Wiring Diagram Book
TRADEMARKS
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### Table 1  Standard Elementary Diagram Symbols

<table>
<thead>
<tr>
<th>SWITCHES</th>
<th>SELECTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disconnect</td>
<td>2-Position Selector Switch</td>
</tr>
<tr>
<td>Circuit Interrupter</td>
<td>J K A1</td>
</tr>
<tr>
<td>Circuit Breakers w/ Thermal OL</td>
<td>O O A2</td>
</tr>
<tr>
<td>Circuit Breakers w/ Magnetic OL</td>
<td>J K A1</td>
</tr>
<tr>
<td>Pressure &amp; Vacuum Switches</td>
<td>3-Position Selector Switch</td>
</tr>
<tr>
<td>N.O.</td>
<td>J K L A1</td>
</tr>
<tr>
<td>N.C.</td>
<td>O O A2</td>
</tr>
<tr>
<td>Liquid Level Switches</td>
<td>J K L A1</td>
</tr>
<tr>
<td>N.O.</td>
<td>O O A2</td>
</tr>
<tr>
<td>N.C.</td>
<td>A1 1</td>
</tr>
<tr>
<td>Temperature Actuated Switches</td>
<td>A2 1</td>
</tr>
<tr>
<td>N.O.</td>
<td>A1 1</td>
</tr>
<tr>
<td>N.C.</td>
<td></td>
</tr>
<tr>
<td>Limit Switches</td>
<td>2-Position Selector Push Button</td>
</tr>
<tr>
<td>N.O.</td>
<td>A1 B 2</td>
</tr>
<tr>
<td>N.C.</td>
<td>3 O 4</td>
</tr>
<tr>
<td>Held Closed</td>
<td></td>
</tr>
<tr>
<td>Held Open</td>
<td></td>
</tr>
<tr>
<td>Flow Switches</td>
<td></td>
</tr>
<tr>
<td>N.O.</td>
<td></td>
</tr>
<tr>
<td>N.C.</td>
<td></td>
</tr>
<tr>
<td>Foot Switches</td>
<td></td>
</tr>
<tr>
<td>N.O.</td>
<td></td>
</tr>
<tr>
<td>N.C.</td>
<td></td>
</tr>
</tbody>
</table>

#### PUSH BUTTONS – MOMENTARY CONTACT

<table>
<thead>
<tr>
<th>N.O.</th>
<th>N.C.</th>
<th>N.O. &amp; N.C. (double circuit)</th>
<th>Mushroom Head</th>
<th>Wobble Stick</th>
<th>Illuminated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### PUSH BUTTONS – MAINTAINED CONTACT

<table>
<thead>
<tr>
<th>2 Single Circuits</th>
<th>1 Double Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### PILOT LIGHTS

<table>
<thead>
<tr>
<th>Non Push-to-Test</th>
<th>Push-to-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>G</td>
</tr>
</tbody>
</table>

(Indicate color by letter)

#### INSTANT OPERATING CONTACTS

<table>
<thead>
<tr>
<th>w/ Blowout</th>
<th>w/o Blowout</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.O.</td>
<td>N.C.</td>
</tr>
</tbody>
</table>

#### TIMED CONTACTS

<table>
<thead>
<tr>
<th>Contact action retarded after coil is:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energized</td>
</tr>
<tr>
<td>Deenergized</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 1  Standard Elementary Diagram Symbols (cont'd)

<table>
<thead>
<tr>
<th>INDUCTORS</th>
<th>TRANSFORMERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron Core</td>
<td>Auto</td>
</tr>
<tr>
<td>Air Core</td>
<td>Iron Core</td>
</tr>
<tr>
<td></td>
<td>Air Core</td>
</tr>
<tr>
<td></td>
<td>Current</td>
</tr>
<tr>
<td></td>
<td>Dual Voltage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OVERLOAD RELAYS</th>
<th>AC MOTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal</td>
<td>Single Phase</td>
</tr>
<tr>
<td>Magnetic</td>
<td>3-Phase Magnetic</td>
</tr>
<tr>
<td></td>
<td>Squirrel Cage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DC MOTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armature</td>
</tr>
<tr>
<td>Shunt Field (show 4 loops)</td>
</tr>
<tr>
<td>Series Field (show 3 loops)</td>
</tr>
<tr>
<td>Commutating or Compensating Field (show 2 loops)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Connected</td>
</tr>
<tr>
<td>Connected</td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>Terminal</td>
</tr>
<tr>
<td>Ground</td>
</tr>
<tr>
<td>Mechanical Connection</td>
</tr>
<tr>
<td>Mechanical Interlock Connection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAPACITORS</th>
<th>RESISTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>Fixed</td>
</tr>
<tr>
<td>Adjustable</td>
<td>Heating Element</td>
</tr>
<tr>
<td></td>
<td>Adjustable, by Fixed Taps</td>
</tr>
<tr>
<td></td>
<td>Rheostat, Potentiometer or Adjustable Taps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMICONDUCTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode or Half Wave Rectifier</td>
</tr>
<tr>
<td>Tunnel Diode</td>
</tr>
<tr>
<td>Zener Diode</td>
</tr>
<tr>
<td>Bidirectional Breakdown Diode</td>
</tr>
<tr>
<td>Triac</td>
</tr>
<tr>
<td>SCR</td>
</tr>
<tr>
<td>PUT</td>
</tr>
<tr>
<td>Photosensitive Cell</td>
</tr>
</tbody>
</table>

| SCR |
| PUT |
| Photosensitive Cell | Gate Turn-Off Thyristor |
**OTHER COMPONENTS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Bell" /></td>
<td>Bell</td>
</tr>
<tr>
<td><img src="image" alt="Annunciator" /></td>
<td>Annunciator</td>
</tr>
<tr>
<td><img src="image" alt="Buzzer" /></td>
<td>Buzzer</td>
</tr>
<tr>
<td><img src="image" alt="Horn, Alarm, Siren, etc." /></td>
<td>Horn, Alarm, Siren, etc.</td>
</tr>
<tr>
<td><img src="image" alt="VM" /></td>
<td>Meter (indicate type by letters)</td>
</tr>
</tbody>
</table>

**SUPPLEMENTARY CONTACT SYMBOLS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="SPST, N.O." /></td>
<td>Single Break</td>
</tr>
<tr>
<td><img src="image" alt="Double Break" /></td>
<td>Double Break</td>
</tr>
<tr>
<td><img src="image" alt="SPST, N.C." /></td>
<td>Single Break</td>
</tr>
<tr>
<td><img src="image" alt="Double Break" /></td>
<td>Double Break</td>
</tr>
<tr>
<td><img src="image" alt="DPST, 2 N.O." /></td>
<td>Single Break</td>
</tr>
<tr>
<td><img src="image" alt="Double Break" /></td>
<td>Double Break</td>
</tr>
<tr>
<td><img src="image" alt="DPST, 2 N.C." /></td>
<td>Single Break</td>
</tr>
<tr>
<td><img src="image" alt="Double Break" /></td>
<td>Double Break</td>
</tr>
</tbody>
</table>

**IEC SYMBOLS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Push Buttons" /></td>
<td>N.O. N.C.</td>
</tr>
<tr>
<td><img src="image" alt="Coil" /></td>
<td>Aux. Contacts N.O. N.C.</td>
</tr>
<tr>
<td><img src="image" alt="Contactor Breakers" /></td>
<td></td>
</tr>
</tbody>
</table>

**STATIC SWITCHING CONTROL**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Limit Switch, N.O., Static Control" /></td>
<td></td>
</tr>
</tbody>
</table>

Static switching control is a method of switching electrical circuits without the use of contacts, primarily by solid state devices. To indicate static switching control, use the symbols shown in this table, enclosing them in a diamond as shown.

**TERMS**

- **SPST**: Single Pole, Single Throw
- **SPDT**: Single Pole, Double Throw
- **DPST**: Double Pole, Single Throw
- **DPDT**: Double Pole, Double Throw
- **N.O.**: Normally Open
- **N.C.**: Normally Closed
- **T.O.**: Timed Open
- **T.C.**: Timed Closed
- **PUT**: Programmable Unijunction Transistor
- **SCR**: Silicon Controlled Rectifier
- **Triac**: Bidirectional Triode Thyristor
- **UJT**: Unijunction Transistor
### Table 2  NEMA and IEC Terminal Markings

<table>
<thead>
<tr>
<th></th>
<th>NEMA</th>
<th>IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>L1</td>
<td>L2</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NEMA**
- Alphanumeric, corresponding to incoming line and motor terminal designations
- No specific marking
- No standard designation

**IEC**
- Single digit numeric, odd for supply lines, even for load connections
- 2-digit numeric, 1st designates sequence, 2nd designates function (1-2 for N.C., 3-4 for N.O.)

### Table 3  NEMA and IEC Controller Markings and Elementary Diagrams

**NEMA**
- Typical Controller Markings
- Typical Elementary Diagram

**IEC**
- Typical Controller Markings
- Typical Elementary Diagram

### Table 4  Control and Power Connections for Across-the-Line Starters, 600 V or less

(From NEMA standard ICS 2-321A.60)

<table>
<thead>
<tr>
<th>Line Markings</th>
<th>1-Phase</th>
<th>2-Phase, 4-Wire</th>
<th>3-Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground, when used</td>
<td>L1, L2</td>
<td>L1, L3: Phase 1</td>
<td>L1, L2, L3</td>
</tr>
<tr>
<td>Motor Running</td>
<td></td>
<td>L1</td>
<td></td>
</tr>
<tr>
<td>Overcurrent, units in:</td>
<td>1 element</td>
<td>L1, L4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 element</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 element</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Control Circuit Connected to</td>
<td>L1, L2</td>
<td>L1, L3</td>
<td>L1, L2, L3</td>
</tr>
<tr>
<td>For Reversing, Interchange Lines</td>
<td>—</td>
<td>L1, L3</td>
<td>L1, L3</td>
</tr>
</tbody>
</table>

**Notes:**
- 1-Phase: L1 is always ungrounded
- 2-Phase, 4-Wire: L1, L4: Phase 2
A wiring diagram shows, as closely as possible, the actual location of all component parts of the device. The open terminals (marked by an open circle) and arrows represent connections made by the user.

Since wiring connections and terminal markings are shown, this type of diagram is helpful when wiring the device or tracing wires when troubleshooting. Bold lines denote the power circuit and thin lines are used to show the control circuit. Black wires are conventionally used in power circuits and red wire in control circuits for AC magnetic equipment.

A wiring diagram is limited in its ability to completely convey the controller’s sequence of operation. The elementary diagram is used where an illustration of the circuit in its simplest form is desired.

An elementary diagram is a simplified circuit illustration. Devices and components are not shown in their actual positions. All control circuit components are shown as directly as possible, between a pair of vertical lines representing the control power supply. Components are arranged to show the sequence of operation of the devices and how the device operates. The effect of operating various auxiliary contacts and control devices can be readily seen. This helps in troubleshooting, particularly with the more complex controllers.

This form of electrical diagram is sometimes referred to as a “schematic” or “line” diagram.
Low Voltage Release and Low Voltage Protection are the basic control circuits encountered in motor control applications. The simplest schemes are shown below. Other variations shown in this section may appear more complicated, but can always be resolved into these two basic schemes.

Note: The control circuits shown in this section may not include overcurrent protective devices required by applicable electrical codes. See page 11 for examples of control circuit overcurrent protective devices and their use.

Low voltage release is a 2-wire control scheme using a maintained contact pilot device in series with the starter coil. This scheme is used when a starter is required to function automatically without the attention of an operator. If a power failure occurs while the contacts of the pilot device are closed, the starter will drop out. When power is restored, the starter will automatically pickup through the closed contacts of the pilot device.

The term “2-wire” control is derived from the fact that in the basic circuit, only two wires are required to connect the pilot device to the starter.

Low voltage protection is a 3-wire control scheme using momentary contact push buttons or similar pilot devices to energize the starter coil. This scheme is designed to prevent the unexpected starting of motors, which could result in injury to machine operators or damage to the driven machinery. The starter is energized by pressing the Start button. An auxiliary holding circuit contact on the starter forms a parallel circuit around the Start button contacts, holding the starter in after the button is released. If a power failure occurs, the starter will drop out and will open the holding circuit contact. When power is restored, the Start button must be operated again before the motor will restart.

The term “3-wire” control is derived from the fact that in the basic circuit, at least three wires are required to connect the pilot devices to the starter.

A Hand-Off-Auto selector switch is used on 2-wire control applications where it is desirable to operate the starter manually as well as automatically. The starter coil is manually energized when the switch is turned to the Hand position and is automatically energized by the pilot device when the switch is in the Auto position.

When a motor must be started and stopped from more than one location, any number of Start and Stop push buttons may be wired together. It is also possible to use only one Start-Stop station and have several Stop buttons at different locations to serve as an emergency stop.
3-Wire Control: Pilot Light Indicates when Motor is Running

A pilot light can be wired in parallel with the starter coil to indicate when the starter is energized, indicating the motor is running.

3-Wire Control: Pilot Light Indicates when Motor is Stopped

A pilot light may be required to indicate when the motor is stopped. This can be implemented by wiring a normally-closed auxiliary contact on the starter in series with the pilot light, as shown above. When the starter is deenergized, the pilot light illuminates. When the starter picks up, the auxiliary contact opens, turning off the light.

3-Wire Control: Push-to-Test Pilot Light Indicates when Motor is Running

When the Motor Running pilot light is not lit, there may be doubt as to whether the circuit is open or whether the pilot light bulb is burned out. To test the bulb, push the color cap of the Push-to-Test pilot light.

3-Wire Control: Illuminated Push Button Indicates when Motor is Running

*Pushing on pilot light operates Start contacts.

The illuminated push button combines a Start button and pilot light in one unit. Pressing the pilot light lens operates the Start contacts. Space is saved by using a two-unit push button station instead of three.

3-Wire Control: Fused Control Circuit Transformer

As an operator safety precaution, a step-down transformer can be used to provide a control circuit voltage lower than line voltage. The diagram above shows one way to provide overcurrent protection for control circuits.

3-Wire Control: Fused Control Circuit Transformer and Control Relay

A starter coil with a high VA rating may require a control transformer of considerable size. A control relay and a transformer with a low VA rating can be connected so the normally-open relay contact controls the starter coil on the primary or line side. Square D Size 5 Combination Starter Form F4T starters use this scheme.
**Examples of Control Circuits**

3-Wire Control

**Elementary Diagrams**

### Jogging: Selector Switch and Start Push Button

**FIG. 1**

Jogging, or inching, is defined by NEMA as the momentary operation of a motor from rest for the purpose of accomplishing small movements of the driven machine. One method of jogging is shown above. The selector switch disconnects the holding circuit contact and jogging may be accomplished by pressing the Start push button.

