Sinking and Sourcing Concepts

When choosing the type of input or output module for your system (or DL05/DL06/DL105 I/O type), it is very important to have a solid understanding of sinking and sourcing concepts. Use of these terms occurs frequently in discussion of input or output circuits. It is the goal of this section to make these concepts easy to understand, so you can make the right choice the first time when selecting the type of I/O points for your application. This section provides short definitions, followed by general example circuits.

First you will notice that the diagrams on this page are associated with only DC circuits and not AC, because of the reference to (+) and (-) polarities. Therefore, sinking and sourcing terminology applies only to DC input and output circuits. Input and output points that are sinking or sourcing can conduct current in one direction only. 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, the supply and field device can be connected every time based on an understanding of sourcing and sinking.

The figure below depicts a sinking input. To properly connect the external supply, it must be connected so the input provides a path to supply common(-). So, 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, the circuit is completed. Current flows in the direction of the arrow when the switch is closed.

By applying the circuit principles to the four possible combinations of input/output sinking/sourcing types, there are four circuits, as shown above. The common terminal is the terminal that serves as the common return path for all I/O points in the bank.

Sink/source I/O circuits combine sinking and sourcing capabilities. This means that the I/O circuitry in the PLC will allow current to flow in either direction, as shown at the right. The common terminal connects to one polarity, and the I/O point connects to the other polarity (through the field device). This provides flexibility in making connections to your field power supply. Please note:

- Wire all I/O points with a shared common as either sinking or sourcing.
- Do not use an AC power supply on a DC sink/source I/O point.

Field device examples - 3 wire connections

For the latest prices, please check AutomationDirect.com.
Common terminals and how to use them

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 at 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. Together, the main path and the return path create a loop, or a complete circuit for current to flow.

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

**NOTE:** Assuming all input circuits have a similar resistance, the current at the common terminal is four times greater than the current at any one of the inputs. This effect is especially important to note for output circuits, where the current through a common terminal can reach several amperes. You will need to decide whether to fuse each output point individually, or to put a fuse in the common terminal path.

Wiring labels and how to interpret them

**DL205, DL305, DL405** - Most DL205, DL305 and DL405 input and output modules group their I/O points into banks that share a common return path. The best indication of I/O common grouping is on the wiring label. Sample DL05, DL06 and DL105 wiring labels and their meanings are shown below.

In the wiring label example, the positive terminal of a DC supply connects to the common terminals. Some of the symbols you will see on wiring labels and their meanings are shown at the right.

**DL05/DL06/DL105** — Most DL05, DL06 and 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. Sample DL05, DL06 and DL105 wiring labels and their meanings are shown below.

For the latest prices, please check AutomationDirect.com.
ISO 9001/UL/CUL/EU/RoHS

Throughout the world, there is a wide variety of regulatory codes, agency approvals, and other types of certification that may be required in order to install an automation system. These requirements vary and depend on your exact location and situation. For example, there may be national codes, state and local government codes, and even wide-ranging requirements such as the European Union (EU) Directives. The following are some of these codes and requirements, and explanations of how they may affect you as a PLC and industrial controls user.

ISO 9001

Some companies require their suppliers to use products that are built by companies that adhere to a documented set of quality-related procedures. ISO 9001 is one of the standards in the ISO 9000 family of standards for quality management systems. Koyo Electronics Industries Company, Ltd., the manufacturer of most of our PLC products, is an ISO 9001 certified company, as are many of our other Federation members.

Underwriters Laboratories (UL/CUL)

Underwriters Laboratories is one of the world's premier safety testing and certification sources. Many applications require UL approval for insurance and/or other compliance purposes. There are several areas of interest, but the most applicable are: UL508, the standard for Industrial Control Equipment; and UL1604, the standard covering Hazardous Locations. For more information on the Underwriters Laboratories, check their Web site at www.ul.com. There are several tables in this section that show which of our products have a UL listing. (They also indicate the cUL approval, which is required in many applications in Canada.) Please check our Web site for the most current information.

European Union (EU) Directives

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

Which Directives apply to me? Several Directives apply to our products, and Directives may be amended or added, as required:

- Electromagnetic Compatibility Directive (EMC) – Provides a means to ensure that products placed on the market do not generate electromagnetic disturbances that would affect other apparatus, including radio and/or telecommunications equipment.
- Machinery Safety Directive – Covers the safety aspects of the equipment, installation, etc. There are several areas involved, including testing standards covering both electrical noise immunity and noise generation.
- Low Voltage Directive – Is also safety related and covers electrical equipment that has voltage ranges of 50-1,000 VAC and/or 75-1,500 VDC.
- Battery Directive – Covers the production, recycling, and disposal of batteries.

