DISCRETE I/O GUIDELINES

CHAPTER

2

In This Chapter...

Safety Guidelines 2–2
System Wiring Strategies 2–5
I/O Addressing 2–15
Discrete I/O General Specifications 2–17
Glossary of Specification Terms 2–18
F0-08SIM - 8-Point Simulator Input Module 2–19
D0-10ND3 - 10-Point DC Input Module 2–20
D0-10ND3F - 10-Point DC Fast Input Module 2–21
D0-16ND3 - 16-Point DC Input Module 2–22
F0-08NA-1 - 8-Point AC Input Module 2–23
D0-10TD1 - 10-Point DC Output Module 2–24
D0-16TD1 - 16-Point DC Output Module 2–25
D0-10TD2 - 10-Point DC Output Module 2–26
D0-16TD2 - 16-Point DC Output Module 2–27
D0-07CDR - 4-Point DC Input and 3-Point Relay Output Module 2–28
D0-08TR - 8-Point Relay Output Module 2–29
D0-08CDD1 - 4-Point DC Input and 4-Point DC Output Module 2–30
F0-04TRS - 4-Point Relay Output Module 2–31

Safety Guidelines

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

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

Plan for Safety

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

- NEMA — The National Electrical Manufacturers Association, located in Washington, D.C. publishes many different documents that discuss standards for industrial control systems. You can order these publications directly from NEMA. Some of these include:

  ICS 1, General Standards for Industrial Control and Systems

  ICS 3, Industrial Systems

  ICS 6, Enclosures for Industrial Control Systems

- NEC — The National Electrical Code provides regulations concerning the installation and use of various types of electrical equipment. Copies of the NEC Handbook can often be obtained from your local electrical equipment distributor or your local library.
- Local and State Agencies — many local governments and state governments have additional requirements above and beyond those described in the NEC Handbook. Check with your local Electrical Inspector or Fire Marshall office for information.

Three Levels of Protection

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

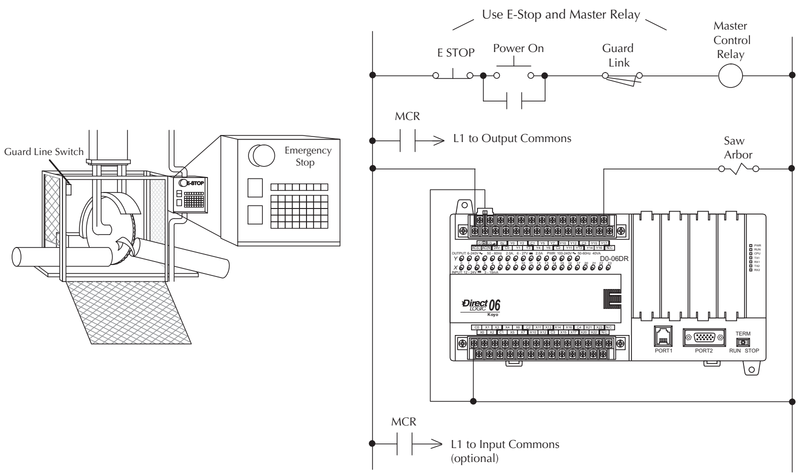
- Emergency stop switch for disconnecting system power
- Mechanical disconnect for output module power
- Orderly system shutdown sequence in the PLC control program

Emergency Stops

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

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

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



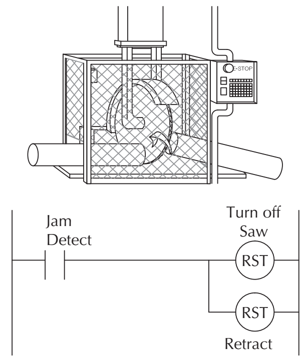
Emergency Power Disconnect

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

After an emergency shutdown or any other type of power interruption, there may be requirements that must be met before the PLC control program can be restarted. For example, there may be specific register values that must be established (or maintained from the state prior to the shutdown) before operations can resume. In this case, you may want to use retentive memory locations, or include constants in the control program to 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 (Applies ONLY to modules used with a DL06 PLC.)

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

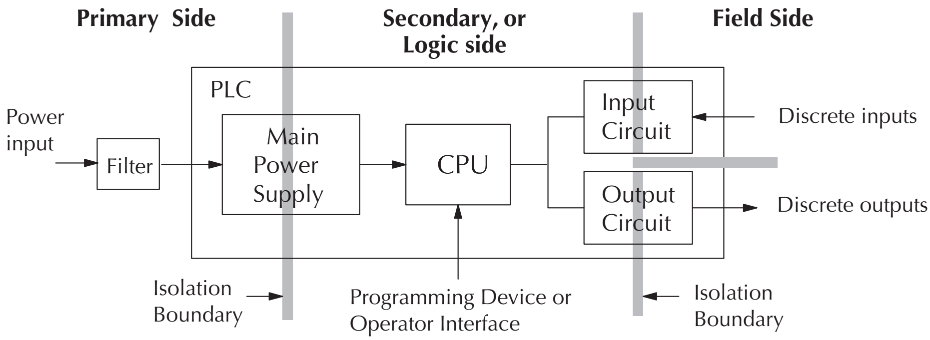
WARNING: Explosion Hazard! Substitution of components may impair suitability for Class 1, Division 2. Do not disconnect equipment unless power has been switched off or area is known to be non-hazardous.

System Wiring Strategies

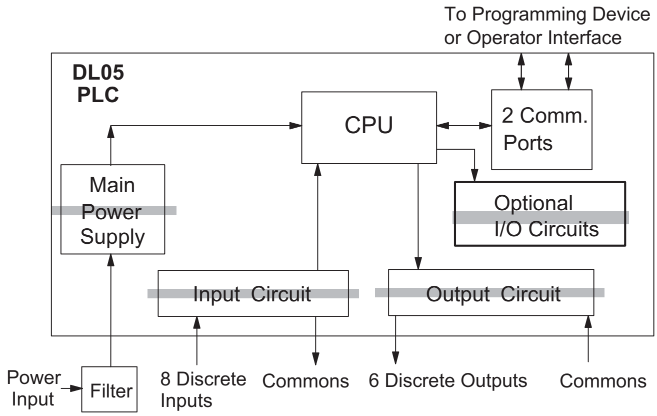
The *Direct*LOGIC Micro PLCs are very flexible and will work in many different wiring configurations. By studying this section before actual installation, you can probably find the best wiring strategy for your application . This will help to lower system cost, wiring errors, and avoid safety problems.

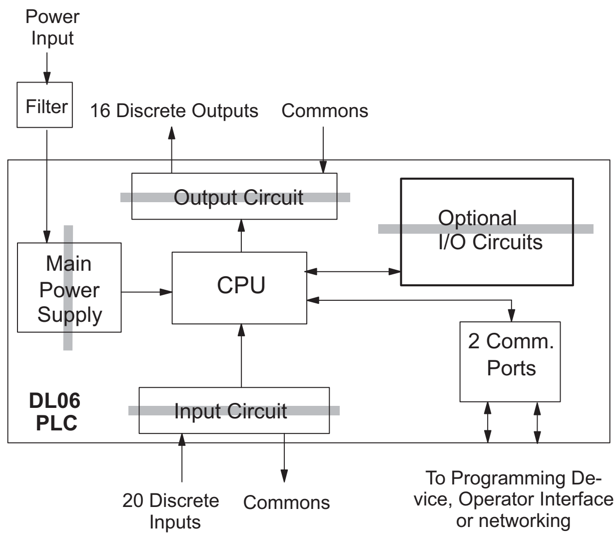
PLC Isolation Boundaries

PLC circuitry is divided into three main regions separated by isolation boundaries, shown in the drawing below. Electrical isolation provides safety, so that a fault in one area does not damage another. A powerline filter will provide isolation between the power source and the power supply. A transformer in the power supply provides magnetic isolation between the primary and secondary sides. Opto-couplers provide optical isolation in Input and Output circuits. This isolates logic circuitry from the field side, where factory machinery connects. Note 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 following figures show the internal layout of the DL05 and DL06 PLCs, as viewed from the front panels.





