2

Installation, Wiring, and Specifications

In This Chapter. . . .

Safety Guidelines

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

Safety Techniques

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 may help reduce the risk of safety concerns.

- Orderly system shutdown sequence in the PLC control program.
- System power disconnects (guard limits, emergency stop switches, etc.)

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.

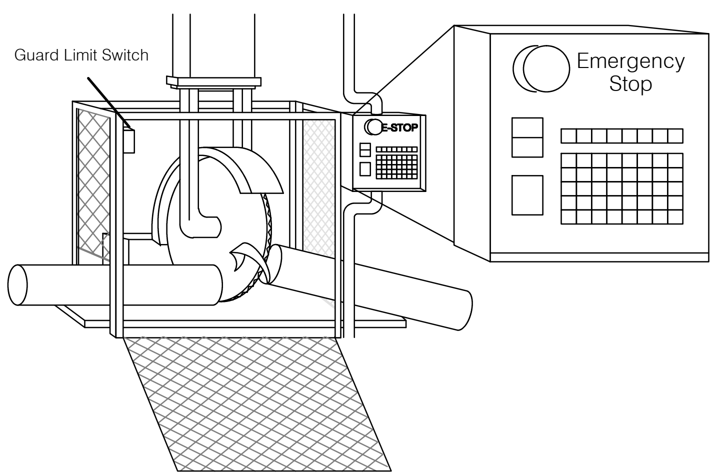
- Orderly system shutdown sequence in the PLC control program
- Mechanical disconnect for output module power
- Emergency stop switch for disconnecting system power

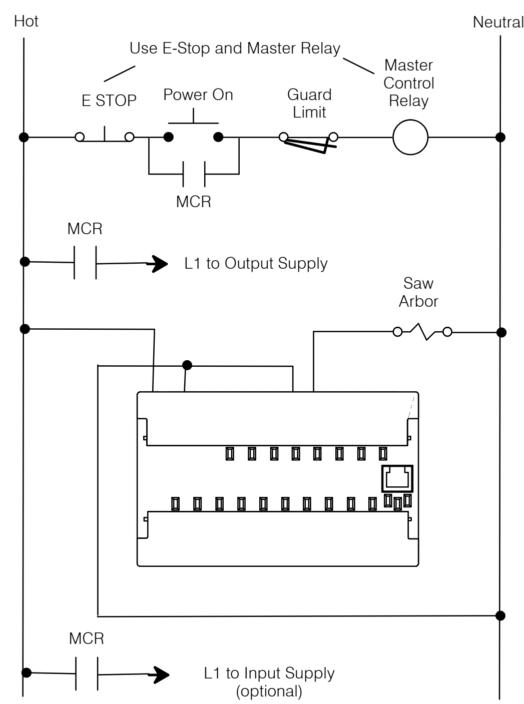
Emergency Stops

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.).





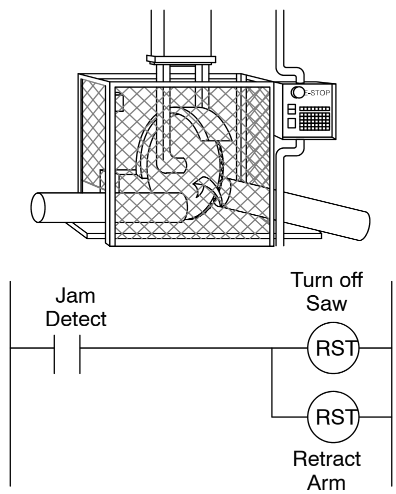
Emergency Power Disconnect

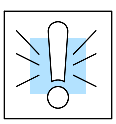
A properly rated emergency power disconnect should be used to power the PLC controlled system as ameans of removing the power from the entire control system. It may be necessary to install a capacitor across the disconnect to protect against a condition known as “outrush“. This condition occurs when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

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

Orderly System Shutdown

Ideally, the first level of protection can be provided with the PLC control program by identifying machine problems. Analyze your application and identify any shutdown sequences that must be performed. Typical problems such as jammed or missing parts, empty bins, etc., create a risk of personal injury or equipment damage.

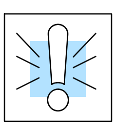




WARNING: The control program *must not* be the only form of protection for any problems that may result in a risk of personal injury or equipment damage.

Class 1, Division 2 Approval

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

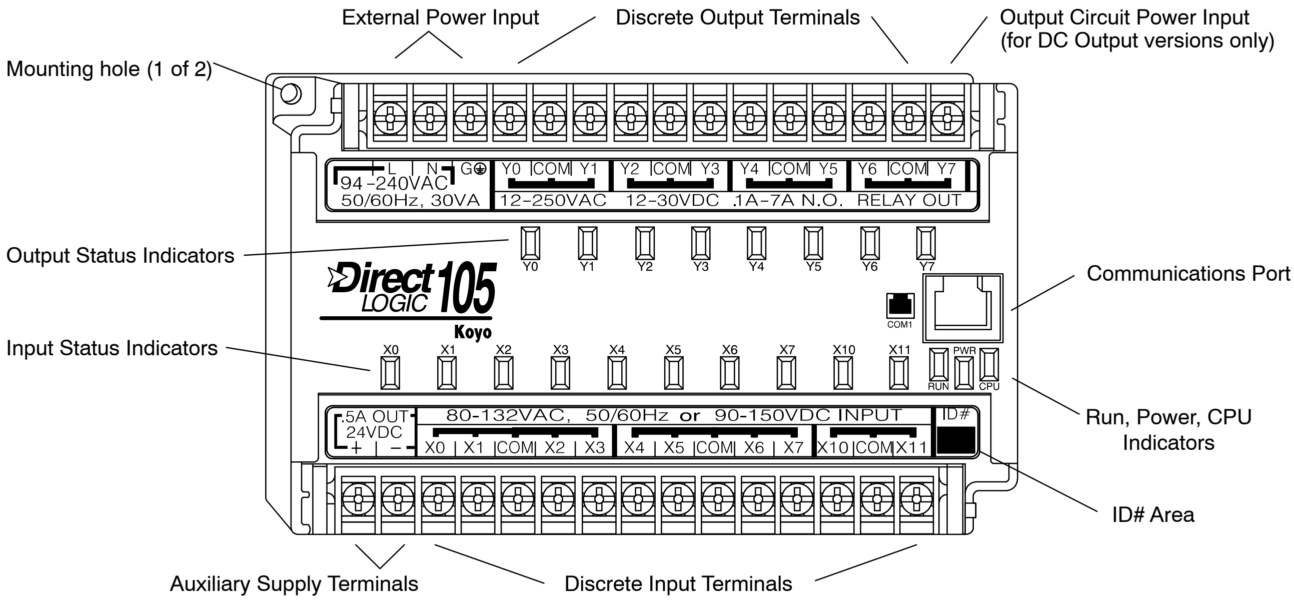


WARNING: Explosion Hazard! Substitution of components may impair suitability for Class 1, Division 2.

Do not disconnect equipment unless power has been switched off or area is known to be non–hazardous.

Orientation to DL105 Front Panel

All connections, indicators, and labels on the DL105 Micro PLCs are located on its front panel. Please refer to the drawing below.

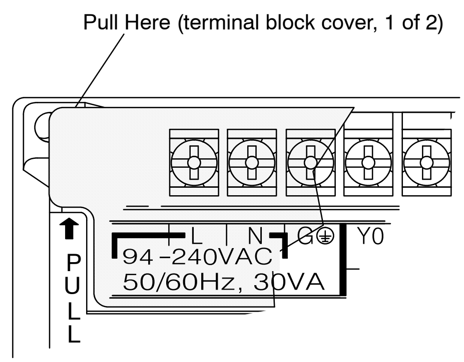


The upper connector accepts external power connections on the left-most terminals. The remainder of the terminals accept wires for the eight output points and their commons. On DC output versions, the end terminal on the right accepts power for the output stage. In many applications the external power to the Micro PLC also powers the loads and output circuit, so this terminal block groups them together.

The lower connector delivers the internal +24VDC auxiliary supply output on the two left-most terminals (AC-powered units only). On DC-powered units, the terminals are not used. The remaining terminals accept wires for the ten discrete inputs and their commons. In many applications the auxiliary +24VDC output also powers the input circuit, so this terminal block groups them together.

Accessing the I/O Terminals

To access the terminals just pull forward on the corner of the terminal cover where it is marked “pull”, as shown to the right. After exposing the connector block, it may be removed from the unit if desired.



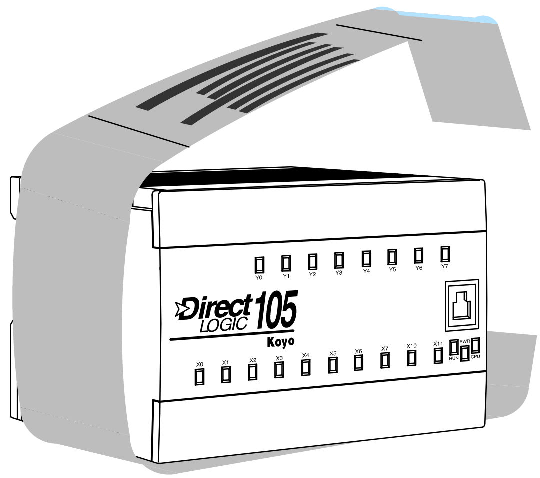
WARNING: For some applications, field device power may still be present on the terminal block even though the Micro PLC is turned off. To minimize the risk of electrical shock, check all field device power *before* you expose or remove either connector. Be sure to leave the covers normally closed.

Protective Sheet for DL105 Vents

Some machine fabrication environments may accidentally cause conductive debris to fall through the DL105 cooling vents and into the unit. All DL105 units come with a protective sheet wrapped around the unit, covering the cooling vents. However, it must be removed before electrical operation. Just unfasten the sheet on the right side of the unit. The instructions are reprinted below for your reference.

CAUTION

1. DO NOT REMOVE THIS PROTECTIVE SHEET until installation and wiring are completed.
2. REMOVE THIS SHEET before operation to enable heat to escape for proper cooling.

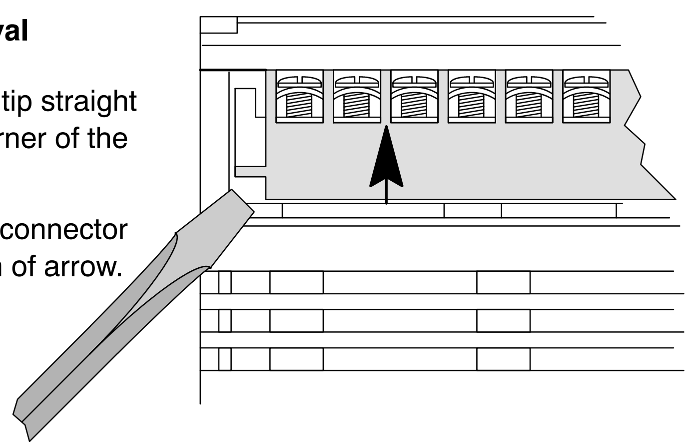


Connector Removal

The input and output terminal block connectors on the DL105 are identical. The connectors are designed for easy removal with just a small screwdriver. The drawing below shows the procedure for removal at one end. You'll need to work at both ends of the connector, so the ends move upwards approximately together.

Connector Removal

1. Insert the screwdriver tip straight into the opening at the corner of the connector as shown.
2. Pry screwdriver tip so connector moves upward in direction of arrow.



The two terminal block connectors on DL105 PLCs have regular screw terminals, which will accept either standard or #2 Philips screwdriver tips. You can insert one 14 AWG wire under a terminal, or two 16 AWG wires (one on each side of the screw). Be careful not to overtighten; maximum torque is 6 inch/ounces.

Spare terminal block connectors and connector covers may be ordered by individual part numbers:

Part Number	Qty Per Package	Description
F1-IOCON	4	DL105 I/O Terminal Block
F1-IOCVR	4	DL105 I/O Terminal Cover

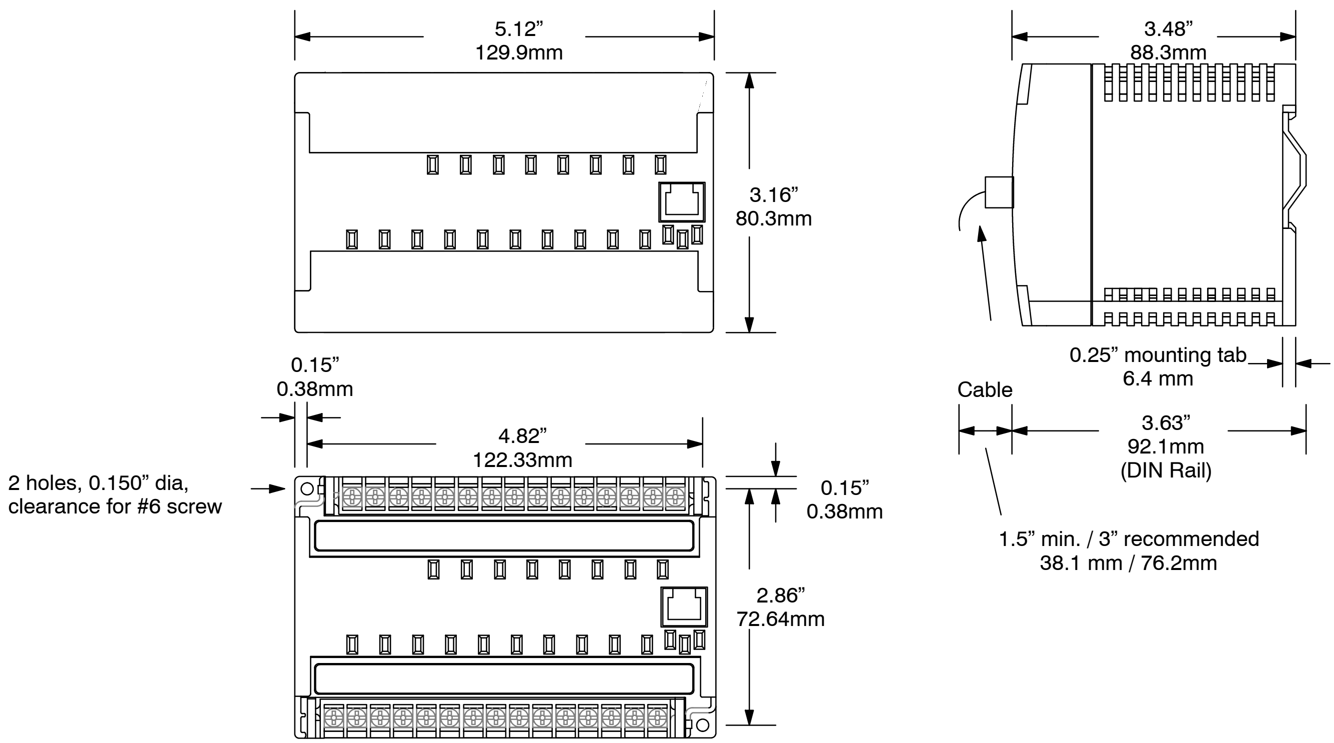
Mounting Guidelines

In addition to the panel layout guidelines, other specifications can affect the definition and 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 DL105. Make sure you follow the installation guidelines to allow proper spacing from other components.



