Wiring Diagram Book
TRADEMARKS

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<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></td>
</tr>
<tr>
<td>Circuit Breakers w/ Thermal OL</td>
<td></td>
</tr>
<tr>
<td>Circuit Breakers w/ Magnetic OL</td>
<td></td>
</tr>
<tr>
<td>Pressure &amp; Vacuum Switches</td>
<td>3-Position Selector Switch</td>
</tr>
<tr>
<td>N.O.</td>
<td>J K A1</td>
</tr>
<tr>
<td>N.C.</td>
<td></td>
</tr>
<tr>
<td>Liquid Level Switches</td>
<td></td>
</tr>
<tr>
<td>N.O.</td>
<td>J K L</td>
</tr>
<tr>
<td>N.C.</td>
<td></td>
</tr>
<tr>
<td>Temperature Actuated Switches</td>
<td></td>
</tr>
<tr>
<td>N.O.</td>
<td></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></td>
</tr>
<tr>
<td>N.C.</td>
<td></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>PUSH BUTTONS – MAINTAINED CONTACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.O.</td>
</tr>
<tr>
<td>N.O.</td>
</tr>
</tbody>
</table>

### PILOT LIGHTS

<table>
<thead>
<tr>
<th>INSTANT OPERATING CONTACTS</th>
<th>TIMED CONTACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>w/ Blowout</td>
<td>Contact action retarded after coil is:</td>
</tr>
<tr>
<td>w/o Blowout</td>
<td>Energized</td>
</tr>
<tr>
<td>N.O.</td>
<td>N.O.T.C.</td>
</tr>
<tr>
<td>N.C.</td>
<td>N.C.T.O.</td>
</tr>
<tr>
<td>N.O.</td>
<td>N.O.T.O.</td>
</tr>
<tr>
<td>N.C.</td>
<td>N.C.T.C.</td>
</tr>
</tbody>
</table>

(Indicate color by letter)
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>[Diagram]</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</td>
</tr>
<tr>
<td>[Diagram]</td>
<td>Squirrel Cage</td>
</tr>
<tr>
<td></td>
<td>2-Phase, 4-Wire</td>
</tr>
<tr>
<td></td>
<td>Wound Rotor</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>CAPACITORS</th>
<th>RESISTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed</td>
<td>Adjustable</td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
</tr>
<tr>
<td></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>
<tr>
<td>RES</td>
<td>H</td>
</tr>
<tr>
<td>RES</td>
<td>RES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMICONDUCTORS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode or Half Wave Rectifier</td>
<td>Tunnel Diode</td>
</tr>
<tr>
<td>Diode</td>
<td>Zener Diode</td>
</tr>
<tr>
<td></td>
<td>Bidirectional Breakdown Diode</td>
</tr>
<tr>
<td></td>
<td>Triac</td>
</tr>
<tr>
<td></td>
<td>SCR</td>
</tr>
<tr>
<td></td>
<td>PUT</td>
</tr>
<tr>
<td></td>
<td>Photosensitive Cell</td>
</tr>
<tr>
<td>[Diagram]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Static Switching Control

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPST:</td>
<td>Single Pole, Single Throw</td>
</tr>
<tr>
<td>SPDT:</td>
<td>Single Pole, Double Throw</td>
</tr>
<tr>
<td>DPST:</td>
<td>Double Pole, Single Throw</td>
</tr>
<tr>
<td>DPDT:</td>
<td>Double Pole, Double Throw</td>
</tr>
<tr>
<td>N.O.:</td>
<td>Normally Open</td>
</tr>
<tr>
<td>N.C.:</td>
<td>Normally Closed</td>
</tr>
<tr>
<td>T.O.:</td>
<td>Timed Open</td>
</tr>
<tr>
<td>T.C.:</td>
<td>Timed Closed</td>
</tr>
<tr>
<td>PUT:</td>
<td>Programmable Unijunction Transistor</td>
</tr>
<tr>
<td>SCR:</td>
<td>Silicon Controlled Rectifier</td>
</tr>
<tr>
<td>Triac:</td>
<td>Bidirectional Triode Thyristor</td>
</tr>
<tr>
<td>UJT:</td>
<td>Unijunction Transistor</td>
</tr>
</tbody>
</table>

### Supplementary Contact Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPST, N.O.</td>
<td>Single Break</td>
</tr>
<tr>
<td></td>
<td>Double Break</td>
</tr>
<tr>
<td>SPST, N.C.</td>
<td>Single Break</td>
</tr>
<tr>
<td></td>
<td>Double Break</td>
</tr>
<tr>
<td>DPST, 2 N.O.</td>
<td>Single Break</td>
</tr>
<tr>
<td></td>
<td>Double Break</td>
</tr>
<tr>
<td>DPST, 2 N.C.</td>
<td>Single Break</td>
</tr>
<tr>
<td></td>
<td>Double Break</td>
</tr>
<tr>
<td>DPDT:</td>
<td>Single Break</td>
</tr>
<tr>
<td></td>
<td>Double Break</td>
</tr>
</tbody>
</table>

### IEC Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push Buttons N.O.</td>
<td>Single Break</td>
</tr>
<tr>
<td></td>
<td>Double Break</td>
</tr>
<tr>
<td></td>
<td>Coils N.O.</td>
</tr>
<tr>
<td></td>
<td>N.C.</td>
</tr>
<tr>
<td></td>
<td>Aux. Contacts N.O.</td>
</tr>
<tr>
<td></td>
<td>N.C.</td>
</tr>
<tr>
<td></td>
<td>Contactor Breakers</td>
</tr>
</tbody>
</table>

### Other Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell</td>
<td></td>
</tr>
<tr>
<td>Annunciator</td>
<td></td>
</tr>
<tr>
<td>Buzzer</td>
<td></td>
</tr>
<tr>
<td>Horn, Alarm, Siren, etc.</td>
<td></td>
</tr>
<tr>
<td>Meter (indicate type by letters)</td>
<td></td>
</tr>
<tr>
<td>Battery</td>
<td></td>
</tr>
<tr>
<td>Fuse</td>
<td></td>
</tr>
<tr>
<td>Thermocouple</td>
<td></td>
</tr>
<tr>
<td>Meter Shunt</td>
<td></td>
</tr>
</tbody>
</table>

### Table 1: Standard Elementary Diagram Symbols (cont'd)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annunicator</td>
<td></td>
</tr>
<tr>
<td>Bell</td>
<td></td>
</tr>
<tr>
<td>Annunciator</td>
<td></td>
</tr>
<tr>
<td>Buzzer</td>
<td></td>
</tr>
<tr>
<td>Horn, Alarm, Siren, etc.</td>
<td></td>
</tr>
<tr>
<td>Meter (indicate type by letters)</td>
<td></td>
</tr>
<tr>
<td>Battery</td>
<td></td>
</tr>
<tr>
<td>Fuse</td>
<td></td>
</tr>
<tr>
<td>Thermocouple</td>
<td></td>
</tr>
<tr>
<td>Meter Shunt</td>
<td></td>
</tr>
</tbody>
</table>

---

*Standard Elementary Diagram Symbols*
Table 2  NEMA and IEC Terminal Markings

<table>
<thead>
<tr>
<th></th>
<th>NEMA</th>
<th>IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Terminals</strong></td>
<td><img src="image" alt="NEMA Power Terminals Diagram" /></td>
<td><img src="image" alt="IEC Power Terminals Diagram" /></td>
</tr>
<tr>
<td><strong>Control Terminals</strong></td>
<td><img src="image" alt="NEMA Control Terminals Diagram" /></td>
<td><img src="image" alt="IEC Control Terminals Diagram" /></td>
</tr>
<tr>
<td><strong>Coil Terminals</strong></td>
<td><img src="image" alt="NEMA Coil Terminals Diagram" /></td>
<td><img src="image" alt="IEC Coil Terminals Diagram" /></td>
</tr>
</tbody>
</table>

Table 3  NEMA and IEC Controller Markings and Elementary Diagrams

<table>
<thead>
<tr>
<th></th>
<th>NEMA</th>
<th>IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical Controller Markings</strong></td>
<td><img src="image" alt="NEMA Typical Controller Markings Diagram" /></td>
<td><img src="image" alt="IEC Typical Controller Markings Diagram" /></td>
</tr>
<tr>
<td><strong>Typical Elementary Diagram</strong></td>
<td><img src="image" alt="NEMA Typical Elementary Diagram" /></td>
<td><img src="image" alt="IEC Typical Elementary Diagram" /></td>
</tr>
</tbody>
</table>

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

FIG. 1

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: 3-Wire Control**

FIG. 2

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.

**2-Wire Control: Maintained Contact Hand-OFF-Auto Selector Switch**

FIG. 3

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.

**3-Wire Control: Momentary Contact Multiple Push Button Station**

FIG. 4

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

![Diagram](FIG. 1)

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

![Diagram](FIG. 2)

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

![Diagram](FIG. 3)

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

![Diagram](FIG. 4)

*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

![Diagram](FIG. 5)

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

![Diagram](FIG. 6)

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.
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: 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.
3-Wire Control: Reversing Starter Multiple Push Button Station

More than one Forward-Reverse-Stop push button station may be required and can be connected in the manner shown above.

