

INSTALLATION AND WIRING



CHAPTER 3

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Safety Guidelines



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



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

Plan for Safety

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

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

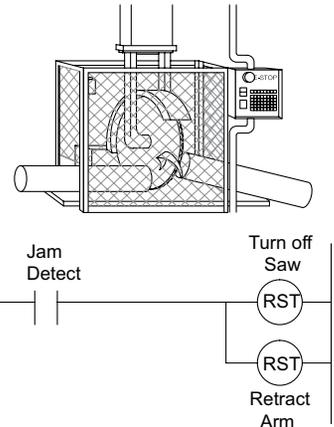
Three Levels of Protection



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.

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.

1. Orderly system shutdown sequence in the PLC control program
2. Mechanical disconnect for output module power
3. Emergency stop switch for disconnecting system power



Orderly System Shutdown

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

System Power Disconnect

You should also use electromechanical devices, such as master control relays and/or limit switches, to prevent accidental equipment startup at an unexpected time. These devices should be installed in a manner that will prevent any machine operations from occurring.

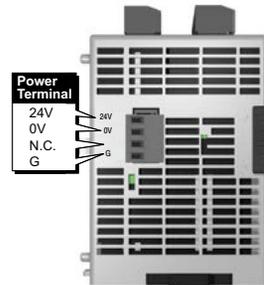
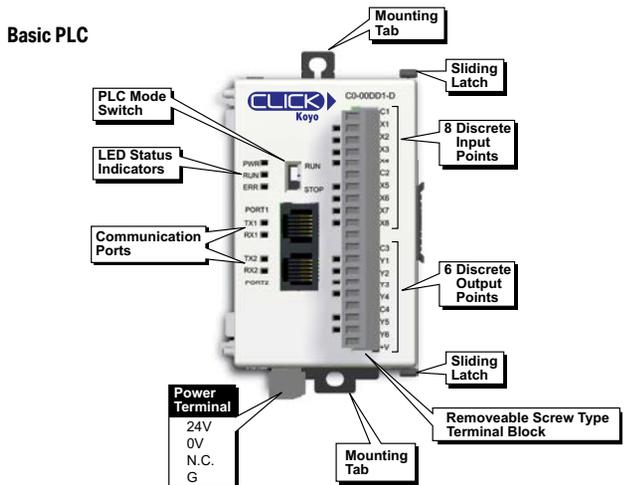
For example, if the machine in the illustration has a jammed part, the PLC control program can turn off the saw blade and retract the arbor. If the operator must open the guard to remove the part, you should also include a bypass switch that disconnects all system power any time the guard is opened.

Introduction to the CLICK PLC Mechanical Design

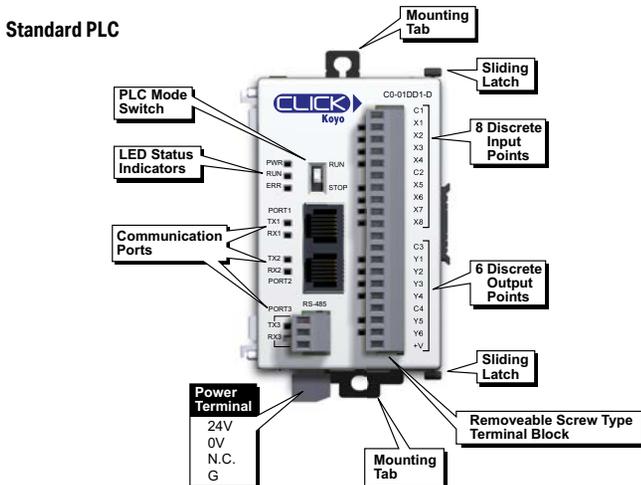
CLICK PLC Units

All CLICK PLCs are similar in appearance. Please see the diagrams below to familiarize yourself with the PLC features. The main components located on the front of the PLC are a removable 20-pin I/O connector, Run/Stop switch, communications ports and LED status indicators. A removable 4-pin 24VDC input power connector is located on the bottom of the PLC. The I/O module extension port is located on the right side of the PLC case. See Mounting Guidelines in this chapter for module dimensions and Chapter 2 for CLICK PLC specifications.

Component Locations on Basic and Standard PLC Units

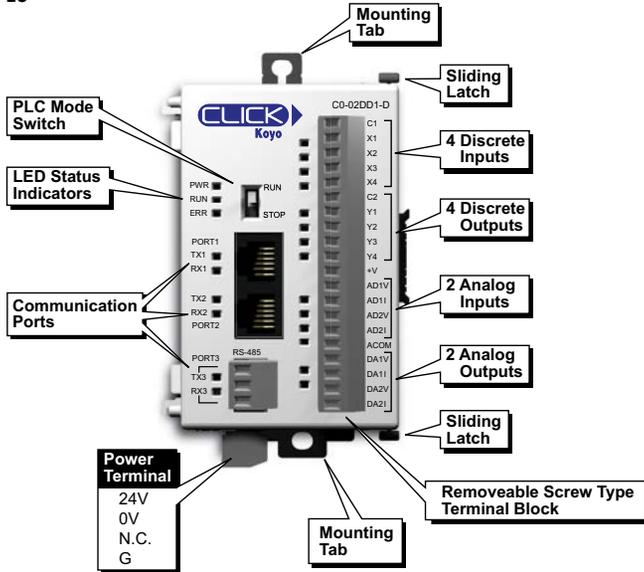


Bottom view same for all PLC's

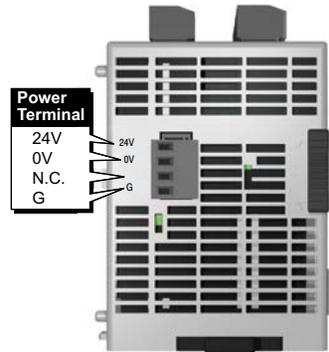
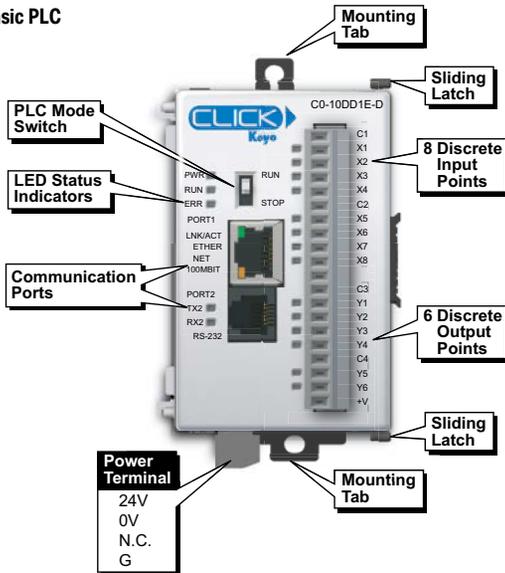


Component Locations on Analog PLC Units

Analog PLC



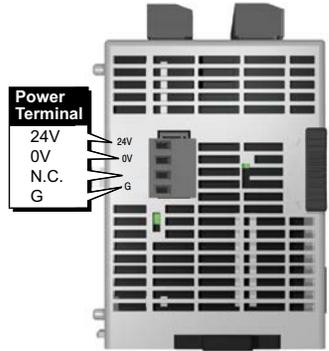
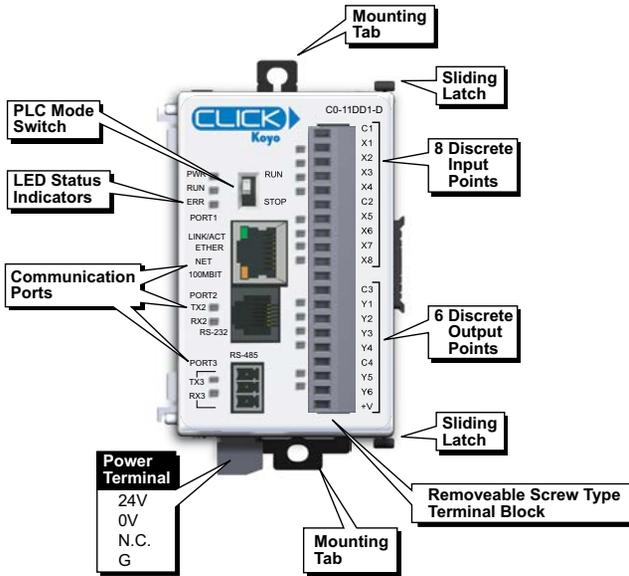
Ethernet Basic PLC



Bottom view same for all PLC's

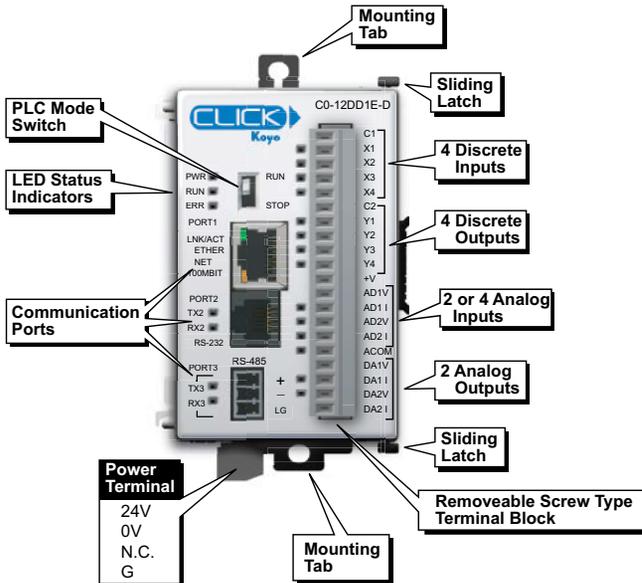
Component Locations on Ethernet PLC Units