Enclosures

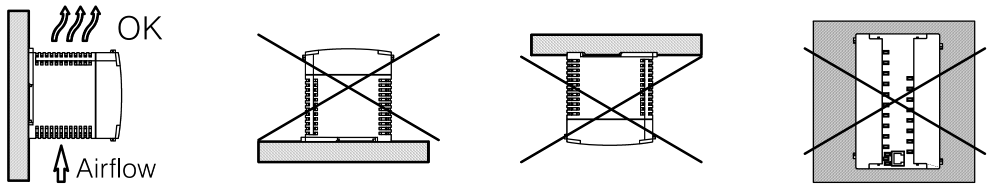
Your selection of a proper enclosure is important to ensure safe and proper operation of your DL105 system. Applications of DL105 systems vary and may require additional features. The minimum considerations for enclosures include:

- 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

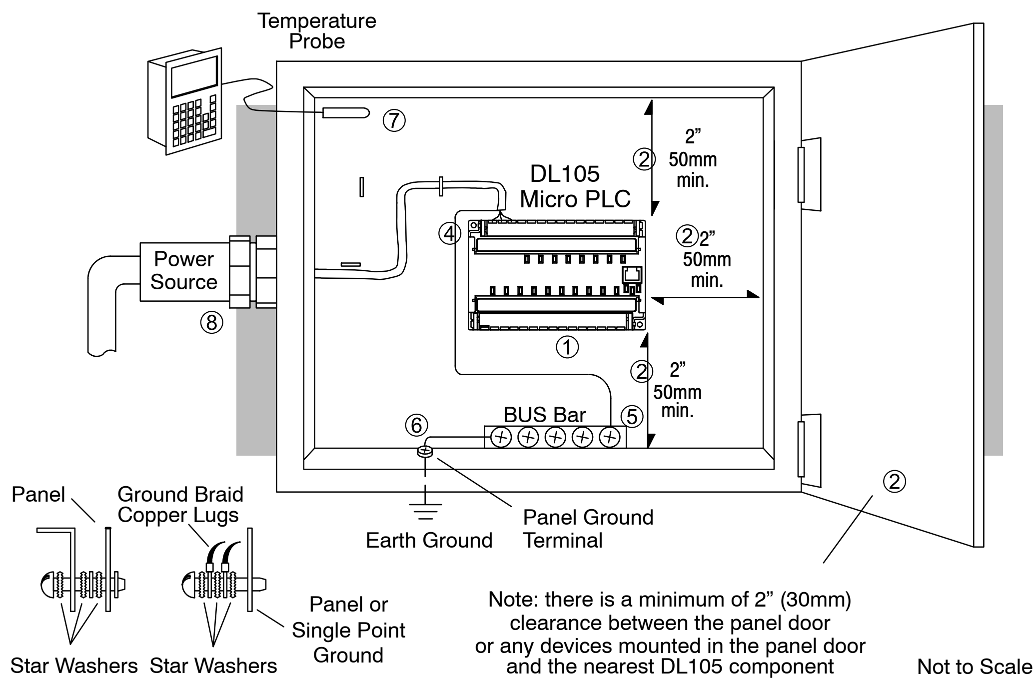
Panel Layout & Clearances

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 bases horizontally as shown below to provide proper ventilation. You ***cannot*** mount the DL105 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 2" (50mm) between the unit and all sides of the cabinet. *Note, 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 DL105 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.
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 DL105. 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 DL105 system, measures such as installing a cooling/heating source must be taken to get the ambient temperature within the range of specifications.
8. The DL105 systems are designed to be powered by 110 VAC , 220 VAC, 125 VDC or 24 VDC normally available throughout an industrial environment. Isolation transformers and noise suppression devices are not normally necessary, but may be helpful in eliminating/reducing suspected power problems.

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.

Agency Approvals

Some applications require agency approvals for particular components. The DL105 Micro PLC approval are listed below:

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

Environmental Specifications

The following table lists the environmental specifications that generally apply to DL105 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 DL105.

Specification	Rating
Storage temperature	-4° F to 158° F (-20° C to 70° C)
Ambient operating temperature*	32° F to 140° F (0° C to 60° C)
Ambient humidity**	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

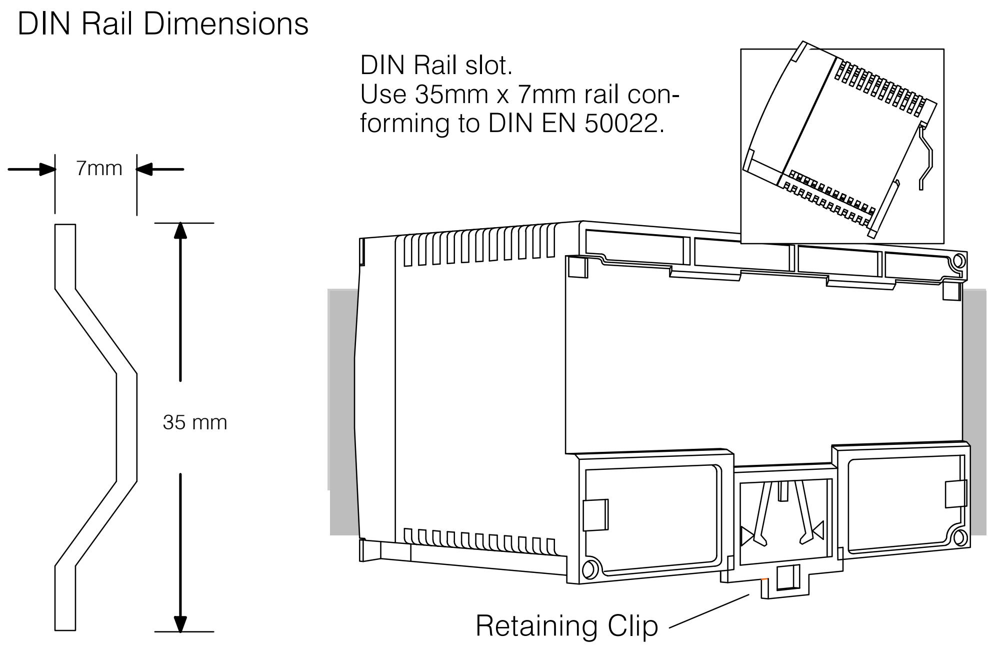
* Operating temperature for the Handheld Programmer and the DV-1000 is 32° to 122° F (0° to 50° C) Storage temperature for the Handheld Programmer and the DV-1000 is -4° to 158° F (-20° to70° C).
**Equipment will operate down to 5% relative humidity. However, static electricity problems occur much more 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.

Using Mounting Rails

DL105 Micro PLCs can also be secured to a cabinet by using mounting rails. We recommend rails that conform to DIN EN standard 50 022. They are approximately 35mm high, with a depth of 7.5mm. 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. These items can be ordered from **AutomationDirect.com** website, or from our catalog.

On the bottom of the PLC is a small retaining clip. To secure the PLC to a DIN rail, place it onto the rail and gently push up on the clip to lock it onto the rail.

To remove the PLC, pull down on the retaining clip, lift up on the PLC slightly, then pulling it away from the rail.

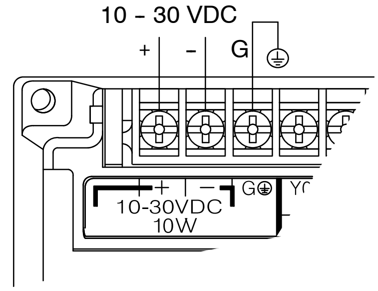


Wiring Guidelines

Power Input Wiring

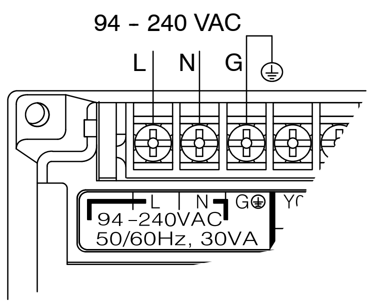
The diagram shows various possible external power connections for DL105 Micro PLCs. The terminals can accept up to 14 AWG wire. You may be able to use larger wiring depending on the wire type, but 14 AWG is the recommended size.

12/24 VDC Power Input

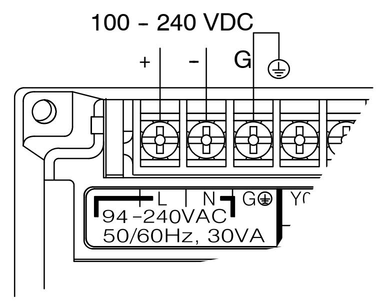


NOTE: You can connect either 115 VAC, 220 VAC, or 125 VDC to AC-powered versions of the DL105. Special wiring or jumpers are not required as with some of the other ***Direct***LOGIC products.

110/220 VAC Power Input



125 VDC Power Input



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

Fuse Protection for Input Power

There are no internal fuses for the input power circuits, so external circuit protection is needed to ensure the safety of service personnel and the safe operation of the equipment itself. To meet UL/CSA specifications, the input power must be fused.

Depending on the type of input power being used, follow these fuse protection recommendations:

208/240 VAC Operation

When operating the unit from 208/240 VAC, whether the voltage source is a step-down transformer or from two phases, fuse both the line (L) and neutral (N) leads. The recommended fuse size is 0.375A (for example, a Littlefuse 312.375 or equivalent).

110/125 VAC Operation

When operating the unit from 110/125 VAC, it is only necessary to fuse the line (L) lead; it is not necessary to fuse the neutral (N) lead. The recommended fuse size is 0.5A (for example, a Littlefuse 312.500 or equivalent).

125 VDC Operation

Proper fusing techniques are required when operating from 125 VDC. Depending on your ground reference, the hot lead must be fused. A DC failure can maintain an arc for much longer time and distance. Typically, the main bus is fused at a higher level than the branch device, which in this case would be the DL105 unit. This double fusing technique is required when operating from direct current. The recommended fuse size for the branch circuit to the DL105 is 0.5A (for example, a Littlefuse 312.500 or equivalent).

12/24 VDC Operation

When operating at these lower dc voltages, wire gauge size is just as important as proper fusing techniques. Using large conductors minimizes the voltage drop in the conductor. Each DL105 input power terminal can accommodate one 14 AWG or two 16 AWG wires. Each terminal block junction and/or connection creates a voltage drop, so try to keep the number of connections to a minimum. In general, when using 12/24 VDC input power, observe the same double fusing techniques that are used with 125 VDC input power. The recommended fuse size for the branch circuit to the DL105 is 1A (for example, a Littlefuse 312.001 or equivalent).

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:

Part Numbers	**F1-130AR, F1-130DR, F1-130AD, F1-130DD, F1-130AA, F1-130DA**	**F1-130DR-D, F1-130DD-D**
Input Voltage Range	85-132 VAC (110 nominal) 170-264 VAC (220 nominal), 100 – 264 VDC (125 nominal)	10 – 30 VDC (12 to 24VDC) with less than 10% ripple
Maximum Inrush Current	12 A, <1/2 mS	12 A, <1/2 mS
Maximum Power	30 VA (for AC power) 30 W (for DC power)	10W (0.3A @ 30VDC)
Voltage Withstand (dielectric)	1 minute @ 1500 VAC between primary, secondary, field ground	
Insulation Resistance	> 10 MΩ at 500 VDC	
Auxiliary 24 VDC Output	21.6-26.4 VDC Ripple less than 200 mV p-p 500 mA max, isolated.	None

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

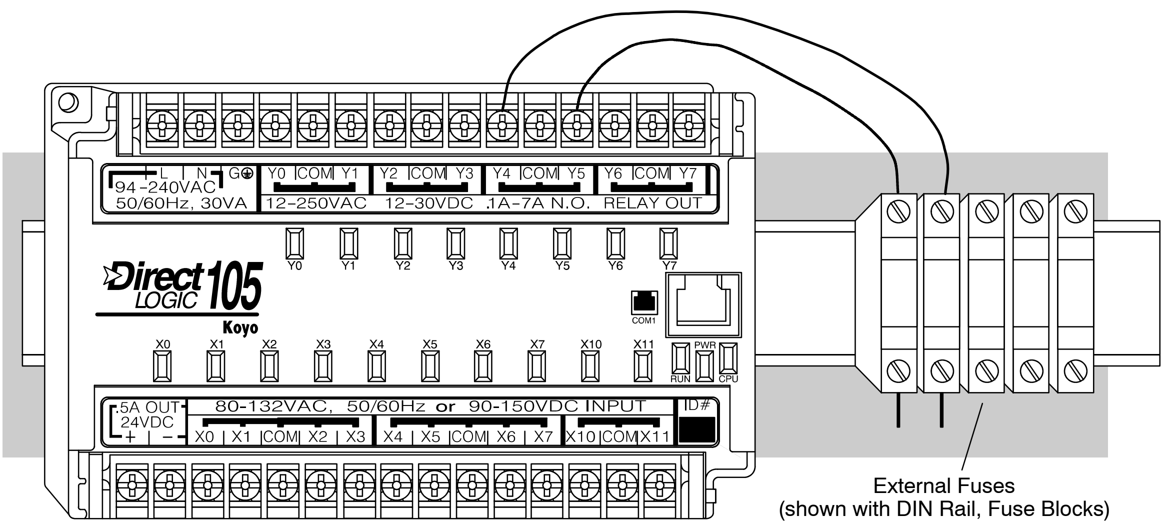
Planning the Wiring Routes

The following guidelines provide general information on how to wire the I/O connections to DL105 Micro PLCs. For specific information on wiring a particular PLC refer to the corresponding specification sheet further in this chapter.

1. Each terminal connection of the DL105 PLC can accept one 14 AWG wire or two 16 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.

Fuse Protection for Input and Output Circuits

Input and Output circuits on DL105 Micro PLCs do not have internal fuses. However, the +24V Auxiliary Supply is current-limited. 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.



External Fuses
(shown with DIN Rail, Fuse Blocks)

I/O Point Numbering

All DL105 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.

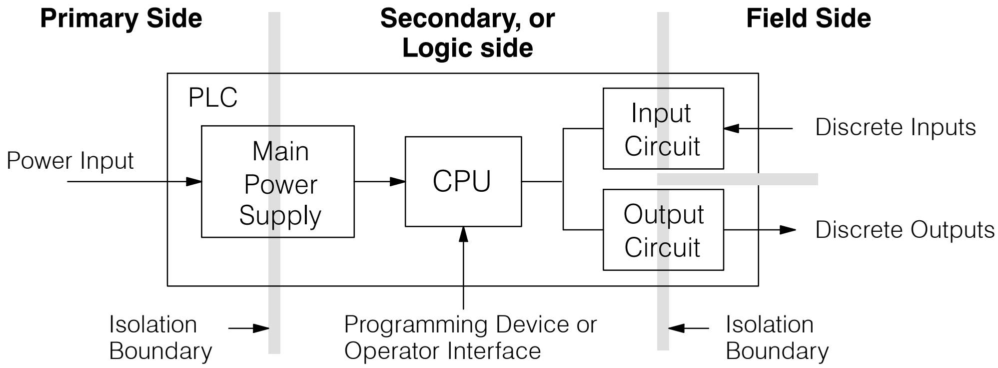
The I/O numbering always starts at zero and does not include the digits 8 or 9. The addresses are typically assigned in groups of 8 or 16, depending on the number of points in an I/O group. For the DL105 the ten inputs use reference numbers X0 – X7 and X10 – X11. The eight output points use references Y0 – Y7.

System Wiring Strategies

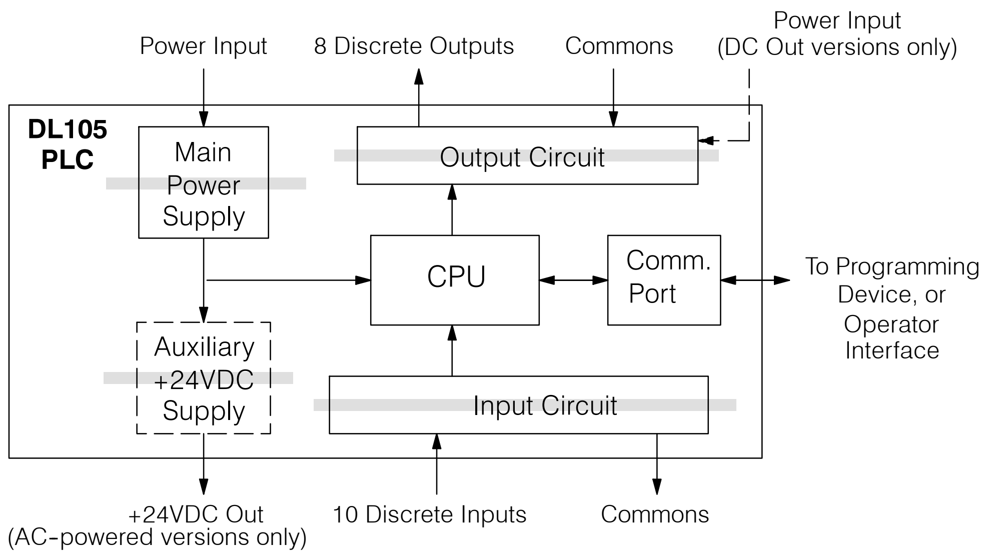
The DL105 Micro PLC is very flexible and will work in many different wiring configurations. By studying this section before actual installation, you can probably find the best wiring strategy for your application . This will help to lower system cost, wiring errors, and avoid safety problems.

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 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.*



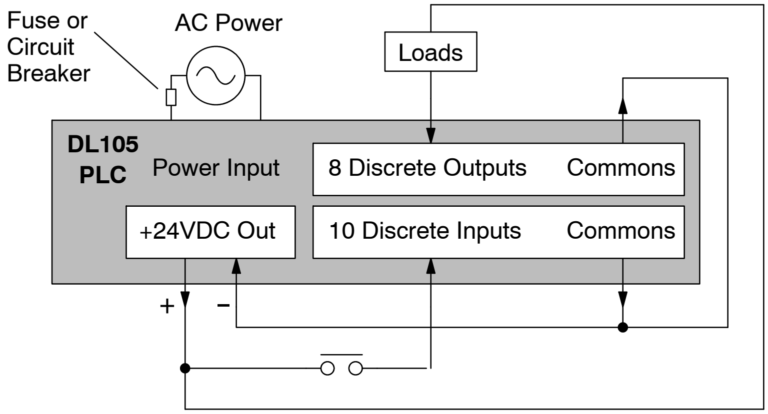
The next figure shows the internal layout of DL105 PLCs, as viewed from the front panel. In addition to the basic circuits covered above, it includes an auxiliary +24VDC power supply with its own isolation boundary. Since the supply output is isolated from the other three circuits, it can power input and/or output circuits!