3-Wire Control: Reversing Starter w/ Pilot Lights to Indicate Motor Direction

Pilot lights may be connected in parallel with the forward and reverse contactor coils, indicating which contactor is energized and thus which direction the motor is running.

3-Wire Control: 2-Speed Starter

3-wire control of a 2-speed starter with a High-Low-Stop push button station is shown above. This scheme allows the operator to start the motor from rest at either speed or to change from low to high speed. The Stop button must be operated before it is possible to change from high to low speed. This arrangement is intended to prevent excessive line current and shock to motor and driven machinery, which results when motors running at high speed are reconnected for a lower speed.

3-Wire Control: 2-Speed Starter w/ 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 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.
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

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

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

3-Wire Control:
Fusing in Both Primary Lines

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

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

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

Control circuit transformer with fusing in both primary lines and both secondary lines, with all lines ungrounded. Used for large VA coils only.
AC Manual Starters and Manual Motor Starting Switches
Class 2510

### Manual Motor Starting Switches: Class 2510 Type K

**FIG. 1**

- Two pole, 1-phase
- Diagram showing T1, L1, L1, T3, L3, L2, T1, T3
- Motor symbol
- Pilot light (if used)

**FIG. 2**

- Three pole, 3-phase
- Diagram showing T1, L1, L2, L2, T2, T3, L3, L3, T1, T2, T3
- Motor symbol
- Pilot light (if used)

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

**FIG. 3**

- One pole
- Diagram showing T2, L2, L1, T1
- Motor symbol
- Pilot light (if used)

**FIG. 4**

- Two pole
- Diagram showing T2, L2, L1, T1
- Motor symbol
- Pilot light (if used)

**FIG. 5**

- Two pole with selector switch
- Diagram showing T2, L2, L1, T1
- Motor symbol
- Pilot light (if used)
- 2-wire control device

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

**FIG. 6**

- Two pole, 1-phase
- Diagram showing L1, L2, T1, T2
- Motor symbol

**FIG. 7**

- Three pole, DC
- Diagram showing L1, L2, T1, T1, T2
- Motor symbol

**FIG. 8**

- Three pole, 1-phase
- Diagram showing L1, L2, L3, T1, T2, T3
- Motor symbol

**FIG. 9**

- Three pole, 3-phase
- Diagram showing L1, L2, L3, T1, T2, T3, T2
- Motor symbol

**FIG. 10**

- Three pole, 3-phase with additional interlock (Form X)
- Diagram showing L1, L2, L3, T1, T2, T3, T2
- Motor symbol
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**
- FWD
- REV

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

**FIG. 2**
- L1
- L2
- L3
- T1
- T2
- T3

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

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

**FIG. 3**
- HIGH
- LOW

2-Pole, 1-Phase w/ Pilot Lights

**FIG. 4**
- HIGH
- LOW

3-Pole, 3-Phase

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

**FIG. 5**
- HIGH
- LOW

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

**FIG. 6**
- HIGH
- LOW

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

Motor Protective Switches:
Class 2520

IEC Manual Starters:
GV1/GV3

Telemecanique

GV3 A08 95  GV3 A09 97

GV3 A06 13 23 31 13 23 31

GV3 A07 13 23 31 13 23 31

GV1 A01 13 21 13 23

GV1 A02 14 22 14 24

GV1 A03 13 23 31 13 23 33

GV1 A04 14 24 32 14 24 34

GV1 A05 13 23 33 13 23 31

GV1 A06 14 24 34 14 24 33
Drum Switches
Class 2601

**FIG. 1**

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

Internal Switching

**FIG. 2**

3-Phase, 3-Wire Motor

**FIG. 3**

1-Phase, Capacitor or Split-Phase Motor

**FIG. 4**

1-Phase, 4-Lead Repulsion Induction Motor

**FIG. 5**

1-Phase, 3-Lead Repulsion Induction Motor

**FIG. 6**

2-Phase, 3-Wire Motor

**FIG. 7**

2-Phase, 4-Wire Motor

**FIG. 8**

DC, Shunt Motor

**FIG. 9**

DC, Series Motor

**FIG. 10**

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

Constant Speed DC Starter: Class 7135

Adjustable Speed DC Starter: Class 7136

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

Typical Elementary Diagram for NEMA Size 2, 3 and 4

Reversing Adjustable Speed DC Starter: Class 7146

Typical Elementary Diagram for NEMA Size 2, 3 and 4
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

Medium Voltage Motor Controllers
Class 8198

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

FIG. 1

FPO 18-1
130%
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

[Diagram of Full Voltage, Non-Reversing Synchronous Motor Controller]

170%

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

FIG. 1

Medium Voltage Motor Controllers
Class 8198
Reduced-Voltage, Autotransformer, Non-Reversing Synchronous Motor Controller:
Class 8198 Type RSA1 and RSA2

FIG. 1

[Diagram of Reduced-Voltage, Autotransformer, Non-Reversing Synchronous Motor Controller: Class 8198 Type RSA1 and RSA2]
Full-Voltage, Non-Reversing, Brushless Synchronous Motor Controller:
Class 8198 Type FSB1 and FSB2
Solid State Protective Relays:
Class 8430 Type DAS, DASW, DASV and DASVW

**FIG. 1**

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.

**FIG. 2**

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.

**FIG. 3**

Dashed lines represent optional contacts

(DIAW and DUAW devices only)

Type DIA, DIAW, DUA and DUAW

**Solid State Protective Relays: Class 8430**

**FIG. 4**

Type MPD

**FIG. 5**

Type MPS 240V

**FIG. 6**

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**

**Wiring Diagram**
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
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>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>XO-20</td>
<td>S O O S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-11</td>
<td>S O I S</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>XO-30</td>
<td>S 1 1 S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-21</td>
<td>O 1 O S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-12</td>
<td>O 1 1 S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-03</td>
<td>1 1 1 S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-40</td>
<td>O O O O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-31</td>
<td>O 1 O O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-22</td>
<td>O 1 1 O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-13</td>
<td>O 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>XO-04</td>
<td>1 1 1 1</td>
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</tr>
</tbody>
</table>

**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).

**CONTROL RELAY**

<table>
<thead>
<tr>
<th>Pole Number</th>
<th>Type</th>
<th>Pole Numbers</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
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<tbody>
<tr>
<td>8</td>
<td>XO-80</td>
<td>O O O O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-71</td>
<td>O 1 0 O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-62</td>
<td>O 0 0 O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-53</td>
<td>O 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>XO-44</td>
<td>O 1 1 0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>XO-35</td>
<td>O 1 1 1</td>
<td></td>
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<tr>
<td></td>
<td>XO-26</td>
<td>1 1 1 1</td>
<td></td>
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<tr>
<td></td>
<td>XO-17</td>
<td>1 1 1 1</td>
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<tr>
<td></td>
<td>XO-08</td>
<td>1 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MOUNTING SLOT**

**Note:** All contacts are convertible.

---

Timer Attachment:  
Class 9999 Type XTD and XTE

FIG. 2

2 N.O. | 1 N.C. | 1 N.O. | 2 N.C. | ON DELAY (TDE)  
---|---|---|---|---
14 | 13 | 14 | 13 | 14

2 N.C. | OFF DELAY (TDD)  
---|---
14 | 13

**No. of Timed Contacts**  
Class 9999  
Pole No.*  
13 14

2 XTD  
0 1

**Note:** O = N.O. Contact  
1 = N.C. Contact

---

FPO 27-1

Maximum of 8 N.C. Poles

---

NEMA Control Relays  
Class 8501 and 9999
General Purpose Relays and Sensing Relays
Class 8501 and Telemecanique RM2 LA1/LG1

Mineral Control Relays:
Class 8501 Type RS and RSD

FIG. 1
1 5 9
13 (-) 14 (+)
Type RS41 and RSD41

FIG. 2
1 4 5 8
9 12
13 (-) 14 (+)
Type RS42 and RSD42

FIG. 3
1 2 5 6 4 10 12
9
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 ON 2 OFF 3
4 OFF 5 ON
6
Intrinsically Safe Terminals

FIG. 6
7 8 9 10 11 12
SUPPLY VOLTAGE
Non-Hazardous Location Terminals

Sensing Relays:
RM2 LA1/LG1

FIG. 7
Telemecanique

RM2 LG1
2 Levels
Supply voltage
A1 15 B1 16 18 B2 15
B1 B2 15 16 18
B3
A2
RM2 LA1
1 Level
Supply voltage
A1 15 B1 16 18 B2 15
B1 B2 15 16 18
B3
A2
H = High level electrode
L = Low level electrode
M = Reference electrode (common)
### Control Relays: CA2 and CA3