Who is responsible for ensuring compliance with these Directives? Ultimately, we are all responsible for our various pieces of the puzzle. Manufacturers must test their products and document any test results and/or installation procedures necessary to comply with the Directives. As a machine builder, you are responsible for installing the products in a manner that will ensure compliance is maintained. You are also responsible for testing any combinations of products that may (or may not) comply with the Directives when used together. The end user of the products must comply with any Directives that may cover maintenance, disposal, etc., of equipment or various components. Although we strive to provide the best assistance available, it is impossible for us to test all possible configurations of the products we carry with respect to any specific Directive. Because of this, it is ultimately your responsibility to ensure that your machinery (as a whole) complies with these Directives and to keep up with applicable Directives and/or practices that are required for compliance.

Which programmable controller products carry the CE label? See Tables on pp. 35-11 through 35-14 for controller systems manufactured by Koyo Electronics Industries, Host Engineering or FACTS Engineering. When properly installed and used, the approved components conform to the Electromagnetic Compatibility (EMC), Low Voltage Directive, and Machinery Directive requirements of the standards on the next page.

EC 61000-3-2 Power Factor Correction

The IEC 61000-3-2 standard is intended to reduce the amount of disturbance a device feeds back into its power source. AutomationDirect power supplies all carry the CE mark. Normally, 61000-3-2 is met or does not apply. Only our PS24-150D and PS24-300D could potentially be used in a manner not compliant with the 61000-3-2 standard.

RoHS

The Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC (1) was adopted in February 2003 by the EU. The RoHS directive, which took effect July 1, 2006, restricts the use of six hazardous materials in the manufacture of various types of electrical and electronic equipment. RoHS is linked with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC which sets collection, recycling and recovery targets for electrical goods and is part of a legislative initiative to solve the problem of large amounts of toxic e-waste.

Each EU member state will adopt its own enforcement and implementation policies using the directive as a guide. Therefore, there could be as many different versions of the directive as there are states in the EU.

RoHS is often referred to as the lead-free directive, however, it restricts the use of the following six substances:

- Lead
- Mercury
- Cadmium
- Hexavalent chromium (chromium VI or Cr 6+)
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ether (PBDE)

For a listing of all products and their compliance status see:
http://support.automationdirect.com/compliance.html#rohs
EU - European Union

- **EMC Directive Standards Relevant to PLCs**
  - EN50081-1 – Generic emission standard for residential, commercial, and light industry
  - EN50081-2 – Generic emission standard for industrial environment
  - EN50082-1 – Generic immunity standard for residential, commercial, and light industry
  - EN50082-2 – Generic immunity standard for industrial environment
- **Low Voltage Directive Standards Applicable to PLCs**
  - EN61010-1 – Safety requirements for electrical equipment for measurement, control, and laboratory use
- **Product Specific Standard for PLCs**
  - EN61131-2 – Programmable controllers, equipment requirements and tests. This standard replaces the above generic standards for immunity and safety. However, the generic emissions standards must still be used in conjunction with the following standards:
    - EN 61000-3-2 – Harmonics
    - EN 61000-3-2 – Fluctuations. We are currently in the process of changing our testing procedures from the generic standards to the product specific standards.

We do have separate Declarations of Conformity that cover the specific products and part numbers approved. Not all of the products have been labeled for CE as of this writing, so you should check the tables on the following pages to be sure. Please also check our Web site for the most up-to-date information on CE approvals or to obtain copies of our Declarations of Conformity.

Are there any special requirements necessary when using controller equipment? Yes, the installation requirements to comply with the requirements of the Machinery Directive, EMC Directive and Low Voltage Directive are slightly more complex than the normal installation requirements found in the United States. First, check the Declaration for specific application conditions required.

Then, refer to the following manual:
- **DA-EU-M** – EU Installation Manual that covers special installation requirements to meet the EU Directive requirements. You should download the manual from our Web site to obtain the most current information. The manual is available for download at: support.automationdirect.com/compliance.html

Finally, check your user manual for EU information.

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

- BSI publication TH42073: February 1996 – Covers the safety and electrical aspects of the Machinery Directive
- EN60204-1:1992 – General electrical requirements for machinery, including Low Voltage and EMC considerations
- IEC 1000-5-2: EMC earthing and cabling requirements
- IEC 1000-5-1: EMC general considerations

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

The Office for Official Publications of the European Communities at www.europa.eu.int

Another source is:

**Global Engineering Documents**
15 Inverness Way East
Englewood, CO 80112-5776
1(800) 854-7179 (within the U.S.)
(303) 397-7956 (international)
(303) 397-2740 (fax)
www.global.ihs.com