Ethernet Standard PLC



Bottom view same for all PLC's

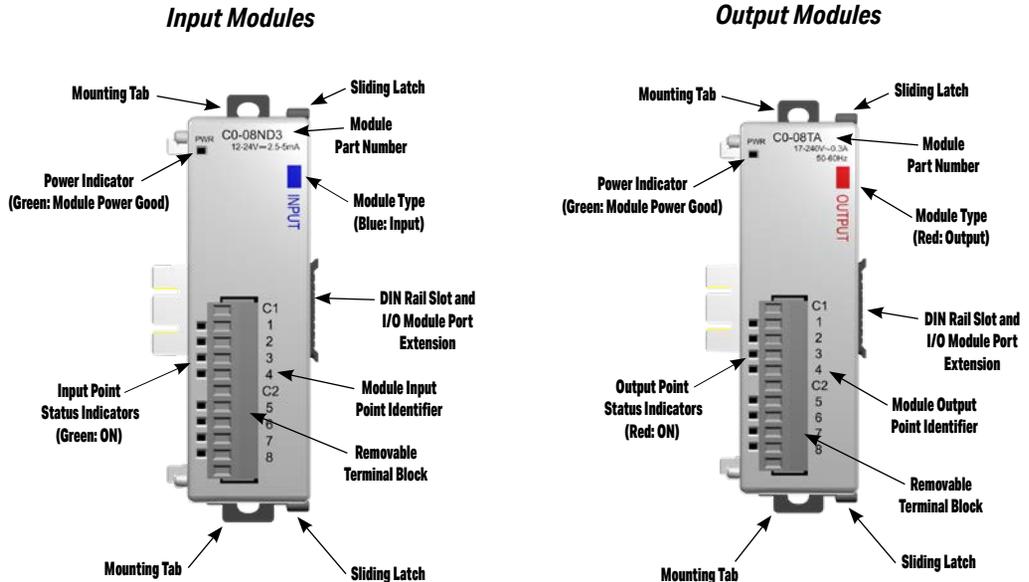
Ethernet Analog PLC



CLICK I/O Modules

Several different types of input and output modules are available for the CLICK PLC system. Please see the diagrams below to familiarize yourself with the I/O module features.

Each I/O module is identified as an Input or Output module on its front panel using the color coding scheme listed below. Up to eight I/O option modules can be connected to a CLICK PLC. See Mounting Guidelines in this chapter for module dimensions and Chapter 2 for CLICK I/O module specifications.



CLICK Power Supplies

All CLICK PLCs require 24VDC input power from either a CLICK power supply or other suitable external power supply. Two models of CLICK power supplies are available to supply power to the PLC and I/O modules.

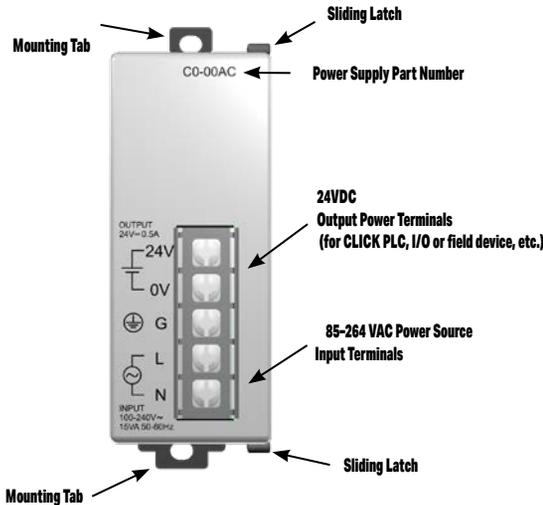
- C0-00AC - 0.5 A @ 24VDC output
- C0-01AC - 1.3 A @ 24VDC output

Select a power supply based on the power requirements of your system components. See Mounting Guidelines in this chapter for module dimensions and Chapter 2 for CLICK power supply specifications.

Power wires must be connected from the output terminals on the front of the power supply to the input power connector on the bottom of the CLICK PLC (There is no internal 24VDC power bus to the PLC.) See Mounting Guidelines for additional wiring information.

Only a single CLICK power supply can be attached directly to a CLICK PLC system. If multiple CLICK power supplies are used, or if other type of power supplies are used, mount them separately from the PLC. For example, the PSP24-DC12-1 DC-DC converter shown below must be mounted separately from the PLC.

C0-00AC and C0-01AC Power Supplies Component Locations



The PSP24-DC12-1 DC-DC converter must be mounted separately from the PLC.

Battery Backup (Standard, Analog and Ethernet PLC Units)

All of the CLICK PLC units have a super capacitor to maintain back up data in SRAM. However, the backup period by the super capacitor depends on the CLICK PLC unit type you use.

CLICK PLC Unit	Backup Period by the Super Capacitor
Basic PLC units Standard PLC units Analog PLC units	7 days
Ethernet Basic PLC units Ethernet Standard PLC units Ethernet Analog PLC units	1 hour

If you need the CLICK PLC unit to maintain data in the SRAM for longer than the above period after the power is shut off, you must install a battery in the CLICK PLC unit.



NOTE: CLICK Basic PLC units do not have the battery backup feature.

Use battery part number D2-BAT-1 (not included with the PLC unit; order battery separately). Typical battery life is 3 years, which includes PLC runtime and normal shutdown periods.



NOTE: Please power off the PLC while installing and/or changing the battery.

To install or replace the D2-BAT-1 battery:

1. Press the retaining clip on the battery door and swing the battery door open.
2. Install the battery into the coin-type slot with the +, or flat, side out.
3. Close the battery door so that it locks securely.
4. Make a note of the date the battery was installed.

The battery backup is now available.



WARNING: Do not attempt to recharge the battery or dispose of it by fire. The battery may explode or release hazardous materials.



TIP: The CLICK PLC has a feature that indicates the pre-scheduled battery replacement date has passed. In the CLICK programming software, go to the pull-down menu: Setup > Battery backup Setup.

Mounting Guidelines

Environmental Specifications

The CLICK family of PLC products should be stored, installed, and used within their range of environmental specifications, such as storage temperature, operating temperature, humidity, environmental air, vibration, shock, and noise immunity. Certain output module circuit types may have derating curves depending on the ambient temperature and the number of outputs ON. Refer to the I/O module specifications in Chapter 2: *Specifications* for CLICK PLC environmental specifications and I/O module derating curves.

Agency Approvals

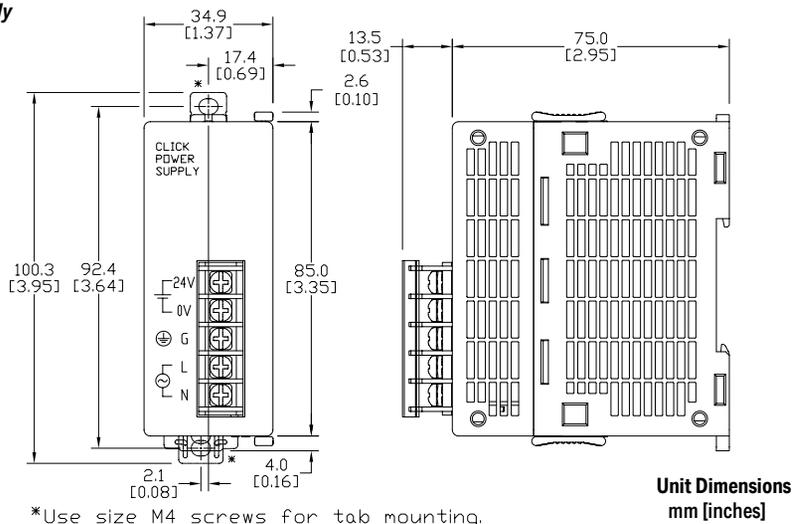
In addition to the panel layout guidelines, other specifications can affect the definition and installation of a PLC system. Always consider the following:

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

CLICK Unit Dimensions

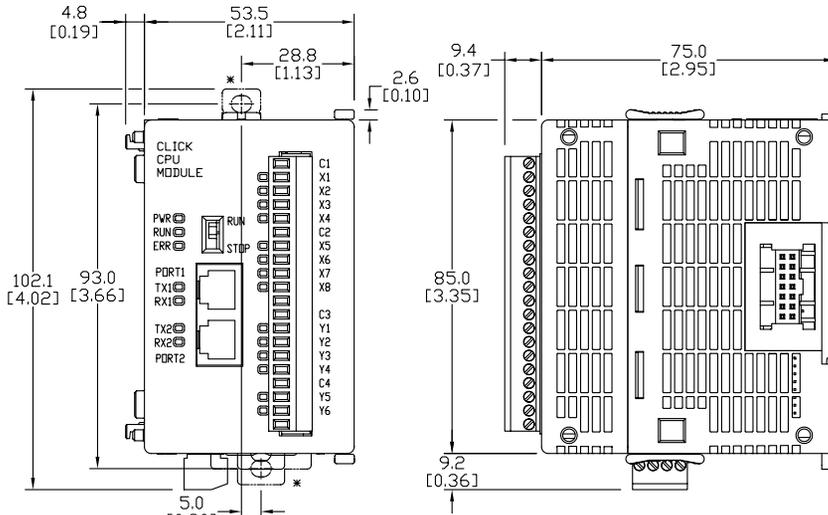
The following diagrams illustrate the dimensions of the CLICK power supply, CLICK PLC, and I/O modules. The CLICK PLC system is designed to be mounted on standard 35mm DIN rail, or it can be surface mounted. See the following pages for installations and mounting information, including page 3-17 for DIN rail and surface-mounting instructions.

Power Supply



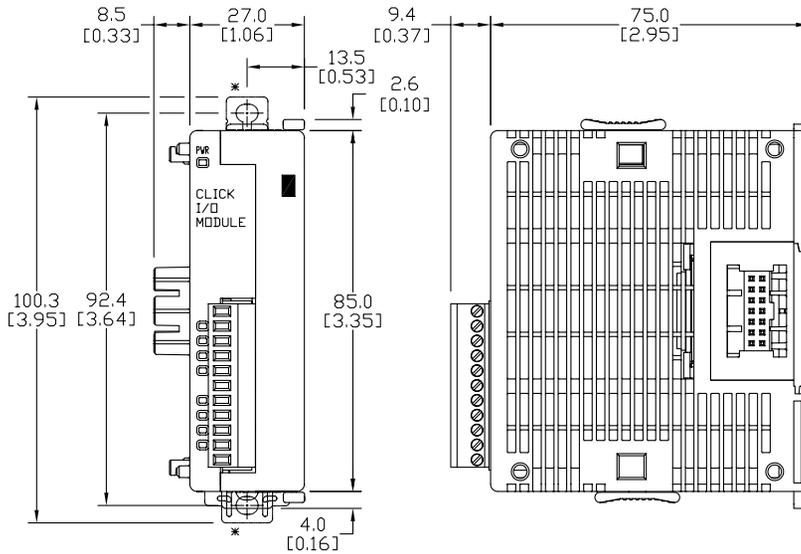
NOTE: The dimensions for the C0-00AC and C0-01AC power supplies are the same.

