	The operating voltage range of the input circuit.
<b>Output Volt. Range</b>	The operating voltage range of the output circuit.
<b>Peak Voltage</b>	Maximum voltage allowed for the input circuit.
<b>AC Frequency</b>	AC modules are designed to operate within a specific frequency range.
<b>ON Voltage Level</b>	The voltage level at which the input point will turn ON.
<b>OFF Voltage Level</b>	The voltage level at which the input point will turn OFF.
<b>Input Impedance</b>	Input impedance can be used to calculate input current for a particular operating voltage.
<b>Input Current</b>	Typical operating current for an active (ON) input.
<b>Min. ON Current</b>	The minimum current for the input circuit to operate reliably in the ON state.
<b>Max. OFF Current</b>	The maximum current for the input circuit to operate reliably in the OFF state.
<b>Minimum Load</b>	The minimum load current for the output circuit to operate properly.
<b>Ext. DC Required</b>	Some output modules require external power for the output circuitry.
<b>ON Voltage Drop</b>	Sometimes called “saturation voltage”, it is the voltage measured from an output point to its common terminal when the output is ON at max. load.
<b>Max. Leakage Current</b>	The maximum current a connected maximum load will receive when the output point is OFF.
<b>Max Inrush Current</b>	The maximum current used by a load for a short duration upon an OFF to ON transition of a output point. It is greater than the normal ON state current and is characteristic of inductive loads in AC circuits.
<b>Base Power Required</b>	Power from the base power supply is used by the DL205 input modules and varies between different modules. The guidelines for using module power are explained in the power budget section of the manual for your CPU-slot device.
<b>OFF to ON Response</b>	The time the module requires to process an OFF to ON state transition.
<b>ON to OFF Response</b>	The time the module requires to process an ON to OFF state transition.
<b>Terminal Type</b>	Indicates whether the terminal type is a removable or non-removable connector or a terminal.
<b>Status Indicators</b>	The LEDs that indicate the ON/OFF status of an input point. These LEDs are electrically located on either the logic side or the field device side of the input circuit.
<b>Weight</b>	Indicates the weight of the module.
<b>Fuses</b>	Protective device for an output circuit, which stops current flow when current exceeds the fuse rating. They may be replaceable or non-replaceable, or located externally or internally.

### D2-08ND3 DC Input

Inputs per module	8 (sink/source)
Commons per module	1 (2 I/O terminal points)
Input voltage range	10.2–26.4 VDC
Peak voltage	26.4 VDC
AC frequency	n/a
ON voltage level	9.5 VDC minimum
OFF voltage level	3.5 VDC maximum
Input impedance	2.7 K
Input current	4.0 mA @ 12 VDC 8.5 mA @ 24 VDC
Minimum ON current	3.5 mA
Maximum OFF current	1.5 mA
Base power required	50 mA max
OFF to ON response	1 to 8 ms
ON to OFF response	1 to 8 ms
Terminal type	Removable
Status Indicator	Logic side
Weight	2.3 oz. (65 g)

### D2-16ND3-2 DC Input

Inputs per module	16 (sink/source)
Commons per module	2 (isolated)
Input voltage range	20–28 VDC
Peak voltage	30 VDC (10 mA)
AC frequency	N/A
ON voltage level	19 VDC minimum
OFF voltage level	7 VDC maximum
Input impedance	3.9 K
Input current	6 mA @ 24 VDC
Minimum ON current	3.5 mA
Maximum OFF current	1.5 mA
Base power required	100 mA Max
OFF to ON response	3 to 9 ms
ON to OFF response	3 to 9 ms
Terminal type	Removable
Status Indicator	Logic side
Weight	2.3 oz. (65 g)



I/O Wiring and Specifications

### D2-32ND3 DC Input

Inputs per module	32 (sink/source)
Commons per module	4 (8 I/O terminal points)
Input voltage range	20-28 VDC
Peak voltage	30 VDC
AC frequency	n/a
ON voltage level	19 VDC minimum
OFF voltage level	7 VDC maximum
Input impedance	4.8 K
Input current	8.0 mA @ 24 VDC
Minimum ON current	3.5 mA
Maximum OFF current	1.5 mA
Base power required	25 mA max
OFF to ON response	3 to 9 ms
ON to OFF response	3 to 9 ms
Terminal type	40-pin Connector
Status Indicator	Module Activity LED
Weight	2.1 oz. (60 g)

D2-32ND3

A0	A4
A1	A5
A2	A6
A3	A7
C1	C1
B0	B4
B1	B5
B2	B6
B3	B7
C11	C11
C0	C4
C1	C5
C2	C6
C3	C7
C111	C111
D0	D4
D1	D5
D2	D6
D3	D7
C1V	C1V

22-26VDC  
4-6mA  
CLASS2

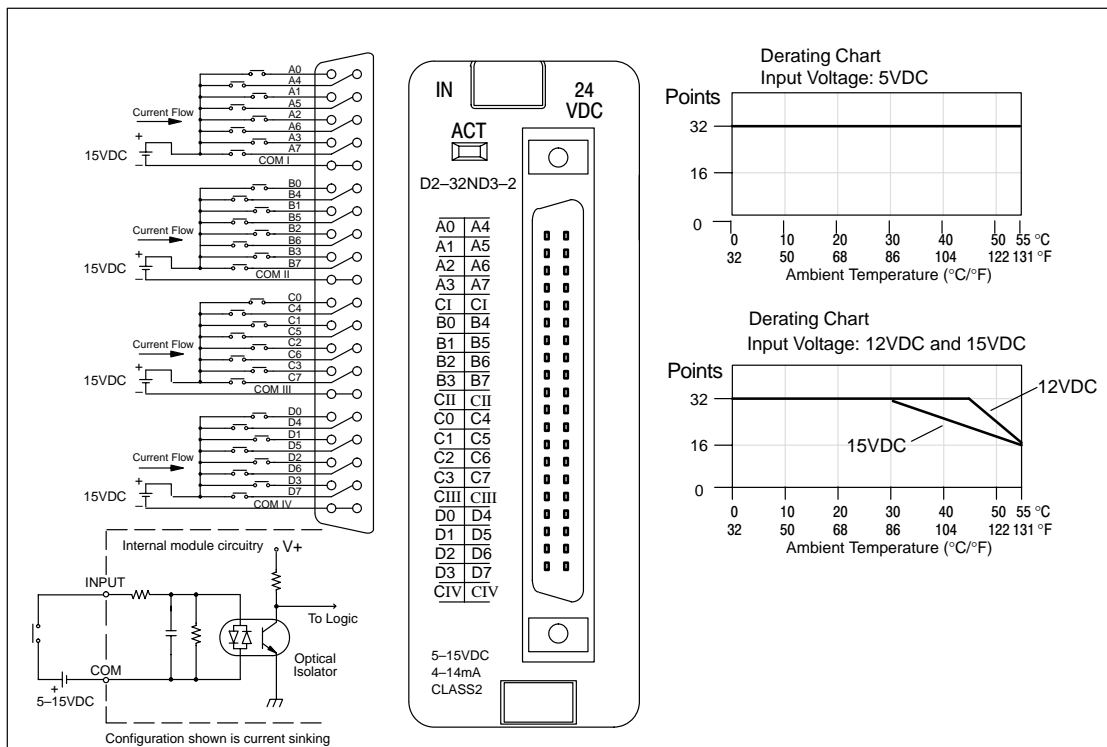
#### Derating Chart

Ambient Temperature (°C/°F)	Points
0 / 32	32
10 / 50	32
20 / 68	32
30 / 86	32
40 / 104	32
50 / 122	20
55 / 131	16

Configuration shown is current sinking

## D2-32ND3-2 DC Input

Inputs per module	32 (sink/source)
Commons per module	4 (8 I/O terminal points)
Input voltage range	4.50 to 15.6VDC min to max
Peak voltage	16VDC
Input current	4mA @ 5VDC, 11mA @ 12VDC, 14mA @ 15VDC
Max input current	16mA @ 15.6VDC
Input impedance	1k ohms @ 5-15VDC
ON voltage level	4VDC
OFF voltage level	2VDC
Min ON current	3mA
Max OFF current	0.5mA
OFF to ON response	3 to 9ms
ON to OFF response	3 to 9ms
Status Indicators	Module activity LED
Terminal type	Removeable 40-pin connector
Base power required	5V/25mA max (all points on)
Weight	2.1 oz (60g)



I/O Wiring and Specifications

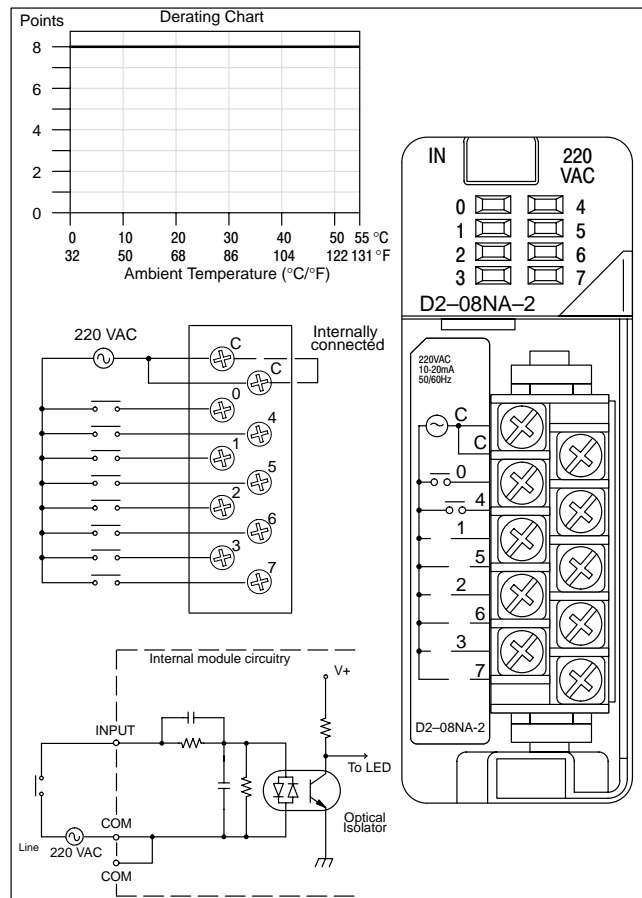
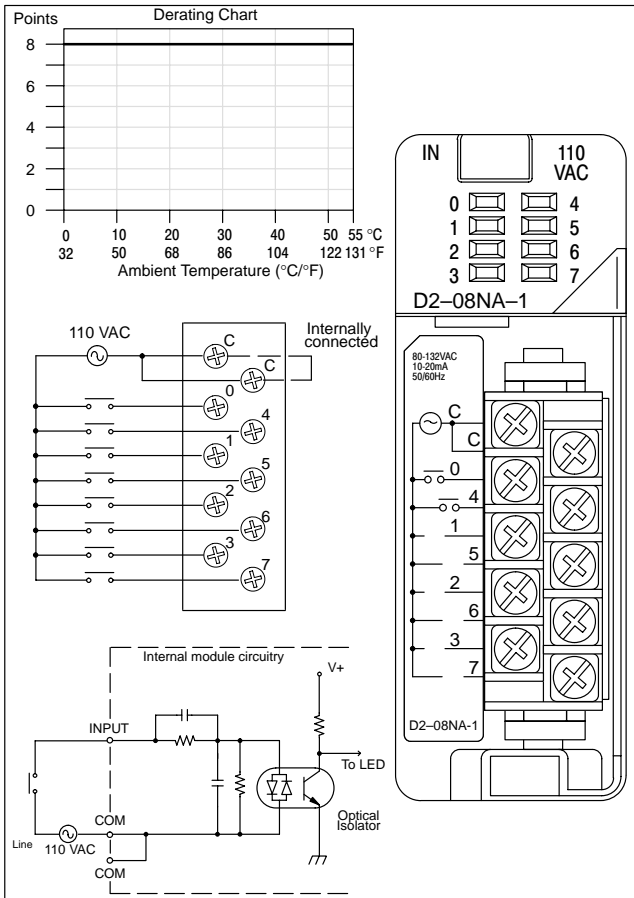
### D2-08NA-1 AC Input

Inputs per module	8
Commons per module	1 (2 I/O terminal points)
Input voltage range	80–132 VAC
Peak voltage	132 VAC
AC frequency	47–63 Hz
ON voltage level	75 VAC minimum
OFF voltage level	20 VAC maximum
Input impedance	12K @ 60 Hz
Input current	13mA @ 100VAC, 60Hz 11mA @ 100VAC, 50Hz
Minimum ON current	5 mA
Maximum OFF current	2 mA
Base power required	50 mA Max
OFF to ON response	5 to 30 ms
ON to OFF response	10 to 50 ms
Terminal type	Removable
Status indicator	Logic side
Weight	2.5 oz. (70 g)

### D2-08NA-2 AC Input

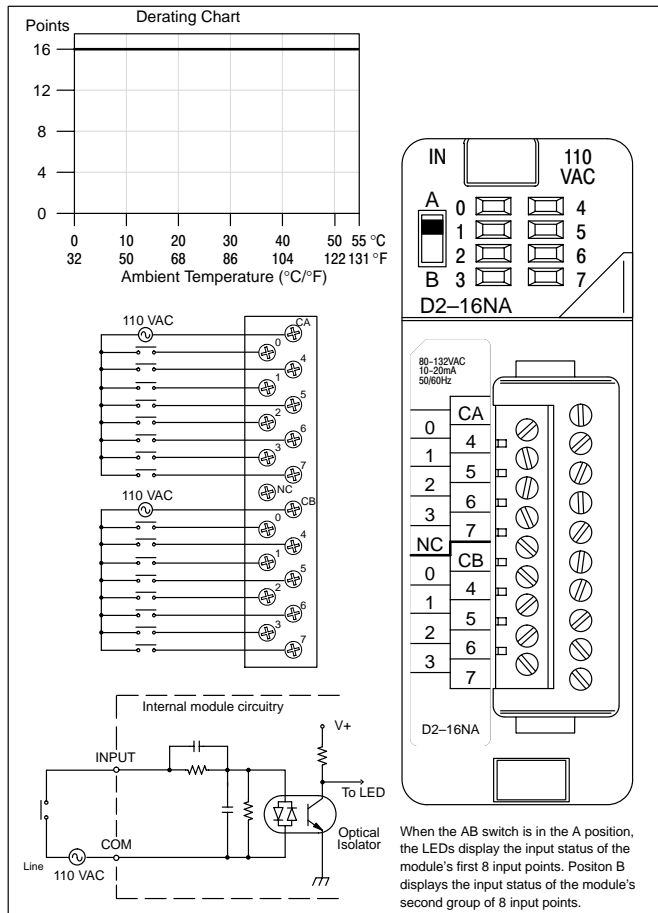
Inputs per module	8
Commons per module	2 (internally connected)
Input voltage range	170–265 VAC
Peak voltage	265 VAC
AC frequency	47–63 Hz
ON voltage level	150 VAC minimum
OFF voltage level	40 VAC maximum
Input impedance	18K @ 60 Hz
Input current	9mA @ 220VAC, 50Hz 11mA @ 265VAC, 60Hz 10mA @ 220VAC, 60Hz 12mA @ 265VAC, 60Hz
Minimum ON current	10 mA
Maximum OFF current	2 mA
Base power required	100 mA Max
OFF to ON response	5 to 30 ms
ON to OFF response	10 to 50 ms
Terminal type	Removable
Status indicator	Logic side
Weight	2.5 oz. (70 g)

I/O Wiring and Specifications



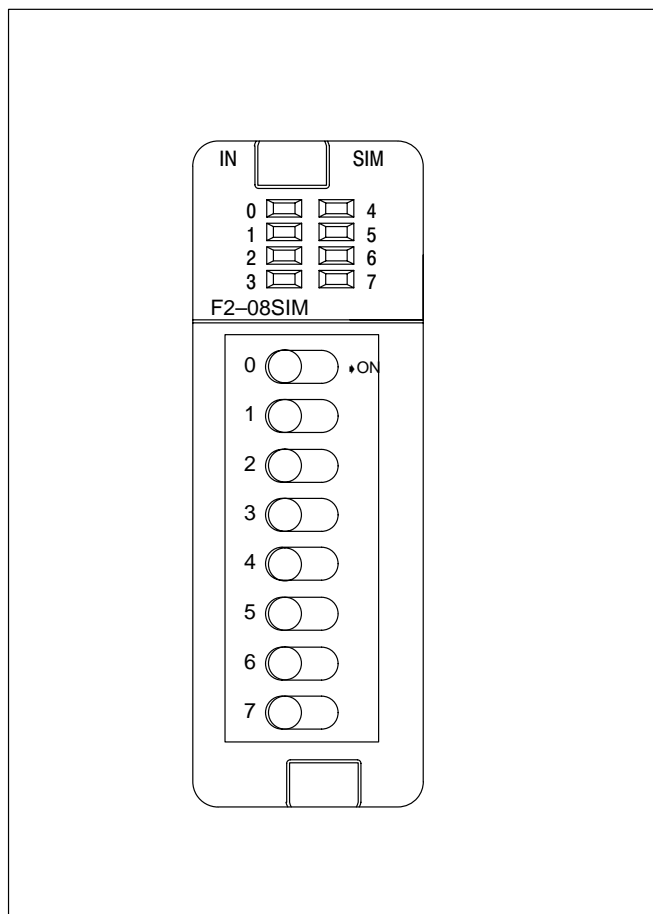
## D2-16NA AC Input

Inputs per module	16
Commons per module	2 (isolated)
Input voltage range	80-132 VAC
Peak voltage	132 VAC
AC frequency	47-63 Hz
ON voltage level	70 VAC minimum
OFF voltage level	20 VAC maximum
Input impedance	12K @ 60 Hz
Input current	11mA @ 100VAC, 50Hz 13mA @ 100VAC, 60Hz 15mA @ 132VAC, 60Hz
Minimum ON current	5 mA
Maximum OFF current	2 mA
Base power required	100 mA Max
OFF to ON response	5 to 30 ms
ON to OFF response	10 to 50 ms
Terminal type	Removable
Status indicator	Logic side
Weight	2.4 oz. (68 g)



## F2-08SIM Input Simulator

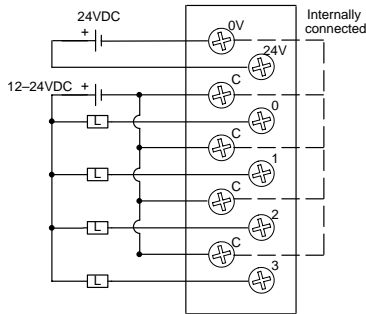
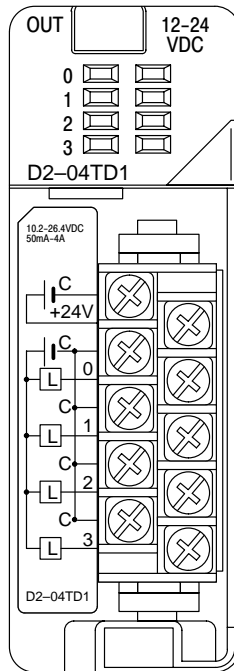
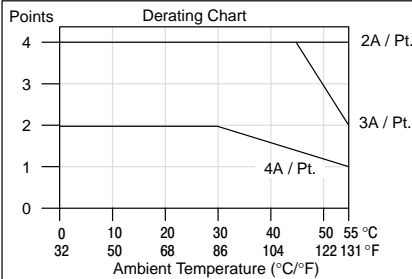
Inputs per module	8
Base power required	50 mA Max
Terminal type	None
Status indicator	Switch side
Weight	2.65 oz. (75 g)



### D2-04TD1 DC Output

Outputs per module	4 (current sinking)
Output Points Consumed	8 points (only 1st 4 pts. used)
Commons per module	1 (4 I/O terminal points)
Operating voltage	10.2–26.4 VDC
Output type	NMOS FET (open drain)
Peak voltage	40 VDC
AC frequency	n/a
ON voltage drop	0.72 VDC maximum
Max load current (resistive)	4A / point 8A / common
Max leakage current	0.1mA @ 40 VDC

Max inrush current	6A for 100ms, 15A for 10 ms
Minimum load	50mA
Base power required 5v	60mA Max
OFF to ON response	1 ms
ON to OFF response	1 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	2.8 oz. (80 g)
Fuses	4 (1 per point) (6.3A slow blow, replaceable) Order D2-FUSE-3, 5/pack

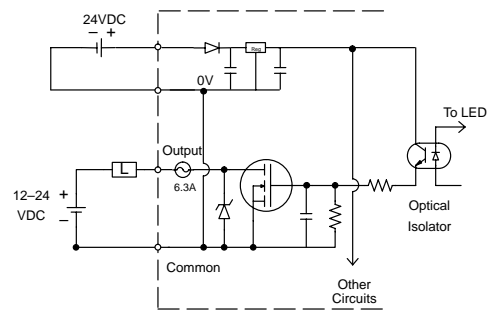


#### Inductive Load Maximum Number of Switching Cycles per Minute

Load Current	Duration of output in ON state		
	7ms	40ms	100ms
0.1A	8000	1400	600
0.5A	1600	300	120
1.0A	800	140	60
1.5A	540	90	35
2.0A	400	70	—
3.0A	270	—	—
4.0A	200	—	—

At 40ms duration, loads of 3.0A or greater cannot be used.  
At 100ms duration, loads of 2.0A or greater cannot be used.