### Jogging: Selector Push Button

**FIG. 2**

A selector push button may be used to obtain jogging, as shown above. In the Run position, the selector push button provides normal 3-wire control. In the Jog position, the holding circuit is broken and jogging is accomplished by depressing the push button.

### Jogging: Control Relay

**FIG. 3**

When the Start push button is pressed, the control relay is energized, which in turn energizes the starter coil. The normally-open starter auxiliary contact and relay contact then form a holding circuit around the Start push button. When the Jog push button is pressed, the starter coil is energized (independent of the relay) and no holding circuit forms, thus jogging can be obtained.

### Jogging: Control Relay for Reversing Starter

**FIG. 4**

This control scheme permits jogging the motor either in the forward or reverse direction, whether the motor is at standstill or rotating. Pressing the Start-Forward or Start-Reverse push button energizes the corresponding starter coil, which closes the circuit to the control relay. The relay picks up and completes the holding circuit around the Start button. As long as the relay is energized, either the forward or reverse contactor remains energized. Pressing either Jog push button will deenergize the relay, releasing the closed contactor. Further pressing of the Jog button permits jogging in the desired direction.

### 3-Wire Control: More than 1 Starter, 1 Push Button Station Controls all

**FIG. 5**

When one Start-Stop station is required to control more than one starter, the scheme above can be used. A maintained overload on any one of the motors will drop out all three starters.

### 3-Wire Control: Reversing Starter

**FIG. 6**

3-wire control of a reversing starter can be implemented with a Forward-Reverse-Stop push button station as shown above. Limit switches may be added to stop the motor at a certain point in either direction. Jumpers 6 to 3 and 7 to 5 must then be removed.
More than one Forward-Reverse-Stop push button station may be required and can be connected in the manner shown above.

3-Wire Control: 2-Speed Starter

3-Wire Control: 2-Speed Starter with 1 Pilot Light to Indicate Motor Operation at Each Speed

One pilot light may be used to indicate operation at both low and high speeds. One extra normally-open auxiliary contact on each contactor is required. Two pilot lights, one for each speed, may be used by connecting pilot lights in parallel with high and low coils (see reversing starter diagram above).

Plugging: Plugging a Motor to a Stop from 1 Direction Only

Plugging is defined by NEMA as a braking system in which the motor connections are reversed so the motor develops a counter torque, thus exerting a retarding force. In the above scheme, forward rotation of the motor closes the normally-open plugging switch contact and energizing control relay CR. When the Stop push button is operated, the forward contactor drops out, the reverse contactor is energized through the plugging switch, control relay contact and normally-closed forward auxiliary contact. This reverses the motor connections and the motor is braked to a stop. The plugging switch then opens and disconnects the reverse contactor. The control relay also drops out. The control relay makes it impossible for the motor to be plugged in reverse by rotating the motor rotor closing the plugging switch. This type of control is not used for running in reverse.

Anti-Plugging: Motor to be Reversed but Must Not be Plugged

Anti-plugging protection is defined by NEMA as the effect of a device that operates to prevent application of counter-torque by the motor until the motor speed has been reduced to an acceptable value. In the scheme above, with the motor operating in one direction, a contact on the anti-plugging switch opens the control circuit of the contactor used for the opposite direction. This contact will not close until the motor has slowed down, after which the other contactor can be energized.
**Shunting Thermal Units During Starting Period**

Article 430-35 of the NEC describes circumstances under which it is acceptable to shunt thermal units during abnormally long accelerating periods.

430-35. Shunting During Starting Period.

(a) Nonautomatically Started. For a nonautomatically started motor, the overload protection shall be permitted to be shunted or cut out of the circuit during the starting period of the motor if the device by which the overload protection is shunted or cut out cannot be left in the starting position and if fuses or inverse time circuit breakers rated or set at not over 400 percent of the full-load current of the motor are so located in the circuit as to be operative during the starting period of the motor.

(b) Automatically Started. The motor overload protection shall not be shunted or cut out during the starting period if the motor is automatically started.

Exception. The motor overload protection shall be permitted to be shunted or cut out during the starting period on an automatically started motor where:

1. The motor starting period exceeds the time delay of available motor overload protective devices, and
2. Listed means are provided to:
   a. Sense motor rotation and to automatically prevent the shunting or cut out in the event that the motor fails to start, and
   b. Limit the time of overload protection shunting or cut out to less than the locked rotor time rating of the protected motor, and
   c. Provide for shutdown and manual restart if motor running condition is not reached.

Figures 1 and 2 show possible circuits for use in conjunction with 3-wire control schemes. Figure 1 complies with NEC requirements. Figure 2 exceeds NEC requirements, but the additional safety provided by the zero speed switch might be desirable.

Figure 3 shows a circuit for use with a 2-wire, automatically started control scheme that complies with NEC requirements. UL or other listed devices must be used in this arrangement.
Examples of Control Circuits
Overcurrent Protection for 3-Wire Control Circuits
Elementary Diagrams

3-Wire Control: Fusing in 1 Line Only

FIG. 1

L1
FU1
STOP
M
OL
L2

Common control with fusing in one line only and with both lines ungrounded or, if user's conditions permit, with one line grounded.

3-Wire Control: Fusing in Both Lines

FIG. 2

L1
FU1
STOP
M
OL
L2
FU2

Common control with fusing in both lines and with both lines ungrounded.

3-Wire Control: Fusing in Both Primary Lines

FIG. 3

L1
FU1
PRI
X1
SEC
X2
FU2

Control circuit transformer with fusing in both primary lines, no secondary fusing and all lines ungrounded.

3-Wire Control: Fusing in Both Primary and Secondary Lines

FIG. 4

L1
FU3
PRI
FU1
X1
SEC
X2
FU2
FU4

Control circuit transformer with fusing in both primary lines and both secondary lines, with all lines ungrounded.

3-Wire Control: Fusing in Both Primary Lines and 1 Secondary Line

FIG. 5

L1
FU1
PRI
FU3
FU2
FU4
SEC

Control circuit transformer with fusing in one secondary line and both primary lines, with one line grounded.

3-Wire Control: Fusing in Both Primary and Secondary Lines

For Large Starters using Small Transformer

FIG. 6

L1
FU3
CR
M
FU4

Control circuit transformer with fusing in both primary lines and both secondary lines, with all lines ungrounded. Used for large VA coils only.
### Manual Motor Starting Switches:
**Class 2510 Type K**

**FIG. 1**

- T1
- L1 → L1
- T3
- L3 → L2
- T1, T3 → PILOT LIGHT (IF USED)
- MOTOR

2-Pole, 1-Phase

**FIG. 2**

- T1
- L1 → L1
- T2
- L2 → L2
- T3
- L3 → L3
- T1, T2, T3 → PILOT LIGHT (IF USED)
- MOTOR

3-Pole, 3-Phase

### Fractional Horsepower Manual Starters:
**Class 2510 Type F**

**FIG. 3**

- T2
- L2
- T1, T2 → PILOT LIGHT (IF USED)
- MOTOR

1-Pole

**FIG. 4**

- T2
- L2
- T1, T2 → PILOT LIGHT (IF USED)
- MOTOR

2-Pole

**FIG. 5**

- T2
- L2
- T1, T2 → PILOT LIGHT (IF USED)
- 2-WIRE CONTROL DEVICE
- MOTOR

2-Pole w/ Selector Switch

### Integral Horsepower Manual Starters:
**Class 2510 Size M0 and M1**

**FIG. 6**

- L1
- T1, T2 → MOTOR

2-Pole, 1-Phase

**FIG. 7**

- L1
- T1, T2 → MOTOR

3-Pole, DC

**FIG. 8**

- L1
- T1, T2 → MOTOR

3-Pole, 1-Phase

**FIG. 9**

- L1
- T1, T2, T3 → MOTOR

3-Pole, 3-Phase

**FIG. 10**

- L1
- T1, T2, T3 → MOTOR

3-Pole, 3-Phase w/ additional Interlock (Form X)
AC Manual Starters and Manual Motor Starting Switches
Class 2511 and 2512

AC Reversing Manual Starters and Manual Motor Starting Switches:
Class 2511

FIG. 1
Reversing Manual Motor Starting Switch  
Type K, 3-Pole, 3-Phase

FIG. 2
Reversing Manual Starter  
Sizes M0 and M1, 3-Pole, 3-Phase

AC 2-Speed Manual Motor Starting Switches:
Class 2512 Type K

FIG. 3
2-Pole, 1-Phase w/ Pilot Lights

FIG. 4
3-Pole, 3-Phase

AC 2-Speed Manual Motor Starters:
Class 2512 Type F

FIG. 5
2-Unit, 2-Pole w/ Mechanical Interlock and Pilot Lights

FIG. 6
3-Unit, 2-Pole w/ Selector Switch and Pilot Lights
2-Speed AC Manual Starters and IEC Motor Protectors
Class 2512 and 2520 and Telemecanique GV1/GV3

2-Speed AC Manual Motor Starters:
Class 2512 Size M0 and M1

2-Speed Manual Starter for Wye-Connected, Separate Winding Motor

Motor Protective Switches:
Class 2520

FIG. 2 1/L1 3/L2 5/L3
2/T1 4/T2 6/T3
T1 T2 T3
MOTOR
3-Pole, 3-Phase

FIG. 3 1/L1 3/L2 5/L3
2/T1 4/T2 6/T3
T1 T3
MOTOR
2-Pole Application

FIG. 4 1/L1 3/L2 5/L3
2/T1 4/T2 6/T3
T3
MOTOR
1-Pole Application

IEC Manual Starters:
GV1/GV3

FIG. 5 1/L1 3/L2 5/L3
2/T1 4/T2 6/T3
GV3 M+ Motor Protector

GV3 A08 95
GV3 A09 97

GV3 A0+ Fault Signalling Contacts

FIG. 6 GV3 B-
D1
GV3 D-
C1

GV3 Voltage Trips

FIG. 7 GV1 A01
GV1 A02
13 21 13 23
14 22 14 24
14 23 31 14 23 33
14 24 32 14 24 34

GV1 A06 GV1 A07
13 23 33 13 23 31

GV1 A0+ Contact Block

GV1 A01 GV1 A02
95 97
GV1 A06 GV1 A07
96 98
## Drum Switches: Class 2601

### FIG. 1
**HANDLE END**

<table>
<thead>
<tr>
<th>REVERSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ← 2</td>
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<tr>
<td>3 ← 4</td>
</tr>
<tr>
<td>5 ← 6</td>
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</table>

<table>
<thead>
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<th>OFF</th>
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<tbody>
<tr>
<td>1  1</td>
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<tr>
<td>3  3</td>
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<tr>
<td>5  5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FORWARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2  4</td>
</tr>
<tr>
<td>4  6</td>
</tr>
</tbody>
</table>

- Internal Switching
- 3-Phase, 3-Wire Motor

### FIG. 2
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- 1-Phase, Capacitor or Split-Phase Motor

### FIG. 3
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- 1-Phase, Capacitor or Split-Phase Motor

### FIG. 4
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- 1-Phase, 4-Lead Repulsion Induction Motor

### FIG. 5
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- 1-Phase, 3-Lead Repulsion Induction Motor

### FIG. 6
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- 2-Phase, 3-Wire Motor

### FIG. 7
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- 2-Phase, 4-Wire Motor

### FIG. 8
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- DC, Shunt Motor

### FIG. 9
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- DC, Series Motor

### FIG. 10
**MOTOR DRUM SW. LINE**

```
1 2
3 4
5 6
```

- DC, Compound Motor
DC Starters, Constant and Adjustable Speed
Class 7135 and 7136

Constant Speed DC Starter: Class 7135

FIG. 1

 Typical Elementary Diagram for NEMA Size 2, 3 and 4

Adjustable Speed DC Starter: Class 7136

FIG. 2

 Typical Elementary Diagram for NEMA Size 2, 3 and 4

### Acceleration Contactors: Class 7135, 7136, 7145 and 7146

<table>
<thead>
<tr>
<th>NEMA Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Acceleration Contactors</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Reversing DC Starters, Constant and Adjustable Speed
Class 7145 and 7146

Reversing Constant Speed DC Starter: Class 7145

FIG. 1

Reversing Adjustable Speed DC Starter: Class 7146

FIG. 2
Mechanically Latched Contactors and Medium Voltage Motor Controllers
Class 8196 and 8198

Mechanically Latched Contactor:
Class 8196 Type FL13, FL23, FL12 and FL22

Full-Voltage, Non-Reversing Squirrel Cage Motor Controller:
Class 8198 Type FC11, FC21, FC13, FC23, FC12 and FC22
Full-Voltage Squirrel Cage Motor Controller:
Class 8198 Type FCR1 and FCR2

FIG. 1

FPO 17-3
160%
Reduced-Voltage, Primary Reactor, Non-Reversing Squirrel Cage Motor Controller: Class 8198 Type RCR1 and RCR2

FIG. 1

![Diagram of motor controller system with labels and connections for Reduced-Voltage, Primary Reactor, Non-Reversing Squirrel Cage Motor Controller.]
Reduced-Voltage, Primary Reactor, Autotransformer, Non-Reversing Squirrel Cage Motor Controller:
Class 8198 Type RCA1 and RCA2

FIG. 1
Medium Voltage Motor Controllers
Class 8198

Full Voltage, Non-Reversing Synchronous Motor Controller:
Class 8198 Type FS1 and FS2

FIG. 1

5000 VOLTS (MAX.) 3 PH. 60 HZ SUPPLY

1F01 1F02 1F03

2F01 2F02 2F03

L1 L2 L3

1PT

DRAINER MONITOR INTLK

NI 120V

3FU 3PT

STOP START

ICR 1CR

1PC

TAE1 1AE2

1PC

TAE3

TO DC VOLTAGE EXCITATION

FPO 18-1

170%
Reduced-Voltage, Primary Reactor, Non-Reversing Synchronous Motor Controller:
Class 8198 Type RS1 and RS2

FIG. 1
Reduced-Voltage, Autotransformer, Non-Reversing Synchronous Motor Controller:
Class 8198 Type RSA1 and RSA2

FIG. 1
Full-Voltage, Non-Reversing, Brushless Synchronous Motor Controller:
Class 8198 Type FSB1 and FSB2

FIG. 1

5000 VOLTS (MAX) 3 PH, 60 Hz
SUPPLY

STOP
START

1CR

CHOKE

REC 1

25
With the line voltage connections directly at the motor terminals, the relay will detect all phase loss conditions ahead of the connection points. However, the motor may sustain a momentary "bump" in the reverse condition if the proper phase sequence is not present.

With the line voltage connections ahead of the starter, the motor can be started in the reverse direction. The relay cannot detect a phase loss on the load side of the starter.

