Installation, Wiring, and Specifications

Chapter 2

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Safety Guidelines

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

WARNING: Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system planning and installation. Automation systems can fail and may result in situations that can cause serious injury to personnel and/or damage equipment. Do not rely on the automation system alone to provide a safe operating environment. Sufficient emergency circuits should be provided to stop the operation of the PLC or the controlled machine or process, either partially or totally. These circuits should be routed outside the PLC in the event of controller failure, so that independent and rapid shutdown are available. Devices, such as mushroom switches or end of travel limit switches, should operate motor starter, solenoids, or other devices without being processed by the PLC. These emergency circuits should be designed using simple logic with a minimum number of highly reliable electromechanical components. Every automation application is different, so there may be special requirements for your particular application. Make sure all national, state, and local government requirements are followed for the proper installation and use of your equipment.

Plan for Safety

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

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

Three Levels of Protection

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

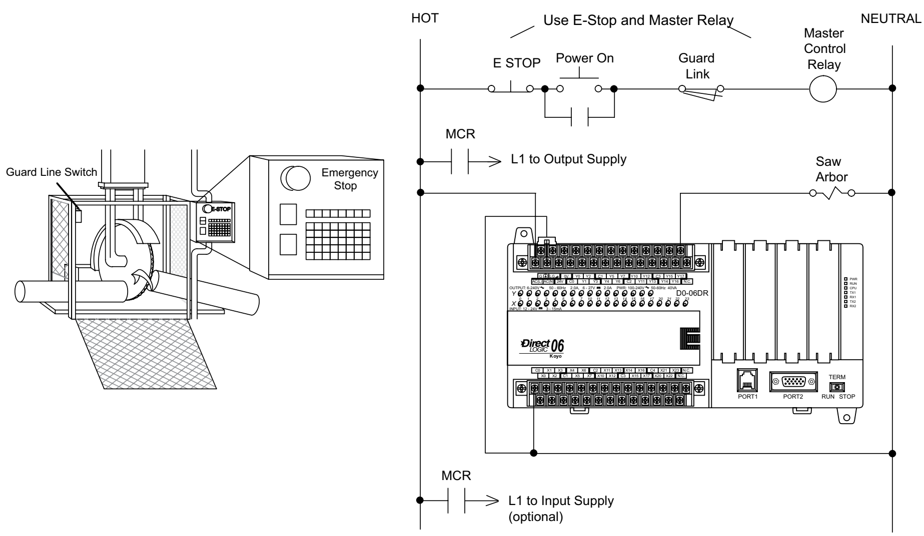
- Emergency stop switch for disconnecting system power
- Mechanical disconnect for output module power
- Orderly system shutdown sequence in the PLC control program

Emergency Stops

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

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

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



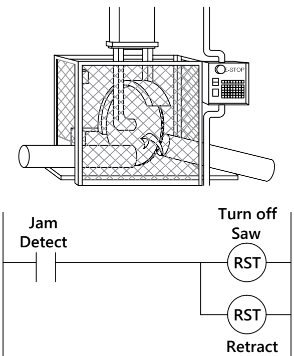
Emergency Power Disconnect

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

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

Orderly System Shutdown

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



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

Class 1, Division 2 Approval

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

WARNING: Explosion Hazard! Substitution of components may impair suitability for Class 1, Division 2.

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

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

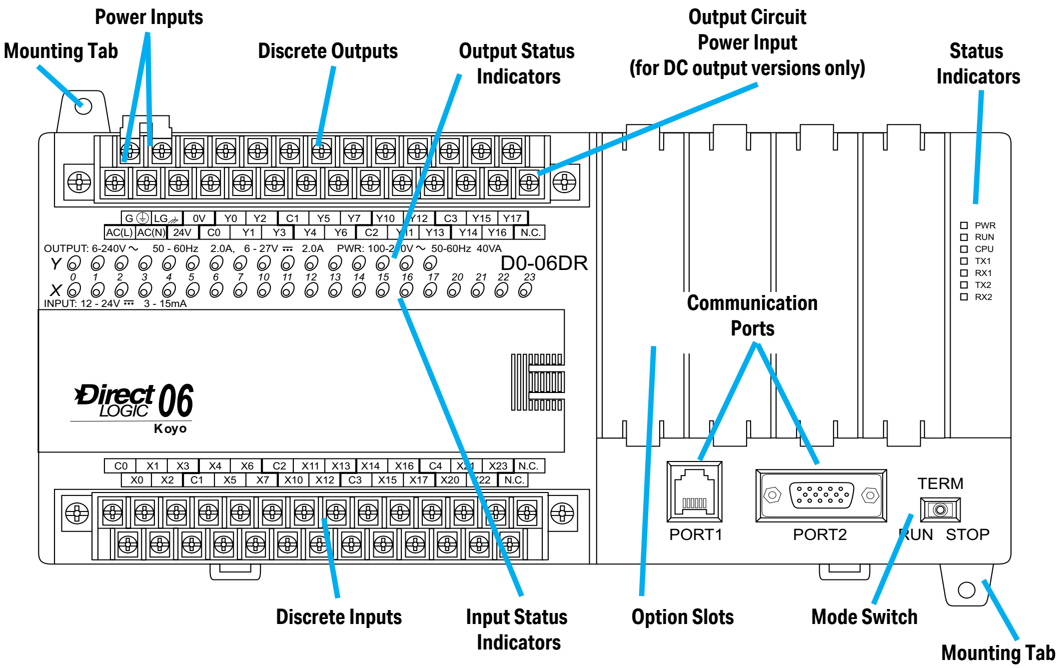
WARNING: This equipment is designed for use in Pollution Degree 2 environments (installed within an enclosure rated at least IP54).

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

Orientation to DL06 Front Panel

Most connections, indicators and labels on the DL06 Micro PLCs are located on its front panel. The communication ports are located on front of the PLC, as are the option card slots and the mode selector switch. Please refer to the drawing below.

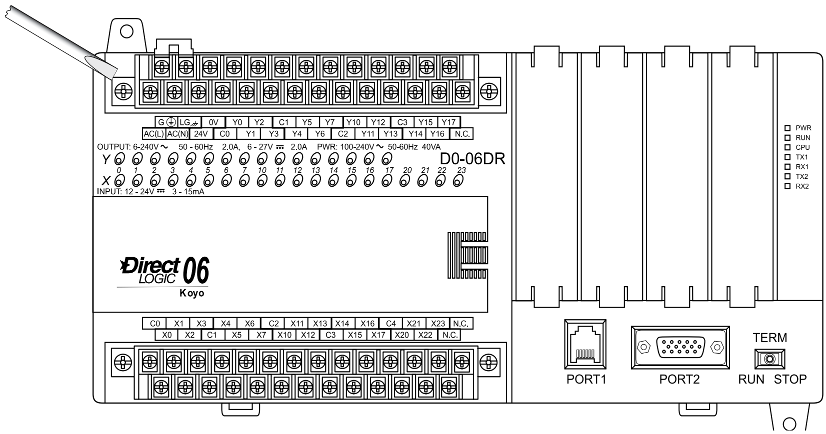
The output and power connector accepts external power and logic and chassis ground connections on the indicated terminals. The remaining terminals are for connecting commons and output connections Y0 through Y17. The sixteen output terminals are numbered in octal, Y0-Y7 and Y10-Y17. On DC output units, the end terminal on the right accepts power for the output stage. The input side connector provides the location for connecting the inputs X0 and X23 and the associated commons.



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

Terminal Block Removal

The DL06 terminals are divided into two groups. Each group has its own terminal block. The outputs and power wiring are on one block, and the input wiring is on the other. In some instances, it may be desirable to remove the terminal block for easy wiring. The terminal block is designed for easy removal with just a small screwdriver. The drawing below shows the procedure for removing one of the terminal blocks.



1. Loosen the retention screws on each end of the connector block.

2. From the center of the connector block, pry upward with the screwdriver until the connector is loose.

The terminal blocks on DL06 PLCs have regular (m3 size) screw terminals, which will accept either standard blade-type or #1 Philips screwdriver tips. Use No. 16 to 22 AWG solid/ stranded wire. Be careful not to over-tighten; maximum torque is 0.882 to 1.020 N·m (7.806 to 9.028 in·lbs).

Spare terminal blocks are available in an accessory kit. Please refer to part number D0-ACC-2. You can find this and other accessories on our web site.

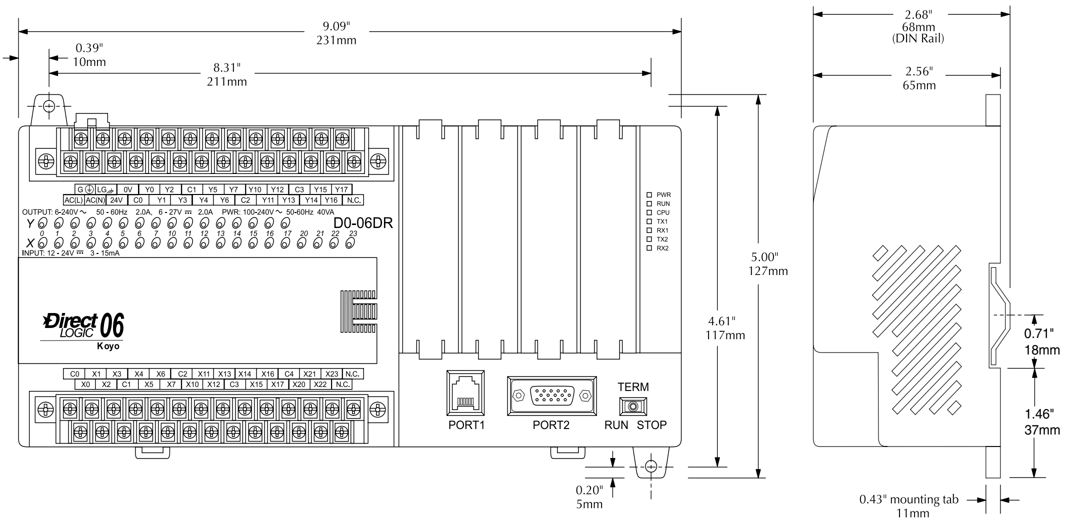
Mounting Guidelines

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

- Environmental Specifications
- Power Requirements
- Agency Approvals
- Enclosure Selection and Component Dimensions

Unit Dimensions

The following diagram shows the outside dimensions and mounting hole locations for all versions of the DL06. Make sure you follow the installation guidelines to allow proper spacing from other components.



Enclosures

Your selection of a proper enclosure is important to ensure safe and proper operation of your DL06 system. Applications of DL06 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

Panel Layout & Clearances

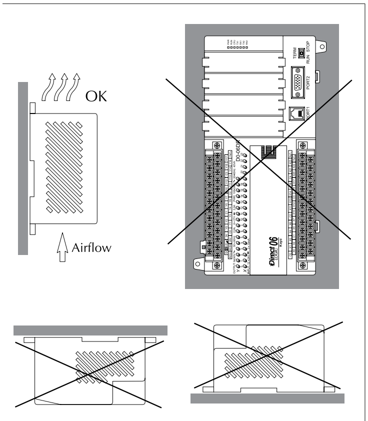
There are many things to consider when designing the panel layout. The following items correspond to the diagram shown. **Note:** there may be additional requirements, depending on your application and use of other components in the cabinet.

1. Mount the PLCs horizontally as shown below to provide proper ventilation. You cannot mount the DL06 units vertically, upside down, or on a flat horizontal surface. If you place more than one unit in a cabinet, there must be a minimum of 7.2" (183mm) between the units.

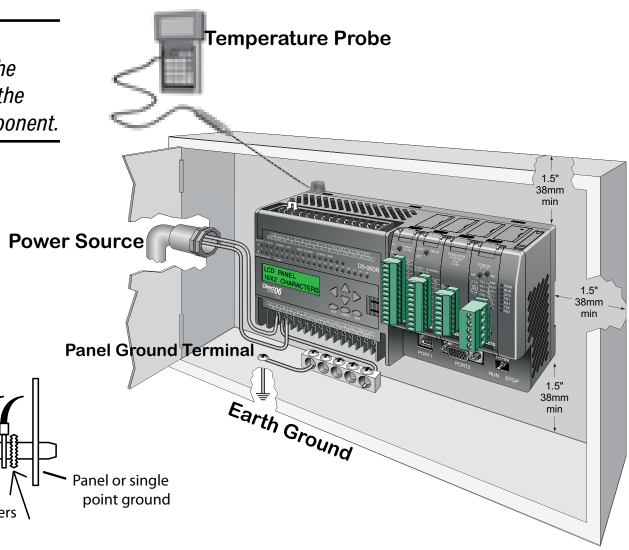
2. Provide a minimum clearance of 1.5" (38mm) between the unit and all sides of the cabinet. Remember to allow for any operator panels or other items mounted in the door.

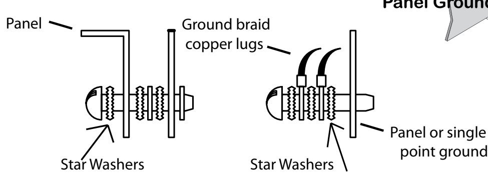
3. There should also be at least 3" (78mm) of clearance between the unit and any wiring ducts that run parallel to the terminals.