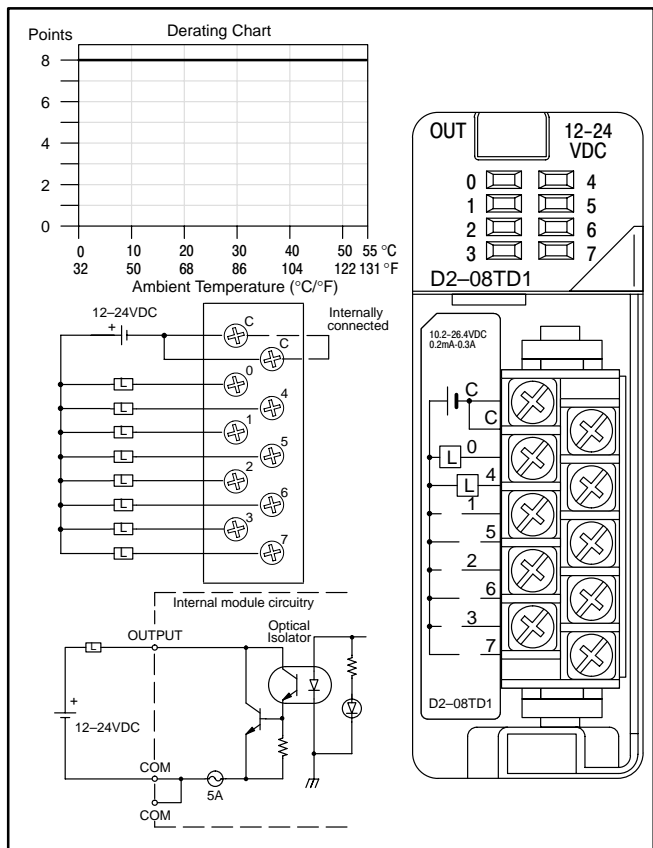
Here's how to use the table. Find the load current you expect to use and the duration that the output is ON. The number at the intersection of the row and column represents the switching cycles per minute. For example, a 1A inductive load that is on for 100ms can be switched on and off a maximum of 60 times per minute. To convert this to duty cycle percentage use: (Duration x cycles) / 60. Our example would be (60x.1) / 60 = .1 (10% duty cycle).





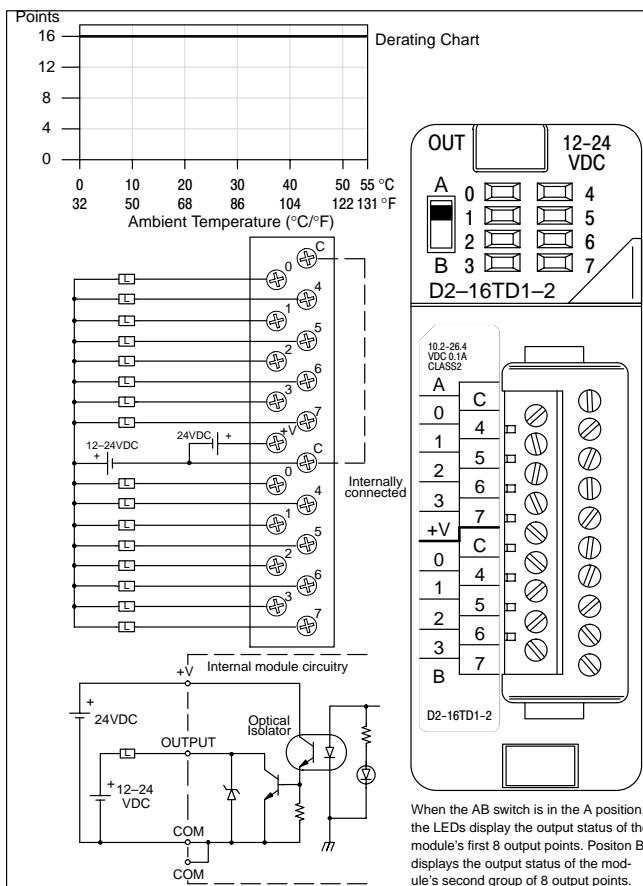
## D2-08TD1 DC Output

Outputs per module	8 (current sinking)
Commons per module	1 (2 I/O terminal points)
Operating voltage	10.2–26.4 VDC
Output type	NPN open collector
Peak voltage	40 VDC
AC frequency	n/a
ON voltage drop	1.5 VDC maximum
Max load current	0.3A / point 2.4A / common
Max leakage current	0.1mA @ 40 VDC
Max inrush current	1A for 10 ms
Minimum load	0.5mA
Base power required 5v	100mA Max
OFF to ON response	1 ms
ON to OFF response	1 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	2.3 oz. (65 g)
Fuses	1 per common 5A fast blow, replaceable Order D2-FUSE-2 (5 per pack)



## D2-16TD1-2 DC Output

Outputs per module	16 (current sinking)
Commons per module	1 (2 I/O terminal points)
Operating voltage	10.2–26.4 VDC
Output type	NPN open collector
Peak voltage	30 VDC
AC frequency	N/A
ON voltage drop	0.5 VDC maximum
Max load current	0.1A / point 1.6A / common
Max leakage current	0.1mA @ 30 VDC
Max inrush current	150mA for 10 ms
Minimum load	0.2mA
Base power required	200mA Max
OFF to ON response	0.5 ms
ON to OFF response	0.5 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	2.3 oz. (65 g)
Fuses	none
External DC required	24VDC ±4V @ 80mA max



When the AB switch is in the A position, the LEDs display the output status of the module's first 8 output points. Position B displays the output status of the module's second group of 8 output points.

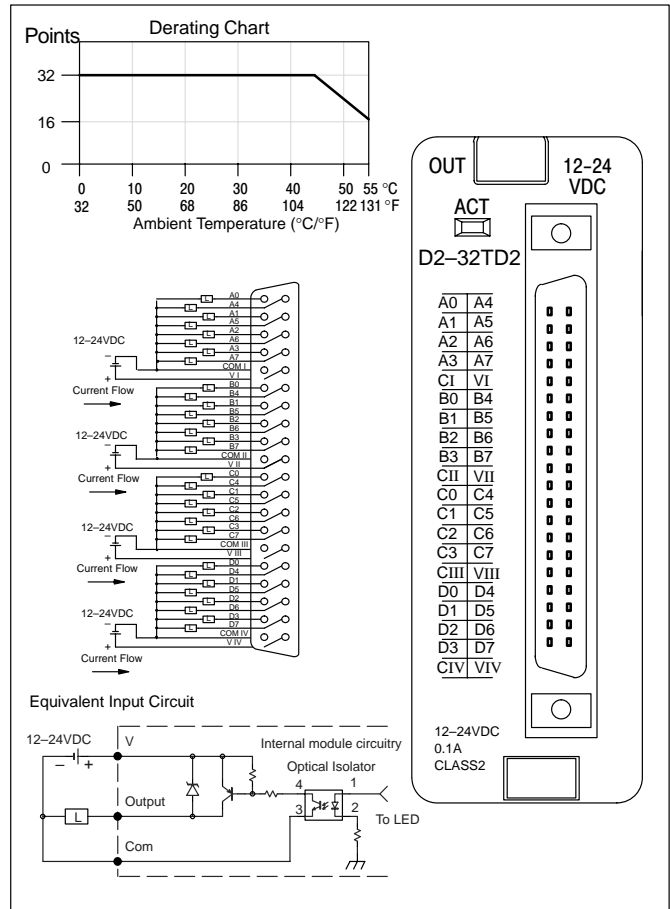
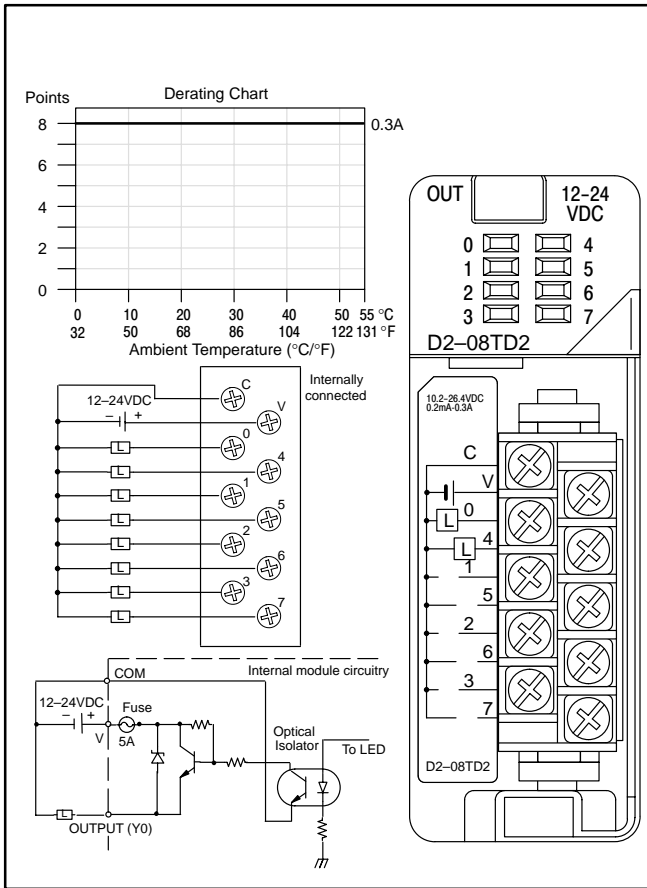
### D2-08TD2 DC Output

Outputs per module	8 (current sinking)
Commons per module	1
Output voltage	10.8–26.4VDC
Operating voltage range	12–24VDC
Peak voltage	40VDC
AC frequency	n/a
ON voltage drop	1.5 VDC
Max output current	0.3A / point, 2.4A / common
Max leakage current	0.1mA @ 40VDC
Max inrush current	1mA for 10ms
OFF to ON response	1ms
ON to OFF response	1ms
Terminal type	Removable
Status indicators	Logic Side
Weight	2.3 oz. (65 g)
Fuse	5A/250V fast blow, replaceable Order D2-FUSE-2 (5 per pack)
Base power required	5V/100mA max

### D2-32TD2 DC Output

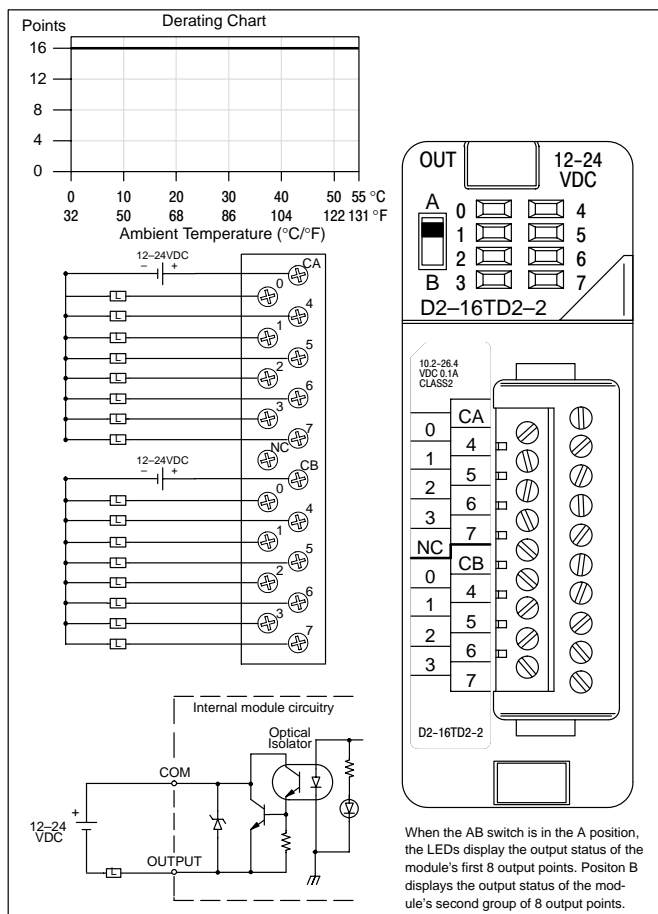
Outputs per module	32 (current sourcing)
Commons per module	4, 8 points / common (isolated)
Operating voltage	12 to 24VDC
Peak voltage	30VDC
Max load current	0.1A / point, 0.8A / common
Min load	0.2mA
Max leakage current	0.1mA @ 30VDC
ON voltage drop	0.5 VDC @ 0.1A
Max inrush current	150mA @ 10ms
OFF to ON response	0.5ms
ON to OFF response	0.5ms
Status indicators	Module activity: green LED I/O Status: none
Terminal type	Removable 40-pin connector (connector sold separately)
Weight	2.1oz. (60g)
Fuses	none
Base power required	5V/350mA max (all points on)

I/O Wiring and Specifications



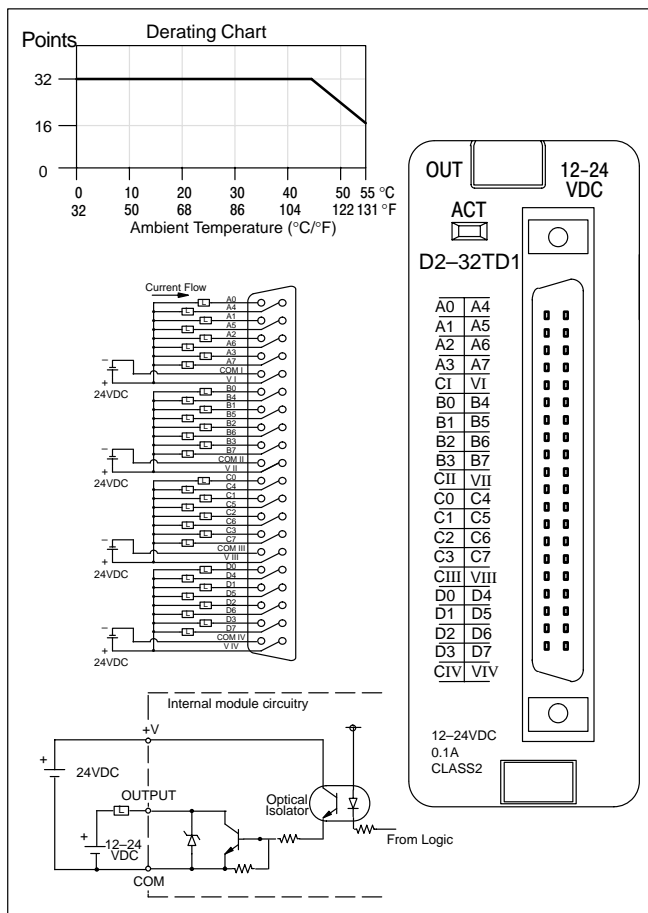
## D2-16TD2-2 DC Output

Outputs per module	16 (current sourcing)
Commons per module	2
Operating voltage	10.2-26.4 VDC
Output type	NPN open collector
Peak voltage	30 VDC
AC frequency	N/A
ON voltage drop	1.0 VDC maximum
Max load current	0.1A / point 1.6A / common
Max leakage current	0.1mA @ 30 VDC
Max inrush current	150 mA for 10 ms
Minimum load	0.2mA
Base power required	200mA Max
OFF to ON response	0.5 ms
ON to OFF response	0.5 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	2.8 oz. (80 g)
Fuses	none