Dashed lines represent optional contacts (DIAW and DUAW devices only)

Type DIA, DIAW, DUA and DUAW

Type MPD

Type MPS 240V

Type MPS 480V
Load Detector Relay:  
Class 8430 Type V

FIG. 1

Wiring Diagram

Elementary Diagram (Common Control)

Load Converter Relay:  
Class 8430 Type G

FIG. 2
General Purpose Relays
Class 8501

Control Relays:
Class 8501 Type CO and CDO

FIG. 1
Type CO6 and CDO6

FIG. 2
Type CO7 and CDO7

FIG. 3
Type CO8 and CDO8

FIG. 4
Type CO21 and CDO21

FIG. 5
Type CO15 and CDO15

FIG. 6
Type CO16, CDO16, CO22 and CDO22

Control Relays:
Class 8501 Type UBS

FIG. 7

Control Relays:
Class 8501 Type K

FIG. 8
Type KL

FIG. 9
Type KU, KF, KX, KUD, KFD and KXD
2-Pole

FIG. 10
Type KP and KPD
2-Pole

FIG. 11
Type KLD

FIG. 12
Type KU, KF, KX, KUD, KFD and KXD
3-Pole

FIG. 13
Type KP and KPD
3-Pole
**NEMA Control Relays**

**Class 8501 and 9999**

10 A Control Relay w/ Convertible Contacts:
Class 8501 Type X

**FIG. 1**

<table>
<thead>
<tr>
<th>No. of Poles</th>
<th>Type</th>
<th>Pole Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>XO-20</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td></td>
<td>XO-11</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td></td>
<td>XO-03</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-40</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-31</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-22</td>
<td>1 1 1 1</td>
</tr>
</tbody>
</table>

2, 3 and 4 Pole Relay
All Contacts Convertible

<table>
<thead>
<tr>
<th>No. of Poles</th>
<th>Type</th>
<th>Pole Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>XO-51</td>
<td>2 3 4</td>
</tr>
<tr>
<td></td>
<td>XO-42</td>
<td>2 3 4</td>
</tr>
<tr>
<td></td>
<td>XO-03</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-40</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-31</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-22</td>
<td>1 1 1 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Poles</th>
<th>Type</th>
<th>Pole Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>XO-51</td>
<td>2 3 4</td>
</tr>
<tr>
<td></td>
<td>XO-42</td>
<td>2 3 4</td>
</tr>
<tr>
<td></td>
<td>XO-03</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-40</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-31</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>XO-22</td>
<td>1 1 1 1</td>
</tr>
</tbody>
</table>

**FIG. 2**

Timer Attachment:
Class 9999 Type XTD and XTE

*Note: Class 8501 Type XO***XL, XDO***XL, XDO***XDL and XO***XDL latch relays use the same diagram except for the addition of an unlatch coil (8 poles maximum).*

**Table:**

<table>
<thead>
<tr>
<th>No. of Timed Contacts</th>
<th>Class 9999 Type</th>
<th>Pole No.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>XTD XTE</td>
<td>0 1</td>
</tr>
</tbody>
</table>

*O = N.O. Contact
1 = N.C. Contact
General Purpose Relays and Sensing Relays
Class 8501 and Telemecanique RM2 LA1/LG1

Miniature Control Relays:
Class 8501 Type RS and RSD

FIG. 1

1
5
9
13 (-)
14 (+)

Type RS41 and RSD41

FIG. 2

1
5
9
13 (-)
14 (+)

Type RS42 and RSD42

FIG. 3

1
2
3
4
5
6
7
8
9
10
11
12
13 (-)
14 (+)

Type RS43 and RSD43

FIG. 4

1
2
3
4
5
6
7
8
9
10
11
12
13 (-)
14 (+)

Type RS4, RSD4, RS14, RSD14, RS24, RSD24, RS34, RSD34, RS44 and RSD44

Control Relays w/ Intrinsically Safe Terminals:
Class 8501 Type TO41 and TO43

FIG. 5

1
2
3
4
5
6

ON
OFF
OFF
ON

Intrinsically Safe Terminals

FIG. 6

7
8
9
10
11
12

SUPPLY
VOLTAGE

Non-Hazardous Location Terminals

Sensing Relays:
RM2 LA1/LG1

FIG. 7

H = High level electrode
L = Low level electrode
M = Reference electrode (common)
## Control Relays: CA2 and CA3

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4 N.O. Instantaneous CA2 DN40 and CA3 DN40</td>
</tr>
<tr>
<td>2</td>
<td>3 N.O. &amp; 1 N.C. Instantaneous CA2 DN31 and CA3 DN31</td>
</tr>
<tr>
<td>3</td>
<td>2 N.O. &amp; 2 N.C. Instantaneous CA2 DN22 and CA3 DN22</td>
</tr>
<tr>
<td>4</td>
<td>2 N.O. &amp; 2 N.C. Instantaneous, w/ 2 Make-Before-Break CA2 DC22 and CA3 DC22</td>
</tr>
<tr>
<td>5</td>
<td>2 N.O. &amp; 2 N.C. Instantaneous w/ Mechanical Latch CA2 DK22 and CA3 DK22</td>
</tr>
</tbody>
</table>

## Front-Mounted Standard Instantaneous Auxiliary Contact Blocks: LA1

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1 N.O. &amp; 1 N.C. LA1 DN11</td>
</tr>
<tr>
<td>7</td>
<td>2 N.O. LA1 DN20</td>
</tr>
<tr>
<td>8</td>
<td>2 N.C. LA1 DN02</td>
</tr>
<tr>
<td>9</td>
<td>2 N.O. &amp; 2 N.C. LA1 DN22</td>
</tr>
<tr>
<td>10</td>
<td>1 N.O. &amp; 3 N.C. LA1 DN13</td>
</tr>
<tr>
<td>11</td>
<td>2 N.O. &amp; 2 N.C. w/ 2 Make-Before-Break LA1 DC22</td>
</tr>
<tr>
<td>12</td>
<td>4 N.O. LA1 DN40</td>
</tr>
<tr>
<td>13</td>
<td>4 N.C. LA1 DN04</td>
</tr>
<tr>
<td>14</td>
<td>3 N.O. &amp; 1 N.C. LA1 DN31</td>
</tr>
</tbody>
</table>

## Front-Mounted Damp- and Dust-Protected Instantaneous Auxiliary Contact Blocks: LA1

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2 N.O. LA1 DX20</td>
</tr>
<tr>
<td>16</td>
<td>2 N.O. w/ Grounding Screw LA1 DY20</td>
</tr>
<tr>
<td>17</td>
<td>2 Dusttight N.O. &amp; 2 N.O. LA1 DZ40</td>
</tr>
<tr>
<td>18</td>
<td>2 Dusttight N.O. &amp; 1 N.O. &amp; 1 N.C. LA1 DZ31</td>
</tr>
</tbody>
</table>

## Front-Mounted Time Delay Auxiliary Contacts: LA2 and LA3

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>On Delay, 1 N.O. &amp; 1 N.C. LA2 DT</td>
</tr>
<tr>
<td>20</td>
<td>On Delay, 1 N.C. w/ 1 Offset N.O. LA2 DS</td>
</tr>
<tr>
<td>21</td>
<td>Off Delay, 1 N.O. &amp; 1 N.C. LA3 DR</td>
</tr>
</tbody>
</table>

## Front-Mounted Mechanical Latch Adder Blocks: LA6

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>LA6 DK1</td>
</tr>
<tr>
<td>23</td>
<td>LA6 DK2</td>
</tr>
</tbody>
</table>

## Side-Mounted Auxiliary Contact Blocks: LA8

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>1 N.O. &amp; 1 N.C. Instantaneous LA8 DN11</td>
</tr>
<tr>
<td>25</td>
<td>2 N.O. Instantaneous LA8 DN20</td>
</tr>
</tbody>
</table>
IEC Relays
Class 8501

Miniature IEC Relays:
Class 8501 Type PR 1

FIG. 1
Type PR 1 and PRD 1 Relays

PR 1.11 E

PR 1.20 E

PRD 1.11 E

PRD 1.20 E

FIG. 2
Type PV Adder Decks for PR 1.20 E

PV 11

PV 20

PV 02

Alternating Relays:
Class 8501 Type PHA

FIG. 3
relay coil
energized
deenergized
closed
open

13 14
23 24

13 21
14 22

13 23
14 24

33 41
34 42
35 43
36 44

31 41
32 42
33 43
34 44
### Power Terminals

**FIG. 1**

<table>
<thead>
<tr>
<th>Power Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

Power terminals on contactors, overloads and switches are single digits – odd for line side terminals and even for load side terminals.

### Coil Terminals

**FIG. 2**

<table>
<thead>
<tr>
<th>Coil Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
</tr>
<tr>
<td>A2</td>
</tr>
</tbody>
</table>

Coil terminals are designated by a letter and a number. Terminals for a single winding coil are designated “A1” and “A2”.

### Auxiliary Contact Terminals

**FIG. 3**

<table>
<thead>
<tr>
<th>Auxiliary Contact Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
</tbody>
</table>

Auxiliary contacts on contactors, relays and push button contacts use 2-digit terminal designations, as shown in the diagram above. The first digit indicates the location of the contact on the device. The second digit indicates the status of the contacts, N.O. or N.C. “1” and “2” indicate N.C. contacts. “3” and “4” indicate N.O. contacts.

### Overload Relay Contact Terminals

**FIG. 4**

<table>
<thead>
<tr>
<th>Overload Relay Contact Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
</tr>
<tr>
<td>96</td>
</tr>
</tbody>
</table>

With Isolated N.O. Alarm Contact  
With Non-Isolated N.O. Alarm Contact

Overload contact terminals are marked with two digits. The first digit is “9”. The second digits are “5” and “6” for a N.C. and “7” and “8” for a N.O. isolated contact. If the device has a non-isolated alarm contact (single pole), the second digits of the N.O. terminals are “5” and “8”.

### Class 8502 Type PD or PE Contactor  
with Class 9065 Type TR Overload Relay

**FIG. 5**

Wiring Diagram  
Elementary Diagram
Type P Contactors and Type T Overload Relays
Class 8502 and 9065

Class 8502 Type PG or PD Contactor w/ Class 9065 Type TD Overload Relay

FIG. 1

Wiring Diagram

Elementary Diagram

Class 8502 Type PE Contactor w/ Class 9065 Type TE Overload Relay

FIG. 2

Wiring Diagram

Elementary Diagram

Class 8502 Type PF, PG or PJ Contactor w/ Class 9065 Type TF, TG or TJ Overload Relay

FIG. 3

Wiring Diagram

Elementary Diagram
Class 8502 Type PJ or PK Contactor
w/ Class 9065 Type TJE Overload Relay

FIG. 4

Class 8702 Type PDV or PEV Reversing Contactor
w/ Class 9065 Type TR Overload Relay

FIG. 1
# Type S AC Magnetic Contactors

Class 8502

## AC Magnetic Contactors: Class 8502 Type S

<table>
<thead>
<tr>
<th>FIG. 1</th>
<th>FIG. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
<tr>
<td>1-Pole, Size 0 and 1</td>
<td>2-Pole, Size 00, 0 and 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG. 3</th>
<th>FIG. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Diagram" /></td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
<tr>
<td>2-Pole, Size 2 to 5</td>
<td>3-Pole, Size 00 to 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG. 5</th>
<th>FIG. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
</tr>
<tr>
<td>4-Pole, Size 0, 1 and 2</td>
<td>5-Pole, Size 0, 1 and 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG. 7</th>
<th>FIG. 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7.png" alt="Diagram" /></td>
<td><img src="image8.png" alt="Diagram" /></td>
</tr>
<tr>
<td>2- and 3-Wire Control for Figure 1 to 5</td>
<td>Separate Control for Figure 6</td>
</tr>
</tbody>
</table>
**Type S AC Magnetic Contactors**

Class 8502

---

**Size 6, 3-Pole Contactor – Common Control**

Class 8502 Type SH Series B

---

**FIG. 1**

**Wiring Diagram**

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.

**Short-Circuit Protection**

Rating of branch circuit protective device must comply with applicable electrical codes and the following limitations:

<table>
<thead>
<tr>
<th>Type of Device</th>
<th>Max. Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class K5 or RK5 time-delay fuse</td>
<td>600 A</td>
</tr>
<tr>
<td>Class J, T or L fuse</td>
<td>1200 A</td>
</tr>
<tr>
<td>Inverse-time circuit breaker</td>
<td>800 A</td>
</tr>
</tbody>
</table>
Type S AC Magnetic Contactors
Class 8502

Size 6, 3-Pole Contactor – Separate Control
Class 8502 Type SH Form S Series B

FIG. 1

Wiring Diagram

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.

Elementary Diagram

Information:
- Short-Circuit Protection
  Rating of branch circuit protective device must comply with applicable electrical codes and the following limitations:

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</tr>
<tr>
<td>Class J, T or L fuse</td>
<td>1200 A</td>
</tr>
<tr>
<td>Inverse-time circuit breaker</td>
<td>800 A</td>
</tr>
</tbody>
</table>
Size 7, 3-Pole Contactor – Common Control  
Class 8502 Type SJ Series A

Wiring Diagram

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.

Short-Circuit Protection
Rating of branch circuit protective device must comply with applicable electrical codes and the following limitations:

<table>
<thead>
<tr>
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<th>Max. Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class K5 or RK5 time-delay fuse</td>
<td>600 A</td>
</tr>
<tr>
<td>Class J, T or L fuse</td>
<td>1600 A</td>
</tr>
<tr>
<td>Inverse-time circuit breaker</td>
<td>2000 A</td>
</tr>
</tbody>
</table>

Elementary Diagram
**Type S AC Magnetic Contactors**
Class 8502

Size 7, 3-Pole Contactor – Separate Control
Class 8502 Type SJ Form S Series A

**FIG. 1**

Wiring Diagram

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.

