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# STANDARD ELEMENTARY DIAGRAM SYMBOLS

The diagram symbols shown below have been adopted by the Square D Company and conform where applicable to standards established by the National Electrical Manufacturers Association (NEMA).

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| \( \text{SPEED (PLUGGING) ANTI-PLUG} \) | \( \text{SELECTOR} \) | \( \text{2 POSITION} \) | \( \text{3 POSITION} \) | \( \text{3 POSITION} \) |
|-----------------------------------|-------------------|-------------------|-------------------|
| | CONTACTS | SELECTION POSITION | A | B |
| | | | | |
| | | | | |

| \( \text{PUSH BUTTONS} \) | \( \text{PILOT LIGHTS} \) | \( \text{MAINTAINED CONTACT} \) | \( \text{ILLUMINATED} \) | \( \text{INDICATE COLOR BY LETTER} \) |
|-------------------|-------------------|-------------------|-------------------|
| SINGLE CIRCUIT | DOUBLE CIRCUIT | MUSHROOM HEAD | WOBBLE STICK | TWO SINGLE CIRCUIT | ONE DOUBLE CIRCUIT | NONPUSH-TO-TEST | PUSH-TO-TEST |

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| \( \text{(SHOW 4 LOOPS)} \) | \( \text{(SHOW 3 LOOPS)} \) | \( \text{(SHOW 2 LOOPS)} \) |

**SQUARE D COMPANY**

www.OzarkToolManuals.com
STANDARD ELEMENTARY DIAGRAM SYMBOLS

WIRING

NOT CONNECTED

CONNECTED

POWER

CONTROL

WIRING TERMINAL

MECHANICAL

FIXED

ADJ BY FIXED TAPS

RHEOSTAT, NOT OR ADJ TAP

CAPACITORS

FIXED

ADJ

ANNUNCIATOR

BELL

BUZZER

HORN SIREN, ETC.

METER

METER SHUNT

HALF WAVE RECTIFIER

FULL WAVE RECTIFIER

BATTERY

FUSE

THERMO COUPLE

POWER OR CONTROL

IGNITOR TUBE

SEMI CONDUCTORS

DIODE

TUNNEL DIODE

UNIVERSIONAL BREAKDOWN (ZENER) DIODE

BIDIRECTIONAL BREAKDOWN DIODE

PHOTO SENSITIVE CELL

TRI AC (BIDIRECTIONAL TRIODE IN IRIUM)

TRANSISTOR

UNIJUNCTION TRANSISTOR

SUPPLEMENTARY CONTACT SYMBOLS

SPST, N.O.

SPST, N.C.

SPDT

TERMS

SINGLE BREAK

DOUBLE BREAK

SINGLE BREAK

DOUBLE BREAK

SINGLE BREAK

DOUBLE BREAK

SINGLE BREAK

DOUBLE BREAK

SINGLE BREAK

DOUBLE BREAK

SPST - SINGLE POLE SINGLE THROW

SPST - DOUBLE POLE SINGLE THROW

SPDT - SINGLE POLE DOUBLE THROW

SPDT - DOUBLE POLE SINGLE THROW

DPST - SINGLE POLE DOUBLE THROW

DPST - DOUBLE POLE DOUBLE THROW

N.O. - NORMALLY OPEN

N.C. - NORMALLY CLOSED

SYMBOLS FOR STATIC SWITCHING CONTROL DEVICES

STATIC SWITCHING CONTROL IS A METHOD OF SWITCHING ELECTRICAL CIRCUITS WITHOUT THE USE OF CONTACTS, PRIMARILY BY SOLID STATE DEVICES. USE THE SYMBOLS SHOWN IN TABLE ABOVE EXCEPT ENCLOSED IN A DIAMOND.

EXAMPLES:

INPUT "COIL" OUTPUT "SWITCH"

LIMIT SWITCH "N.O.

CONTROL AND POWER CONNECTIONS - 600 VOLTS OR LESS - ACROSS-THE-LINE STARTERS

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

LINE MARKINGS

1 PHASE

2 PHASE

3 PHASE

4 WIRE

LI, L2

LI, L3 - PHASE 1

LI, L2, L3

LI, L2, L3

LI, L2

LI, L4

LI, L4

LI, L2, L3

LI, L3

LI, L3

LI, L3

SQUARE D COMPANY
TERMINOLOGY

WIRING DIAGRAM

A WIRING DIAGRAM shows, as closely as possible, the actual location of all of the 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. Note that bold lines denote the power circuit, and thin lines are used to show the control circuit. Conventionally, in ac magnetic equipment, black wires are used in power circuits and red wiring is used for control circuits.

A wiring diagram, however, is limited in its ability to convey a clear picture of the sequence of operation of a controller. Where an illustration of the circuit in its simplest form is desired, the elementary diagram is used.