Sinking/Sourcing Concepts

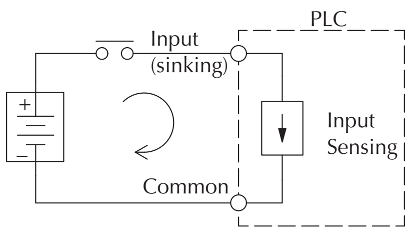
Before going further in our study of wiring strategies, we must have a solid understanding of *"sinking"* and *"sourcing"* concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring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

Sinking = Path to supply **ground** (–)

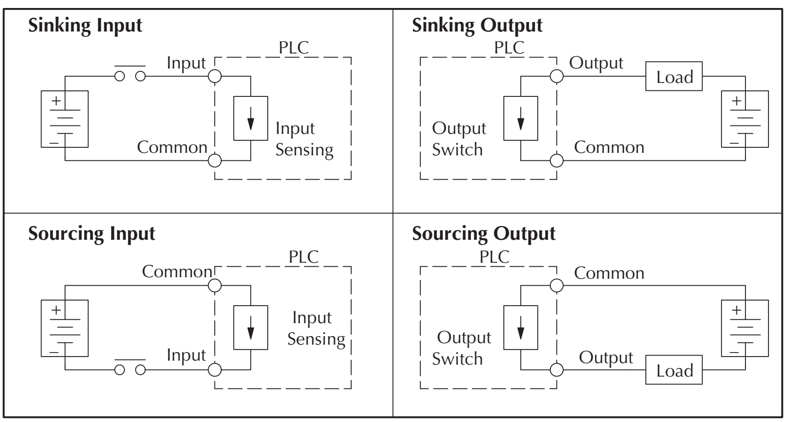
Sourcing = Path to supply **source** (+)

First you will notice that 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 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 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.

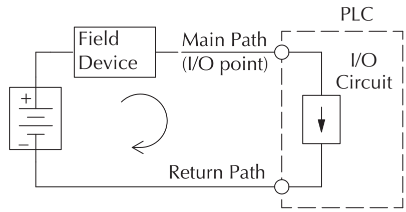


By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types, we have the four circuits as shown below. ***Direct***LOGIC Micro PLCs provide all except the sourcing output I/O circuit types.

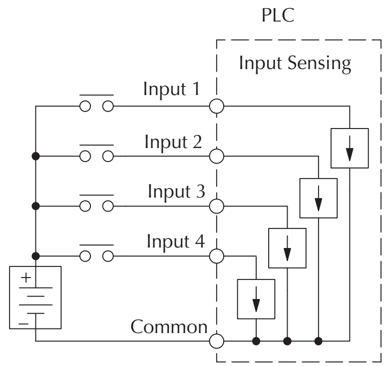


I/O "Common" Terminal Concepts

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.

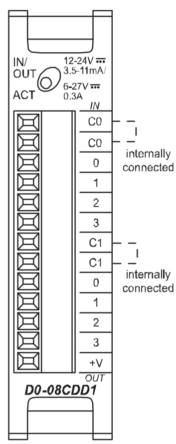


If we had unlimited space and budget for I/O terminals, then every I/O point could have two dedicated terminals just as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output point groups on PLCs share the 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 above, the current in the common path is equal to the sum of the energized channels. This is especially important in output circuits, where larger gauge wire is sometimes needed for the common.*

Some of the input and output modules often share a common return path. The best indication of I/O common grouping is on the wiring label. The combination I/O module to the right is an exception. The inputs and the outputs have separate commons.

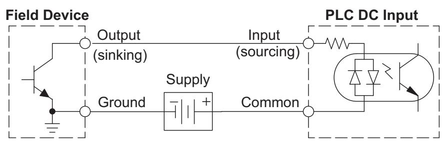


Connecting DC I/O to Solid State Field Devices

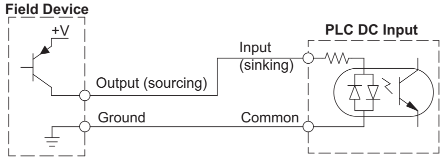
In the previous section on Sourcing/Sinking concepts, we explained that DC I/O circuits sometimes will only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *When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

Solid State Input Sensors

The PLC 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 source can be a FA-24PS, +24 VDC, power supply or another supply (+12 VDC or +24VDC) of your choice, 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.

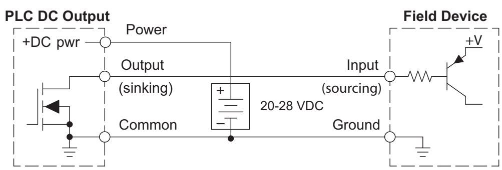


Solid State Output Loads

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.

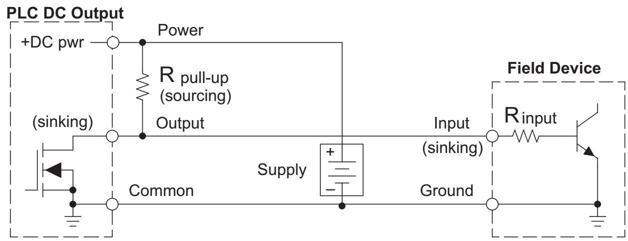
Some of the optional DC output modules are sinking-only. This means that each DC output provides a path to ground when it is energized. The six outputs of the DL05 have the same electrical common, even though there are two common terminal screws. Not so with the DL06 which has four isolated commons. Finally, recall that the DC output circuit requires power (20–28 VDC) from an external power source.

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.



2

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 Rpull-up from the output to the DC output circuit power input.



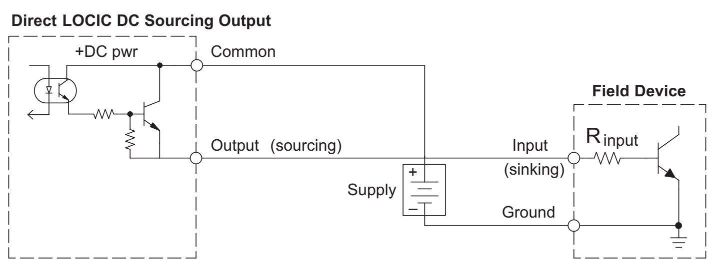
NOTE: *DO NOT attempt to drive a heavy load (>25 mA) with this pull-up method.*
NOTE 2: *Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the PLC output is OFF, from a ladder logic point-of-view.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

It is important to choose the correct value of Rpull-up. In order to do so, 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 15 mA). Then use I input and the voltage of the external supply to compute Rpull-up. Then calculate the power Ppull-up (in watts), in order to size Rpull-up properly.

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

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

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



Relay Output Guidelines

Relay outputs are available for the *Direct*LOGIC PLCs. 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)

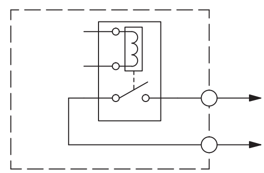
Some applications in which NOT to use relays:

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

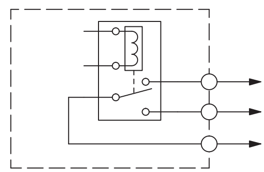
Relay outputs in the *Direct*LOGIC PLCs and modules are available in two contact arrangements, shown to the right. The Form A type, or SPST (single pole, single throw) type is normally open and is the simplest to use. The Form C type, or SPDT (single pole, double throw) type has a center contact which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



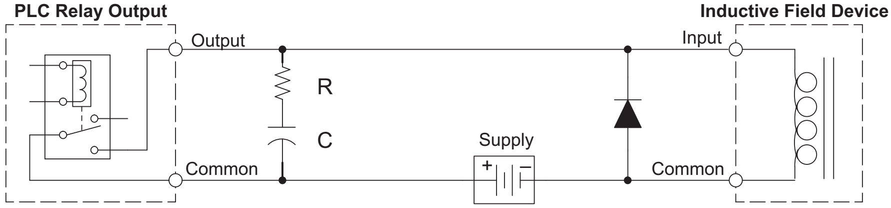
Relay with Form C contacts



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. However, there are some steps you can take to help prolong the life of relay contacts:

- Switch the relay on or off only when the application requires it.
- If you have the option, switch the load on or off at a time when it will draw the least current.
- Take measures to suppress inductive voltage spikes from inductive DC loads such as contactors and solenoids (circuit given below).



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.

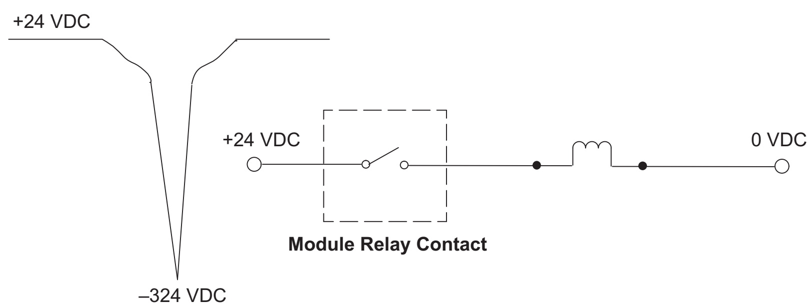
When switching a DC-supplied inductive load the full supply voltage is always present when the relay contact opens (or "bounces"). When switching an AC-supplied inductive load there is one chance in 60 (60 Hz) or 50 (50 Hz) that the relay contact will open (or "bounce") when the AC sine wave is zero 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.