<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>4 N.O. Instantaneous CA2 DN40 and CA3 DN40</td>
<td>3 N.O. &amp; 1 N.C. Instantaneous CA2 DN31 and CA3 DN31</td>
<td>2 N.O. &amp; 2 N.C. Instantaneous CA2 DN22 and CA3 DN22</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>FIG. 6</th>
<th>FIG. 7</th>
<th>FIG. 8</th>
<th>FIG. 9</th>
<th>FIG. 10</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>
<td><img src="image7" alt="Diagram" /></td>
<td><img src="image8" alt="Diagram" /></td>
</tr>
<tr>
<td>1 N.O. &amp; 1 N.C. LA1 DN11</td>
<td>2 N.O. LA1 DN20</td>
<td>2 N.C. LA1 DN02</td>
<td>2 N.O. &amp; 2 N.C. LA1 DN22</td>
<td>1 N.O. &amp; 3 N.C. LA1 DN13</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>FIG. 15</th>
<th>FIG. 16</th>
<th>FIG. 17</th>
<th>FIG. 18</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9" alt="Diagram" /></td>
<td><img src="image10" alt="Diagram" /></td>
<td><img src="image11" alt="Diagram" /></td>
<td><img src="image12" alt="Diagram" /></td>
</tr>
<tr>
<td>2 N.O. LA1 DX20</td>
<td>2 N.O. w/ Grounding Screw LA1 DY20</td>
<td>2 Dusttight N.O. &amp; 2 N.O. LA1 DZ40</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. 19</th>
<th>FIG. 20</th>
<th>FIG. 21</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image13" alt="Diagram" /></td>
<td><img src="image14" alt="Diagram" /></td>
<td><img src="image15" alt="Diagram" /></td>
</tr>
<tr>
<td>On Delay, 1 N.O. &amp; 1 N.C. LA2 DT</td>
<td>On Delay, 1 N.C. w/ 1 Offset N.O. LA2 DS</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. 22</th>
<th>FIG. 23</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image16" alt="Diagram" /></td>
<td><img src="image17" alt="Diagram" /></td>
</tr>
<tr>
<td>LA6 DK1</td>
<td>LA6 DK2</td>
</tr>
</tbody>
</table>

### Side-Mounted Auxiliary Contact Blocks: LA8

<table>
<thead>
<tr>
<th>FIG. 24</th>
<th>FIG. 25</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image18" alt="Diagram" /></td>
<td><img src="image19" alt="Diagram" /></td>
</tr>
<tr>
<td>1 N.O. &amp; 1 N.C. Instantaneous LA8 DN11</td>
<td>2 N.O. Instantaneous LA8 DN20</td>
</tr>
</tbody>
</table>

---

*Telemecanique*
Miniature IEC Relays:
Class 8501 Type PR 1

FIG. 1

PR 1.11 E
A1 13 21
A2 14 22

PRD 1.11 E

PR 1.20 E
A1 13 23
A2 14 24

PRD 1.20 E

Type PR 1 and PRD 1 Relays

FIG. 2

PV 11
33 41
34 42

PV 11 NO NC

PV 20
35 43
34 44

PV 20 NO NC

Type PV Adder Decks for PR 1.20 E

Alternating Relays:
Class 8501 Type PHA

FIG. 3

A1
13 23

A2
14 24

relay coil
energized

deeenergized

closed
open

closed
open
Power Terminals

FIG. 1

1 3 5
2 4 6

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

A1
A2

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>Location</th>
<th>Status (N.O. or N.C.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>54</td>
<td>54</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

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
w/ Class 9065 Type TR Overload Relay

FIG. 5

L2 OR SEPARATE VOLTAGE SOURCE — X
3 WIRE CONTROL
START
STOP
L1 OR SEPARATE VOLTAGE SOURCE
2 WIRE CONTROL
L1 OR SEPARATE VOLTAGE SOURCE
2 WIRE DEVICE

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

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

FIG. 2

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

FIG. 3

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

**FIG. 1**

1-Pole, Size 0 and 1

**FIG. 2**

2-Pole, Size 00, 0 and 1

**FIG. 3**

2-Pole, Size 2 to 5

**FIG. 4**

3-Pole, Size 00 to 5

**FIG. 5**

4-Pole, Size 0, 1 and 2

**FIG. 6**

5-Pole, Size 0, 1 and 2

**FIG. 7**

2- and 3-Wire Control for Figure 1 to 5

**FIG. 8**

Separate Control for Figure 6
Type S AC Magnetic Contactors
Class 8502

Size 6, 3-Pole Contactor – Common Control
Class 8502 Type SH Series B

FIG. 1

START
STOP
3-WIRE
CONTROL
2-WIRE
CONTROL
HAND-OFF-AUTO
SELECTOR
SWITCH

"ON" PILOT LIGHT (120 V.)
ADD'L. N.C.
INTERLOCK
"OFF" PILOT LIGHT (120 V.)

DISCONNECTING MEANS, PROVIDED BY USER OR WITH CONTROLLER

WARNING: DO NOT GROUND SEC. OF TRANS.

SINGLE OR DUAL-VOLT. PRI. CONN. PER TRANSFORMER NAMEPLATE

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>

Elementary Diagram
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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</thead>
<tbody>
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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>
Class 8502 Type SJ Series A

Size 7, 3-Pole Contactor – Common Control

FIG. 1

START
STOP
3-WIRE CONTROL
2-WIRE CONTROL
2-WIRE CONTROL DEVICE
SELECTOR SWITCH

"ON" PILOT LIGHT (120V)

"OFF" PILOT LIGHT (120V)

WARNING: DO NOT GROUND SEC. OF TRANS.

NOTE: REMOVE JUMPER BETWEEN TERMINALS 3 & 4

SOLID STATE CONTROL MODULE

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>1600 A</td>
</tr>
<tr>
<td>Inverse-time circuit breaker</td>
<td>2000 A</td>
</tr>
</tbody>
</table>

Elementary Diagram
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>1600 A</td>
</tr>
<tr>
<td>Inverse-time circuit breaker</td>
<td>2000 A</td>
</tr>
</tbody>
</table>
IEC Contactors

IEC Contactors and Auxiliary Contact Blocks
(for Input Modules see page 42)

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="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
</tbody>
</table>

<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>Relay Interface Amplifier Module LA4 DF</td>
<td>Relay Interface Amplifier Module w/ Manual Override, LA4 DL</td>
<td>Solid State Interface Amplifier Module LA4 DW</td>
</tr>
</tbody>
</table>

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

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

3-Pole, 3-Phase Magnetic Starters, Size 00 to 3, Connected for Single Phase:
Class 8536 Type S

FIG. 3
Wiring Diagram
Elementary Diagram

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

* 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

* Marked “OL” if alarm contact is supplied

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

FIG. 3

Wiring Diagram

Elementary Diagram

Size 00 to 4

* Marked “OL” if alarm contact is supplied

FIG. 4

Wiring Diagram

Elementary Diagram

Size 5

* Marked “OL” if alarm contact is supplied

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

Marked “OL” if alarm contact is supplied
3-Pole, 3-Phase Magnetic Starters, Size 6 – Common Control
Class 8536/8538/8539 Type SH Series B

**FIG. 1**

- **START**
  - 2
- **STOP**
  - 1

3-WIRE CONTROL

2-WIRE CONTROL

2-WIRE CONTROL DEVICE

SELECTOR SWITCH

"ON" PILOT LIGHT (120V.)

"ON" PILOT LIGHT (120V.)

"OFF" PILOT LIGHT (120V.)

**NOTE:** REMOVE JUMPER BETWEEN TERMINALS 3 & 4

**ALARM (IF SUPPLIED)**

**COM.**

**MOTOR**

**DISCONNECTING MEANS, PROVIDED BY USER OR WITH CONTROLLER**

**L1**

**L2**

**L3**

**A1**

**A2**

**T1**

**T2**

**T3**

**C1**

**C2**

**SOLID-STATE CONTROL MODULE**

**WARNING:** DO NOT GROUND SEC. OF TRANS. SINGLE OR DUAL VOLT. PRL. CONN. PER TRANSFORMER NAMEPLATE

**30VA TRANSFORMER LOCATED UNDER TERMINAL BLOCK**

**A B C D E F G H**

**<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.**
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

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
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

* Marked “OL” if alarm contact is supplied

FIG. 2

Wiring Diagram
Elementary Diagram

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

* Marked “OL” if alarm contact is supplied

FIG. 3

Wiring Diagram
Elementary Diagram

Form F4T – Control Circuit Transformer and Primary Fuses

* Marked ‘OL’ if alarm contact is supplied

△ 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

Wiring Diagram
Elementary Diagram

Form S – Separate Control

Fig. 2

Wiring Diagram
Elementary Diagram

Form X – Additional Auxiliary Contacts

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

Fig. 3

Wiring Diagram
Elementary Diagram

Form F4T – Control Circuit Transformer and Primary Fuses
3-Pole, 3-Phase Magnetic Starters, Size 6 – Separate Control
Class 8536/8538/8539 Type SH Form S Series B

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

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
### State of Auxiliary Contacts for LD1

#### Auxiliary contact actuators

<table>
<thead>
<tr>
<th>Action</th>
<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>Contact open</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
</tr>
<tr>
<td>Contact closed</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
</tr>
</tbody>
</table>