ELEMENTARY DIAGRAM

The elementary diagram gives a fast, easily understood picture of the circuit. The devices and components are not shown in their actual positions. All the control circuit components are shown as directly as possible, between a pair of vertical lines, representing the control power supply. The arrangement of the components is designed to show the sequence of operation of the devices, and helps in understanding how the circuit operates. The effect of operating various interlocks, control devices etc. can be readily seen — this helps in trouble shooting, particularly with the more complex controllers. This form of electrical diagram is sometimes referred to as a "schematic" or "line" diagram.
EXAMPLES OF CONTROL CIRCUITS - ELEMENTARY DIAGRAMS

The control circuits shown may not include overcurrent protective devices that may be required by applicable electrical codes.

For examples of control circuit overcurrent protective devices and the way they are used, see page 9.

Low Voltage Release and Low Voltage Protection are the two basic control circuits encountered in motor control applications. The simplest schemes are shown below. Other variations shown on this and the following pages may appear more complicated, but can always be resolved into these two basic principles.

1

**Low Voltage Release** is a "two 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 the power is restored, the starter will pickup automatically through the closed contacts of the pilot device. The term "two wire" control arises from the fact that in the basic circuit, only two wires are required to connect the pilot device to the starter.

**2 WIRE CONTROL**

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 used to prevent the unexpected starting of motors which could result in possible injury to machine operators or damage to driven machinery. The starter is energized by pressing the start button. An auxiliary "holding circuit" interlock 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 interlock. Upon resumption of power, the start button must be operated again before the motor will restart. The term "3 wire" control arises from the fact that in the basic circuit at least three wires are required to connect the pilot devices to the starter.

**3 WIRE CONTROL**

3

**2 WIRE CONTROL - WITH MAINTAINED CONTACT HAND-OFF-AUTO SELECTION SWITCH**

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

**4 WIRE CONTROL - MOMENTARY CONTACT MULTIPLE PUSH BUTTON STATION**

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 as required. It is also possible to use only one "Start-Stop" station and have several "Stop" buttons at different locations to serve as emergency stop.

SQUARE D COMPANY
EXAMPLES OF CONTROL CIRCUITS – ELEMENTARY DIAGRAMS

1. 3 WIRE CONTROL WITH PILOT LIGHT TO INDICATE WHEN MOTOR IS RUNNING

![Diagram 1]

A pilot light can be wired in parallel with the starter coil to indicate when the starter is energized and thus show that the motor is running.

2. 3 WIRE CONTROL WITH PILOT LIGHT TO INDICATE WHEN MOTOR IS STOPPED

![Diagram 2]

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

3. 3 WIRE CONTROL WITH PUSH-TO-TEST PILOT LIGHT TO INDICATE WHEN MOTOR IS RUNNING

![Diagram 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. The push-to-test pilot light enables the testing of the bulb simply by pushing on the color cap.

4. 3 WIRE CONTROL WITH ILLUMINATED PUSH BUTTON TO INDICATE WHEN MOTOR IS RUNNING

![Diagram 4]

The illuminated push button combines a start button and a pilot light in one unit. Pressing the pilot light turns operates the start contacts. Speed is saved by requiring only a two unit push button station instead of three.

5. 3 WIRE CONTROL WITH FUSED CONTROL CIRCUIT TRANSFORMER

![Diagram 5]

A step down transformer can be used to provide a control circuit voltage lower than line voltage for reasons of operator safety. This scheme shows one of the ways overcurrent protection can be provided for control circuits. For others, see page 9.

6. 3 WIRE CONTROL WITH FUSED CONTROL CIRCUIT TRANSFORMER AND CONTROL RELAY

![Diagram 6]

A starter coil with a high volt-ampere rating may require a control transformer of considerable size. A control relay and a transformer with a low VA rating can be connected so that the normally open relay contact controls the starter coil on the primary or line side. Square D Size B Form FT starters use this scheme.
EXAMPLES OF CONTROL CIRCUITS – ELEMENTARY DIAGRAMS

1. JOGGING USING A SELECTOR SWITCH – JOG WITH START BUTTON

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 interlock and jogging may be accomplished by pressing the "Start" button.

2. JOGGING USING A SELECTOR PUSH BUTTON

The use of a selector push button to obtain jogging is shown above. In the "Run" position, the selector push button gives normal 3 wire control. In the "Jog" position, the holding circuit is broken and jogging is accomplished by depressing the button.

3. JOGGING USING A CONTROL RELAY

Pressing the "Start" button energizes the control relay which in turn energizes the starter coil. The normally open starter interlock and relay contact then form a holding circuit around the "Start" button. Pressing the "Jog" button energizes the starter coil independent of the relay and no holding circuit forms, thus jogging can be obtained.

4. JOGGING USING A CONTROL RELAY FOR REVERSING STARTER

This control scheme permits jogging the motor either in the forward or reverse direction whether the motor is at standstill or is rotating in either direction. Pressing the "Start-Forward" or "Start-Reverse" buttons 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 will remain energized. Pressing either "Jog" button will de-energize the relay releasing the closed contactor. Further pressing of the "Jog" button permits jogging in the desired direction.

5. 3 WIRE CONTROL – MORE THAN ONE STARTER, ONE PUSH BUTTON STATION CONTROLS ALL

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.

6. 3 WIRE CONTROL – REVERSING STARTER

3 wire control of a reversing starter can be accomplished with a "Forward-Reverse-Stop" push button station as shown above. Limit switches can 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.
EXAMPLES OF CONTROL CIRCUITS – ELEMENTARY DIAGRAMS

1  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.