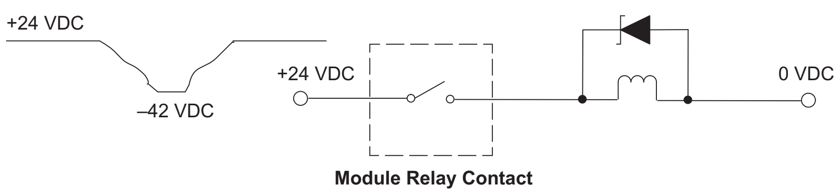
Transient Voltage Suppressors (**TVS or transorb**) provide the best surge and transient suppression of AC and DC powered coils, providing the fastest response with the smallest overshoot.

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.

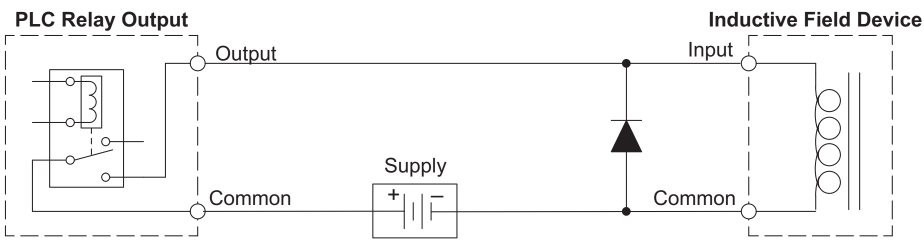
Surge Suppressors			
Vendor / Catalog	**Type**	**Inductive Load Voltage**	**Part Number**
AutomationDirect Transient Voltage Suppressors, LiteOn Diodes; from Digi-Key Catalog: Phone: 1-800-344-4539	TVS TVS TVS TVS Diode	110/120 VAC 24 VDC 220/240 VAC 12/24 VDC 12/24 VDC	ZL-TD8-120 ZL-TD8-24 P6KE350CA P6K30CAGICT–ND 1N4004CT–ND
Digi-key www.digikey.com	MOV MOV	110/120 VAC 220/240 VAC	Contact Digi-Key, Corp.

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.

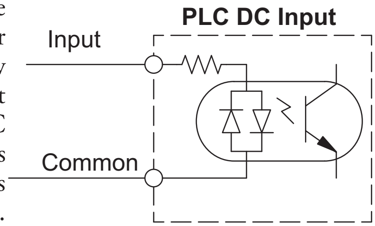
For inductive loads in DC circuits we recommend using a suppression diode as shown in the following diagram (DO NOT use this circuit with an AC power supply). When the load is energized the diode is reverse-biased (high impedance). When the load is turned off, energy stored in its coil is released in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

*Direct*LOGIC Micro PLCs with DC inputs are particularly flexible because they can be either sinking or sourcing. The dual diodes (shown to the right) allow current to flow in either direction. The inputs accept 10.8–26.4 VDC. The target applications are +12 VDC and +24 VDC. You can actually wire half of the inputs as DC sinking and the other half as DC sourcing. Inputs grouped by a common must be all sinking or all sourcing.



DC Output Wiring Methods

The PLC 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:

- The DL05 has only one electrical common for all six outputs. All six outputs belong to one bank.
- The DL05 output switches are current-sinking only. However, you can still use different DC voltages from one load to another.
- The DL06 has isolated commons for each group of four outputs. There are two DL06 models with output switches that are current-sinking only, and one that has sourcing output switches.
- The output circuit inside the PLC requires external power. The supply (–) must be connected to a common terminal, and the supply (+) connects the the right-most terminal on the upper connector.

Firmware and Software

The discrete option modules will only function properly in a DL05 with firmware version V4.10 (or later). If you have a DL05 with an earlier firmware version, the latest version can be downloaded from our website, **www.automationdirect.com**. If you are unable to download the latest firmware version along with the upgrade support tool software, call our technical support group to arrange to have your PLC upgraded.

The DL05 PLCs need to have ***Direct***SOFT32 Version 3.0c (or later) in order for the analog feature to perform properly. The DL06 must use ***Direct***SOFT32 Version 4.0 in order to use the option modules.

I/O Addressing

Module I/O Points and Addressing for the DL05 and DL06

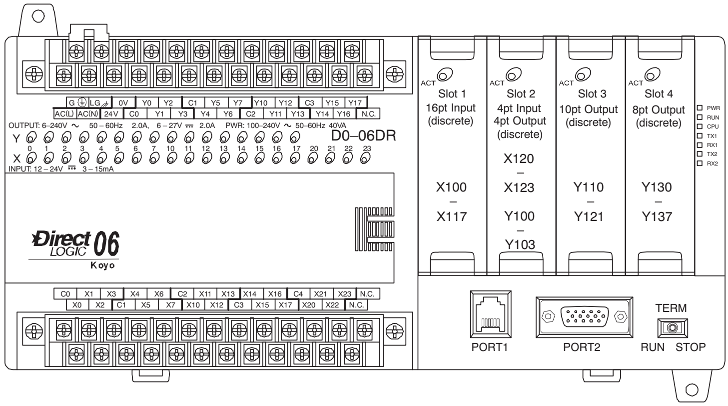
Each discrete option module has a set number of I/O points. (This does not hold true for the analog modules). The following table shows the number of I/O points per module when used in the DL05 PLC or the first slot of a DL06 PLC that has a discrete module installed. Discrete I/O addressing for a DL06 is automatic from slot 1 to slot 4 by default.

DC Input Modules	Physical I/O Points	Total I/O Points Consumed	Slot 1 I/O Address
F0-08SIM	8 Input	8 Input	X100 - X107
D0-10ND3	10 Input	16 Input (6 unused)	X100 - X107 and X110 - X111
D0-10ND3F	10 Input (fast)	16 Input (6 unused)	X100 - X107 and X110 - X111
D0-16ND3	16 Input	16 Input	X100 - X107 and X110 - X117
AC Input Modules	**Physical I/O Points**	**Total I/O Points Consumed**	**Slot 1 I/O Address**
F0-08NA-1	8 Input	8 Input*	X100 - X107
DC Output Modules	**Physical I/O Points**	**Total I/O Points Consumed**	**Slot 1 I/O Address**
D0-10TD1	10 Output	16 Output (6 unused)	Y100 - Y107 and Y110 - Y111
D0-16TD1	16 Output	16 Output	Y100 - Y107 and Y110 - Y117
D0-10TD2	10 Output	16 Output (6 unused)	Y100 - Y107 and Y110 - Y111
D0-16TD2	16 Output	16 Output	Y100 - Y107 and Y110 - Y117
Relay Output Modules	**Physical I/O Points**	**Total I/O Points Consumed**	**Slot 1 I/O Address**
D0-08TR	8 Output	8 Output*	Y100 - Y107
F0-04TRS	4 Output	8 Output (4 unused)*	Y100 - Y103
Combination Modules	**Physical I/O Points**	**Total I/O Points Consumed**	**Slot 1 I/O Address**
D0-07CDR	4 Input, 3 Output	8 Input (4 unused)*, 8 Output (5 unused)*	X100 - X103 and Y100 - Y102
D0-08CDD1	4 Input, 4 Output	8 Input (4 unused)*, 8 Output (4 unused)*	X100 - X103 and Y100 - Y103

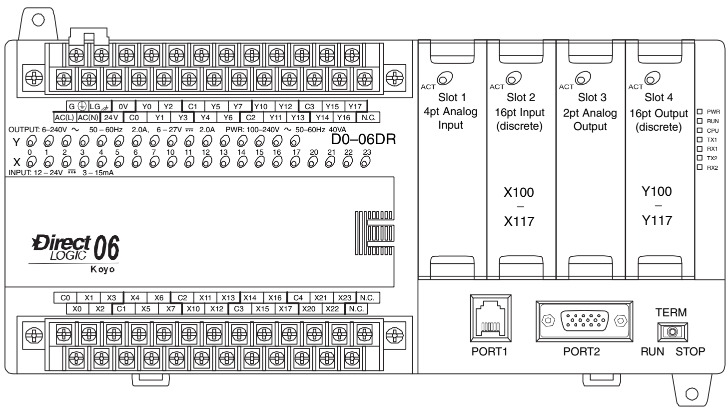
NOTE: *The information shown above is for Automatic I/O Configuration, which can assign addresses in groups as small as 8 I/O points. If manual I/O Configuration is used, the smallest allowable address group size is 16 I/O points. Therefore, each manually configured I/O module will consume at least 16 X (input) and/or 16 Y (output) addresses.*

The diagrams on the next page show examples of the DL06 I/O addressing with various option modules installed.