#### Off

- 13 23 31
- 14 24 32

#### On, contactor open

- 13 23 31
- 14 24 32

#### On, contactor closed

- 13 23 31
- 14 24 32

#### Tripped on overload

- 13 23 31
- 14 24 32

#### Tripped on short circuit

- 13 23 31
- 14 24 32

#### Off after short circuit

- 13 23 31
- 14 24 32

#### Manual reset

- 13 23 31
- 14 24 32

**Legend:**
- Contact open
- Contact closed

---

**State of Auxiliary Contacts**

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

<table>
<thead>
<tr>
<th>Auxiliary contact actuators</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>Contact open</td>
<td>13 23 31</td>
<td>13 31 97</td>
<td>13 31 95</td>
<td>13 31 95</td>
<td>13 31 95</td>
<td>13 31 95</td>
</tr>
<tr>
<td>Contact closed</td>
<td>14 24 32</td>
<td>14 32 98</td>
<td>14 32 96</td>
<td>14 32 96</td>
<td>14 32 96</td>
<td>14 32 96</td>
</tr>
</tbody>
</table>

### Off

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

### On, contactor open

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

### On, contactor II closed

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

### On, contactor I closed

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

### Tripped on overload

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

### Tripped on short circuit

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

### Off after short circuit

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

### Manual reset

- Contact open: 13 23 31 14 24 32
- Contact closed: 95 97 96 98

Legend:
- ⬜ Contact open
- ⬝ Contact closed
### State of Auxiliary Contacts for LD4

#### Auxiliary contact actuators

<table>
<thead>
<tr>
<th>LD4</th>
<th>LA1-LC010</th>
<th>LA1-LC012</th>
<th>LA1-LC020</th>
<th>LA1-LC030</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13 23 31</td>
<td>16 18</td>
<td>06 08</td>
<td>96 98</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>15</td>
<td>05</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td>08</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>05</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 23 31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td></td>
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<td>13 23 31</td>
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<td>14 24 32</td>
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<td></td>
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<tr>
<td></td>
<td>13 23 31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Auxiliary contacts

- **Off + isolation**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **Off**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **On, contactor open**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **On, contactor closed**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **Tripped, on overload**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **Off, after overload**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **Tripped, on short circuit**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **Off, after short circuit**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98

- **Manual reset**
  - LA1-LC010: 13 23 31 16 18 06 08 96 98
  - LA1-LC012: 13 23 31 08 98
  - LA1-LC020: 13 23 31 98
  - LA1-LC030: 13 23 31 98
### Integral Self-Protected Starters

#### Integral 32 and 63

**State of Auxiliary Contacts**

#### FIG. 1: State of Auxiliary Contacts for LD5

<table>
<thead>
<tr>
<th>Auxiliary Contact Actuators</th>
<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>Off + isolation</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>Off</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>On, both contactors open</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>On, contactor open</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>On, contactor closed</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>Tripped on overload</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>Off, after overload</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>Tripped on short circuit</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>Off after short circuit</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
<tr>
<td>Manual reset</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>13 23 31</td>
<td>53 63</td>
</tr>
<tr>
<td></td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>14 24 32</td>
<td>54 64</td>
</tr>
</tbody>
</table>
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
Integral Self-Protected Starters

Wiring Diagrams

**Auxiliary Contact Blocks**

**FIG. 1**

For LD1 or LD4 and reverser LD5 (mounted on right)
LA1 LC010, LA1 LC012 and LA1 LC020

**FIG. 2**

For LD4 w/ isolating contacts (mounted on left)
LA1 LC030

**FIG. 3**

For reversing LD5 (mounted on left)
LA1 LC021

**FIG. 4**

Isolating contacts (mounted on left)
LA1 LC031

**Remote Reset Units**

**FIG. 5**

For starter and reverser already fitted with a block, LA1 LC010 or LA1 LC012.
LA1 LC052

**Trip Units**

**FIG. 6**

Use of the LA1 LC020 contact block prevents the mounting of trip or remote units
LA1 LC07**

**Interface Modules**

**FIG. 7**

LA1 LC180, LA1 LD180

**FIG. 8**

LA1 LC580, LA1 LD580
Add-on Blocks: LA1 LB0**

**FIG. 1**

Contactor breakers:
- LA1 LB015
- LA1 LB017
- LA1 LB019
- LA1 LB001

Contact diagram:
- Trip signal
- and  

For LD1 (mounted on right)

**FIG. 2**

For LD1 (mounted on left)

**FIG. 3**

For LD5 (mounted on left)

Time Delay Modules

**FIG. 4**

On Module
LA4 DT

**FIG. 5**

Off Module
LA4 DR

Control Module

**FIG. 6**

Auto-Man-Stop Module
LA4 DM

Interface Modules

**FIG. 7**

Solid State Module
LA4 DW

**FIG. 8**

Relay Module
LA4 DF

**FIG. 9**

Relay Module w/ Manual Override
LA4 DL

Voltage Converters: LA1 LC080 and LA1 LD080

**FIG. 10**

Control by supply switching 24 or 48V
For 24 or 48 V Supply

**FIG. 11**

110V
For 110 V Supply

**FIG. 12**

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

Size 0-4

FIG. 2

Wiring Diagram

Elementary Diagram

* Marked ‘OL’ if alarm contact is supplied

Size 5
Type S AC Combination Magnetic Starters
Class 8538 and 8539
3-Phase Additions and Special Features

3-Pole, 3-Phase Combination Starters w/ Control Circuit Transformer and Primary Fuses:
Class 8538 and 8539 Type S Form F4T

FIG. 1

Wiring Diagram

Elementary Diagram

Size 0-4

FIG. 2

Wiring Diagram

Elementary Diagram

Size 5

* Marked “OL” if alarm contact is supplied
Reduced Voltage Controllers
Class 8606
Autotransformer Type, Size 2-6

Reduced Voltage Autotransformer Controllers w/ Closed Transition Starting: Class 8606 Size 2-5

FIG. 1

Reduced Voltage Autotransformer Controller w/ Closed Transition Starting: Class 8606 Size 6

FIG. 2
Reduced Voltage Controllers
Class 8606
Autotransformer Type, Size 7

Reduced Voltage Autotransformer Controllers w/ Closed Transition Starting:
Class 8606 Size 7

FIG. 1

L1
L2
L3
CIRCUIT BREAKER
OR DISCONNECT SWITCH

R
R
R

1S
2S
2S

2S
2S
1S

1TR
1TR
1TR

MOTOR

SOLID STATE OVERLOAD RELAY

1CT
2CT
3CT
T1
T2
T3

PRI
SEC
PRI
SEC
PRI

(H1)
(H1)
(H1)

(X1)
(X2)
(X1)
(X2)
(X1)
(X2)

1S
2S
R

2WIRE CONTROL DEVICE (If used)

STOP
START
OL

GROUND

(If used)
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%
Wye-Delta Type Reduced Voltage Controllers, Size 6YΔ:
Class 8630

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

FPO
46-3
110%

Size 6YΔ Controller with Open-Transition Starting

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>1/2 Wye or Delta 6 Leads</td>
<td>T₁ T₂ T₃ T₇ T₈ T₉</td>
<td>2/3 Wye or Delta 6 Leads</td>
<td>T₁ T₂ T₇ T₈ T₉</td>
</tr>
<tr>
<td>1/2 Wye 9 Leads [¹]</td>
<td>T₁ T₂ T₃ T₇ T₈ T₉</td>
<td>2/3 Wye 9 Leads [¹]</td>
<td>T₁ T₂ T₇ T₈ T₉</td>
</tr>
<tr>
<td>1/2 Delta 9 Leads [²]</td>
<td>T₁ T₈ T₃ T₆ T₂ T₉</td>
<td>2/3 Delta 9 Leads [²]</td>
<td>T₁ T₄ T₉ T₆ T₂ T₃</td>
</tr>
</tbody>
</table>

[¹] Connect terminals T₄, T₅ and T₆ together at terminal box.  
[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.
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

FIG. 1
Non-Reversing Wound-Rotor Motor Controller w/ 3 Points of Acceleration
Class 8650

FIG. 2
Reversing Wound-Rotor Motor Controller w/ 3 Points of Acceleration
Class 8651
ALPHA PAK® Solid State Reduced Voltage Starters:
Class 8660 Type MD-MG

**FIG. 1**
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

*OT is a switch that opens when an overtemperature condition exists (Type MFO and MGO only)*
Solid State Reduced Voltage Controllers
Class 8660
Type MH, MJ, MK and MM

FIG. 1
Type MH (200 A), MJ (320 A), MK (500 A) and MM (750 A)

FIG. 2
Type MH (200 A) w/ Shorting Contactor

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

FIG. 2
Type MJ (320 A), MK (500 A) and MM (750 A) w/ Isolation Contactor and Shorting Contactor
Reversing Starters, 2- and 3-Pole, Size 00-1:
Class 8736 Type S