2  3 WIRE CONTROL - REVERSING STARTER
WITH PILOT LIGHTS TO INDICATE
DIRECTION MOTOR IS RUNNING

Pilot lights can be connected in parallel with the forward and reverse contactor coils to indicate which contactor is energized and thus which direction the motor is running.

3  3 WIRE CONTROL - TWO SPEED STARTER

3 wire control of a two 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.

4  3 WIRE CONTROL - TWO SPEED STARTER
WITH ONE PILOT LIGHT TO INDICATE
MOTOR OPERATION AT EACH SPEED

One pilot light can be used to indicate operation at both low and high speeds. One extra normally open interlock on each contactor is required. Two pilot lights, one for each speed, could be used by connecting pilot lights in parallel with high and low coils. (See Reversing Starter diagram above.)

5  PLUGGING A MOTOR TO A STOP
FROM ONE DIRECTION ONLY

Plugging is defined by NEMA as a system of braking in which the motor connections are reversed so that the motor develops a counter torque, thus exerting a retarding force. In the above scheme the forward rotation of the motor closes the normally open plugging switch contact and energizing control relay CR. When the “Stop” button is operated the forward contactor drops out, the reverse contactor is energized through the plugging switch, the control relay contact as well as the normally closed forward interlock. 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 drops out as well. 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 used for plugging and not for reversing in reverse.

6  ANTI-PLUGGING - MOTOR TO BE
REVERSED BUT MUST NOT BE PLUGGED

Anti-plugging protection is defined by NEMA as the effect of a device which 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.
EXAMPLES OF OVERCURRENT PROTECTION FOR CONTROL CIRCUITS

(Some of these schemes may be required by applicable electrical codes)

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

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

3. Control circuit transformer with fusing in one secondary line and with both secondary lines ungrounded or, if user's conditions permit, with one line grounded.

4. Control circuit transformer with fusing in both secondary lines and with both secondary lines ungrounded.

5. Control circuit transformer with fusing in one primary and one secondary line, and with all lines ungrounded, or, if user's conditions permit, with one primary and one secondary line grounded.

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

7. Control circuit transformer with fusing in both primary lines, with no secondary fusing and with all lines ungrounded.
AC MANUAL STARTERS AND MANUAL MOTOR STARTING SWITCHES

MANUAL MOTOR STARTING SWITCHES — TYPE K

2 Pole, 1 Phase

3 Pole, 3 Phase

FRACTIONAL HORSEPOWER MANUAL STARTERS - TYPE F

1 Pole

2 Pole

2 Pole with Selector Switch

INTEGRAL HORSEPOWER MANUAL STARTERS - SIZES M-0 AND M-1

2 Pole, 1 Phase

3 Pole, 1 Phase
AC MANUAL STARTERS

INTEGRAL HORSEPOWER MANUAL STARTERS - SIZES M-0 AND M-1

1. 3 Pole, 3 Phase
2. 3 Pole, Direct Current
3. 3 Pole, 3 Phase with Two Additional Interlocks (Form X)

AC REVERSING MANUAL STARTERS AND MANUAL MOTOR STARTING SWITCHES

4. REVERSING MANUAL MOTOR STARTING SWITCH
   Type K, 3 Pole, 3 Phase

5. REVERSING MANUAL STARTER
   Sizes M-0 and M-1, 3 Pole, 3 Phase

AC TWO SPEED MANUAL STARTERS AND MANUAL MOTOR STARTING SWITCHES

6. TWO SPEED MANUAL MOTOR STARTING SWITCH - TYPE K
   2 Pole, Single Phase with Pilot Light
   3 Pole, 3 Phase
AC TWO SPEED MANUAL STARTERS

TWO SPEED MANUAL MOTOR STARTERS - TYPE F

2 Unit - 2 Pole with Mechanical Interlock and Pilot Lights

3 Unit - 2 Pole with Selector Switch and Pilot Lights

SIZES M-O AND M-1 TWO SPEED MANUAL STARTERS

Two Speed Starter For Wye Connected Separate Winding Motor

DRUM SWITCHES

<table>
<thead>
<tr>
<th>FORWARD</th>
<th>OFF</th>
<th>REV/RSF</th>
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<tbody>
<tr>
<td>1-02</td>
<td>10 02</td>
<td>10 02</td>
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<tr>
<td>2-04</td>
<td>30 04</td>
<td>30 04</td>
</tr>
<tr>
<td>50-06</td>
<td>50 06</td>
<td>50 06</td>
</tr>
</tbody>
</table>

Internal Switching

3 Phase - 3 Wire Motor
DRUM SWITCHES

1. Single Phase—Capacitor or Split Phase Motor

2. Single Phase—4 Lead Repulsion Induction Motor

3. Single Phase—3 Lead Repulsion Induction Motor

4. 2 Phase - 3 Wire Motor

5. 2 Phase - 4 Wire Motor

6. Direct Current - Shunt Motor

7. Direct Current - Series Motor

8. Direct Current - Compound Motor

SQUARE D COMPANY
CONSTANT SPEED, DC STARTER

ADJUSTABLE SPEED, DC STARTER

ACCELERATION CONTACTORS
CLASS 7135, 7136, 7735, 7736

<table>
<thead>
<tr>
<th>NEMA Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Number of accel. contactors</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Typical Elementary Diagram, NEMA Size 2, 3 and 4
HIGH VOLTAGE MOTOR STARTERS

Type FC-11, FC-21, FC-13, FC-23, FC-12 or FC-22
Full Voltage, Non-Reversing Squirrel Cage Motor Starter.