PLC Unit



*Use size M4 screws for tab mounting.

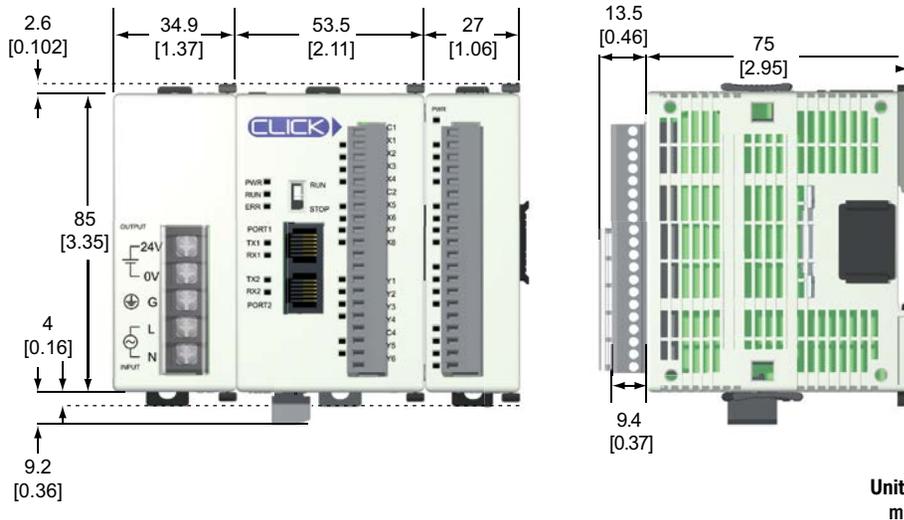
I/O Module



*Use size M4 screws for tab mounting.

Unit Dimensions
mm [inches]

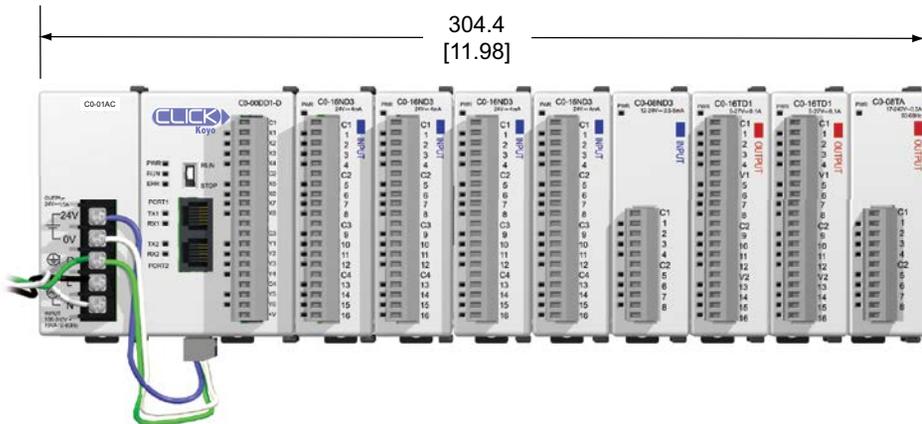
PLC Unit System



Unit Dimensions
mm [inches]

Maximum system: Power Supply + PLC + eight I/O modules.

Follow the installation guidelines to allow for proper spacing from other components within an enclosure.



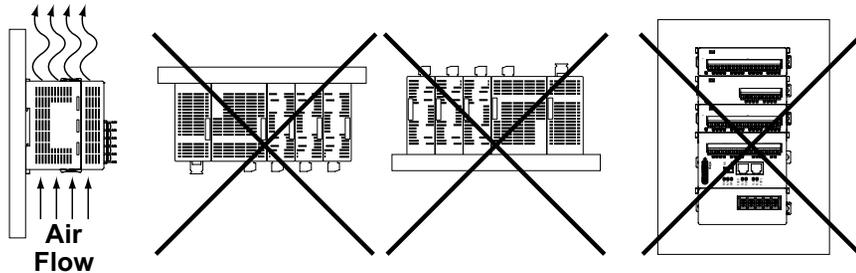
Enclosures

Your selection of a proper enclosure is important to ensure safe and proper operation of your CLICK PLC system. Control applications vary and yours may require additional considerations. At a minimum your enclosure should include:

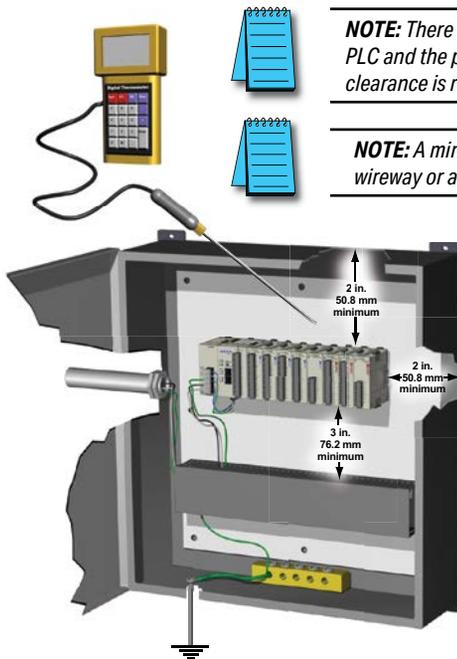
- Conformance to electrical standards
- Protection from the elements in an industrial environment
- Common ground reference
- Maintenance of specified ambient temperature
- Access to equipment
- Security or restricted access
- Sufficient space for proper installation and maintenance of equipment

Panel Layout and Clearances

1. Mount the CLICK PLC unit (system) horizontally as shown below to provide proper ventilation. Do not mount the CLICK PLC units upside down, on a horizontal surface or in a vertical arrangement. If you place more than one unit in a cabinet, there must be a minimum of 7.2" (183mm) between the units.

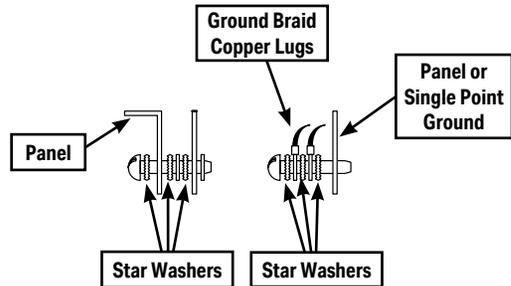


2. Provide a minimum clearance of 2" (50mm) between the unit and all sides of the cabinet.
NOTE: Remember to allow clearance for any operator panels or other items mounted directly in front of the unit in the door.
3. There should also be at least 3" (78mm) of clearance between the unit and any wiring ducts that run parallel to the terminals.
4. The ground terminal on the CLICK PLC 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 ground. Minimum wire sizes, color coding, and general safety practices should comply with appropriate electrical codes and standards for your area.



NOTE: There is a minimum clearance requirement of 2" (51mm) between the **CLICK PLC** and the panel door or any devices mounted in the panel door. The same clearance is required between the PLC and surrounding enclosure.

NOTE: A minimum clearance of 3" (76mm) is required between the PLC and a wireway or any heat producing device.



6. A good common ground reference (Earth ground) is essential for proper operation of the CLICK PLC. 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 CLICK PLC system, measures such as installing a cooling/heating source must be taken to get the ambient temperature within the range of specifications.
8. CLICK PLC systems are modular and can be powered by any suitable 24VDC power supply. The optional CLICK power supply is designed to attach to the left side of the CLICK PLC case. CLICK power supplies accept 85-264 VAC and produce nominal 24VDC to power the CLICK PLC and I/O modules. Powerline filters are recommended for protecting the CLICK PLC from power surges and EMI/RFI noise. The AutomationDirect Powerline Filter, for use with 120VAC and 240VAC, 1–5 Amps, is an excellent choice (locate at www.automationdirect.com), however, you can use a filter of your choice. The filter units install easily between the AC power source and the PLC.

Installing the CLICK PLC

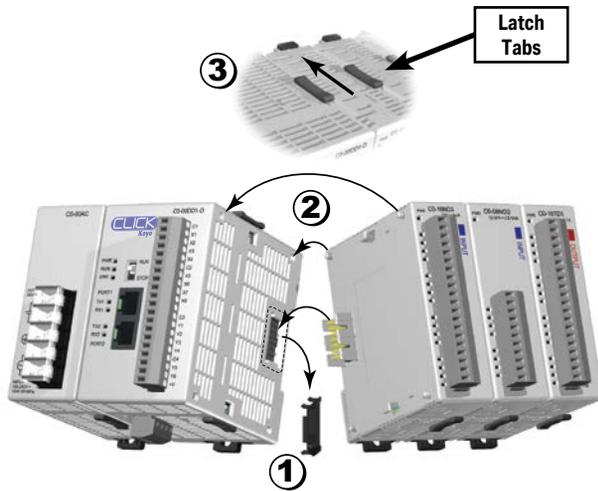
Connecting the Modules Together

CLICK PLCs and I/O modules connect together using the Extension Ports that are located on the side panels of the modules. The modules secure together by sliding LOCK/UNLOCK latch tabs located on the top and bottom panels of the modules. A PLC backplane or base is not required.

When connecting an I/O module to the PLC, first remove the Extension Port covers, slide the latches forward (unlock), align the module pins, and press the I/O module onto the PLC's right side. Slide the latches backward to lock the modules together.