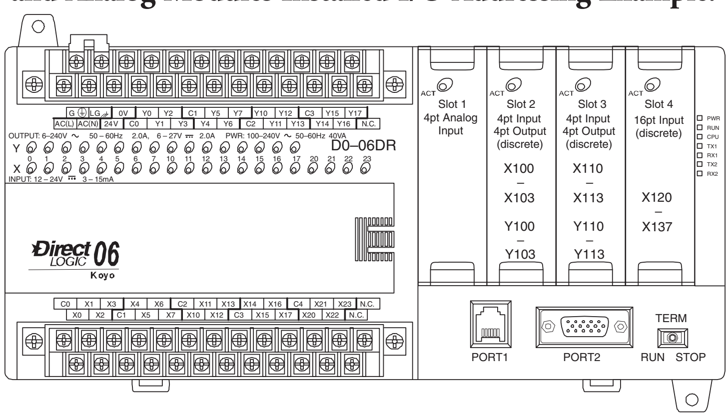
All Discrete Modules Installed I/O Addressing Example:



Discrete and Analog Modules Installed I/O Addressing Example:



Discrete and Analog Modules Installed I/O Addressing Example:



Discrete I/O General Specifications

The following is a list of general specifications for the discrete I/O option modules that are available for both the DL05 and DL06 PLCs. Also shown is information on the various removable connectors that are used for field wiring on the dicrete I/O option modules along with reference to the *ZIP*Link connection system products that are available for the 16-point I/O modules.

General Specifications			
Operating Temperature	0 to 55 °C (32 to 131 °F)	**Shock**	MIL STD 810C 516.2
Storage Temperature	-20 to 70 °C (-4 to 158 °F)	**Hi-pot**	1500 VAC, 1 min.
Humidity	5 to 95% (non-condencing)	**Insulation Resistance**	More than 10M ohms at 500VDC
Environmental Air	No Corrosive gasses permitted	**Noise Immunity**	NEMA ICS3-304
Vibration	MIL STD 810C 514.2		

Discrete I/O Connector Specifications

I/O Module	Connector	Wire Size	Screw Torque	Screwdriver Size
D0-10ND3	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 13-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
D0-10ND3F	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 13-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
D0-16ND3	**ZIP**Link ZL-CBL056 cable & ZL-CM056 conn. mod. or ZL-CBL056L cable & ZL-CM16L24 LED conn. mod. or build your own using a 24-pin Molex Micro Fit 3.0 receptacle, p/n 43025, or compatible.	(see **ZIP**Link specifications in AutomationDirect catalog under “Connection” tab.)		
F0-08NA-1	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 10-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
D0-10TD1	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 13-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
D0-16TD1	**ZIP**Link ZL-CBL056 cable & ZL-CM056 conn. mod. or ZL-CBL056FR cable & ZL-CM16RL24B relay mod. or ZL-CM16TF2 fuse mod.or build your own using a 24-pin Molex Micro Fit 3.0 receptacle, p/n 43025, or compatible.	(see **ZIP**Link specifications in AutomationDirect catalog under “Connection” tab.)		
D0-10TD2	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 13-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
D0-16TD2	**ZIP**Link ZL-CBL056 cable & ZL-CM056 conn. mod. or ZL-CBL056FR cable & ZL-CM16RL24B relay mod. or ZL-CM16TF2 fuse mod.or build your own using a 24-pin Molex Micro Fit 3.0 receptacle, p/n 43025, or compatible.	(see **ZIP**Link specifications in AutomationDirect catalog under “Connection” tab.)		
D0-07CDR	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 10-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
D0-08TR	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 10-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
D0-08CDD1	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 13-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)
F0-04TRS	AutomationDirect replacement terminal kit p/n D0-ACC-4 or use Dinkle: EC350, 13-pin. *	22 - 16 AWG	0.39 Nm	DN-SS1 (recommended)

* I/O modules are supplied with connector; replacement terminal kit includes (2) 13-position & (2) 10-position terminal blocks.

Glossary of Specification Terms

Discrete Input

One of the 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 the 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

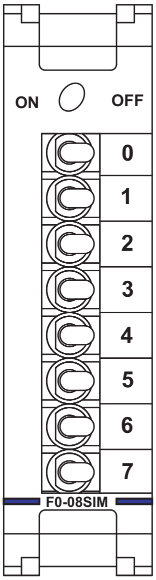
The time the module requires to process an ON to OFF state transition.

Status Indicators

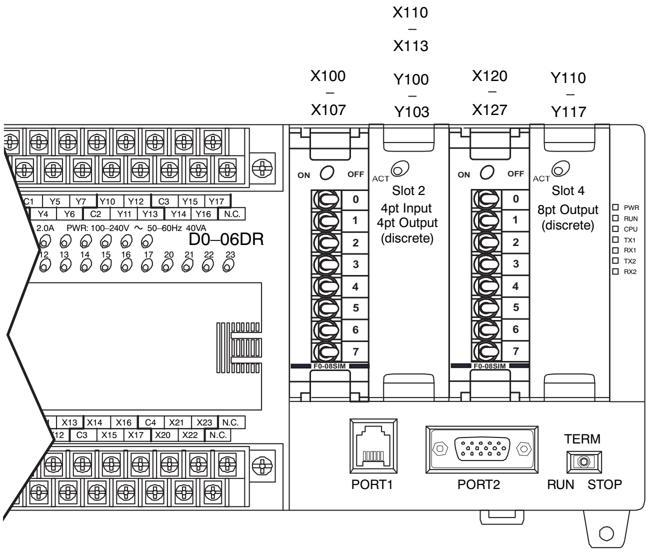
The LEDs that indicate the ON/OFF status of an input or output point. All LEDs on the Micro PLCs are electrically located on the logic side of the input or output circuit.

F0-08SIM
8-Point Simulator Input Module

Input Specifications	
Number of Inputs	8
Status Indicators	None
Power Budget Requirements	1 mA @ 5 VDC (supplied by base)
Weight	45.36 g (1.6 oz.)



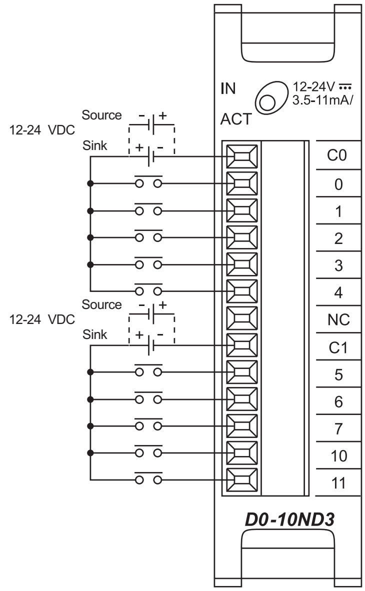
F0-08SIM addressing example



***NOTE:** The DL05 CPU's discrete feature for the F0-08SIM module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.90 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.80 (or later). See our website for more information: **www.automationdirect.com**.*

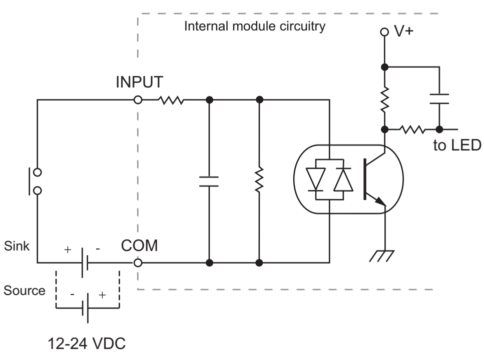
D0-10ND3
10-Point DC Input Module

Input Specifications	
Number of Inputs	10 (sink/source)
Input Voltage Range	10.8-26.4 VDC
Operating Voltage Range	12-24 VDC
Peak Voltage	30.0 VDC
Input Current	Typical:4.0 mA @ 12 VDC 8.5 mA @ 24 VDC
Maximum Input Current	11 mA @ 26.4 VDC
Input Impedance	2.8 KΩ @ 12-24 VDC
On Voltage Level	> 10.0 VDC
Off Voltage Level	< 2.0 VDC
Minimum ON Current	3.5 mA
Minimum OFF Current	0.5 mA
Off to On Response	2-8 ms, Typ. 4 ms
On to Off Response	2-8 ms, Typ. 4 ms
Status Indicators	Module activity: one green LED (See page 1-6)
Commons	2 (5 pts/common) Isolated
Fuse	No fuse
Power Budget Requirements	35 mA @ 5 VDC (supplied by base), (all pts ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	32 g (1.13 oz.)