Elementary Diagram

**Short-Circuit Protection**
Rating of branch circuit protective device must comply with applicable electrical codes and the following limitations:

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<tr>
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<tbody>
<tr>
<td>Class K5 or RK5 time-delay fuse</td>
<td>600 A</td>
</tr>
<tr>
<td>Class J, T or L fuse</td>
<td>1600 A</td>
</tr>
<tr>
<td>Inverse-time circuit breaker</td>
<td>2000 A</td>
</tr>
</tbody>
</table>
IEC Contactors and Auxiliary Contact Blocks

3- and 4-Pole Contactors: LC1 and LP1
(Terminal markings conform to standards EN 50011 and 50012)

Front-Mounted Standard Instantaneous Auxiliary Contact Blocks: LA1

Front-Mounted Damp- and Dust-Protected (IP 54) Instantaneous Auxiliary Contact Blocks: LA1

Front-Mounted Time Delay Auxiliary Contacts: LA2 and LA3

Front-Mounted Mechanical Latch Adder Blocks: LA6

Side-Mounted Auxiliary Contact Blocks: LA8
### IEC Contactors

**Input Modules and Reversing Contactors**

#### Input Modules: LA4

<table>
<thead>
<tr>
<th>FIG. 1</th>
<th>FIG. 2</th>
<th>FIG. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="On Delay Timer Module LA4 DT" /></td>
<td><img src="image2" alt="Off Delay Timer Module LA4 DR" /></td>
<td><img src="image3" alt="Auto-Manual-Off Control Module LA4 DM" /></td>
</tr>
</tbody>
</table>

- **On Delay Timer Module** LA4 DT
- **Off Delay Timer Module** LA4 DR
- **Auto-Manual-Off Control Module** LA4 DM

<table>
<thead>
<tr>
<th>FIG. 4</th>
<th>FIG. 5</th>
<th>FIG. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="Relay Interface Amplifier Module LA4 DF" /></td>
<td><img src="image5" alt="Relay Interface Amplifier Module w/ Manual Override, LA4 DL" /></td>
<td><img src="image6" alt="Solid State Interface Amplifier Module LA4 DW" /></td>
</tr>
</tbody>
</table>

- **Relay Interface Amplifier Module** LA4 DF
- **Relay Interface Amplifier Module w/ Manual Override, LA4 DL**
- **Solid State Interface Amplifier Module** LA4 DW

#### Contactors: LC2, LP2 and LA9

<table>
<thead>
<tr>
<th>FIG. 7</th>
<th>FIG. 8</th>
<th>FIG. 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="Reversing Contactor 3-Pole, for Motor Control LC2, LP2 D0901 to D3201" /></td>
<td><img src="image8" alt="Transfer Contactor, 4-Pole, Mechanically Interlocked LC2, LP2 D12004 to D8004" /></td>
<td><img src="image9" alt="Mechanical Interlock w/ Electrical Interlock LA9 D0902, D4002 and D8002" /></td>
</tr>
</tbody>
</table>

- **Reversing Contactor** 3-Pole, for Motor Control LC2, LP2 D0901 to D3201
- **Transfer Contactor**, 4-Pole, Mechanically Interlocked LC2, LP2 D12004 to D8004
- **Mechanical Interlock w/ Electrical Interlock** LA9 D0902, D4002 and D8002
Type S AC Magnetic Starters
Class 8536
1-Phase, Size 00 to 3

1-Pole, 1-Phase Magnetic Starters, Size 00 to 3:
Class 8536 Type S

FIG. 1

Wiring Diagram
Elementary Diagram

Single Phase Starter w/ Single Voltage Motor

FIG. 2

Wiring Diagram
Elementary Diagram

Single Phase Starter w/ Dual Voltage Motor

FIG. 3

Wiring Diagram
Elementary Diagram

3-Phase Starter Connected for Single Phase, Single Voltage Motor

Note: Starters are factory-wired with coil connected for the higher voltage. If starter is used on lower voltage, connect per coil diagram.

* Marked ‘OL’ if alarm contact is supplied
Type S AC Magnetic Starters
Class 8536
2-Phase and 3-Phase, Size 00 to 5

4-Pole, 2-Phase Magnetic Starters:
Class 8536 Type S

FIG. 1
Wiring Diagram

Elementary Diagram

Size 0, 1 and 2

FIG. 2
Wiring Diagram

Elementary Diagram

Size 3 and 4

3-Pole, 3-Phase Magnetic Starters:
Class 8536 Type S

FIG. 3
Wiring Diagram

Elementary Diagram

Size 00 to 4

FIG. 4
Wiring Diagram

Elementary Diagram

Size 5
3-Pole, 3-Phase Magnetic Starters, Size 6 – Common Control
Class 8536/8538/8539 Type SH Series B

FIG. 1

- **START**
- **STOP**
- **3-WIRE CONTROL**
- **2-WIRE CONTROL**
- **HAND-OFF-AUTO**
- **SELECTOR SWITCH**
- **"ON" PILOT LIGHT (120V.)**
- **PUSH-TO-TEST "ON" PILOT LIGHT (120V.)**
- **ADD'L N.C. INTERLOCK**
- **"OFF" PILOT LIGHT (120V.)**

**Wiring Diagram**

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.

**Elementary Diagram**
Type S AC Magnetic Starters
Class 8536
3-Phase, Size 7

3-Pole, 3-Phase Magnetic Starters, Size 7 – Common Control
Class 8536 Type SJ Series A

FIG. 1

Wiring Diagram

Elementary Diagram

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.
3-Pole, 3-Phase Magnetic Starters, Size 00 to 4: 
Class 8536 Type S

FIG. 1

Wiring Diagram

Elementary Diagram

FORM A – Start-Stop Push Button Mounted in Cover

FIG. 2

Wiring Diagram

Elementary Diagram

FORM C – Hand-Off-Auto Selector Switch Mounted in Cover

FIG. 3

Wiring Diagram

Elementary Diagram

FORM F4T – Control Circuit Transformer and Primary Fuses

* Marked “OL” if alarm contact is supplied

Δ Single or dual voltage primary connection per transformer nameplate.
Type S AC Magnetic Starters
Class 8536
3-Phase Additions and Special Features

3-Pole, 3-Phase Magnetic Starters, Size 00 to 4:
Class 8536 Type S

FIG. 1

3 WIRE CONTROL

TO SEPARATE CONTROL

T1 T2 T3

MOTOR

3 WIRE CONTROL

Wiring Diagram

Elementary Diagram

FORM S – SEPARATE CONTROL

* Marked “OL” if alarm contact is supplied

On NEMA Size 3 and 4 starters, holding circuit contact is in position 
#1. Max. of 3 external auxiliary contacts on NEMA Size 00.

3-Pole, 3-Phase Magnetic Starters, Size 5:
Class 8536 Type S

FIG. 3

2 WIRE CONTROL

T1 T2 T3

MOTOR

Wiring Diagram

Elementary Diagram

Form F4T – Control Circuit Transformer and Primary Fuses

* Marked “OL” if alarm contact is supplied

Δ If alarm contact is supplied, a single (3 thermal unit) overload
block is furnished, fed from 3 current transformers

On NEMA Size 3 and 4 starters, holding circuit contact is in position
#1. Max. of 3 external auxiliary contacts on NEMA Size 00.
Type S AC Magnetic Starters
Class 8536, 8538 and 8539
3-Phase Additions and Special Features

FIG. 1

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.
Type S AC Magnetic Starters
Class 8536
3-Phase Additions and Special Features

3-Pole, 3-Phase Magnetic Starters, Size 7 – Separate Control
Class 8536 Type SJ Form S Series A

Wiring Diagram

Elementary Diagram

This symbol denotes the coil function, provided by a solid-state control module, 30 VA transformer, two fuses in the secondary of the transformer, N.C. electrical interlock and DC magnet coil.
### State of Auxiliary Contacts for LD1

#### Auxiliary contact actuators

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Auxiliary contacts

<table>
<thead>
<tr>
<th>LA1-LB015</th>
<th>LA1-LB017</th>
<th>LA1-LB019</th>
<th>LA1-LB001</th>
<th>LA1-LB031</th>
<th>LA1-LB034</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 23 31</td>
<td>95 97</td>
<td>13 31</td>
<td>97</td>
<td>13 31</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>96 98</td>
<td>14 22</td>
<td>98</td>
<td>14 22</td>
<td>96</td>
</tr>
<tr>
<td>15 17</td>
<td>15 17</td>
<td>15 17</td>
<td>16 18</td>
<td>16 18</td>
<td>6 8</td>
</tr>
<tr>
<td>5 7</td>
<td>5 7</td>
<td>5 7</td>
<td>6 8</td>
<td>6 8</td>
<td>6 8</td>
</tr>
</tbody>
</table>

- **Off**: Contact open
- **On, contactor open**: Contact open
- **On, contactor closed**: Contact closed
- **Tripped on overload**: Tripped on overload
- **Tripped on short circuit**: Tripped on overload
- **Off after short circuit**: Tripped on overload
- **Manual reset**: Tripped on overload
## State of Auxiliary Contacts for LD5

### Auxiliary contact actuators

<table>
<thead>
<tr>
<th></th>
<th>LA1-LB015</th>
<th>LA1-LB017</th>
<th>LA1-LB019</th>
<th>LA1-LB001</th>
<th>LA1-LB021</th>
<th>LA1-LB001 On Integral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13 23 31</td>
<td>13 31 97</td>
<td>13 31 97</td>
<td>13 31 95</td>
<td>13 31 41</td>
<td>13 23 31 14 24 32 16 18 41 6 8</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>96 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>Off</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>13 31 97</td>
<td>13 31 97</td>
<td>13 31 95</td>
<td>13 31 41</td>
<td>13 23 31 14 24 32 16 18 41 6 8</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>96 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>On, contactor open</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>13 31 97</td>
<td>13 31 97</td>
<td>13 31 95</td>
<td>13 31 41</td>
<td>13 23 31 14 24 32 16 18 41 6 8</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>96 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>On, contactor II closed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>13 31 97</td>
<td>13 31 97</td>
<td>13 31 95</td>
<td>13 31 41</td>
<td>13 23 31 14 24 32 16 18 41 6 8</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>96 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>On, contactor I closed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>13 31 97</td>
<td>13 31 97</td>
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<td>14 24 32</td>
<td>96 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>Tripped on overload</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
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<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>Tripped on short circuit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>96 97</td>
<td>13 31 96</td>
<td>13 31 96</td>
<td>13 31 41</td>
<td>13 23 31 14 24 32 16 18 41 6 8</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>97 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>Off after short circuit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>96 97</td>
<td>13 31 96</td>
<td>13 31 96</td>
<td>13 31 41</td>
<td>13 23 31 14 24 32 16 18 41 6 8</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>97 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
<tr>
<td><strong>Manual reset</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>96 97</td>
<td>13 31 96</td>
<td>13 31 96</td>
<td>13 31 41</td>
<td>13 23 31 14 24 32 16 18 41 6 8</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>97 98</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 42</td>
<td>14 24 32 15 17 42 5 7</td>
</tr>
</tbody>
</table>
## State of Auxiliary Contacts for LD4

### Auxiliary contact actuators

![Auxiliary contact actuators diagram]

### Auxiliary contacts

<table>
<thead>
<tr>
<th>LA1-LC010</th>
<th>LA1-LC012</th>
<th>LA1-LC020</th>
<th>LA1-LC030</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 23 31</td>
<td>06 08 09</td>
<td>14 24 32</td>
<td>08 98</td>
</tr>
<tr>
<td>15 05 95</td>
<td>13 23 31</td>
<td>14 24 32</td>
<td>53 (63)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>05 95</td>
<td>54 (64)</td>
</tr>
</tbody>
</table>

- **Off + isolation**: Contact open
- **Off**: Contact closed
- **On, contactor open**: Contact open
- **On, contactor closed**: Contact closed
- **Tripped, on overload**: Contact open
- **Off, after overload**: Contact closed
- **Tripped, on short circuit**: Contact open
- **Off, after short circuit**: Contact closed
- **Manual reset**: Contact closed

### State of Auxiliary Contacts

- **LD4**
  - Contact open
  - Contact closed

- **LA1-LC010**: Contact open, contact closed
- **LA1-LC012**: Contact open, contact closed
- **LA1-LC020**: Contact open, contact closed
- **LA1-LC030**: Contact open, contact closed
State of Auxiliary Contacts for LD5

 Auxiliary contacts

<table>
<thead>
<tr>
<th>LA1-LC010</th>
<th>LA1-LC012</th>
<th>LA1-LC020</th>
<th>LA1-LC021</th>
<th>LA1-LC031</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 23 31</td>
<td>16 18</td>
<td>06 08</td>
<td>06 98</td>
<td>06 98</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>95</td>
<td>08</td>
<td>05</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
<tr>
<td>14 24 32</td>
<td>15 05</td>
<td>05</td>
<td>98</td>
<td>95</td>
</tr>
</tbody>
</table>

**Auxiliary contact actuators**

**State of Auxiliary Contacts**

- **Off + isolation**: Contact open
- **Off**: Contact open
- **On, both contactors open**: Contact open
- **On, contactor open**: Contact open
- **On, contactor closed**: Contact open
- **Tripped on overload**: Contact open
- **Off, after overload**: Contact open
- **Tripped on short circuit**: Contact open
- **Off after short circuit**: Contact open
- **Manual reset**: Contact open
Integral Self-Protected Starters

Wiring Diagrams

Integral 18

**FIG. 1**

Self-Protected Starter w/ Protection Module LB•
Integral 18 LD1 L80

**FIG. 2**

Self-Protected Reversing Starter w/ Protection Module LB•
Integral 18 LD5 LB130 + LB1 LB03P

Integral 32

**FIG. 3**

Starter w/ Isolator
Integral 32 LD4

**FIG. 4**

Starter w/o Isolator
Integral 32 LD1

**FIG. 5**

Reversing Starter w/ Isolator
Integral 32 LD5

Protection Modules: LB•

**FIG. 6**

Thermal and Magnetic Trip
LB1

**FIG. 7**

Magnetic Trip Only
LB6
### Auxiliary Contact Blocks

**FIG. 1**

For LD1 or LD4 and reverser LD5 (mounted on right)

<table>
<thead>
<tr>
<th>LA1 LC010</th>
<th>LA1 LC012</th>
<th>LA1 LC020</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
</tr>
<tr>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
</tr>
<tr>
<td>Trip signal</td>
<td>Short-circuit signal</td>
<td>Knob position signal</td>
</tr>
<tr>
<td>98 95</td>
<td>06 08</td>
<td>05 15</td>
</tr>
</tbody>
</table>

1 Contactor signalling placed on the right

**FIG. 2**

For LD4 w/ isolating contacts (mounted on left)

<table>
<thead>
<tr>
<th>LA1 LC030</th>
</tr>
</thead>
<tbody>
<tr>
<td>(63) 53 54 64</td>
</tr>
</tbody>
</table>

1 or 2 LA1 LC030

**FIG. 3**

For reversing LD5 (mounted on left)

<table>
<thead>
<tr>
<th>LA1 LC021</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 23 31</td>
</tr>
<tr>
<td>14 24 32</td>
</tr>
</tbody>
</table>

2 Contactor signalling placed on the left

**FIG. 4**

Isolating contacts (mounted on left)

<table>
<thead>
<tr>
<th>LA1 LC031</th>
</tr>
</thead>
</table>

### Remote Reset Units

**FIG. 5**

For starter and reverser already fitted with a block, LA1 LC010 or LA1 LC012.