Type FL-13, FL-23, FL-12 or FL-22
Mechanical Latched Contactor

Type FCR-1 or FCR-2 Reversing Full Voltage Squirrel Cage Motor Starter.
Type RCR-1 or RCR-2 Reduced Voltage, Primary Reactor, Non-Reversing Squirrel Cage Motor Starter.

Type RCA-1 or RCA-2 Reduced Voltage, Autotransformer Non-Reversing Squirrel Cage Motor Starter.
Type FS-1 or FS-2 Full Voltage, Non-Reversing Synchronous Motor Starter.

Type RSR-1 or RSR-2 Reduced Voltage Primary Reactor Non-Reversing Synchronous Motor Starter.
Type RSA-1 or RSA-2 Reduced Voltage Autotransformer Non-Reversing Synchronous Motor Starter.

Type FSB-1 or FSB-2 Full Voltage Non-Reversing Brushless Synchronous Motor Starter.
CONTROL RELAYS

1

TYPE C RELAY

TYPE CO-1

TYPE CO-2

TYPE CO-3

TYPE CO-4

TYPE CO-5

TYPES CO-1 & CO-13

TYPES CO-12 & CO-14

2

TYPE D, 10 AMPERE RELAY, FIXED CONTACTS

#1  #2  #3  #4

#5  #6  #7  #8

#9  #10

3

TYPE D RELAY OPERATED TIMER, FIXED CONTACTS

Type Number

Contact Number

DDO-22

DDO-42

DEO-22

DEO-42

0

*0

*1

*1

0

*0

*1

*1

O—Normally Open Contact.
1—Normally Closed Contact.
*—Contacts of individual double throw poles must be used on the same polarity.

Note: Class 8508 Type D latching relays have same contact arrangements as shown at left except unlatch coil is added to diagram.

4

TYPE G, 10 AMPERE RELAY, CONVERTIBLE CONTACTS

No. of Poles

Contact Number

Type

1  2  3  4

2

GO-20

0

GO-11

0

GO-02

1

GO-30

0

GO-21

0

GO-12

0

GO-03

1

GO-40

0

GO-31

0

GO-22

0

GO-13

0

GO-04

1

Note: Class 8501 Type GO—GL, latching relays have same contact arrangements as above except unlatch coil is added to diagram.

O—Normally Open Contact.
1—Normally Closed Contact.
CONTROL RELAYS

CLASS 8501

1. TYPE G, 10 AMPERE RELAY
   WITH UNIVERSAL POLE ATTACHMENT

   8, 10 and 12 Pole Contact Arrangement

   FRONT ROW
   #5  #6  #7  #8
   #9  #10 #11 #12

   MIDDLE ROW
   #1  #2  #3  #4

   REAR ROW

   #1  #2  #3  #4

   "MOUNTING SLOT"

   0—Normally Open Contact.
   1—Normally Closed Contact.

   *Poles 1, 2, 3 and 4 Convertible
   Poles 5, 6, 7, 8, 9, 10, 11 and 12
   non-convertible.

   No. of Contact Type Contact Number
   Poles      Number *   5  6  7  8  9  10  11  12
   8
   GO-00-    0  0  0  0  1  2  3  4
   GU-44
   GO-20-    0  0  0  0  1  1  1  1
   GU-44
   GO-11-    0  0  0  0  1  1  1  1
   GU-44
   GO-02-    0  0  0  0  1  1  1  1
   GU-44
   GO-40-    0  0  0  0  1  1  1  1
   GU-44
   GO-21-    0  0  0  0  1  1  1  1
   GU-44
   GO-22-    0  0  0  0  1  1  1  1
   GU-44
   GO-13-    0  0  0  0  1  1  1  1
   GU-44
   GO-04-    0  0  0  0  1  1  1  1
   GU-44

   10

   12

   2. TYPE G, RELAY OPERATED TIMER

   Contact Arrangement

   Type GO-GD
   Type GO-GE

   MOUNTING SLOT

   0—Normally Open Contact.
   1—Normally Closed Contact.