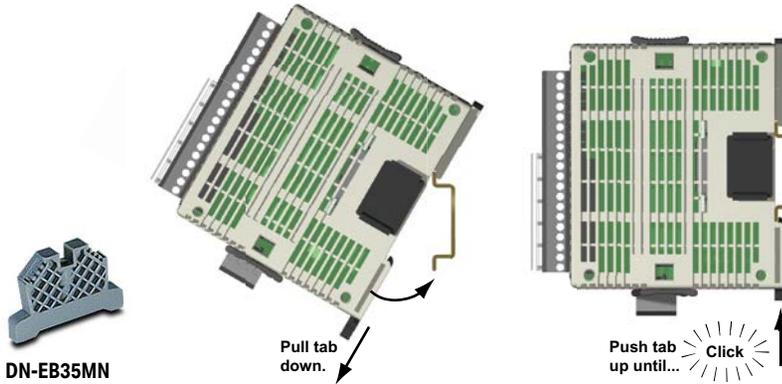
NOTE: If you are using other components in your system, make sure you refer to the appropriate manual to determine how those units can affect mounting dimensions.



- 1) Remove extension port covers and slide latch tabs forward.
- 2) Align the module pins and connection plug, and press the I/O module onto the right side of the PLC.
- 3) Slide the latch tabs backward to lock the modules together.

Mounting CLICK PLC System on DIN Rail

CLICK PLCs can be secured to a panel by using mounting rails. We recommend rails that conform to DIN EN standard 50 022. They are approximately 35mm high, with a depth of 7mm. If you mount the CLICK PLC on a rail, consider using end brackets on each side of the PLC. The end bracket helps keep the PLC from sliding horizontally along the rail, reducing the possibility of accidentally pulling the wiring loose. On the bottom of the PLC 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 pull it away from the rail.



NOTE: When mounting on DIN rail, using DINnectors end brackets at both ends is recommended (part number DN-EB35MN).

Optional Mounting Method

The CLICK PLC system can be secured to the equipment panel or desired location using the mounting tabs located on the back panel of the PLC, I/O modules and power supplies. Extend the upper and lower retaining clips to the full out position. Mount using M4 screws in the center hole of the tabs.



Wiring Guidelines

Power Input Wiring to Click Power Supply

Connect the AC power source input wiring to the CLICK power supply (the CLICK power supply voltage and current requirements are listed in chapter 2). If you are not using a CLICK power supply, be sure that it meets CLICK PLC requirements.

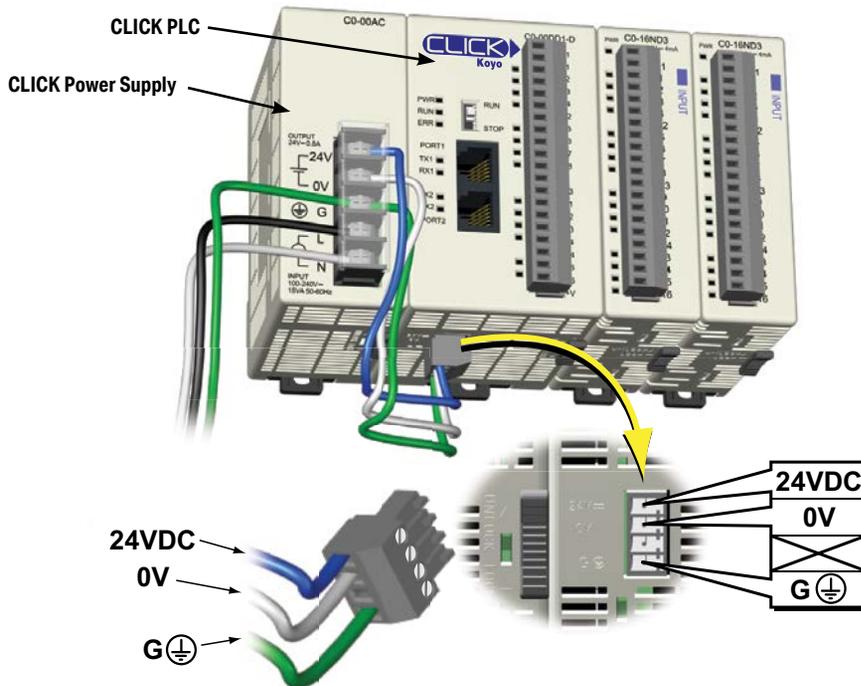
Do not apply power at this time. Observe all precautions stated earlier in this manual.



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.

Power Input Wiring to CLICK PLC

Connect the 24VDC power source input wiring to the 4-pin 24VDC input connector located on the bottom panel of the CLICK PLC. Do not apply power at this time. Observe all precautions stated earlier in this manual.



Fuse Protection

Fuse Protection for PLC Input Power

External circuit protection is needed to ensure the safety of service personnel and the safe operation of the equipment itself. To meet UL/CUL specifications, the input power must be fused. Fuse the AC side of the power supply that provides the 24VDC power to the CLICK PLC.

When operating the power supply from a 110/120 VAC system with a grounded neutral, it is only necessary to fuse the line (L) lead; it is not necessary to fuse the grounded neutral (N) lead. Select the fuse size based on the input current draw of the power supply. Refer to Chapter 2 of this manual for specifications of CLICK power supplies.

Fuse Protection for I/O Module Circuits

Input and Output circuits on CLICK PLCs do not have internal fuses. In order to protect your 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 I/O module specifications in Chapter 2 to find the maximum current per output point or per output common. Adding the external fuse does not guarantee the prevention of PLC damage, but it will provide added protection.



WARNING: The discrete inputs and outputs will be damaged if the signal exceeds the rated voltage.



Planning the I/O Wiring Routes

The following guidelines provide general information on how to wire the I/O connections to CLICK PLCs. For additional information about wiring a particular I/O type refer to the corresponding information in this chapter.

1. Each terminal connection of the CLICK PLC can accept one 16AWG wire or two 18AWG size wires. Do not exceed this recommended capacity. Refer to Chapter 2 *Specifications* for more detailed specifications of the terminal blocks.
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 lower voltage wires near higher voltage wiring.
6. Avoid running input wiring close to output wiring where possible.
7. To minimize voltage drops when wires must run a long distance, consider using multiple wires for the return line.
8. Avoid running DC wiring in close proximity to AC wiring where possible.
9. Avoid creating sharp bends in the wires.
10. Install the recommended powerline filter to reduce power surges and EMI/RFI noise.

Wiring I/O Modules

There are three sizes of I/O module terminal blocks used for field wiring connections (11pt, 13pt & 20pt). They can be removed from the module for wiring convenience. There are no clips or screws retaining the terminal block. Firmly grip the block and pull it away from the PLC or I/O module. The connector terminal points have recessed screws to help minimize the risk of someone accidentally touching active wiring. Make sure the terminal blocks are properly seated against the module when replacing them and wiring is properly constrained.

For your convenience we also have DINnectors, DIN-rail mounted terminal blocks. Refer to our website or catalog for a complete listing of all available products. We strongly recommend using our *ZIPLinks* connections systems. See the following pages for *ZIPLink* compatibility and special pre-assembled cables, with the I/O connectors installed and wired.

ZIPLinks Connection Systems



ZIPLinks Cables with Connectors

ZIPLinks Modules



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

ZIPLink Wiring System Compatibility Matrix for CLICK PLCs

Use the following tables to select your ZIPLink components. See our website for more specifications and information on ZIPLinks.

CLICK PLC Units ZIPLink Selector				
PLC		ZIPLink		
PLC Module	Terminals	Component	Module Part No.	Cable Part No.
C0-00DD1-D	20	Feedthrough	ZL-RTB20	ZL-C0-CBL20*
C0-00DD2-D				
C0-00DR-D				
C0-00AR-D				
C0-01DD1-D				
C0-01DD2-D				
C0-01DR-D				
C0-01AR-D				
C0-02DD1-D	20	No ZIPLinks are available for analog PLC units.		
C0-02DD2-D				
C0-02DR-D				
C0-10DD1E-D	20	Feedthrough	ZL-RTB20	ZL-C0-CBL20*
C0-10DD2E-D				
C0-10DRE-D				
C0-10ARE-D				
C0-11DD1E-D				
C0-11DD2E-D				
C0-11DRE-D				
C0-11ARE-D				
C0-12DD1E-D	20	No ZIPLinks are available for Ethernet Analog PLC units.		
C0-12DD2E-D				
C0-12DRE-D				
C0-12ARE-D				
C0-12DD1E-1-D				
C0-12DD2E-1-D				
C0-12DRE-1-D				
C0-12ARE-1-D				
C0-12DD1E-2-D				
C0-12DD2E-2-D				
C0-12DRE-2-D				
C0-12ARE-2-D				

* Select the cable length by replacing the * with: Blank = 0.5 m, -1 = 1.0 m, or -2 = 2.0 m.

ZIPLink Wiring System Compatibility Matrix for CLICK PLCs (continued)

CLICK PLC Discrete Input Module ZIPLink Selector				
I/O Module		ZIPLink		
Input Module	Terminals	Component	Module Part No.	Cable Part No.
CO-08SIM	Not supported by ZIPLink			
CO-08ND3	11	Feedthrough	ZL-RTB20	ZL-CO-CBL11*
CO-08ND3-1				
CO-08NE3				
CO-08NA				
CO-16ND3	20	Feedthrough	ZL-RTB20	ZL-CO-CBL20*
CO-16NE3		Sensor	ZL-LTB16-24-1	
		Feedthrough	ZL-RTB20	
		Sensor	ZL-LTB16-24-1	

* Select the cable length by replacing the * with: Blank = 0.5 m, -1 = 1.0 m, or -2 = 2.0 m.

CLICK PLC Discrete Output Module ZIPLink Selector				
I/O Module		ZIPLink		
Output Module	Terminals	Component	Module Part No.	Cable Part No.
CO-08TD1	11	Feedthrough	ZL-RTB20	ZL-CO-CBL11*
CO-08TD2				
CO-08TR				
CO-08TR-3	Not supported by ZIPLink			
CO-08TA	11	Feedthrough	ZL-RTB20	ZL-CO-CBL11*
CO-16TD1	20	Feedthrough	ZL-RTB20	ZL-CO-CBL20*
CO-16TD2		Fuse	ZL-RFU20 ²	
		Relay (sinking)	ZL-RRL16-24-1	
		Feedthrough	ZL-RTB20	
CO-04TRS ¹		Fuse	ZL-RFU20 ²	
CO-04TRS-10	Relay (sourcing)	ZL-RRL16-24-2		
	Feedthrough	ZL-RTB20		
Not supported by ZIPLink				

* Select the cable length by replacing the * with: Blank = 0.5 m, -1 = 1.0 m, or -2 = 2.0 m.