FIG. 1
Wiring Diagram
2-Pole, w/ Single Phase, 3-Lead Motor

HORIZONTAL MOUNTING ARRANGEMENT
* Marked "OL" if alarm contact is supplied

FIG. 2
Wiring Diagram
3-Pole, w/ Single Phase, 4-Lead Repulsion-Induction Motor

HORIZONTAL MOUNTING ARRANGEMENT
* Marked "OL" if alarm contact is supplied

FIG. 3
Wiring Diagram
3-Pole, w/ Single Phase, 4-Lead Capacitor or Split-Phase Motor

HORIZONTAL MOUNTING ARRANGEMENT
* Marked "OL" if alarm contact is supplied
**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

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

Wiring Diagram

Elementary Diagram

---

**FIG. 2**

Wiring Diagram

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

Wiring Diagram

Elementary Diagram

---

**FIG. 3**

Wiring Diagram

Size 5, 3-Pole, 3-Phase

Wiring Diagram

Elementary Diagram

---

*Marked ‘OL’ if alarm contact is supplied*

---

HORIZONTAL MOUNTING ARRANGEMENT

---

Motor
Type S AC 2-Speed Magnetic Starters
Class 8810

Starters for 2-Speed, 2-Winding (Separate Winding), 3-Phase Motors:
Class 8810 Type S

FIG. 1

Wiring Diagram

Elementary Diagram

Size 0-4

FIG. 2

Size 5 Wiring Diagram

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

FIG. 3

Wiring Diagram

Elementary Diagram

Size 0-2

* Marked ‘OL’ if alarm contact is supplied
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

Wiring Diagram
Elementary Diagram

Size 0-2

FIG. 4

FIG. 5

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 R1</th>
<th>Compelling Relay, Requiring Motor Starting in Low Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIG. 1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form R2</th>
<th>Accelerating Relay, Providing Timed Acceleration to Selected Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIG. 2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form R3</th>
<th>Decelerating Relay, w/ Time Delay During Transfer from Higher to Lower Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIG. 3</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Form R2R3</th>
<th>Accelerating Relay and Decelerating Relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIG. 4</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Form R1R3</th>
<th>Compelling Relay and Decelerating Relay</th>
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</thead>
<tbody>
<tr>
<td>FIG. 5</td>
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</table>

<table>
<thead>
<tr>
<th>Form A10C</th>
<th>Hand-Off-Auto Selector Switch and High-Low Push Button</th>
</tr>
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<tbody>
<tr>
<td>FIG. 6</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Form CC17</th>
<th>Hand-Off-Auto Selector Switch and High-Low Selector Switch</th>
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<tbody>
<tr>
<td>FIG. 7</td>
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</table>

<table>
<thead>
<tr>
<th>Form A10CR1</th>
<th>Hand-Off-Auto Selector Switch and High-Low Push Button w/ Compelling Relay/Timer</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIG. 8</td>
<td></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**

**FIG. 1**

High-Low-Off-Auto Selector Switch

**Form CC17 R2R3**

**FIG. 2**

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

---

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

<table>
<thead>
<tr>
<th>FIG. 3</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
<td>L2</td>
<td>Open</td>
<td>Together</td>
</tr>
<tr>
<td>Low</td>
<td>T1</td>
<td>T2</td>
<td>T3, T4</td>
<td>—</td>
</tr>
<tr>
<td>High</td>
<td>T3</td>
<td>T4</td>
<td>T1, T2</td>
<td>—</td>
</tr>
</tbody>
</table>

2 Windings

<table>
<thead>
<tr>
<th>FIG. 6</th>
<th>T1</th>
<th>COM</th>
<th>T4</th>
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<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
<td>L2</td>
<td>Open</td>
</tr>
<tr>
<td>Low</td>
<td>COM</td>
<td>T1</td>
<td>T4</td>
</tr>
<tr>
<td>High</td>
<td>COM</td>
<td>T1</td>
<td>T4</td>
</tr>
</tbody>
</table>

1 Winding

---

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

<table>
<thead>
<tr>
<th>FIG. 9</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
</tr>
<tr>
<td>Low</td>
<td>T3</td>
</tr>
<tr>
<td>High</td>
<td>T6</td>
</tr>
</tbody>
</table>

1 Winding, Constant Horsepower

<table>
<thead>
<tr>
<th>FIG. 10</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
</tr>
<tr>
<td>Low</td>
<td>T3</td>
</tr>
<tr>
<td>High</td>
<td>T6</td>
</tr>
</tbody>
</table>

1 Winding, Constant Torque

<table>
<thead>
<tr>
<th>FIG. 11</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
</tr>
<tr>
<td>Low</td>
<td>T1</td>
</tr>
<tr>
<td>High</td>
<td>T6</td>
</tr>
</tbody>
</table>

1 Winding, Variable Torque

---

**Separate Windings**

<table>
<thead>
<tr>
<th>FIG. 12</th>
<th>T1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
</tr>
<tr>
<td>Low</td>
<td>T3</td>
</tr>
<tr>
<td>High</td>
<td>T11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG. 13</th>
<th>T1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
</tr>
<tr>
<td>Low</td>
<td>T3</td>
</tr>
<tr>
<td>High</td>
<td>T11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FIG. 14</th>
<th>T1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>L1</td>
</tr>
<tr>
<td>Low</td>
<td>T3</td>
</tr>
<tr>
<td>High</td>
<td>T11</td>
</tr>
</tbody>
</table>
Multispeed Motor Connections: 3-Phase, 2-Speed Motors

**FIG. 1**

- Speed: L1, L2, L3, Open
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T13, T17

Separate Windings

**FIG. 2**

- Speed: L1, L2, L3, L4, Open
- Low: T1, T2, T3, T5, T6, T7, T13, T17
- High: T11, T12, T14, T15

2-Phase, 1 Winding, Variable Torque

**FIG. 3**

- Speed: L1, L2, L3, L4, Open
- Low: T1, T2, T3, T5, T6, T7, T13, T17
- High: T11, T12, T14, T15

2-Phase, Separate Windings

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

**FIG. 4**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T13, T17

2 Windings, Constant Torque

**FIG. 5**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Variable Torque

**FIG. 6**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Variable Torque

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

**FIG. 7**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T13, T17

2 Windings, Constant Torque

**FIG. 8**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Variable Torque

**FIG. 9**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Variable Torque

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

**FIG. 10**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T13, T17

2 Windings, Constant Horsepower

**FIG. 11**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Constant Horsepower

**FIG. 12**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Constant Torque

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

**FIG. 13**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T13, T17

2 Windings, Constant Torque

**FIG. 14**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Variable Torque

**FIG. 15**

- Speed: L1, L2, L3, Open Together
- Low: T1, T2, T3, T7, T13, T17
- High: T11, T12, T14, T15

2 Windings, Variable Torque
Programmable Lighting Controllers
Class 8865

Programmable Lighting Controller:
Class 8865 Type TC12

FIG. 1

Demand Input

INPUTS

RELAY OUTPUT CONNECTIONS CIRCUITS 1-6

RELAY OUTPUT CONNECTIONS CIRCUITS 7-12

24 VAC INPUT
Load Connections for AC Lighting Contactors: Class 8903

**FIG. 1**

1-Phase, 2-Wire, Single Load

\[ V_{load} = V_{line-to-line} \]

**FIG. 2**

1-Phase, 2-Wire, Multiple Loads

\[ V_{load} = V_{line-to-line} \]

**FIG. 3**

1-Phase, 3-Wire, Loads Connected Line-to-Neutral

\[ V_{load} = V_{line-to-neutral} \]

**FIG. 4**

1-Phase, 3-Wire, Load Connected Line-to-Line

\[ V_{load} = V_{line-to-line} \]

**FIG. 5**

3-Phase, 3-Wire, Wye-Connected Load

\[ V_{load} = \frac{V_{line-to-line}}{1.732} \]

**FIG. 6**

3-Phase, 3-Wire, Delta-Connected Load

\[ V_{load} = V_{line-to-line}, \quad I_{load} = I_{contacts} \]

**FIG. 7**

3-Phase, 4-Wire, Loads Connected Line-to-Neutral

\[ V_{load} = V_{line-to-neutral} \]

**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.
**AC Lighting Contactors**
Class 8903
Control Circuit Connections

Control Circuit Connections for Electrically-Held Contactors:
Class 8903 Type L and S

**FIG. 1**
On-Off Push Button (Form A12)

**FIG. 2**
Direct Control from Pilot Device

**FIG. 3**
On-Off Selector Switch (Form C6)

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

**FIG. 5**
On-Off Push Button (Form A3)

**FIG. 6**
On-Off Selector Switch (Form C6)

**FIG. 7**
Control from 2-Pole Pilot Device

**FIG. 8**
1-Pole Pilot Device w/ CR relay (Form R6)
QWIK-STOP® Electronic Motor Brake:
Class 8922

Type ETB10, ETB18 and ETBS18 w/ Internal Braking Contactor

Type ETB20-ETB800 and ETBS20-ETBS800
Electronic Motor Brakes, Duplex Motor Controllers and Fiber Optic Transceivers
Class 8922, 8941 and 9005

QWIK-STOP® Electronic Motor Brake: Class 8922 Type ETBC

AC Duplex Motor Controller: Class 8941

Fiber Optic Transceiver: Class 9005

[Diagram of QWIK-STOP® Electronic Motor Brake: Class 8922 Type ETBC]

[Diagram of AC Duplex Motor Controller: Class 8941]

[Diagram of Fiber Optic Transceiver: Class 9005]

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

Semiconductor fuses.