4. The ground terminal on the DL06 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.



***NOTE**: There is a minimum clearance requirement of 1.5" (38 mm) between the panel door (or any devices mounted in the panel door) and the nearest DL06 component.*





5. 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. Minimum wire sizes, color coding, and general safety practices should comply with appropriate electrical codes and standards for your area.

6. A good common ground reference (Earth ground) is essential for proper operation of the DL06. One side of all control and power circuits and the ground lead on flexible shielded cable must be properly connected to Earth ground. 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

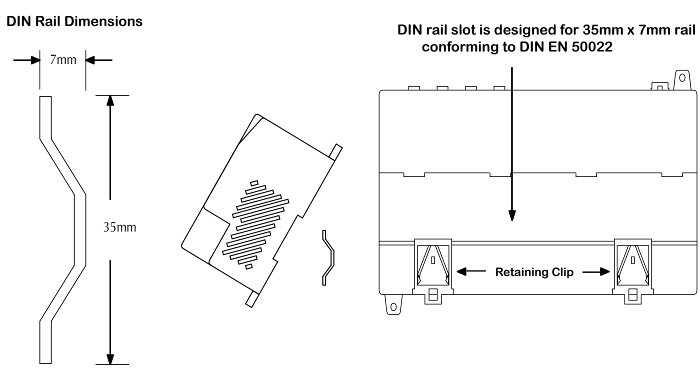
7. Evaluate any installations where the ambient temperature may approach the lower or upper limits of the specifications. If you suspect the ambient temperature will not be within the operating specification for the DL06 system, measures such as installing a cooling/heating source must be taken to get the ambient temperature within the range of specifications.

8. The DL06 systems are designed to be powered by 95–240 VAC or 12–24 VDC normally available throughout an industrial environment. Electrical power in some areas where the PLCs are installed is not always stable and storms can cause power surges. Due to this, power line filters are recommended for protecting the DL06 PLCs from power surges and EMI/RFI noise. The Automationdirect power line filter, for use with 120VAC and 240VAC, 1–5 Amps, is an excellent choice (locate at automationdirect.com); however, you can use a filter of your choice. These units install easily between the power source and the PLC.

***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.*

Using Mounting Rails

DL06 Micro PLCs can be secured to a panel by using mounting rails. We recommend rails that conform to DIN EN standard 50022. They are approximately 35 mm high, with a depth of 7 mm. If you mount the Micro PLC on a rail, do consider using end brackets on each side of the PLC. The end bracket helps keep the PLC from sliding horizontally along the rail, reducing the possibility of accidentally pulling the wiring loose. On the bottom of the PLC are two small retaining clips. To secure the PLC to a DIN rail, place it onto the rail and gently push up on the clips to lock it onto the rail. To remove the PLC, pull down on the retaining clips, lift up on the PLC slightly, then pull it away from the rail.



***NOTE:** Refer to our catalog or web site for a complete listing of **DINnector** connection systems.*

Environmental Specifications

The following table lists the environmental specifications that generally apply to DL06 Micro PLCs. The ranges that vary for the Handheld Programmer are noted at the bottom of this chart. Certain output circuit types may have derating curves, depending on the ambient temperature and the number of outputs ON. Please refer to the appropriate section in this chapter pertaining to your particular DL06 PLC.

Environmental Specifications	
Specification	**Rating**
Storage temperature	–4°F to 158°F (–20°C to 70°C)
Ambient operating temperature*	32°F to 131°F (0°C to 55°C)
Ambient humidity**	5% – 95% relative humidity (non–condensing)
Vibration resistance	MIL STD 810C, Method 514.2
Shock resistance	MIL STD 810C, Method 516.2
Noise immunity	NEMA (ICS3–304)
Atmosphere	No corrosive gases
Agency approvals	UL, CE (C1D2), FCC class A

* Operating temperature for the Handheld Programmer and the DV–1000 is 32° to 122°F (0° to 50°C)
Storage temperature for the Handheld Programmer and the DV–1000 is –4° to 158°F (–20° to 70°C).

**Equipment will operate down to 5% relative humidity; however, static electricity problems occur much more frequently at low humidity levels (below 30%). 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.

Agency Approvals

Some applications require agency approvals for particular components. The DL06 Micro PLC agency approvals are listed below:

- UL (Underwriters' Laboratories, Inc.)
- CUL (Canadian Underwriters' Laboratories, Inc.)
- CE (European Economic Union)

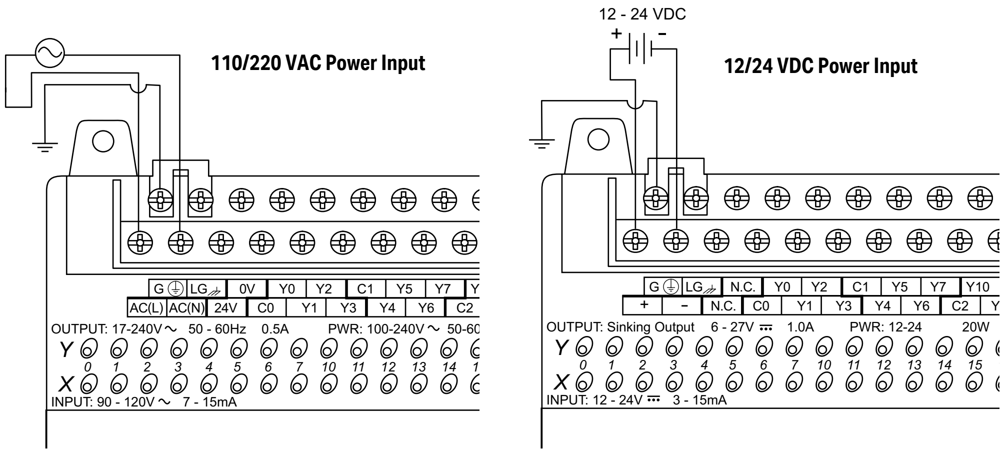
Marine Use

American Bureau of Shipping (ABS) certification requires flame-retarding insulation as per 4-8-3/5.3.6(a). ABS will accept Navy low smoke cables, cable qualified to NEC **Plenum rated** (fire resistant level 4), or other similar flammability resistant rated cables. Use cable specifications for your system that meet a recognized flame retardant standard (i.e., UL, IEEE, etc.), including evidence of cable test certification (i.e., tests certificate, UL file number, etc.).

NOTE: *Wiring must be* ***low smoke*** *per the above paragraph. Teflon coated wire is also recommended.*

Wiring Guidelines

Connect the power input wiring for the DL06. Observe all precautions stated earlier in this manual. When the wiring is complete, close the connector covers. Do not apply power at this time.



WARNING: Once the power wiring is connected, secure the terminal block cover in the closed position. There is a risk of electrical shock if you accidentally touch the connection terminals or power wiring when the cover is open.

External Power Source

The power source must be capable of suppling voltage and current complying with individual Micro PLC specifications, according to the following specifications:

NOTE: *The rating between all internal circuits is BASIC INSULATION ONLY.*

Power Source Specifications		
Item	**DL06 AC Powered Units**	**DL06 DC Powered Units**
Input Voltage Range	110/220 VAC (100–240 VAC/50-60 Hz)	12–24 VDC (10.8–26.4 VDC)
Maximum Inrush Current	13A, 1ms (100–240 VAC) 15A, 1ms (240–264 VAC)	10A
Maximum Power	40VA	20W
Voltage Withstand (dielectric)	1 minute @ 1500VAC between primary, secondary, field ground	
Insulation Resistance	> 10MΩ at 500VDC	

NOTE: *Recommended wire size for field devices is 16–22 AWG solid/stranded. Tighten terminal screws to 7.81 lb·in (0.882 N·m) to 9.03 lb-in (1.02 N·m).*

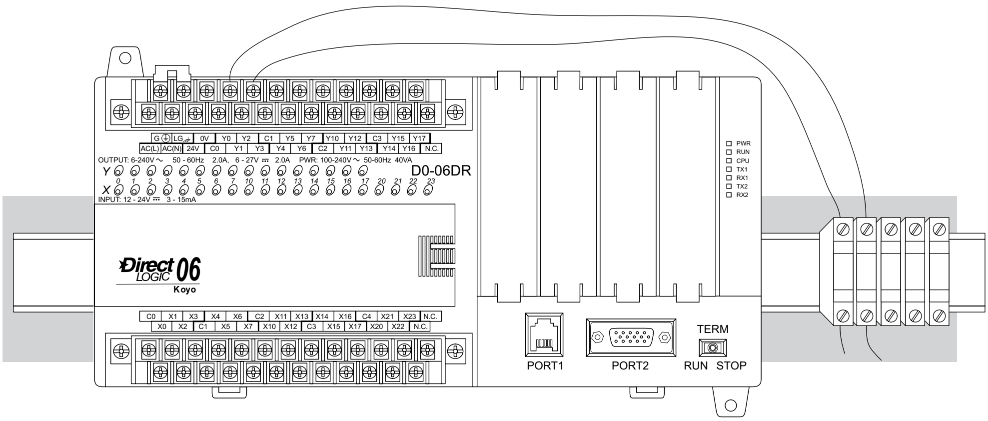
Planning the Wiring Routes

The following guidelines provide general information on how to wire the I/O connections to DL06 Micro PLCs. Refer to the corresponding specification sheet which appears later in this chapter for specific information on wiring a particular PLC .

1. Each terminal connection of the DL06 PLC can accept one 16 AWG wire or two 18 AWG size wires. Do not exceed this recommended capacity.
2. Always use a continuous length of wire. Do not splice 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. Install the recommended power line filter to reduce power surges and EMI/RFI noise.

Fuse Protection for Input and Output Circuits

Input and Output circuits on DL06 Micro PLCs do not have internal fuses. In order to protect your Micro PLC, we suggest you add external fuses to your I/O wiring. A fast-blow fuse, with a lower current rating than the I/O bank's common current rating, can be wired 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 the Micro PLC specification sheets further in this chapter to find the maximum current per output point or per output common. Adding the external fuse does not guarantee the prevention of Micro PLC damage, but it will provide added protection.



I/O Point Numbering

All DL06 Micro PLCs have a fixed I/O configuration. It follows the same octal numbering system used on other ***Direct***Logic family PLCs, starting at X0 and Y0. The letter X is always used to indicate inputs and the letter Y is always used for outputs.

The I/O numbering always starts at zero and does not include the digits 8 or 9. The addresses are typically assigned in groups of 8 or 16, depending on the number of points in an I/O group. For the DL06, the twenty inputs use reference numbers X0 – X23. The sixteen output points use references Y0 – Y17.

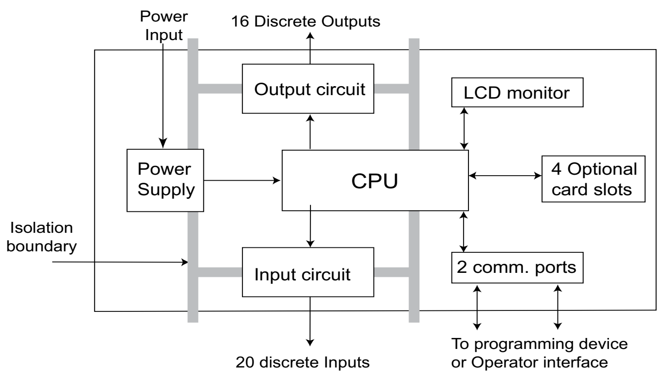
Additional I/O modules can be installed in the four option slots. See the DL05/06 Option Modules User Manual, D0-OPTIONS-M, for a complete selection of modules and how to address them in the DL06. This manual can either be ordered from Automationdirect or downloaded from our website.

System Wiring Strategies

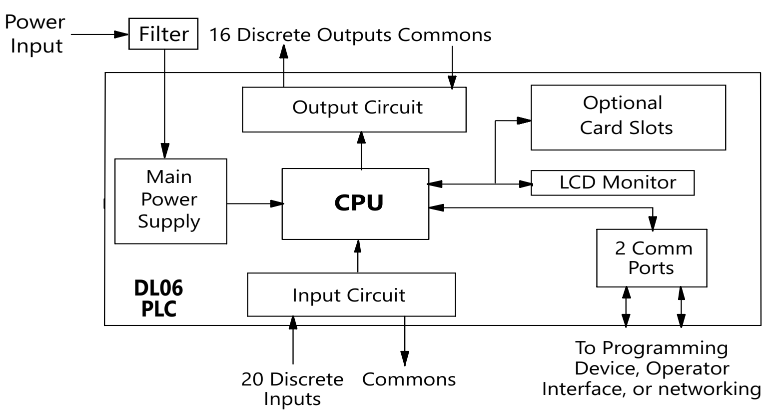
The DL06 Micro PLC is very flexible and will work in many different wiring configurations. By studying this section before actual installation, you can probably find the best wiring strategy for your application. This will help to lower system cost and wiring errors, and avoid safety problems.

PLC Isolation Boundaries

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

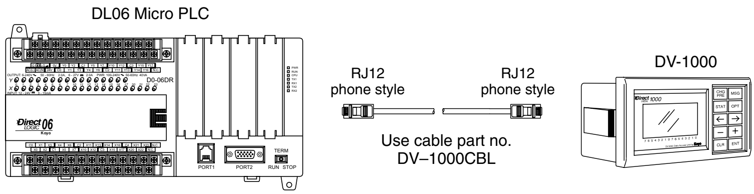


The next figure shows the internal layout of DL06 PLCs, as viewed from the front panel.