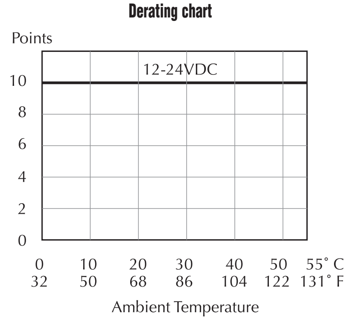


***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent input circuit

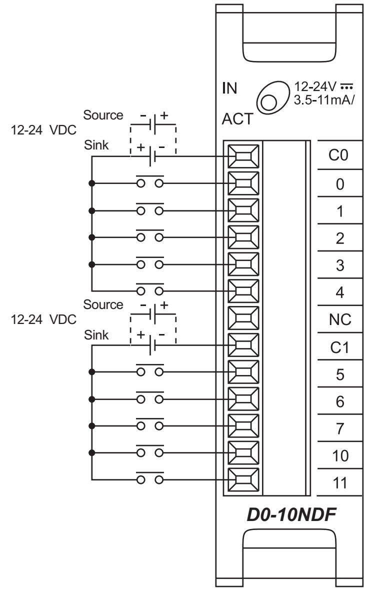


Derating chart



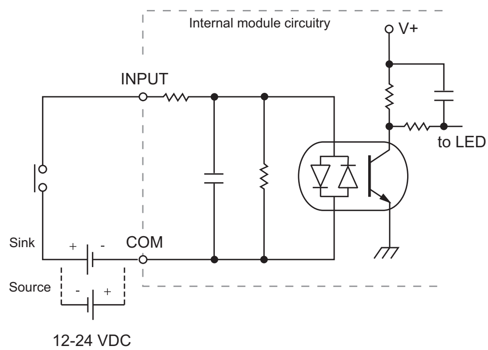
D0-10ND3F
10-Point DC Fast Input Module

Input Specifications	
Number of Inputs	10 (sink/source)
Input Voltage Range	10.8-26.4 VDC
Operating Voltage Range	12-24 VDC
Peak Voltage	30.0 VDC
Input Current	Typical:4.0 mA @ 12 VDC 8.5 mA @ 24 VDC
Maximum Input Current	11 mA @ 26.4 VDC
Input Impedance	2.8 KΩ @ 12-24 VDC
On Voltage Level	> 10.0 VDC
Off Voltage Level	< 2.0 VDC
Minimum ON Current	3.5 mA
Minimum OFF Current	0.5 mA
Off to On Response	2 ms, Typ. 1 ms
On to Off Response	2 ms, Typ. 1 ms
Status Indicators	Module activity: one green LED (See page 1-6)
Commons	2 (5 pts/common) Isolated
Fuse	No fuse
Power Budget Requirements	35 mA @ 5 VDC (supplied by base), (all pts ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	32 g (1.13 oz.)

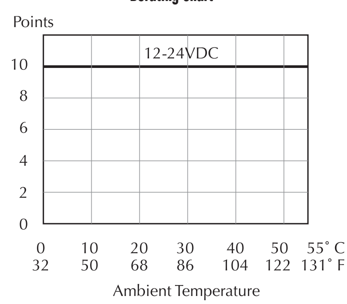


***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.70 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.50 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent input circuit

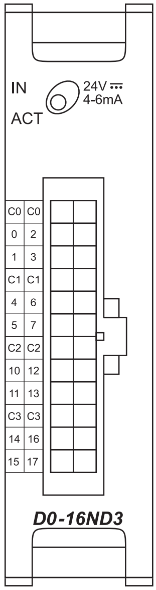


Derating chart

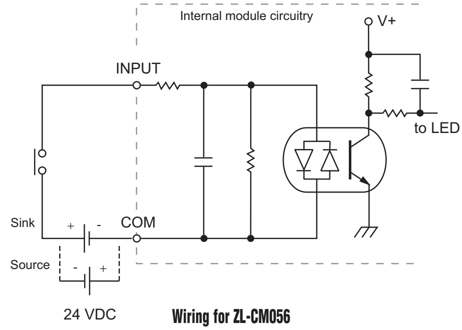


D0-16ND3
16-Point DC Input Module

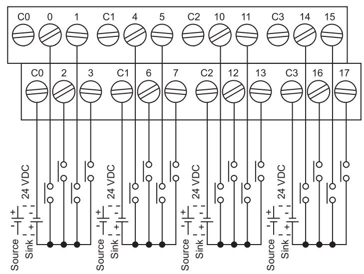
Input Specifications	
Number of Inputs	16 (sink/source)
Input Voltage Range	20-28 VDC
Operating Voltage Range	24 VDC
Peak Voltage	30.0 VDC
Input Current	Typical: 4.0 mA @ 24 VDC
Maximum Input Current	6 mA @ 28 VDC
Input Impedance	4.7 KΩ @ 24 VDC
On Voltage Level	> 19.0 VDC
Off Voltage Level	< 7.0 VDC
Minimum ON Current	3.5 mA
Minimum OFF Current	1.5 mA
Off to on Response	2-8 ms, Typ. 4 ms
On to off Response	2-8 ms, Typ. 4 ms
Status Indicators	Module activity: one green LED (See page 1-6)
Commons	4 (4 pts/common) Isolated
Fuse	No fuse
Power Budget Requirements	35 mA @ 5 VDC (supplied by base), (all pts ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	20 g (0.71 oz.)



Equivalent input circuit

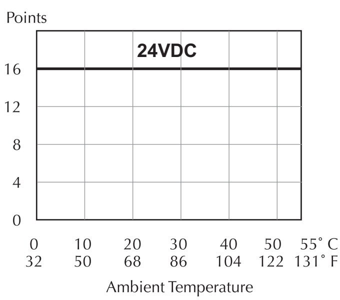


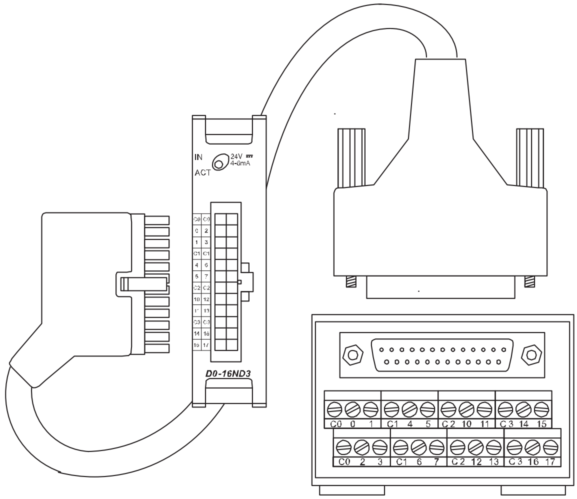
Wiring for ZL-CM056



NOTE: *The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Derating chart

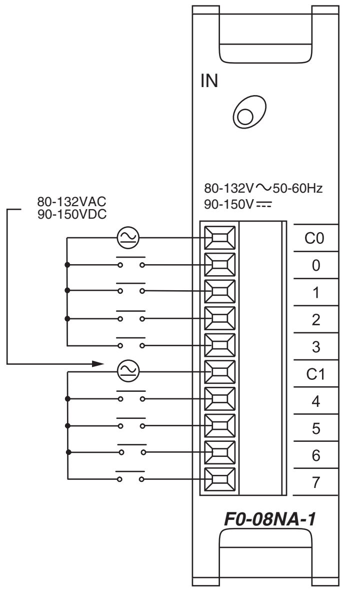




Use ZipLink ZL-CBL056 cable and ZL-CM056 connector module, or ZL-CBL056L cable and ZL-CM16L24 LED connector module. You can also build your own cables using 24-pin Molex Micro Fit 3.0 receptacle, part number 43025, or compatible.

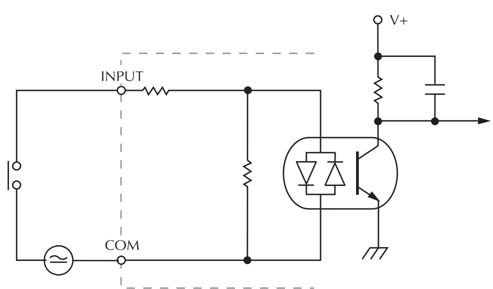
F0-08NA-1
8-Point AC Input Module

Input Specifications	
Number of Inputs	8
Input Voltage Range	80-132 VAC (90-150 VDC)
AC Frequency	47-63 Hz
Input Current	4.0 mA @ 132 VAC
Input Impedance	33 KΩ
On Voltage Level	80 VAC minimum
Off Voltage Level	20 VAC maximum
Minimum On Current	2.4 mA
Maximum Off Current	1.6 mA
Off to On Response	< 20 ms
On to Off Response	< 10 ms
Status Indicators	None
Commons	2 (4 pts/common) Isolated
Fuse	No fuse
Power Budget Requirements	5 mA @ 5 VDC (supplied by base), (all pts ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	31.2 g (1.1 oz.)