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

**Books**
Following is a list of books that may be helpful to you:

- **Title:** EMC For Systems and Installations
  - Authors: Tim Williams and Keith Armstrong
  - Publisher: Newnes Woburn, MA

- **Title:** CE From A to Z
  - Authors: Mette Winther Pedersen & Gert Bukkjær
  - Publisher: Levison & Johnson & Johnson a/s Denmark

- **Title:** EU Directive Handbook: Understanding the European Union Compliance Process and What it Means to You
  - Authors: Allen R. Bailey & Melinda C. Bailey
  - Publisher: St. Lucie Press Boca Raton, FL

- **Title:** Practical Guide to the Low Voltage Directive
  - Authors: Gregg Kervill
  - Publisher: Newnes Woburn, MA

- **Title:** C E Marking Handbook: A Practical Approach to Global Safety Certification
  - Authors: David Lohbeck
  - Publisher: Newnes Woburn, MA
# NEC and NEMA

## The National Electrical Code (NEC)

NEC provides regulations concerning the installation and use of various types of electrical equipment. These classifications are being “harmonized” with the IEC and European Hazardous Location Ratings. A source of information about this “harmonization” is the Instrument Society of America (ISA).

Contact the ISA at: 67 Alexander Drive RTP, NC 27709 Phone: (919)549-8411 www.isa.org

Another resource is: www.ul.com/hazloc

## National Electrical Manufacturers Association (NEMA)

NEMA publishes many different documents that discuss standards for industrial control equipment. Please note that these standards are undergoing “harmonization” with the IEC and European standards and may be replaced. Global Engineering Documents handles the sale of NEMA, IEC and CE documents. For more information, please contact Global Information at:

1 (800) 854-7179 (within the U.S.)
(303) 397-7956 (international)
(303) 397-2740 (fax)
15 Inverness Way East Englewood, CO 80112-5776 www.global.ihs.com

- ICS 1, General Standards for Industrial Control and Systems
- ICS 2, Controllers, Contactors, and Overload Relays, Rated no more than 2000 Volts AC or 750 Volts DC
- ICS 3, Factory Built Assemblies
- ICS 6, Enclosures for Industrial Control Systems

## National Electric Code (NEC) Article 500 Hazardous Location Classification

<table>
<thead>
<tr>
<th>Class</th>
<th>Division</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Locations in which there are explosive mixtures of air and combustible dust.</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Locations in which there are explosive mixtures of air and combustible dust.</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Locations in which there is the presence of easily-ignited fibers or flyings, but where the fibers or flyings are not likely to be in suspension in the air in quantities great enough to produce ignitable mixtures.</td>
<td></td>
</tr>
</tbody>
</table>

### Group A: Atmospheres containing acrylonitrile

- butadiene
- ethylene oxide
- hydrogen
- gases containing more than 30% Hydrogen by volume
- propylene oxide

### Group B: Atmospheres containing:

- allyl alcohol
- carbon monoxide
- diethyl ether
- ethylene
- hydrogen sulfide
- methyl ether
- n-propyl ether
- or gases or vapors of equivalent hazard

### Group C: Atmospheres containing:

- alcohols
- acetone
- hexane
- heptane
- gasoline
- butyl alcohol
- benzene
- toluene
- styrene
- toluene
- carbon monoxide
- ammonia
- n-propyl ether
- methyl ethyl ketone (MEK)
- naphtha
- ethylene oxide
- butadiene
- containing:

### Group D: Atmospheres containing:

- acetone
- ammonia
- benzene
- butane
- butyl alcohol
- ethane
- ethyl alcohol
- gasoline
- heptane
- hexane
- methane (natural gas)
- methyl alcohol
- methyl ethyl ketone (MEK)
- naphtha
- ethylene oxide
- butadiene
- containing:

### Group E: Atmospheres containing combustible dusts that:

- have a combustible equivalence greater than 100,000,000 ohm-centimeter
- or gases or vapors of equivalent hazard

### Group F: Atmospheres containing combustible dusts which have more than 8% total volatile material or, carbon black, charcoal, or coke dusts sensitized by other materials so that they present an explosion hazard, and having a resistivity greater than 10 ohm-centimeter but equal to or less than 100,000,000 ohm-centimeter