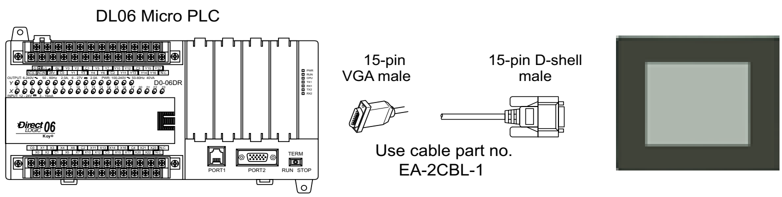


Connecting Operator Interface Devices

Operator interfaces require data and power connections. Some operator interfaces usually require separate AC power. However, other operator interface devices like the popular DV-1000 Data Access Unit may be powered directly from the DL06 Micro PLC. Connect the DV-1000 to communication port 1 on the DL06 Micro PLC using the cable shown below. A single cable contains transmit/receive data wires and +5V power.

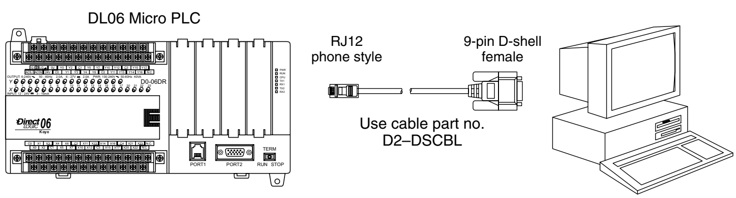


C-more operator interface touch panels use a provided 24 VDC plug-in power supply. Connect the DL06 to the serial connector on the rear of the C-more panel using the cable shown below.

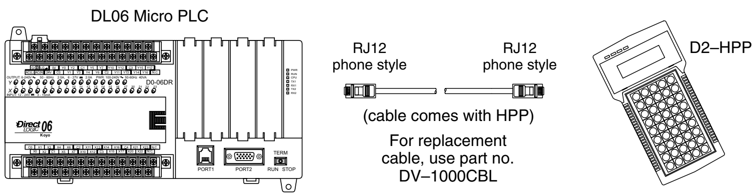


Connecting Programming Devices

DL06 Micro PLCs can be programmed with either a handheld programmer or with ***Direct***SOFT on a PC. Connect the DL06 to a PC using the cable shown below.



The D2-HPP Handheld Programmer comes with a communications cable. For a replacement part, use the cable shown below.



Sinking / Sourcing Concepts

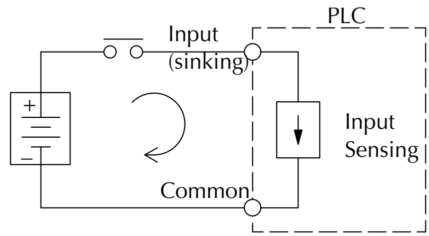
Before going further in our presentation of wiring strategies, we need to introduce the concepts of **sinking** and **sourcing**. These terms apply to typical input or output circuits. It is the goal of this section to make these concepts easy to understand. First, we give the following short definitions, followed by practical applications.

Sinking = Path to supply ground (–)

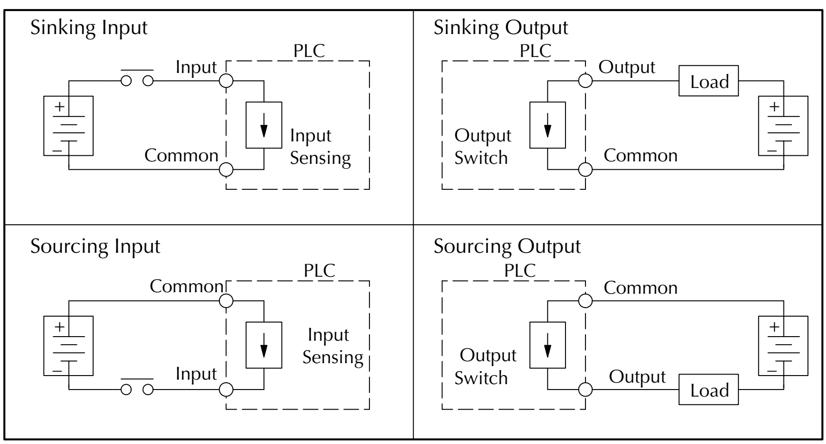
Sourcing = Path to supply source (+)

Notice the reference to (+) and (–) polarities. *Sinking and sourcing terminology applies only to DC input and output circuits.* Input and output points that are either sinking or sourcing 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, we 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, we just have to connect it so the input *provides a path to ground (–)*. So, we start at the PLC input terminal, follow through the input sensing circuit, exit at the common terminal, and connect the supply (–) to the common terminal. By adding the switch, between the supply (+) and the input, we have completed the circuit. Current flows in the direction of the arrow when the switch is closed.

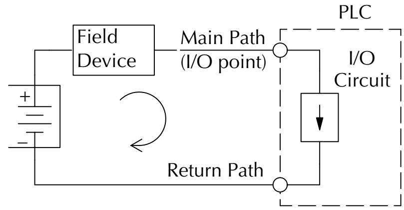


By applying the circuit principle above to the four possible combinations of input/output **sinking/sourcing** types, we have the four circuits as shown below. The DC-powered DL06 Micro PLCs have selectable **sinking** or **sourcing** inputs and either **sinking** or **sourcing** outputs. Any pair of input/output circuits shown below is possible with one of the DL06 models.

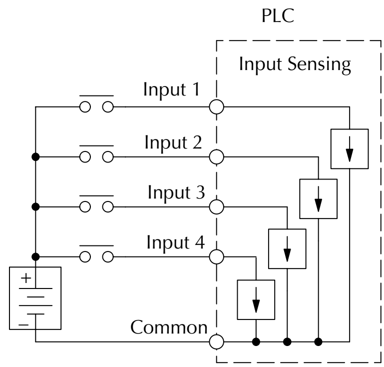


I/O Common Terminal Concepts

In order for a PLC I/O circuit to operate, current must enter at one terminal and exit at another. This means 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.

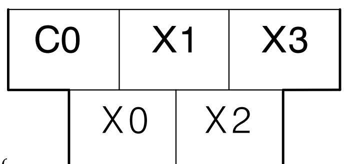


Most input or output point groups on PLCs share the return path among two or more I/O points. The figure to the right shows a group (*or bank*) of 4 input points which share a **common** return path. In this way, the four inputs require only five terminals instead of eight.

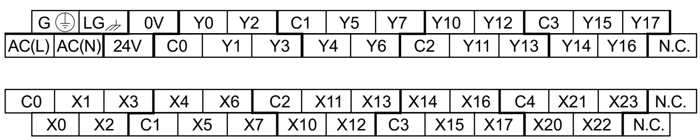


NOTE*: In the circuit to the right, the current in the common path is 4 times any channel's input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons.*

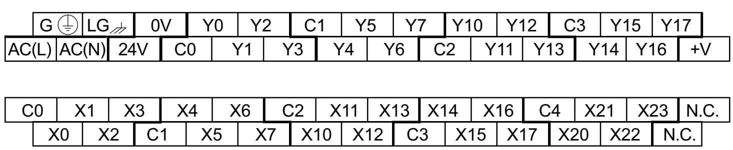
Most DL06 input and output circuits are grouped into banks that share a common return path. The best indication of I/O common grouping is on the wiring label. The I/O common groups are separated by a bold line. A thinner line separates the inputs associated with that common. To the right, notice that X0, X1, X2, and X3 share the common terminal C0, located to the left of X1.



The following complete set of labels shows five banks of four inputs and four banks of four outputs. One common is provided for each bank.



This set of labels is for DC (sinking) output versions such as the D0-06DD1 and D0-06DD1-D. One common is provided for each group of four outputs, and one designated terminal on the output side accepts power for the output stage.

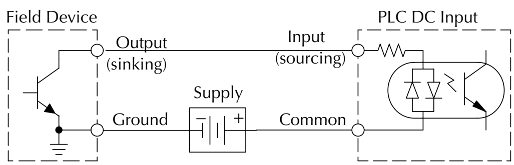


Connecting DC I/O to Solid State Field Devices

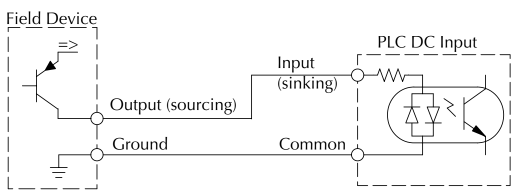
In the previous section on sinking and sourcing concepts, we discussed DC I/O circuits that only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *When connecting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

Solid State Input Sensors

The DL06's DC inputs are flexible in that they detect current flow in either direction, so they can be wired as either sourcing or sinking. In the following circuit, a field device has an open-collector NPN transistor output. It sinks current from the PLC input point, which sources current. The power supply can be the included auxiliary 24VDC power supply or another supply (+12VDC or +24VDC), as long as the input specifications are met.



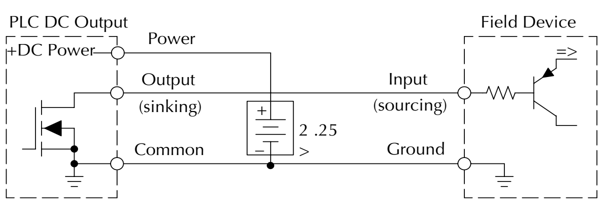
In the next circuit, a field device has an open-emitter PNP transistor output. It sources current to the PLC input point, which sinks the current back to ground. Since the field device is sourcing current, no additional power supply is required between the device and the PLC DC Input.



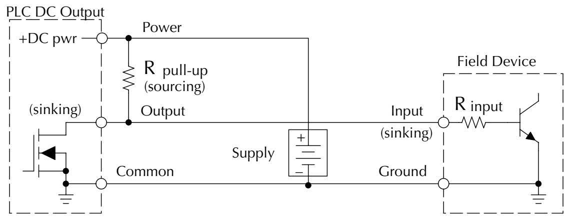
Solid State Output Loads

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

The DL06 PLC family offers DC outputs that are sinking only or DC outputs that are sourcing. All sixteen outputs have the same electrical common, even though there are four common terminal screws. In the following circuit, the PLC output point sinks current to the output common when energized. It is connected to a sourcing input of a field device input.



In the next example we connect a PLC DC output point to the sinking input of a field device. This is a bit tricky, because both the PLC output and field device input are sinking type. Since the circuit must have one sourcing and one sinking device, we add sourcing capability to the PLC output by using a pull-up resistor. In the circuit below, we connect $R_{pull\text{-}up}$ from the output to the DC output circuit power input.



***NOTE:** DO NOT attempt to drive a heavy load (>25mA) with this pull-up method.*

***NOTE:** Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the PLC output is OFF, from a ladder logic point-of-view. Your ladder program must comprehend this and generate an inverted output. Or, you may choose to cancel the effect of the inversion elsewhere, such as in the field device.*

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

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

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

Relay Output Wiring Methods

The D0–06AR and the D0–06DR models feature relay outputs. Relays are best for the following applications:

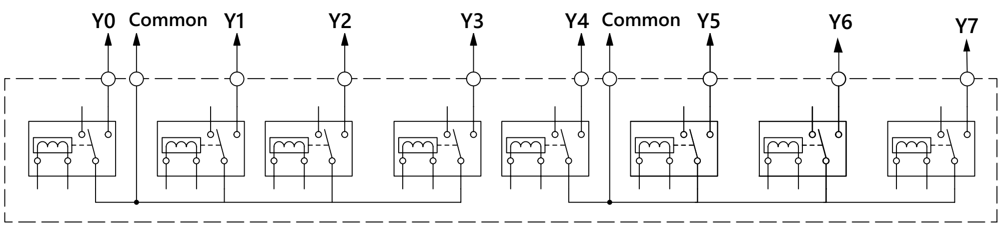
- Loads that require higher currents than the solid-state DL06 outputs can deliver
- Cost-sensitive applications
- Some output channels need isolation from other outputs (such as when some loads require AC while others require DC)

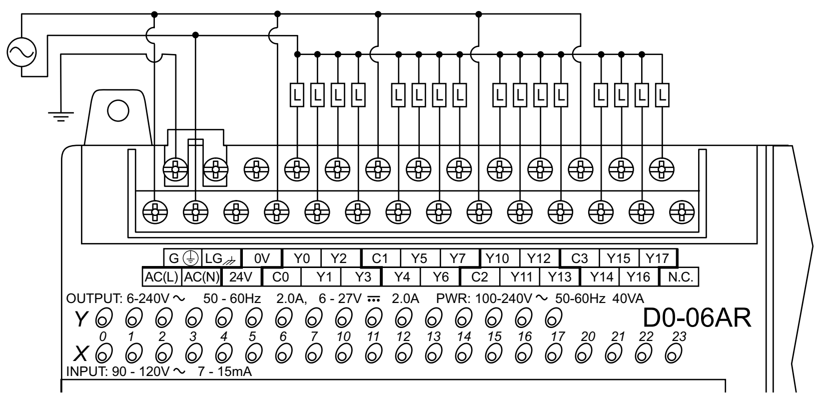
Some applications in which NOT to use relays:

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

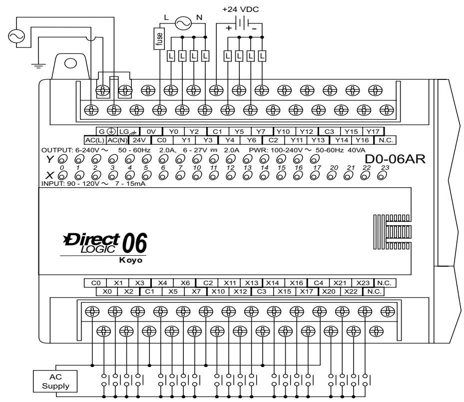
This section presents various ways to wire relay outputs to the loads. The relay output DL06s have sixteen normally-open SPST relays available. They are organized with four relays per common. The figure below shows the relays and the internal wiring of the PLC. Note that each group is isolated from the other group of outputs.