## D2-32TD1 DC Output

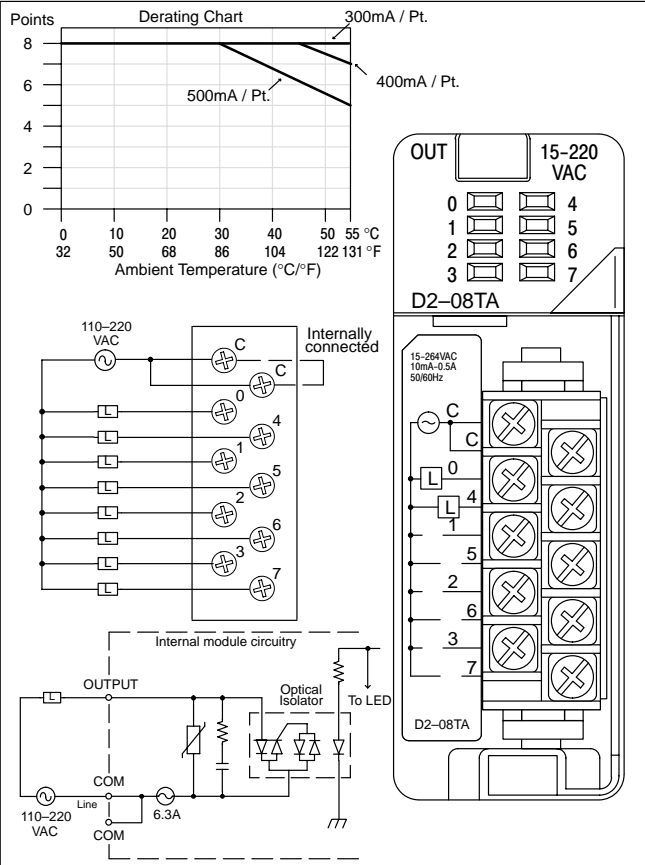
Outputs per module	32 (current sinking)
Commons per module	4 (8 I/O terminal points)
Operating voltage	12-24 VDC
Output type	NPN open collector
Peak voltage	30 VDC
AC frequency	N/A
ON voltage drop	0.5 VDC maximum
Max load current	0.1A / point
Max leakage current	0.1mA @ 30 VDC
Max inrush current	150 mA for 10 ms
Minimum load	0.2mA
Base power required	350mA Max
OFF to ON response	0.5 ms
ON to OFF response	0.5 ms
Terminal type	40-pin connector (see page NO TAG)
Status indicators	Module Activity
Weight	2.1 oz. (60 g)
Fuses	none



I/O Wiring and Specifications

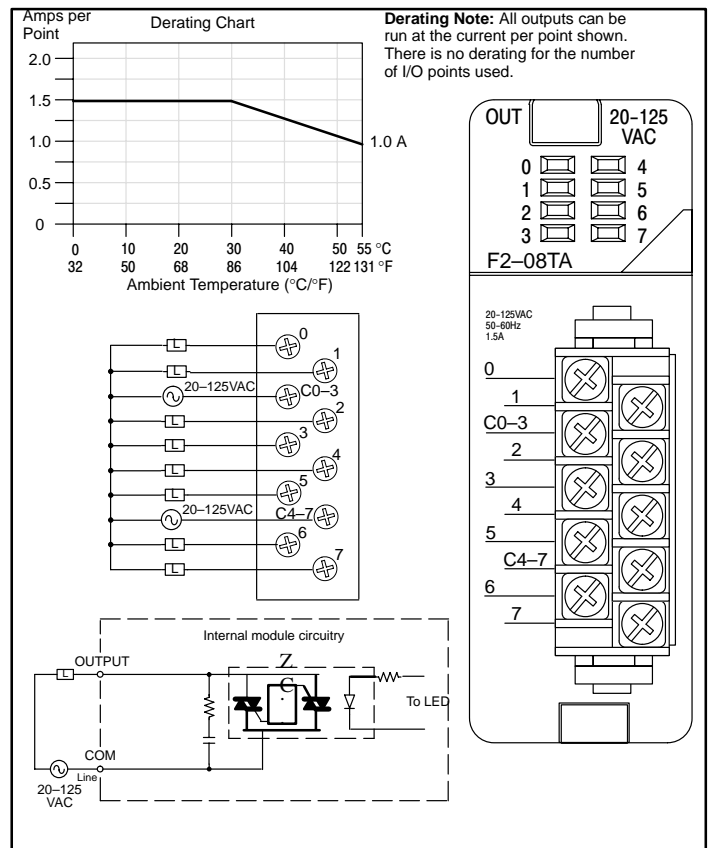
### D2-08TA AC Output

Outputs per module	8
Commons per module	1 (2 I/O terminal points)
Operating voltage	15-264 VAC
Output type	SSR (Triac)
Peak voltage	264 VAC
AC frequency	47 to 63 Hz
ON voltage drop	< 1.5 VAC (> 0.1A) < 3.0 VAC (< 0.1A)
Max load current	0.5A / point 4A / common
Max leakage current	4mA (264VAC, 60Hz) 1.2mA (100VAC, 60Hz) 0.9mA (100VAC, 50Hz)
Max inrush current	10A for 10 ms
Minimum load	10 mA
Base power required	20 mA / ON pt. 250 mA max
OFF to ON response	1 ms
ON to OFF response	1 ms +1/2 cycle
Terminal type	Removable
Status indicators	Logic Side
Weight	2.8 oz. (80 g)
Fuses	1 per common, 6.3A slow blow



### F2-08TA AC Output

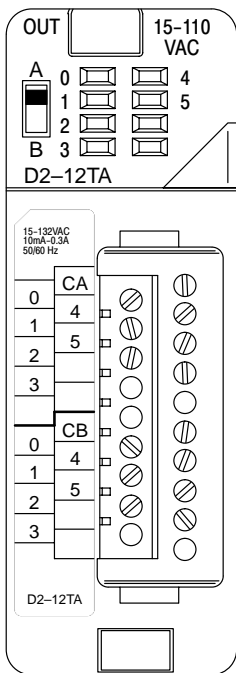
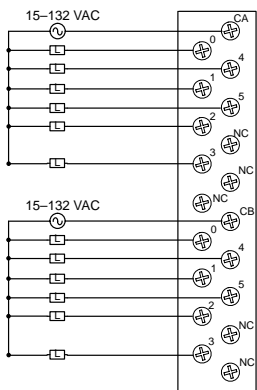
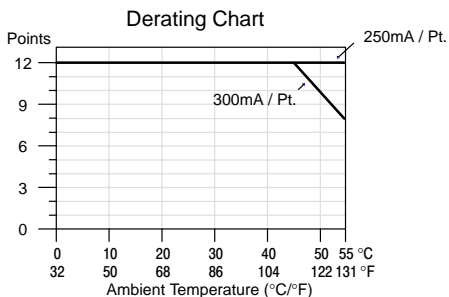
Outputs per module	8
Output Points Consumed	8
Commons per module	2 (isolated)
Operating voltage	24-140 VAC
Output type	SSR (Triac with Zero Crossover)
Peak voltage	140 VAC
AC frequency	47 to 63 Hz
ON voltage drop	1.6 Vrms @ 1.5A
Max load current	1.5A / point @ 30°C, 1.0A / point @ 60°C 4.0A / common; 8A/module @ 60°C
Max leakage current	0.7 mA (rms)
Peak one cycle surge current	15 A
Minimum load	10 mA
Base power required	250 mA max
OFF to ON response	0.5 ms- 1/2 cycle
ON to OFF response	0.5 ms- 1/2 cycle
Terminal type	Removable
Status indicators	Logic side
Weight	3.5 oz.
Fuses	N/A



## D2-12TA AC Output

Outputs per module	12
Output Points Consumed	16 (4 unused, see chart below)
Commons per module	2 (isolated)
Operating voltage	15-132 VAC
Output type	SSR (Triac)
Peak voltage	132 VAC
AC frequency	47 to 63 Hz
ON voltage drop	< 1.5 VAC (> 50mA) < 4.0 VAC (< 50mA)
Max load current	0.3A / point, 1.8A / common

Max leakage current	2mA (132VAC, 60Hz)
Max inrush current	10A for 10 ms
Minimum load	10 mA
Base power required	350 mA Max
OFF to ON response	1 ms
ON to OFF response	1 ms + 1/2 cycle
Terminal type	Removable
Status indicators	Logic Side
Weight	2.8 oz. (80 g)
Fuses	(2) 1 per common 3.15A slow blow, replaceable Order D2-FUSE-1 (5 per pack)

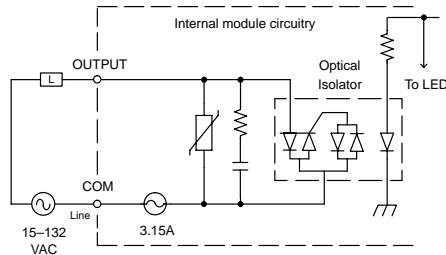


When the AB switch is in the A position, the LEDs display the output status of the module's first 8 output points. Position B displays the output status of the module's second group of 8 output points.

### Addresses Used

Points	Used?	Points	Used?
Yn+0	Yes	Yn+10	Yes
Yn+1	Yes	Yn+11	Yes
Yn+2	Yes	Yn+12	Yes
Yn+3	Yes	Yn+13	Yes
Yn+4	Yes	Yn+14	Yes
Yn+5	Yes	Yn+15	Yes
Yn+6	No	Yn+16	No
Yn+7	No	Yn+17	No

n is the starting address



### D2-04TRS Relay Output

Outputs per module	4
Commons per module	4 (isolated)
Output Points Consumed	8 (only 1st 4pts. are used)
Operating voltage	5-30VDC / 5-240VAC
Output type	Relay, form A (SPST)
Peak voltage	30VDC, 264VAC
AC frequency	47-63 Hz
ON voltage drop	0.72 VDC maximum
Max load current (resistive)	4A / point 8A / module (resistive)
Max leakage current	0.1mA @ 264VAC

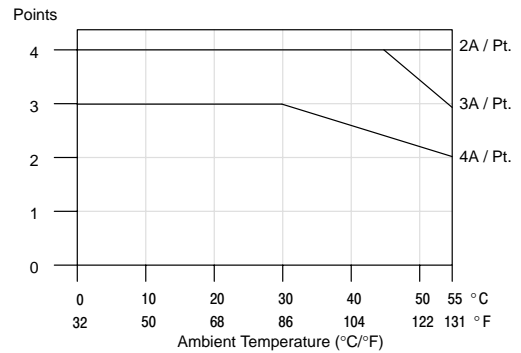
Max inrush current	5A for < 10ms
Minimum load	10mA
Base power required 5v	250mA Max
OFF to ON response	10 ms
ON to OFF response	10 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	2.8 oz. (80 g)
Fuses	1 per point 6.3A slow blow, replaceable Order D2-FUSE-3 (5 per pack)

Typical Relay Life (Operations)

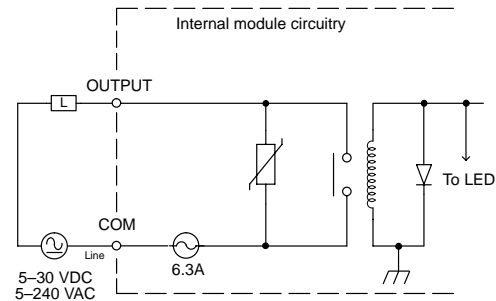
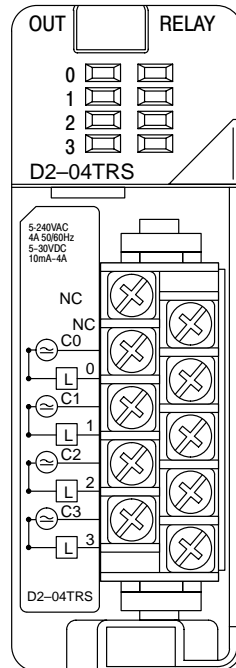
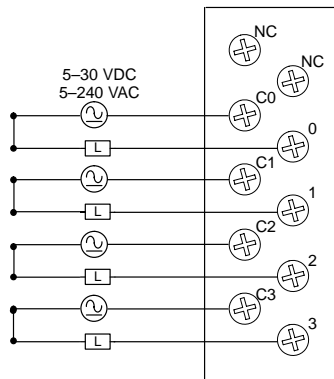
Voltage & Type of Load	Load Current			
	1A	2A	3A	4A
24 VDC Resistive	500K	200K	100K	50K
24 VDC Solenoid	100K	40K	-	-
110 VAC Resistive	500K	250K	150K	100K
110 VAC Solenoid	200K	100K	50K	-
220 VAC Resistive	350K	150K	100K	50K
220 VAC Solenoid	100K	50K	-	-

At 24 VDC, solenoid (inductive) loads over 2A cannot be used.  
 At 110 VAC, solenoid (inductive) loads over 3A cannot be used.  
 At 220 VAC, solenoid (inductive) loads over 2A cannot be used.

Derating Chart



I/O Wiring and Specifications



### D2-08TR Relay Output

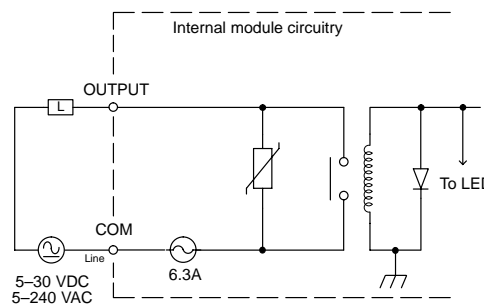
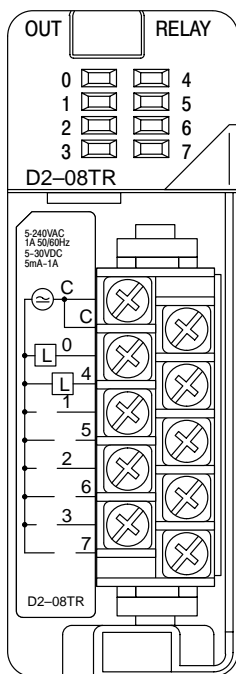
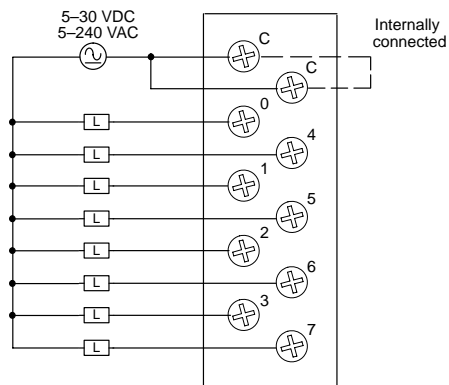
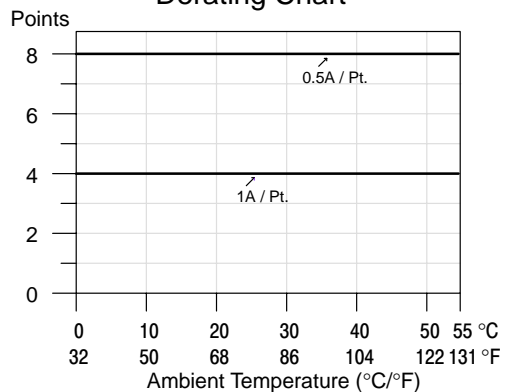
Outputs per module	8
Commons per module	1 (2 I/O terminal points)
Operating voltage	5-30VDC / 5-240VAC
Output type	Relay, form A (SPST)
Peak voltage	30VDC / 264VAC
AC frequency	47 to 60 Hz
ON voltage drop	N/A
Max current (resistive)	1A / point 4A / common
Max leakage current	0.1mA @ 265 VAC
Max inrush current	Output: 3A for 10 ms Common: 10A for 10ms

Minimum load	5mA @ 5VDC
Base power required	250mA max
OFF to ON response	12 ms
ON to OFF response	10 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	3.9 oz. (110 g)
Fuses	1 6.3A slow blow, replaceable Order D2-FUSE-3 (5 per pack)

#### Typical Relay Life (Operations)

Voltage / Load	Current	Closures
24VDC Resistive	1A	500K
24VDC Solenoid	1A	100K
110VAC Resistive	1A	500K
110VAC Solenoid	1A	200K
220VAC Resistive	1A	350K
220VAC Solenoid	1A	100K

#### Derating Chart



I/O Wiring and Specifications

### F2-08TR Relay Output

Outputs per module	8
Commons per module	2 (isolated)
Output Points Consumed	8
Operating voltage	12-28VDC, 12-250VAC, 10A 120VDC, 0.5A
Output type	8 Form A (SPST normally open)
Peak voltage	150VDC, 265VAC
AC frequency	47-63 Hz
ON voltage drop	N/A
Max load current (resistive)	10A/common (subject to derating)

Max leakage current	N/A
Max inrush current	12A
Minimum load	10mA @ 12VDC
Base power required 5v	670mA Max
OFF to ON response	15 ms (typical)
ON to OFF response	5 ms (typical)
Terminal type	Removable
Status indicators	Logic Side
Weight	5.5 oz. (156g)
Fuses	None

#### Typical Relay Life<sup>1</sup> (Operations) at Room Temperature

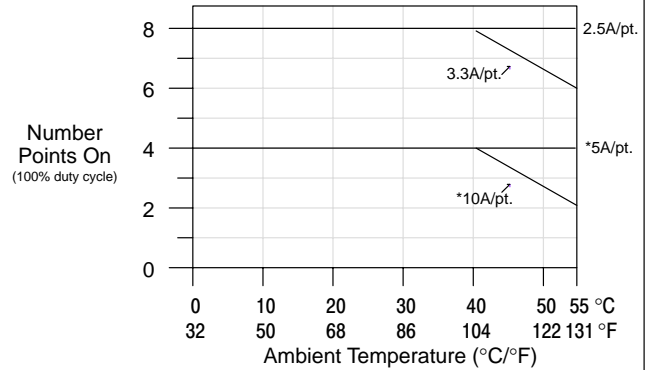
Voltage & Type of Load <sup>2</sup>	Load Current		
	50mA	5A	7A
24 VDC Resistive	10M	600K	300K
24 VDC Solenoid	-	150K	75K
110 VAC Resistive	-	600K	300K
110 VAC Solenoid	-	500K	200K
220 VAC Resistive	-	300K	150K
220 VAC Solenoid	-	250K	100K

1 Contact life may be extended beyond those values shown by the use of arc suppression techniques described in the 205 User Manual. Since these modules have no leakage current, they do not have a built in snubber. For example, if you place a diode across a 24VDC inductive load, you can significantly increase the life of the relay.

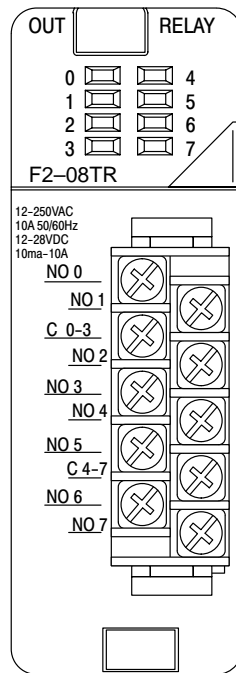
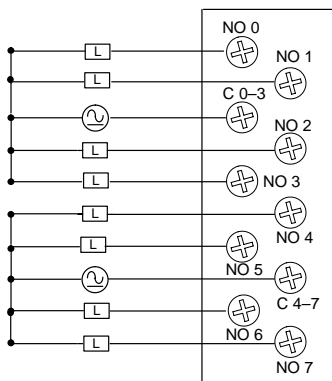
2 At 120 VDC 0.5A resistive load, contact life cycle is 200K cycles.