FIG. 1

FIG. 2

FIG. 3

FIG. 4

QWIK-STOP is a registered trademark of Square D.

Elementary Diagram for Duplex Motor Controller w/ Electric Alternator

Transceiver, Front View

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 PUSH BUTTON, SELECTOR SWITCH, LIMIT SWITCH, ETC.
FIBER OPTIC TRANSCIEVER
CLASS 9005 TYPE FT
BOUNDARY SEAL TO BE IN ACCORDANCE WITH ARTICLE 501-5 OF THE NATIONAL ELECTRICAL CODE

Location
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.

2-Wire AC, Single Device Operation

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.

AC Emitter

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

4-Wire DC, Single Device Operation, 10-30 VDC, 250 mA Max. Load

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.

DC Emitter

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

FIG. 5
12-24 VDC, Sinking (NPN)
These switches are light operated only.
Beam broken = load deenergized
Beam unbroken = load energized

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

FIG. 7
120 VAC, Emitter Only

Photoelectric Switches:
Class 9006 Type PEA120 (Obsolete)

FIG. 8
Diagram shows contact arrangement with beam broken.

120 VAC Amplifier

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)
# Inductive Proximity Sensors

**XS, XSC, XSF and XSD**

## XS Tubular Inductive Proximity Sensors

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Schematic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1" alt="Schema" /></td>
<td>2-Wire DC, Non-Polarized</td>
</tr>
<tr>
<td>2</td>
<td><img src="image2" alt="Schema" /></td>
<td>2-Wire AC/DC, Programmable</td>
</tr>
<tr>
<td>3</td>
<td><img src="image3" alt="Schema" /></td>
<td>3-Wire DC, N.O. or N.C.</td>
</tr>
<tr>
<td>4</td>
<td><img src="image4" alt="Schema" /></td>
<td>3-Wire DC, N.O. and N.C., Complementary</td>
</tr>
</tbody>
</table>

## XSC Rectangular Inductive Proximity Sensors

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Schematic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><img src="image5" alt="Schema" /></td>
<td>2-Wire DC, Non-Polarized</td>
</tr>
<tr>
<td>6</td>
<td><img src="image6" alt="Schema" /></td>
<td>2-Wire AC, Programmable</td>
</tr>
<tr>
<td>7</td>
<td><img src="image7" alt="Schema" /></td>
<td>2-Wire AC/DC, Programmable</td>
</tr>
<tr>
<td>8</td>
<td><img src="image8" alt="Schema" /></td>
<td>3-Wire DC, Selectable PNP/NPN, N.O./N.C.</td>
</tr>
</tbody>
</table>

## XSF Rectangular Inductive Proximity Sensors

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Schematic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td><img src="image9" alt="Schema" /></td>
<td>2-Wire AC, Programmable N.O. or N.C.</td>
</tr>
<tr>
<td>10</td>
<td><img src="image10" alt="Schema" /></td>
<td>3-Wire DC, N.O. or N.C.</td>
</tr>
</tbody>
</table>

## XSD Rectangular Inductive Proximity Sensors

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Schematic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td><img src="image11" alt="Schema" /></td>
<td>2-Wire DC, Non-Polarized</td>
</tr>
<tr>
<td>12</td>
<td><img src="image12" alt="Schema" /></td>
<td>2-Wire AC, Programmable N.O. or N.C.</td>
</tr>
<tr>
<td>13</td>
<td><img src="image13" alt="Schema" /></td>
<td>3-Wire DC, N.O. or N.C.</td>
</tr>
</tbody>
</table>
**Inductive and Capacitive Proximity Sensors XS and XTA**

**XS Tubular Inductive Proximity NAMUR Sensors**

*FIG. 1*

Object present → BN-1+ → Hi = 1K → 7...12V DC → BU-2

Object absent → BN-1+ → I < 1mA → 7...12V DC → BU-2

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

With XZD Power Supply/Relay Amplifier Unit

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

*FIG. 3*  

Output current | Value of Load R (max.)
---|---
@ 24 V:  
0-10 mA | 1800 Ω
0-16 mA | 1125 Ω
@ 48 V:  
0-10 mA | 4200 Ω

2-Wire DC

*FIG. 4*  

Output current | Value of Load R (max.)
---|---
@ 24 V:  
4-14 mA | 640 Ω
4-20 mA | 450 Ω
@ 48 V:  
4-14 mA | 2350 Ω

3-Wire DC

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

**XTA Tubular Capacitive Proximity Sensors**

*FIG. 5*  

BN → L1 → L2 → Gn*

* Ground for XTA A115 only

2-Wire AC

*FIG. 6*  

BN → BU → NPN

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
- SGB 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, SG1 8004, SGA 8005 and SGA 8040
- SG0 L8003 and SG1 L8004
- SGC 8027 and SGC 8025

#### SG Magnet Actuated Proximity Sensors, Tubular Style

<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>
</tbody>
</table>

- SG0 B8114, SG1 B8147, SG0 BL8114, SG0 BL8147 and SGC 8142-T -P
- SGC 8058 and SGC 8181

#### SG Magnet Actuated Proximity Sensors, Maintained Contact

<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

#### ST Grounded Probe Switch

<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

- 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. 13</th>
<th>FIG. 14</th>
<th>FIG. 15</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image13.png" alt="Diagram" /></td>
<td><img src="image14.png" alt="Diagram" /></td>
<td><img src="image15.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

- 2-Wire AC
- AC Emitter
- DC Emitter
### Photoelectric Sensors

#### XUM Miniature High Performance Photoelectric Sensors

**FIG. 1**
- **Emitter**: DC 3 wire
- **PNP output**: Prog. - Light, - Dark
- **NPN output**: Prog. - Light, - Dark

#### XUH and XUG Medium Range Photoelectric Sensors

**FIG. 3**
- **5-Wire AC**
- **Connectors**: N/C, N/O, COMMON

#### XUL Subcompact Photoelectric Sensors

**FIG. 4**
- **Emitter DC**
- **Connector, PNP output**: Prog. - Light, - Dark
- **NPN output**: Prog. - Light, - Dark
- **DC connector**: Prog. Output

#### XUJ Compact High Performance Photoelectric Sensors

**FIG. 6**
- **5-Wire Relay, AC/DC**
- **AC/DC Microchange DC Connector**

**FIG. 7**
- **For dark mode connect Brown wire to terminal 2**
- **For NO contact connect White wire to terminal 4**

**FIG. 8**
- **PNP**: Light 3, Light 2
- **NPN**: Light 3, Light 2

**FIG. 9**
- **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

FIG. 2
XUE A

FIG. 3
XUE H, NPN

FIG. 4
XUE H, PNP

FIG. 5
XUE F

FIG. 6
XUE T

XUR Color Registration Photoelectric Sensors

FIG. 7
PNP

FIG. 8
NPN

XUD Amplifiers

FIG. 9
XUD H

FIG. 10
XUD J

XUG Amplifiers

FIG. 11
for XUF N Plastic Fiber Optics – DC models

XUE S Security Light Barriers

FIG. 12
Emitter

FIG. 13
Receiver
# Limit Switches

Class 9007

## Contact Forms for Class 9007 Limit Switches

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Form</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>SPST-NO</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>SPST-NC</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>SPDT</td>
</tr>
<tr>
<td></td>
<td>AA</td>
<td>DPST-NO</td>
</tr>
<tr>
<td></td>
<td>BB</td>
<td>DPST-NC</td>
</tr>
<tr>
<td></td>
<td>CC</td>
<td>DPDT</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>SPST-NO-DB</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>SPST-NC-DB</td>
</tr>
<tr>
<td></td>
<td>Z</td>
<td>SPDT-DB</td>
</tr>
<tr>
<td></td>
<td>XX</td>
<td>DPST-NO-DB</td>
</tr>
<tr>
<td></td>
<td>YY</td>
<td>DPST-NC-DB</td>
</tr>
<tr>
<td></td>
<td>ZZ</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

[^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.