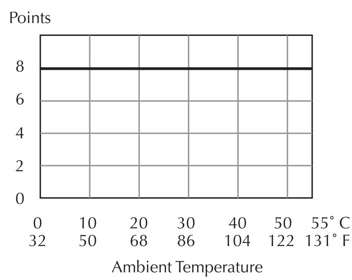


***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.70 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.50 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent input circuit



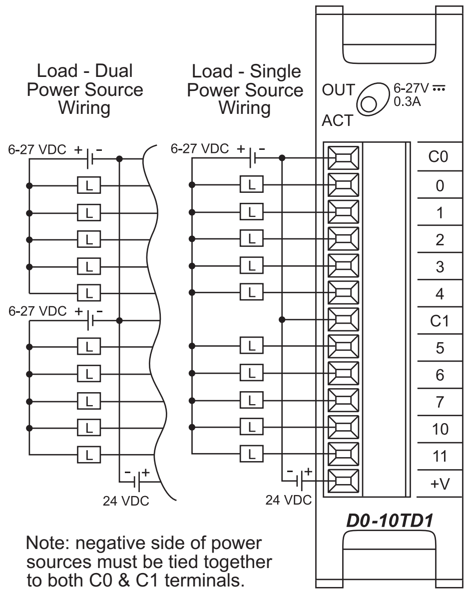
Derating chart



2

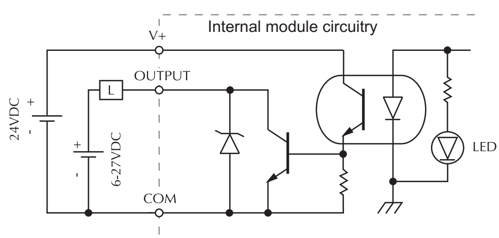
D0-10TD1
10-Point DC Output Module

Output Specifications	
Number of Outputs	10 (sinking)
Operating Voltage Range	6-27 VDC
Output Voltage Range	5-30 VDC
Peak Voltage	50.0 VDC
Maximum Output Current	0.3 A/point 1.5 A/common
Minimum Output Current	0.5 mA
ON Voltage Drop	0.5.VDC @ 0.3 A
Maximum Leakage Current	15 µA @ 30.0 VDC
Maximum Inrush Current	1 A for 10 ms
OFF to ON Response	< 10 µs
ON to OFF Response	< 60 µs
Status Indicators	Module activity: one green LED (See page 1-6)
Commons	2 (5 points/common) Non-isolated
Fuse	No fuse
Power Budget Requirements	Max. 150 mA @ 5 VDC (supplied by base), (all pts. ON)
External DC Power Required	20-28 VDC max. 200 mA (all pts. ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	34 g (1.20 oz.)

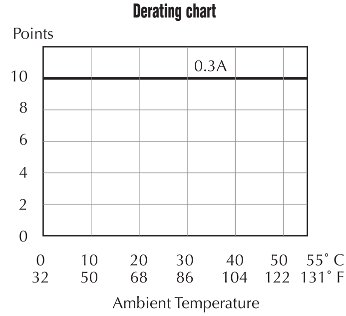


***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent output circuit

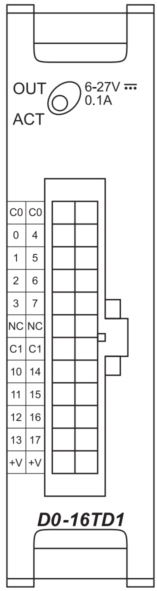


Derating chart

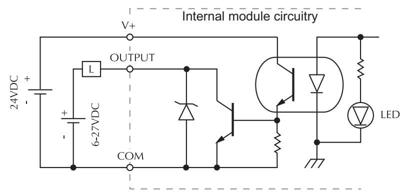


D0-16TD1
16-Point DC Output Module

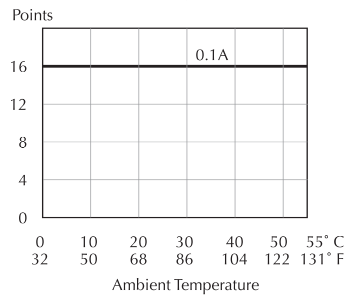
Output Specifications	
Number of Outputs	16 (sinking)
Operating Voltage Range	6-27 VDC
Output Voltage Range	5-30 VDC
Peak Voltage	50.0 VDC
Maximum Output Current	0.1 A/point 0.8 A/common
Minimum Output Current	0.5 mA
ON Voltage Drop	0.5.VDC @ 0.1 A
Maximum Leakage Current	15 µA @ 30.0 VDC
Maximum Inrush Current	1 A for 10 ms
OFF to ON Response	< 0.5 ms
ON to OFF Response	< 0.5 ms
Status Indicators	Module activity: one green LED (See page 1-6)
Commons	2 (8 points/common) Non-isolated
Fuse	No fuse
Power Budget Requirements	Max. 200 mA @ 5 VDC (supplied by base), (all pts. ON)
External DC Power Required	20-28 VDC max 70 mA (all pts. ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	22 g (0.78 oz.)



Equivalent input circuit

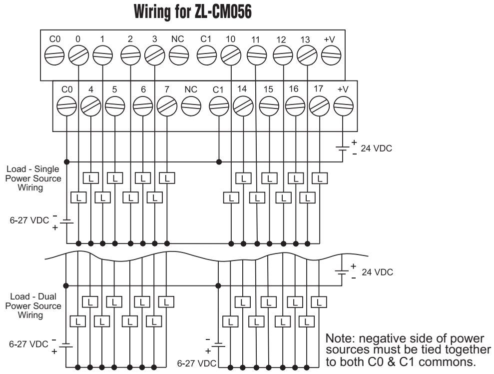


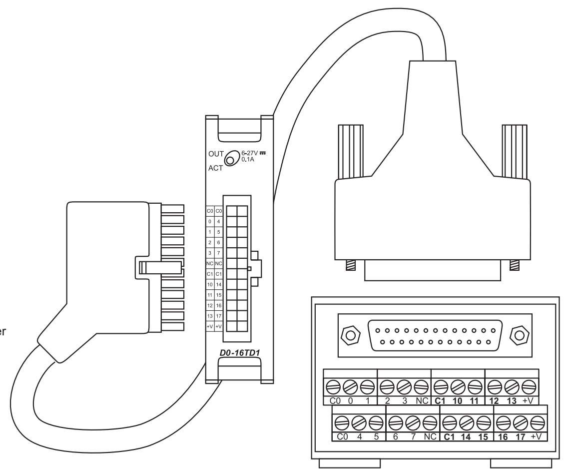
Derating chart



***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Wiring for ZL-CM056

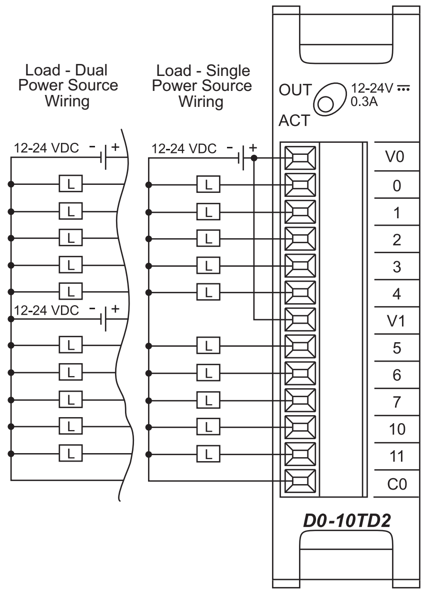




Use ZipLink ZL-CBL056 cable and ZL-CM056 connector module, or ZL-CBL056FR cable and ZL-CM16RL24B relay module or ZL-CM16TF2 fuse module. You can also build your own cables using 24-pin Molex Micro Fit 3.0 receptacle, part number 43025, or compatible.

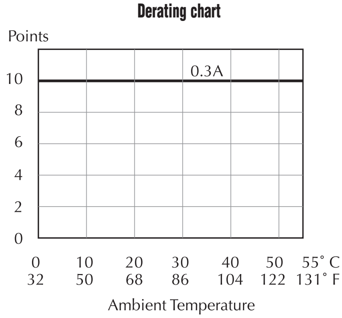
D0-10TD2
10-Point DC Output Module

Output Specifications	
Number of Outputs	10 (sourcing)
Operating Voltage Range	12-24 VDC
Output Voltage Range	10.8-26.4 VDC
Peak Voltage	50.0 VDC
Maximum Output Current	0.3 A/point 1.5 A/common
Minimum Output Current	0.5 mA
ON Voltage Drop	1.0.VDC @0.3 A
Maximum Leakage Current	1.5 µA @ 30.0 VDC
Maximum Inrush Current	1 A for 10 ms
OFF to ON Response	< 10 µs
ON to OFF Response	< 60 µs
Status Indicators	Module activity: one green LED (See page 1-6)
+V Terminals & Common	2 (5 points/+V Terminal) Isolated, 1 Common
Fuse	No fuse
Power Budget Requirements	Max. 150 mA @ 5 VDC (supplied by base), (all pts. ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	38 g (1.34 oz.)