| LA1 LC052 |

Use of the LA1 LC020 contact block prevents the mounting of trip or remote units

### Trip Units

**FIG. 6**

| LA1 LC07++ |

### Interface Modules

**FIG. 7**

| LA1 LC180, LA1 LD180 |

**FIG. 8**

| LA1 LC580, LA1 LD580 |
Add-on Blocks: LA1 LB0\textsuperscript{••}

For LD1 (mounted on right)

For LD1 (mounted on left)

For LD5 (mounted on left)

Time Delay Modules

Control Module

Interface Modules

Voltage Converters: LA1 LC080 and LA1 LD080

For 24 or 48 V Supply

For 110 V Supply

For 24 or 48 V Supply w/ Low Voltage Input

Contactor breakers

Knob position

Short circuit signal

Contacts integrated into device

V-Short circuit signal

Knob position

Signal

On Module
LA4 DT

Off Module
LA4 DR

Auto-Man-Stop Module
LA4 DM

Solid State Module
LA4 DW

Relay Module
LA4 DF

Relay Module w/ Manual Override
LA4 DL

Control by supply switching 24 or 48V

Low voltage control 24 or 48V

Low voltage input

Low voltage control 24 or 48V w/ Low Voltage Input

Control Module

Interface Modules

Voltage Converters: LA1 LC080 and LA1 LD080

For 24 or 48 V Supply

For 110 V Supply

For 24 or 48 V Supply w/ Low Voltage Input

Contactor breakers

Short circuit signal

Signal

Auto signal

A1 A2

AC

K

E1 E2

+ -
Type S AC Combination Magnetic Starters
Class 8538 and 8539
3-Phase, Size 0-5 (see pages 45 and 49 for Size 6)

3-Pole, 3-Phase Combination Starters:
Class 8538 and 8539 Type S

FIG. 1

Wiring Diagram

Elementary Diagram

* Marked ‘OL’ if alarm contact is supplied

FIG. 2

Wiring Diagram

Elementary Diagram

* Marked ‘OL’ if alarm contact is supplied
3-Pole, 3-Phase Combination Starters w/ Control Circuit Transformer and Primary Fuses:
Class 8538 and 8539 Type S Form F4T

**FIG. 1**

- START
- STOP
- 3-WIRE CONTROL
- T1 T2 T3

**Wiring Diagram**

**Elementary Diagram**

**FIG. 2**

- START
- STOP
- 3-WIRE CONTROL
- T1 T2 T3

**Wiring Diagram**

**Elementary Diagram**
Reduced Voltage Controllers
Class 8606
Autotransformer Type, Size 2-6
Reduced Voltage Autotransformer Controllers w/ Closed Transition Starting:
Class 8606 Size 7

FIG. 1

CIRCUIT BREAKER
OR DISCONNECT SWITCH

L1
L2
L3

1TR
2TR
1S
2S

SOLID STATE
OVERLOAD RELAY

T1
T2
T3

MOTOR

1CT
2CT
3CT

R

1S
2S

PRI
SEC

(H1)
(X1)
(X2)

1TR
2TR

SOLID STATE
OVERLOAD RELAY

2 WIRE CONTROL DEVICE (If used)

STOP
START

OL

GROUND
(If used)

PRI
SEC

(H1)
(X1)
(X2)

Reduced Voltage Controllers
Class 8606
Autotransformer Type, Size 7
Reduced Voltage Controllers
Class 8630
Wye-Delta Type, Size 1YΔ-5YΔ

Wye-Delta Type Reduced Voltage Controllers, Size 1YΔ-5YΔ:
Class 8630

FIG. 1

Size 1YΔ-5YΔ Controllers with Open-Transition Starting

FPO 46-1
110%

FIG. 2

Size 1YΔ-5YΔ Controllers with Closed-Transition Starting

FPO 46-2
110%
Reduced Voltage Controllers
Class 8630
Wye-Delta Type, Size 6YΔ

FIG. 1
Wye-Delta Type Reduced Voltage Controllers, Size 6YΔ:
Class 8630

FPO 46-3
110%

Size 6YΔ Controller with Open-Transition Starting

FIG. 2

FPO 46-4
110%

Size 6YΔ Controller with Closed-Transition Starting
Table 5  Motor Lead Connections

<table>
<thead>
<tr>
<th>Part Winding Schemes</th>
<th>Lettered Terminals in Panel</th>
<th>Part Winding Schemes</th>
<th>Lettered Terminals in Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>1/2 Wye or Delta 6 Leads</td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
</tr>
<tr>
<td>1/2 Wye 9 Leads [1]</td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
</tr>
</tbody>
</table>

[2] Connect terminals T4 and T8, T5 and T9, T6 and T7 together in 3 separate pairs at terminal box.

**Part-Winding Reduced Voltage Controllers: Class 8640, Size 1PW-7PW**

FIG. 1  
Size 1PW-4PW, 2-Step Part-Winding Controllers

FIG. 2  
Size 5PW, 2-Step Part-Winding Controller

FIG. 3  
Size 6PW, 2-Step Part-Winding Controller

FIG. 4  
Size 7PW, 2-Step Part-Winding Controller

1. Disconnect means (optional): 2 required, 1 for each motor winding.  
2. See Table 5 for motor lead connections.
Reduced Voltage Controllers
Class 8647
Primary-Resistor Type

3-Phase Primary-Resistor Reduced Voltage Controllers:
Class 8647, Size 1-7

FIG. 1

FIG. 2

FIG. 3

FIG. 4

Size 1-4

Size 5

Size 6

Size 7
Reduced Voltage Controllers
Class 8650 and 8651
Wound-Rotor Type

Wound-Rotor Reduced Voltage Controllers:
Class 8650 and 8651

Non-Reversing Wound-Rotor Motor Controller w/ 3 Points of Acceleration
Class 8650

Reversing Wound-Rotor Motor Controller w/ 3 Points of Acceleration
Class 8651
Solid State Reduced Voltage Starters
Class 8660
ALPHA PAK®, Type MD-MG

FIG. 1

ALPHA PAK® Solid State Reduced Voltage Starters:
Class 8660 Type MD-MG

Type MD (16 A), ME (32 A), MF (64 A) and MG (128 A)

FIG. 2

Type MD (16 A), ME (32 A), MF (64 A) and MG (128 A) w/ Isolation Contactor
Solid State Reduced Voltage Controllers
Class 8660
Type MH, MJ, MK and MM

FIG. 1
Solid State Reduced Voltage Controllers: Class 8660 Type MH, MJ, MK and MM

FIG. 2
Type MH (200 A), MJ (320 A), MK (500 A) and MM (750 A)

FIG. 3
Type MJ (320 A), MK (500 A) and MM (750 A) w/ Shorting Contactor
Solid State Reduced Voltage Controllers
Class 8660
Type MH, MJ, MK and MM

FIG. 1
Type MH (200 A) w/ Isolation Contactor

FPO 51-1 130%

FIG. 2
Type MJ (320 A), MK (500 A) and MM (750 A) w/ Isolation Contactor

FPO 51-2 130%
Solid State Reduced Voltage Controllers
Class 8660
Type MH, MJ, MK and MM

FIG. 1
Type MH (200 A) w/ Isolation Contactor and Shorting Contactor

FPO 51-3
130%

FIG. 2
Type MJ (320 A), MK (500 A) and MM (750 A) w/ Isolation Contactor and Shorting Contactor

FPO 51-4
130%
Type S AC Reversing Magnetic Starters
Class 8736
2- and 3-Pole

Reversing Starters, 2- and 3-Pole, Size 00-1:
Class 8736 Type S

FIG. 1
3-WIRE CONTROL
FWD  2
REV  3
STOP  4
2-WIRE CONTROL, FWD.
REV.
3
ALARM (IF SUPPLIED)
3 LEAD REPULSION-INDUCTION REVERSING MOTOR
HORIZONTAL MOUNTING ARRANGEMENT
* Marked “OL” if alarm contact is supplied

Wiring Diagram
Elementary Diagram

FIG. 2
5-WIRE CONTROL
FWD  2
REV  3
STOP  4
2-WIRE CONTROL, FWD.
REV.
3
ALARM (IF SUPPLIED)
4 LEAD REPULSION-INDUCTION MOTOR
HORIZONTAL MOUNTING ARRANGEMENT
* Marked “OL” if alarm contact is supplied

Wiring Diagram
Elementary Diagram

FIG. 3
3-WIRE CONTROL
FWD  2
REV  3
STOP  4
2-WIRE CONTROL, FWD.
REV.
3
ALARM (IF SUPPLIED)
CAPACITOR OR SPLIT PHASE MOTOR
HORIZONTAL MOUNTING ARRANGEMENT
* Marked “OL” if alarm contact is supplied

Wiring Diagram
Elementary Diagram
Type S AC Reversing Magnetic Starters
Class 8736
3- and 4-Pole

Reversing Starters, 3- and 4-Pole:
Class 8736 Type S

FIG. 1

Wiring Diagram
Horizontal Mounting Arrangement
* Marked ‘OL’ if alarm contact is supplied

Elementary Diagram
Size 00-2, 4-Pole, 2-Phase

FIG. 2

Wiring Diagram
* Marked ‘OL’ if alarm contact is supplied
Horizontal Mounting Arrangement

Elementary Diagram
Size 00-4, 3-Pole, 3-Phase

FIG. 3

Wiring Diagram

Elementary Diagram
Size 5, 3-Pole, 3-Phase
Starters for 2-Speed, 2-Winding (Separate Winding), 3-Phase Motors:
Class 8810 Type S

FIG. 1

Starters for 2-Speed, 1-Winding (Consequent Pole), Constant or Variable Torque, 3-Phase Motors:
Class 8810 Type S

FIG. 3

* Marked ‘OL’ if alarm contact is supplied

Wiring Diagram
Elementary Diagram

Wiring Diagram
Elementary Diagram

Size 5 Wiring Diagram

Size 0-4
Size 0-2
Type S AC Reversing Magnetic Starters
Class 8810

Starters for 2-Speed, 1-Winding (Consequent Pole), Constant or Variable Torque, 3-Phase Motors:
Class 8810 Type S

FIG. 1

FIG. 2

Size 3 and 4 Wiring Diagram
Size 5 Wiring Diagram

Starters for 2-Speed, 1-Winding (Consequent Pole), Constant Horsepower, 3-Phase Motors:
Class 8810 Type S

FIG. 3

FIG. 4

FIG. 5

Size 0-2
Elementary Diagram
Size 3 and 4 Wiring Diagram
Size 0, w/ High-Off-Selector Switch (Form C7) Wiring Diagram

* Marked 'OL' if alarm contact is supplied
### 2-Speed Magnetic Starters

**Class 8810**

**Special Control Circuits**

<table>
<thead>
<tr>
<th>Form</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form R1</strong></td>
<td>Compelling Relay, Requiring Motor Starting in Low Speed</td>
</tr>
<tr>
<td><strong>FIG. 1</strong></td>
<td><img src="image1" alt="Compelling Relay, Requiring Motor Starting in Low Speed" /></td>
</tr>
<tr>
<td><strong>Form R2</strong></td>
<td>Accelerating Relay, Providing Timed Acceleration to Selected Speed</td>
</tr>
<tr>
<td><strong>FIG. 2</strong></td>
<td><img src="image2" alt="Accelerating Relay, Providing Timed Acceleration to Selected Speed" /></td>
</tr>
<tr>
<td><strong>Form R3</strong></td>
<td>Decelerating Relay, w/ Time Delay During Transfer from Higher to Lower Speed</td>
</tr>
<tr>
<td><strong>FIG. 3</strong></td>
<td><img src="image3" alt="Decelerating Relay, w/ Time Delay During Transfer from Higher to Lower Speed" /></td>
</tr>
<tr>
<td><strong>Form R1R3</strong></td>
<td>Compelling Relay and Decelerating Relay</td>
</tr>
<tr>
<td><strong>FIG. 5</strong></td>
<td><img src="image5" alt="Compelling Relay and Decelerating Relay" /></td>
</tr>
<tr>
<td><strong>Form A10C</strong></td>
<td>Hand-Off-Auto Selector Switch and High-Low Push Button</td>
</tr>
<tr>
<td><strong>FIG. 6</strong></td>
<td><img src="image6" alt="Hand-Off-Auto Selector Switch and High-Low Push Button" /></td>
</tr>
<tr>
<td><strong>Form CC17</strong></td>
<td>Hand-Off-Auto Selector Switch and High-Low Selector Switch</td>
</tr>
<tr>
<td><strong>FIG. 7</strong></td>
<td><img src="image7" alt="Hand-Off-Auto Selector Switch and High-Low Selector Switch" /></td>
</tr>
<tr>
<td><strong>Form A10CR1</strong></td>
<td>Hand-Off-Auto Selector Switch and High-Low Push Button w/ Compelling Relay/Timer</td>
</tr>
<tr>
<td><strong>FIG. 8</strong></td>
<td><img src="image8" alt="Hand-Off-Auto Selector Switch and High-Low Push Button w/ Compelling Relay/Timer" /></td>
</tr>
</tbody>
</table>
2-Speed Magnetic Starters and Multispeed Motor Connections
Class 8810
Special Control Circuits and 1- and 3-Phase Motor Connections

Form C25

High-Low-Off-Auto Selector Switch

Form CC17 R2R3

Hand-Off-Auto Selector Switch and High-Low Selector Switch w/ Accelerating and Decelerating Relay/Timer

Multispeed Motor Connections: 1-Phase, 2-Speed Motors

FIG. 3 T1 T2 T3 T4 Speed L1 L2 Open Together

Low T1 T2 T3 T4 — —
High T3 T2 T4 T1, T2 —

2 Windings

FIG. 4 T1 T2 T3 T4 Speed L1 L2 Open Together

Low T3 T4 T1, T2 T3, T4 — —
High T1 T2 T3, T4 T3, T4 —

2 Windings

FIG. 5 COM A B Speed L1 L2 Open Together

Low COM A B — —
High COM B A — —

1 Winding

Multispeed Motor Connections: 3-Phase, 2-Speed Motors

FIG. 6 T1 COM T4 Speed L1 L2 Open Together

Low COM T1 T4 — —
High COM T4 T1 — —

1 Winding

FIG. 7 T1 COM T4 Speed L1 L2 Open Together

Low T1 COM — T1, T4 —
High T1 COM — T1, T4 —

1 Winding

FIG. 8 T1 COM T4 Speed L1 L2 Open Together

Low T1 COM — T1, T4 —
High T1 COM — T1, T4 —

1 Winding

Multispeed Motor Connections: 3-Phase, 2-Speed Motors

FIG. 9 T4 T3 T1 Speed L1 L2 L3 Open Together

Low T1, T2, T3 T4, T5, T6 — —
High T6 T2 T4 T3, T5 — —

1 Winding, Constant Horsepower

FIG. 10 T4 T3 T1 Speed L1 L2 L3 Open Together

Low T1 T2 T3 T4 T5 All others — —
High T6 T2 T4 T3, T5 — —

1 Winding, Constant Torque

FIG. 11 T4 T3 T1 Speed L1 L2 L3 Open Together

Low T1 T2 T3 T4 All others — —
High T6 T2 T4 T3, T5 — —

1 Winding, Variable Torque

FIG. 12 T1 T3 T13 T11 Speed L1 L2 L3 Open

Low T1 T11 T12 T13 All others
High T11 T12 T13 T1 —

Separate Windings

FIG. 13 T1 T2 T17 T11 Speed L1 L2 L3 Open

Low T1 T11 T12 T13 All others
High T11 T12 T13 T17 All others

Separate Windings

FIG. 14 T1 T2 T13 T11 Speed L1 L2 L3 Open

Low T1 T11 T12 T13 All others
High T11 T12 T13 T7 All others

Separate Windings
Multispeed Motor Connections: 3-Phase, 2-Speed Motors

**FIG. 1**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3, T7, T12, T13, T17, T3, T7, T12, T13, T17
  - High: T1 T2 T3, T7, T12, T13, T17, T3, T7, T12, T13, T17