¹ NOTE: The CO-04TRS relay output is derated not to exceed 2A per point max. when used with the ZIPLink wiring system.

² NOTE: Fuses (5 x 20 mm) are not included. See Edison Electronic Fuse section for (5 x 20 mm) fuse. S500 and GMA electronic circuit protection for fast-acting maximum protection. S506 and GMC electronic circuit protection for time-delay performance. Ideal for inductive circuits.

To ensure proper operation, do not exceed the voltage and current rating of ZIPLink module. ZL-RFU20 = 2A per circuit.

ZIPLink Wiring System Compatibility Matrix for CLICK PLCs (continued)

CLICK PLC Combo I/O Module ZIPLink Selector				
I/O Module		ZIPLink		
Combo Module	# of Terms	Component	Module Part No.	Cable Part No.
C0-16CDD1	20	Feedthrough	ZL-RTB20	ZL-C0-CBL20*
C0-16CDD2				ZL-C0-CBL11*
C0-08CDR	11			ZL-C0-CBL11*

* Select the cable length by replacing the * with: Blank = 0.5m, -1 = 1.0m, or -2 = 2.0m.

CLICK PLC Analog I/O Module ZIPLink Selector				
I/O Module		ZIPLink		
Analog Module	# of Terms	Component	Module Part No.	Cable Part No.
C0-04AD-1	11	Feedthrough	ZL-RTB20	ZL-C0-CBL11*
C0-04AD-2	11			
C0-04RTD	20	No ZIPLinks are available for RTD and thermocouple modules.		
C0-04THM	11	Feedthrough	ZL-RTB20	ZL-C0-CBL11*
C0-04DA-1	11			ZL-C0-CBL11*
C0-04DA-2	11			ZL-C0-CBL20*
C0-4AD2DA-1	20			ZL-C0-CBL20*
C0-4AD2DA-2	20			ZL-C0-CBL20*

* Select the cable length by replacing the * with: Blank = 0.5m, -1 = 1.0m, or -2 = 2.0m.

I/O Wiring Checklist

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

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

Terminal Block AWG and Torque	
Connector Type (all)	Removable Terminal Block
Wire Range	28-16 AWG
Wire strip length	7.0 mm
Screw Size	M2.0
Screw Torque	Analog, analog combo I/O modules only: 1.7 lb-in; All other modules: 2.0 to 2.2 lb-in



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

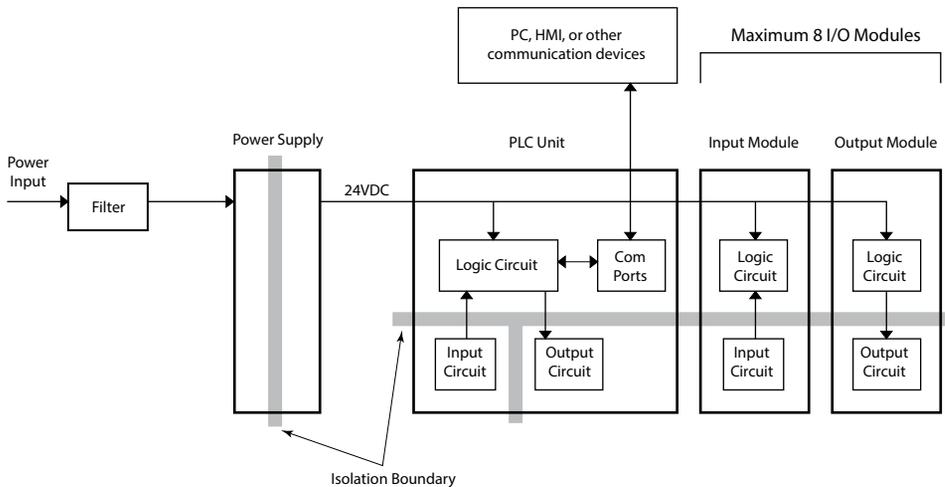
2. Always use a continuous length of wire, do not combine wires to attain a needed length.
3. Use the shortest possible wire length.
4. Use wire trays for routing where possible.
5. Avoid running wires near high energy wiring. Also, avoid running input wiring close to output wiring where possible.
6.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

System Wiring Strategies

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

PLC Isolation Boundaries

PLC circuitry is divided into three main regions separated by isolation boundaries, shown in the drawing below. Electrical isolation provides safety, so that a fault in one area does not damage an adjacent area. A powerline filter will provide isolation between the power source and the power supply. The transformer in the power supply provides magnetic isolation between the primary and secondary sides. Optical isolators provide optical isolation in Input and Output circuits. These methods isolate logic circuitry from the field side, where factory machinery connects. The discrete inputs are isolated from the discrete outputs, because each is isolated from the logic side. Isolation boundaries protect the devices such as PC and HMI that are connected to the communication ports, 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 more than one circuit.

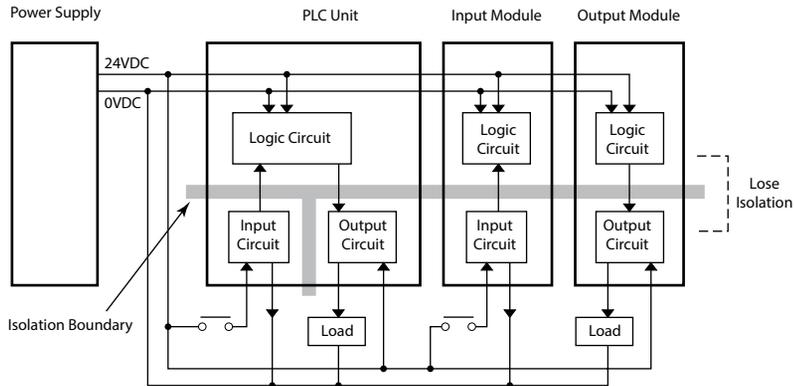


NOTE: If you do not use one of the CLICK PLC power supplies C0-00AC and C0-01AC to provide 24VDC to the PLC module (and I/O modules), be sure the power supply you use has isolation with a transformer.

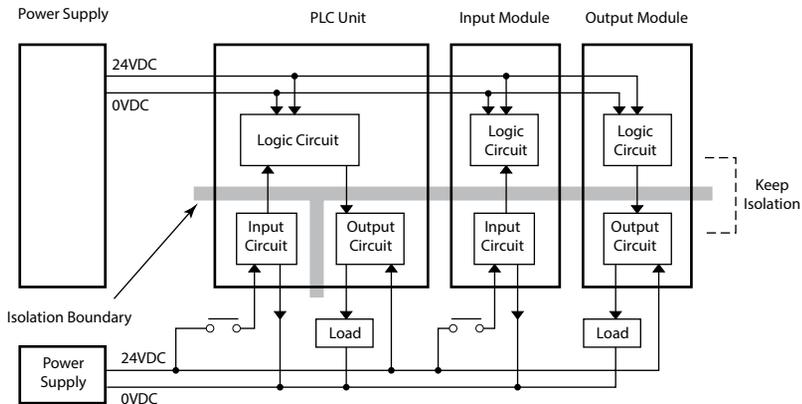
Powering I/O Circuits

In most applications, it will be necessary to power the input devices from one power source, and to power output loads from another source. Loads often require high-energy AC power, while input sensors use low-energy DC. If a machine operator is likely to come in close proximity to input wiring, then for safety reasons, high-energy output circuits would be isolated.

For the DC input/output circuits, you can use the same power source as the PLC module (and I/O modules). However, you lose the isolation between the logic circuits and the input/output circuits. For AC input/output circuits, you don't need to worry about sharing the 24VDC.



To keep the isolation between the logic circuits and the input/output circuits, we recommend using another power supply for the DC input and output circuits.

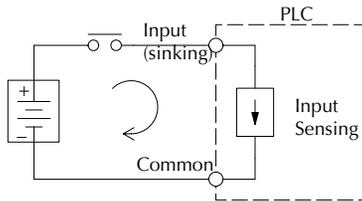


Sinking/Sourcing Concepts

Before wiring field devices to the PLC I/O, it's necessary to have a basic understanding of sinking and sourcing concepts. Use of these terms occurs frequently in input or output circuit discussions. The purpose of this section is to explain the terms. The short definitions are as follows:

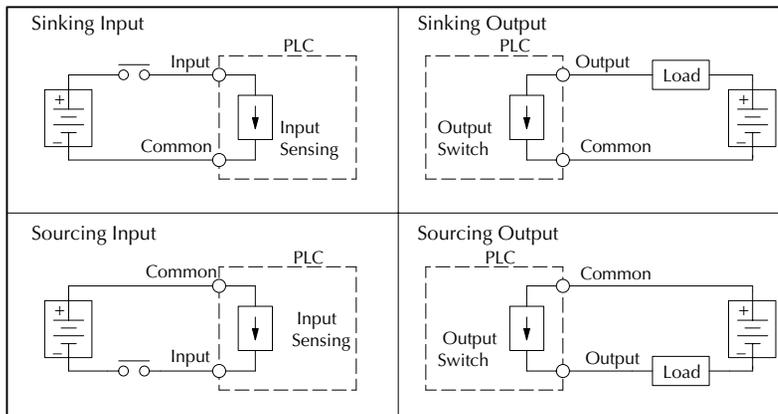
- Sinking = Path to supply ground (-) or switching ground
- Sourcing = Path to supply source (+) or switching +V

These terms only apply to DC circuits, not AC circuits. Input and output points that are either sinking or sourcing can conduct current in only one direction. This means it is possible to wire the external supply and field device to the I/O point with current trying to flow in the wrong direction, in which case the circuit will not operate.