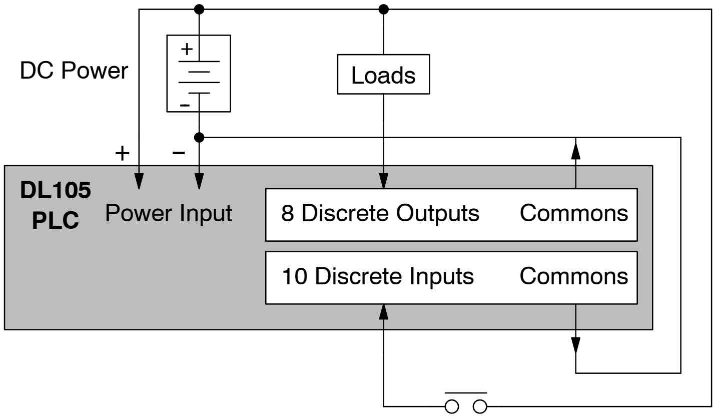
In many cases, using the built-in auxiliary +24VDC supply can result in a cost savings for your control system. It can power combined loads up to 500 mA, which is enough to eliminate the need for an additional power supply in some applications. If you are the system designer for your application, you may be able to select and design in field devices which can use the +24VDC auxiliary supply.

Powering I/O Circuits with the Auxiliary Supply

All AC-powered DL105 Micro PLCs feature the internal auxiliary supply. If input devices AND output loads need +24VDC power, the auxiliary supply can power both circuits as shown in the following diagram.



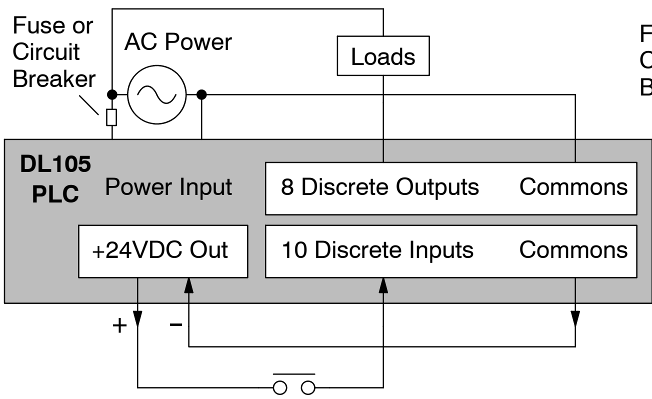
DC-powered DL105 Micro PLCs are designed for application environments in which low-voltage DC power is more readily available than AC. These include a wide range of battery–powered applications, such as remotely-located control, in vehicles, portable machines, etc. For this application type, all input devices and output loads typically use the same DC power source. The F1-130DR-D and F1-130DD-D are compatible with either +12VDC or +24VDC systems. Typical wiring for DC-powered applications is shown in the following diagram.

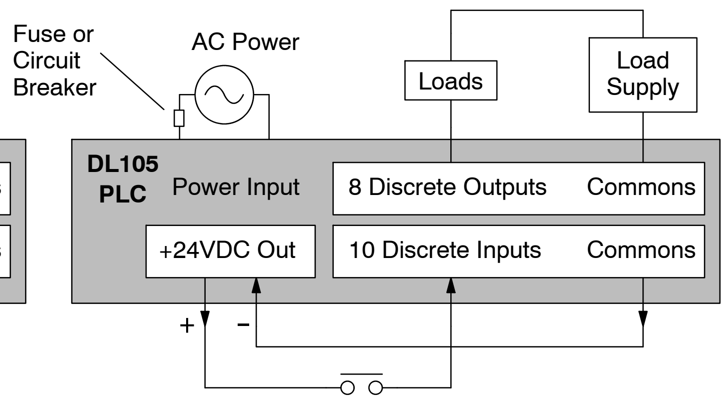


Powering I/O Circuits Using Separate Supplies

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

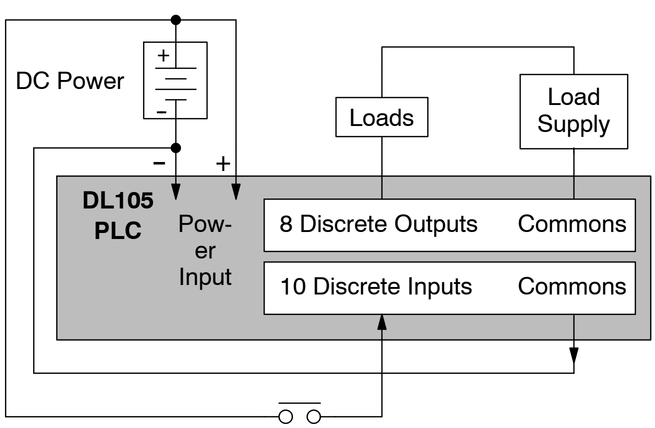
If the loads cannot be powered from the Micro PLC supply, then a separate supply must be used as shown to the right in the figure below.

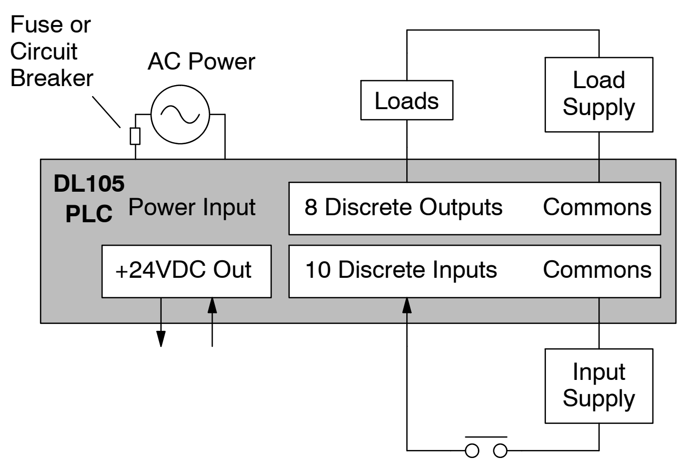




Some applications will use the Micro PLC power source to also power the input circuit. This typically occurs on a DC-powered DL105, as shown in the drawing below to the left. The inputs share the PLC power source supply, while the outputs have their own separate supply.

A worst-case scenario, from a cost and complexity view-point, is an application which requires separate power sources for the PLC, input devices, and output loads. The example wiring diagram below on the right shows how this can work, but also that the auxiliary supply out is an unused resource. For these reasons, you'll probably want to avoid this situation if possible.

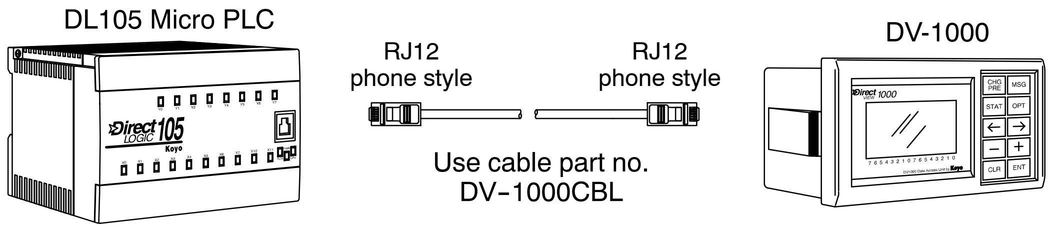




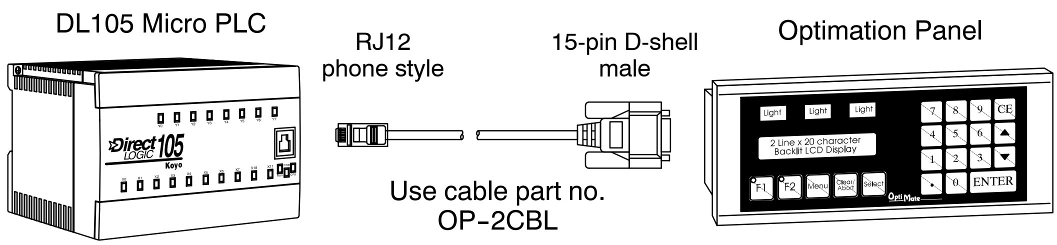
Connecting Operator Interface Devices

Operator interfaces require data and power connections. Operator interfaces with a large CRT usually require separate AC power. However, small operator interface devices like the DV-1000 Data Access Unit, some C–more Micro–Graphic panels and some Optimation panels may be powered directly from the DL105 Micro PLC.

Connect the DV-1000 to the DL105 Micro PLC COM1 port using the cable shown below. A single cable contains transmit/receive data wires and +5V power.

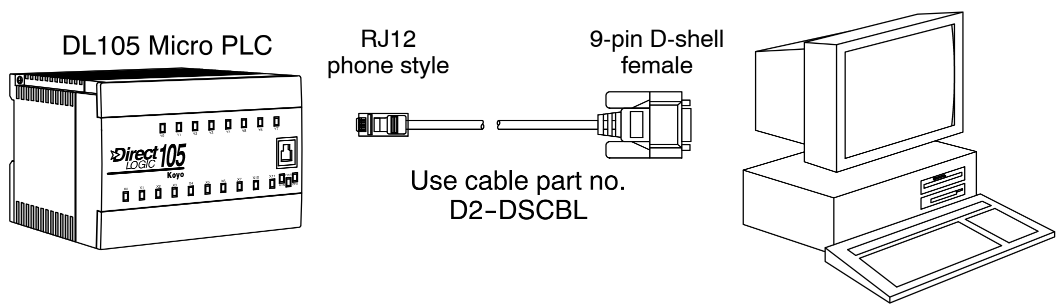


Optimation operator interface panels require separate power and communications connections. Connect the DL105 COM1 port to the 15-pin D-shell connector on the rear of the Optimation panel using the cable shown below. Optimation panels require 8–30VDC power, so use separate wiring to connect the +24VDC supply output on AC-powered DL105 PLCs. Use external +24VDC power for DC-powered DL105s.

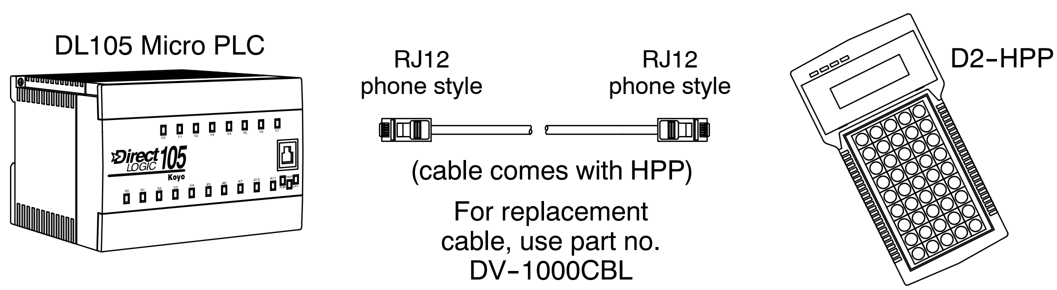


Connecting Programming Devices

DL105 Micro PLCs can be programmed with either a handheld programmer or with ***Direct***SOFT32 on a PC. Connect the DL105 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

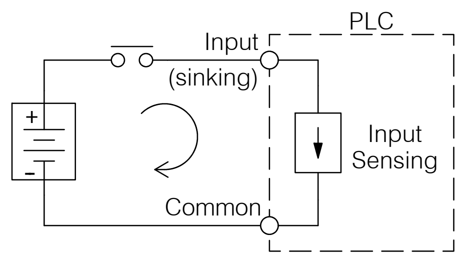
Before going further in our study of wiring strategies, we must have a solid understanding of "*sinking*" and "*sourcing*" concepts. Use of these terms occurs frequently in input or output circuit discussions. It is the goal of this section to make these concepts easy to understand, further ensuring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

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

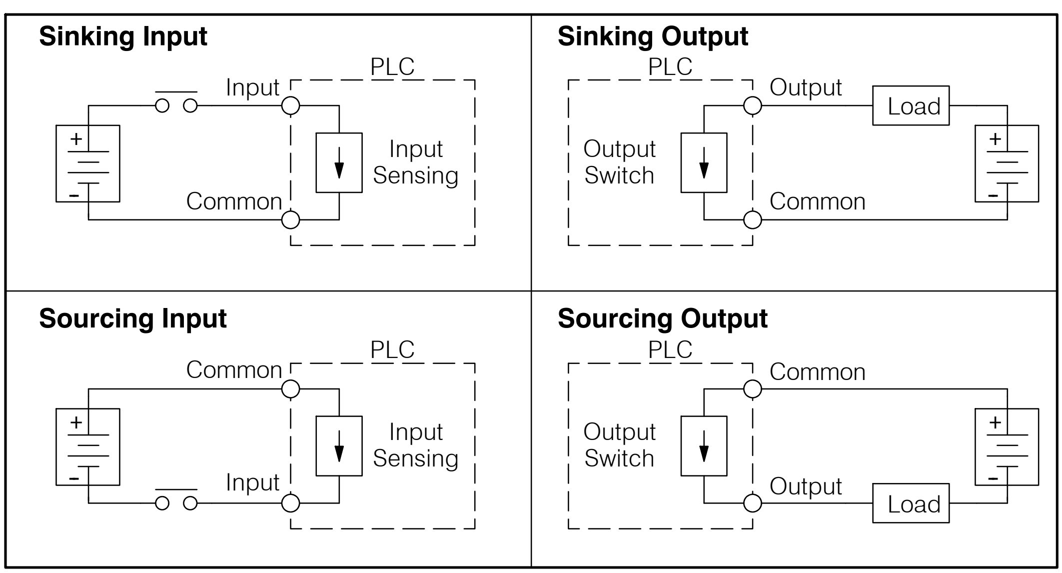
Sourcing = Path to supply **source (+)**

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.

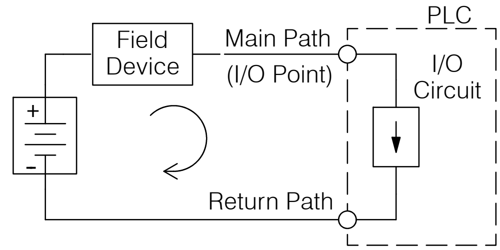


By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types, we have the four circuits as shown below. DL105 Micro PLCs provide all except the sourcing output I/O circuit types.

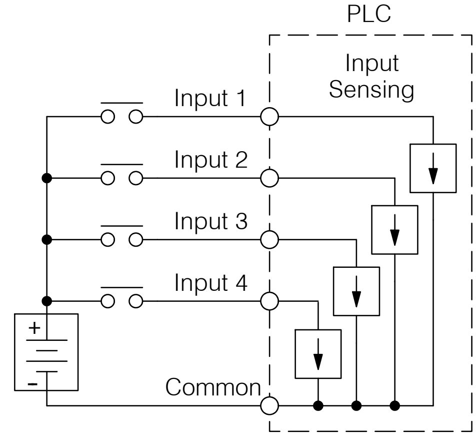


I/O "Common" Terminal Concepts

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.

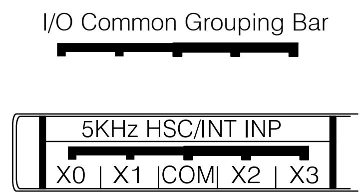


If we had unlimited space and budget for I/O terminals, then every I/O point could have two dedicated terminals just as the figure above shows. However, providing this level of flexibility is not practical or even necessary for most applications. So, most Input or Output point groups on PLCs share the 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.

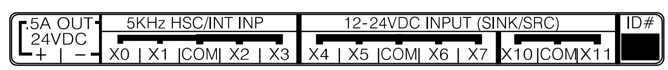


Note: In the circuit above, the current in the common path is 4 times any channel's input current when all inputs are energized. This is especially important in output circuits, where heavier gauge wire is sometimes necessary on commons.

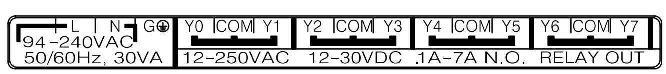
Most DL105 input and output circuits are grouped into banks that share a common return path. The best indication of I/O common grouping is on the wiring label. The I/O common grouping bar, labeled at the right, occurs in the section of wiring label below it. It indicates X0, X1, X2, and X3 share the common terminal located between X1 and X2.



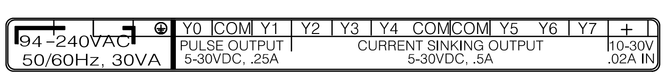
The following complete label shows two banks of four inputs and one bank of two.