### Group G: Atmospheres containing dusts having resistivity of 10 ohm-centimeter or less

## NEMA Electrical Enclosure Environmental Protection Ratings

<table>
<thead>
<tr>
<th>Type</th>
<th>Protection</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General purpose</td>
<td>Indoor</td>
<td>Accidental contact</td>
</tr>
<tr>
<td>2</td>
<td>Drip-proof</td>
<td>Indoor</td>
<td>Falling non-corrosive liquids and falling dirt (dripping and light splashes)</td>
</tr>
<tr>
<td>3</td>
<td>Dust-tight, rain-tight</td>
<td>Outdoor</td>
<td>Windblown dust, water, and sleet; ice-resistant</td>
</tr>
<tr>
<td>3R</td>
<td>Dust-tight, rain-tight</td>
<td>Outdoor</td>
<td>Same as above, plus melting of sleet/ice will not damage external enclosure or mechanisms</td>
</tr>
<tr>
<td>4</td>
<td>Water-tight/dust-tight</td>
<td>Indoor/ outdoor</td>
<td>Splashing water, outdoor seepage of water, falling or hose-directed water</td>
</tr>
<tr>
<td>4X</td>
<td>Water-tight/dust-tight</td>
<td>Indoor/ outdoor</td>
<td>Same as above, plus corrosion resistant</td>
</tr>
<tr>
<td>5</td>
<td>Dust-tight</td>
<td>Indoor</td>
<td>Dust and falling dirt</td>
</tr>
<tr>
<td>6</td>
<td>Water-tight/dust-tight</td>
<td>Indoor/ outdoor</td>
<td>Temporary entry of water limited submersion, formation of ice on enclosure</td>
</tr>
<tr>
<td>6P</td>
<td>Water-tight/dust-tight</td>
<td>Indoor/ outdoor</td>
<td>Same as previous, plus prolonged submersion</td>
</tr>
<tr>
<td>7</td>
<td>Explosion proof Class D Hazardous Locations</td>
<td>Indoor</td>
<td>Hazardous chemicals and gases</td>
</tr>
<tr>
<td>9</td>
<td>Explosion proof Class II Hazardous Locations</td>
<td>Indoor</td>
<td>Hazardous dust</td>
</tr>
<tr>
<td>11</td>
<td>Drip-proof Corrosion Resistant</td>
<td>Indoor</td>
<td>Oil immersion, corrosive effects of liquids and gases</td>
</tr>
<tr>
<td>12</td>
<td>Drip-tight/dust-tight</td>
<td>Indoor</td>
<td>Fibers, lint, dust, and splashing, and dripping condensation of non-corrosive liquids</td>
</tr>
<tr>
<td>13</td>
<td>Oil-tight/dust-tight</td>
<td>Indoor</td>
<td>Dust, spraying of water, oil, and non-corrosive coolant</td>
</tr>
</tbody>
</table>
# How to interpret IP Ratings

The first number defines the degree of protection against penetration of **solid objects** into the housing.

The second number defines the degree of protection against penetration of **liquid** into the housing.

## IP-67 (sample IP rating)

<table>
<thead>
<tr>
<th>First Number</th>
<th>Level of Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Not evaluated</td>
</tr>
<tr>
<td>0</td>
<td>No protection against contact or entry of solids</td>
</tr>
<tr>
<td>1</td>
<td>Protection against accidental contact by hand, but not deliberate contact. Protection against large foreign objects.</td>
</tr>
<tr>
<td>2</td>
<td>Protection against contact by fingers. Protection against medium-size foreign objects.</td>
</tr>
<tr>
<td>3</td>
<td>Protection against contact by tools, wires, etc. Protection against small foreign objects.</td>
</tr>
<tr>
<td>4</td>
<td>Protection against contact by small tools and wires. Protection against small foreign objects.</td>
</tr>
<tr>
<td>5</td>
<td>Complete protection against contact with live or moving parts. Protection against harmful deposits of dust.</td>
</tr>
<tr>
<td>6</td>
<td>Complete protection from live or moving parts. Protection against penetration of dust.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Number</th>
<th>Level of Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Not evaluated</td>
</tr>
<tr>
<td>0</td>
<td>No Protection</td>
</tr>
<tr>
<td>1</td>
<td>Protection against drops of condensed water. Condensed water falling on housing shall have no effect.</td>
</tr>
<tr>
<td>2</td>
<td>Protection against drops of liquid. Drops of falling liquid shall have no effect when housing is tilted to 15° from vertical.</td>
</tr>
<tr>
<td>3</td>
<td>Protection against rain. No harmful effect from rain at angles less than 60° from vertical.</td>
</tr>
<tr>
<td>4</td>
<td>Protection against splashing from any direction.</td>
</tr>
<tr>
<td>5</td>
<td>Protection against water jets from any direction.</td>
</tr>
<tr>
<td>6</td>
<td>Protection against conditions on ships and decks. Water from heavy seas will not enter.</td>
</tr>
<tr>
<td>7</td>
<td>Protection against immersion in water. Water will not enter under stated conditions of pressure and length of time.</td>
</tr>
<tr>
<td>8</td>
<td>Protection against indefinite immersion in water under a specified pressure.</td>
</tr>
<tr>
<td>8K</td>
<td>Protection against indefinite immersion in water under a specified pressure.</td>
</tr>
<tr>
<td>9</td>
<td>Protection against indefinite immersion in water under a specified pressure.</td>
</tr>
<tr>
<td>9K</td>
<td>Protection against high-pressure/steam-jet cleaning.</td>
</tr>
</tbody>
</table>

Additional information on IP ratings can be found in the 1976 IEC Publication: Classification of Degrees of Protection Provided by Enclosures or at [www.iec.ch](http://www.iec.ch).