In the circuit below, all loads use the same AC power supply which powers the DL06 PLC. In this example, all commons are connected together.





In the circuit on the following page, loads for Y0 – Y3 use the same AC power supply which powers the DL06 PLC. Loads for Y4 – Y7 use a separate DC supply. In this example, the commons are separated according to which supply powers the associated load.



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

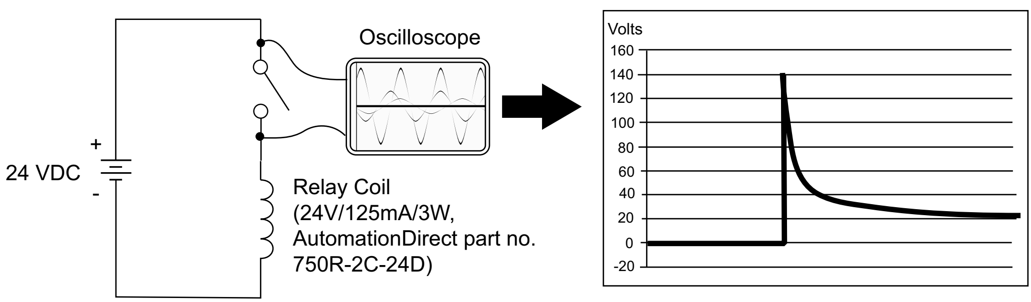
The following pages are intended to give a quick overview of the negative effects of transient voltages on a control system and provide some simple advice on how to effectively minimize them. The need for transient suppression is often not apparent to the newcomers in the automation world. Many mysterious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

What is a Transient Voltage and Why is it Bad?

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

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

Example: Circuit with no Suppression



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

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

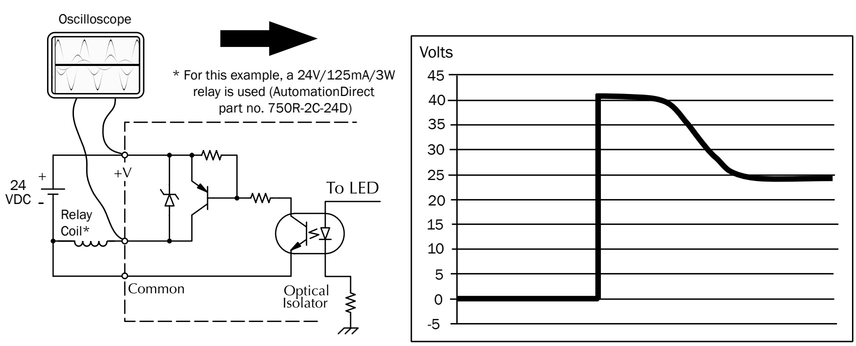
A very destructive side-effect of the arcing across relay contacts is the electromagnetic interference (EMI) it can cause. This occurs because the arcing causes a current surge, which releases RF energy. The entire length of wire between the relay contacts, the coil, and the power source carries the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

PLC's Integrated Transient Suppressors

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

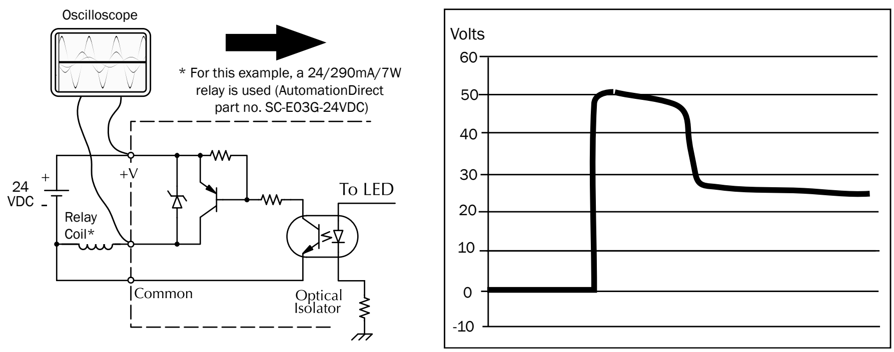
Here is another example using the same 24V / 125mA / 3W relay used earlier. This example measures the PNP transistor output of a D0-06DD2 PLC, which incorporates an integrated Zener diode for transient suppression. Instead of the 140V peak in the first example, the transient voltage here is limited to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

Example: Small Inductive Load with Only Integrated Suppression



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

Example: Larger Inductive Load with Only Integrated Suppression

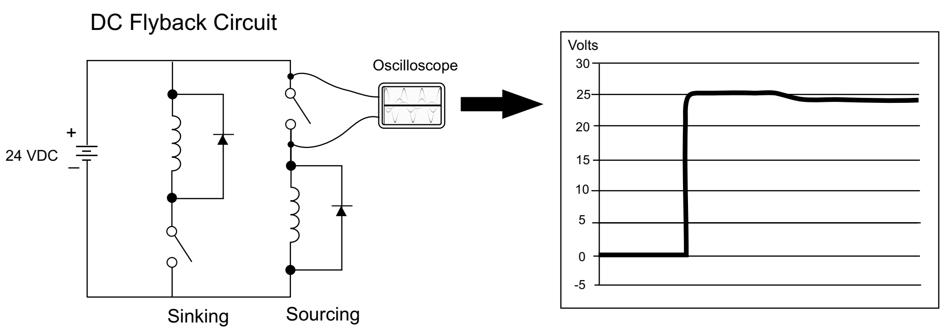


Additional transient suppression should be used in both these examples. If you are unable to measure the transients generated by the connected loads of your control system, using additional transient suppression on all inductive loads would be the safest practice.

Types of Additional Transient Protection

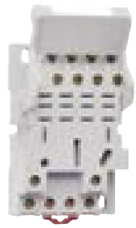
DC Coils:

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

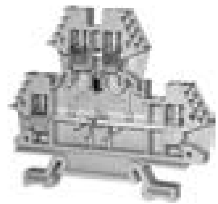


Many AutomationDirect socketed relays and motor starters have add-on flyback diodes that plug or screw into the base, such as the AD-ASMD-250 protection diode module and 784-4C-SKT-1 socket module shown below. If an add-on flyback diode is not available for your inductive load, an easy way to add one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

AD-ASMD-250
Protection Diode Module



784-4C-SKT-1
Relay Socket



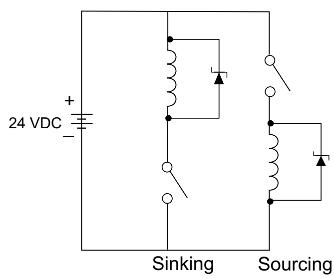
DN-D10DR-A
Diode Terminal Block

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

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

ZL-TSD8-24
Transorb Module

DC MOV or TVS Diode Circuit



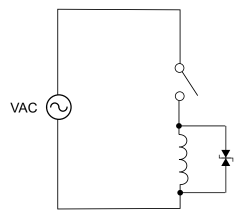
AC Coils:

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

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

ZL-TSD8-120
Transorb Module

AC MOV or Bi-Directional Diode Circuit



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

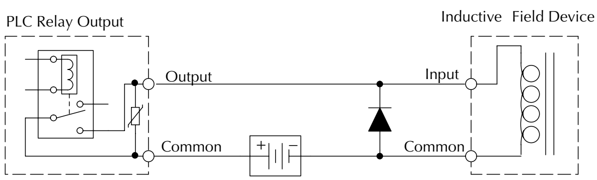
For example, a MOV or TVS diode rated for use on 24–48 VDC coils would need to have a high enough voltage rating to NOT conduct at 48V. That suppressor might typically start conducting at roughly 60VDC. If it were mounted across a 24V coil, transients of roughly 84V (if sinking output) or -60V (if sourcing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

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.

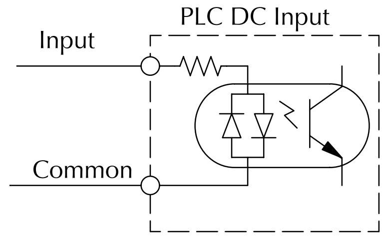
For inductive loads in DC circuits we recommend using a suppression diode as shown in the following diagram (DO NOT use this circuit with an AC power supply). When the load is energized the diode is reverse-biased (high impedance). When the load is turned off, energy stored in its coil is released in 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.

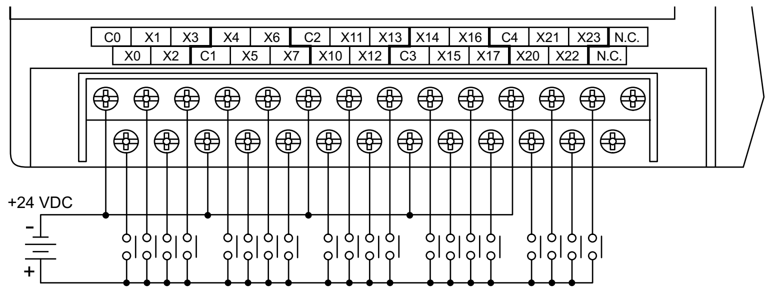


DC Input Wiring Methods

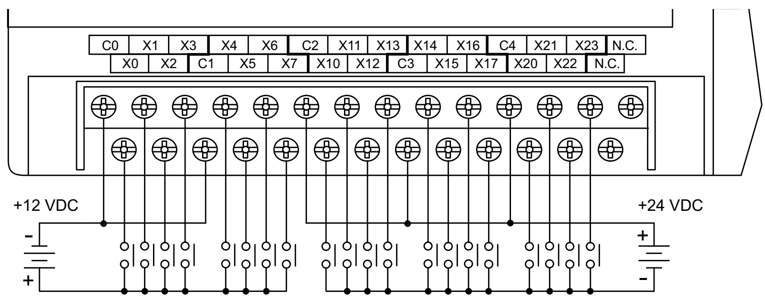
DL06 Micro PLCs with DC inputs are particularly flexible because they can be wired as either sinking or sourcing. The dual diodes (shown to the right) allow 10.8–26.4 VDC. The target applications are +12VDC and +24VDC. You can actually wire each group of inputs associated common group of inputs as DC sinking and the other half as DC sourcing. Inputs grouped by a common must be all sinking or all sourcing.



In the first and simplest example below, all commons are connected together and all inputs are sinking.



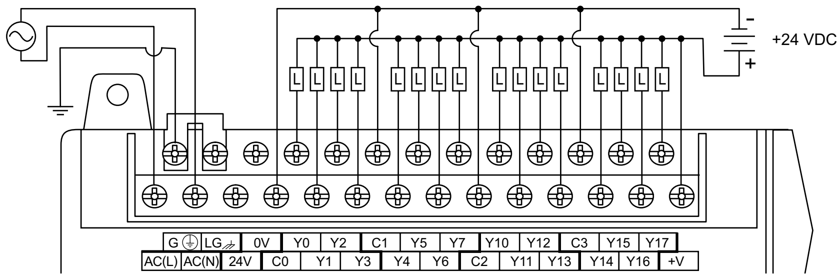
In the next example, the first eight inputs are sinking, and the last twelve are sourcing.



DC Output Wiring Methods

DL06 DC output circuits are high-performance transistor switches with low on-resistance and fast switching times. Please note the following characteristics which are unique to the DC output type:

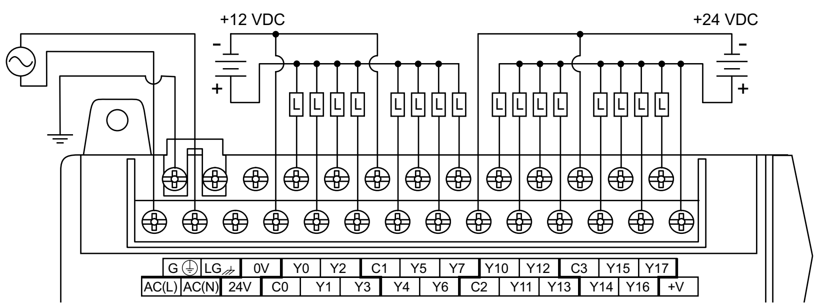
- There is only one electrical common for all sixteen outputs. All sixteen outputs belong to one bank.
- The output switches are current-sinking only or current sourcing only. Refer to the detailed specifications in this manual to determine which type output is present on a particular model.
- The output circuit inside the PLC requires external power. The supply (–) must be connected to a common terminal, and the supply (+) connects the right-most terminal on the upper connector (+V).