The following label for relay outputs shows four banks of two output points each.



The last label below for DC outputs has no common grouping bar. In this unique case, all eight outputs share the same electrical common. The common is available on three terminals, so there is a physical place to connect each point's common wire.

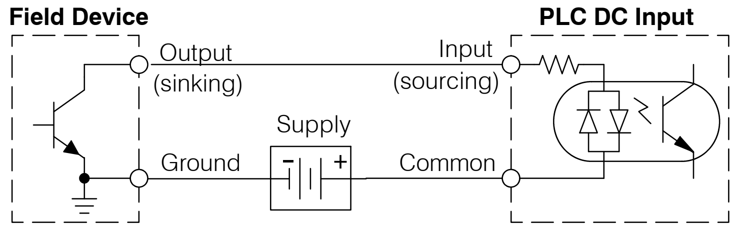


Connecting DC I/O to "Solid State" Field Devices

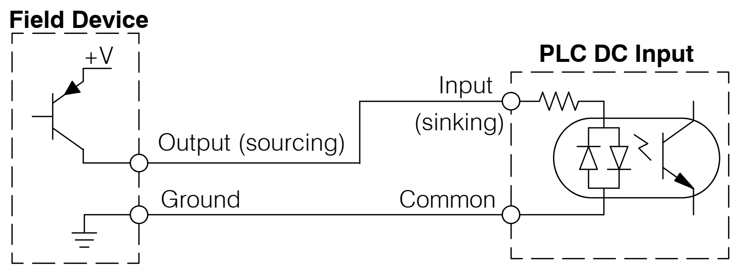
In the previous section on Sourcing and Sinking concepts, we explained that DC I/O circuits sometimes will only allow current to flow one way. This is also true for many of the field devices which have solid-state (transistor) interfaces. In other words, field devices can also be sourcing or sinking. *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 DL105'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 +24 auxiliary supply or another supply (+12 VDC or +24VDC), as long as the input specifications are met.



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

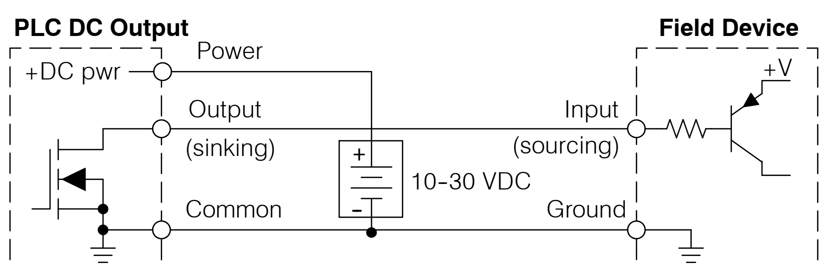


Solid State Output Loads

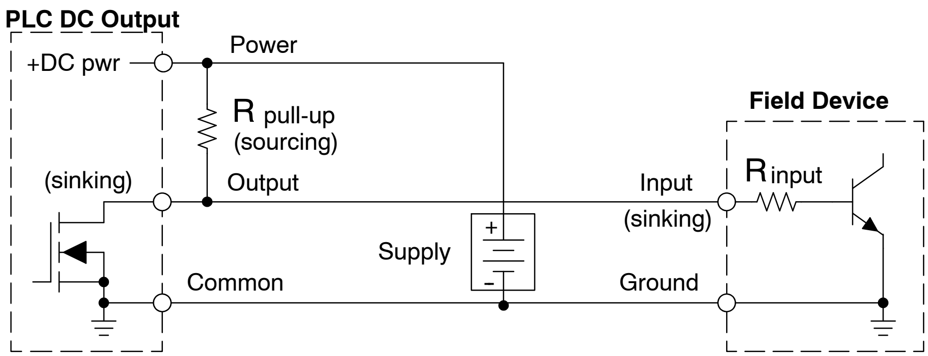
Sometimes an application requires connecting a PLC output point to a solid state input on a device. This type of connection is usually made to carry a low-level signal, not to send DC power to an actuator.

The DL105's DC outputs are sinking-only. This means that each DC output provides a path to ground when it is energized. Also, remember that all eight outputs have the same electrical common, even though there are three common terminal screws. Finally, recall that the DC output circuit requires power (10 – 30 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.



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 $R_{pull-up}$ from the output to the DC output circuit power input.



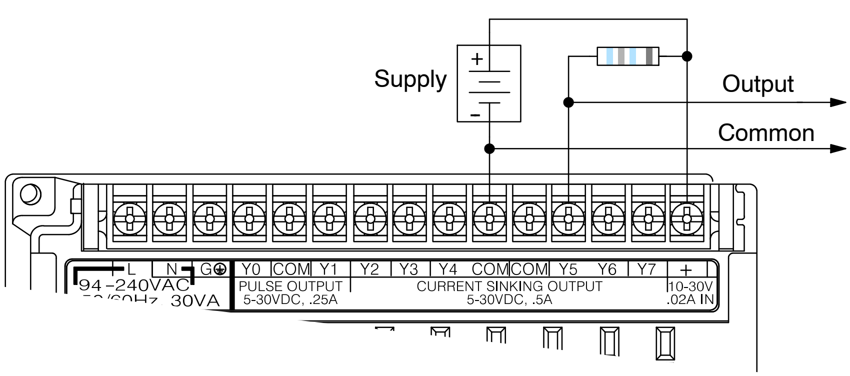
NOTE 1: DO NOT attempt to drive a heavy load (>25 mA) with this pull-up method.
NOTE 2: Using the pull-up resistor to implement a sourcing output has the effect of inverting the output point logic. In other words, the field device input is energized when the PLC output is OFF, from a ladder logic point-of-view. 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 $R_{pull-up}$. 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 $R_{pull-up}$. Then calculate the power $P_{pull-up}$ (in watts), in order to size $R_{pull-up}$ properly.

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

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

The drawing below shows the actual wiring of the DL105 Micro PLC to the supply and pull-up resistor.



Relay Output Wiring Methods

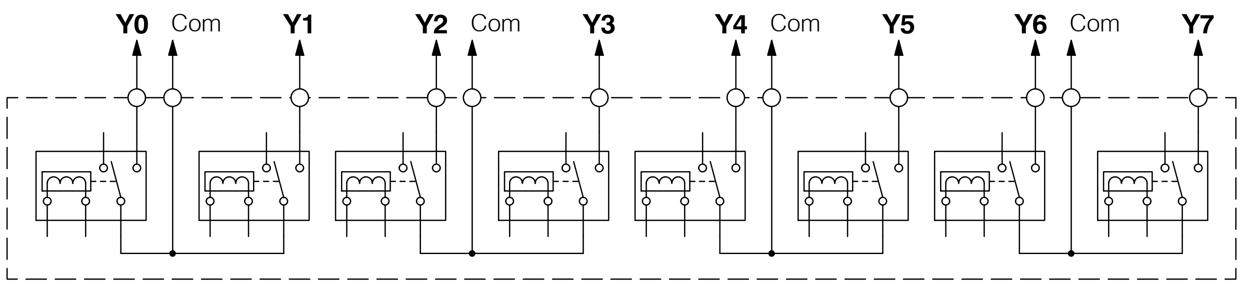
The F1-130AR, F1-130DR/F1-130DR-CE, and F1-130DR-D models feature relay outputs. Relays are best for the following applications:

- Loads that require higher currents than the solid-state DL105 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)

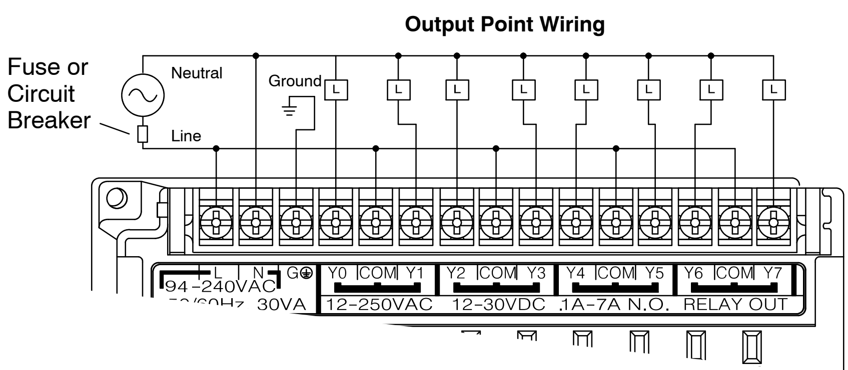
Some applications in which NOT to use relays:

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

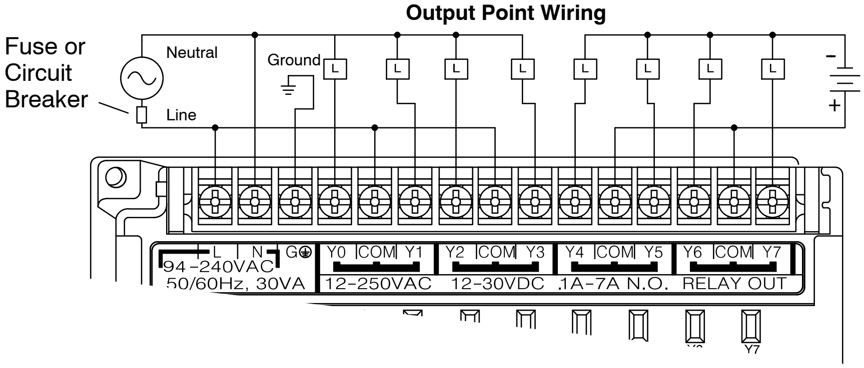
Assuming relays are right for your application, we're now ready to explore various ways to wire relay outputs to the loads. Note that there are eight normally-open SPST relays available. They are organized into four pairs with individual commons. The figure below shows the relays and the internal wiring of the PLC. Note that each pair is isolated from the other three relay pairs.



In the circuit below, all loads use the same AC power supply which powers the DL105 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 DL105 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.



Surge Suppresion 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.

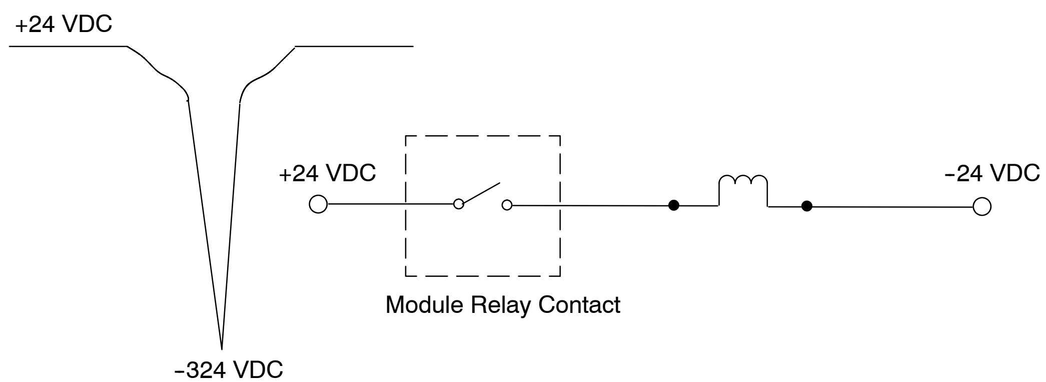
When switching a DC-supplied inductive load the full supply voltage is always present when the relay contact opens (or “bounces”). When switching an AC-supplied inductive load there is one chance in 60 (60 Hz) or 50 (50 Hz) that the relay contact will open (or “bounce”) when the AC sine wave is zero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

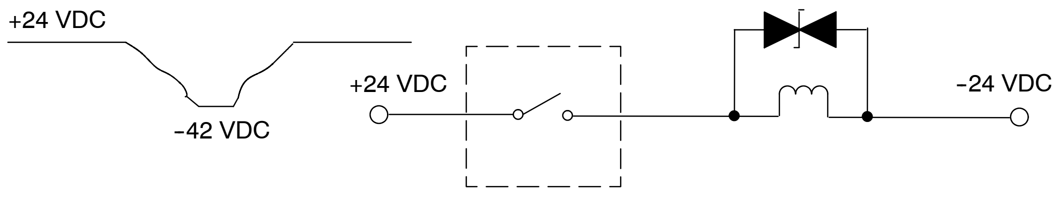
Transient Voltage Suppressors (TVS or transorb) provide the best surge and transient suppression of AC and DC powered coils, providing the fastest response with the smallest overshoot.

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.

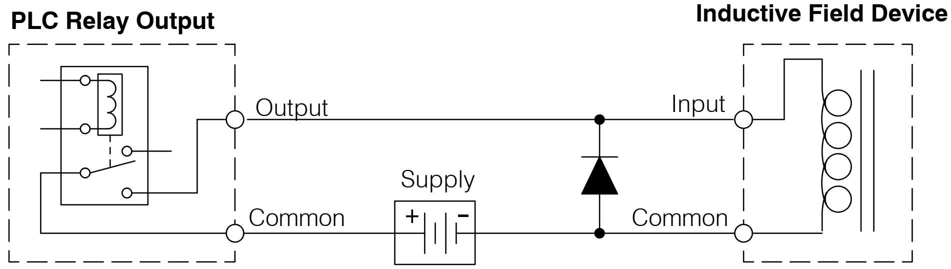
Surge Suppressors			
Vendor / Catalog	**Type (TVS, MOV, Diode)**	**Inductive Load Voltage**	**Part Number**
AutomationDirect Transient Voltage Suppressors www.automationdirect.com	TVS TVS	110/120 VAC 24 VDC	ZL-TD8-120 ZL-TD8-24
General Instrument Transient Voltage Suppressors and LiteOn Diodes: from-Digi-Key Catalog: www.digikey.com; Phone: 1-800-344-4539	TVS, MOV TVS, MOV TVS Diode	110/120 VAC 220/240 VAC 12/24 VDC or VAC 12/24 VDC or VAC	Contact Digi-Key, Corp. catalog or website

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.

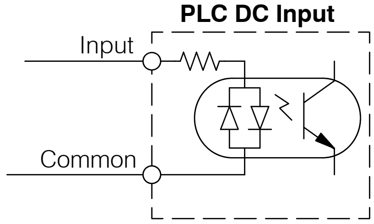
For inductive loads in DC circuits we recommend using a suppression diode as shown in the following diagram (DO NOT use this circuit with an AC power supply). When the load is energized the diode is reverse-biased (high impedance). When the load is turned off, energy stored in its coil is released in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

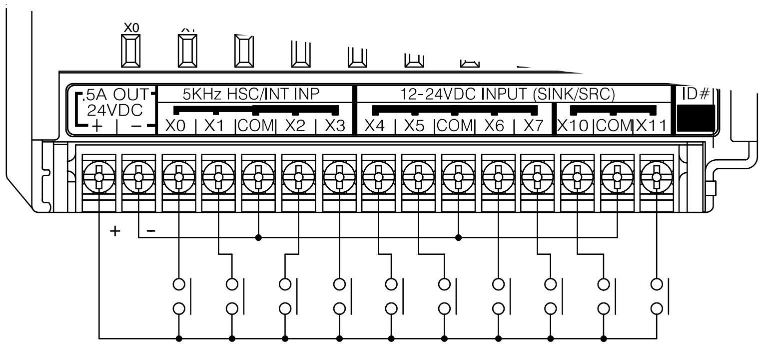


DC Input Wiring Methods

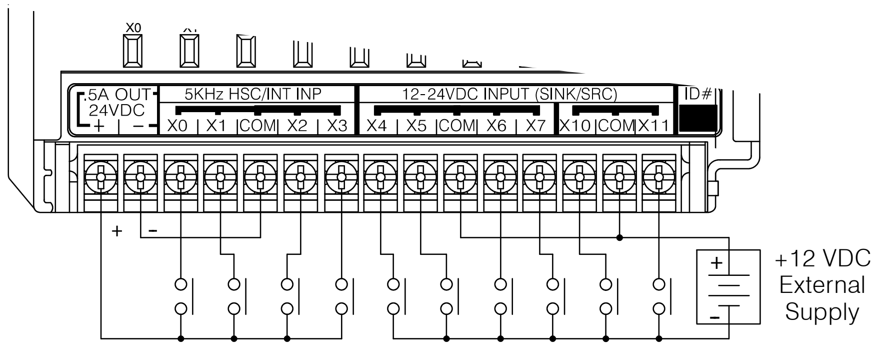
DL105 Micro PLCs with DC inputs are particularly flexible because they can be either sinking or sourcing. The dual diodes (shown to the right) allow current to flow in either direction. The inputs accept either 10 – 26.4 VDC or 21.6 – 26.4 VAC. That's right, either AC or DC voltages will work. The target applications are +12 VDC, +24 VDC, and 24 VAC. You can actually wire part of the inputs as DC sinking, others as DC sourcing, and the rest as AC!