   No. of Poles Type Contact Number
   0     GO-00    1  2  3  4
   2     GO-20    0  0  0  0
   GO-11    0  0  0  0
   GO-02    1  1  1  1
   GO-40    0  0  0  0
   GO-21    0  0  0  0
   GO-22    0  0  0  0
   GO-04    0  0  0  0
   GO-13    0  0  0  0
   GO-05    1  1  1  1
   GO-31    0  0  0  0
   GO-32    0  0  0  0
   GO-15    0  0  0  0
   GO-04    1  1  1  1

3. TYPE H, 10 AMPERE AND TYPE HM, 20 AMPERE RELAY, CONVERTIBLE CONTACTS

   2, 3 and 4 Pole Contact Arrangement

   UNLATCH COIL

   No. of Poles Type Contact Number
   Poles      1  2  3  4
   2
   HO-30    0  0  0  0
   HO-11    0  0  0  0
   HO-02    1  1  1  1
   HO-30    0  0  0  0
   HO-11    0  0  0  0
   HO-02    1  1  1  1
   HO-03    1  1  1  1
   HO-13    0  0  0  0
   HO-04    0  0  0  0
   HO-31    0  0  0  0
   HO-29    0  0  0  0
   HO-13    0  0  0  0
   HO-04    0  0  0  0

   3

   4

   0—Normally Open Contact.
   1—Normally Closed Contact.

   Note: Class 8501 Types HL and HML latching
   relays have the same contact arrangement as
   above except latching coil
   is added to diagram.

   No. of Poles Type Contact Number
   Poles      1  2  3  4  5  6  7  8
   6
   HO-60    0  0  0  0  0  0  0
   HO-51    0  0  0  0  0  0  0
   HO-42    0  0  0  0  0  0  0
   HO-53    0  0  0  0  0  0  0
   HO-44    0  0  0  0  0  0  0
   HO-35    0  0  0  0  0  0  0
   HO-26    0  0  0  0  0  0  0
   HO-17    0  0  0  0  0  0  0
   HO-08    1  1  1  1  1  1  1

   8

   8

   8

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1

**TYPE HX, 10 AMPERE AND TYPE HXM, 20 AMPERE RELAY, CONVERTIBLE CONTACTS**

8, 10 and 12 Pole Contact Arrangement

![Diagram](image)

- O—Normally Open Contact.
- I—Normally Closed Contact.

Note: Class 8501 Types HXL and HXML latching relays have the same contact arrangement as above except latching coil is added to diagram.

<table>
<thead>
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<th>Type</th>
<th>Contact Number</th>
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<td>HXO-80</td>
<td>O O O O O O O O O O O O</td>
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<td>HXO-71</td>
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<td>HXO-82</td>
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<td>HXO-53</td>
<td>O O O O O I I I I I I I</td>
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<td>HXO-11</td>
<td>O O O O O O O O O O O O</td>
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<td>HXO-35</td>
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<td>HXO-17</td>
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<td>HXO-06</td>
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<td></td>
<td>HXO-1000</td>
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<td>HXO-501</td>
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<td>HXO-802</td>
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<td>HXO-010</td>
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<td>HXO-309</td>
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<td>HXO-210</td>
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<tr>
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<td>O I I I I I I I I I I I</td>
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<tr>
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<td>HXO-012</td>
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</tr>
</tbody>
</table>

2

**TYPE H, 10 AMPERE AND TYPE HM, 20 AMPERE FORM Y165 (WITH HTF-1 COIL) TDO RELAY, CONVERTIBLE CONTACTS**

2, 3 and 4 Pole Contact Arrangement

![Diagram](image)

- O—Normally Open Contact.
- I—Normally Closed Contact.

- All contacts are time delay after energization.

<table>
<thead>
<tr>
<th>No. of Poles</th>
<th>Type</th>
<th>Contact Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>HO-20</td>
<td>O O</td>
</tr>
<tr>
<td></td>
<td>HO-11</td>
<td>O 1</td>
</tr>
<tr>
<td></td>
<td>HO-02</td>
<td>I 1</td>
</tr>
<tr>
<td></td>
<td>HO-30</td>
<td>O 0</td>
</tr>
<tr>
<td></td>
<td>HO-21</td>
<td>O 1</td>
</tr>
<tr>
<td></td>
<td>HO-12</td>
<td>O 1</td>
</tr>
<tr>
<td></td>
<td>HO-03</td>
<td>I 1</td>
</tr>
<tr>
<td></td>
<td>HO-40</td>
<td>O 0 O 0</td>
</tr>
<tr>
<td></td>
<td>HO-31</td>
<td>O 0 O 1</td>
</tr>
<tr>
<td></td>
<td>HO-22</td>
<td>O 0 1 1</td>
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<td></td>
<td>HO-13</td>
<td>O 1 1 1</td>
</tr>
<tr>
<td></td>
<td>HO-04</td>
<td>I 1 1 1</td>
</tr>
</tbody>
</table>

3

**TYPE HD, 10 AMPERE AND TYPE HMD, 20 AMPERE DC RELAY, CONVERTIBLE CONTACTS**

2 and 3 Pole Contact Arrangement

![Diagram](image)

- O—Normally Open Contact.
- I—Normally Closed Contact.

- Not available for use, economizing coil contact.

<table>
<thead>
<tr>
<th>No. of Poles</th>
<th>Type</th>
<th>Contact Number</th>
</tr>
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<tbody>
<tr>
<td>2</td>
<td>HDO-20</td>
<td>O * 0</td>
</tr>
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<td></td>
<td>HDO-11</td>
<td>O * 1</td>
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<td></td>
<td>HDO-02</td>
<td>I * 1</td>
</tr>
<tr>
<td></td>
<td>HDO-30</td>
<td>O * 0 O</td>
</tr>
<tr>
<td></td>
<td>HDO-21</td>
<td>O * 1 O</td>
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<td></td>
<td>HDO-12</td>
<td>O * 1 1</td>
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<tr>
<td></td>
<td>HDO-03</td>
<td>I * 1 1</td>
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TYPE HD, 10 AMPERE AND TYPE HMD, 20 AMPERE DC RELAY, CONVERTIBLE CONTACTS (CONT.)