In the example below, all sixteen outputs share a common supply.

In the next example below, the outputs have **split** supplies. The first eight outputs are using a +12 VDC supply, and the last eight are using a +24VDC supply. However, you can split the outputs among any number of supplies, as long as:

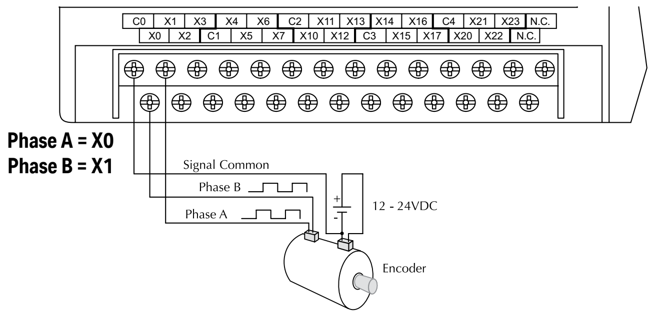
- All supply voltages are within the specified range
- All output points are wired as sinking
- All source (–) terminals are connected together



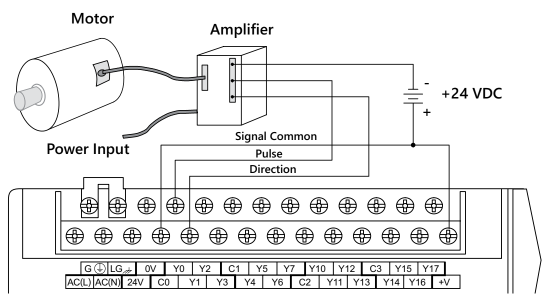
Warning: The maximum output current from the Auxiliary 24VDC power depends on the I/O configuration. Refer to Chapter 4, page 4-6, to determine how much current can be drawn from the Auxiliary 24VDC power for your particular I/O configuration.

High-Speed I/O Wiring Methods

DL06 versions with DC type input or output points contain a dedicated High-Speed I/O circuit (HSIO). The circuit configuration is programmable, and it processes specific I/O points independently from the CPU scan. Appendix E discusses the programming options for HSIO. While the HSIO circuit has six modes, we show wiring diagrams for two of the most popular modes in this chapter. The high-speed input interfaces to points X0–X3. Properly configured, the DL06 can count quadrature pulses at up to 7kHz from an incremental encoder as shown below.



***NOTE:** Do not use this drawing to wire your device. This is a general example and is not specific to any PLC model, stepper or encoder. Always refer to the device documentation for proper wiring connections.*



DL06 versions with DC type output points can use the High Speed I/O Pulse Output feature. It can generate high-speed pulses at up to 10 kHz for specialized control such as stepper motor / intelligent drive systems. Output Y0 and Y1 can generate pulse and direction signals, or it can generate CCW and CW pulse signals respectively. See Appendix E on high-speed input and pulse output options.

***NOTE:** Do not use this drawing to wire your device. This is a general example and is not specific to any PLC model, stepper or encoder. Always refer to the device documentation for proper wiring connections.*

Wiring Diagrams and Specifications

The remainder of this chapter provides detailed technical information for the DL06 PLCs. A basic wiring diagram, equivalent I/O circuits, and specification tables are laid out for each PLC.

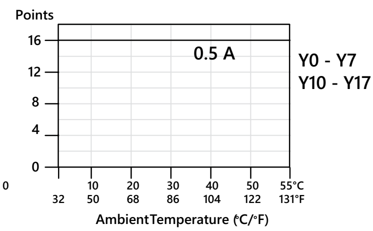
D0–06AA I/O Wiring Diagram

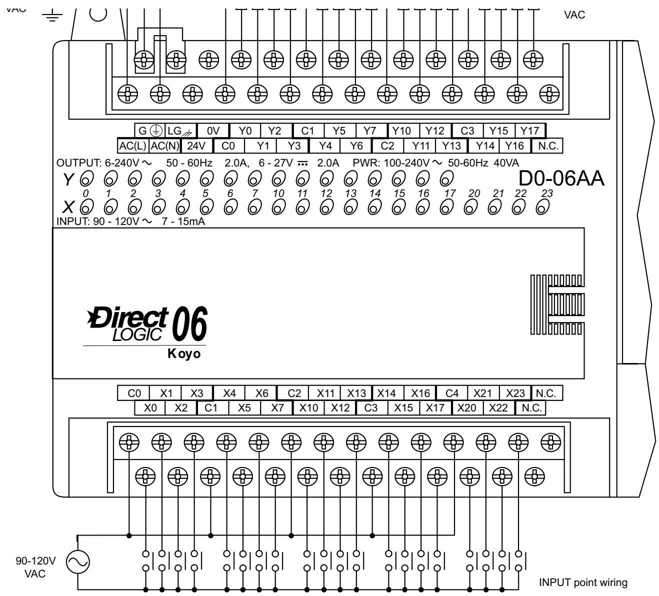
The D0–06AA PLC has twenty AC inputs and sixteen AC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses four terminals as shown.

Inputs are organized into five banks of four. Each bank has an isolated common terminal. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used. The equivalent input circuit shows one channel of a typical bank.

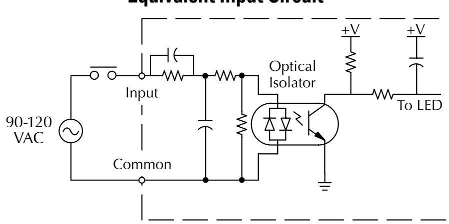
Outputs are organized into four banks of four triac switches. Each bank has a common terminal. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used. The equivalent output circuit shows one channel of a typical bank.

Derating Chart for AC Outputs

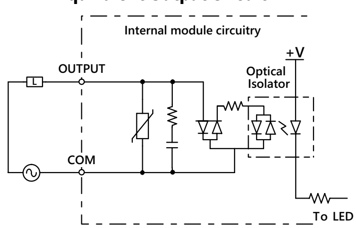




Equivalent Input Circuit



Equivalent Output Circuit



D0-06AA General Specifications	
External Power Requirements	100–240 VAC/50–60 Hz, 40VA maximum
Communication Port 1 9600 baud (Fixed), 8 data bits, 1 stop bit odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2 9600 baud (default) 8 data bits, 1 stop bit odd parity	K–Sequence (Slave),DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence / print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

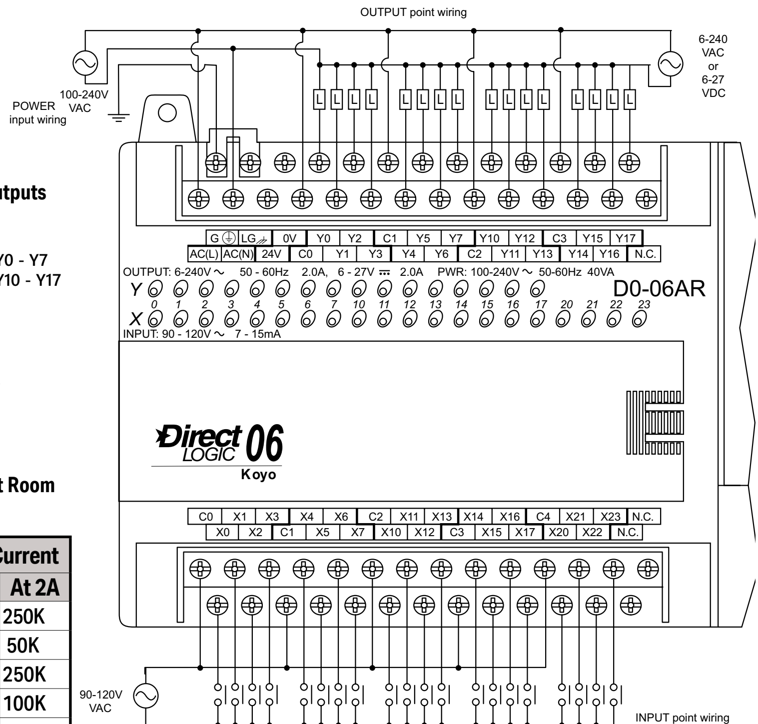
AC Input Specifications	
Input Voltage Range (Min. - Max.)	80–132 VAC, 47–63 Hz
Operating Voltage Range	90–120 VAC, 47–63 Hz
Input Current	8mA @100VAC at 50Hz 10mA @100VAC at 60Hz
Max. Input Current	12mA @132VAC at 50 Hz 15mA @132VAC at 60 Hz
Input Impedance	14KΩ @50 Hz, 12KΩ @60Hz
ON Current/Voltage	> 6mA @ 75VAC
OFF Current/Voltage	< 2mA @ 20VAC
OFF to ON Response	< 40ms
ON to OFF Response	< 40ms
Status Indicators	Logic Side
Commons	4 channels / common x 5 banks (isolated)

AC Output Specifications	
Output Voltage Range (Min. - Max.)	15–264 VAC, 47–63 Hz
Operating Voltage	17–240 VAC, 47–63 Hz
On Voltage Drop	1.5 VAC (>50mA) 4.0 VAC (<50mA)
Max Current	0.5 A / point, 1.5 A / common
Max leakage current	<4mA @ 264VAC
Max inrush current	10A for 10ms
Minimum Load	10mA
OFF to ON Response	1ms
ON to OFF Response	1 ms +1/2 cycle
Status Indicators	Logic Side
Commons	4 channels / common x 4 banks (isolated)
Fuses	None (external recommended)

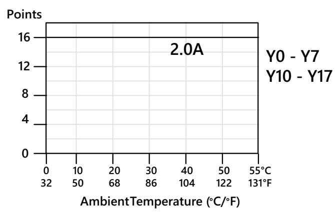
D0–06AR I/O Wiring Diagram

The D0–06AR PLC has twenty AC inputs and sixteen relay contact outputs. The following diagram shows a typical field wiring example. The AC external power connection uses four terminals at the left as shown.

The twenty AC input channels use terminals on the bottom of the connector. Inputs are organized into five banks of four. Each bank has a common terminal. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used. The equivalent input circuit shows one channel of a typical bank.



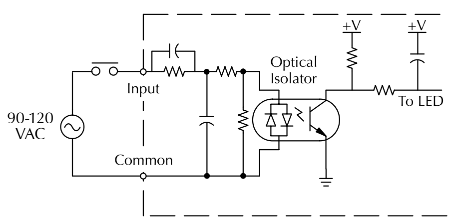
Derating Chart for Relay Outputs



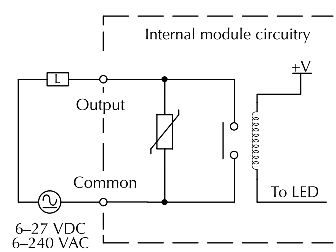
Typical Relay Life (Operations) at Room Temperature

Voltage & Load Type	Load Current	
	At 1A	At 2A
24VDC Resistive	500K	250K
24VDC Inductive	100K	50K
110VAC Resistive	500K	250K
110VAC Inductive	200K	100K
220VAC Resistive	350K	200K
220VAC Inductive	100K	50K

Equivalent Input Circuit



Equivalent Output Circuit



The sixteen relay output channels use terminals on the right side top connector. Outputs are organized into four banks of four normally-open relay contacts. Each bank has a common terminal. The wiring example on the last page shows all commons connected together, but separate supplies and common circuits may be used. The equivalent output circuit shows one channel of a typical bank. The relay contacts can switch AC or DC voltages.