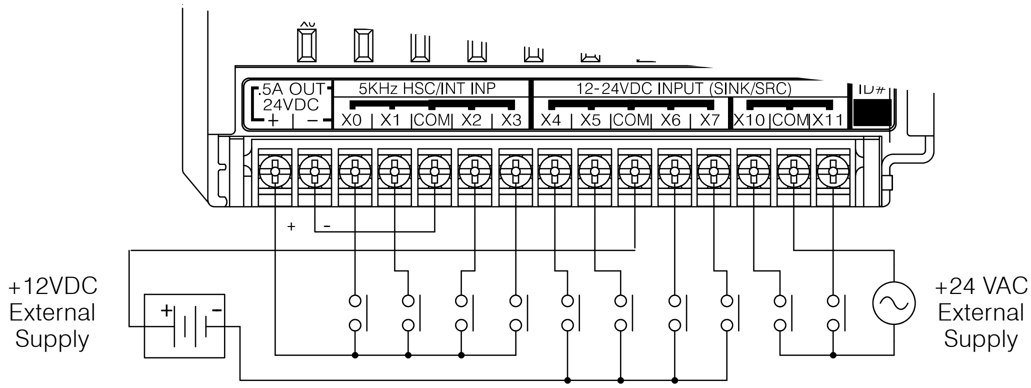
In the first and simplest example below, all commons are connected together and all inputs are sinking.



In the next example, the first four inputs are sinking, and the last six are sourcing.



In the last example, four inputs are sinking DC, four are sourcing DC, and two are AC.



DC Output Wiring Methods

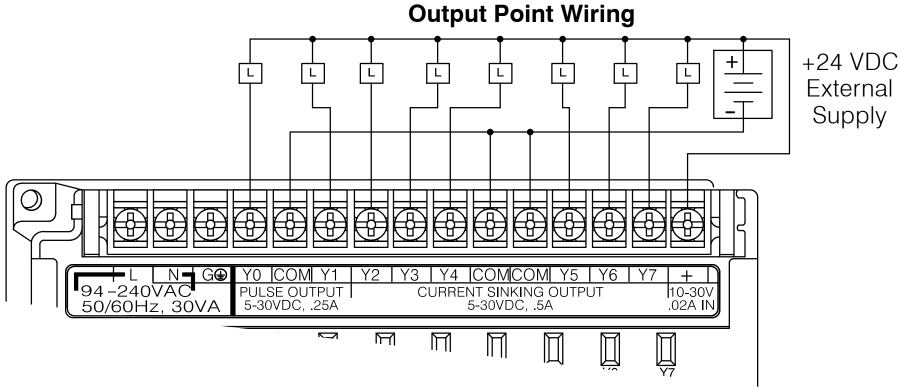
DL105 DC output circuits are high-performance MOSFET switches with low on-resistance and fast switching times. Please note the following characteristics which are unique to the DC output type:

- There is only one electrical common for all eight outputs, even though there are three common terminals. All eight outputs belong to one bank.
- The output switches are current-sinking only. However, you can still use different DC voltages from one load to another.
- 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.

NOTE: Always connect all three common terminals together at the connector with short wires (do not leave some common terminals unconnected).This provides three connections to share the load return current, enhancing reliability.

In the example below, all eight outputs share a common supply. It may be external as shown, or they may use the auxiliary +24VDC supply when available.

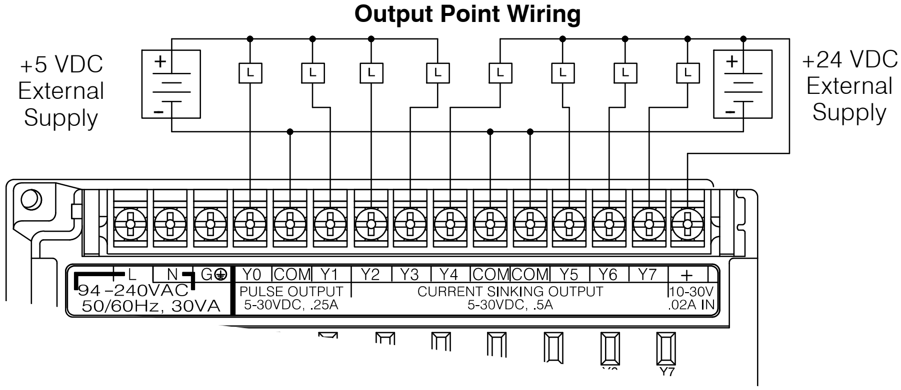
Output Point Wiring



In the next example below, the outputs have "split" supplies. The first four outputs are using a +5 VDC supply, and the last four are using a +24 VDC supply. However, you can split the outputs among any number of supplies, as long as:

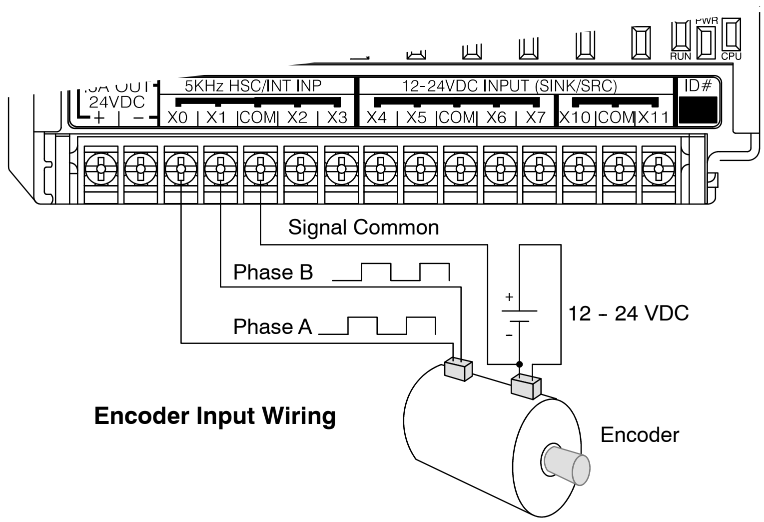
- all supply voltages are within the specified range
- all output points are wired as sinking
- all source (–) terminals are connected together

Output Point Wiring



High-Speed I/O Wiring Methods

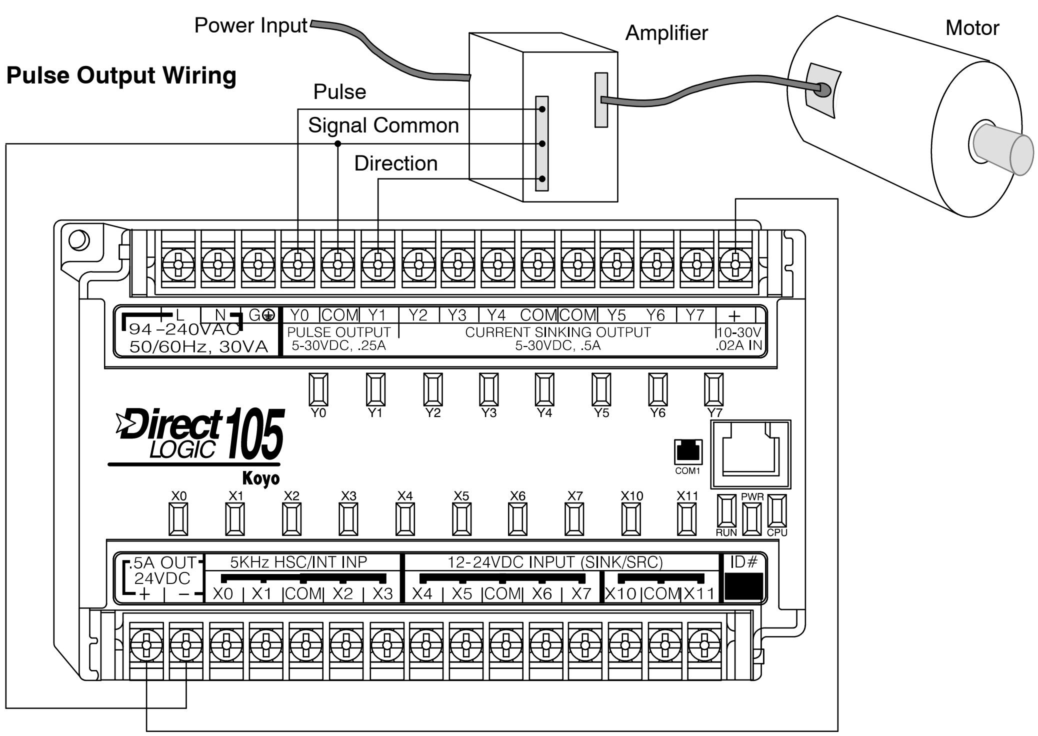
DL105 versions with DC type input or output points contain a dedicated High-Speed I/O circuit (HSIO). The circuit configuration is programmable, and it processes select I/O points independently from the CPU scan. Chapter 4 discusses the programming options for HSIO. While the HSIO circuit has six modes, 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 DL105 can count quadrature pulses at up to 5 kHz from an incremental encoder as shown below.



Encoder Input Wiring

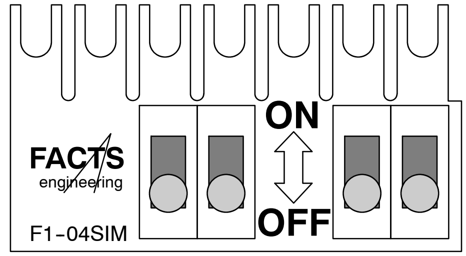
DL105 versions with DC type output points can use the High Speed I/O Pulse Output feature. It can generate high-speed pulses for specialized control such as stepper motor / intelligent drive systems. Outputs Y0 and Y1 can generate pulse and direction signals, or they can generate CCW and CW pulse signals respectively. See Chapter 3 on high-speed input and pulse output options.

Pulse Output Wiring



F1–04SIM Input Simulator Wiring

The F1–04SIM Input Simulator, shown to the right, provides four switches for inputs X0 through X3. The simulator is useful during program development or for debug purposes. It works by using the +24VDC auxiliary supply output, routing the voltage through the switches and into the inputs.



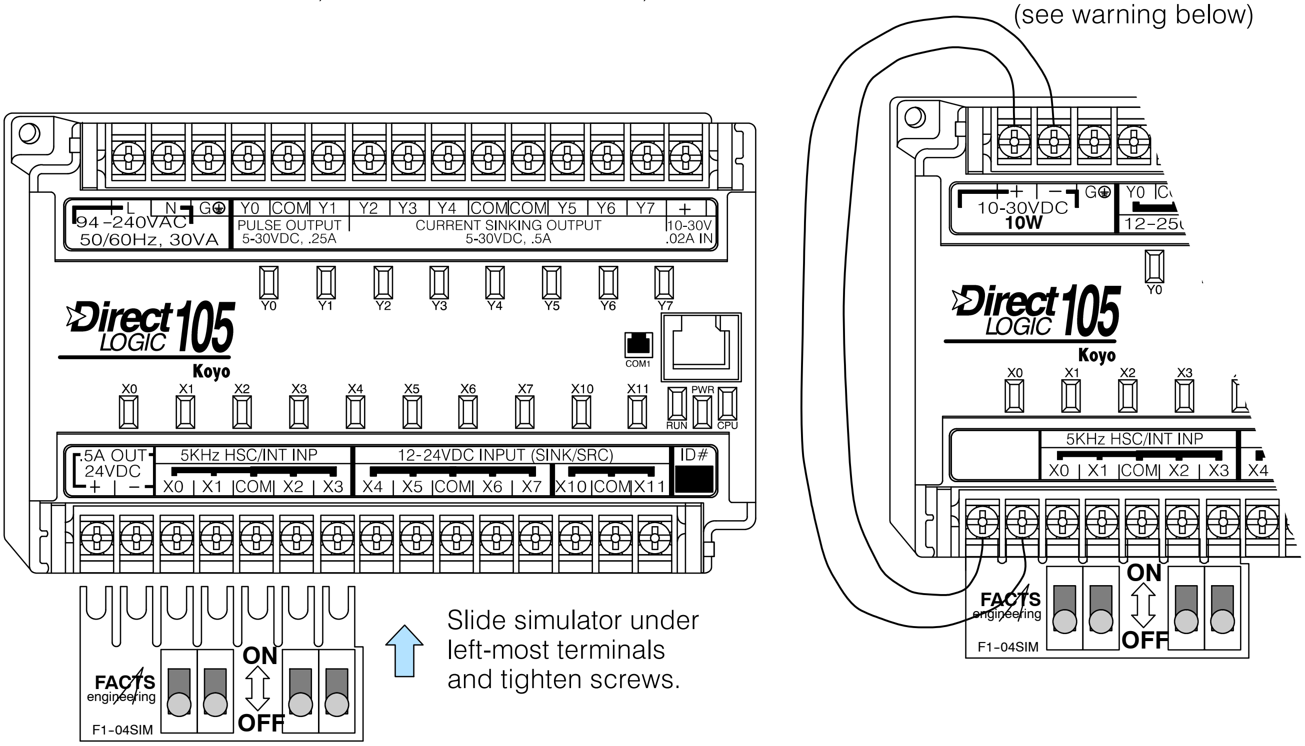
In use, the simulator can quickly provide test inputs to your ladder program. The status of outputs is observable on the front panel LEDs, even without wiring the outputs to any loads.

The Simulator works on all DC input versions of the DL105. DC-powered versions need two wires from the power input to connect to the two left-most terminals on the simulator (wiring shown below), since DC-powered units do not generate +24VDC auxiliary output. Polarity does not matter, since the inputs can be sinking or sourcing.

NOTE: The Input Simulator will not work on DL105 micros with AC type inputs. The +24 VDC auxiliary supply voltage is less than the required input threshold.

F1–130DR/F1–130DR–CE, F1–130DD/F1–130DD–CE, F1–130DA

F1–130DR–D, F1–130DD–D only
(see warning below)



NOTE: Never attempt to install more than one simulator on one DL105 PLC.

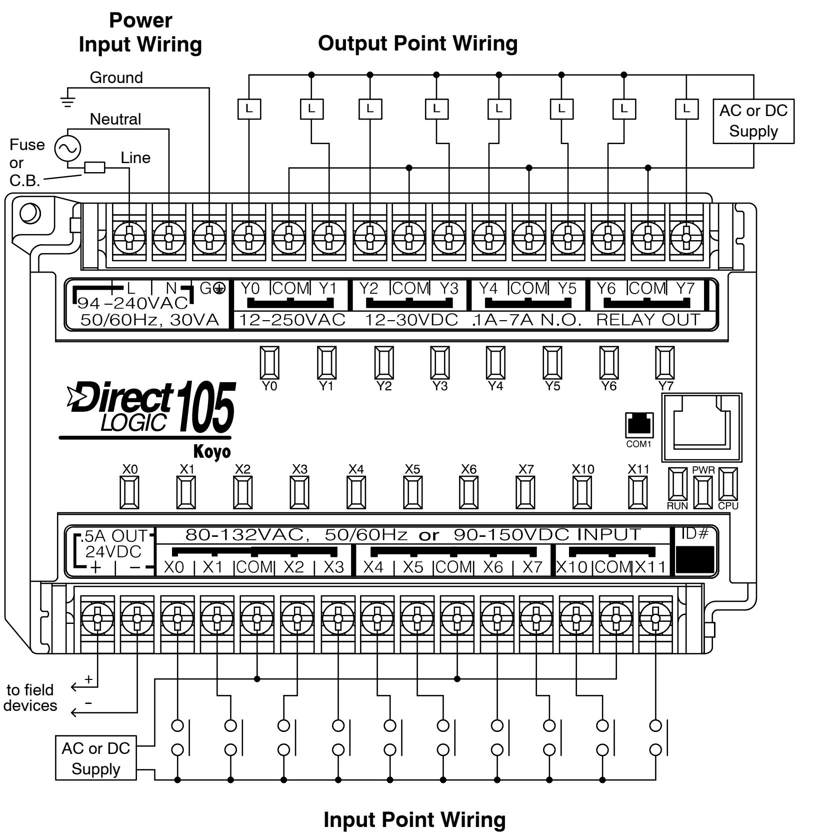
WARNING: DO NOT use the two wires as shown above on AC-powered DL105 PLCs. Doing so will permanently damage the Micro PLC and may result in electrical shock due to the exposed circuit board of the input simulator.