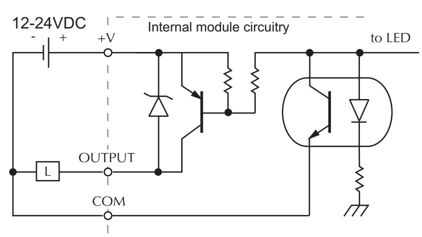


NOTE: *The DL05 CPU's discrete feature for this module requires* ***Direct****SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires* ***Direct****SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information:* ***www.automationdirect.com****.*

Derating chart

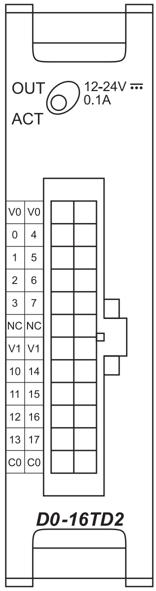


Equivalent output circuit

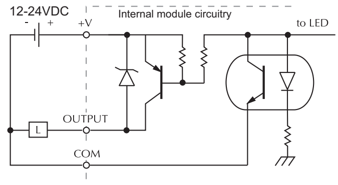


D0-16TD2
16-Point DC Output Module

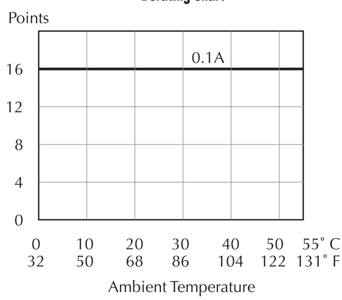
Output Specifications	
Number of Outputs	16 (sourcing)
Operating Voltage Range	12-24 VDC
Output Voltage Range	10.8-26.4 VDC
Peak Voltage	50.0 VDC
Maximum Output Current	0.1 A/point, 0.8 A/common
Minimum Output Current	0.5 mA
ON Voltage Drop	1.0.VDC @ 0.1 A
Maximum Leakage Current	1.5 µA @ 26.4 VDC
Maximum Inrush Current	1 A for 10 ms
OFF to ON Response	< 0.5 ms
ON to OFF Response	< 0.5 ms
Status Indicators	Module activity: one green LED (See page 1-6)
+V Terminals & Common	2 (8 points/+V Terminal) Isolated, 1 Common
Fuse	No fuse
Power Budget Requirements	Max. 200 mA @ 5 VDC (supplied by base), (all pts. ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	22 g (0.78 oz.)



Equivalent output circuit

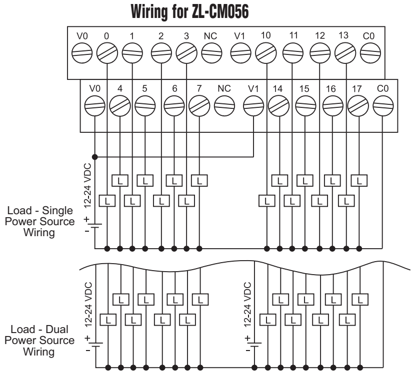


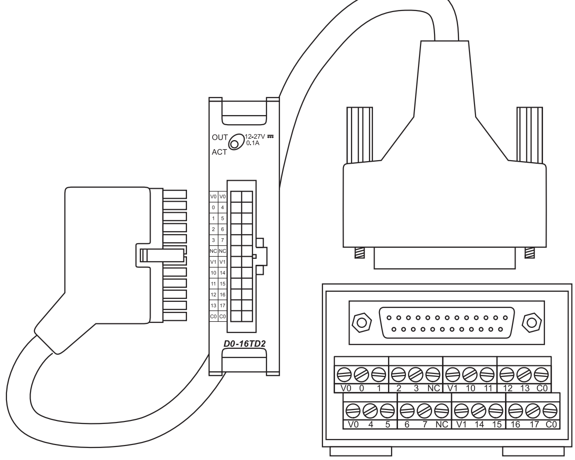
Derating chart



***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Wiring for ZL-CM056





Use ZipLink ZL-CBL056 cable and ZL-CM056 connector module, or ZL-CBL056FR cable and ZL-CM16RL24B relay module or ZL-CM16TF2 fuse module. You can also build your own cables using 24-pin Molex Micro Fit 3.0 receptacle, part number 43025, or compatible.

2

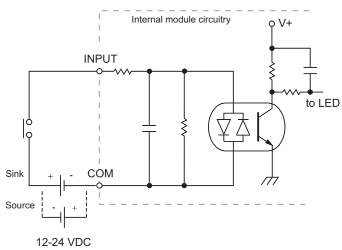
D0-07CDR
4-Point DC Input and 3-Point Relay Output Module

Input Specifications	
Number of Inputs	4 (sink/source)
Operating Voltage Range	12-24 VDC
Input Voltage Range	10.8-26.4 VDC
Peak Voltage	30.0 VDC
Maximum Input Current	11 mA @ 26.4 VDC
Input Current	Typical: 4 mA @ 12 VDC 8.5 mA @ 24 VDC
Input Impedance	2.8 KΩ @ 12-24 VDC
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Minimum ON Current	3.5 mA
Maximum OFF Current	0.5 mA
OFF to ON Response	2-8 ms, typical 4 ms
ON to OFF Response	2-8 ms, typical 4 ms
Commons	1 (4 points/common)
Power Budget Requirements	Max. 200 mA @ 5 VDC (supplied by base), (all pts. ON)

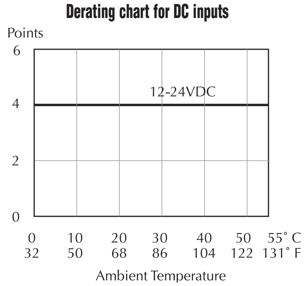
Output Specifications	
Number of Outputs	3
Operating Voltage Range	6-27 VDC/6-240 VAC
Output Type	Relay, form A, SPST
Peak Voltage	30.0 VDC/264 VAC
Maximum Current (Resistive)	1 A/point, 4 A/common
Minimum Load Current	5 mA @ 5 VDC
Maximum Leakage Current	0.1 mA @ 264 VAC
ON Voltage Drop	N/A
Maximum Inrush Current	Output: 3 A for 10 ms, Comm: 10 A for 10 ms
OFF to ON Response	< 15 ms
ON to OFF Response	< 10 ms
Status Indicators	Module acitivity: one green LED (See page 1-6)
Commons	1 (3 points/common)
Fuse	No fuse
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	38 g (1.34 oz.)

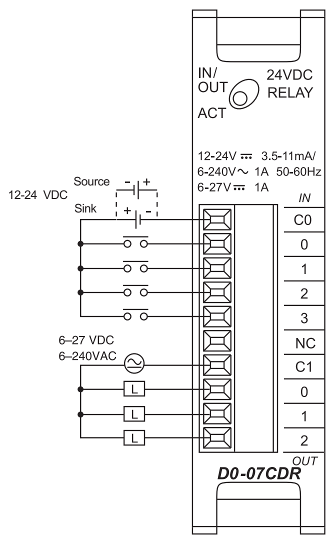
***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent input circuit

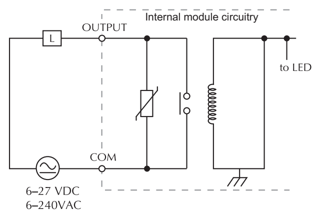


Derating chart for DC inputs

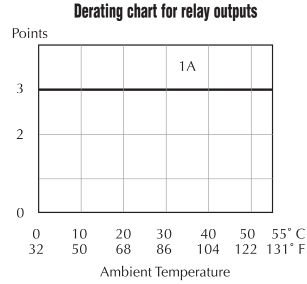




Equivalent output circuit

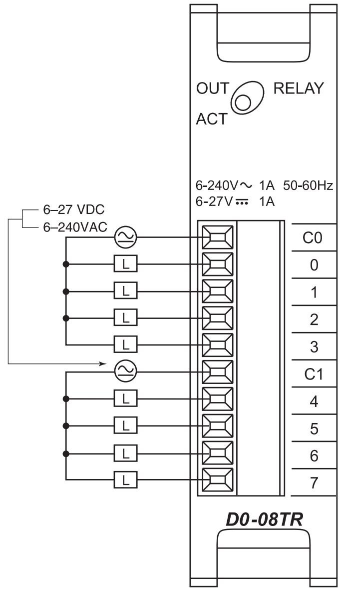


Derating chart for relay outputs



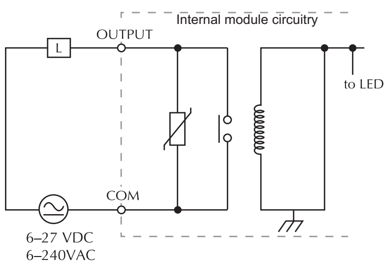
D0-08TR
8-Point Relay Output Module

Output Specifications	
Number of Outputs	8
Operating Voltage Range	6-27 VDC/6-240 VAC
Output Type	Relay, form A, SPST
Peak Voltage	30.0 VDC/264 VAC
Maximum Current (Resistive)	1 A/point, 4 A/common
Minimum Load Current	0.5mA
Maximum Leakage Current	0.1 mA @ 264 VAC
ON Voltage Drop	N/A
Maximum Inrush Current	Output: 3A for 10 ms, Common: 10A for 10 ms
OFF to ON Response	< 15 ms
ON to OFF Response	< 10 ms
Status Indicators	Module acitivity: one green LED (See page 1-6)
Commons	2 Isolated. (4 points/common)
Fuse	No fuse
Power Budget Requirements	Max. 280 mA @ 5 VDC (supplied by base), (all pts. ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	55 g (1.94 oz.)