D0-06AR General Specifications	
External Power Requirements	100– 240 VAC/ 50–60 Hz, 40VA maximum
Communication Port 1 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2 9600 baud (default), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence / print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

AC Input Specifications X0-X23	
Input Voltage Range (Min. - Max.)	80–132 VAC, 47–63 Hz
Operating Voltage Range	90–120 VAC, 47–63 Hz
Input Current	8mA @ 100VAC at 50Hz 10mA @ 100VAC at 60Hz
Max. Input Current	12mA @ 132VAC at 50Hz 15mA @ 132VAC at 60Hz
Input Impedance	14KΩ @50Hz, 12KΩ @60Hz
ON Current/Voltage	>6mA @ 75VAC
OFF Current/Voltage	<2mA @ 20VAC
OFF to ON Response	< 40ms
ON to OFF Response	< 40ms
Status Indicators	Logic Side
Commons	4 channels / common x 5 banks (isolated)

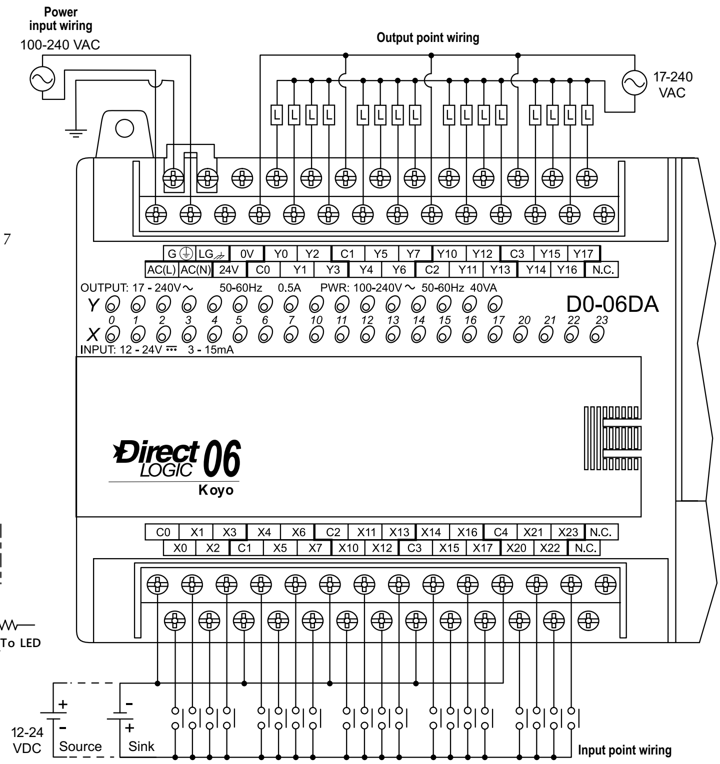
Relay Output Specifications Y0-Y17	
Output Voltage Range	(Min. – Max.) 5–264 VAC (47–63 Hz), 5–30 VDC
Operating Voltage Range	6–240 VAC (47–63 Hz), 6–27 VDC
Output Current	2A / point, 6A / common
Max. leakage current	0.1 mA @ 264VAC
Smallest Recommended Load	5mA @ 5VDC
OFF to ON Response	< 15ms
ON to OFF Response	< 10ms
Status Indicators	Logic Side
Commons	4 channels / common x 4 banks (isolated)
Fuses	None (external recommended)

D0–06DA I/O Wiring Diagram

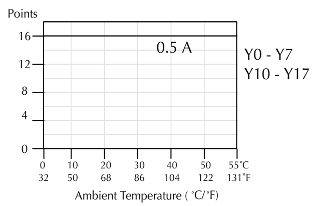
The D0–06DA PLC has twenty DC inputs and sixteen AC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses four terminals as shown.

Inputs are organized into five banks of four. Each bank has an isolated common terminal, and may be wired as sinking or sourcing. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used. The equivalent circuit for standard inputs is shown below, and the high-speed input circuit is shown to the left.

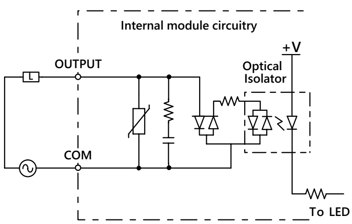
Outputs are organized into four banks of four triac switches. Each bank has a common terminal. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used. The equivalent output circuit shows one channel of a typical bank.



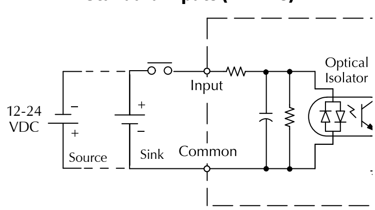
Derating Chart for AC Outputs



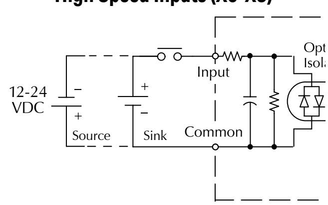
Equivalent Output Circuit



Standard Inputs (X4-X23)



High Speed Inputs (X0-X3)



D0-06DA General Specifications	
External Power Requirements	100–240 VAC/ 50–60 Hz, 40VA maximum
Communication Port 1 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2 9600 baud (default), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence/print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

DC Input Specifications		
Parameter	High–Speed Inputs, X0 – X3	Standard DC Inputs X4 – X23
Input Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage Range	12–24 VDC	12–24 VDC
Maximum Voltage	30VDC (7kHz maximum frequency)	30VDC
Minimum Pulse Width	70μs	N/A
ON Voltage Level	> 10VDC	> 10VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	1.8 kΩ @ 12–24 VDC	2.8 kΩ @ 12–24 VDC
Minimum ON Current	>5mA	>4mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<70μs	2–8 ms, 4ms typical
ON to OFF Response	<70μs	2–8 ms, 4ms typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 5 bank (isolated)	

AC Output Specifications	
Output Voltage Range (Min. - Max.)	15–264 VAC, 47–63 Hz
Operating Voltage	17–240 VAC, 47–63 Hz
On Voltage Drop	1.5 VAC @> 50mA, 4VAC @< 50mA
Max Current	0.5 A / point, 1.5 A / common
Max leakage current	< 4mA @ 264VAC, 60Hz
Max inrush current	10A for 10ms
Minimum Load	10mA
OFF to ON Response	1ms
ON to OFF Response	1 ms +1/2 cycle
Status Indicators	Logic Side
Commons	4 channels / common x 4 banks (isolated)
Fuses	None (external recommended)

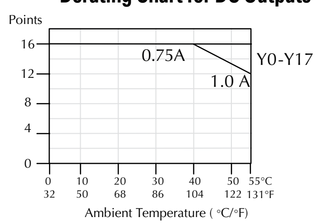
D0–06DD1 I/O Wiring Diagram

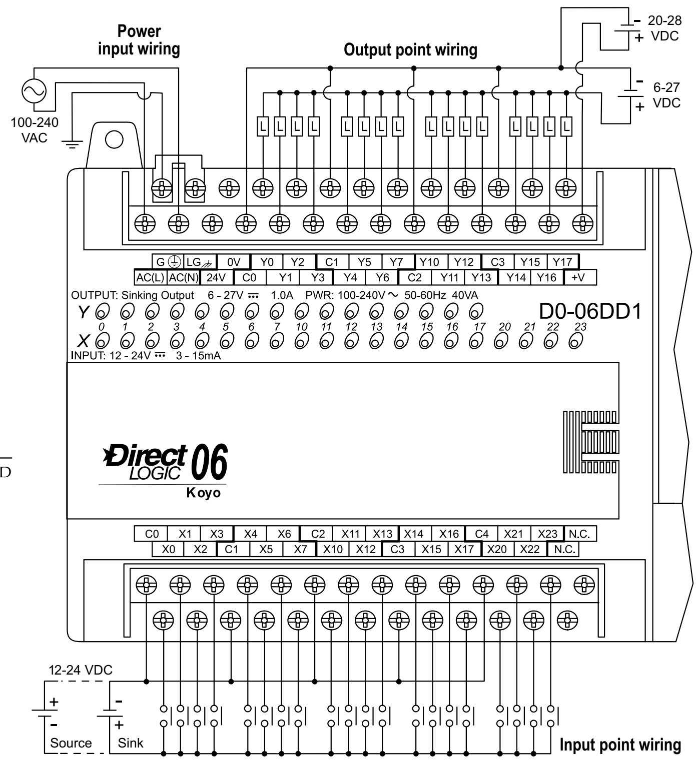
The D0-06DD1 PLC has twenty sinking/sourcing DC inputs and sixteen sinking DC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses four terminals as shown.

Inputs are organized into five banks of four. Each bank has an isolated common terminal, and may be wired as either sinking or sourcing inputs. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used.

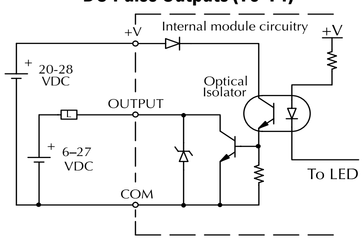
Outputs all share the same common. Note the requirement for external power.

Derating Chart for DC Outputs

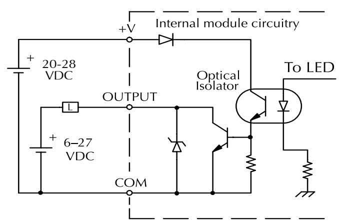




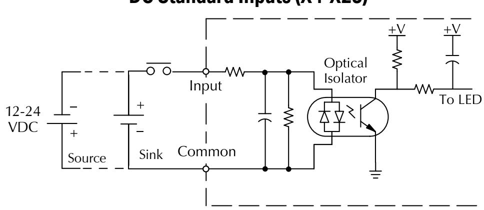
DC Pulse Outputs (Y0-Y1)



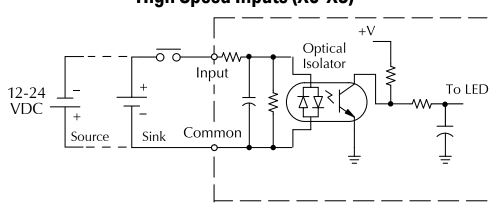
DC Standard Outputs (Y2-Y17)



DC Standard Inputs (X4-X23)



High Speed Inputs (X0-X3)



D0-06DD1 General Specifications	
External Power Requirements	100–240 VAC/ 50–60 Hz, 40VA maximum
Communication Port 1 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2 9600 baud (default), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence / print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

DC Input Specifications		
Parameter	**High–Speed Inputs, X0 – X3**	**Standard DC Inputs X4 – X23**
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage Range	12–24 VDC	12–24 VDC
Peak Voltage	30VDC (7kHz maximum frequency)	30VDC
Minimum Pulse Width	100µs	N/A
ON Voltage Level	> 10.0 VDC	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Max. Input Current	6mA @12VDC, 13mA @24VDC	4mA @12VDC, 8.5mA @24VDC
Input Impedance	1.8 Ωk @ 12–24 VDC	2.8 Ωk @ 12–24 VDC
Minimum ON Current	>5mA	>4mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<70µs	2–8 ms, 4ms typical
ON to OFF Response	<70µs	2–8 ms, 4ms typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 5 banks isolated	

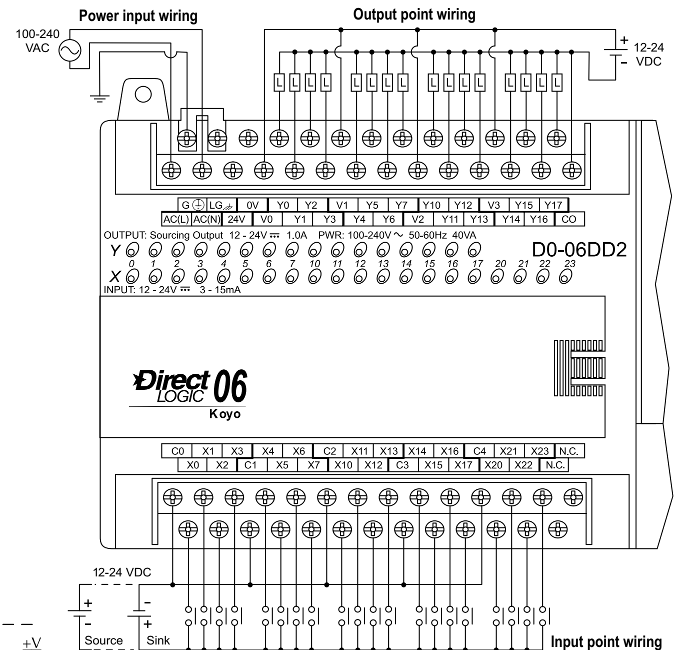
DC Output Specifications		
Parameter	**Pulse Outputs Y0 – Y1**	**Standard Outputs Y2 – Y17**
Min. - Max. Voltage Range	5–30 VDC	5–30 VDC
Operating Voltage	6–27 VDC	6–27 VDC
Peak Voltage	< 50VDC (10kHz max. frequency)	< 50VDC
On Voltage Drop	0.3 VDC @ 1 A	0.3 VDC @ 1A
Max Current (resistive)	0.5 A / pt., 1A / pt. as standard pt.	1.0 A / point
Max leakage current	15µA @ 30VDC	15µA @ 30VDC
Max inrush current	2A for 100ms	2A for 100ms
External DC power required	20–28 VDC Max 150mA	20–28 VDC Max 280mA (Aux. 24VDC powers V+ terminal (sinking outputs)
OFF to ON Response	< 10µs	< 10µs
ON to OFF Response	< 20µs	< 60µs
Status Indicators	Logic Side	Logic Side
Commons	4 channels / common x 4 banks non-isolated	
Fuses	None (external recommended)	

D0–06DD2 I/O Wiring Diagram

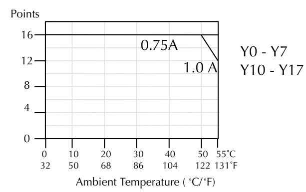
The D0–06DD2 PLC has twenty sinking/sourcing DC inputs and sixteen sourcing DC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses four terminals as shown.

Inputs are organized into four banks of four. Each bank has an isolated common terminal, and may be wired as either sinking or sourcing inputs. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used.

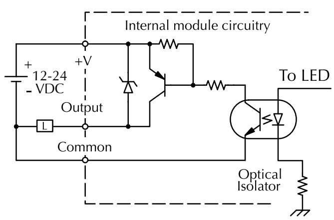
All outputs share the same common. Note the requirement for external power.