Example: What is IP-67? Complete protection of live parts, protection against the penetration of dust. Additionally, protection while immersed in water.
## IEC Utilization Categories

### IEC Utilization Categories for Low Voltage Switchgear and Control Gear

<table>
<thead>
<tr>
<th>Current</th>
<th>Category</th>
<th>Typical Applications</th>
<th>Relevant IEC Product Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>AC-1</td>
<td>Non inductive or slightly inductive loads, resistance furnaces, heaters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-2</td>
<td>Slip-ring motors: switching off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-3</td>
<td>Squirrel-cage motors: starting, switching off motors during running most typical industrial application</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-4</td>
<td>Squirrel-cage motors: starting, plugging (1), inching (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-5a</td>
<td>Switching of electric discharge lamps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-5b</td>
<td>Switching of incandescent lamps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-6a</td>
<td>Switching of transformers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-6b</td>
<td>Switching of capacitor banks</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-7a</td>
<td>Slightly inductive load in household appliances: mixers, blenders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-7b</td>
<td>Motor-loads for household applications: fans, central vacuum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-8a</td>
<td>Hermetic refrigerant compressor motor control with manual resetting overloads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-8b</td>
<td>Hermetic refrigerant compressor motor control with automatic resetting overloads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-12</td>
<td>Control of resistive loads and solid state loads with opto-coupler isolation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-13</td>
<td>Control of solid state loads with transformer isolation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-14</td>
<td>Control of small electromagnetic loads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-15</td>
<td>Control of AC electromagnetic loads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-20</td>
<td>Connecting and disconnecting under no-load conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-21</td>
<td>Switching of resistive loads, including moderate loads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-22</td>
<td>Switching of mixed resistive and inductive loads, including moderate overloads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC-23</td>
<td>Switching of motor loads or other highly inductive loads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC and DC</td>
<td>A Protection of circuits, with no rated short-time withstand current</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B Protection of circuits, with a rated short-time withstand current</td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>DC-1</td>
<td>Non-inductive or slightly inductive loads, resistance furnaces, heaters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-3</td>
<td>Shunt-motors, starting, plugging (1), inching (2), dynamic breaking of motors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-5</td>
<td>Series-motors, starting, plugging (1), inching (2), dynamic breaking of motors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-6</td>
<td>Switching of incandescent lamps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-12</td>
<td>Control of resistive loads and solid state loads with opto-coupler isolation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-13</td>
<td>Control of DC electromagnetics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-14</td>
<td>Control of DC electromagnetic loads having economy resistors in the circuit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-20</td>
<td>Connecting and disconnecting under no-load conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-21</td>
<td>Switching of resistive loads, including moderate overloads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-22</td>
<td>Switching of mixed resistive and inductive loads, including moderate overloads (i.e., shunt motors)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC-23</td>
<td>Switching of highly inductive loads (i.e., series motors)</td>
<td></td>
</tr>
</tbody>
</table>
Wiring Devices – NEMA Wiring Diagrams

Reference material only. Please see Wiring Section in the catalog for product part number.

2-Pole 2-Wire

125V

208V or 250V

2-Pole 3-Wire Grounding

125V

208V or 250V

277V AC

For the latest prices, please check AutomationDirect.com.
Wiring Devices – NEMA Wiring Diagrams

2-Pole 3-Wire Grounding

480V AC

600V AC

3-Pole 3-Wire

125V/250V AC

3φ 250V AC

3φ 480V AC
Wiring Devices – NEMA Wiring Diagrams

3-Pole 3-Wire Continued

3φ 600V AC

600V AC 600V AC

600V AC

L13-30R

3-Pole 4-Wire Grounding

125/250V AC

250V AC 125V AC

125V AC

W

SYS.

GR.

G

EQUIP.

GR.

14-15R 14-20R 14-30R 14-50R 14-60R L14-20R L14-30R

250V AC

250V AC

250V AC

G

EQUIP.

GR.


3φ 250V AC

250V AC 250V AC

250V AC

G

EQUIP.

GR.


3φ 480V AC

480V AC 480V AC

480V AC

G

EQUIP.

GR.