#### Derating Chart

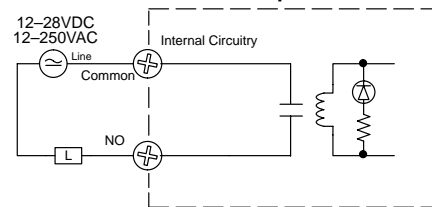
(\*Use separate commons)



I/O Wiring and Specifications



#### Typical Circuit all points





## F2-08TRS Relay Output

Outputs per module	8
Commons per module	8 (isolated)
Output Points Consumed	8
Operating voltage	12-28VDC, 12-250VAC, 7A 120VDC, 0.5A
Output type	3, Form C (SPDT) 5, Form A (SPST normally open)
Peak voltage	150VDC, 265VAC
AC frequency	47-63 Hz
ON voltage drop	N/A
Max load current (resistive)	7A/points (subject to derating)

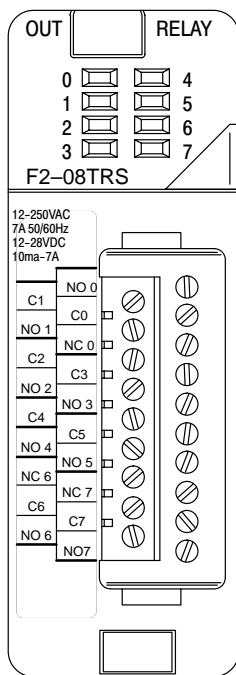
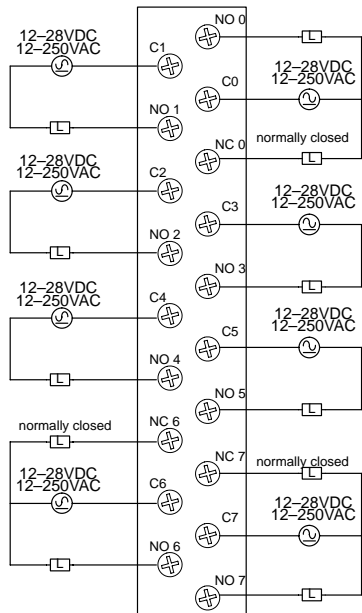
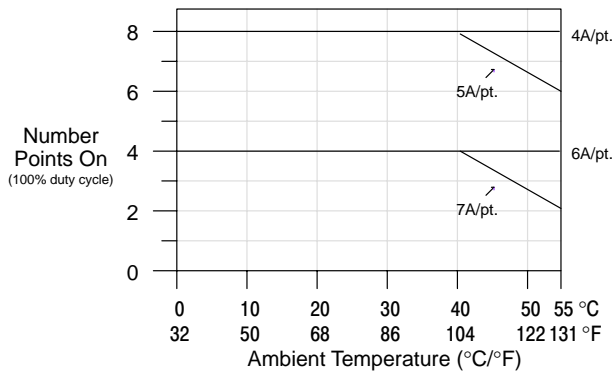
Max leakage current	N/A
Max inrush current	12A
Minimum load	10mA @ 12VDC
Base power required 5v	670mA Max
OFF to ON response	15 ms (typical)
ON to OFF response	5 ms (typical)
Terminal type	Removable
Status indicators	Logic Side
Weight	5.5 oz. (156g)
Fuses	None

Typical Relay Life<sup>1</sup> (Operations)  
at Room Temperature

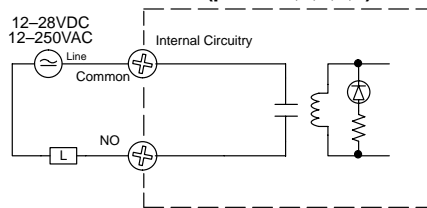
Voltage & Type of Load <sup>2</sup>	Load Current <sup>3</sup>		
	50mA	5A	7A
24 VDC Resistive	10M	600K	300K
24 VDC Solenoid	-	150K	75K
110 VAC Resistive	-	600K	300K
110 VAC Solenoid	-	500K	200K
220 VAC Resistive	-	300K	150K
220 VAC Solenoid	-	250K	100K

- At 120 VDC 0.5A resistive load, contact life cycle is 200K cycles.
- Normally closed contacts have 1/2 the current handling capability of the normally open contacts.

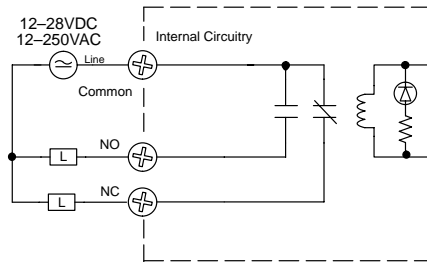
Derating Chart



Typical Circuit  
(points 1,2,3,4,5)



Typical Circuit  
(Points 0, 6, & 7 only)



### D2-12TR Relay Output

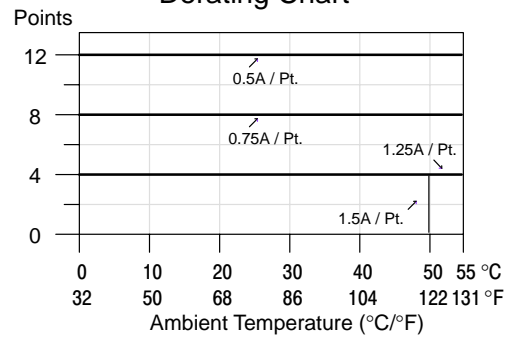
Outputs per module	12
Outputs Consumed	16 (4 unused, see chart below)
Commons per module	2 (6pts. per common)
Operating voltage	5-30VDC / 5-240VAC
Output type	Relay, form A (SPST)
Peak voltage	30VDC / 264VAC
AC frequency	47 to 60 Hz
ON voltage drop	N/A
Max current (resistive)	1.5A / point 3A / common
Max leakage current	0.1mA @ 265 VAC

Max inrush current	Output: 3A for 10 ms Common: 10A for 10ms
Minimum load	5mA @ 5VDC
Base power required	450mA max
OFF to ON response	10 ms
ON to OFF response	10 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	4.6 oz. (130 g)
Fuses	2 4A slow blow, replaceable Order D2-FUSE-4 (5 per pack)

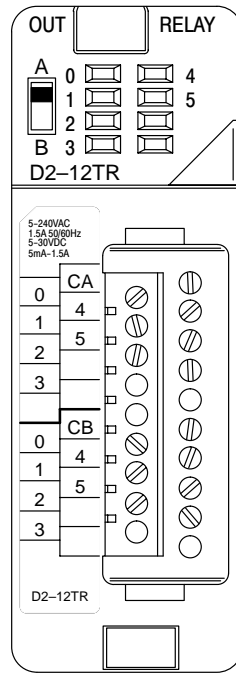
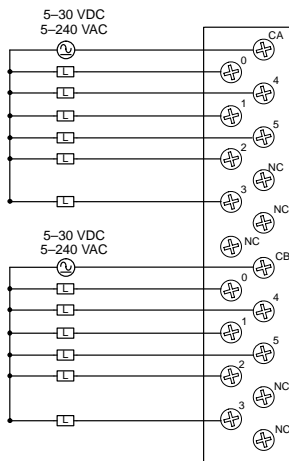
#### Typical Relay Life (Operations)

Voltage / Load	Current	Closures
24VDC Resistive	1A	500K
24VDC Solenoid	1A	100K
110VAC Resistive	1A	500K
110VAC Solenoid	1A	200K
220VAC Resistive	1A	350K
220VAC Solenoid	1A	100K

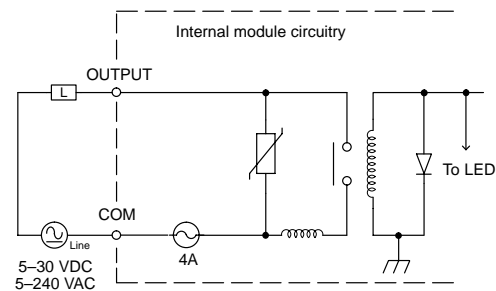
#### Derating Chart



I/O Wiring and Specifications



When the AB switch is in the A position, the LEDs display the output status of the module's first 8 output points. Position B displays the output status of the module's second group of 8 output points.



#### Addresses Used

Points	Used?	Points	Used?
Yn+0	Yes	Yn+10	Yes
Yn+1	Yes	Yn+11	Yes
Yn+2	Yes	Yn+12	Yes
Yn+3	Yes	Yn+13	Yes
Yn+4	Yes	Yn+14	Yes
Yn+5	Yes	Yn+15	Yes
Yn+6	No	Yn+16	No
Yn+7	No	Yn+17	No

n is the starting address

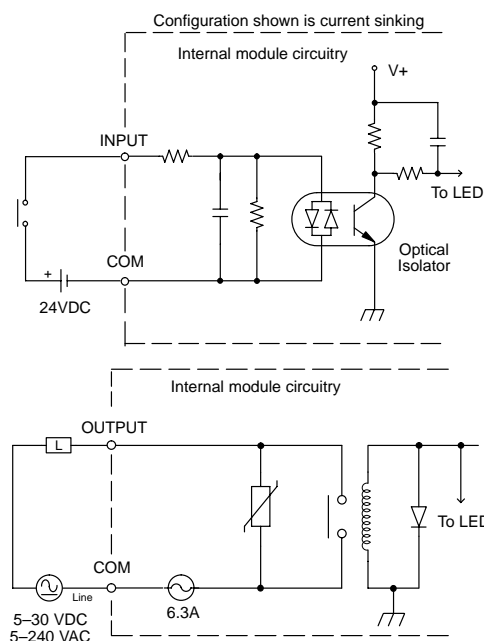
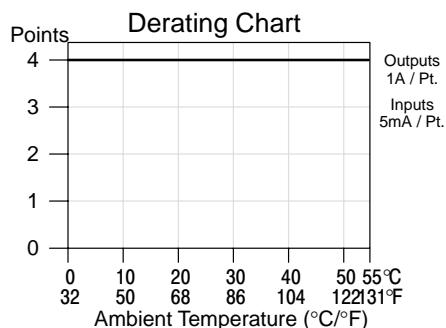
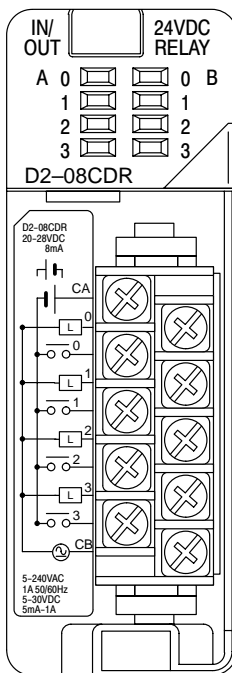
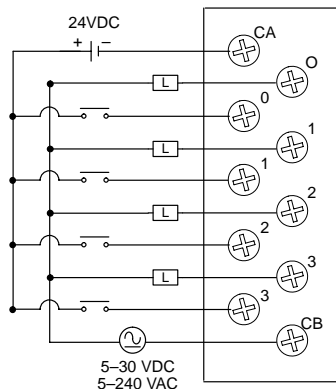
## D2-08CDR 4 pt. DC Input / 4pt. Relay Output

Input Specifications	
Inputs per module	4 (sink/source)
Input Points Consumed	8 (only 1st 4pts. are used)
Input Commons per module	1
Input voltage range	20 – 28 VDC
Peak voltage	30 VDC
AC frequency	n/a
ON voltage level	19 VDC minimum
OFF voltage level	7 VDC maximum
Input impedance	4.7 K
Input current	5 mA @ 24 VDC
Maximum Current	8 mA @ 30 VDC
Minimum ON current	4.5 mA
Maximum OFF current	1.5 mA
OFF to ON response	1 to 10 ms
ON to OFF response	1 to 10 ms
Fuse (input circuits)	None

Output Specifications	
Outputs per module	4
Output Points Consumed	8 (only 1st 4pts. are used)
Output Commons per module	1
Operating voltage	5-30VDC / 5-240VAC
Output type	Relay, form A (SPST)
Peak voltage	30VDC, 264VAC
AC frequency	47-63 Hz
Max load current (resistive)	1A / point 4A / module (resistive)
Max leakage current	0.1mA @ 264VAC
Max inrush current	3A for <100 ms 10A for < 10 ms (common)
Minimum load	5 mA @ 5 VDC
OFF to ON response	12 ms
ON to OFF response	10 ms
Fuse (output circuits)	1 (6.3A slow blow, replaceable) Order D2-FUSE-3 (5 per pack)

General Specifications	
Base power required	200 mA max
Terminal type	Removable
Status Indicators	Logic side
Weight	3.5 oz. (100 g)

Typical Relay Life (Operations)			
Voltage / Load		Current	Closures
24VDC Resistive		1A	500K
24VDC Solenoid		1A	100K
110VAC Resistive		1A	500K
110VAC Solenoid		1A	200K
220VAC Resistive		1A	350K
220VAC Solenoid		1A	100K



## F2-04AD-1 4 Channel 4-20mA Analog Input

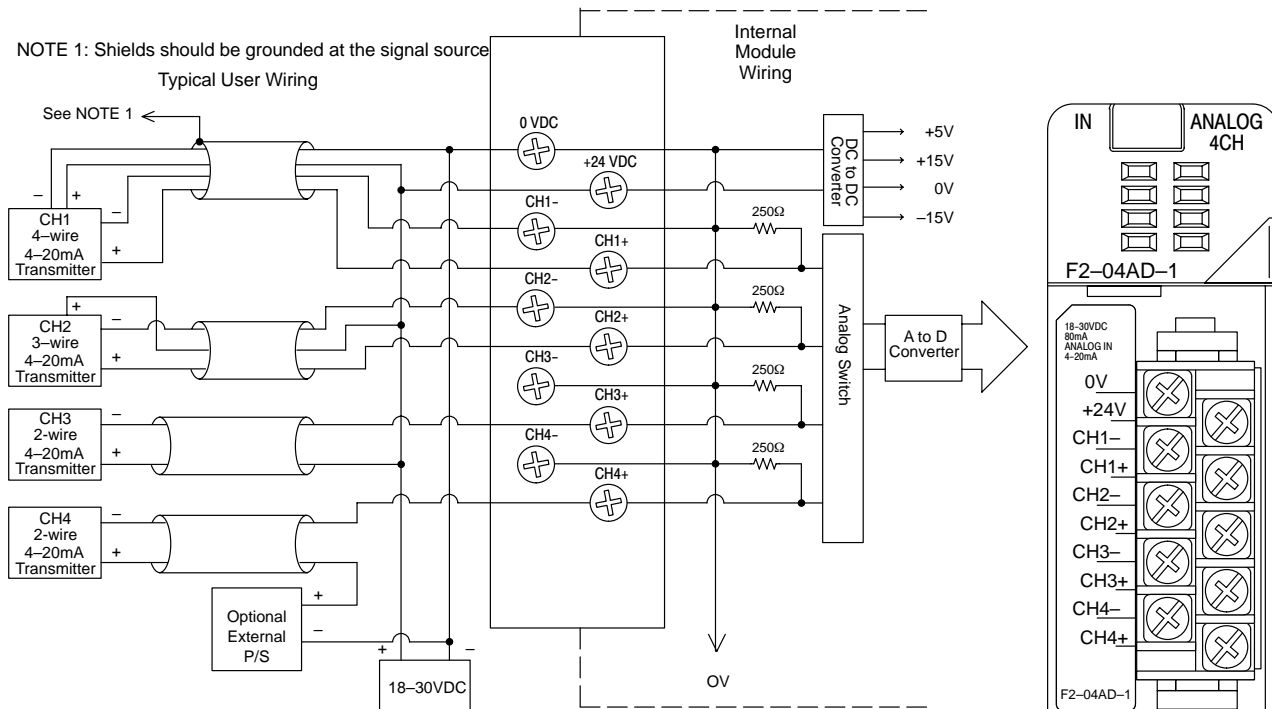
This module requires a 24VDC user power supply for operation. See the F2-04AD-1L if you want to use a 12VDC supply.

Number of Channels	4, single ended (one common)
Input Ranges	4 to 20 mA current
Resolution	12 bit (1 in 4096)
Active Low-pass Filtering	-3 dB at 20Hz, 2 poles (-12 dB per octave)
Input Impedance	250Ω ± 0.1%, ½W current input
Absolute Maximum Ratings	-40 mA to +40 mA, current input
Converter type	Successive approximation
Conversion Time (PLC update rate)	1 channel per scan minimum (D2-230 CPU) 4 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (End to End)	± 1 count (0.025% of full scale) maximum
Input Stability	± 1 count
Full Scale Calibration Error (offset error not included)	± 12 counts max., @ 20mA current input
Offset Calibration Error	± 7 counts max., @ 4mA current input

Maximum inaccuracy	± .5% @ 77°F (25°C) ± .65% 32 to 140°F (0 to 60°C)
Accuracy vs. Temperature	± 50 ppm/°C maximum full scale (including max. offset change)
Recommended Fuse	0.032 A, Series 217 fast-acting, current inputs
Digital Inputs	16 (X) input points
Input points required	12 binary data bits, 2 channel ID bits
Power Budget Requirement	50 mA maximum, 5 VDC (supplied by base)
External Power Supply	80 mA maximum, +18 to +30 VDC
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

I/O Wiring and Specifications



More than one external power supply can be used provided all the power supply commons are connected. A Series 217, 0.032A, fast-acting fuse is recommended for 4-20mA current loops. If the power supply common of an external power supply is not connected to 0VDC on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4-20mA transmitter types are:

2 or 3 wire: Isolation between input signal and power supply.