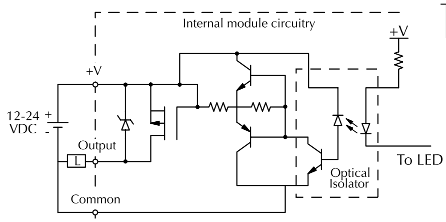
Derating Chart for DC Outputs



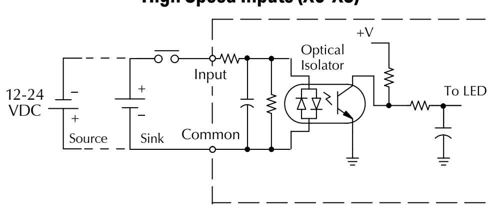
DC Standard Outputs (Y2-Y17)



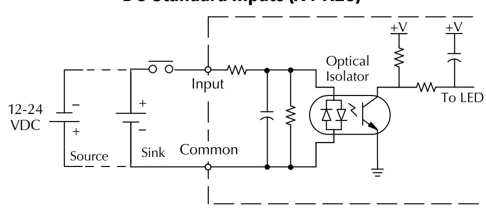
DC Pulse Outputs (Y0-Y1)



High Speed Inputs (X0-X3)



DC Standard Inputs (X4-X23)



D0-06DD2 General Specifications	
External Power Requirements	100–240 VAC/50–60 Hz, 40VA maximum
Communication Port 1 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K-Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2 9600 baud (default), 8 data bits, 1 stop bit, odd parity	K-Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence / print, ASCII in/out
Programming cable type	D2-DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

DC Input Specifications		
Parameter	High-Speed Inputs, X0 – X3	Standard DC Inputs X4 – X23
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage Range	12–24 VDC	12–24 VDC
Peak Voltage	30 VDC (7 kHz maximum frequency)	30VDC
Minimum Pulse Width	70 µs	N/A
ON Voltage Level	> 10.0 VDC	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Max. Input Current	6mA @ 12VDC, 13mA @ 24VDC	4mA @ 12VDC, 8.5 mA @ 24VDC
Input Impedance	1.8 Ωk @ 12–24 VDC	2.8 Ωk @ 12–24 VDC
Minimum ON Current	>5mA	>4mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<70µs	2–8 ms, 4ms typical
ON to OFF Response	<70µs	2–8 ms, 4ms typical
Status Indicators	Logic side	Logic side
Commons	4 channels/common x 5 banks (isolated)	

DC Output Specifications		
Parameter	Pulse Outputs Y0 – Y1	Standard Outputs Y2 – Y17
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage	12–24 VDC	12–24 VDC
Peak Voltage	< 50VDC (10kHz max. frequency)	< 50VDC
On Voltage Drop	0.5 VDC @ 1A	1.2 VDC @ 1A
Max Current (resistive)	0.5 A / pt., 1A / pt. as standard pt.	1.0 A / point
Max leakage current	15µA @ 30VDC	15µA @ 30VDC
Max inrush current	2A for 100ms	2A for 100ms
External DC power required	12–24 VDC	12 -24 VDC
OFF to ON Response	< 10µs	< 10µs
ON to OFF Response	< 20µs	< 0.5 µs
Status Indicators	Logic Side	Logic Side
Commons	4 channels / common x 4 banks (non-isolated)	
Fuses	None (external recommended)	

D0–06DR I/O Wiring Diagram

The D0–06DR PLCs feature twenty DC inputs and sixteen relay contact outputs. The following diagram shows a typical field wiring example. The AC external power connection uses four terminals as shown.

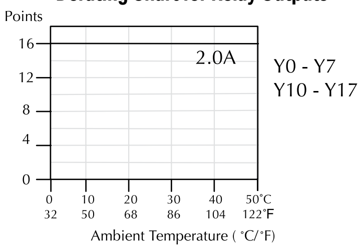
Inputs are organized into five banks of four. Each bank has an isolated common terminal, and may be wired as either sinking or sourcing inputs. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used. The equivalent circuit for standard inputs is shown below, and the high-speed input circuit is shown to the left.

Outputs are organized into four banks of four normally-open relay contacts. Each bank has a common terminal. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used. The equivalent output circuit shows one channel of a typical bank. The relay contacts can switch AC or DC voltages.

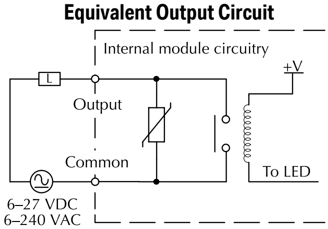
Typical Relay Life (Operations) at Room Temperature

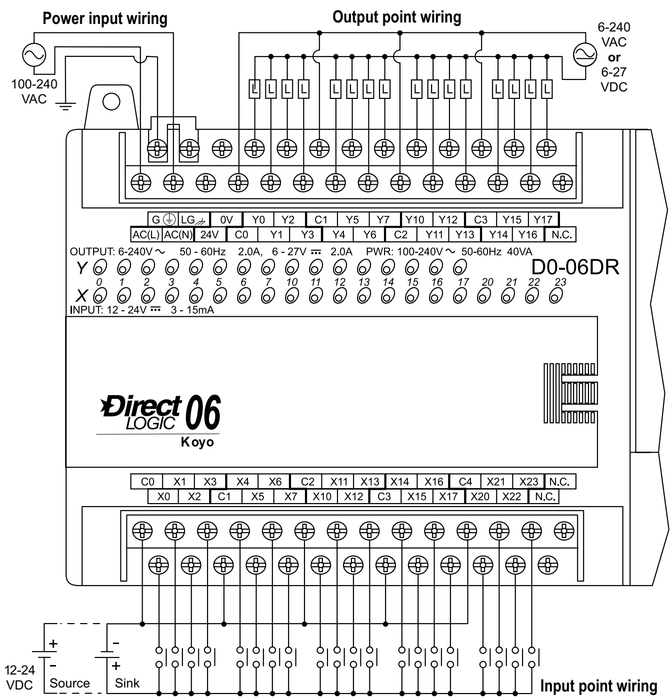
Voltage & Load Type	Load Current	
	At 1A	At 2A
24VDC Resistive	500K	250K
24VDC Inductive	100K	50K
110VAC Resistive	500K	250K
110VAC Inductive	200K	100K
220VAC Resistive	350K	200K
220VAC Inductive	100K	50K

Derating Chart for Relay Outputs

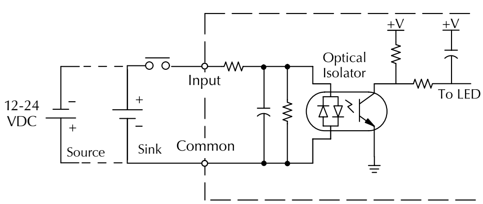


Equivalent Output Circuit

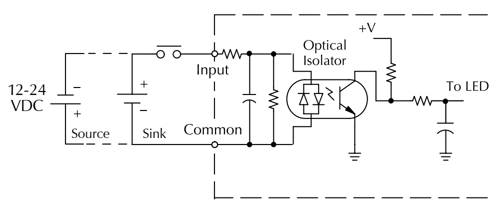




Equivalent Circuit, Standard Inputs (X4-X23)



Equivalent Circuit, High-speed Inputs (X0-X3)



D0-06DR General Specifications	
External Power Requirements	100–240 VAC/ 50–60 Hz, 40VA maximum
Communication Port 1 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2 9600 baud (default), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence /print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

DC Input Specifications		
Parameter	High–Speed Inputs, X0 – X3	Standard DC Inputs X4 – X23
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage Range	12–24 VDC	12–24 VDC
Peak Voltage	30VDC (7kHz maximum frequency)	30VDC
Minimum Pulse Width	70µs	N/A
ON Voltage Level	> 10VDC	> 10VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	1.8 kΩ @ 12–24 VDC	2.8 kΩ @ 12–24 VDC
Max. Input Current	6mA @12VDC 13mA @ 24VDC	4mA @ 12VDC 8.5 mA @ 24VDC
Minimum ON Current	>5mA	>4mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<70µs	2–8 ms, 4ms typical
ON to OFF Response	<70µs	2–8 ms, 4ms typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 5 banks (isolated)	

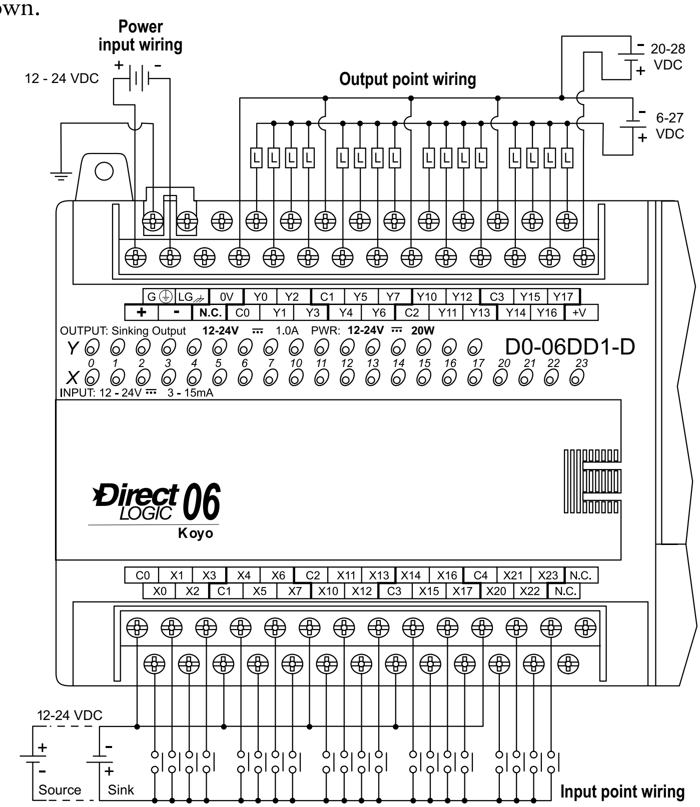
Relay Output Specifications	
Output Voltage Range (Min. - Max.)	5–264 VAC (47–63 Hz), 5–30 VDC
Operating Voltage	6–240 VAC (47–63 Hz), 6–27 VDC
Output Current	2A / point 6A / common
Maximum Voltage	264VAC, 30VDC
Max leakage current	0.1 mA @ 264VAC
Smallest Recommended Load	5mA
OFF to ON Response	< 15ms
ON to OFF Response	< 10ms
Status Indicators	Logic Side
Commons	4 channels / common x 4 banks (isolated)
Fuses	None (external recommended)

D0–06DD1–D I/O Wiring Diagram

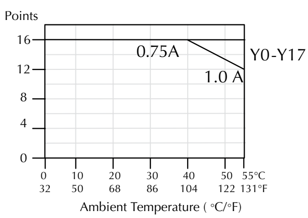
These micro PLCs feature twenty DC inputs and sixteen sinking DC outputs. The following diagram shows a typical field wiring example. The DC external power connection uses four terminals at the left as shown.

Inputs are organized into five banks of four. Each bank has an isolated common terminal, and may be wired as either sinking or sourcing inputs. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used.

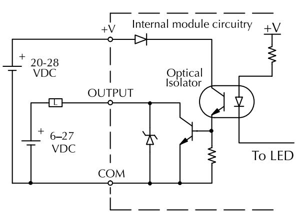
All outputs actually share the same common. Note the requirement for external power.



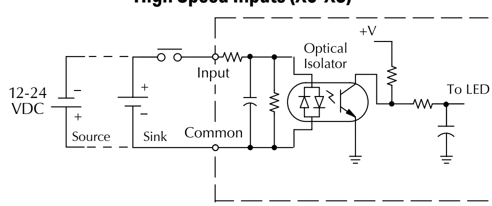
Derating Chart for DC Outputs



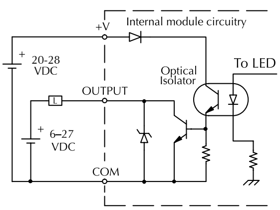
DC Pulse Outputs (Y0-Y1)



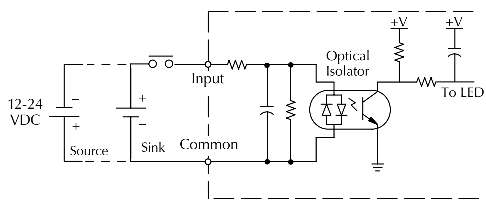
High Speed Inputs (X0-X3)



DC Standard Outputs (Y2-Y17)



Standard Input Circuit (X4-X23)



D0-06DD1-D General Specifications	
External Power Requirements	12–24 VDC, 20W maximum,
Communication Port 1: 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2: 9600 baud (default), 8 data bits, 1 stop bit,odd parity	K–Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence/print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

DC Input Specifications		
Parameter	High–Speed Inputs, X0 – X3	Standard DC Inputs X4 – X23
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage Range	12–24 VDC	12–24 VDC
Peak Voltage	30VDC (7kHz maximum frequency)	30VDC
Minimum Pulse Width	70µs	N/A
ON Voltage Level	>10.0 VDC	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Max. Input Current	6mA @12VDC, 13mA @ 24VDC	4mA @12VDC, 8.5 mA @ 24VDC
Input Impedance	1.8 kΩ @ 12–24VDC	2.8 kΩ @ 12–24 VDC
Minimum ON Current	>5mA	>4mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<70µs	2–8 ms, 4ms typical
ON to OFF Response	<70µs	2–8 ms, 4 ms typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 5 banks (isolated)	