L16-20R L16-30R

For the latest prices, please check AutomationDirect.com.
For the latest prices, please check AutomationDirect.com.
4-Pole 5-Wire Grounding

**3ØY 120/208V AC**

```
W
SYS.
GR.
G
EQUIP.
GR.
```

```
208V AC 208V AC 120V AC 120V AC
120V AC
208V AC
```

```
L21-20R  L21-30R
```

**3ØY 277/480V AC**

```
W
SYS.
GR.
G
EQUIP.
GR.
```

```
480V AC 480V AC 277V AC 277V AC
277V AC
480V AC
```

```
L22-20R  L22-30R
```

**3ØY 347/600V AC**

```
W
SYS.
GR.
G
EQUIP.
GR.
```

```
600V AC 600V AC 347V AC 347V AC
347V AC
600V AC
```

```
L23-20R  L23-30R
```
Product Compatibility

Compatible products

Here’s a brief list to help you identify compatible products.

<table>
<thead>
<tr>
<th>DirectLogic</th>
<th>Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>DL05</td>
<td>None</td>
</tr>
<tr>
<td>DL06</td>
<td>None</td>
</tr>
<tr>
<td>DL105</td>
<td>None</td>
</tr>
<tr>
<td>DL205</td>
<td>None</td>
</tr>
<tr>
<td>DL305</td>
<td>GE Series 1 TI 305 Siemens TI 305</td>
</tr>
<tr>
<td>DL405</td>
<td>TI 405 Siemens TI 405</td>
</tr>
</tbody>
</table>

Compatible communication drivers

A driver created for a compatible PLC will probably work with our PLCs. However, some of our newer CPUs have more memory than similar products offered by previous vendors. If using one of their drivers, make sure you ask if their driver performs memory range checking. If it does, then you may not be able to access all of the memory locations.

<table>
<thead>
<tr>
<th>DirectLogic</th>
<th>Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>DirectNet</td>
<td>CCM (GE), Hostlink (TI/Siemens)</td>
</tr>
</tbody>
</table>

Communication protocols

Some vendors may specify a communication protocol instead of a PLC family name. Use the chart shown on this page to help you identify the protocol and PLC port usage.

<table>
<thead>
<tr>
<th>CPU/ device</th>
<th>Port</th>
<th>Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>DL05</td>
<td>Port 1</td>
<td>K-sequence, DirectNET and Modbus RTU slave</td>
</tr>
<tr>
<td>DL05</td>
<td>Port 2</td>
<td>K-sequence slave, DirectNET and Modbus RTU master/slave</td>
</tr>
<tr>
<td>DL06</td>
<td>Port 1</td>
<td>K-sequence, DirectNET and Modbus RTU slave</td>
</tr>
<tr>
<td>DL06</td>
<td>Port 2</td>
<td>K-sequence slave, DirectNET and Modbus RTU master/slave</td>
</tr>
<tr>
<td>DL0-DCM</td>
<td>Port 1</td>
<td>K-sequence, DirectNET and Modbus RTU slave</td>
</tr>
<tr>
<td>DL0-DCM</td>
<td>Port 2</td>
<td>K-sequence slave, DirectNET and Modbus RTU master/slave</td>
</tr>
<tr>
<td>DL105</td>
<td>F1-130</td>
<td>Only one K-sequence slave</td>
</tr>
<tr>
<td>DL205</td>
<td>D2-230</td>
<td>Only one K-sequence slave</td>
</tr>
<tr>
<td>DL205</td>
<td>D2-240</td>
<td>Top port K-sequence slave, Bottom port K-sequence and DirectNET slaves</td>
</tr>
<tr>
<td>DL205</td>
<td>D2-250-1</td>
<td>Top port K-sequence, DirectNET and Modbus RTU slaves, Bottom port K-sequence slave, DirectNET and Modbus RTU master/slave</td>
</tr>
<tr>
<td>DL205</td>
<td>D2-260</td>
<td>Top port K-sequence, DirectNET and Modbus RTU slaves, Bottom port K-sequence slave, DirectNET and Modbus RTU master/slave</td>
</tr>
<tr>
<td>DL205</td>
<td>D2-260-1</td>
<td>Only one K-sequence slave Modbus RTU slave</td>
</tr>
<tr>
<td>DL305</td>
<td>D3-330</td>
<td>Requires DCU DirectNET slave</td>
</tr>
<tr>
<td>DL305</td>
<td>D3-330P</td>
<td>Requires DCU DirectNET slave</td>
</tr>
<tr>
<td>DL305</td>
<td>D3-340</td>
<td>Top port DirectNET slave, Bottom port DirectNET master/slave Modbus RTU slave</td>
</tr>
<tr>
<td>DL305</td>
<td>D3-350</td>
<td>Top port K-sequence and DirectNET slave, Bottom port K-sequence slave, DirectNET and Modbus RTU master/slave</td>
</tr>
<tr>
<td>DL305</td>
<td>D3-350-1</td>
<td>Only one K-sequence slave DirectNET master/slave Modbus RTU slave</td>
</tr>
<tr>
<td>DL405</td>
<td>D4-430</td>
<td>Top port (15-pin) K-sequence slave, Bottom port (25-pin) K-sequence and DirectNET slave</td>
</tr>
<tr>
<td>DL405</td>
<td>D4-440</td>
<td>Top port (15-pin) K-sequence slave, Bottom port (25-pin) K-sequence and DirectNET slave</td>
</tr>
<tr>
<td>DL405</td>
<td>D4-450</td>
<td>Top port (15-pin) K-sequence slave, Bottom port (25-pin) K-sequence slave, DirectNET and Modbus RTU master/slave</td>
</tr>
<tr>
<td>DL405</td>
<td>D4-DCM</td>
<td>Only one K-sequence slave DirectNET master/slave Modbus RTU slave</td>
</tr>
</tbody>
</table>
SI\textsc{DIRECT}: System Integrator Program