The diagram on the left shows a sinking PLC input. To properly connect the external supply, connect it so the input provides a path to ground (-). Start at the PLC input terminal, follow through the input sensing circuit, exit at the common terminal, and connect the supply (-) to the common terminal.

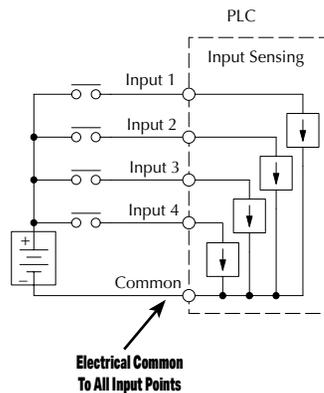
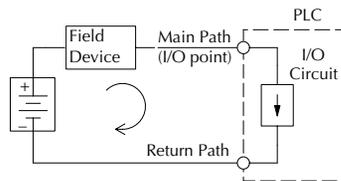
The switch between the supply (+) and the input completes the circuit. Current flows in the direction of the arrow when the switch is closed. By applying the circuit principle above to the four possible combinations of input/output sinking/sourcing types, we have the four circuits as shown below.



I/O “Common Terminal” Concepts

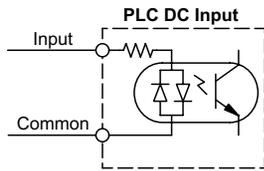
In order for a PLC I/O circuit to operate, current must enter at one terminal and exit at another. This means at least two terminals are associated with every I/O point. In the figure to the right, the input or output terminal is the main path for the current. One additional terminal must provide the return path to the power supply.

If there was unlimited module space, then every I/O point could have two dedicated terminals as the figure above shows. Providing this level of flexibility is not practical or necessary for most applications. So, most I/O point groups share the return path (common) among two or more I/O points. The figure to the right shows a group (or bank) of 4 input points which share a common return path. In this way, the four inputs require only five terminals instead of eight.



NOTE: In the circuit above, the current in the common path is equal to the sum of the energized channels. This is especially important in output circuits, where larger gauge wire is sometimes needed for the commons.

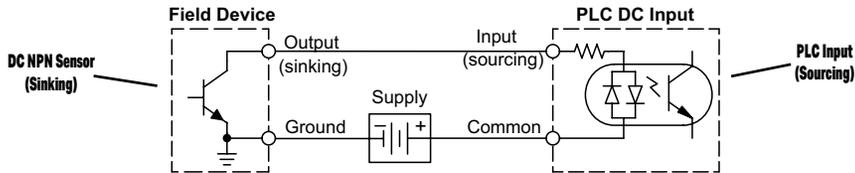
DC Input Wiring Methods



CLICK PLCs and I/O modules with DC inputs can be wired as either sinking or sourcing inputs. The dual diodes (shown in this diagram) allow current to flow in either direction. Inputs grouped by a common point must be either all sinking or all sourcing. DC inputs typically operate in the range of +12-24 VDC.

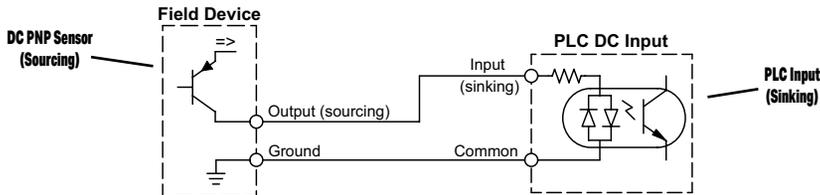
Sinking Input Sensor (NPN Type) to PLC Sourcing Input

In the following example, a field device has an open-collector NPN transistor output. When energized, it sinks current to ground from the DC input point. The PLC input current is sourced from the common terminal connected to power supply (+).



Sourcing Input Sensor (PNP Type) to PLC Sinking Input

In the following example, a field device has an open-emitter PNP transistor output. When energized, it sources current to the PLC input point, which sinks the current to ground. Since the field device loop is sourcing current, no additional power supply is required for the module.



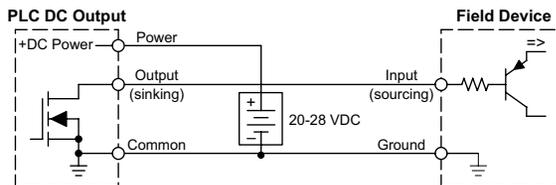
DC Output Wiring Methods

CLICK PLCs and I/O modules with DC output circuits are wired as all current sinking only or current sourcing only depending on which PLC or output module part number is used. DC outputs typically operate in the range of +5-24 VDC.

PLC Sinking Output to Sourcing Load Device

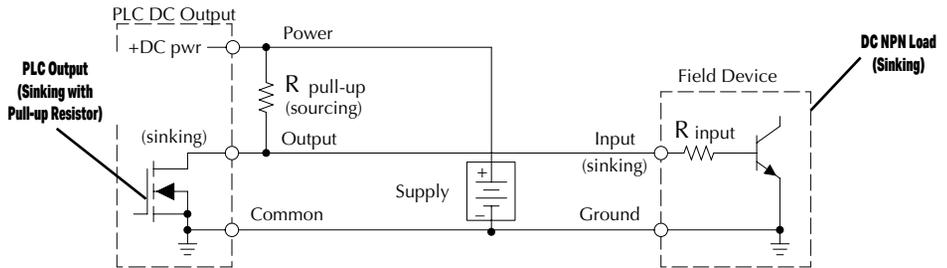
Many applications require connecting a PLC output point to a DC input on a field device load. This type of connection is made to carry a low-level DC signals.

In the following example, the PLC output point sinks current to ground (common) when energized. The output is connected to a field device load with a sourcing input.



PLC DC Sinking Output to Sinking Load Device

In the example below, a PLC sinking output point is connected to the sinking input of a field device load. In this case, 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.

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

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

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

Relay Outputs - Wiring Methods

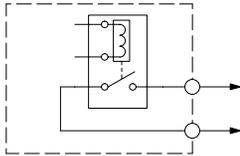
Relay outputs are available for the CLICK PLCs. Relays are best for the following applications:

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

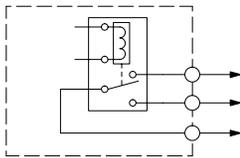
Some applications in which NOT to use relays:

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

Relay with Form A contacts



Relay with Form C contacts



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

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

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

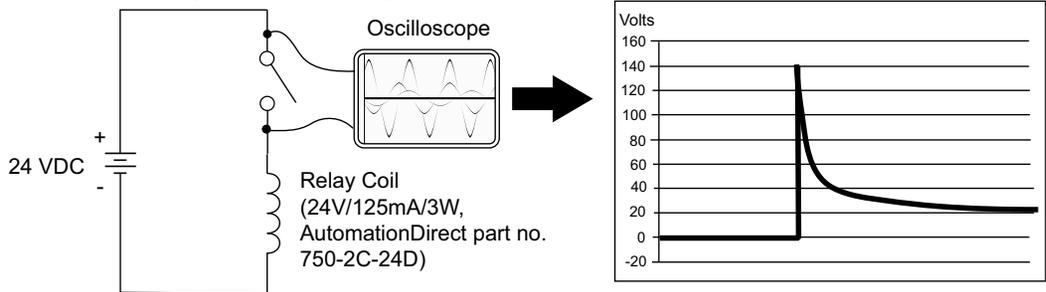
The following pages are intended to give a quick overview of the negative effects of transient voltages on a control system and provide some simple advice on how to effectively minimize them. The need for transient suppression is often not apparent to the newcomers in the automation world. Many mysterious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

What is a Transient Voltage and Why is it Bad?

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

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

Example: Circuit with no Suppression



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

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

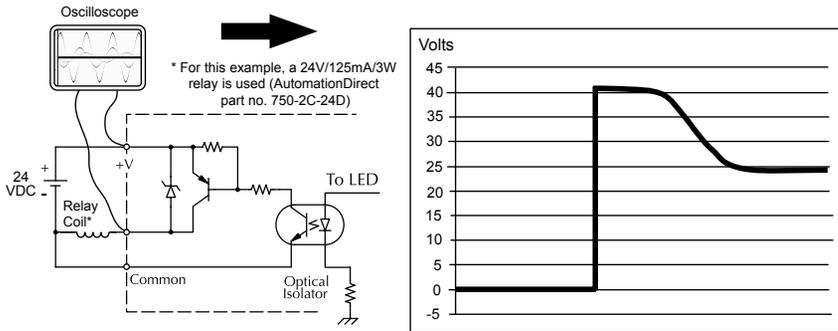
A very destructive side-effect of the arcing across relay contacts is the electromagnetic interference (EMI) it can cause. This occurs because the arcing causes a current surge, which releases RF energy. The entire length of wire between the relay contacts, the coil, and the power source carries the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

PLC's Integrated Transient Suppressors

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

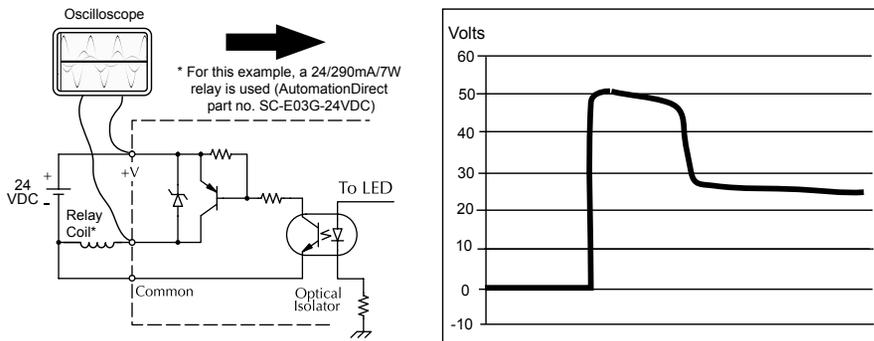
Here is another example using the same 24V, 125mA, 3W relay used earlier. This example measures the PNP transistor output of a D0-06DD2 PLC, which incorporates an integrated Zener diode for transient suppression. Instead of the 140V peak in the first example, the transient voltage here is limited to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

Example: Small Inductive Load with Only Integrated Suppression



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

Example: Larger Inductive Load with Only Integrated Suppression

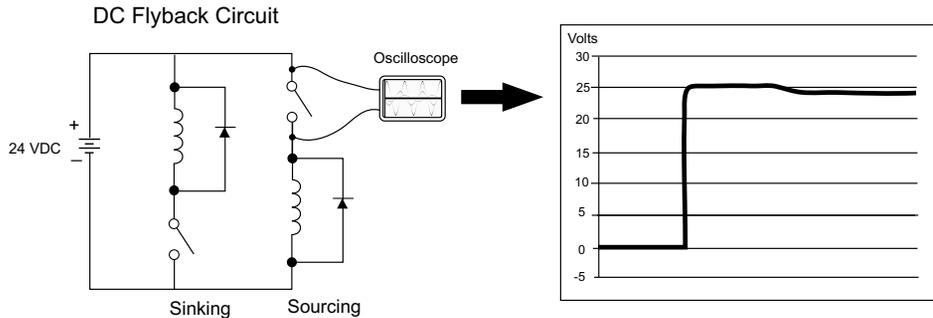


Additional transient suppression should be used in both these examples. If you are unable to measure the transients generated by the connected loads of your control system, using additional transient suppression on all inductive loads would be the safest practice.