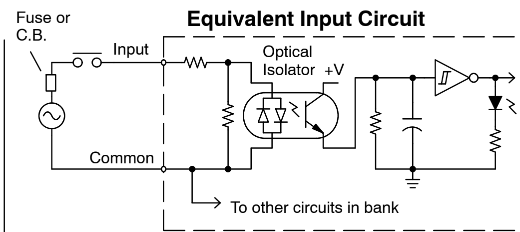
Wiring Diagrams and Specifications

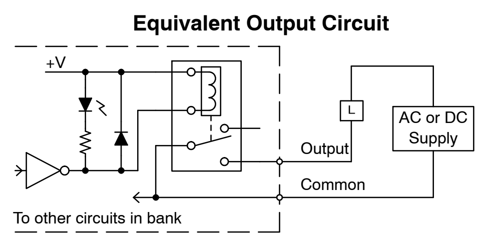
The remainder of this chapter dedicates two to three pages to each of the eight versions of DL105 Micro PLCs. Each section contains a basic wiring diagram, equivalent I/O circuits, and specification tables. Please refer to the section which describes the particular DL105 version used in your application.

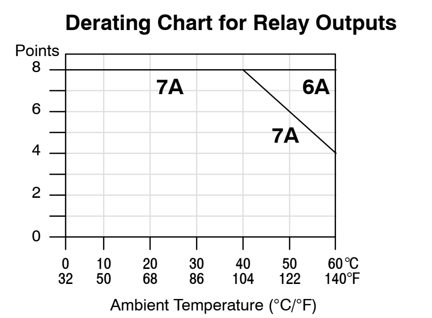
F1–130AR I/O Wiring Diagram

The F1–130AR Micro PLC features ten AC inputs and eight relay contact outputs. The following diagram shows a typical field wiring example. The AC external power connection uses three terminals at the top left as shown.









The ten AC input channels use terminals on the bottom connector. This input type also works for high-voltage DC signals. Inputs are organized into two banks of four, plus one bank of two. Each bank has a common terminal. In the case of DC input signals, the input may be wired in as either the sourcing or sinking type. The wiring example above 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.

The eight relay output channels use terminals on the top connector. Outputs are organized into four banks of two 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.

Auxiliary +24V Power Supply

The F1–130AR has a +24V supply output to power external devices. The output is rated at 0.5 Amperes, and includes short-circuit protection and full isolation from internal CPU circuitry. These features make it ideal for powering sensors, solenoids, and other field devices. In fact, it can be used as the DC supply for loads in the relay output circuits. Be sure the combined load currents do not exceed 0.5 A. Note that on the F1–130AR, the +24V auxiliary output is not high enough to power its input circuits (input ON threshold is 90VDC).

F1–130AR General Specifications

External Power Requirements	100 – 240 +10% –15%
Communication Port	K–Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2–DSCBL
Internal Field Supply Ratings	+24VDC , 0.5A maximum, isolated
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	–4 to 158° F (–20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

AC Input Specifications X0 – X7, X10 – X11

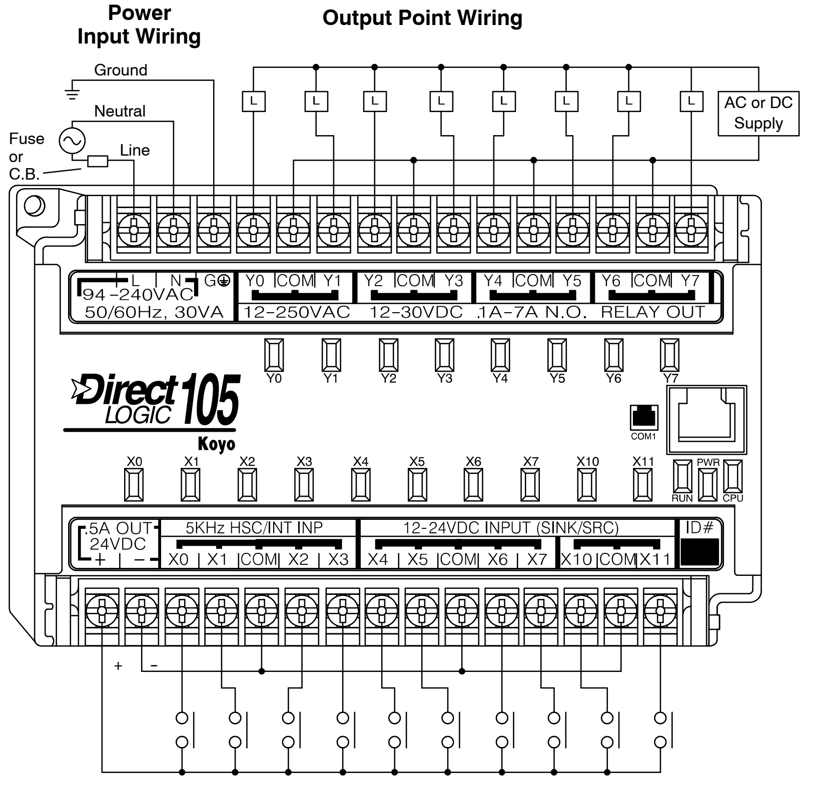
Input Voltage Range for ON condition	80 – 132 VAC, or 90 – 150 VDC
Input Current	6 mA @ 132 VAC 6.8 mA @ 150 VDC
Maximum Voltage	132 VAC, or 150 VDC
ON Current/Voltage	>4 mA @ 80 VAC, or 90 VDC
OFF Current/Voltage	<2 mA @ 45 VAC, or 60 VDC
OFF to ON Response	< 8 mS
ON to OFF Response	<15 mS
Status Indicators	Logic Side
Commons	4 channels / common x 2 banks, 2 channels / common x 1 bank

Relay Output Specifications Y0 – Y7

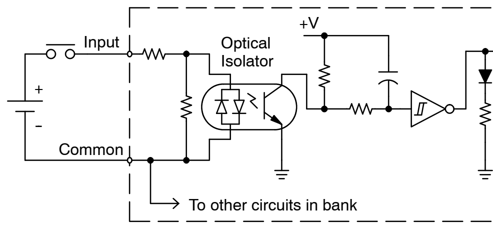
Operating Voltage	12 – 250 VAC, 12 – 30 VDC @ 7A, 30 – 150 VDC @ 0.5A, resistive
Output Current	7A / point (subject to derating) 14A / common
Maximum Motor Load	1/3 HP
Maximum Voltage	265 VAC, 150 VDC
Minimum Off Resistance	100 meg ohms @ 500 VDC
Smallest Recommended Load	10 mA
OFF to ON Response	15 mS
ON to OFF Response	5 mS
Status Indicators	Logic Side
Commons	2 channels / common x 4 banks
Fuses	None (external recommended)

F1–130DR/ F1–130DR–CE I/O Wiring Diagram

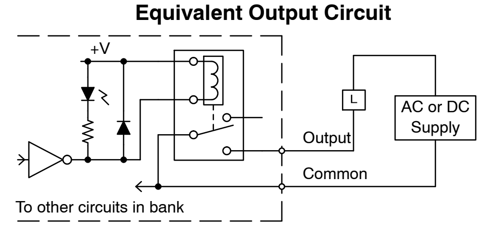
These micro PLCs feature ten DC inputs and eight relay contact outputs. The following diagram shows a typical field wiring example. The AC external power connection uses three terminals at the top left as shown.



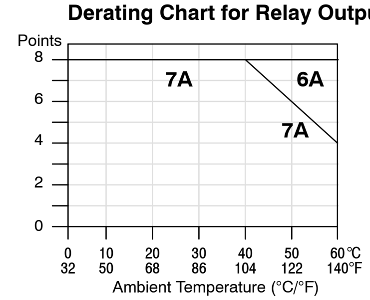
Equivalent Circuit, Standard Inputs (X4 – X11)



Equivalent Output Circuit

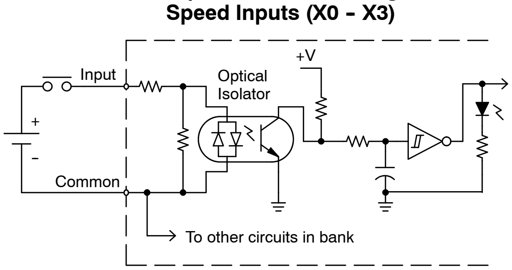


Derating Chart for Relay Outputs



The ten DC input channels use terminals on the bottom connector. Inputs are organized into two banks of four, plus one bank of two. 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. The equivalent circuit for standard inputs is shown above, and the high-speed input circuit is shown to the right.

Equivalent Circuit, High-Speed Inputs (X0 – X3)



The eight output channels use terminals on the top connector. Outputs are organized into four banks of two 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.

Auxiliary +24V Power Supply

These versions have a +24V supply output to power external devices. The output is rated at 0.5 Amperes, and includes short-circuit protection and full isolation from internal CPU circuitry. These features make it ideal for powering sensors, solenoids, and other field devices. In fact, it can be used as the DC supply for switches or sensors in the input circuit, or for loads in the relay output circuits. Be sure the combined load currents do not exceed 0.5 A.

F1-130DR/ F1-130DR-CE General Specifications

External Power Requirements	100 – 240 +10% -15%
Communication Port	K-Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2-DSCBL
Internal Field Supply Ratings	+24VDC , 0.5A maximum, isolated
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

DC Input Specifications

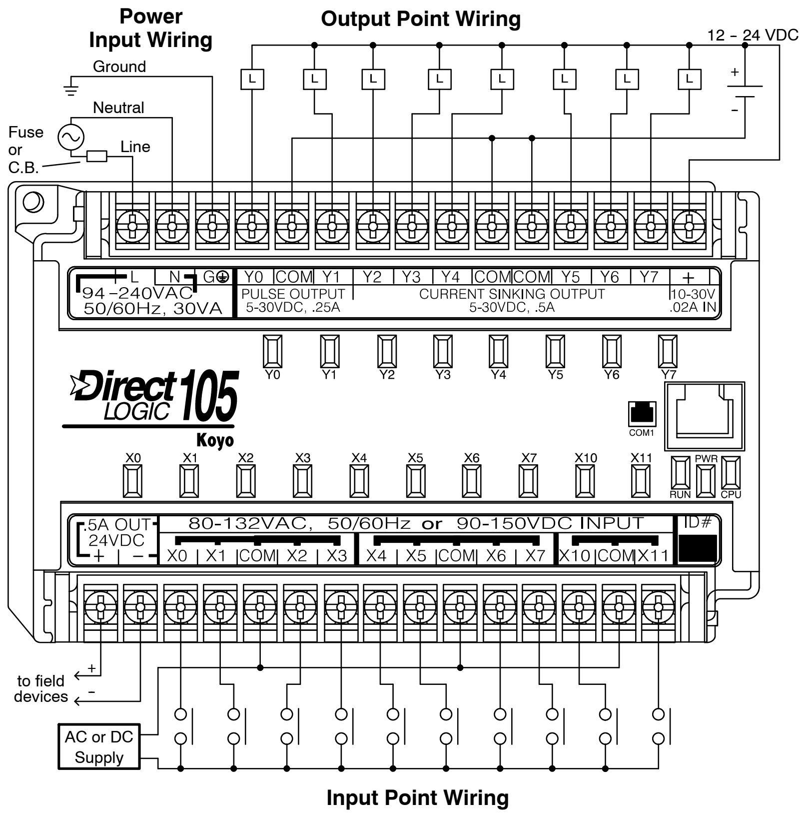
Parameter	High-Speed Inputs, X0 – X3	Standard DC Inputs X4 – X11
Input Voltage Range	10 – 26.4 VDC	10 – 26.4 VDC or 21.6 – 26.4 VAC
Maximum Voltage	30 VDC (5 kHz maximum frequency)	30 VDC
Minimum Pulse Width	100 μs	N/A
ON Voltage Level	> 9.0 VDC	> 9.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	2.8 kΩ @ 12 – 24 VDC	2.8 kΩ @ 12 – 24 VDC
Minimum ON Current	>3 mA	>3 mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<50 μs	2 – 8 mS, 4 mS typical
ON to OFF Response	< 50 μs	2 – 8 mS, 4 mS typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 1 bank	4 channels / common x 1 bank, 2 channels / common x 1 bank

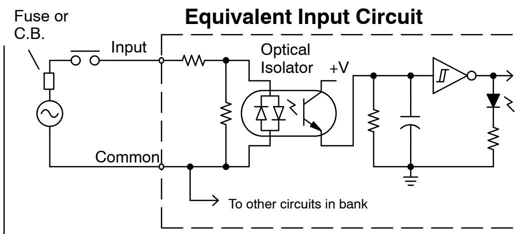
Relay Output Specifications

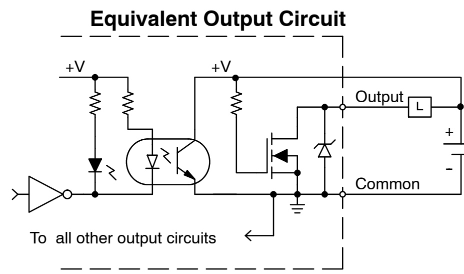
Operating Voltage	12 – 250 VAC, 12 – 30 VDC @ 7A, 30 – 150 VDC @ 0.5A, resistive
Output Current	7A / point (subject to derating) 14A / common
Maximum Motor Load	1/3 HP
Maximum Voltage	265 VAC, 30 VDC
Minimum Off Resistance	100 meg ohms @ 500 VDC
Smallest Recommended Load	10 mA
OFF to ON Response	15 mS
ON to OFF Response	5 mS
Status Indicators	Logic Side
Commons	2 channels / common x 4 banks
Fuses	None (external recommended)

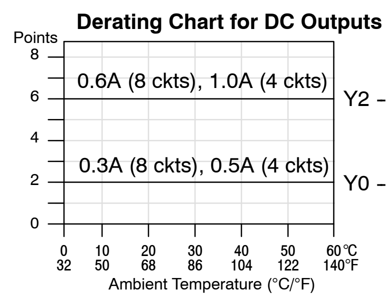
F1–130AD I/O Wiring Diagram

The F1–130AD Micro PLC features ten AC inputs and eight DC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses three terminals at the top left as shown.









The ten AC input channels use terminals on the bottom connector. This input type also works for high-voltage DC signals. Inputs are organized into two banks of four, plus one bank of two. Each bank has an isolated common terminal. In the case of DC input signals, the input may be wired in as either the sourcing or sinking type. The wiring example above 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.

The eight current sinking DC output channels use terminals on the top connector. The three common terminals are internally connected, meaning all outputs actually share the same electrical common. The wiring example above shows all commons connected together, because it is best to share the common current among the three terminal connections. Note the requirement for external power on the end (right-most) terminal. The equivalent output circuit shows one channel of the bank of eight.

Auxiliary +24V Power Supply

The F1–130AD has a +24V supply output to power external devices. The output is rated at 0.5 Amperes, and includes short-circuit protection and full isolation from internal CPU circuitry. These features make it ideal for powering sensors, solenoids, and other field devices. In fact, it can be used as the supply for loads in the DC output circuits. Since the outputs are the sinking type, you'll need to connect +24V to the output commons. Be sure the combined load currents do not exceed 0.5 A. Note that on the F1–130AD, the +24V auxiliary output is not high enough to power its input circuits (input ON threshold is 90VDC).