**FIG. 2**

- Speed L1 L2 L3 L4 Open Together
  - Low: T1, T2, T3, T4, T5, T6 T1, T2, T3, T7, T12, T13, T17

**FIG. 3**

- Speed L1 L2 L3 L4 Open Together
  - Low: T1, T2, T3, T4, T5, T6 T1, T2, T3, T7, T12, T13, T17

Separate Windings

2-Phase, 1 Winding, Variable Torque

2-Phase, Separate Windings

Multispeed Motor Connections: 3-Phase, 3-Speed Motors

**FIG. 4**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T6, T4, T3 All others —
  - High: T1 T2 T6, T4, T3 All others —

2 Windings, Constant Torque

**FIG. 5**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3, T7, T12, T13, T17 All others —
  - High: T1 T2 T3, T7, T12, T13, T17 All others —

2 Windings, Variable Torque

**FIG. 6**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Variable Torque

Multispeed Motor Connections: 3-Phase, 4-Speed Motors

**FIG. 7**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Constant Torque

**FIG. 8**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Variable Torque

**FIG. 9**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Variable Torque

Multispeed Motor Connections: 3-Phase, 4-Speed Motors

**FIG. 10**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Constant Horsepower

**FIG. 11**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Constant Horsepower

**FIG. 12**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Constant Torque

**FIG. 13**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3, T7, T12, T13, T17 All others —
  - High: T1 T2 T3, T7, T12, T13, T17 All others —

2 Windings, Constant Torque

**FIG. 14**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Variable Torque

**FIG. 15**

- Speed L1 L2 L3 Open Together
  - Low: T1 T2 T3 All others —
  - High: T1 T2 T3 All others —

2 Windings, Variable Torque
Programmable Lighting Controller:
Class 8865 Type TC12

FIG. 1

Demand
Input

INPUTS

RELAY OUTPUT CONNECTIONS
CIRCUITS 1-6

24 VAC
INPUT

RELAY OUTPUT CONNECTIONS
CIRCUITS 7-12

CIRCUIT 1
1
2
3
CIRCUIT 2
4
5
6
CIRCUIT 3
7
8
9
CIRCUIT 4
10
11
12
CIRCUIT 5
13
14
15
CIRCUIT 6
16
17
18

CIRCUIT 7
19
CIRCUIT 8
20
21
CIRCUIT 9
22
23
24
CIRCUIT 10
25
26
27
CIRCUIT 11
28
29
30
CIRCUIT 12
31
32
33

+1 - +2 - +3 - +4 - +5 - +6 - +7 - +8 -
## Load Connections for AC Lighting Contactors: Class 8903

<table>
<thead>
<tr>
<th>FIG. 1</th>
<th>FIG. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>1-Phase, 2-Wire, Single Load</strong></td>
<td><strong>1-Phase, 2-Wire, Multiple Loads</strong></td>
</tr>
<tr>
<td>$V_{load} = V_{line-to-line}$</td>
<td>$V_{load} = V_{line-to-line}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG. 3</th>
<th>FIG. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Diagram" /></td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>1-Phase, 3-Wire, Loads Connected Line-to-Neutral</strong></td>
<td><strong>1-Phase, 3-Wire, Load Connected Line-to-Line</strong></td>
</tr>
<tr>
<td>$V_{load} = V_{line-to-neutral}$</td>
<td>$V_{load} = V_{line-to-line}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG. 5</th>
<th>FIG. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>3-Phase, 3-Wire, Wye-Connected Load</strong></td>
<td><strong>3-Phase, 3-Wire, Delta-Connected Load</strong></td>
</tr>
</tbody>
</table>
| $V_{load} = V_{line-to-line}$ | $V_{load} = V_{line-to-line}$  
$V_{load} = \frac{1.732}{1.732}$ |

<table>
<thead>
<tr>
<th>FIG. 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>3-Phase, 4-Wire, Loads Connected Line-to-Neutral</strong></td>
</tr>
<tr>
<td>$V_{load} = V_{line-to-neutral}$</td>
</tr>
</tbody>
</table>

### Application Limits:
1. Voltage between line side conductors must not exceed line-to-line voltage rating of contactor.
2. $V_{load}$ must not exceed volts-per-load rating of contactor.
3. Line current carried by any contact must not exceed ampere rating of contactor.

For contact ratings, refer to the Square D Digest.
Control Circuit Connections for Electrically-Held Contactors:
Class 8903 Type L and S

**FIG. 1**
To AC common or separate control supply
On-Off Push Button (Form A12)

**FIG. 2**
To AC common or separate control supply
Direct Control from Pilot Device

**FIG. 3**
To AC common or separate control supply
On-Off Selector Switch (Form C6)

Control Circuit Connections for Mechanically-Held Contactors:
Class 8903 Type LX and S

**FIG. 5**
To AC common or separate control supply
On-Off Push Button (Form A3)

**FIG. 6**
To AC common or separate control supply
On-Off Selector Switch (Form C6)

**FIG. 7**
To AC common or separate control supply
Control from 2-Pole Pilot Device

**FIG. 8**
To AC common or separate control supply
1-Pole Pilot Device w/ CR relay (Form R6)
QWIK-STOP® Electronic Motor Brake:
Class 8922

FIG. 5

CUSTOMER CONTROL CIRCUIT

[1] Contacts 15 and 18 close when L1 and L2 are energized.

Type ETB10, ETB18 and ETBS18 w/ Internal Braking Contactor

FIG. 6

CUSTOMER CONTROL CIRCUIT

[1] Contacts 15 and 18 close when L1 and L2 are energized.

Type ETB20-ETB800 and ETBS20-ETBS800
**QWIK-STOP® Electronic Motor Brake: Class 8922 Type ETBC**

![Diagram of QWIK-STOP® Electronic Motor Brake]

† To control electronic motor brake ETBC with input B+/B–, terminals 3 and 4 must be jumpered.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>B+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>B–</td>
</tr>
</tbody>
</table>

24 VDC INPUT

**AC Duplex Motor Controller: Class 8941**

![Diagram of AC Duplex Motor Controller]

**Fiber Optic Transceiver: Class 9005**

![Diagram of Fiber Optic Transceiver]

**Fig. 4**

**HAZARDOUS LOCATIONS**

CLASS I GROUPS A, B, C & D
CLASS II GROUPS E, F & G
CLASS III

**NONHAZARDOUS LOCATIONS**

**FIBER OPTIC CABLE**

**FIBER OPTIC CABLE**

**FIBER OPTIC CABLE**

**FIBER OPTIC CABLE**

BOUNDARY SEAL TO BE IN ACCORDANCE WITH ARTICLE 501-5 OF THE NATIONAL ELECTRICAL CODE

QWIK-STOP is a registered trademark of Square D.

Elementary Diagram for Duplex Motor Controller w/ Electric Alternator

Transceiver, Front View
Photoelectric Switches:
Class 9006 Type PE1 (Obsolete)

**FIG. 1**
Connect load in series. To prevent damage, all switches except emitters must have load connected to switch.

**FIG. 2**
AC thru-beam emitter has no output switching capability, therefore leakage current is not applicable. Thru-beam emitter is connected directly across the AC line and typically draws 15 mA.

**FIG. 3**
DC switches cannot be wired in series. To prevent damage, all switches except emitters must have load connected to switch.

**FIG. 4**
DC thru-beam emitter has no output switching capability, therefore it requires only a 2-wire cable connected directly across the DC. Thru-beam emitter draws a maximum of 45 mA.

Photoelectric Switches:
Class 9006 Type PE6 and PE7 (Obsolete)

**FIG. 5**
12-24 VDC, Sinking (NPN)

**FIG. 6**
12-24 VDC, Sourcing (PNP)

**FIG. 7**
120 VAC, Emitter Only

These switches are light operated only.
Beam broken = load deenergized
Beam unbroken = load energized

Inductive Proximity Switches:
Class 9006 Type PS (Obsolete)

**FIG. 9**
2-Wire AC, N.O.

**FIG. 10**
2-Wire AC, N.C.

**FIG. 11**
2-Wire AC, N.O. or N.C.

**FIG. 12**
2-Wire DC, N.O.

**FIG. 13**
4-Wire DC, Sinking (NPN)

**FIG. 14**
4-Wire DC, Sourcing (PNP)

Diagram shows contact arrangement with beam broken.

120 VAC Amplifier
Inductive Proximity Sensors
XS, XSC, XSF and XSD

XS Tubular Inductive Proximity Sensors

FIG. 1

2-Wire DC, Non-Polarized

FIG. 2

2-Wire AC/DC

for connector version only

FIG. 3

3-Wire DC, N.O. or N.C.

FIG. 4

3-Wire DC, N.O. and N.C., Complementary

FIG. 5

3-Wire DC, Selectable PNP/NPN, N.O./N.C.

XSC Rectangular Inductive Proximity Sensors

FIG. 6

2-Wire DC, Non-Polarized

FIG. 7

2-Wire AC, Programmable

FIG. 8

2-Wire AC/DC, Programmable

FIG. 9

3-Wire DC, N.O. or N.C.

XSF Rectangular Inductive Proximity Sensors

FIG. 10

2-Wire AC, Programmable N.O. or N.C.

FIG. 11

3-Wire DC, N.O. or N.C.

XSD Rectangular Inductive Proximity Sensors

FIG. 12

2-Wire DC, Non-Polarized

FIG. 13

2-Wire AC, Programmable N.O. or N.C.

FIG. 14

3-Wire DC, N.O. or N.C.
**XS Tubular Inductive Proximity NAMUR Sensors**

**FIG. 1**

<table>
<thead>
<tr>
<th>Object present</th>
<th>Object absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>BN-1+</td>
<td>Hi = 1K</td>
</tr>
<tr>
<td>BU-2</td>
<td>I &lt; 1mA</td>
</tr>
<tr>
<td>BN-1+</td>
<td>Ri = 1K</td>
</tr>
<tr>
<td>BU-2</td>
<td>I &gt; 3mA</td>
</tr>
</tbody>
</table>

Non-Intrinsically Safe Applications (Normal Safe Zone), Connected to a Solid State Input

With XZD Power Supply/Relay Amplifier Unit

**FIG. 2**

Wiring diagram

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>XZD</td>
<td>proximity sensor</td>
</tr>
<tr>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>BN</td>
<td>BU</td>
</tr>
</tbody>
</table>

**FIG. 3**

**XS Inductive Proximity Sensors w/ Analog Output**

<table>
<thead>
<tr>
<th>Output current</th>
<th>Value of Load R (max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 mA @ 24 V:</td>
<td>1800 Ω</td>
</tr>
<tr>
<td>0-16 mA @ 24 V:</td>
<td>1125 Ω</td>
</tr>
<tr>
<td>0-10 mA @ 48 V:</td>
<td>4200 Ω</td>
</tr>
</tbody>
</table>

2-Wire DC

<table>
<thead>
<tr>
<th>Output current</th>
<th>Value of Load R (max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-14 mA @ 24 V:</td>
<td>640 Ω</td>
</tr>
<tr>
<td>4-20 mA @ 24 V:</td>
<td>450 Ω</td>
</tr>
<tr>
<td>4-14 mA @ 48 V:</td>
<td>2350 Ω</td>
</tr>
</tbody>
</table>

3-Wire DC

These sensors may be wired in the 2- or 3-wire mode, depending on the current output characteristics required.

**FIG. 4**

**XTA Tubular Capacitive Proximity Sensors**

**FIG. 5**

<table>
<thead>
<tr>
<th>BN</th>
<th>L1</th>
</tr>
</thead>
<tbody>
<tr>
<td>BU</td>
<td>L2</td>
</tr>
</tbody>
</table>

* Ground for XTA A115 only

2-Wire AC

**FIG. 6**

<table>
<thead>
<tr>
<th>PNP</th>
<th>BN</th>
<th>BK</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPN</td>
<td>BN</td>
<td>BK</td>
</tr>
</tbody>
</table>

3-Wire DC
# Magnet Actuated Proximity Sensors and Photoelectric Sensors

## SG, ST and XUB

### SG Magnet Actuated Proximity Sensors, Surface Mount Style

<table>
<thead>
<tr>
<th>FIG. 1</th>
<th>FIG. 2</th>
<th>FIG. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- SGA 8016, SGA 8031, SGA 8182, SGA 8053, SGA 8176, SGA 8177, SG0 8168 and SG08239
- SGA 8175
- SG2 8195

### SG Magnet Actuated Proximity Sensors, Limit Switch Style

<table>
<thead>
<tr>
<th>FIG. 4</th>
<th>FIG. 5</th>
<th>FIG. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4.png" alt="Diagram" /></td>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- SG0 8003, SGI 8003, SGA 8005 and SGA 8040
- SG0 L8003 and SGI L8004
- SGC 8027 and SGC 8025

### SG Magnet Actuated Proximity Sensors, Tubular Style

<table>
<thead>
<tr>
<th>FIG. 9</th>
<th>FIG. 10</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9.png" alt="Diagram" /></td>
<td><img src="image10.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- SGA 8057, SGA 8189, SGA 8072, SGA 8179, SGA 8180 and SGA 8038
- SGC 8058 and SGC 8181

### SG Magnet Actuated Proximity Sensors, Maintained Contact

<table>
<thead>
<tr>
<th>FIG. 11</th>
<th>FIG. 12</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image11.png" alt="Diagram" /></td>
<td><img src="image12.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- SGA 8018, SGO 8026
- SGO 8110

### ST Grounded Probe Switch

<table>
<thead>
<tr>
<th>FIG. 13</th>
<th>FIG. 14</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image13.png" alt="Diagram" /></td>
<td><img src="image14.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- ST switches may be wired in series or parallel. For series operation, connect red lead (terminal 4) to black lead (terminal 1) of other switch. The voltage drop across each switch (in the closed state) does not exceed 2 VAC.