4 wire:

Isolation between input signal, power supply, and 4-20mA output

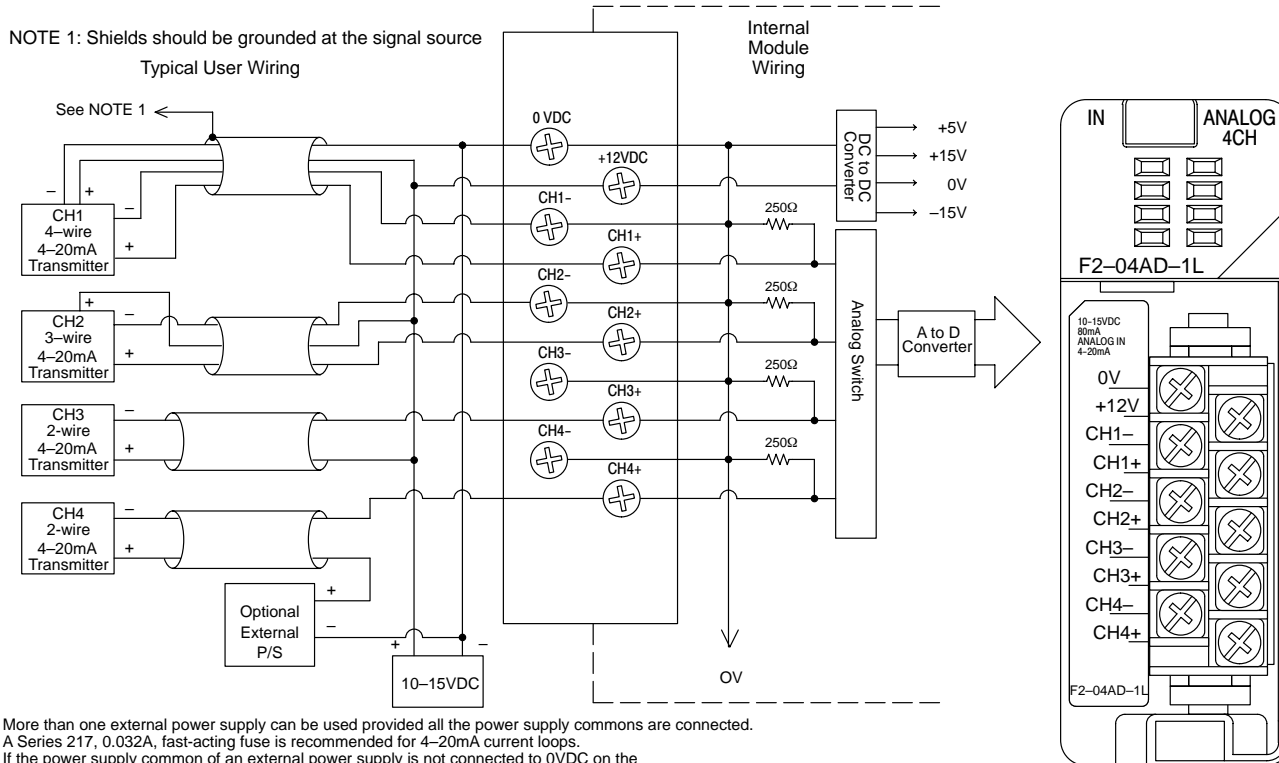
## F2-04AD-1L 4 Channel 4-20mA Analog Input

This module requires a 12VDC user power supply for operation. See the F2-04AD-1 if you want to use a 24VDC supply.

Number of Channels	4, single ended (one common)
Input Ranges	4 to 20 mA current
Resolution	12 bit (1 in 4096)
Active Low-pass Filtering	-3 dB at 20Hz, 2 poles (-12 dB per octave)
Input Impedance	250Ω ± 0.1%, ½W current input
Absolute Maximum Ratings	-40 mA to +40 mA, current input
Converter type	Successive approximation
Conversion Time (PLC update rate)	1 channel per scan minimum (D2-230 CPU) 4 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (End to End)	± 1 count (0.025% of full scale) maximum
Input Stability	± 1 count
Full Scale Calibration Error (offset error not included)	± 12 counts max., @ 20mA current input
Offset Calibration Error	± 7 counts max., @ 4mA current input

Maximum inaccuracy	± .5% @ 77°F (25°C) ± .65% 32 to 140°F (0 to 60°C)
Accuracy vs. Temperature	± 50 ppm/°C maximum full scale (including max. offset change)
Recommended Fuse	0.032 A, Series 217 fast-acting, current inputs
Digital Inputs	16 (X) input points
Input points required	12 binary data bits, 2 channel ID bits
Power Budget Requirement	60 mA maximum, 5 VDC (supplied by base)
External Power Supply	90 mA maximum, +10 to +15 VDC
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).



More than one external power supply can be used provided all the power supply commons are connected. A Series 217, 0.032A, fast-acting fuse is recommended for 4-20mA current loops. If the power supply common of an external power supply is not connected to 0VDC on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4-20mA transmitter types are:

- 2 or 3 wire: Isolation between input signal and power supply.
- 4 wire: Isolation between input signal, power supply, and 4-20mA output

I/O Wiring and Specifications

## F2-04AD-2 4 Channel Voltage Analog Input

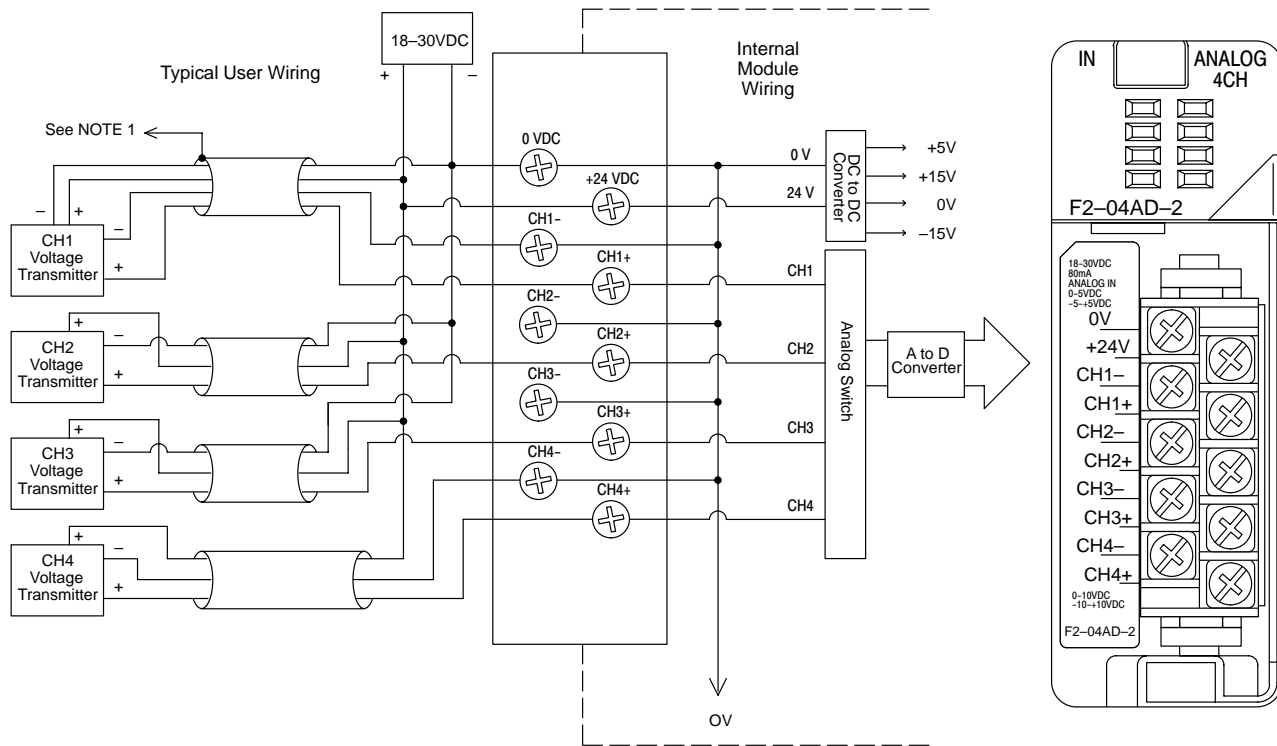
This module requires a 24VDC user power supply for operation. See the F2-04AD-2L if you want to use a 12VDC supply.

Number of Channels	4, single ended (one common)
Input Ranges	0 to 5V, 0 to 10V, $\pm 5V$ , $\pm 10V$
Resolution	12 bit (1 in 4096)
Active Low-pass Filtering	-3 dB at 20Hz, 2 poles (-12 dB per octave)
Input Impedance	> 20 M $\Omega$
Absolute Maximum Ratings	-75 to +75 VDC
Converter type	Successive approximation
Conversion Time (PLC update rate)	1 channel per scan minimum (D2-230 CPU) 4 channels per scan minimum (D2-240 and D2-250)
Linearity Error (End to End)	$\pm 1$ count (0.025% of full scale) maximum
Input Stability	$\pm 1$ count
Full Scale Calibration Error (offset error not included)	$\pm 7$ counts maximum
Offset Calibration Error	$\pm 1$ count maximum (0V input)

Maximum inaccuracy	$\pm .3\%$ @ 77°F (25°C) $\pm .45\%$ 32 to 140°F (0 to 60°C)
Accuracy vs. Temperature	$\pm 50$ ppm / °C full scale calibration change (including maximum offset change)
Digital Inputs Input points required	16 (X) input points 12 binary data bits, 2 channel ID bits
Power Budget Requirement	60 mA maximum, 5 VDC (supplied by base)
External Power Supply	90 mA maximum, +18 to +30 VDC
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

NOTE 1: Shields should be grounded at the signal source



## F2-04AD-2L 4 Channel Voltage Analog Input

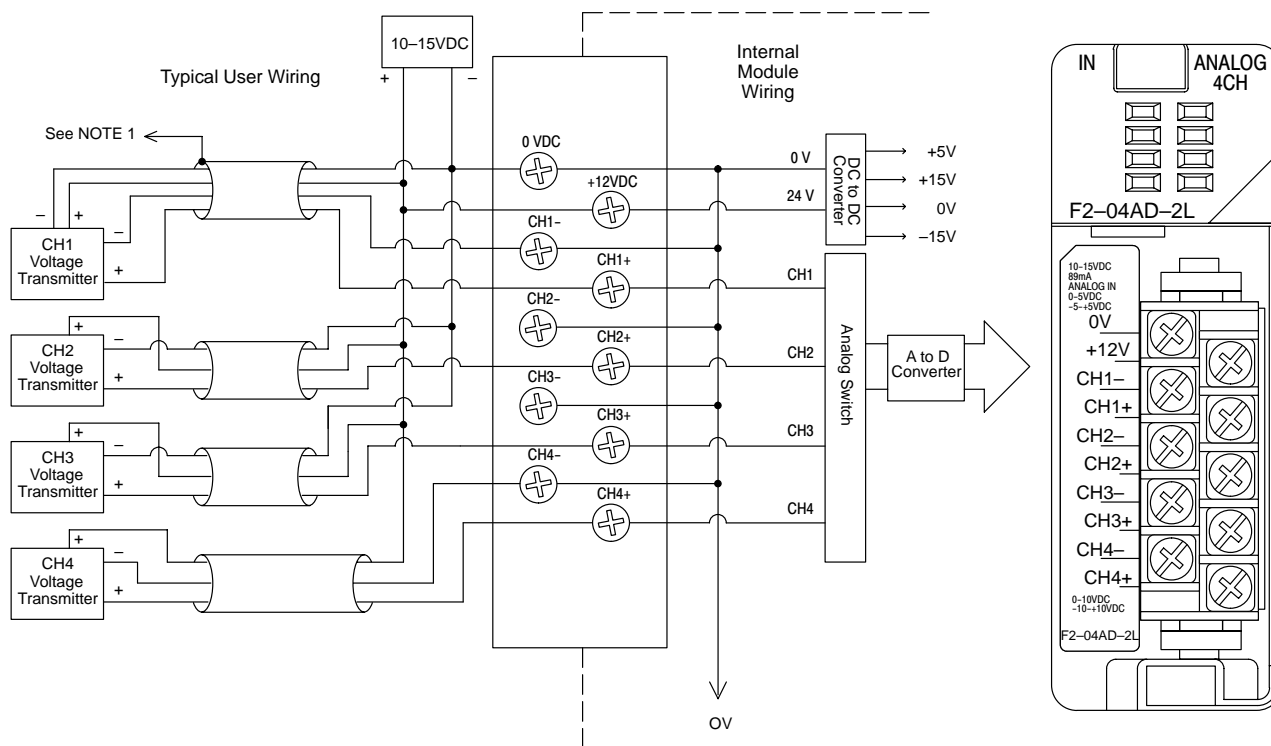
This module requires a 12VDC user power supply for operation. See the F2-04AD-2 if you want to use a 24VDC supply.

Number of Channels	4, single ended (one common)
Input Ranges	0 to 5V, 0 to 10V, $\pm 5V$ , $\pm 10V$
Resolution	12 bit (1 in 4096)
Active Low-pass Filtering	-3 dB at 20Hz, 2 poles (-12 dB per octave)
Input Impedance	> 20 M $\Omega$
Absolute Maximum Ratings	-75 to +75 VDC
Converter type	Successive approximation
Conversion Time (PLC update rate)	1 channel per scan minimum (D2-230 CPU) 4 channels per scan minimum (D2-240 and D2-250 CPU)
Linearity Error (End to End)	$\pm 1$ count (0.025% of full scale) maximum
Input Stability	$\pm 1$ count
Full Scale Calibration Error (offset error not included)	$\pm 7$ counts maximum
Offset Calibration Error	$\pm 1$ count maximum (0V input)

Maximum inaccuracy	$\pm .3\%$ @ 77°F (25°C) $\pm .45\%$ 32 to 140°F (0 to 60°C)
Accuracy vs. Temperature	$\pm 50$ ppm / °C full scale calibration change (including maximum offset change of 2 counts)
Digital Inputs Input points required	16 (X) input points 12 binary data bits, 2 channel ID bits
Power Budget Requirement	60 mA maximum, 5 VDC (supplied by base)
External Power Supply	90 mA maximum, +10 to +15 VDC
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

NOTE 1: Shields should be grounded at the signal source

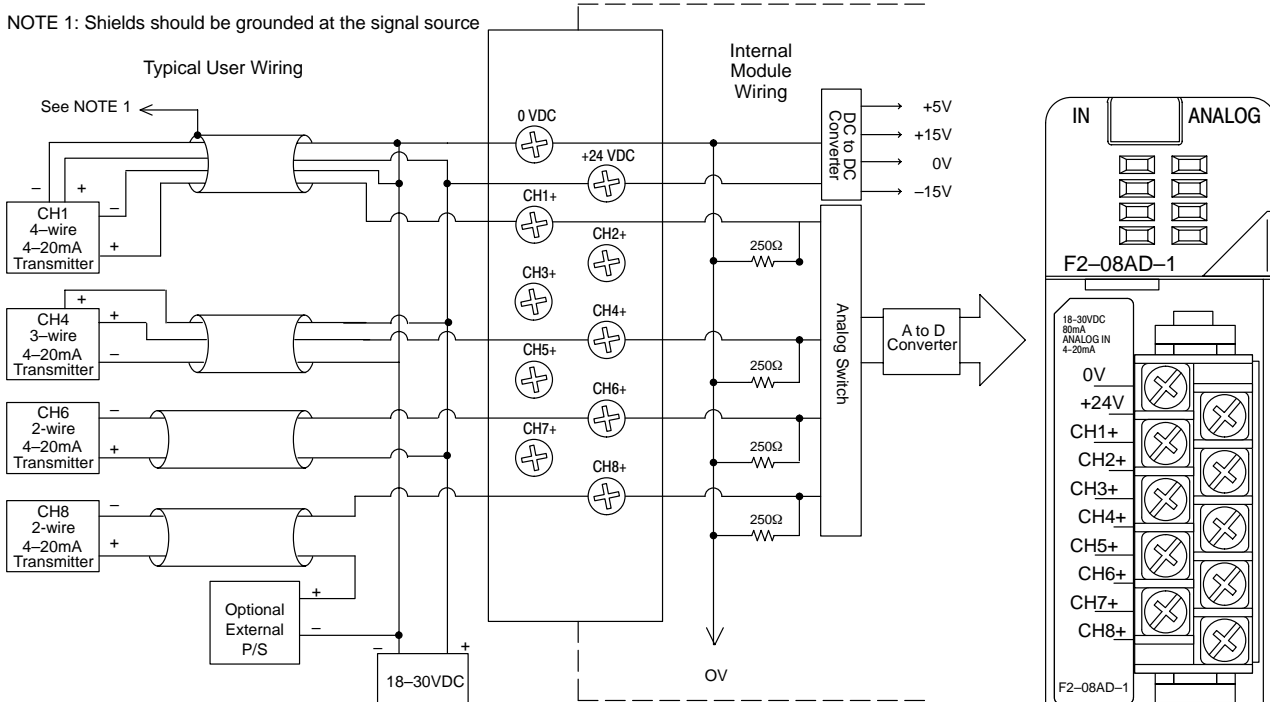


### F2-08AD-1 8 Channel 4-20mA Analog Input

Number of Channels	8, single ended (one common)
Input Ranges	4 to 20 mA current
Resolution	12 bit (1 in 4096)
Active Low-pass Filtering	-3 dB at 50Hz (-6 dB per octave)
Input Impedance	250Ω ± 0.1%, ½W current input
Absolute Maximum Ratings	-40 mA to +40 mA, current input
Converter type	Successive approximation
Conversion Time (PLC update rate)	1 channel per scan minimum (D2-230 CPU) 8 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (End to End)	± 1 count (0.025% of full scale) maximum
Input Stability	± 1 count
Full Scale Calibration Error (offset error not included)	± 4 counts max., @ 20mA current input
Offset Calibration Error	± 1 counts max., @ 4mA current input

Maximum inaccuracy	± .5% @ 77°F (25°C) ± .65% 32 to 140°F (0 to 60°C)
Accuracy vs. Temperature	± 50 ppm/°C maximum full scale (including max. offset change of 2 counts)
Recommended Fuse	0.032 A, Series 217 fast-acting, current inputs
Digital Inputs	16 (X) input points
Input points required	12 binary data bits, 2 channel ID bits
Power Budget Requirement	50 mA maximum, 5 VDC (supplied by base)
External Power Supply	80 mA maximum, +18 to +26.4 VDC
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).  
Includes circuitry to automatically detect broken or open transmitters.