F1–130AD General Specifications

External Power Requirements	100 – 240 + 10% –15%
Communication Port	K–Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2–DSCBL
Internal Field Supply Ratings	+24VDC , 0.5A maximum, isolated
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	–4 to 158° F (–20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

AC Input Specifications

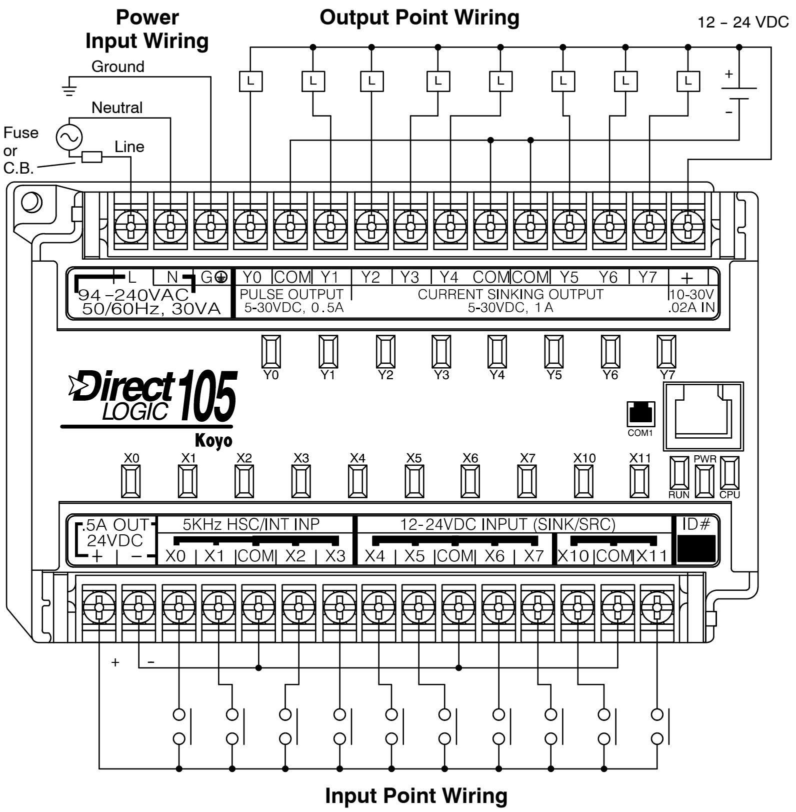
Input Voltage Range for ON condition	80 – 132 VAC, or 90 – 150 VDC
Input Current	6 mA @ 132 VAC 6.8 mA @ 150 VDC
Maximum Voltage	132 VAC, or 150 VDC
ON Current/Voltage	>4 mA @ 80 VAC, or 90 VDC
OFF Current/Voltage	<2 mA @ 45 VAC, or 60 VDC
OFF to ON Response	< 8 mS
ON to OFF Response	<15 mS
Status Indicators	Logic Side
Commons	4 channels / common x 2 banks, 2 channels / common x 1 bank

DC Output Specifications

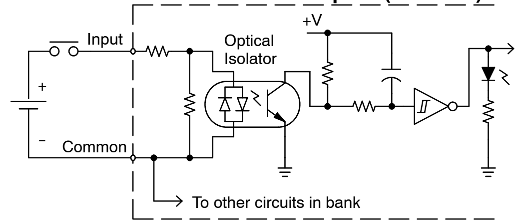
Parameter	Pulse Outputs, Y0 – Y1	Standard Outputs, Y2 – Y7
Operating Voltage	5 – 30 VDC	5 – 30 VDC
Peak Voltage	60 VDC (7 kHz maximum frequency)	60 VDC
On Voltage Drop	0.4 VDC @ 0.25A	0.4 VDC @ 0.5A
Max Current (resistive)	0.5 A / point (subject to derating)	1.0 A / point (subject to derating)
Max leakage current	15 μA @ 30 VDC	15 μA @ 30 VDC
Max inrush current	1.5 A for 10 mS, 0.5 A for 100 mS	3 A for 10 mS, 1 A for 100 mS
Extenal DC power required	10 – 30 VDC @30 mA, plus load current	10 – 30 VDC @30 mA, plus load current
OFF to ON Response	<10 μS	3.5 μS
ON to OFF Response	<70 μS	110 μS
Status Indicators	Logic Side	Logic Side
Commons	Internally connected	Internally connected
Fuses	None	None

**F1–130DD/
F1–130DD–CE
I/O Wiring Diagram**

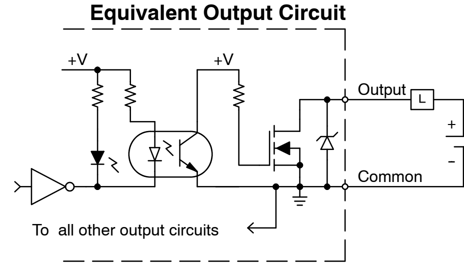
These micro PLCs feature ten DC inputs and eight DC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses three terminals at the top left as shown.



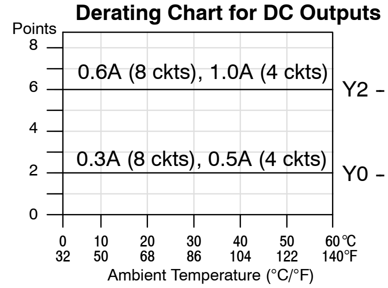
Equivalent Circuit, Standard Inputs (X4 – X11)



Equivalent Output Circuit

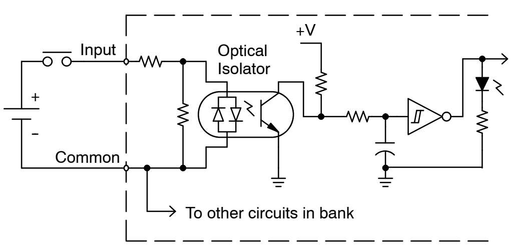


Derating Chart for DC Outputs



The ten DC input channels use terminals on the bottom connector. Inputs are organized into two banks of four, plus one bank of two. 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. The equivalent circuit for standard inputs is shown above, and the high-speed input circuit is shown to the right.

Equivalent Circuit, High-Speed Inputs (X0 – X3)



The eight current sinking DC output channels use terminals on the top connector. Outputs are organized as one bank of sinking outputs. The three common terminals are internally connected, so all outputs actually share the same electrical common. The wiring example above shows all commons connected together, because it is best to share the common current among the three terminal connections. The equivalent output circuit shows one channel of the bank of eight.

Auxiliary +24V Power Supply

These versions have a +24V supply output to power external devices. The output is rated at 0.5 Amperes, and includes short-circuit protection and full isolation from internal circuitry. These features make it ideal for powering sensors, solenoids, and other field devices. In fact, it can be used as the DC supply for switches or sensors in the input circuit, or for loads in the DC output circuits (up to 0.5 A).

F1–130DD/ F130–DD–CE General Specifications

External Power Requirements	100 – 240 +10% –15%
Communication Port	K–Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2–DSCBL
Internal Field Supply Ratings	+24VDC , 0.5A maximum, isolated
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	–4 to 158° F (–20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

DC Input Specifications

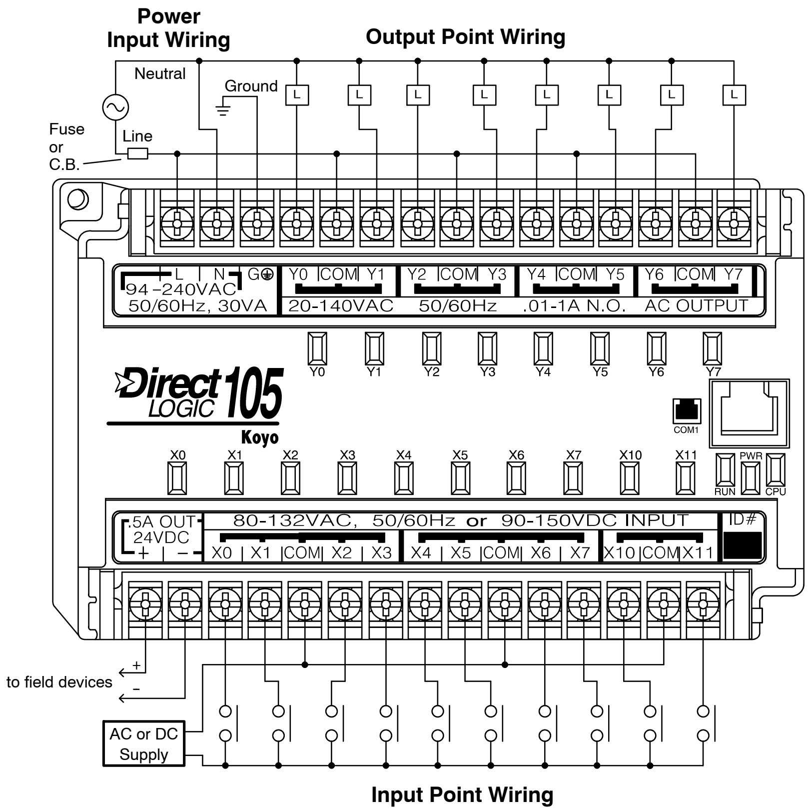
Parameter	High–Speed Inputs, X0 – X3	Standard DC Inputs X4 – X11
Input Voltage Range	10 – 26.4 VDC	10 – 26.4 VDC or 21.6 – 26.4 VAC
Maximum Voltage	30 VDC (5 kHz maximum frequency)	30 VDC
Minimum Pulse Width	100 μs	N/A
ON Voltage Level	> 9.0 VDC	> 9.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	2.8 kΩ @ 12 – 24 VDC	2.8 kΩ @ 12 – 24 VDC
Minimum ON Current	>3 mA	>3 mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<50 μS	2 – 8 mS, 4 mS typical
ON to OFF Response	< 50 μS	2 – 8 mS, 4 mS typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 1 bank	4 channels / common x 1 bank, 2 channels / common x 1 bank

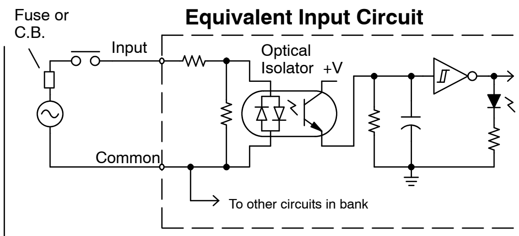
DC Output Specifications

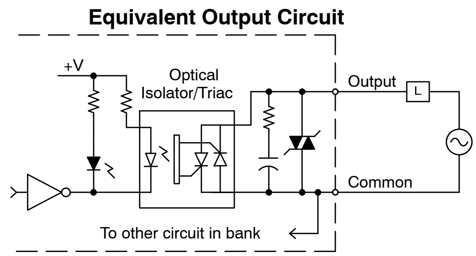
Parameter	Pulse Outputs, Y0 – Y1	Standard Outputs, Y2 – Y7
Operating Voltage	5 – 30 VDC	5 – 30 VDC
Peak Voltage	60 VDC (7 kHz maximum frequency)	60 VDC
On Voltage Drop	0.4 VDC @ 0.25A	0.4 VDC @ 0.5A
Max Current (resistive)	0.5 A / point (subject to derating)	1.0 A / point (subject to derating)
Max leakage current	15 μA @ 30 VDC	15 μA @ 30 VDC
Max inrush current	1.5 A for 10 mS, 0.5 A for 100 mS	3 A for 10 mS, 1 A for 100 mS
External DC power required	10 – 30 VDC @30 mA, plus load current	10 – 30 VDC @30 mA, plus load current
OFF to ON Response	<10 μs	3.5 μs
ON to OFF Response	<70 μs	110 μs
Status Indicators	Logic Side	Logic Side
Commons	Internally connected	Internally connected
Fuses	None	None

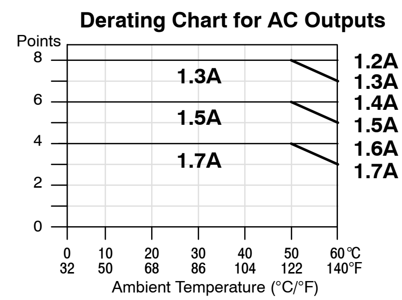
F1–130AA I/O Wiring Diagram

The F1–130AA Micro PLC features ten AC inputs and eight AC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses three terminals at the top left as shown.









The ten AC input channels use terminals on the bottom connector. This input type also works for high-voltage DC signals. Inputs are organized into two banks of four, plus one bank of two. Each bank has an isolated common terminal. In the case of DC input signals, the input may be wired in as either the sourcing or sinking type. The wiring example above 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.

The eight output channels use terminals on the top connector. Outputs are organized into four banks of two triac switches. 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.

Auxiliary +24V Power Supply

The F1–130AA has a +24V supply output to power external devices. The output is rated at 0.5 Amperes, and includes short-circuit protection and full isolation from internal CPU circuitry. These features make it ideal for powering sensors, solenoids, and other field devices. Note that on the F1–130AA, the +24V auxiliary output cannot directly power its input and output circuits(input ON threshold is 90VDC, outputs require AC only).

F1-130AA General Specifications

External Power Requirements	100 - 240 +10% -15%
Communication Port	K-Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2-DSCBL
Internal Field Supply Ratings	+24VDC , 0.5A maximum, isolated
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

AC Input Specifications

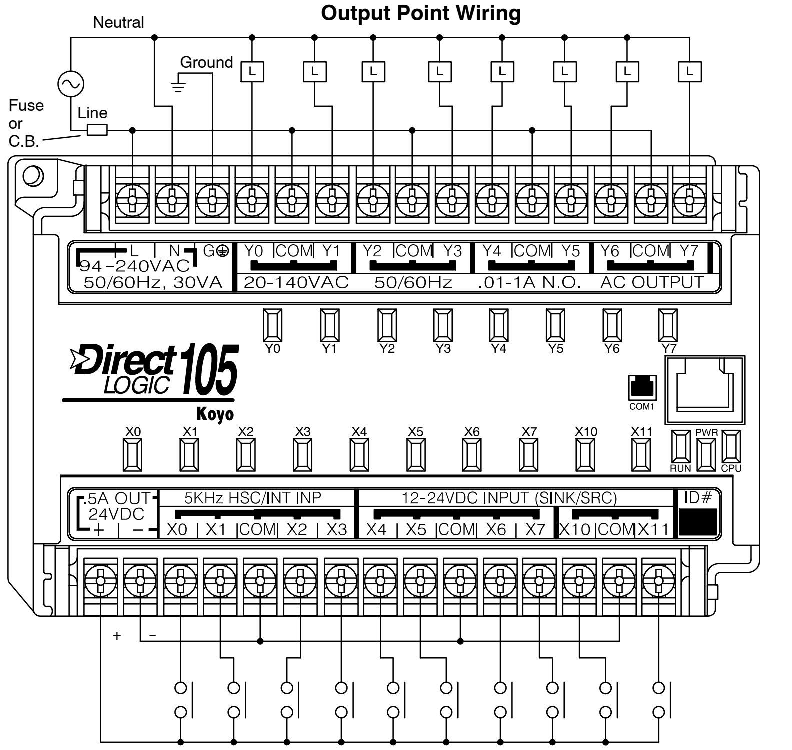
Input Voltage Range for ON condition	80 - 132 VAC, or 90 - 150 VDC
Input Current	6 mA @ 132 VAC 6.8 mA @ 150 VDC
Maximum Voltage	132 VAC, or 150 VDC
ON Current/Voltage	>4 mA @ 80 VAC, or 90 VDC
OFF Current/Voltage	<2 mA @ 45 VAC, or 60 VDC
OFF to ON Response	< 8 mS
ON to OFF Response	<15 mS
Status Indicators	Logic Side
Commons	4 channels / common x 2 banks, 2 channels / common x 1 bank

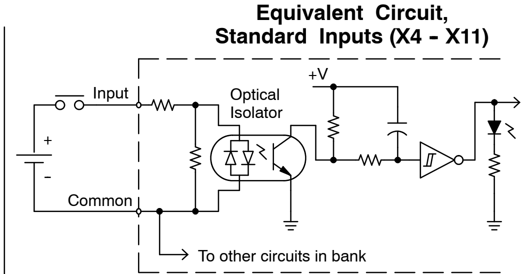
AC Output Specifications

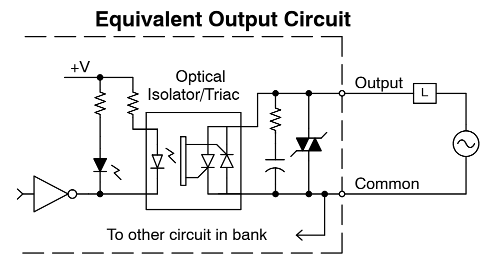
Operating Voltage	20 - 140 VAC, 47 - 63 Hz
Peak Voltage	400 VAC
On Voltage Drop	1.3 VAC @ 2 A
Max Current	1.7 A / point, subject to derating
Max leakage current	1 mA @ 400 VAC
Max inrush current	30 A for 10 mS, 15 A for 100 mS
Minimum Load	10 mA
OFF to ON Response	8.33 mS @ 60 Hz, zero-crossing, 10 mS @ 50 Hz, zero-crossing
ON to OFF Response	8.33 mS @ 60 Hz, zero-crossing, 10 mS @ 50 Hz, zero-crossing
Status Indicators	Logic Side
Commons	2 channels / common x 4 banks
Fuses	None (external recommended)

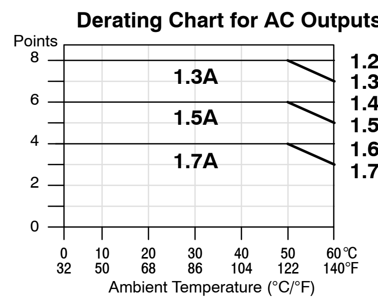
F1–130DA I/O Wiring Diagram

The F1–130DA Micro PLC features ten DC inputs and eight AC outputs. The following diagram shows a typical field wiring example. The AC external power connection uses three terminals at the top left as shown.

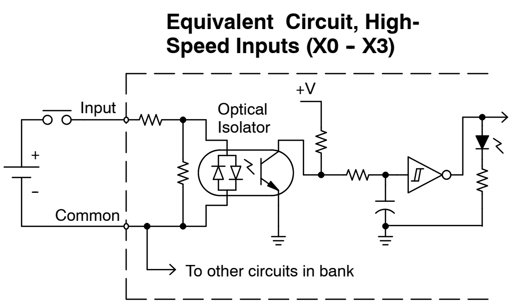








The ten DC input channels use terminals on the bottom connector. Inputs are organized into two banks of four, plus one bank of two. Each bank has an isolated common terminal, and may be wired as sinking or sourcing inputs. The wiring example above shows all commons connected together, but separate supplies and common circuits may be used. The equivalent circuit for standard inputs is shown above, and the high-speed input circuit is shown to the right.