### FIG. 6

Type C Reeds

## Limit Switches: Class 9007 Type XA

### FIG. 7

Type XA73 Reeds

### FIG. 8

Type XA75 Reeds
Limit Switches:
Class 9007 Type AW

FIG. 1
MUST BE SAME POLARITY
MUST BE SAME POLARITY

CW Operation Only
CCW Operation Only

Type AW12 and AW14

FIG. 2
1 A 0
MUST BE SAME POLARITY
1 A 0
MUST BE SAME POLARITY

CW Operation Only
CCW Operation Only

Type AW18

FIG. 3
MUST BE SAME POLARITY
MUST BE SAME POLARITY

2 4
CW Operation Only
2 4
CCW Operation Only

Type AW16

w/ Lever Arm Opposite Conduit Hole

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

FIG. 4
1 3
MUST BE SAME POLARITY
1 3
MUST BE SAME POLARITY

2 4
CW Operation Only
2 4
CCW Operation Only

Type AW19

w/ Lever Arm Opposite Conduit Hole

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

FIG. 5
MUST BE SAME POLARITY
2 4
CW Operation Only
2 4
CCW Operation Only

Type AW32, AW34, AW42 and AW44

FIG. 6
MUST BE SAME POLARITY

2 4
Type AW36 and AW46

FIG. 7
MAY BE OPPOSITE POLARITY

2 4
Type AW38 and AW48

FIG. 8
2 4
Type AW39 and AW49

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

FIG. 9
BROWN
BLACK
BLUE
LOAD

V SUPPLY 10 TO 30 VDC

Type SGS1DK

FIG. 10
SWITCH

BROWN
BLUE

POWER SUPPLY
LOGIC UNIT

* Connect up to 3 switches for series operation. Unused inputs must be connected to +Vs for proper operation.

Type SGP1
Limit Switches and Safety Interlocks

XCK and MS

### XCK Limit Switches

<table>
<thead>
<tr>
<th>FIG. 1</th>
<th>FIG. 2</th>
<th>FIG. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>21</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>22</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>No polarity</td>
<td>11, 13 and 21, 23</td>
<td>No polarity</td>
</tr>
<tr>
<td>SPDT, 1 N.O. and 1 N.C.</td>
<td>SPDT, 2 N.O. and 2 N.C.</td>
<td>SPDT, Isolated N.O. and N.C.</td>
</tr>
<tr>
<td>Positive Opening, Snap Action</td>
<td>Same polarity each pole</td>
<td>Positive Opening, Slow-Make Slow-Break</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>21</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>22</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>No polarity</td>
<td>LED 24 VDC</td>
<td>AC</td>
</tr>
<tr>
<td>SPDT, Positive Opening, Slow-Make Slow-Break</td>
<td>24 VDC</td>
<td>L1</td>
</tr>
<tr>
<td>LED 24 VDC</td>
<td>Orange</td>
<td>Orange</td>
</tr>
<tr>
<td>X3</td>
<td>LOAD</td>
<td>X2</td>
</tr>
<tr>
<td>0 V</td>
<td></td>
<td></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>21</td>
<td>22</td>
<td>11</td>
<td>12</td>
<td>X1</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td>13</td>
<td>14</td>
<td>X2</td>
</tr>
<tr>
<td>Zb</td>
<td>Zb</td>
<td>Za</td>
<td>Indicator Light, Direct</td>
<td></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></td>
<td></td>
</tr>
</tbody>
</table>

### MS Miniature Limit Switches

<table>
<thead>
<tr>
<th>FIG. 12</th>
<th>FIG. 13</th>
</tr>
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<tbody>
<tr>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>White</td>
<td>Orange</td>
</tr>
<tr>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>SPST</td>
<td>SPDT</td>
</tr>
</tbody>
</table>
Pressure and Temperature Switches:
Class 9012 and 9025 Type G

- FIG. 1: Machine Tool, SPDT, 1 N.O. and 1 N.C.
- FIG. 2: Machine Tool, DPDT, 2 N.O. and 2 N.C.
- FIG. 3: Industrial, SPST, 1 N.O. and 1 N.C.

- FIG. 4: Machine Tool, SPDT, 1 N.O. and 1 N.C. w/ Form H10
- FIG. 5: Machine Tool, SPDT, 1 N.O. and 1 N.C. w/ Form H11

Commercial Pressure Switches:
Class 9013 Type CS

- FIG. 6: Acceptable Wiring Schematics

Pressure Transducers:
Class 9022 Type PTA and PTB

- FIG. 7: Type PTA, 2-Wire
- FIG. 8: Type PTA, 3-Wire
- FIG. 9: Type PTA, 4-Wire

- FIG. 10: Type PTB, 2-Wire
- FIG. 11: Type PTB, 3-Wire
- FIG. 12: Type PTB, 4-Wire
Level Sensors:  
Class 9034 Types LSD and LSV

**FIG. 1**  
Wiring Diagram  
Elementary Diagram

- Fill Cycle, Tank Full
- Output selection of both sensors in maximum (N.C. when absent). Both devices at max. setting.

**FIG. 2**  
Wiring Diagram  
Elementary Diagram

- Drain Cycle, Tank Empty
- Output selection of both sensors in minimum (N.O. when absent). Both devices at min. setting.

Electric Alternators:  
Class 9039 Type X

**FIG. 3**

- 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</th>
<th>FIG.</th>
<th>Type</th>
<th>FIG.</th>
<th>Type</th>
<th>FIG.</th>
<th>Type</th>
<th>FIG.</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AO10E</td>
<td>2</td>
<td>AO10D</td>
<td>3</td>
<td>AO20E</td>
<td>4</td>
<td>AO20D</td>
<td>5</td>
<td>AO110DE</td>
</tr>
<tr>
<td>6</td>
<td>AO120DE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>AO11E</td>
<td>8</td>
<td>AO11D</td>
<td>9</td>
<td>AO21E</td>
<td>10</td>
<td>AO21D</td>
<td>11</td>
<td>AO111DE</td>
</tr>
<tr>
<td>12</td>
<td>AO121DE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>AO12E</td>
<td>14</td>
<td>AO12D</td>
<td>15</td>
<td>AO22E</td>
<td>16</td>
<td>AO22D</td>
<td>17</td>
<td>AO112DE</td>
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<tr>
<td>18</td>
<td>AO122DE</td>
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<tr>
<td>19</td>
<td>AO210DE</td>
<td>20</td>
<td>AO211DE</td>
<td>21</td>
<td>AO212DE</td>
<td>22</td>
<td>AO220DE</td>
<td>23</td>
<td>AO221DE</td>
</tr>
<tr>
<td>24</td>
<td>AO222DE</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</table>

## Type HO

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

## Types B and C

<table>
<thead>
<tr>
<th>FIG.</th>
<th>Type</th>
<th>FIG.</th>
<th>Type</th>
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</thead>
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<tr>
<td>27</td>
<td>Off Delay</td>
<td>28</td>
<td>On Delay</td>
</tr>
<tr>
<td></td>
<td>Type B</td>
<td></td>
<td>Type C</td>
</tr>
</tbody>
</table>
Pneumatic Timing Relays and Solid State Industrial Timing Relays
Class 9050

Class 9050 Pneumatic Timing Relays: Typical Elementary Diagrams

FIG. 1
L1 INITIATING CONTACT TR L2
TR NOTC
TR TR LOAD 2
On Delay

FIG. 2
L1 START TR TR TR TR TR LOAD
L2
FIG. 3
L1 INITIATING CONTACT TR (ON DELAY) TR LOAD
L2
Interval, Momentary Start

FIG. 4
L1 INITIATING CONTACT TR L2
TR NOTC
TR TR LOAD 2
Off Delay

FIG. 5
L1 INITIATING CONTACT TR INTR TR (ON DELAY) TR LOAD
L2
Interval, Maintained Start

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

FIG. 6
L1 L1 TR TR L2
P SOLID STATE INITIATING CONTACT TIMING RELAY
TR LOAD
External Initiating Contact
Elementary Diagram

FIG. 7
L1 AC Supply Voltage L2
L1 L2 C1 C3 Timed Contacts
C2 C4 Instantaneous Contacts (optional)
C5 C7
C6 C8
External Initiating Contact
Wiring Diagram

Solid State Industrial Timing Relays: Class 9050 Type FT

FIG. 8
L1 L1 TR TR L2
P SOLID STATE INITIATING CONTACT TIMING RELAY
TR LOAD
External Initiating Contact
Elementary Diagram

FIG. 9
L1 AC Supply Voltage L2
L1 L2 C1 C3 Timed Contacts
C2 C4 Instantaneous Contacts (optional)
C5 C7
C6 C8
External Initiating Contact
Wiring Diagram
Solid State Industrial Timing Relays:
Class 9050 Type JCK

FIG. 1
Control Power
Polarity markings are for DC units only. JCK 90 is AC only.
Type JCK 11-19, 31-39 and 51-60

FIG. 2
External Initiating Contact
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>Yes</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dust, lint, fibers and flyings</td>
<td>...</td>
<td>...</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>Hosedown and splashing water</td>
<td>...</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Oil and coolant seepage</td>
<td>...</td>
<td>...</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>Oil and coolant spraying and splashing</td>
<td>...</td>
<td>...</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>Corrosive agents</td>
<td>...</td>
<td>...</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>Rain, snow and sleet[^4]</td>
<td>...</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Windblown dust</td>
<td>...</td>
<td>Yes</td>
<td>...</td>
<td>[^5]</td>
<td>Yes</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></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen, manufactured gas</td>
<td>I</td>
<td>B</td>
<td>NEMA Type 7</td>
</tr>
<tr>
<td>Ethyl ether, ethylene, cyclopropane</td>
<td>I</td>
<td>C</td>
<td>Yes</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>
</tr>
<tr>
<td>Metal dust</td>
<td>II</td>
<td>E</td>
<td>...</td>
</tr>
<tr>
<td>Carbon black, coal dust, coke dust</td>
<td>II</td>
<td>F</td>
<td>...</td>
</tr>
<tr>
<td>Flour, starch, grain dust</td>
<td>II</td>
<td>G</td>
<td>...</td>
</tr>
</tbody>
</table>