4, 5, 6 and 7 Pole Contact Arrangement

<table>
<thead>
<tr>
<th>No. of Pole</th>
<th>Type</th>
<th>Contact Number</th>
</tr>
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<tbody>
<tr>
<td>4</td>
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<td>O O O O O</td>
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<tr>
<td></td>
<td>HD-51</td>
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<td>HD-53</td>
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<td>HD-14</td>
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<td>HD-01</td>
<td>O O O O O</td>
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</tbody>
</table>

---

*—Not available for use, economizing coil contact.
O—Normality Open Contact.
1—Normality Closed Contact.

EXTERNAL RELAY TYPE K
120 V COIL 50/60 HZ

EXTERNAL RELAY TYPE K
24 VDC COIL

INPUT 120 V 50/60 HZ
DO NOT SHORT 1 TO 3

INPUT 24 VDC
DO NOT SHORT 1 TO 3

Types JC2, JG2 w/Knob
Types JC1, JG1 w/o Knob

Types KS, KT,
KSD and KTD

Types KP and KPD
CONTROL RELAYS

TYPE L, 10 AMPERE RELAY,
CONVERTIBLE CONTACTS

2, 3 and 4 Pole Relay
All Contacts Convertible

<table>
<thead>
<tr>
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<th>Type</th>
<th>Pole Number</th>
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<td></td>
<td>1 2 3 4</td>
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</tr>
<tr>
<td>2</td>
<td>LO-20</td>
<td>0 S S 0</td>
</tr>
<tr>
<td></td>
<td>LO-21</td>
<td>1 S S 1</td>
</tr>
<tr>
<td></td>
<td>LO-30</td>
<td>0 S S 0</td>
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<td>LO-31</td>
<td>0 S 0 1</td>
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<td></td>
<td>LO-03</td>
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<td></td>
<td>LO-13</td>
<td>U S S 1</td>
</tr>
<tr>
<td></td>
<td>LO-05</td>
<td>1 U S 1</td>
</tr>
</tbody>
</table>

10 - Normally Open Contact
1 - Normally Closed Contact
S - Space for future contact

Note: Class 8501 Type LO - LL latching relays have same contact arrangements as above except unlatch coil is added to diagram.

6 and 8 Pole Relay
All Contacts Convertible

<table>
<thead>
<tr>
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<th>Type</th>
<th>Pole Number</th>
</tr>
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<tr>
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<td></td>
<td>LO-24</td>
<td>1 U S S 1</td>
</tr>
<tr>
<td></td>
<td>LO-14</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>LO-05</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>LO-44</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>LO-35</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td></td>
<td>LO-25</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>LO-17</td>
<td>1 1 1 1</td>
</tr>
<tr>
<td></td>
<td>LO-08</td>
<td>1 1 1 1</td>
</tr>
</tbody>
</table>

R

<table>
<thead>
<tr>
<th>No. of Timed Contacts</th>
<th>Type</th>
<th>Pole Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>LI</td>
<td>0 1</td>
</tr>
</tbody>
</table>

10 - Normally Open Contact
1 - Normally Closed Contact
S - Space for future contact

TYPE LT TIMER ATTACHMENT,
ALL CONTACTS CONVERTIBLE

D30064-962

D30064-962

SQUARED COMPANY
TYPES J and K AC MAGNETIC CONTACTORS

3 Pole, Size 7 and 8 Contactors
GROUND FAULT RELAYS FOR GROUNDED SYSTEMS

WIRING DIAGRAM

ELEMENTARY DIAGRAM

CIRCUIT BREAKERS

WIRING DIAGRAM

ELEMENTARY DIAGRAM

MOTOR STARTERS
WIRING DIAGRAM

START 2
STOP 3
3 WIRE CONTROL

1

2 WIRE CONTROL

T1 T2

MOTOR

ELEMENTARY DIAGRAM

NOTE STARTERS LEAVE FACTORY WITH COIL CONNECTED FOR THE HIGHER VOLTAGE. IF STARTER IS USED ON LOWER VOLTAGE, CONNECT PER COIL DIAGRAM.