The eight output channels use terminals on the top connector. Outputs are organized into four banks of two triac switches. 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.

Auxiliary +24V Power Supply

The F1–130DA has a +24V supply output to power external devices. The output is rated at 0.5 Amperes, and includes short-circuit protection and full isolation from internal CPU circuitry. These features make it ideal for powering sensors, solenoids, and other field devices. In fact, it can be used as the DC supply for switches or sensors in the input circuit. Note that on the F1–130DA, the +24V output cannot power its output circuits, because they require AC voltages.

F1–130DA General Specifications

External Power Requirements	100 – 240 +10% –15%
Communication Port	K–Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2–DSCBL
Internal Field Supply Ratings	+24VDC , 0.5A maximum, isolated
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	–4 to 158° F (–20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

DC Input Specifications

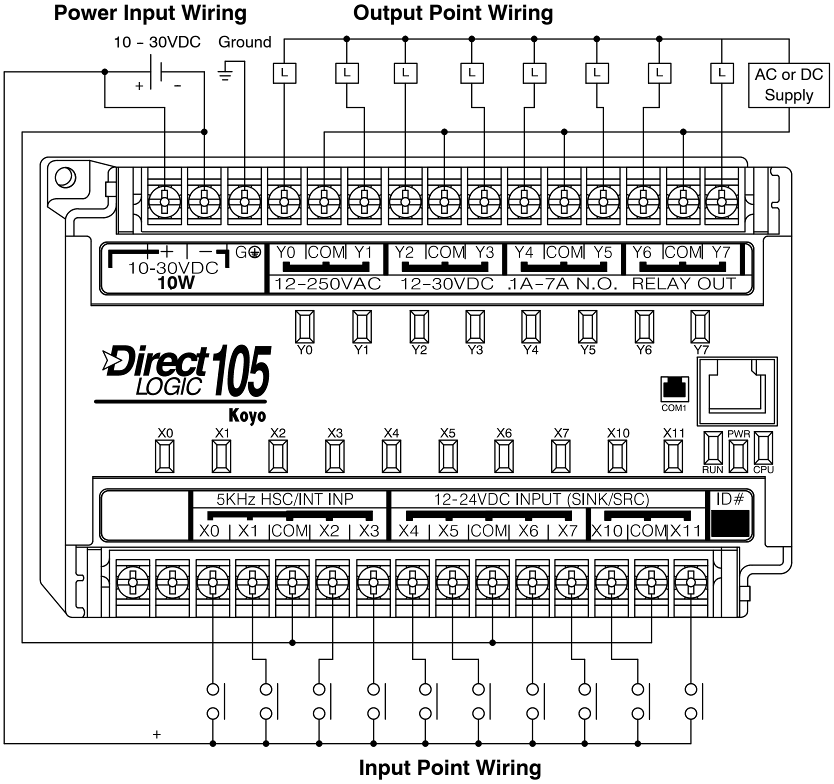
Parameter	High–Speed Inputs, X0 – X3	Standard DC Inputs X4 – X11
Input Voltage Range	10 – 26.4 VDC	10 – 26.4 VDC or 21.6 – 26.4 VAC
Maximum Voltage	30 VDC (5 kHz maximum frequency)	30 VDC
Minimum Pulse Width	100 µS	N/A
ON Voltage Level	> 9.0 VDC	> 9.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	2.8 kΩ @ 12 – 24 VDC	2.8 kΩ @ 12 – 24 VDC
Minimum ON Current	>3 mA	>3 mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<50 µS	2 – 8 mS, 4 mS typical
ON to OFF Response	< 50 µS	2 – 8 mS, 4 mS typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 1 bank	4 channels / common x 1 bank, 2 channels / common x 1 bank

AC Output Specifications

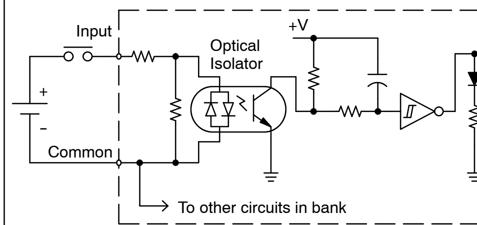
Operating Voltage	20 – 140 VAC, 47 – 63 Hz
Peak Voltage	400 VAC
On Voltage Drop	1.3 VAC @ 2 A
Max Current	1.7 A / point, subject to derating
Max leakage current	1 mA @ 400 VAC
Max inrush current	30 A for 10 mS, 15 A for 100 mS
Minimum Load	10 mA
OFF to ON Response	8.33 mS @ 60 Hz, zero-crossing, 10 mS @ 50 Hz, zero-crossing
ON to OFF Response	8.33 mS @ 60 Hz, zero-crossing, 10 mS @ 50 Hz, zero-crossing
Status Indicators	Logic Side
Commons	2 channels / common x 4 banks
Fuses	None (external recommended)

F1–130DR–D I/O Wiring Diagram

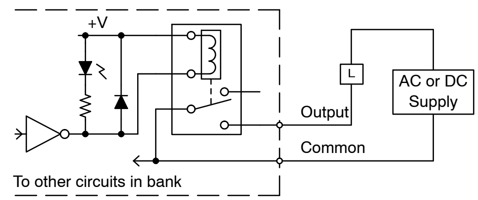
The F1–130DR–D Micro PLC features ten DC inputs and eight relay outputs. The following diagram shows a typical field wiring example. The DC external power connection uses three terminals at the top left as shown.



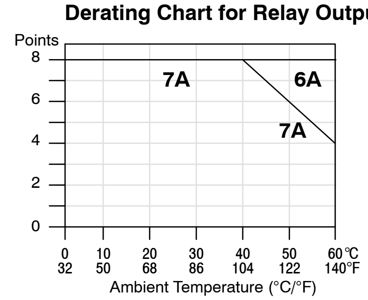
Equivalent Circuit, Standard Inputs (X4 – X11)



Equivalent Output Circuit

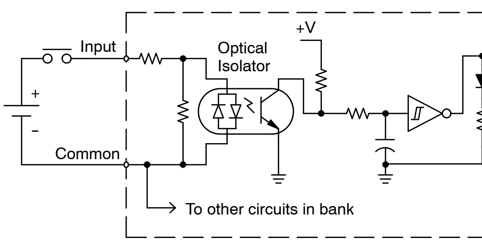


Derating Chart for Relay Outputs



The ten DC input channels use terminals on the bottom connector. Inputs are organized into two banks of four, plus one bank of two. Each bank has an isolated common terminal, and may be wired as sinking or sourcing inputs. The wiring example above shows all commons connected together, but separate supplies and common circuits may be used. The equivalent circuit for standard inputs is shown above, and the high-speed input circuit is shown to the right.

Equivalent Circuit, High-Speed Inputs (X0 – X3)



The eight output channels use terminals on the top connector. Outputs are organized into four banks of two 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.

No Auxiliary +24V Power Supply

The F1–130DR–D does not include a +24V output, as do most other DL105 PLCs. Since this unit requires +24V as the main supply input, it it usually most economical to use the same supply to power suitable field devices. In the wiring diagram above, the external power source for the unit also powers the input circuitry. The same external supply can power both input and output circuits, because they are both isolated from the internal logic circuitry.

F1-130DR-D General Specifications

External Power Requirements	10-30VDC, 1.5A
Communication Port	K-Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2-DSCBL
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

DC Input Specifications

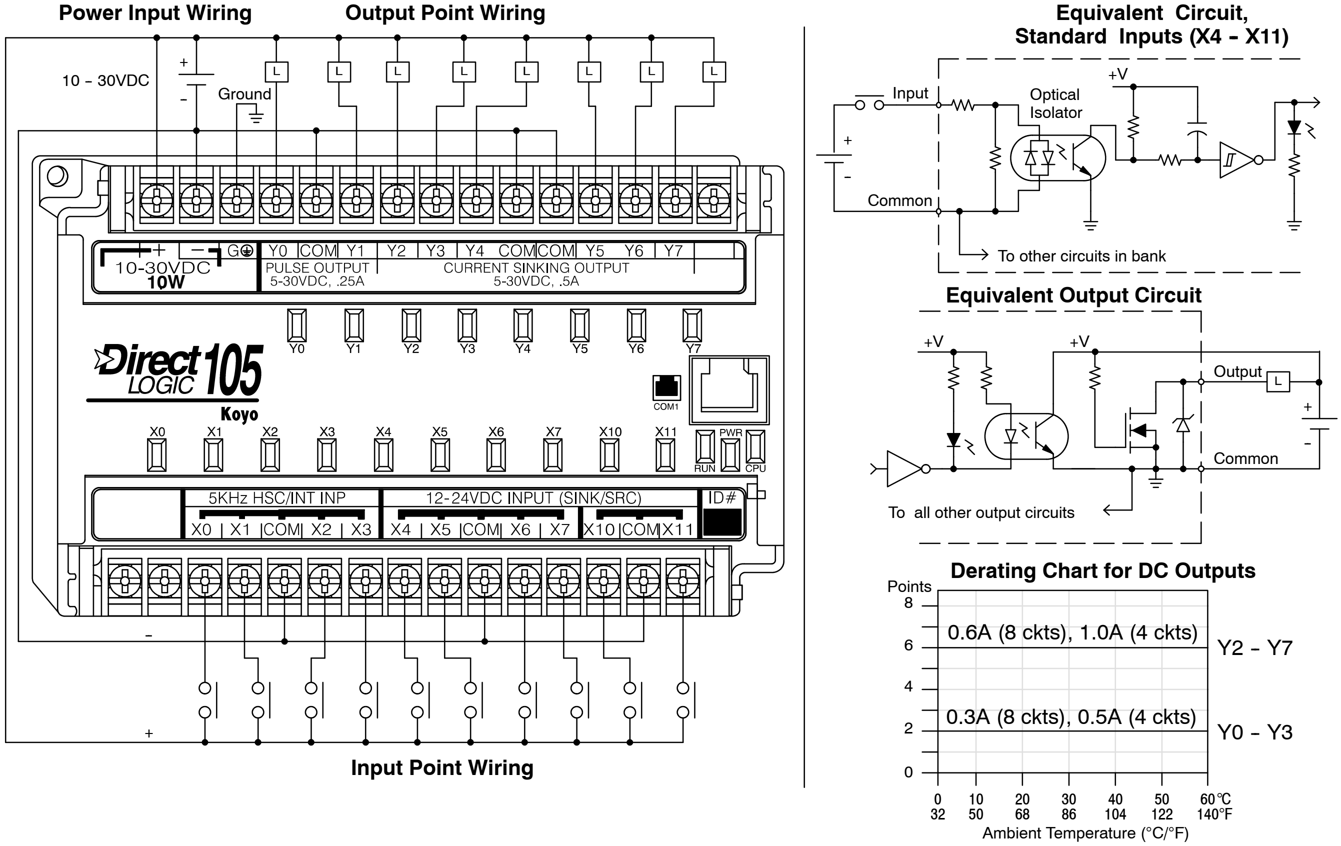
Parameter	High-Speed Inputs, X0 - X3	Standard DC Inputs X4 - X11
Input Voltage Range	10 - 26.4 VDC	10 - 26.4 VDC or 21.6 - 26.4 VAC
Maximum Voltage	30 VDC (5 kHz maximum frequency)	30 VDC
Minimum Pulse Width	100 μs	N/A
ON Voltage Level	> 9.0 VDC	> 9.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	2.8 kΩ @ 12 - 24 VDC	2.8 kΩ @ 12 - 24 VDC
Minimum ON Current	>3 mA	>3 mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<50 μS	2 - 8 mS, 4 mS typical
ON to OFF Response	< 50 μS	2 - 8 mS, 4 mS typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 1 bank	4 channels / common x 1 bank, 2 channels / common x 1 bank

Relay Output Specifications

Operating Voltage	12 - 250 VAC, 12 - 30 VDC @ 7A, 30 - 150 VDC @ 0.5A, resistive
Output Current	7A / point (subject to derating) 14A / common
Maximum Motor Load	1/3 HP
Maximum Voltage	265 VAC, 150 VDC
Minimum Off Resistance	100 meg ohms @ 500 VDC
Smallest Recommended Load	10 mA
OFF to ON Response	15 ms
ON to OFF Response	5 ms
Status Indicators	Logic Side
Commons	2 channels / common x 4 banks
Fuses	None (external recommended)

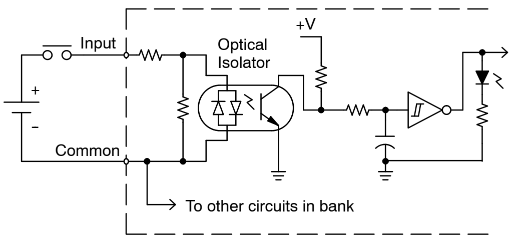
F1-130DD-D I/O Wiring Diagram

The F1-130DD-D Micro PLC features ten DC inputs and eight DC outputs. The following diagram shows a typical field wiring example. The DC external power connection uses three terminals at the top left as shown.



The ten DC input channels use terminals on the bottom connector. Inputs are organized into two banks of four, plus one bank of two. Each bank has an isolated common terminal, and can 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. The equivalent circuit for standard inputs is shown above, and the high-speed input circuit is shown to the right.

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



The eight current-sinking DC output channels use terminals on the top connector. Outputs are organized as one bank of eight. The three common terminals are internally connected, meaning all outputs actually share the same electrical common. The wiring example above shows all commons connected together, because it is best to share the common current among the three terminal connections. The equivalent output circuit shows one channel of the bank of eight.

No Auxiliary +24V Power Supply

The F1-130DR-D does not include a +24V output, as do most other DL105 PLCs. Since this unit requires +24V as the main supply input, it it usually most economical to use the same supply to power suitable field devices. In the wiring diagram above, the external power source for the unit also powers the input and output circuitry. The same external supply can power both input and output circuits, because they are both isolated from the internal logic circuitry.

F1-130DD-D General Specifications

External Power Requirements	10-30VDC, 1.5A
Communication Port	K-Sequence, 9600 baud, 8 data bits, odd parity
Programming cable type	D2-DSCBL
Operating Temperature	32 to 140° F (0 to 60° C)
Storage Temperature	-4 to 158° F (-20 to 70° C)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3-304
Terminal Type	Removable
Wire Gauge	One AWG14 or two AWG16, AWG24 minimum

DC Input Specifications

Parameter	High-Speed Inputs, X0 - X3	Standard DC Inputs X4 - X11
Input Voltage Range	10 - 26.4 VDC	10 - 26.4 VDC or 21.6 - 26.4 VAC
Maximum Voltage	30 VDC (5 kHz maximum frequency)	30 VDC
Minimum Pulse Width	100 μs	N/A
ON Voltage Level	> 9.0 VDC	> 9.0 VDC
OFF Voltage Level	< 2.0 VDC	< 2.0 VDC
Input Impedance	2.8 kΩ @ 12 - 24 VDC	2.8 kΩ @ 12 - 24 VDC
Minimum ON Current	>3 mA	>3 mA
Maximum OFF Current	< 0.5 mA	<0.5 mA
OFF to ON Response	<50 μS	2 - 8 mS, 4 mS typical
ON to OFF Response	< 50 μS	2 - 8 mS, 4 mS typical
Status Indicators	Logic side	Logic side
Commons	4 channels / common x 1 bank	4 channels / common x 1 bank, 2 channels / common x 1 bank

DC Output Specifications

Parameter	Pulse Outputs, Y0 - Y1	Standard Outputs, Y2 - Y7
Operating Voltage	5 - 30 VDC	5 - 30 VDC
Peak Voltage	60 VDC (7 kHz maximum frequency)	60 VDC
On Voltage Drop	0.4 VDC @ 0.25A	0.4 VDC @ 0.5A
Max Current (resistive)	0.5 A / point (subject to derating)	1.0 A / point (subject to derating)
Max leakage current	15 μA @ 30 VDC	15 μA @ 30 VDC
Max inrush current	1.5 A for 10 mS, 0.5 A for 100 mS	3 A for 10 mS, 1 A for 100 mS
Extenal DC power required	10 - 30 VDC @30 mA, plus load current	10 - 30 VDC @30 mA, plus load current
OFF to ON Response	<10 μs	3.5 μs
ON to OFF Response	<70 μs	110 μs
Status Indicators	Logic Side	Logic Side
Commons	Internally connected	Internally connected
Fuses	None	None

Glossary of Specification Terms

Discrete Input One of ten 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 eight 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.

Terminal Type Indicates whether the terminal type is a removable or non-removable connector or a fixed terminal.

Status Indicators The LEDs that indicate the ON/OFF status of an input or output point. All LEDs on DL105 Micro PLCs are electrically located on the logic side of the input or output circuit.