More than one external power supply can be used provided all the power supply commons are connected.  
A Series 217, 0.032A, fast-acting fuse is recommended for 4-20mA current loops.  
If the power supply common of an external power supply is not connected to 0VDC on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4-20mA transmitter types are:

- 2 or 3 wire: Isolation between input signal and power supply.
- 4 wire: Isolation between input signal, power supply, and 4-20mA output

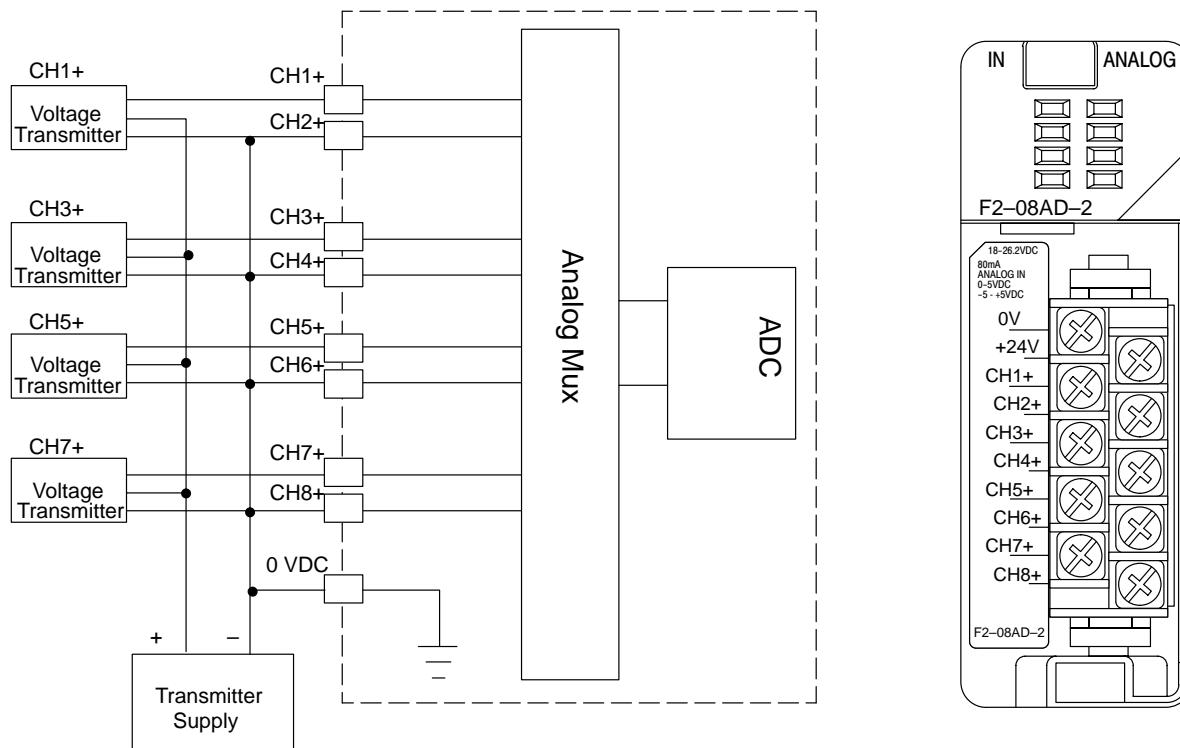


## F2-08AD-2 8 Channel Voltage Analog Input

Number of Channels	8, single ended (one common)	Maximum inaccuracy	± .1% @ 77°F (25°C) ± .3% 32° to 140°F (0 to 60°C)
Input Ranges	0 to 5, 0 to 10, ±5, ±10 VDC	Accuracy vs. Temperature	± 50 ppm/°C maximum full scale (including max. offset change of 2 counts)
Resolution	12 bit (0 to 4095) uni-polar	Digital Inputs Input points required	16 (X) input points 12 binary data bits, 3 channel ID bits
Active Low-pass Filtering	-3 dB at 200Hz (-6 dB per octave)	Power Budget Requirement	60 mA maximum, 5 VDC (supplied by base)
Input Impedance	> 20 MΩ	External Power Supply	80 mA maximum, +18 to +26.4 VDC
Absolute Max Ratings	-75 to +75 VDC	Operating Temperature	32 to 140° F (0 to 60° C)
Converter type	Successive approximation	Storage Temperature	-4 to 158° F (-20 to 70° C)
Conversion Time (PLC update rate)	1 channel per scan minimum (D2-230 CPU) 8 channels per scan maximum (D2-240 or D2-250 CPU)	Relative Humidity	5 to 95% (non-condensing)
Linearity Error	± 1 count (± 0.025% of full scale) max	Environmental air	No corrosive gases permitted
Input Stability	± 1 count	Vibration	MIL STD 810C 514.2
Full Scale Calibration Error (offset error not included)	± 3 counts maximum	Shock	MIL STD 810C 516.2
Offset Calibration Error	± 1 count maximum (0V input)	Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

Includes circuitry to automatically detect broken or open transmitters.

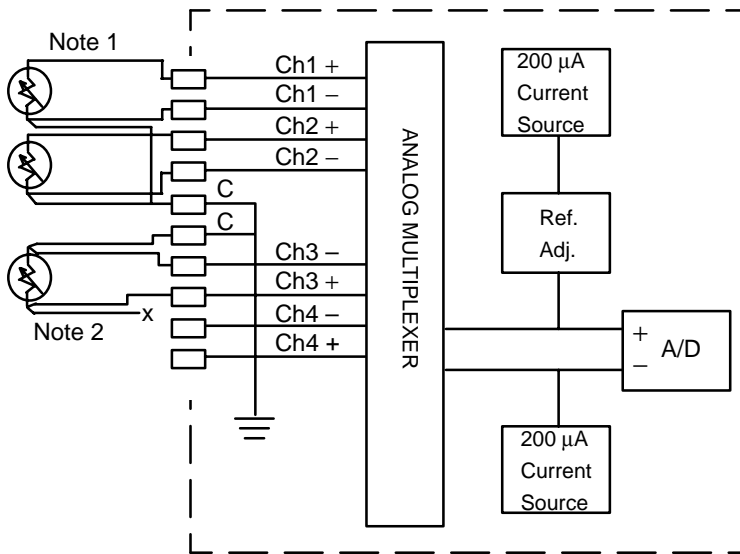


Note 1: Connect unused channels (CH2+, CH4+, CH6+, CH8+, COM)

I/O Wiring and Specifications

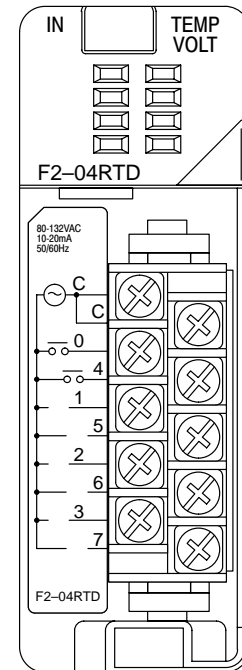
### F2-04RTD Input

Number of Channels	4	Converter Type	Charge Balancing
Input Ranges	Type Pt100: -200.0/850.0 °C, -328/1562 °F	Linearity Error	± .05°C maximum, ± .01°C typical
	Type Pt1000: -200.0/595.0 °C, -328/1103 °F	Full Scale Calibration Error	± 1° C
	Type jPt100: -38.0/450.0 °C, -36/842 °F	PLC Update Rate	4 Channel/scan max., 240/250 CPU 1 ch. per scan min., 230 CPU
	Type CU-10/25Ω: -200.0/260.0 °C, -328/500 °F	Digital Input Points Required	32 inputs, 16 binary data 2 inputs, channel identification 4 inputs, open/shorted fault
Resolution	16 bit (1 in 65535)	Base Power Required 5V	90 mA @ 5VDC
Display Resolution	± 0.1°C, ± 0.1°F (± 3276.7)	External Power Supply	24 VDC ± 10%, 50 mA current
RTD Excitation Current	200 µA	Operating Temperature	32° to 140° F (0° to 60° C)
Input Type	Differential	Storage Temperature	-4° to 158° F (-20° to 70° C)
Notch Filter	> 100 db notches at 50/60 Hz -3db=13.1 Hz	Temperature Drift	None (self-calibrating)
Maximum Settling Time	100 msec (full-scale step input)	Relative Humidity	5 to 95% (non-condensing)
Common Mode Range	0-5 Vdc	Environmental air	No corrosive gases permitted
Absolute Maximum Ratings	Fault protected inputs to ± 50Vdc	Vibration	MIL STD 810C 514.2
Sampling Rate	160 msec per channel	Shock	MIL STD 810C 516.2
		Noise Immunity	NEMA ICS3-304



**Notes:**

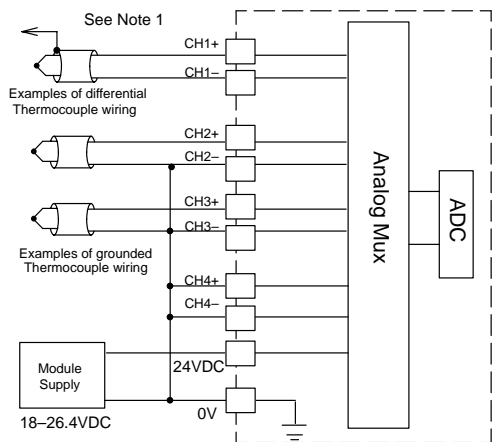
1. The three wires connecting the RTD to the module must be the same type and length. Do not use the shield or drain wire for the third connection.
2. If a RTD sensor has 4 wires, the plus sense wire should be left unconnected as shown.



## F2-04THM 4 Channel Thermocouple Input

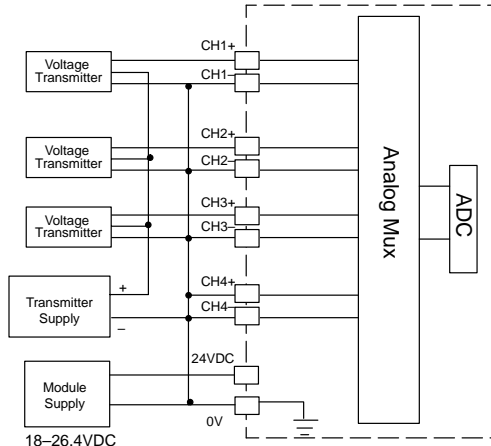
Number of Channels	4	PLC Update Rate	4 Channel/scan max., 240/250 CPU 1 ch. per scan min., 230 CPU
Resolution	16 bit (1 in 65535)	Digital Input Points Required	16 inputs, binary data 2 inputs, channel identification 4 inputs, open/shorted fault
Display Resolution	± 0.1°C, ± 0.1°F	Base Power Required 5V	110mA mA @ 5VDC
RTD Excitation Current	200 µA	External Power Required	60mA max., 18-26.4VDC
Input Type	Differential	Power Supply Rejection	85 db typical
Input Impedence	20 MΩ	Operating Temperature	32° to 140° F (0° to 60° C)
Notch Filter	> 100 db notches at 50/60 Hz -3db=13.1 Hz	Storage Temperature	-4° to 158° F (-20° to 70° C)
Maximum Settling Time	100 msec (full-scale step input)	Accuracy vs. Temperature*	57 ppm / °C maximum full scale
Common Mode Range	± 5 Vdc	Temperature Drift	5ppm maximum
Common Mode Rejection	90 db minimum at DC 150 db minimum at 50 Hz and 60 Hz	Relative Humidity	5 to 95% (non-condensing)
Absolute Maximum Ratings	Fault protected inputs to ± 50Vdc	Environmental air	No corrosive gases permitted
Sampling Rate	160 msec per channel	Vibration	MIL STD 810C 514.2
Converter Type	Charge Balancing	Shock	MIL STD 810C 516.2
Linearity Error	± .05°C maximum, ± .01°C typical	Noise Immunity	NEMA ICS3-304
Full Scale Calibration Error	± 1° C		

### Temperature Wiring Diagram

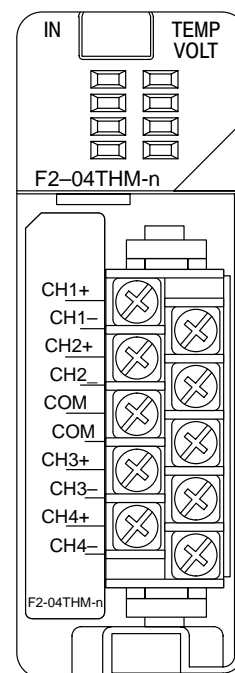


Note 1: Terminate shields at the respective signal source  
 Note 2: Connect unused channels (CH4+, CH4-, Com)

### Voltage Wiring Diagram



Note 1: Connect unused channels (CH4+, CH4-, Com)



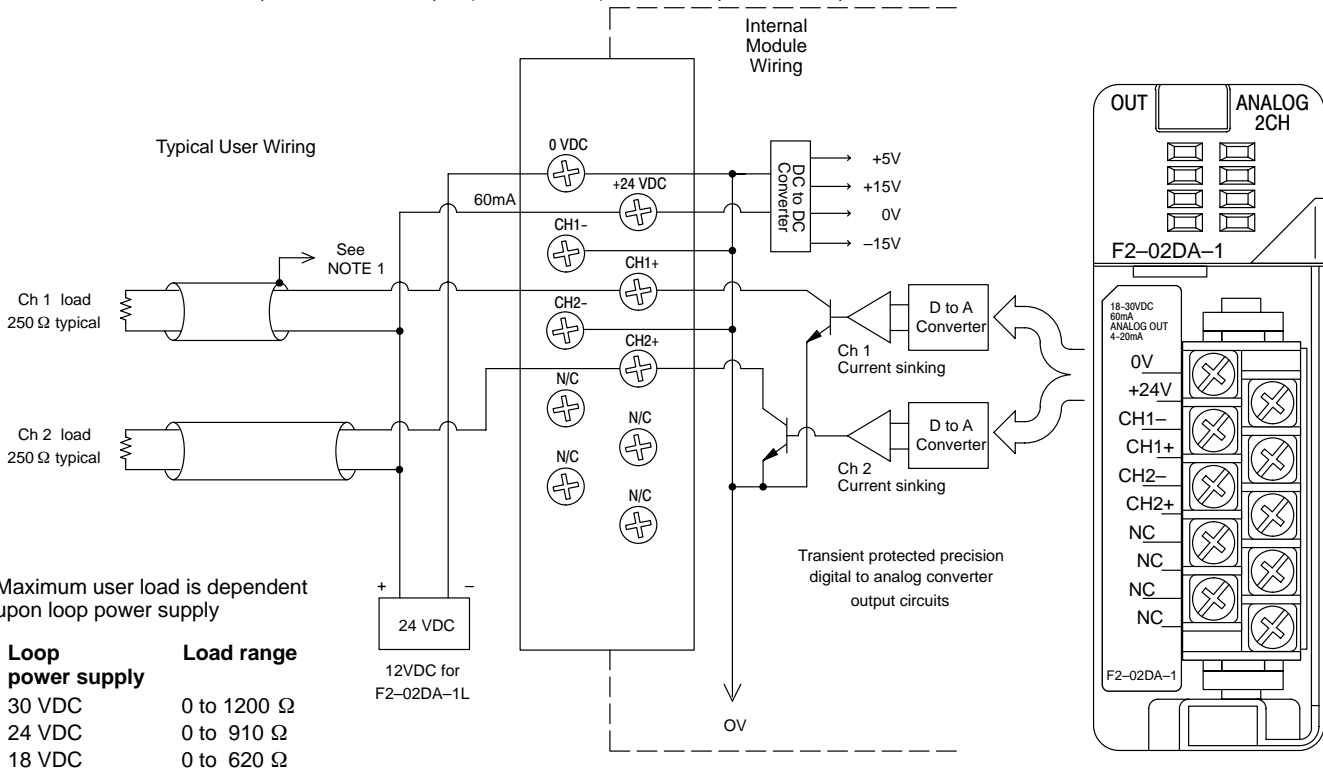
## F2-02DA-1(L) 2 Channel 4-20mA Analog Output

Number of Channels	2
Output Ranges	4 to 20 mA
Resolution	12 bit (1 in 4096)
Output Type	Single ended, 1 common
Maximum loop supply	30VDC
Peak output voltage	40VDC (clamped by transient voltage suppressor)
Load Impedance	0Ω minimum
Maximum Load / Power Supply	620Ω /18V, 910Ω /24V, 1200Ω /30V
PLC update rate	1 channel per scan minimum (D2-230 CPU) 2 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (end to end)	± 1 count (± 0.025% of full scale) maximum
Conversion Settling time	100μs maximum (full scale change)
Full scale calibration error (offset error included)	± 5 counts max., 20mA @ 77°F (25°C)
Offset Calibration Error	± 3 counts max., 4mA @ 77°F (25°C)

Accuracy vs. Temperature	± 50 ppm/°C full scale calibration change (including maximum offset change of 2 counts)
Maximum Inaccuracy	0.1% @ 77°F (25°C) 0.3% @ 32 to 140°F (0 to 60°C)
Digital outputs Output points required	16 (Y) output points 12 binary data bits, 2 channel ID bits
Power Budget Requirement	40 mA @ 5 VDC (supplied by base)
External Power Supply	F2-02DA-1: 18 to 30 VDC, 60mA F2-02DA-1L: 12-15VDC, 70mA (add 20 mA for each current loop used)
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

NOTE 1: Shields should be connected to the 0V of the module or the 0v of the P/S.  
NOTE 2: Unused current outputs should remain open (no connections) for minimum power consumption.