Do you need local service and support for your AutomationDirect equipment?

Would you like help planning and installing an AutomationDirect project?

Check out SI\textsc{DIRECT}, The AutomationDirect System Integrator Program!

To extend our award-winning customer service and support into the field, we’ve formed a team of qualified system integrators who are ready to help. Whether you need an integrator to design, build, and install your next automation project, or someone to troubleshoot your existing machinery, simply contact one of our authorized system integrators. You can be assured you’re dealing with a company that has the expertise and experience to tackle your automation challenges.

View our list of integrators at \url{www.automationdirect.com/si} or use the link on our homepage to access the System Integrator section. There, search for integrators by geographical region, product expertise or industry experience.

Not sure which integrator is right for your particular project? We’ll be happy to assist you; just email us at systemintegration@automationdirect.com.

Attention Integrators!

Are you a reputable system integrator with a proven history of installing and servicing AutomationDirect components? If so, think about joining our team of integrators! At \url{www.automationdirect.com/si}, you can take a look at SI\textsc{DIRECT}, our authorized System Integrator Program. There you can view the benefits and requirements associated with becoming an authorized SI, and submit an application.

If your company has expertise with our wide array of industrial control components, and wants to enter into a mutually beneficial relationship with AutomationDirect, we want to hear from you!
Training Courses and Information

Training by seasoned veteran Doug Bell of InterConnecting Automation, Inc.

Do you need training courses for PLCs or drives, taught by someone who has used many of our products to solve difficult, real-world application problems? Would you be even more interested if the training was held in a city near you? We thought so!

For the most current schedule, visit the InterConnectingAutomation website: www.interconnectingautomation.com

If your city isn’t listed there, or if you need an on-site class, custom class etc., then please call the folks at InterConnecting Automation. They can usually create a class to suit a wide variety of special requirements.

Mr. Doug Bell of InterConnecting Automation, Inc., has been using both our products and competitive products for over 25 years. He has years of design and consulting experience, has been the focus of PLC magazine articles, and now offers training classes taught at various locations around the country.

Mr. Bell started his career as an Electronics Technician on the factory floor at Crown Cork & Seal, one of the world’s premier suppliers of cans and closure systems. So, he can relate to the day-to-day problems associated with using and troubleshooting PLC systems. After his stint at Crown, he established a very successful firm that designs and implements control applications, including programming and startup. Here’s a brief list of Mr. Bell’s qualifications and applications experience:

- Over 25 years of experience in PLC and control system design, for more than 45 facilities worldwide, including sites in the U.S., France, Germany, England, and Mexico
- Managed various automation projects, including specification, procurement, programming, site startup and maintenance
- Applications experience, including electronic feeder controls, HVAC controls, automated test stations, coating systems, printing lines, motion control systems, high-speed applications, communication systems, device-level network applications, PC-based control solutions, HMI systems, etc.
- Experience in training both factory technicians and operations personnel

**Note:** PID class may be taught by guest instructors chosen by Mr. Bell.

**Introductory PLC course contents**

You’ll use custom-built training panels that contain our D4-450 CPU, a variety of I/O modules, operator panels, and DirectSOFT.

- PLC family overview for all DirectLOGIC products
- Basic PLC theory of operation including CPU, bases, discrete I/O, analog I/O, and communications
- System configuration techniques
- Simple RLL programming including timers, counters, drums, basic math, and more.
- Advanced programming including number conversions, subroutines, RLL Plus, PID theory, etc.