Types of Additional Transient Protection

DC Coils:

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



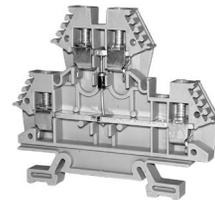
Many AutomationDirect socketed relays and motor starters have add-on flyback diodes that plug or screw into the base, such as the AD-ASMD-250 protection diode module and 784-4C-SKT-1 socket module shown below. If an add-on flyback diode is not available for your inductive load, an easy way to add one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



AD-ASMD-250
Protection Diode Module



784-4C-SKT-1
Relay Socket



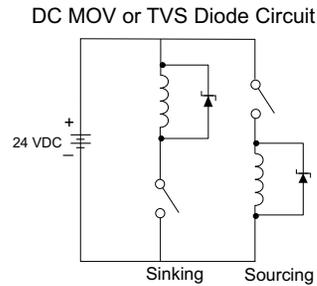
DN-D10DR-A
Diode Terminal Block

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

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



ZL-TSD8-24
Transorb Module



AC Coils:

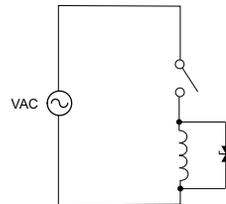
Two options for AC coils are MOVs or bi-directional TVS diodes. These devices are most effective at protecting the driver from a transient voltage when connected across the driver (PLC output) but are also commonly connected across the coil. The optimum voltage rating for the suppressor is the lowest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

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



ZL-TSD8-120
Transorb Module

AC MOV or Bi-Directional Diode Circuit



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

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

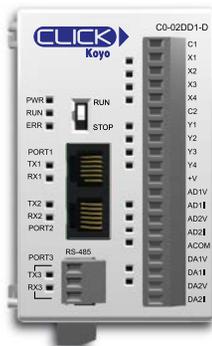
Analog I/O Configuration

Built-in Analog I/O are available in the CLICK models listed below. (Expansion Analog I/O modules are shown on following page.)

Analog PLC Units	Inputs	Outputs
C0-02DD1-D	2 - Current/ Voltage, Selectable	2 - Current/ Voltage, Selectable
C0-02DD2-D		
C0-02DR-D		
C0-12DD1E-D		
C0-12DD2E-D		
C0-12DRE-D		
C0-12ARE-D	4 - Current only	2 - Current only
C0-12DD1E-1-D		
C0-12DD2E-1-D		
C0-12DRE-1-D		
C0-12ARE-1-D	4 - Voltage only	2 - Voltage only
C0-12DD1E-2-D		
C0-12DD2E-2-D		
C0-12DRE-2-D		
C0-12ARE-2-D		

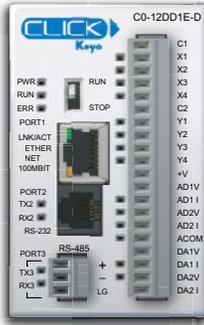
Terminal Block Wiring - Analog PLC Units

The (non-Ethernet) Analog PLC units have two built-in analog inputs and two built-in analog outputs. You can select analog voltage or analog current for each analog I/O separately. As shown below, you must use the proper terminal when using analog voltage or analog current.



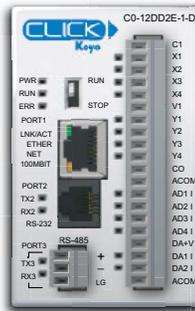
Analog Terminals	
Terminal Name	Terminal Description
AD1V	Analog voltage input
AD1I	Analog current input
AD2V	Analog voltage input
AD2I	Analog current input
ACOM	Common for all analog inputs and outputs
DA1V	Analog voltage output
DA1I	Analog current output
DA2V	Analog voltage output
DA2I	Analog current output

Some Ethernet Analog PLC units have two built-in analog inputs and two built-in analog outputs.



Ethernet Analog Terminals	
Terminal Name	Terminal Description
AD1V	Analog voltage input
AD1I	Analog current input
AD2V	Analog voltage input
AD2I	Analog current input
ACOM	Common for all analog inputs and outputs
DA1V	Analog voltage output
DA1I	Analog current output
DA2V	Analog voltage output
DA2I	Analog current output

Some Ethernet Analog PLC units have four built-in (current or voltage) analog inputs and two analog outputs.



Ethernet Analog Current Terminals	
Terminal Name	Terminal Description
ACOM	Common for analog inputs
AD1I- AD4I	Analog current input
DA+V	Analog voltage source
DA1I- DA2I	Analog current output
ACOM	Common for analog outputs

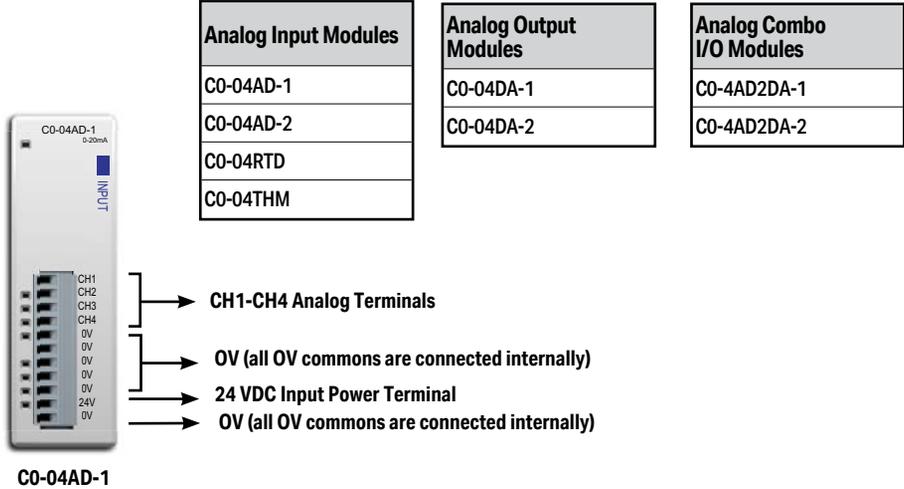


Ethernet Analog Voltage Terminals	
Terminal Name	Terminal Description
AD1V- AD4V	Analog voltage input
ACOM	Common for analog inputs
DA1V- DA2V	Analog voltage output
ACOM	Common for analog outputs

Terminal Block Wiring - Expansion Analog I/O Modules

The terminal block wiring will vary depending on which analog I/O module is being used. For example, the C0-04AD-1 module shown here has four analog terminals, CH1 through CH4, which are all current inputs.

See Chapter 2. Specifications for terminal block wiring diagrams and specifications for all the analog I/O modules.



Configuration in the CLICK Programming Software

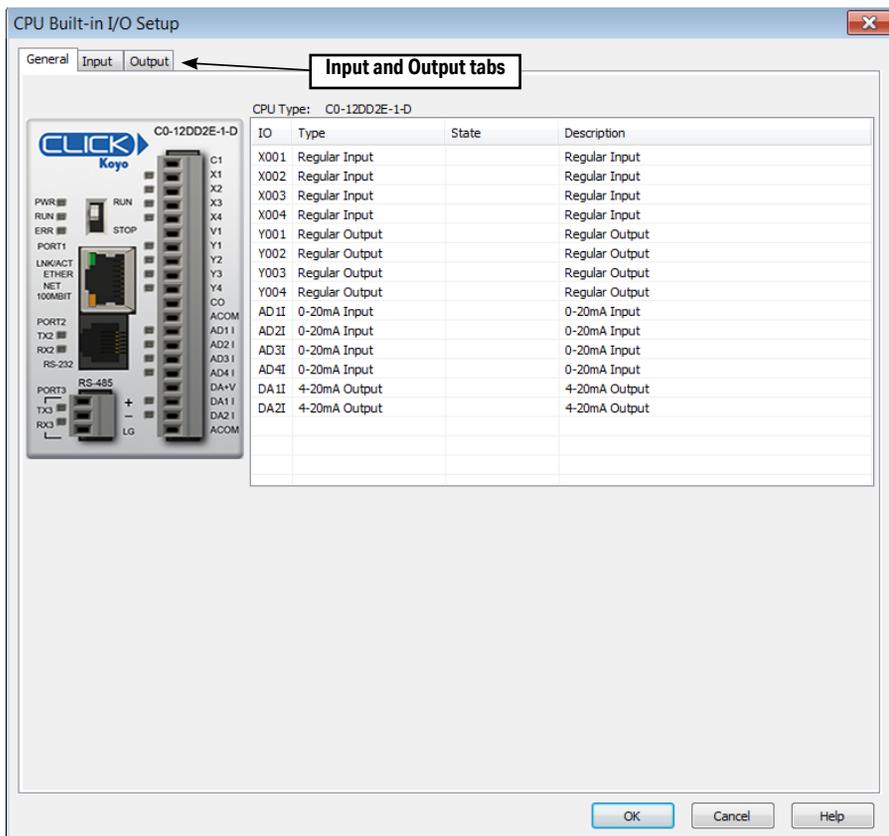
All analog I/O points can be configured in the CLICK Programming Software. There is no jumper switch in these modules.