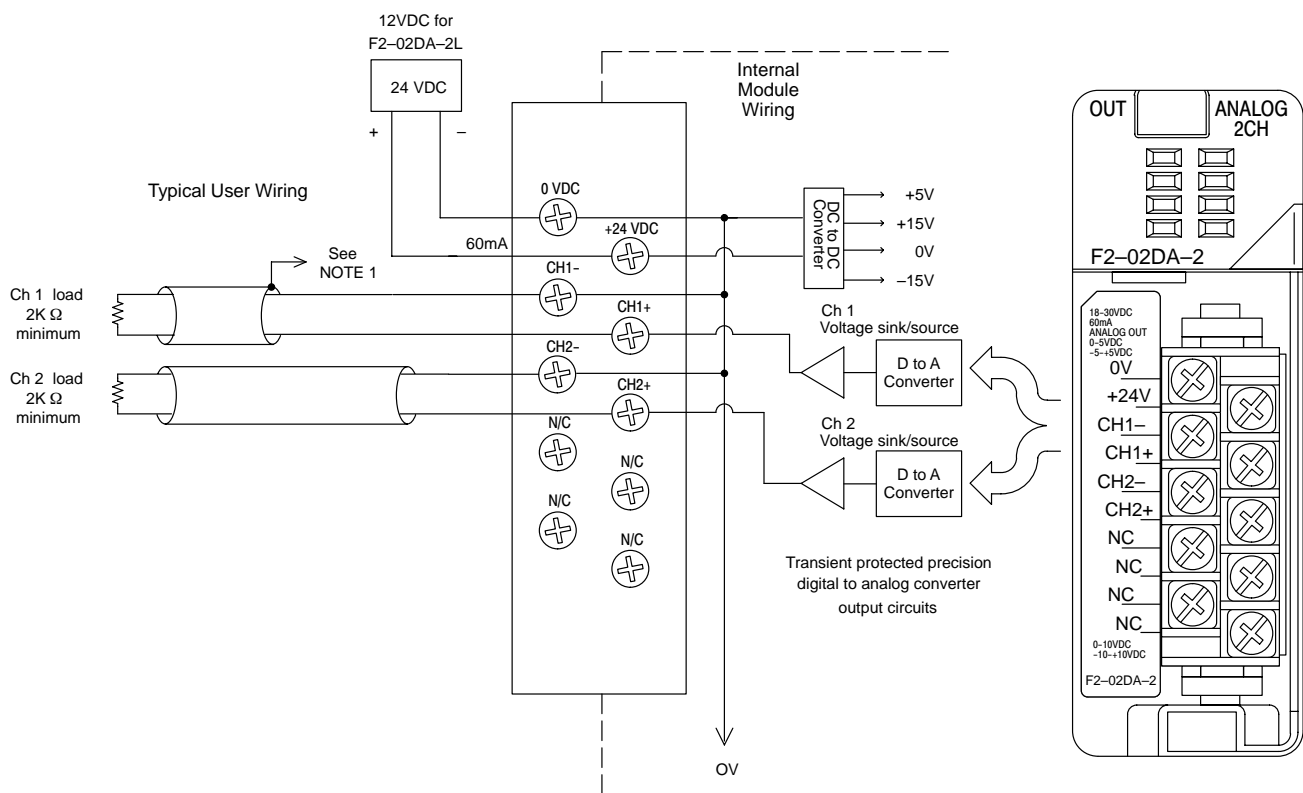
## F2-02DA-2(L) 2 Channel Voltage Analog Output

Number of Channels	2
Output Ranges	0 to 5V, 0 to 10V, $\pm 5V$ , $\pm 10V$
Resolution	12 bit (1 in 4096)
Output Type	Single ended, 1 common
Peak output voltage	15VDC (clamped by transient voltage suppressor)
Load Impedance	2000 $\Omega$ minimum
Load capacitance	.01 $\mu$ F maximum
PLC update rate	1 channel per scan minimum (D2-230 CPU) 2 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (end to end)	$\pm 1$ count ( $\pm 0.025\%$ of full scale) maximum
Conversion Settling time	5 $\mu$ s maximum (full scale change)
Full scale calibration error (offset error included)	$\pm 12$ counts max. unipolar @ 77°F (25°C) $\pm 16$ counts max. bipolar @ 77°F (25°C)
Offset Calibration Error	$\pm 3$ counts max. unipolar @ 77°F (25°C) $\pm 8$ counts max. bipolar @ 77°F (25°C)

Accuracy vs. Temperature	$\pm 50$ ppm/°C full scale calibration change (including maximum offset change of 2 counts)
Maximum Inaccuracy	$\pm 0.3\%$ unipolar ranges @ 77°F (25°C) $\pm 0.45\%$ unipolar ranges > 77°F (25°C) $\pm 0.4\%$ bipolar ranges @ 77°F (25°C) $\pm 0.55\%$ bipolar ranges > 77°F (25°C)
Digital outputs Output points required	16 (Y) output points (12 binary data bits, 2 channel ID bits)
Power Budget Requirement	40 mA @ 5 VDC (supplied by base)
External Power Supply	F2-02DA-2: 18 to 30 VDC, 60 mA F2-02DA-2L: 10-15VDC, 70mA (outputs fully loaded)
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

NOTE 1: Shields should be connected to the 0V of the module or the 0v of the P/S.  
NOTE 2: Unused voltage outputs should remain open (no connections) for minimum power consumption.

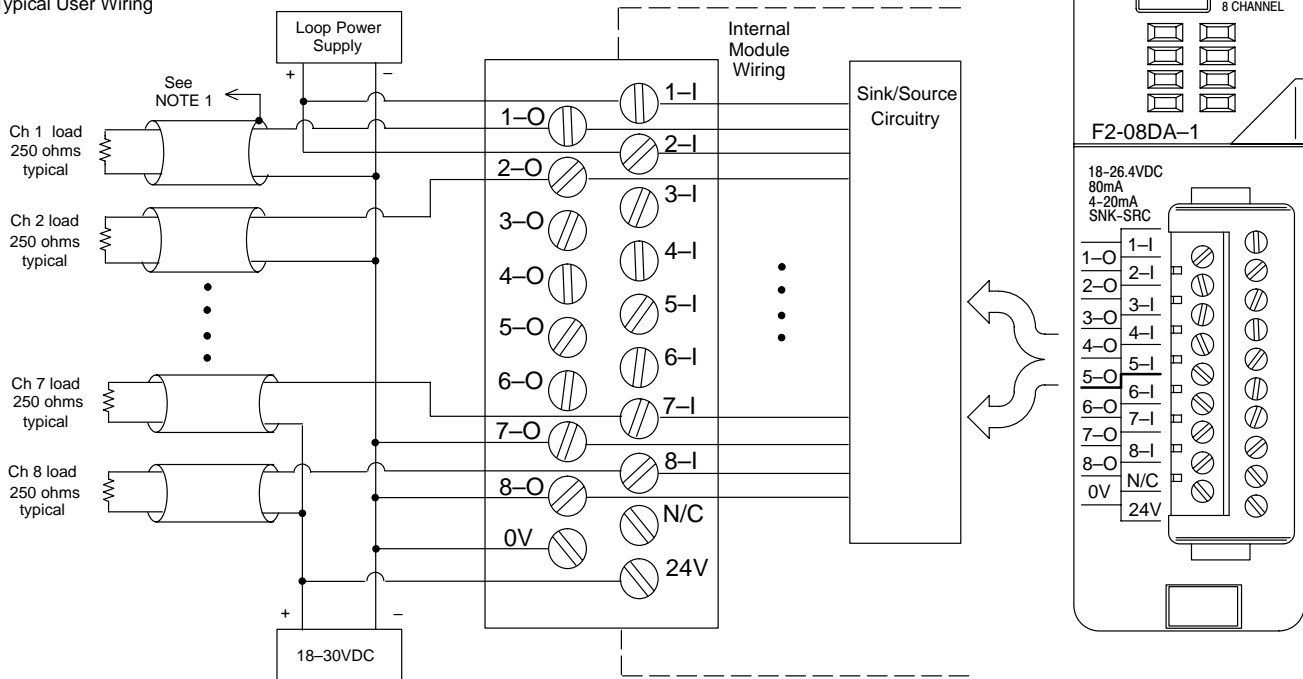


### F2-08DA-1 8-Channel Current Analog Output

Number of Channels	8, Single ended	Maximum Full Scale Inaccuracy @ 60°C	0.5% sinking (any load) & sourcing (125Ω load) 0.64% sourcing (250Ω load) 0.83% sourcing (400Ω load)
Output Range	4 – 20mA	Maximum Full Scale Inaccuracy @ 25°C (includes all errors & temperature drift)	0.3% sinking (any load) & sourcing (125Ω load) 0.44% sourcing (250Ω load) 0.63% sourcing (400Ω load)
Resolution	12 bit (1 in 4096)	Digital outputs Output points required	12 binary data bits, 3 channel ID bits, 1 output enable bit/16 (Y) output points required
Output Type	Current sinking and sourcing	Power Budget Requirement	30mA @ 5 VDC (supplied by base)
Maximum Loop Voltage	30VDC	External Power Supply	18–30VDC, 50mA plus 20mA/output loop, class 2
Source Load	0 – 400Ω (for loop power 18 – 30V)	Operating Temperature	32 to 140° F (0 to 60° C)
Sink Load	0–600Ω/24V, 0–900Ω/24V, 0–1200Ω/30V	Storage Temperature	–4 to 158° F (–20 to 70° C)
Total Load (sink plus source)	600Ω/24V, 900Ω/24V, 1200Ω/30V	Relative Humidity	5 to 95% (non-condensing)
Linearity Error (end to end)	± 2 count (± 0.050% of full scale) maximum	Environmental air	No corrosive gases permitted
Conversion Settling time	400 μs maximum (full scale change)	Vibration	MIL STD 810C 514.2
Full scale calibration error	± 12 counts max. sinking (any load) ± 12 counts max. sourcing (125Ω load) ± 18 counts max. sourcing (250Ω load) ± 26 counts max. sourcing (400Ω load)	Shock	MIL STD 810C 516.2
Offset Calibration Error	± 9 counts max. sinking (any load) ± 9 counts max. sourcing (125Ω load) ± 11 counts max. sourcing (250Ω load) ± 13 counts max. sourcing (400Ω load)	Noise Immunity	NEMA ICS3–304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

Typical User Wiring



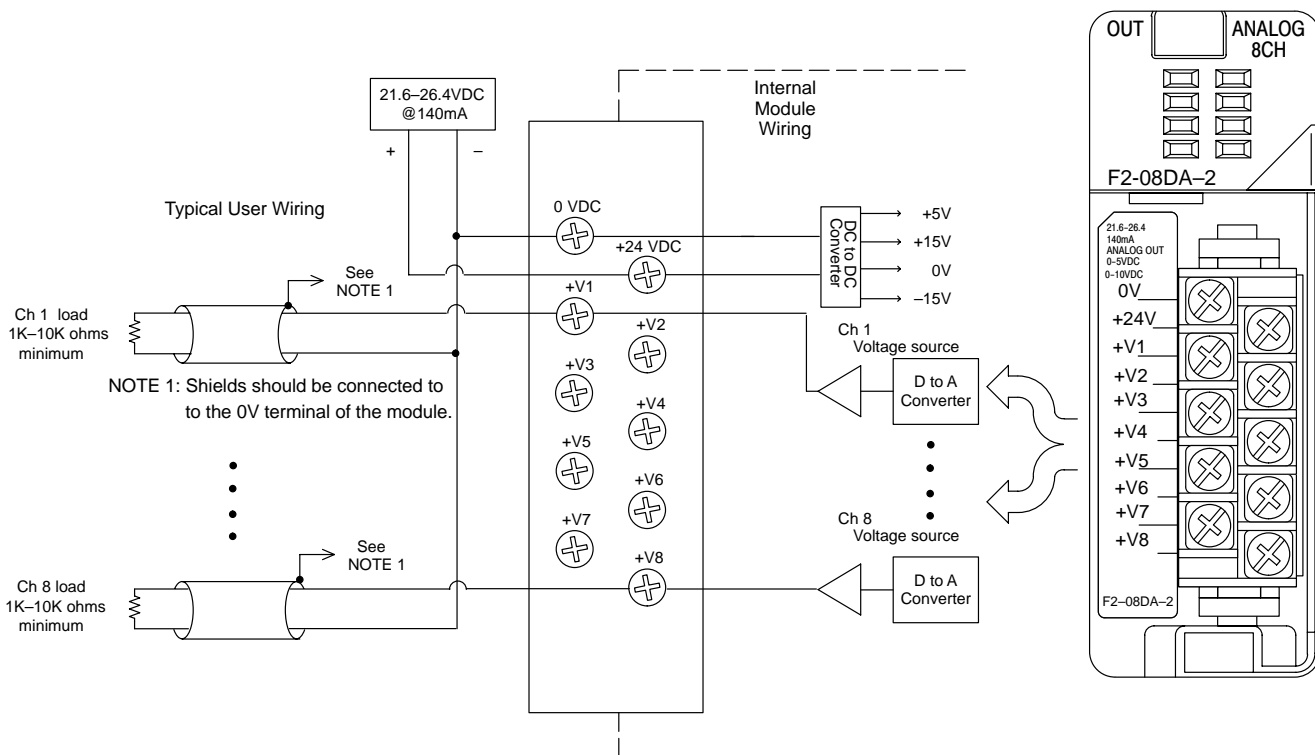
NOTE 1: Shields should be connected to the 0V terminal of the module.

## F2-08DA-2 8-Channel Voltage Analog Output

Number of Channels	8, Single ended
Output Ranges	0 to 5V, 0 to 10
Resolution	12 bit (1 in 4096)
Output Type	voltage sourcing
Peak output voltage	15VDC (clamped by transient voltage suppressor)
Load Impedance	1K ohm to 10K ohm
Load capacitance	.01μF maximum
PLC update rate	1 channel per scan minimum (D2-230 CPU) 8 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (end to end)	± 1 count (± 0.025% of full scale) maximum
Conversion Settling time	400 μs maximum (full scale change) 4.5ms to 9ms for digital out to analog out
Full scale calibration error (offset error included)	± 12 counts max. @ 77°F (25°C)
Offset Calibration Error	± 3 counts max. @ 77°F (25°C)

Accuracy vs. Temperature	± 57 ppm/°C full scale calibration change (including maximum offset change of 2 counts)
Maximum Inaccuracy	± 0.3% @ 77°F (25°C) ± 0.45% @ 0-60°C (32-140°F)
Digital outputs Output points required	16 (Y) output points, (12 binary data bits, 3 channel ID bits, 1 output enable bit)
Power Budget Requirement	60 mA @ 5 VDC (supplied by base)
External Power Supply	21.6-26.4 VDC, 140 mA (outputs fully loaded)
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).



I/O Wiring and Specifications

## F2-02DAS-1 Isolated 2 Channel 4-20mA Analog Output

Number of Channels	2, isolated (2 commons)
Output Ranges	4 to 20 mA
Resolution	16 bit (1 in 65536)
Output Type	current sourcing
Loop supply	12-32VDC
Isolation voltage	± 750V continuous, channel to channel, channel to logic
Load Impedance	0-525 ohms
PLC update rate	1 channel per scan minimum (D2-230 CPU) 2 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (end to end)	± 10 counts (± 0.015% of full scale) maximum
Conversion Settling time	3ms to 0.1% of full scale
Gain Calibration Error	± 32 counts (± 0.05%)
Offset Calibration Error	± 13 counts (± 0.02%)

Output Drift	50 ppm/°C
Maximum Inaccuracy	± 0.07% @ 77°F (25°C) ± 0.18% @ 32 to 140°F (0 to 60°C)
Digital outputs Output points required	32 (Y) output points 16 binary data bits, 2 channel ID bits
Power Budget Requirement	100 mA @ 5 VDC (supplied by base)
External Power Supply	12 to 32 VDC, 50 mA / channel
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

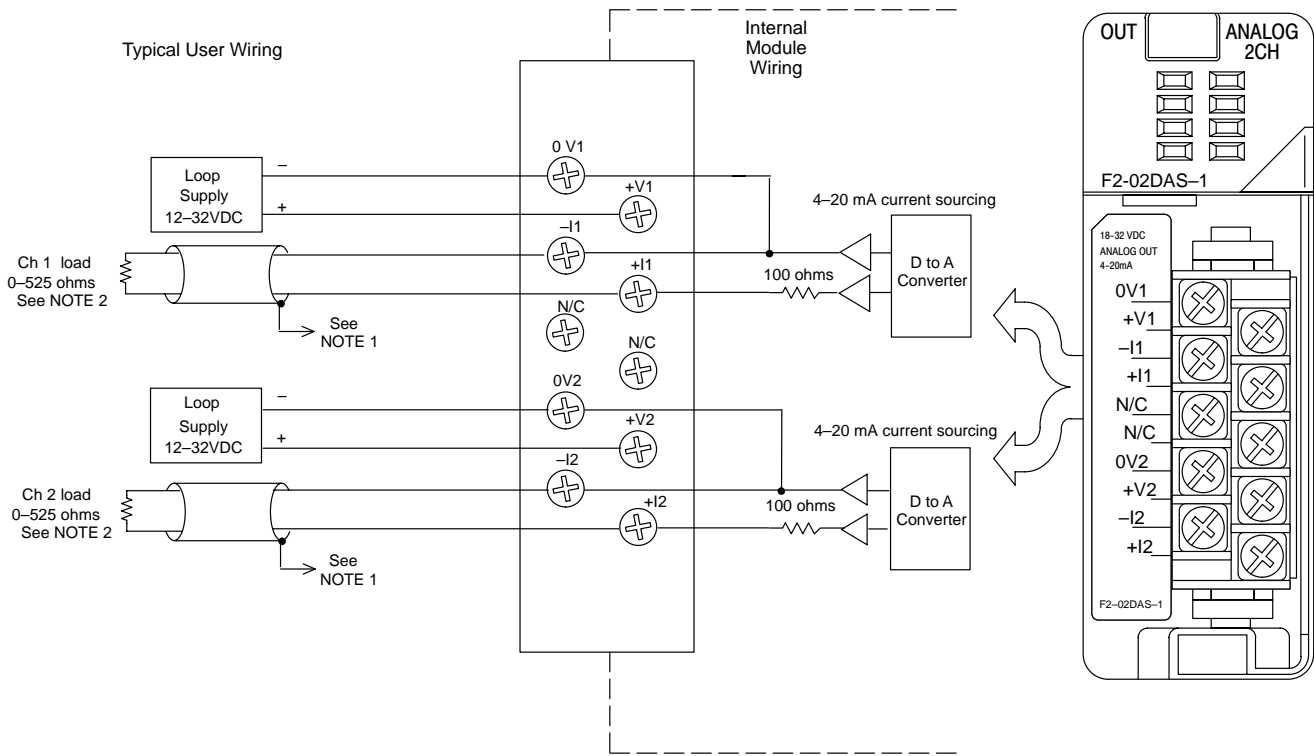
One count in the specification table is equal to one least significant bit of the analog data value (1 in 65536).

NOTE 1: Shields should be connected to the 0V terminal of the module.

NOTE 2: Loads must be within the compliance voltage.

NOTE 3: For non-isolated outputs, connect all 0V's together (0V1.....0V2) and connect all +V's together (+V1.....+V2).

I/O Wiring and Specifications





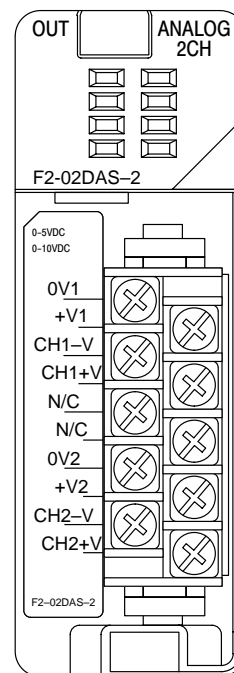
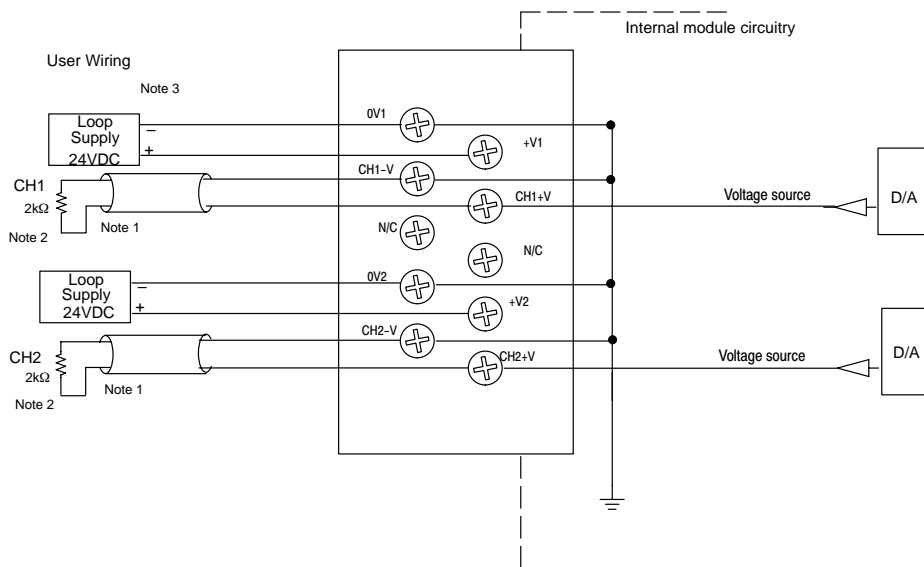
## F2-02DAS-2 Isolated 2 Channel Voltage Analog Output

Number of Channels	2, isolated (2 commons)
Output Ranges	0-5VDC, 0-10VDC
Resolution	16 bit (1 in 65536)
Isolation voltage	± 750V continuous, channel to channel, channel to logic
Load Impedance	2K ohms min.
PLC update rate	1 channel per scan minimum (D2-230 CPU) 2 channels per scan minimum (D2-240 or D2-250 CPU)
Linearity Error (end to end)	± 10 counts (± 0.015% of full scale) maximum
Conversion Settling time	3ms to 0.1% of full scale
Gain Calibration Error	± 32 counts (± 0.05%)
Offset Calibration Error	± 13 counts (± 0.02%)

Maximum Inaccuracy	± 0.07% @ 77°F (25°C) ± 0.18% @ 32 to 140°F (0 to 60°C)
Digital outputs Output points required	32 (Y) output points 16 binary data bits, 2 channel ID bits
Power Budget Requirement	100 mA @ 5 VDC (supplied by base)
External Power Supply	21.6-26.4 VDC, 60 mA / channel
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 65536).