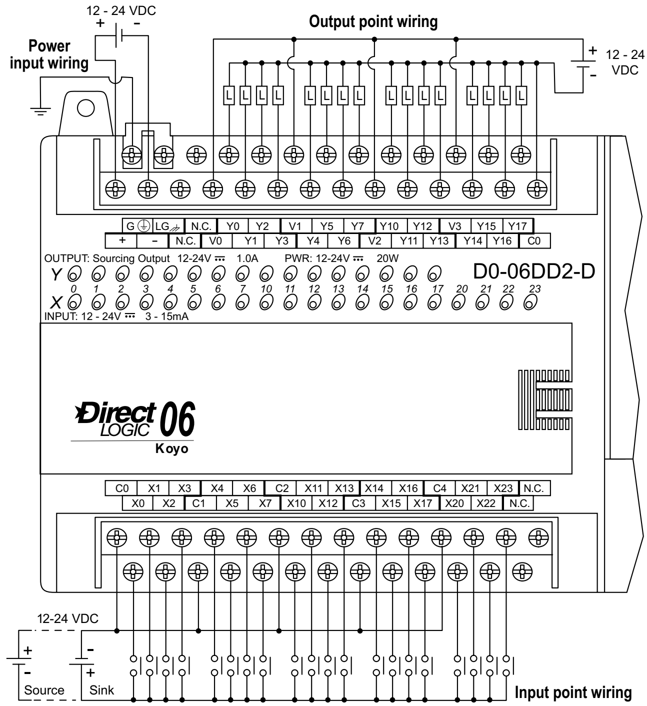
DC Output Specifications		
Parameter	Pulse Outputs, Y0 – Y1	Standard Outputs, Y2 – Y17
Min. - Max. Voltage Range	5–30 VDC	5–30 VDC
Operating Voltage	6–27 VDC	6–27 VDC
Peak Voltage	< 50VDC (10kHz max. frequency)	< 50VDC
On Voltage Drop	0.3 VDC @ 1 A	0.3 VDC @ 1A
Max Current (resistive)	0.5 A / pt., 1A / pt. as standard pt.	1.0 A / point
Max leakage current	15µA @ 30VDC	15µA @ 30VDC
Max inrush current	2 A for 100 ms	2A for 100ms
External DC power required	20–28 VDC Max 150mA	20–28 VDC Max 150mA
OFF to ON Response	< 10µs	< 10µs
ON to OFF Response	< 20µs	< 60µs
Status Indicators	Logic Side	Logic Side
Commons	4 channels / common x 4 banks (non-isolated)	
Fuses	None (external recommended)	

D0–06DD2–D I/O Wiring Diagram

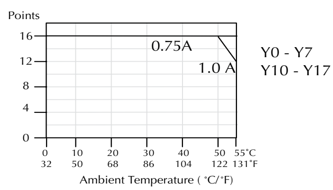
These micro PLCs feature twenty DC inputs and sixteen sourcing DC outputs. The following diagram shows a typical field wiring example. The DC external power connection uses four terminals at the left as shown.

Inputs are organized into five banks of four. Each bank has an isolated common terminal, and may be wired as either sinking or sourcing inputs. The wiring example below shows all commons connected together, but separate supplies and common circuits may be used.

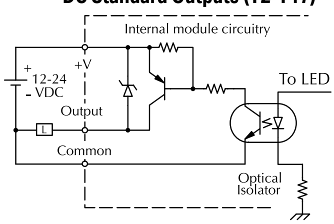
All outputs actually share the same common. Note the requirement for external power.



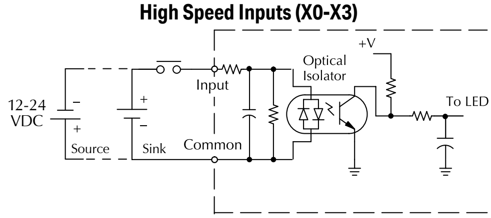
Derating Chart for DC Outputs



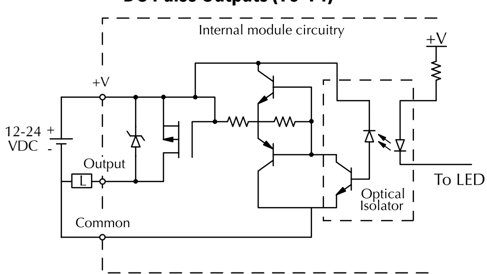
DC Standard Outputs (Y2-Y17)



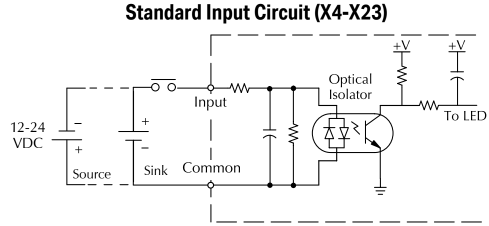
High Speed Inputs (X0-X3)



DC Pulse Outputs (Y0-Y1)



Standard Input Circuit (X4-X23)



D0-06DD2-D General Specifications	
External Power Requirements	12–24 VDC, 20W maximum,
Communication Port 1: 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2: 9600 baud (default), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave), Non-sequence/print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18 AWG, 24 AWG minimum

DC Input Specifications		
Parameter	High–Speed Inputs, X0 – X3	Standard DC Inputs X4 – X23
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage Range	12–24 VDC	12–24 VDC
Peak Voltage	30VDC (7kHz maximum frequency)	30VDC
Minimum Pulse Width	70µs	N/A
ON Voltage Level	>10.0 VDC	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Max. Input Current	15mA @26.4VDC	11mA @ 26.4 VDC
Input Impedance	1.8 kq @ 12–24 VDC	2.8 kq @ 12–24 VDC
Minimum ON Current	5mA	3mA
Maximum OFF Current	0.5 mA	0.5 mA
OFF to ON Response	<70µs	2–8 ms, 4ms typical
ON to OFF Response	<70µs	2–8 ms, 4ms typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 5 banks (isolated)	

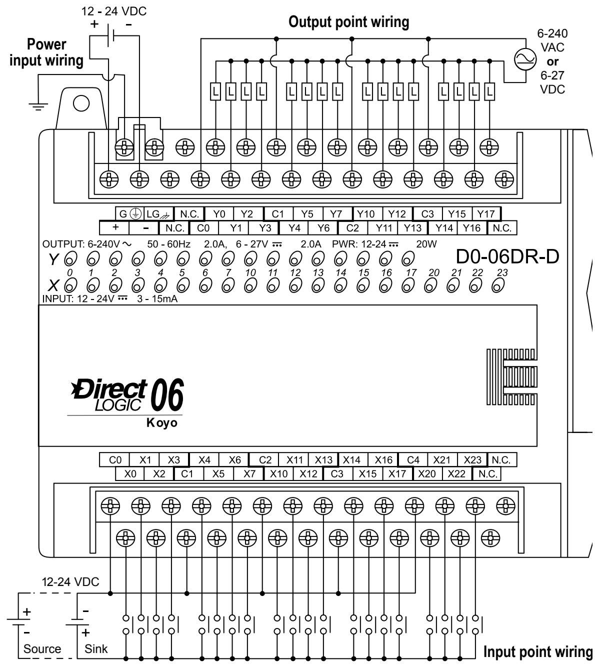
DC Output Specifications		
Parameter	Pulse Outputs, Y0 – Y1	Standard Outputs, Y2 – Y17
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage	12–24 VDC	12–24 VDC
Peak Voltage	30VDC (10kHz max. frequency)	30VDC
On Voltage Drop	0.5 VDC @ 1A	1.2 VDC @ 1 A
Max Current (resistive)	0.5 A / pt., 1A / pt. as standard pt.	1.0 A / point
Max leakage current	15µA @ 30VDC	15µA @ 30VDC
Max inrush current	2A for 100ms	2A for 100ms
External DC power required	N/A	N/A
OFF to ON Response	< 10µs	< 10µs
ON to OFF Response	< 20µs	< 0.5 ms
Status Indicators	Logic Side	Logic Side
Commons	4 channels / common x 4 banks (non-isolated)	
Fuses	None (external recommended)	

D0–06DR–D I/O Wiring Diagram

The D0–06DR–D PLC has twenty DC inputs and sixteen relay contact outputs. The following diagram shows a typical field wiring example. The DC external power connection uses three terminals as shown.

Inputs are organized into five banks of four. Each bank has an isolated common terminal, and may be wired as either sinking or sourcing inputs. The wiring example above shows all commons connected together, but separate supplies and common circuits may be used.

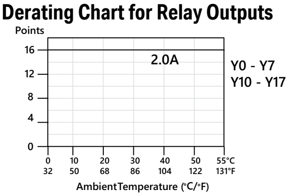
Outputs are organized into four banks of four normally-open relay contacts. Each bank has a common terminal. The wiring example above shows all commons connected together, but separate supplies and common circuits may be used. The equivalent output circuit shows one channel of a typical bank. The relay contacts can switch AC or DC voltages.



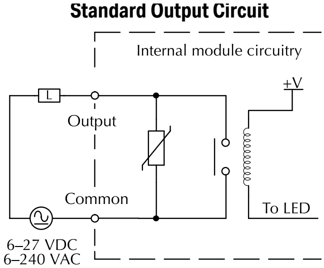
Typical Relay Life (Operations) at Room Temperature

Voltage & Load Type	Load Current	
	At 1A	At 2A
24VDC Resistive	500K	250K
24VDC Inductive	100K	50K
110VAC Resistive	500K	250K
110VAC Inductive	200K	100K
220VAC Resistive	350K	200K
220VAC Inductive	100K	50K

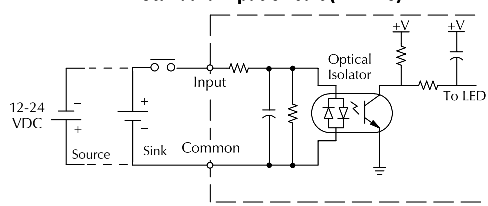
Derating Chart for Relay Outputs



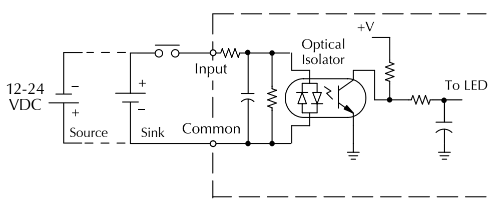
Standard Output Circuit



Standard Input Circuit (X4-X23)



High-speed Input Circuit (X0-X3)



D0-06DR-D General Specifications	
External Power Requirements	12–24 VDC, 20W maximum,
Communication Port 1 9600 baud (Fixed), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Slave), MODBUS (Slave)
Communication Port 2 9600 baud (default), 8 data bits, 1 stop bit, odd parity	K–Sequence (Slave), DirectNET (Master/Slave), MODBUS (Master/Slave),Non-sequence/print, ASCII in/out
Programming cable type	D2–DSCBL
Operating Temperature	32 to 131°F (0 to 55°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
Terminal Type	Removable
Wire Gauge	One 16 AWG or two 18AWG, 24AWG minimum

DC Input Specifications		
Parameter	High–Speed Inputs, X0 – X3	Standard DC Inputs X4 – X23
Min. - Max. Voltage Range	10.8–26.4 VDC	10.8–26.4 VDC
Operating Voltage Range	12–24 VDC	12–24 VDC
Peak Voltage	30VDC (7kHz maximum frequency)	30VDC
Minimum Pulse Width	70μs	N/A
ON Voltage Level	> 10VDC	> 10VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	1.8 kq @ 12–24 VDC	2.8 kq @ 12–24 VDC
Max. Input Current	6mA @ 12VDC 13mA @ 24VDC	4mA @12VDC 8.5mA @ 24VDC
Minimum ON Current	>5mA	>4 mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<70μs	2–8 ms, 4ms typical
ON to OFF Response	< 70μs	2–8 ms, 4ms typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 5 banks (isolated)	

Relay Output Specifications	
Output Voltage Range (Min. - Max.)	5–264 VAC (47–63 Hz), 5–30 VDC
Operating Voltage	6–240 VAC (47–63 Hz), 6–27 VDC
Output Current	2A / point 6A / common
Maximum Voltage	264VAC, 30VDC
Max leakage current	0.1 mA @ 264VAC
Smallest Recommended Load	5mA
OFF to ON Response	< 15ms
ON to OFF Response	< 10ms
Status Indicators	Logic Side
Commons	4 channels / common x 4 banks isolated commons
Fuses	None (external recommended)

Glossary of Specification Terms

Discrete Input

One of twenty input connections to the PLC which converts an electrical signal from a field device to a binary status (off or on), which is read by the internal CPU each PLC scan.

Discrete Output

One of sixteen output connections from the PLC which converts an internal ladder program result (0 or 1) to turn On or Off an output switching device. This enables the program to turn on and off large field loads.

I/O Common

A connection in the input or output terminals which is shared by multiple I/O circuits. It usually is in the return path to the power supply of the I/O circuit.

Input Voltage Range

The operating voltage range of the input circuit.

Maximum Voltage

Maximum voltage allowed for the input circuit.

ON Voltage Level

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

OFF Voltage Level

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

Input Impedance

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

Input Current

Typical operating current for an active (ON) input.

Minimum ON Current

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

Maximum OFF Current

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

OFF to ON Response

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

ON to OFF Response

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

Status Indicators

The LEDs that indicate the ON/OFF status of an input or output point. All LEDs on DL06 Micro PLCs are electrically located on the logic side of the input or output circuit.