### XUB Short Range Tubular Photoelectric Sensors

<table>
<thead>
<tr>
<th>FIG. 15</th>
<th>FIG. 16</th>
<th>FIG. 17</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image15.png" alt="Diagram" /></td>
<td><img src="image16.png" alt="Diagram" /></td>
<td><img src="image17.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- 2-Wire AC
- AC Emitter
- DC Emitter
Photoelectric Sensors
XUM, XUH, XUG, XUL and XUJ

XUM Miniature High Performance Photoelectric Sensors

XUH and XUG Medium Range Photoelectric Sensors

XUL Subcompact Photoelectric Sensors

XUJ Compact High Performance Photoelectric Sensors

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

FIG. 8

FIG. 9

PNP Output
NPN Output
5-Wire AC

Emitter DC
Connector, PNP output
Connector, NPN output
DC connector

Emitter
Relay output
AC/DC versions

5-Wire Relay, AC/DC
AC/DC Microchange DC Connector
DC Output
DC Output Microchange DC Connector

For dark mode connect Brown wire to terminal 2
For NO contact connect White wire to terminal 4

For dark mode connect Brown wire to terminal 2
For NPN output connect White wire to terminal 4
**Photoelectric Sensors and Security Light Barriers**

**XUE, XUR, XUD, XUG and XUE S**

**XUE Long Range Plug-In Photoelectric Sensors**

**FIG. 1**

- DC Emitter
  - XUE Long Range Plug-In Photoelectric Sensors
  - FIG. 1

**FIG. 2**

- XUE A
  - FIG. 2

**FIG. 3**

- XUE H, NPN
  - FIG. 3

**FIG. 4**

- XUE H, PNP
  - FIG. 4

**FIG. 5**

- XUE F
  - FIG. 5

**FIG. 6**

- XUE T
  - FIG. 6

**XUR Color Registration Photoelectric Sensors**

**FIG. 7**

- PNP
  - FIG. 7

**FIG. 8**

- NPN
  - FIG. 8

**XUD Amplifiers**

**FIG. 9**

- XUD H
  - FIG. 9

**FIG. 10**

- XUD J
  - FIG. 10

**XUG Amplifiers**

**FIG. 11**

- for XUF N Plastic Fiber Optics – DC models

**XUE S Security Light Barriers**

**FIG. 12**

- Emitter
  - FIG. 12

**FIG. 13**

- Receiver
  - FIG. 13
### XUV Photoelectric Sensors w/ Separate Optical Heads

#### FIG. 1

- **PNP Output**
- **NPN Output**

#### FIG. 2

- **PNP Output**
- **NPN Output**

#### FIG. 3

<table>
<thead>
<tr>
<th>Terminals</th>
<th>Switches</th>
<th>Potentiometers</th>
<th>LED Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 L1 Supply</td>
<td>1 Light/Dark</td>
<td>A Sensitivity adjustment</td>
<td>1 Green: power supply</td>
</tr>
<tr>
<td>2 L2 Supply</td>
<td>2 Monostable timer (pulse stretcher)</td>
<td>B Sensitivity adjustment, Channel 1</td>
<td>2 Red: unstable</td>
</tr>
<tr>
<td>3 NC output, Channel 2</td>
<td>3 Time delay mode (mono, adjustable time delay)</td>
<td>C Sensitivity adjustment</td>
<td>3 Yellow: output, Channel 2</td>
</tr>
<tr>
<td>4 NC output, Channel 1</td>
<td>4 Time delay mode (On/Off)</td>
<td>1 Green: power supply</td>
<td>4 Red: unstable, Channel 2</td>
</tr>
<tr>
<td>5 Common, Channel 2</td>
<td>5 Logic function (And/Or)</td>
<td>2 Red: output test</td>
<td>5 Yellow: output, Channel 2</td>
</tr>
<tr>
<td>6 Common, Channel 1</td>
<td>6 Logic function (On/Off)</td>
<td>3 Yellow: detection, Channel 1</td>
<td>6 Yellow: detection, Channel 2</td>
</tr>
<tr>
<td>7 NO output, Channel 2</td>
<td>7 Light/Dark, Channel 1</td>
<td>B Sensitivity adjustment, Channel 2</td>
<td>7 Red: unstable, Channel 1</td>
</tr>
<tr>
<td>8 NO output, Channel 1</td>
<td>8 Light/Dark, Channel 2</td>
<td>1 Green: power supply</td>
<td>8 Yellow: synchronization, Channel 2</td>
</tr>
<tr>
<td>9 12 VDC output</td>
<td>9 Logic function (And/Or)</td>
<td>2 Red: output test</td>
<td>9 Yellow: detection, Channel 2</td>
</tr>
<tr>
<td>10 12 VDC output</td>
<td>10 Logic function (On/Off)</td>
<td>3 Yellow: output, Channel 1</td>
<td>10 Red: unstable, Channel 2</td>
</tr>
<tr>
<td>11 Synchronization, Channel 2, NPN</td>
<td>11 Logic function (And/Or)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Synchronization, Channel 1, NPN</td>
<td>12 Logic function (On/Off)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Emitter shield, Channel 1</td>
<td>13 Logic function (And/Or)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Receiver, Channel 1 (white wire)</td>
<td>14 Logic function (On/Off)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Emitter, Channel 1 (red wire)</td>
<td>15 Logic function (And/Or)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 Receiver shield, Channel 1</td>
<td>16 Logic function (On/Off)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Emitter shield, Channel 2</td>
<td>17 Logic function (And/Or)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Receiver, Channel 2 (white wire)</td>
<td>18 Logic function (On/Off)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Emitter, Channel 2 (red wire)</td>
<td>19 Logic function (And/Or)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Receiver shield, Channel 2</td>
<td>20 Logic function (On/Off)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Contact Forms for Class 9007 Limit Switches

**FIG. 1**

<table>
<thead>
<tr>
<th>Form A</th>
<th>Form B</th>
<th>Form C</th>
<th>Form AA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPST-NO</td>
<td>SPST-NC</td>
<td>SPDT</td>
<td>DPST-NO</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form BB</th>
<th>Form CC</th>
<th>Form X</th>
<th>Form Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPST-NC</td>
<td>DPDT</td>
<td>SPST-NO-DB</td>
<td>SPST-NC-DB</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form Z</th>
<th>Form XX</th>
<th>Form YY</th>
<th>Form ZZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPDT-DB</td>
<td>DPST-NO-DB</td>
<td>DPST-NC-DB</td>
<td>DPDT-DB</td>
</tr>
</tbody>
</table>

## Limit Switches: Class 9007 Type C

**FIG. 2**

Types C52, C54
1-Pole

**FIG. 3**

Type C62
2-Pole, Same Polarity Each Pole

**FIG. 4**

Type C66
2-Pole, 2-Stage, Same Polarity Each Pole

**FIG. 5**

2-Pole Neutral Position, Same Polarity Each Pole

**FIG. 6**

Type C Reeds

---

[1] On CR switches, terminals 1-4 on left side are for CW rotation and terminals 5-8 on right side are for CCW rotation.

## Limit Switches: Class 9007 Type XA

**FIG. 7**

Type XA73 Reeds

**FIG. 8**

Type XA75 Reeds
Limit Switches: Class 9007 Type AW

**FIG. 1**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Operation Only</td>
<td>CCW Operation Only</td>
</tr>
</tbody>
</table>

Type AW12 and AW14

**FIG. 2**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
<th>MAY BE OPPOSITE POLARITY</th>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Operation Only</td>
<td>1A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2B</td>
<td></td>
</tr>
</tbody>
</table>

Type AW18

**FIG. 3**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Operation Only</td>
<td>CCW Operation Only</td>
</tr>
</tbody>
</table>

Type AW16

\[1\] If lever arm is placed at same end of box as conduit, N.O. contacts become N.C. and vice versa.

w/ Lever Arm Opposite Conduit Hole [1]

**FIG. 4**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Operation Only</td>
<td>CCW Operation Only</td>
</tr>
</tbody>
</table>

Type AW19

\[1\] If lever arm is placed at same end of box as conduit, N.O. contacts become N.C. and vice versa.

w/ Lever Arm Opposite Conduit Hole [1]

**FIG. 5**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Operation Only</td>
</tr>
</tbody>
</table>

Type AW32, AW34, AW42 and AW44

**FIG. 6**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW Operation Only</td>
</tr>
</tbody>
</table>

Type AW36 and AW46

**FIG. 7**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
<th>MAY BE OPPOSITE POLARITY</th>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2B</td>
<td></td>
</tr>
</tbody>
</table>

Type AW38 and AW48

**FIG. 8**

<table>
<thead>
<tr>
<th>MUST BE SAME POLARITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

Type AW39 and AW49

Limit Switches: Class 9007 Type SG – GATE GARD™ Switch

**FIG. 9**

Type SGS1DK

**FIG. 10**

Type SGP1

* Connect up to 3 switches for series operation. Unused inputs must be connected to +Vs for proper operation.
## Limit Switches and Safety Interlocks

### XCK Limit Switches

<table>
<thead>
<tr>
<th>FIG. 1</th>
<th>FIG. 2</th>
<th>FIG. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>XCK Limit Switches</strong></td>
<td><strong>XCK Limit Switches</strong></td>
<td><strong>XCK Limit Switches</strong></td>
</tr>
<tr>
<td>No polarity</td>
<td>11,13 and 21,23 Same polarity each pole</td>
<td>No polarity</td>
</tr>
</tbody>
</table>

### XCK Safety Interlocks

<table>
<thead>
<tr>
<th>FIG. 4</th>
<th>FIG. 5</th>
<th>FIG. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="Diagram" /></td>
<td><img src="image5" alt="Diagram" /></td>
<td><img src="image6" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>XCK Safety Interlocks</strong></td>
<td><strong>XCK Safety Interlocks</strong></td>
<td><strong>XCK Safety Interlocks</strong></td>
</tr>
<tr>
<td>No polarity</td>
<td>LED 24 VDC</td>
<td>AC L1</td>
</tr>
<tr>
<td>SPDT, Positive Opening, Slow-Make Slow-Break</td>
<td>24 VDC</td>
<td>Orange X3</td>
</tr>
<tr>
<td>SPDT, w/ 24 VDC LED, Positive Opening, Slow-Make Slow-Break</td>
<td>Orange X1</td>
<td>0 V</td>
</tr>
<tr>
<td>SPDT, w/ 2 Pilot Lights, Positive Opening, Slow-Make Slow-Break</td>
<td>X3</td>
<td>AC L2</td>
</tr>
<tr>
<td>Note: N.O. and N.C. contacts are shown with key inserted and fully engaged.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Contact Blocks for XY2CE Limit Switches

<table>
<thead>
<tr>
<th>FIG. 7</th>
<th>FIG. 8</th>
<th>FIG. 9</th>
<th>FIG. 10</th>
<th>FIG. 11</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="Diagram" /></td>
<td><img src="image8" alt="Diagram" /></td>
<td><img src="image9" alt="Diagram" /></td>
<td><img src="image10" alt="Diagram" /></td>
<td><img src="image11" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Contact Blocks for XY2CE Limit Switches</strong></td>
<td><strong>Contact Blocks for XY2CE Limit Switches</strong></td>
<td><strong>Contact Blocks for XY2CE Limit Switches</strong></td>
<td><strong>Contact Blocks for XY2CE Limit Switches</strong></td>
<td><strong>Contact Blocks for XY2CE Limit Switches</strong></td>
</tr>
<tr>
<td>XEN P2151, Isolated N.C. and N.O.</td>
<td>XEN P2141, Isolated N.C. and N.O.</td>
<td>XEN P2051, N.C./N.O., 12 and 14 same polarity</td>
<td>Indicator Light, Direct</td>
<td>Indicator Light w/ Resistance</td>
</tr>
</tbody>
</table>

### MS Miniature Limit Switches

<table>
<thead>
<tr>
<th>FIG. 12</th>
<th>FIG. 13</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image12" alt="Diagram" /></td>
<td><img src="image13" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>MS Miniature Limit Switches</strong></td>
<td><strong>MS Miniature Limit Switches</strong></td>
</tr>
<tr>
<td>Black White Red</td>
<td>Black Orange Red White Green</td>
</tr>
<tr>
<td>SPST</td>
<td>SPDT</td>
</tr>
</tbody>
</table>
Pressure and Temperature Switches:
Class 9012 and 9025 Type G

Machine Tool, SPDT, 1 N.O. and 1 N.C.

Machine Tool, DPDT, 2 N.O. and 2 N.C.

Industrial, SPST, 1 N.O. and 1 N.C.

Machine Tool, SPDT, 1 N.O. and 1 N.C. w/ Form H10

Machine Tool, SPDT, 1 N.O. and 1 N.C. w/ Form H11

Commercial Pressure Switches:
Class 9013 Type CS

Acceptable Wiring Schematics

Pressure Transducers:
Class 9022 Type PTA and PTB

Type PTA, 2-Wire

Type PTA, 3-Wire

Type PTA, 4-Wire

Type PTB, 2-Wire

Type PTB, 3-Wire

Type PTB, 4-Wire
Level Sensors and Electric Alternators
Class 9034 and 9039

Level Sensors:
Class 9034 Types LSD and LSV

FIG. 1  Wiring Diagram
Elementary Diagram

Output selection of both sensors in maximum (N.C. when absent). Both devices at max. setting.

Fill Cycle, Tank Full

FIG. 2  Wiring Diagram
Elementary Diagram

Output selection of both sensors in minimum (N.O. when absent). Both devices at min. setting.

Drain Cycle, Tank Empty

Electric Alternators:
Class 9039 Type X

FIG. 3  Wiring Diagram

Set pilot device A contacts to close before pilot device B contacts.

Connections shown are for common control. If motor line voltage is different from voltage rating stamped on alternator coil terminals, alternator must be connected to motor lines thru control transformers.

Control circuit conductors require overcurrent protection in accordance with applicable electrical codes.