[^1] As described in Article 500 of the National Electrical Code.
Table 8 Conductor Ampacity based on NEC Table 310-16

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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insulated Copper</td>
<td>THHW, THW, RW, USE</td>
<td>THWN, XHHW</td>
<td>Insulated Copper</td>
<td>THHW, THW, RW, USE</td>
<td>THHN, XHHW</td>
</tr>
<tr>
<td></td>
<td>Conduit</td>
<td>Conduit</td>
<td>Conduit</td>
<td>Conduit</td>
<td>Conduit</td>
<td>Conduit</td>
</tr>
<tr>
<td>†14</td>
<td>20</td>
<td>...</td>
<td>1/2</td>
<td>1/2</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>†12</td>
<td>25</td>
<td>...</td>
<td>1/2</td>
<td>1/2</td>
<td>†12</td>
<td>20</td>
</tr>
<tr>
<td>†10</td>
<td>35</td>
<td>...</td>
<td>1/2</td>
<td>1/2</td>
<td>†10</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
<td>3/4</td>
<td>1</td>
<td>1/2 [3]</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>65</td>
<td>1</td>
<td>3/4</td>
<td>1/2 [4]</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>85</td>
<td>1-1/4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>1-1/4</td>
<td>1</td>
<td>1-1/4</td>
<td>3</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>115</td>
<td>1-1/4</td>
<td>1</td>
<td>1-1/4</td>
<td>2</td>
<td>90</td>
</tr>
<tr>
<td>1</td>
<td>130</td>
<td>1-1/4</td>
<td>1</td>
<td>1-1/2</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>1/0</td>
<td>150</td>
<td>1-1/2</td>
<td>2</td>
<td>1-1/2</td>
<td>1/0</td>
<td>120</td>
</tr>
<tr>
<td>2/0</td>
<td>175</td>
<td>1-1/2</td>
<td>2</td>
<td>1-1/2</td>
<td>2/0</td>
<td>135</td>
</tr>
<tr>
<td>3/0</td>
<td>200</td>
<td>2</td>
<td>1-1/2</td>
<td>3</td>
<td>3/0</td>
<td>155</td>
</tr>
<tr>
<td>4/0</td>
<td>230</td>
<td>2</td>
<td>2-1/2</td>
<td>4</td>
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<td>3</td>
<td>2-1/2</td>
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<td>350</td>
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<td>400</td>
<td>335</td>
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<td>2-1/2</td>
<td>3</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>500</td>
<td>380</td>
<td>3</td>
<td>3-1/2</td>
<td>3</td>
<td>500</td>
<td>500</td>
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<tr>
<td>600</td>
<td>420</td>
<td>3</td>
<td>3-1/2</td>
<td>3</td>
<td>600</td>
<td>600</td>
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<tr>
<td>700</td>
<td>460</td>
<td>3-1/2</td>
<td>4</td>
<td>3-1/2</td>
<td>700</td>
<td>700</td>
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<td>750</td>
<td>475</td>
<td>3-1/2</td>
<td>4</td>
<td>3-1/2</td>
<td>750</td>
<td>750</td>
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<tr>
<td>800</td>
<td>490</td>
<td>3-1/2</td>
<td>4</td>
<td>3-1/2</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>900</td>
<td>520</td>
<td>4-1/2</td>
<td>4</td>
<td>4-1/2</td>
<td>900</td>
<td>900</td>
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<tr>
<td>1000</td>
<td>545</td>
<td>4-1/2</td>
<td>5</td>
<td>4-1/2</td>
<td>1000</td>
<td>1000</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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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>
</tr>
</thead>
<tbody>
<tr>
<td>21-25</td>
<td>1.05</td>
<td>1.04</td>
<td>70-77</td>
</tr>
<tr>
<td>26-30</td>
<td>1.00</td>
<td>1.00</td>
<td>78-86</td>
</tr>
<tr>
<td>31-35</td>
<td>.94</td>
<td>.96</td>
<td>87-95</td>
</tr>
<tr>
<td>36-40</td>
<td>.88</td>
<td>.91</td>
<td>96-104</td>
</tr>
<tr>
<td>41-45</td>
<td>.82</td>
<td>.87</td>
<td>105-113</td>
</tr>
<tr>
<td>46-50</td>
<td>.75</td>
<td>.82</td>
<td>114-122</td>
</tr>
<tr>
<td>51-55</td>
<td>.67</td>
<td>.76</td>
<td>123-131</td>
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<tr>
<td>56-60</td>
<td>.58</td>
<td>.71</td>
<td>132-140</td>
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<td>61-70</td>
<td>.33</td>
<td>.58</td>
<td>141-158</td>
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<tr>
<td>71-80</td>
<td>...</td>
<td>.41</td>
<td>159-176</td>
</tr>
</tbody>
</table>

### Table 10: Adjustment Factors

<table>
<thead>
<tr>
<th>No. of Current-Carrying Inductors</th>
<th>Values in Tables as Adjusted for Ambient Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-6</td>
<td>80%</td>
</tr>
<tr>
<td>7-9</td>
<td>70%</td>
</tr>
<tr>
<td>10-20</td>
<td>50%</td>
</tr>
<tr>
<td>21-30</td>
<td>45%</td>
</tr>
<tr>
<td>31-40</td>
<td>40%</td>
</tr>
<tr>
<td>41 and above</td>
<td>35%</td>
</tr>
</tbody>
</table>

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

### 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.

### Table 11: Ratings for 120/240 V, 3-Wire, Single-Phase Dwelling Services – see NEC 310-16 Note 3

<table>
<thead>
<tr>
<th>Rating (A)</th>
<th>100</th>
<th>110</th>
<th>125</th>
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<th>250</th>
<th>300</th>
<th>350</th>
<th>400</th>
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<td>Copper</td>
<td>4 AWG</td>
<td>3 AWG</td>
<td>2 AWG</td>
<td>1 AWG</td>
<td>1/0 AWG</td>
<td>2/0 AWG</td>
<td>3/0 AWG</td>
<td>4/0 AWG</td>
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<td>350 kcmil</td>
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<td>2 AWG</td>
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<td>600 kcmil</td>
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**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>
<thead>
<tr>
<th>AWG Size</th>
<th>Conducteur dia. (mm)</th>
<th>Conducteur dia. (in)</th>
<th>Resistance @ 20 °C (68 °F) Ohm per ft</th>
<th>Resistance @ 20 °C (68 °F) Ohm per m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>Ohm per ft</td>
<td>Ohm per m</td>
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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 1000</td>
</tr>
<tr>
<td>KVA</td>
<td>I x E</td>
<td>I x E x 1.73</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</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>
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<tbody>
<tr>
<td>00</td>
<td>9</td>
<td>1-1/2</td>
<td>1-1/2</td>
<td>1-1/2</td>
<td>2</td>
<td>11</td>
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<tr>
<td>0</td>
<td>18</td>
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<td>3</td>
<td>5</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>1</td>
<td>27</td>
<td>7-1/2</td>
<td>7-1/2</td>
<td>10</td>
<td>10</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
<td>10</td>
<td>15</td>
<td>25</td>
<td>25</td>
<td>52</td>
</tr>
<tr>
<td>3</td>
<td>90</td>
<td>25</td>
<td>30</td>
<td>50</td>
<td>50</td>
<td>104</td>
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<tr>
<td>4</td>
<td>135</td>
<td>40</td>
<td>50</td>
<td>75</td>
<td>100</td>
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<tr>
<td>5</td>
<td>270</td>
<td>75</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>311</td>
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<tr>
<td>6</td>
<td>540</td>
<td>150</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>621</td>
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<tr>
<td>7</td>
<td>810</td>
<td>—</td>
<td>300</td>
<td>—</td>
<td>600</td>
<td>932</td>
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</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 15  Ratings for 3-Phase, Single-Speed, Full-Voltage Magnetic Controllers for Plug-Stop, Plug-Reverse or Jogging Duty**

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<th></th>
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<th></th>
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</thead>
<tbody>
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<td>1-1/2</td>
<td>1-1/2</td>
<td>2</td>
<td>21</td>
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<tr>
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<td>3</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
<td>7-1/2</td>
<td>10</td>
<td>15</td>
<td>15</td>
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<td>75</td>
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<td>125</td>
<td>150</td>
<td>250</td>
<td>300</td>
<td>621</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 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 x 10^{-3}</td>
<td>1.843 x 10^{-3}</td>
<td>1.818 x 10^{-3}</td>
<td>1</td>
</tr>
</tbody>
</table>
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