Sizes 0 and 1 Single Phase Starters Used with Single Voltage Motor
TYPE S AC LINE VOLTAGE MAGNETIC STARTERS

SINGLE PHASE (Continued)

1

WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 0 and 1 Single Phase Starters Used with Dual Voltage Motor

2

WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 0, 1 and 2, 3 Pole, 3 Phase Starters Connected for Single Phase, Single Voltage Motor

TWO PHASE

3

WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 0, 1 and 2, 4 Pole, 2 Phase, 4 Wire Starters with External 2 or 3 Wire Control

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TYPE S AC LINE VOLTAGE MAGNETIC STARTERS

TWO PHASE (Continued)

1

WIRING DIAGRAM

ELEMENTARY DIAGRAM

2 WIRE CONTROL IF USED

START

STOP

3 WIRE CONTROL

L2

L3

L4

L1

PHASE 1

M

OL

T2

T1

T3

T4

MOTOR

STOP

START

PHASE 2

PHASE 3

M

T3

2 PHASE MOTOR

M

T2

2 PHASE MOTOR

M

T1

THREE PHASE

2

WIRING DIAGRAM

ELEMENTARY DIAGRAM

3 WIRE CONTROL

START

STOP

START

STOP

START

STOP

3 WIRE CONTROL MULTIPLE PUSHBUTTON STATION

MOTOR

T1

T2

T3

T3

T2

T1

M MOTOR

FOR SINGLE PHASE OPERATION L3 POLE NOT USED BUT O.L. RELAY ELEMENT MUST BE INSTALLED

Size 00, 2 Pole, 3 Phase Starter with External 2 or 3 Wire Control

3

WIRING DIAGRAM

ELEMENTARY DIAGRAM

3 WIRE CONTROL

START

STOP

START

STOP

START

STOP

3 WIRE CONTROL MULTIPLE PUSHBUTTON STATION

MOTOR

T1

T2

T3

T3

T2

T1

M MOTOR

2 WIRE CONTROL IF USED

START

STOP

OL

L1

L2

L3

M

TL

2 PHASE MOTOR

M

TL

3 PHASE MOTOR

Sizes 0-4, 3 Pole, 3 Phase Starters with External 2 or 3 Wire Control
TYPE S AC LINE VOLTAGE MAGNETIC STARTERS
THREE PHASE (Continued)

Size 5, 3 Pole, 3 Phase Starter with External 2 or 3 Wire Control

Size 6, 3 Pole, 3 Phase Starter, Series B

Size 00, 3 Pole, 3 Phase Starter with Start-Stop Push Button Mounted in Cover (Form A)
**TYPE S AC LINE VOLTAGE MAGNETIC STARTERS - TWO PHASE**

**ADDITIONS AND SPECIAL FEATURES (Continued)**

1. **WIRING DIAGRAM**
   ![Wiring Diagram](image1)
   **ELEMENTARY DIAGRAM**
   ![Elementary Diagram](image2)
   Size 00, 3 Pole, 3 Phase Starter with HAND-OFF-AUTO Selector Switch Mounted in Cover (Form C)

2. **WIRING DIAGRAM**
   ![Wiring Diagram](image3)
   **ELEMENTARY DIAGRAM**
   ![Elementary Diagram](image4)
   Size 00, 3 Pole, 3 Phase Starter with Separate Control (Form S)

3. **WIRING DIAGRAM**
   ![Wiring Diagram](image5)
   **ELEMENTARY DIAGRAM**
   ![Elementary Diagram](image6)
   Sizes 0-4, 3 Pole, 3 Phase Starters with Start-Stop Pushbutton Mounted in Cover (Form A)
TYPE S AC LINE VOLTAGE MAGNETIC STARTERS
ADDITIONS AND SPECIAL FEATURES

1
WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 0-4, 3 Pole, 3 Phase Starters with HAND-OFF-AUTO
Selector Switch Mounted in Cover (Form C)

2
WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 0-4, 3 Pole, 3 Phase Starters with Control Circuit
Transformer and Secondary Fuse (Form FT)

3
WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 0-4, 3 Pole, 3 Phase Starters with Separate Control (Form S)

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**TYPE S AC LINE VOLTAGE MAGNETIC STARTERS - THREE PHASE**

**ADDITONS AND SPECIAL FEATURES (Continued)**

### WIRING DIAGRAM

![Wiring Diagram 1](image1.png)

**ELEMENTARY DIAGRAM**

![Elementary Diagram 1](image2.png)

---

*On NEMA Size 3 and 4 Starters
Holding Circuit Interlock is in Position No. 1.

Sizes 0-4, 3 Pole, 3 Phase Starters with Additional Interlocks (Form X)

---

### WIRING DIAGRAM

![Wiring Diagram 2](image3.png)

**ELEMENTARY DIAGRAM**

![Elementary Diagram 2](image4.png)

Size 5, 3 Pole, 3 Phase Starter with Control Circuit Transformer and Secondary Fuse (Form FT)

---

### WIRING DIAGRAM

![Wiring Diagram 3](image5.png)

**ELEMENTARY DIAGRAM**

![Elementary Diagram 3](image6.png)

Size 6, 3 Pole, 3 Phase Starter with Separate Control (Form S, Series B)