- NOTE 1: Shields should be connected to the 0V.
- NOTE 2: Load must be within compliance voltage.
- NOTE 3: For non-isolated outputs, connect 0V1 to 0V2.



I/O Wiring and Specifications

## F2-4AD2DA 4-Channel Analog Input / 2-Channel Analog Output

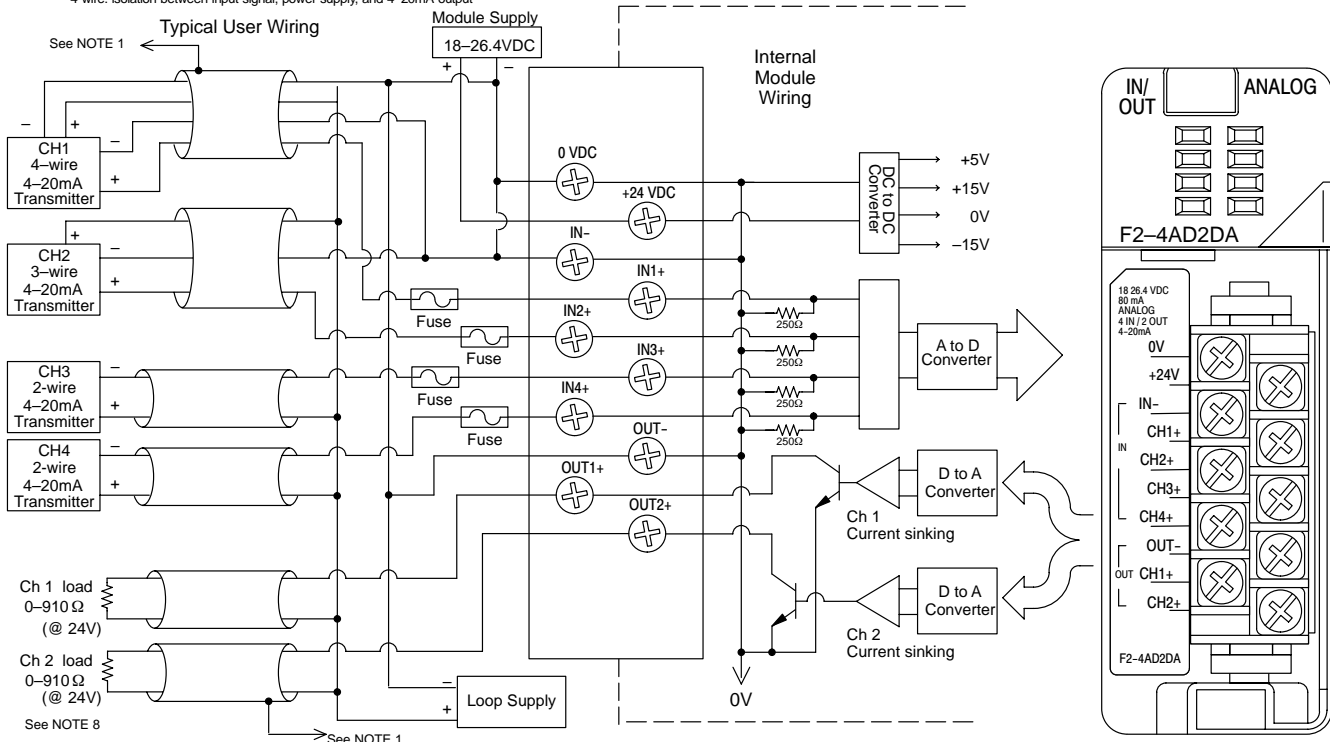
Input Channels	4, single ended (one common)
Output Channels	2, single ended (one common)
Ranges	4 to 20 mA current
Resolution	12 bit (1 in 4096)
Peak withstanding volts	75 VDC, current outputs
Maximum cont. overload	-40 to +40 mA, each current input
Input Impedance	250Ω, ± 0.1%, 1/2W, 25ppm/°C current input resistance
External load resistance	0Ω minimum, current outputs
Maximum loop supply	26VDC, current outputs
Recommended fuse	0.032A, series 217 fast-acting, current inputs
Maximum load / Power supply	910Ω /24V, current outputs
Active low-pass filter	-3 dB at 20Hz, 2 poles (-12 dB per octave)
Linearity Error (end to end)	± 1 count (± 0.025% of full scale) maximum
Output Settling time	100 μs maximum (full scale change)
Accuracy vs. Temperature	± 50 ppm/°C full scale calibration change (including maximum offset change)

Maximum Inaccuracy	± 0.1% @ 77°F (25°C) ± 0.3% @ 32 to 140°F (0 to 60°C)
Digital input and output points required	16 point (X) inputs 16 point (Y) outputs
PLC update rate	4 input channels per scan minimum (D2-240 or D2-250 CPU) 2 output channels per scan minimum (D2-240 or D2-250 CPU) 1 input and 1 output channel per scan minimum (D2-230 CPU)
Power Budget Req. R	60 mA @ 5 VDC (supplied by base)
External Power Sup.	22 to 26 VDC, 100 mA maximum
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 4096).

- Note 1: Shields should be connected at their respective signal source.
- Note 2: Unused channels should remain open for minimum power consumption.
- Note 3: More than one external power supply can be used provided the power supply commons are connected.
- Note 4: A Series 217, 0.032A fast acting fuse is recommended for 4-20mA current input loops.
- Note 5: If the power supply common of an external power supply is not connected to 0VDC on the module, then the output of the external transmitter must be isolated. To avoid "ground loop" errors, recommended 4-20mA transmitter types are:  
2 or 3 wire: isolation between input signal and power supply  
4 wire: isolation between input signal, power supply, and 4-20mA output

- Note 6: If an analog channel is connected backwards, then erroneous data values will be returned for that channel.
- Note 7: To avoid small errors due to terminal block losses, connect 0VDC, IN-, and OUT- on the terminal block as shown. The module's internal connection alone of these nodes is not sufficient to permit module performance up to the accuracy specifications.
- Note 8: Choose an output transducer resistance according to the maximum load/power supply listed in the Output Specifications.



# European Union Directives (CE)

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In This Appendix. . . .

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



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

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

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

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

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

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

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

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

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

- **EMC Directive Standards Relevant to PLCs**
  - EN50081-1 Generic immunity standard for residential, commercial, and light industry (DL05 only at this time)
  - EN50081-2 Generic emission standard for industrial environment.
  - EN50082-1 Generic immunity standard for residential, commercial, and light industry
  - EN50082-2 Generic immunity standard for industrial environment.
- **Low Voltage Directive Standards Applicable to PLCs**
  - EN61010-1 Safety requirements for electrical equipment for measurement, control, and laboratory use.
- **Product Specific Standard for PLCs**
  - EN61131-2 Programmable controllers, equipment requirements and tests. This standard replaces the above generic standards for immunity and safety. However, the generic emissions standards must still be used in conjunction with the following standards:
    - EN 61000-3-2—Harmonics
    - EN 61000-3-2—Fluctuations

**Automationdirect.com** is currently in the process of changing their testing procedures from the generic standards to the product specific standard, so that all new products will be tested to standard EN61131-2. Check our catalog or website for updated information.

### Special Installation Manual

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

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

### Other Sources of Information

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

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

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

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

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

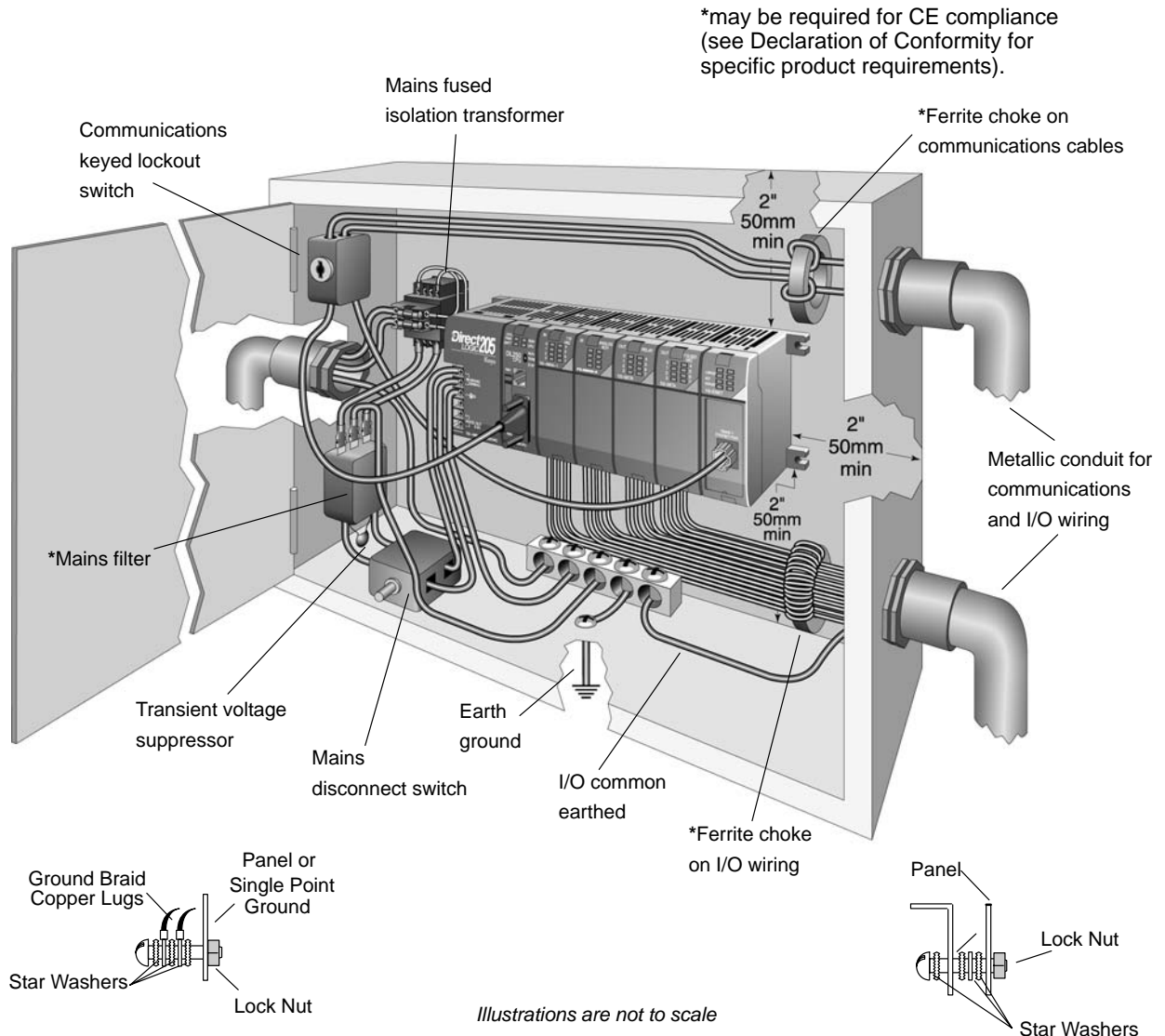
Another source is:

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

## Basic EMC Installation Guidelines

### Enclosures

The following diagram illustrates good engineering practices supporting the requirements of the Machinery and Low Voltage Directives. House all control equipment in an industry standard lockable steel enclosure and use metallic conduit for wire runs and cables.



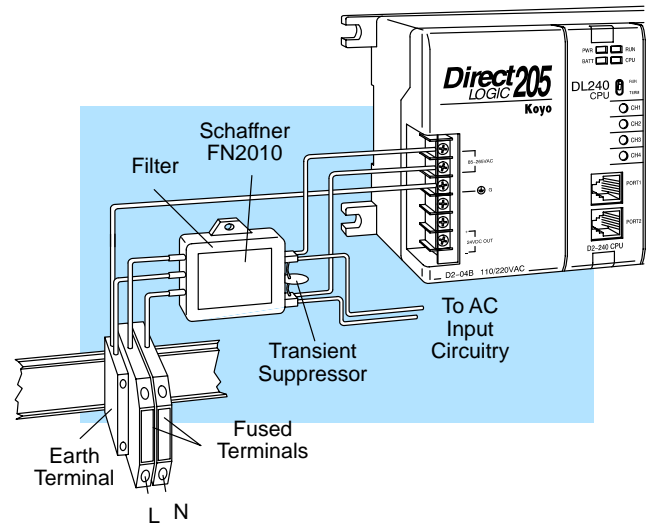
## Electrostatic Discharge (ESD)

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

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

## AC Mains Filters

DL205 AC powered base power supplies require extra mains filtering to comply with the EMC Directive on conducted RF emissions. Applicable PLC equipment has been tested with filters from Schaffner, which reduce emissions levels if the filters are properly grounded (earth ground). A filter with a current rating suitable to supply all PLC power supplies and AC input modules should be selected. We suggest the FN2010 for DL205 systems.



**NOTE:** Very few mains filters can reduce problem emissions to negligible levels. In some cases, filters may increase conducted emissions if not properly matched to the problem emissions. The filters shown above are not the same as a “power filter”, which is used to keep transients on the mains from entering the PLC power supply.

## Suppression and Fusing

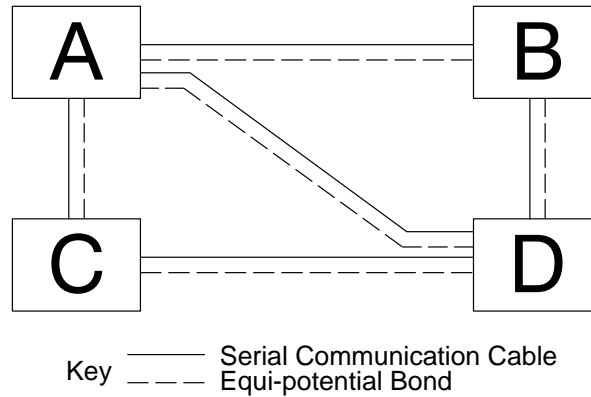
In order to comply with the fire risk requirements of the Low Voltage and Machinery Directive electrical standards EN 61010–1, and EN 60204–1, by limiting the power into “unlimited” mains circuits with power leads reversed, it is necessary to fuse both AC and DC supply inputs. You should also install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

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

## Internal Enclosure Grounding

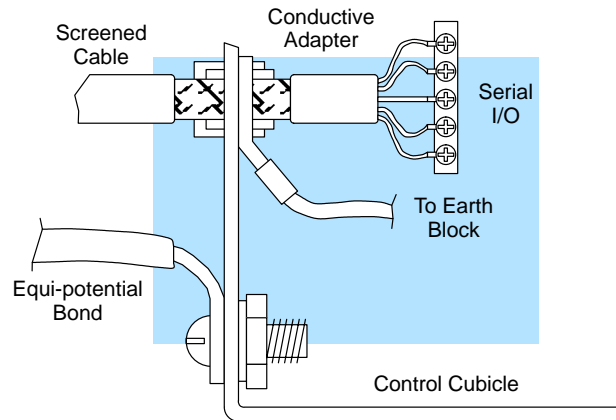
A heavy-duty star earth terminal block should be provided in every cubicle for the connection of all earth ground straps, protective earth ground connections, mains filter earth ground wires, and mechanical assembly earth ground connections. This should be installed to comply with safety and EMC requirements,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

## Equi-potential Grounding



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

## Communications and Shielded Cables



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



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

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

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

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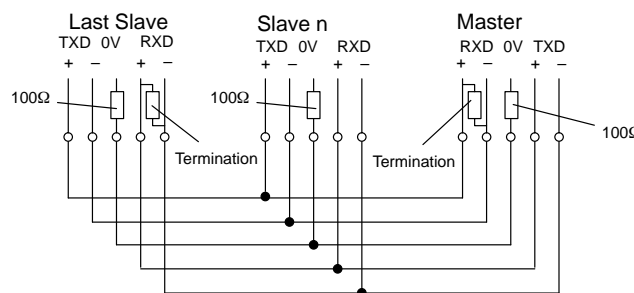


### Analog and RS232 Cables

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

### Multidrop Cables

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



### Shielded Cables within Enclosures

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

**Network Isolation**

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

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

**Items Specific to the DL205**

- This equipment must be properly installed while adhering to the guidelines of the PLC installation manual DA-EU-M, and is suitable for EN 61010-1 installation categories 1 or 2.
- The rating between all circuits in this product are rated as **basic insulation only**, as appropriate for single fault conditions.
- The protection provided by the equipment may be impaired if the equipment is used in a manner not specified by the manufacturer.
- It is the responsibility of the system designer to earth one side of all control and power circuits, and to earth the braid of screened cables.
- Input power cables must be externally fused and have an externally mounted switch or circuit breaker, preferably mounted near the PLC. Note: The DL205 internal base power supply has a 2A@250V slow blow fuse; however, it is not replaceable, so external fusing is required.
- When needed, carefully clean the outside plastic case of PLC components using a dry cloth.
- For hardware maintenance instructions, see the Maintenance and Troubleshooting section in this manual. This section also includes battery replacement information. Also, only replacement parts supplied by **Automationdirect.com** or its agents should be used.
- Cables, whether shielded or not **MUST** be enclosed within earthed metal conduit or other metallic trunking when outside the PLC enclosure.
- This is a Class A product and it may cause radio interference in certain environments. The user may need to provide shielding, or other measures to eliminate the interference.