Analog PLC units

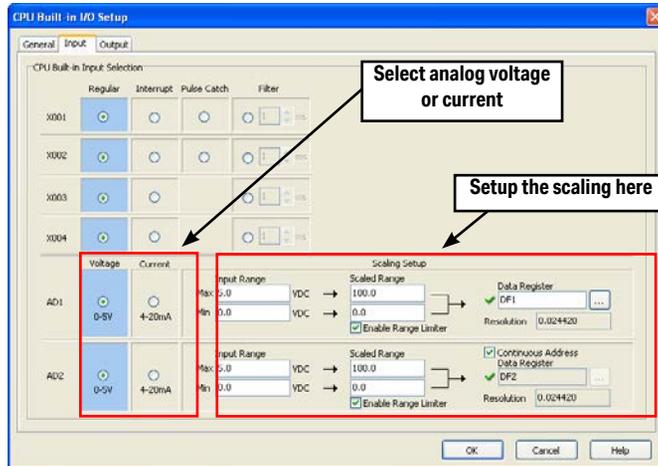
The Analog PLC units cannot detect which terminal is used between the analog voltage and analog current, so you must configure which analog type is used for each analog I/O in the CLICK programming software.

Connect the CLICK programming software to the Analog PLC unit, then open the CPU Built-in I/O Setup window as shown below.

(Pull-down menu: Setup > CPU Built-in I/O Setup)



Click the Input tab to configure the analog inputs and/or click the Output tab to configure the analog outputs. The Input tab is shown below, but the Output tab looks very similar.



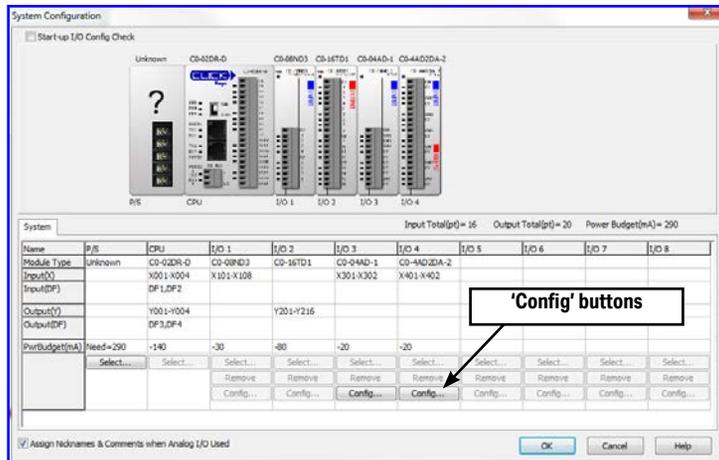
You can select the analog voltage or analog current with the radio buttons. Also use this screen to set the scaling for each Analog I/O. Click the Help button on the right bottom to learn about the scaling feature.

After you configure the Analog I/O, download the project into the Analog PLC module.

Analog I/O Modules

To configure an Analog I/O module, connect the CLICK programming software to the CLICK PLC including the Analog I/O module, then open the System Configuration window as shown below (Pull-down menu: Setup > System Configuration).

Click the 'Config...' button to open the configuration window to configure each analog I/O module.



The following is the configuration window for the C0-04AD-1 current input I/O module.

C0-04AD-1 Setting

Continuous Address

Channel	Input Range	Scale Range	Data Register	Resolution
CH1	0 - 20mA Max: 20.0 mA Min: 0.0 mA	100.0 0.0	<input checked="" type="checkbox"/> <input type="text"/> ...	0.0122085
CH2	0 - 20mA Max: 20.0 mA Min: 0.0 mA	100.0 0.0	<input checked="" type="checkbox"/> <input type="text"/> ...	0.0122085
CH3	0 - 20mA Max: 20.0 mA Min: 0.0 mA	100.0 0.0	<input checked="" type="checkbox"/> <input type="text"/> ...	0.0122085
CH4	0 - 20mA Max: 20.0 mA Min: 0.0 mA	100.0 0.0	<input checked="" type="checkbox"/> <input type="text"/> ...	0.0122085

X301 = Should be mentioned that it is the Watchdog Error bit
X302 = On when external 24VDC input missing.

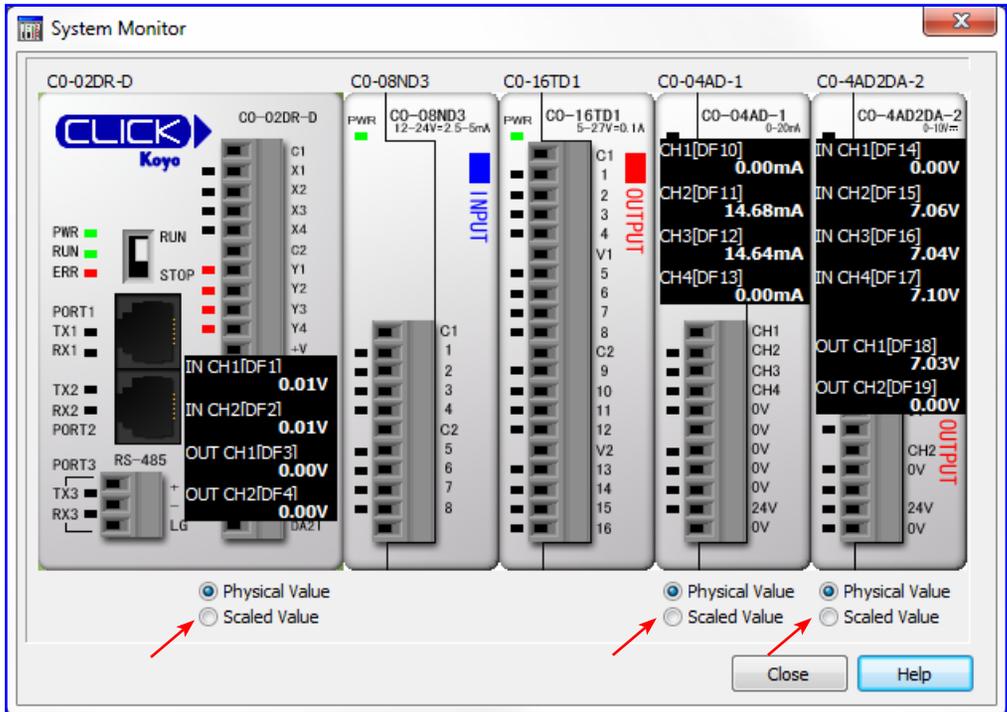
OK Cancel Help

In the CLICK PLC, all analog data is stored in the DF memory addresses. Assign DF memory addresses to the Data Register fields. You can also set up the scaling in this configuration window. For more detailed explanation about this configuration window, refer to the help topic by clicking the Help button on the bottom right corner.

After configuring all the analog I/O modules, download the CLICK project into the CLICK PLC.

Analog I/O Monitoring

To monitor the current analog I/O values, you can use the System Monitor window as shown below (Pull-down menu: Monitor > System Monitor).



You can switch the displayed values between the physical values and scaled values with the radio buttons below the respective graphic.

High-Speed Input Configuration

CLICK CPUs that have built-in digital inputs with High-Speed capability are shown below. The maximum number of available Single Input Counters will depend on the combination of features used.

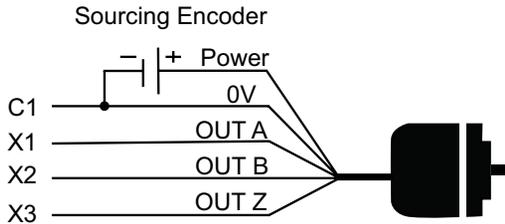
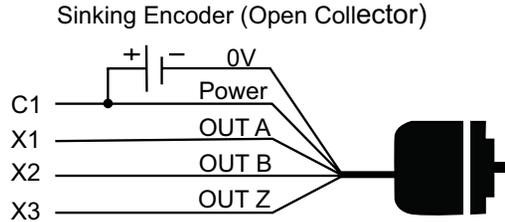
CPU Type	CPU Part Number	High-Speed Input Points	High-Speed Counters (Max.)
Ethernet Basic	C0-10DD1E-D	4	4
	C0-10DD2E-D		
	C0-10DRE-D		
	C0-10ARE-D	N/A	N/A
Ethernet Standard	C0-11DD1E-D	8	6
	C0-11DD2E-D		
	C0-11DRE-D		
	C0-11ARE-D	N/A	N/A
Ethernet Analog	C0-12DD1E-D	4	4
	C0-12DD2E-D		
	C0-12DRE-D		
	C0-12ARE-D	N/A	N/A
	C0-12DD1E-1-D	4	4
	C0-12DD2E-1-D		
	C0-12DRE-1-D		
	C0-12ARE-1-D	N/A	N/A
	C0-12DD1E-2-D	4	4
	C0-12DD2E-2-D		
	C0-12DRE-2-D		
C0-12ARE-2-D	N/A	N/A	

Each Input Mode consumes the available number of High-Speed Inputs. The Reset and Enable features can use High-Speed Inputs, Digital Input Modules, or Control Relays (Internal Bits). The transition delay (latency) is longer for Input Modules and Control Relays since these are scan based.

High-Speed Mode	Input Type	High-Speed Inputs Required	Reset Input	Enable Input
High-Speed Count (HSC)	Up Count	1	Optional	Optional
	Down Count			
	Up and Down Counts	2		
	Pulse and Direction			
	Quadrature (A and B)			
	Quadrature (A and B with Z)	3	N/A	
Interval Measurement (ITV)	Single Input	1	Optional	
	Dual Inputs	2		
Duration Measurement (DUR)	Single Input	1		
Frequency Measurement (FRQ)	Single Input	1	N/A	N/A
	Quadrature (A and B)	2		

Wiring Examples High Speed Inputs

Quadrature with Reset (Z-Pulse):



3-Wire Sensors