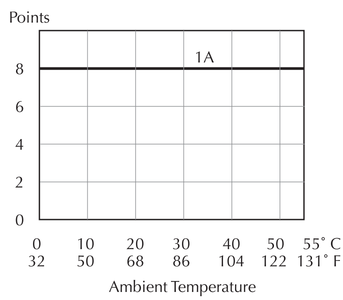


NOTE: *The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent output circuit



Derating chart



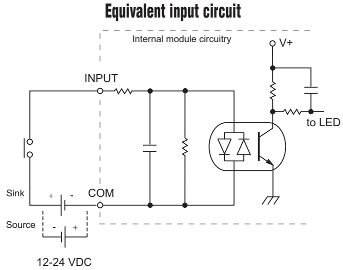
D0-08CDD1
4-Point DC Input and 4-Point DC Output Module

Input Specifications	
Number of Inputs	4 (sink/source)
Operating Voltage Range	10.8-26.4 VDC
Input Voltage Range	12-24 VDC
Peak Voltage	30.0 VDC
Maximum Input Current	11 mA @ 26.4 VDC
Input Current	Typical: 4 mA @ 12 VDC 8.5 mA @ 24 VDC
Input Impedance	2.8 KΩ @ 12-24 VDC
ON Voltage Level	> 10.0 VDC
OFF Voltage Level	< 2.0 VDC
Minimum ON Current	3.5 mA
Maximum OFF Current	0.5 mA
OFF to ON Response	2-8 ms, typical 4 ms
ON to OFF Response	2-8 ms, typical 4 ms
Commons	2 Non-isolated
External DC Power Required	20-28 VDC, max. 80 mA (all pts. ON)
Power Budget Requiremnts	Max. 200 mA @ 5 VDC (supplied by base), (all pts. ON)

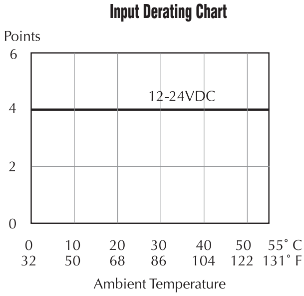
Output Specifications	
Number of Outputs	4 (sinking)
Operating Voltage Range	6-27 VDC
Output Voltage Range	5-30 VDC
Peak Voltage	50.0 VDC
Maximum Output Current	0.3 A/point, 1.2 A/common
Minimum Output Current	0.5 mA
Maximum Leakage Current	1.5 µA @ 30.0 VDC
ON Voltage Drop	0.5 VDC @ 0.3 A
Maximum Inrush Current	1 A for 10 ms
OFF to ON Response	< 10 µs
ON to OFF Response	< 60 µs
Status indicators	Module acitivity: one green LED (See page 1-6)
Commons	2 Non-isolated
Fuse	No fuse
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	34 g (1.20 oz.)

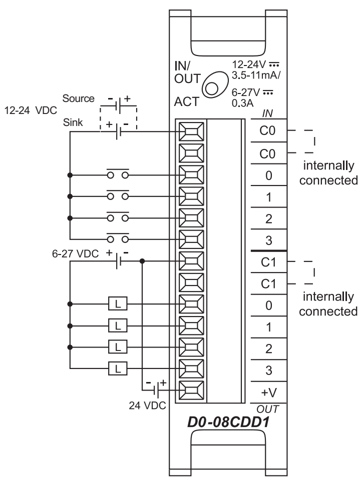
***NOTE:** The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.10 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.00 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent input circuit

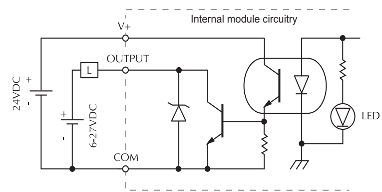


Input Derating Chart

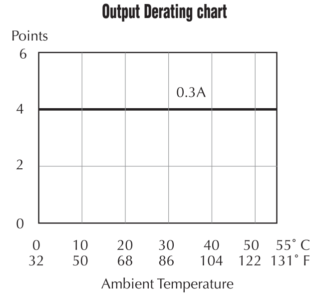




Equivalent output circuit

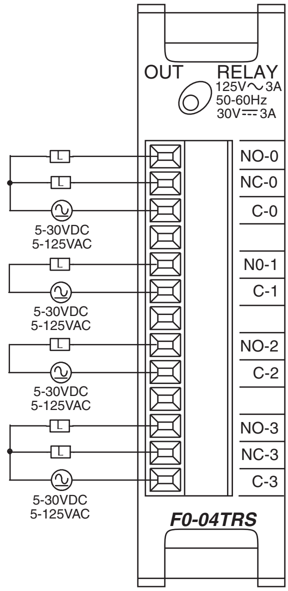


Output Derating chart

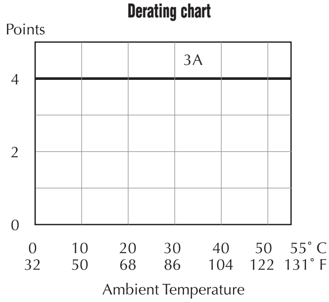


F0-04TRS
4-Point Relay Output Module

Output Specifications	
Number of Outputs	4
Operating Voltage Range	5-30 VDC/5-125 VAC
Output Type	2 - form C (SPDT) 2 - form A (SPST normally open)
Peak Voltage	60 VDC/220 VAC
AC Frequency	47-63 Hz
Maximum Current (Resistive)	3 A/point with no derating
Minimum Load Current	10 mA @ 5 VDC
Maximum Leakage Current	N/A
ON Voltage Drop	N/A
Maximum Inrush Current	5 A
OFF to ON Response	≤ 5 ms (typical)
ON to OFF Response	≤ 5 ms (typical)
Status Indicators	None
Commons	4 Isolated
Fuse	4, IEC 3.15 A, replaceable, D2-FUSE-1
Power Budget Requirements	Max. 250 mA @ 5 VDC (supplied by base), (all pts. ON)
Dimensions (mm)	19.8(W) x 76.8(H) x 53.9(D)
Weight	51 g (1.8 oz.)

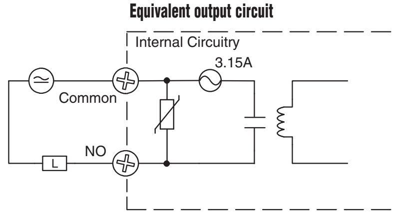


Derating chart

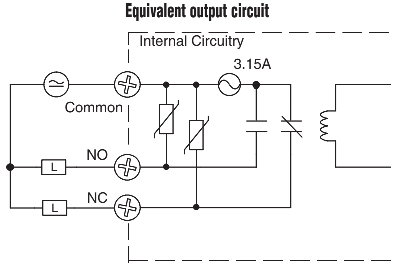


NOTE: *The DL05 CPU's discrete feature for this module requires **Direct**SOFT32 Version 3.0c (or later) and firmware version 4.70 (or later). The DL06 requires **Direct**SOFT32 version V4.0, build 16 (or later) and firmware version 1.50 (or later). See our website for more information: **www.automationdirect.com**.*

Equivalent output circuit



Equivalent output circuit



F0-04TRS Typical Relay Life at 30 Operations per Minute			
Load Type	**Rated Voltage**	**Rated Current**	**Number of Operations**
Resistive	120VAC	3A	120,000
Resistive	120VAC	1A	550,000
Resistive	24VDC	1A	>2M
Inductive: SC-E5 Motor Starter	24VDC	0.2A	>2M (see Note)
Inductive: SC-E5 Motor Starter	120VAC	0.1A operating 1.7A fault	>2M (see Note)
Note: Transient suppression must be installed with inductive loads.			