* Overlapping contact.
### Pneumatic Timing Relays: Class 9050: Type AO

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Type AO10E</th>
<th>Type AO10D</th>
<th>Type AO20E</th>
<th>Type AO20D</th>
<th>Type AO110DE</th>
<th>Type AO120DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
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<td>4</td>
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</table>

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Type AO11E</th>
<th>Type AO11D</th>
<th>Type AO21E</th>
<th>Type AO21D</th>
<th>Type AO111DE</th>
<th>Type AO121DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Type AO12E</th>
<th>Type AO12D</th>
<th>Type AO22E</th>
<th>Type AO22D</th>
<th>Type AO112DE</th>
<th>Type AO122DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>20</td>
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<tr>
<td>21</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Type AO210DE</th>
<th>Type AO211DE</th>
<th>Type AO212DE</th>
<th>Type AO220DE</th>
<th>Type AO221DE</th>
<th>Type AO222DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pneumatic Timing Relays: Class 9050: Type HO

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Type HO10E, On Delay</th>
<th>Type HO10D, Off Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pneumatic Timing Relays: Class 9050: Types B and C

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Type B</th>
<th>Type C</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Off Delay</td>
<td>On Delay</td>
</tr>
<tr>
<td>28</td>
<td>Off Delay</td>
<td>On Delay</td>
</tr>
</tbody>
</table>

*Types B and C are interlocked.*
Class 9050 Pneumatic Timing Relays: Typical Elementary Diagrams

**FIG. 1**
On Delay

**FIG. 2**
Interval, Momentary Start

**FIG. 3**
Interval, Maintained Start

**FIG. 4**
Off Delay

**FIG. 5**
Repeat Cycle

Solid State Industrial Timing Relays: Class 9050 Types FS and FSR

**FIG. 6**
Elementary Diagram

**FIG. 7**
Wiring Diagram

Solid State Industrial Timing Relays: Class 9050 Type FT

**FIG. 8**
Elementary Diagram

**FIG. 9**
Wiring Diagram
Solid State Industrial Timing Relays:
Class 9050 Type JCK

**FIG. 1**

Control Power
Polarity markings are for DC units only. JCK 60 is AC only.

Type JCK 11-19, 31-39 and 51-60

**FIG. 2**

External Initiating Contact
Polarity markings are for DC units only.
Terminals 5 and 10 are internally jumpered. Applying power to terminal 7 or jumpering from terminal 5 to 7 through an external contact initiates the timer.

Type JCK 21-29 and 41-49

**FIG. 3**

External Initiating Contact (used in one-shot and off-delay mode only)

Type JCK 70

Solid State Timers:
Class 9050 Type D

**FIG. 4**

Type DER, DZM, DTR, DWE, DEW and DBR

**FIG. 5**

Type DERP, DERLP, DWEP and DZMP

**FIG. 6**

Type DAR

**FIG. 7**

Type DARP

Solid State Timers:
Class 9050 Type M

**FIG. 8**

Type MAN, MBR, MER, MEW, MTG, MWE and MZM

**FIG. 9**

Type MAR
Transformer Disconnects:
Class 9070

Note: Some factory modifications, depending on enclosure and transformer VA size selected, are not available. Consult factory modification chart.

FIG. 1
For Size 1 Enclosures except w/ Form E23

FIG. 2
For Size 1 Enclosures w/ Form E23

FIG. 3
For Size 2 Enclosures except w/ Form E23

FIG. 4
For Size 2 Enclosures w/ Form E23
### Table 6  Enclosures for Non-Hazardous Locations

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental contact w/ enclosed equipment</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Falling dirt</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Falling liquids and light splashing</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dust, lint, fibers and flyings</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hosedown and splashing water</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Oil and coolant seepage</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Oil and coolant spraying and splashing</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Corrosive agents</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>Yes</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Rain, snow and sleet [4]</td>
<td>Yes</td>
<td>Yes</td>
<td>...</td>
<td>Yes</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Windblown dust</td>
<td>Yes</td>
<td>...</td>
<td>...</td>
<td>Yes</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

[1] Intended for outdoor use.
[3] Square D Industrial Control design NEMA Type 12 enclosures may be field modified for outdoor applications.
[4] External operating mechanisms are not required to be operable when the enclosure is ice covered.
[5] Square D Industrial Control design NEMA Type 4 enclosures provide protection against these environments.

### Table 7  Enclosures for Hazardous Locations

<table>
<thead>
<tr>
<th>Provides Protection Against</th>
<th>Class [1]</th>
<th>Group [1]</th>
<th>NEMA Type 7</th>
<th>Enclosure</th>
<th>NEMA Type 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen, manufactured gas</td>
<td>I</td>
<td>B</td>
<td>Yes</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Ethyl ether, ethylene, cyclopropane</td>
<td>I</td>
<td>C</td>
<td>Yes</td>
<td>Yes</td>
<td>...</td>
</tr>
<tr>
<td>Gasoline, hexane, naphtha, benzine, butane, propane, alcohol, acetone, benzol, natural gas, lacquer solvent</td>
<td>I</td>
<td>D</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Metal dust</td>
<td>II</td>
<td>E</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Carbon black, coal dust, coke dust</td>
<td>II</td>
<td>F</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Flour, starch, grain dust</td>
<td>II</td>
<td>G</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

[1] As described in Article 500 of the National Electrical Code.
**Conductor Ampacity and Conduit Tables**

Based on 1993 National Electrical Code

*Ampacity Based on NEC® Table 310-16 — Allowable Ampacities of Insulated Conductors Rated 0-2000 Volts. Not More Than Three Conductors in Raceway or Cable. Based on 30 °C Ambient Temperature. Trade Size of Conduit or Tubing Based on NEC Chapter 9, Table 3A, 3B, 3C, 4 and 5B.* Refer to Chapter 9 for Maximum Number of Conductors in Trade Sizes of Conduit or Tubing. Dimensions of Insulated Conductors for Conduit Fill Determined from NEC Chapter 9 Tables 5 and 5A.

For information on temperature ratings of terminations to equipment, see NEC Section 110-14c. Underlined conductor insulation types indicates ampacity is for WET locations. See NEC Table 310-13.

---

**Table 8 Conductor Ampacity based on NEC Table 310-16**

<table>
<thead>
<tr>
<th>Wire Size AWG</th>
<th>COPPER CONDUCTORS</th>
<th>ALUMINUM CONDUCTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>75 °C (167 °F)</td>
<td>90 °C (194 °F)</td>
</tr>
<tr>
<td></td>
<td>Conductor Insulation</td>
<td>Conductor Insulation</td>
</tr>
<tr>
<td></td>
<td>THHW, THW, RW, USE</td>
<td>THHN, XHHW</td>
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<tr>
<td>1/4</td>
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<td>1/2</td>
</tr>
<tr>
<td>1/2</td>
<td>30</td>
<td>1/2</td>
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<tr>
<td>1000</td>
<td>800</td>
<td>2-1/2</td>
</tr>
</tbody>
</table>

**[1]** Unless otherwise permitted in the Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 A for No. 14, 20 A for No. 12 and 30 A for No. 10 copper, or 15 A for No. 12 and 25 A for No. 10 aluminum after any correction factors for ambient temperature and number of conductors have been applied.

**[2]** On a 4-wire, 3-phase wye circuit where the major portion of the load consists of nonlinear loads such as electric discharge lighting, electronic computer/data processing, or similar equipment there are harmonic currents present in the neutral conductor and the neutral shall be considered to be a current-carrying conductor.

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Conductor Ampacity and Conduit Tables
Based on 1993 National Electrical Code

**Ampacity Correction Factors:**
For ambient temperatures other than 30 °C (86 °F), multiply the ampacities listed in Table 8 by the appropriate factor listed in Table 9.

**Adjustment Factors:**
Where the number of current-carrying conductors in a raceway or cable exceeds three, reduce the allowable ampacities as shown in Table 9.

### Table 9 Ampacity Correction Factors

<table>
<thead>
<tr>
<th>Ambient Temperature (°C)</th>
<th>75 °C (167 °F) Conductors</th>
<th>90 °C (194 °F) Conductors</th>
<th>Ambient Temperature (°F)</th>
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<tbody>
<tr>
<td>21-25</td>
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<td>70-77</td>
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<td>26-30</td>
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<td>1.00</td>
<td>78-86</td>
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<td>87-95</td>
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<td>46-50</td>
<td>.75</td>
<td>.82</td>
<td>114-122</td>
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<tr>
<td>51-55</td>
<td>.67</td>
<td>.76</td>
<td>123-131</td>
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<td>56-60</td>
<td>.58</td>
<td>.71</td>
<td>132-140</td>
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<tr>
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<td>.33</td>
<td>.58</td>
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<tr>
<td>71-80</td>
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<td>.41</td>
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</table>

### Table 10 Adjustment Factors

<table>
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<tr>
<th>No. of Current-Carrying Conductors</th>
<th>Values in Tables as Adjusted for Ambient Temperature</th>
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<tr>
<td>4-6</td>
<td>80%</td>
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<tr>
<td>31-40</td>
<td>40%</td>
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<tr>
<td>41 and above</td>
<td>35%</td>
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</table>

For exceptions, see exceptions to Note 8 of NEC® Table 310-16.

### Table 11 Ratings for 120/240 V, 3-Wire, Single-Phase Dwelling Services

The ratings in Table 11 are permitted ratings for dwelling unit service and feeder conductors which carry the total load of the dwelling. The grounded conductor (neutral) shall be permitted to be not more than 2 AWG sizes smaller than the ungrounded conductors, provided the requirements of 215-2, 220-22 and 230-42 are met.

**NEC 240-3 Protection of Conductors:**
Conductors, other than flexible cords and fixture wires, shall be protected against overcurrent in accordance with their ampacities as specified in NEC Section 310-15, unless otherwise permitted in parts (a) through (m).

**NEC 220-3 (a) Continuous and Noncontinuous Loads:**
The branch circuit rating shall not be less than the noncontinuous load plus 125% of the continuous load (see exception for 100% rated devices).

**NEC 220-10 (b) Continuous and Noncontinuous Loads:**
Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125% of the continuous load (see exception for 100% rated devices).

**NEC 430-22 (a) Single Motor Circuit Conductors:**
Branch circuit conductors supplying a single motor shall have an ampacity not less than 125% of the motor full-load current rating (see exceptions).

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### Table 12: AWG and Metric Wire Data

<table>
<thead>
<tr>
<th>AWG Size</th>
<th>Conductor dia. (mm)</th>
<th>Conductor dia. (in)</th>
<th>Resistance @ 20 °C (68 °F) Ohm per ft</th>
<th>Resistance @ 20 °C (68 °F) Ohm per m</th>
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<td></td>
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<td>Ohm</td>
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**Resistance Conversion:****
- Ohm per ft
- Ohm per m
### Table 13  Electrical formulas for Amperes, Horsepower, Kilowatts and KVA

<table>
<thead>
<tr>
<th>To find</th>
<th>Single phase</th>
<th>3-phase</th>
<th>Direct current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilowatts</td>
<td>I x E x PF</td>
<td>I x E x 1.73 x PF</td>
<td>I x E x PF x 1.73</td>
</tr>
<tr>
<td>KVA</td>
<td>I x E x 1000</td>
<td>I x E x 1.73 x 1000</td>
<td>__________</td>
</tr>
<tr>
<td>Horsepower (output)</td>
<td>I x E x % Eff x PF</td>
<td>I x E x 1.73 x % Eff x PF</td>
<td>I x E x % Eff x 1.73</td>
</tr>
<tr>
<td></td>
<td>746</td>
<td>746</td>
<td>__________</td>
</tr>
<tr>
<td>Amperes when Horsepower is known</td>
<td>HP x 746</td>
<td>HP x 746</td>
<td>HP x 746</td>
</tr>
<tr>
<td>Amperes when Kilowatts is known</td>
<td>KW x 1000</td>
<td>KW x 1000</td>
<td>KW x 1000</td>
</tr>
<tr>
<td>Amperes</td>
<td>KVA x 1000</td>
<td>KVA x 1000</td>
<td>__________</td>
</tr>
</tbody>
</table>

E=Volts  I = Amperes  %Eff = Percent efficiency  PF = Power factor  HP = Horsepower  KVA = Kilovolt-Amps

### Average Efficiency and Power Factor Values of Motors:

When actual efficiencies and power factors of the motors to be controlled are not known, the following approximations may be used:

**Efficiencies:**
- DC motors, 35 hp and less: 80% to 85%
- DC motors, above 35 hp: 85% to 90%
- Synchronous motors (at 100% PF): 92% to 95%

**“Apparent” efficiencies (Efficiency x PF):**
- 3-phase induction motors, 25 hp and less: 70%
- 3-phase induction motors above 25 hp: 80%
- Decrease these figures slightly for single phase induction motors.

### Table 14  Ratings for 3-Phase, Single-Speed, Full-Voltage Magnetic Controllers for Nonplugging and Nonjogging Duty

<table>
<thead>
<tr>
<th>Size of Controller</th>
<th>Continuous Current Rating (A)</th>
<th>60 Hz 200 V</th>
<th>60 Hz 230 V</th>
<th>50 Hz 380 V</th>
<th>60 Hz 460 or 575 V</th>
<th>Service-Limit Current Rating (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>60 Hz 200 V</td>
<td>60 Hz 230 V</td>
<td>50 Hz 380 V</td>
<td>60 Hz 460 or 575 V</td>
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<td>1-1/2</td>
<td>1-1/2</td>
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<td>600</td>
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</table>

**[1]** These horsepower ratings are based on typical locked-rotor current ratings. For motors having higher locked-rotor currents, use a larger controller to ensure its locked-rotor current rating is not exceeded.
### Table 15  Ratings for 3-Phase, Single-Speed, Full-Voltage Magnetic Controllers for Plug-Stop, Plug-Reverse or Jogging Duty

<table>
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<tr>
<th>Size of Controller</th>
<th>Continuous Current Rating (A)</th>
<th>Horsepower at [1]</th>
<th>Service-Limit Current Rating (A)</th>
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<td>60 Hz 230 V</td>
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<tr>
<td>4</td>
<td>135</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>270</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>6</td>
<td>540</td>
<td>125</td>
<td>150</td>
</tr>
</tbody>
</table>

[1] These horsepower ratings are based on typical locked-rotor current ratings. For motors having higher locked-rotor currents, use a larger controller to ensure its locked-rotor current rating is not exceeded.

### Table 16  Power Conversions

<table>
<thead>
<tr>
<th>From</th>
<th>to kW</th>
<th>to PS</th>
<th>to hp</th>
<th>to ft-lb/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kW (kilowatt) = (10^{10}) erg/s</td>
<td>1</td>
<td>1.360</td>
<td>1.341</td>
<td>737.6</td>
</tr>
<tr>
<td>1 PS (metric horsepower)</td>
<td>0.7355</td>
<td>1</td>
<td>0.9863</td>
<td>542.5</td>
</tr>
<tr>
<td>1 hp (horsepower)</td>
<td>0.7457</td>
<td>1.014</td>
<td>1</td>
<td>550.0</td>
</tr>
<tr>
<td>1 ft-lb/s (foot-pound per sec)</td>
<td>(1.356 \times 10^{-3})</td>
<td>(1.843 \times 10^{-3})</td>
<td>(1.818 \times 10^{-3})</td>
<td>1</td>
</tr>
</tbody>
</table>
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