**Advanced PLC contents**

Using training panels that contain our D4-450 CPU, a variety of I/O modules, operator panels, and DirectSOFT, you will:

- Create programs based on specs given to you in class
- Learn table and pointer commands
- Wire, program and use Terminator and 205 remote I/O
- Writing and structuring programs using Stage
- Debug, diagnose and program PLC over cell phone

**Networking**

- Serial RS-232 and RS-422
- Ethernet
- MAC/IP-PLC-Addressing
- Networking with multiple PLCs
- Control motor speed from a master PLC to a slave w/motor/encoder setup
- Learn to use Read and Write commands and the wiring of a network

**PID course contents**

You’ll use custom-built training panels to:

- Learn PID short cuts and tools
- Learn to setup, tune, troubleshoot and debug PID loops.
- Adjust the gain, reset, rate, and many other PID parameters, to see how they affect the loop

For the latest prices, please check AutomationDirect.com.
Training Videos and Online Training

“Introduction to PLC Logic and Principles” Training Video Set
Mr. Doug Bell of InterConnecting Automation, Inc., offers a basic PLC video training package.

The kit includes the following:
- Two video tapes showing examples of programming with DirectSOFT. You can get “Hands-On” experience by following along with the instructor who is using the same hardware. (DirectSOFT V2.4a, or later, can be used with this course.)
- Pre-wired PLC trainer based on the AutomationDirect D0-05AR PLC, with push-buttons, lights, selector switches and a programming cable ready to plug into your computer
- A DL05 Users Manual, which is referred to throughout the video and is great for future reference

Benefits of this video course:
- Work in the privacy of your own home/office
- No need to travel anywhere — your family won’t have to do without you!
- Learn at your own pace — take a break when you need it
- Refer to the video at any time — you’ll still have the hardware to experiment with

Overview of course content:
- Basics: introduction, basic wiring, logic AND & OR, sensors, relays, reasons for using a PLC, AutomationDirect PLC families
- CPU Internals: scan time, addressing, I/O (Xs and Ys), commands
- I/O: inside the I/O boards, octal addressing, programming methods -- hand-held programmer - DirectSOFT
- DirectSOFT: getting started, the launch pad, links, offline vs. online programming, maneuvering through & using DirectSOFT, creating and editing rungs
- Programming & Debugging: using inputs and outputs, debugging and status mode, PLC commands, troubleshooting

“PLC Analog I/O” Training Video Set
Mr. Doug Bell of InterConnecting Automation, Inc., offers a PLC Analog I/O training video set.

The kit includes the following:
- Two 2-hour analog training videos, firmware upgrade instructional video, a pre-wired analog trainer and DL05 analog I/O module and manual. This unit is a “plug-and-play” add-on to the DL05 PLC Trainer or any existing DL05 PLC.
- PLC Pre-wired Analog I/O Trainer:
  - Two 0-10 VDC meters
  - Two 0-5 VDC potentiometers
  - 24 VDC wall-mount power supply
  - DL05 analog combo module, plus pre-wired cable from the trainer to the module, ready to plug into your DL05 PLC trainer or any existing DL05 PLC.

Benefits of this video course:
- Work in the privacy of your own home/office
- No need to travel anywhere — your family won’t have to do without you!
- Learn at your own pace — take a break when you need it
- Refer back to the video at any time — you’ll still have the hardware to experiment with.

Overview of course content:
- Analog I/O principles - voltage, current, thermocouples
- PLC analog modules - input, output, thermocouple
- Configuring the analog I/O modules in the PLC
- DL05 PLC analog tutorial includes configuration, wiring, scaling (standard and non-standard) and programming, using the potentiometers and voltmeters on the trainer unit
- Application programming examples, including controlling motor speed with a drive and an analog output card in a PLC

To order the PLC Logic and Principles video or the PLC Analog I/O video, contact InterConnecting Automation directly at: 414-425-8348, or online at www.interconnectingautomation.com

Inexpensive online PLC training available
Interconnecting Automation offers an inexpensive subscription-based online training program. The online training section is a component of www.interconnectingautomation.com.

Visitors can view the complete list of videos in each “library” as well as watch sample videos; when ready to purchase, the prospective member registers and pays for their selected libraries on a monthly basis. The member receives unlimited access from a maximum of two PCs anytime during the 30 days; videos can be viewed as many times as needed during the subscription period. Most libraries range from $29.95 - $39.95 per month.

Libraries currently available include:
- Introduction to PLC Principles (For the novice-non user with limited controls knowledge)
- CLICK series PLC Training (includes Introduction to PLCs library)

Future libraries include Productivity3000 Training (includes Introduction to PLCs library) and C-more HMI training.

Many of these video libraries will also be offered as interactive training courses, with progress tests and certification upon completion.

For more information, to view sample videos or register for a subscription, visit: www.interconnectingautomation.com

For the latest prices, please check AutomationDirect.com.