---

*SQUARE COMPANY*
TYPE S AC COMBINATION MAGNETIC STARTERS

**WIRING DIAGRAM**

- **START**
- **STOP**
- **3 WIRE CONTROL**

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

- **2 WIRE CONTROL**

- **MOTOR**

Sizes 0-4, 3 Pole, 3 Phase Combination Starters

**ELEMENTARY DIAGRAM**

- **STOP**
- **START**
- **2 WIRE CONTROL IF USED**

Size 5, 3 Pole, 3 Phase Combination Starter

---

**WIRING DIAGRAM**

- **START**
- **STOP**
- **3 WIRE CONTROL**

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

- **2 WIRE CONTROL IF USED**

Sizes 0-4, 3 Pole, 3 Phase Combination Starters

**ELEMENTARY DIAGRAM**

- **STOP**
- **START**
- **M ALL OK**

Size 5, 3 Pole, 3 Phase Combination Starter

---

**WIRING DIAGRAM**

- **START**
- **STOP**
- **3 WIRE CONTROL**

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

- **2 WIRE CONTROL IF USED**

Size 6, 3 Pole, 3 Phase Starter, Series B

**ELEMENTARY DIAGRAM**

**WARNING:** DO NOT GROUND SEC. OF TRANS.

**SOLID STATE CONTROL MODULE**

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

**VOLT TRANSFORMER LOCATED UNDER TERMINAL BLOCK**

**SELECTOR SWITCH**

**OFF** PILOT LIGHT (100V)

**C31105-491**

---

www.OzarkToolManuals.com
Sizes 1 and 2, 3 Phase Primary Resistor Starters with Control Circuit Transformer and Secondary Fuse (Form FT)

Sizes 3 and 4, 3 Phase Primary Resistor Starter
Size 2 Reduced Voltage Autotransformer Starters with Closed Transition Starting

Sizes 3 and 4 Reduced Voltage Autotransformer Starters with Closed Transition Starting, Control Circuit Transformer and Secondary Fuse (Form FT)
TYPE S REDUCED VOLTAGE STARTERS
WYE-DELTA TYPE

1. ELEMENTARY DIAGRAM

Elementary Diagram of Sizes 1YD-5YD Starters with Open Transition Starting

2. ELEMENTARY DIAGRAM

Elementary Diagram of Sizes 1YD-5YD Starters with Closed Transition Starting

3. WIRING DIAGRAM

Sizes 1YD and 2YD Starters with Open Transition Starting

4. WIRING DIAGRAM

Sizes 1YD and 2YD Starters with Closed Transition Starting
TYPE S REDUCED VOLTAGE STARTERS - WYE-DELTA TYPE

1

WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 3YD and 4YD, 3 Phase, Starters, with Open Transition Starting and Separate Control (Form S)

TYPE S REDUCED VOLTAGE STARTERS - PART WINDING TYPE

2

ELEMENTARY DIAGRAM

3

ELEMENTARY DIAGRAM

FOR MOTOR LEAD CONNECTIONS
SEE TABLE IN 42-3

Elementary Diagram of Sizes 1PW-4PW, 2 Step Part Winding Starters

Elementary Diagram of Size 3PW, 2 Step Part Winding Starters with Control Circuit Transformer and Secondary Fuse (Form FT)
TYPE S REDUCED VOLTAGE STARTERS
PART WINDING TYPE

1. WIRING DIAGRAM
   
   FOR MOTOR LEAD CONNECTIONS
   SEE TABLE IN 42-3

   Sizes 1PW and 2PW, 2 Step Part Winding Starters

2. WIRING DIAGRAM
   
   FOR MOTOR LEAD CONNECTIONS
   SEE TABLE IN 42-3

   Sizes 3 PW and 4 PW, 2 Step Part Winding Starters

3. WIRING DIAGRAM
   
   Size 3 PW Starter with Fusible Disconnect Switch Having Two Sets of Fuses (Form Y 79-61)

   ELEMENTARY DIAGRAM

   MOTOR LEAD CONNECTIONS

<table>
<thead>
<tr>
<th>NO. OF MOTOR LEADS</th>
<th>PART WINDING SCHEME</th>
<th>LOAD TERMINAL ON STR.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1/2 WYE or 1/2 DELTA</td>
<td>T1, T2, T3, T7, T9, T8</td>
</tr>
<tr>
<td>6</td>
<td>2/3 WYE or 2/3 DELTA</td>
<td>T1, T2, T3, T4, T7, T8</td>
</tr>
<tr>
<td>9 (1)</td>
<td>1/2 WYE</td>
<td>T1, T2, T3, T4, T9, T8</td>
</tr>
<tr>
<td>9 (1)</td>
<td>2/3 WYE</td>
<td>T1, T2, T3, T4, T7, T8</td>
</tr>
<tr>
<td>9 (2)</td>
<td>1/2 DELTA</td>
<td>T1, T8, T3, T7, T9, T2</td>
</tr>
</tbody>
</table>

   (1) AT TERMINAL BOX CONNECT T4, T5, AND T6 TOGETHER
   (2) AT TERMINAL BOX CONNECT T5 AND T9 TOGETHER
   CONNECT T6 AND T7 TOGETHER

SQUARE D COMPANY
TYPE S REDUCED VOLTAGE STARTERS - WOUND ROTOR TYPE

1. ELEMENTARY DIAGRAM
   Elementary Diagram of Non-Reversing Wound Rotor Motor Starter with 2 Points of Acceleration

2. ELEMENTARY DIAGRAM
   Elementary Diagram of Reversing Wound Rotor Motor Starter with 3 Points of Acceleration

3. WIRING DIAGRAM
   Size 1 Wound Rotor Motor Starter with 2 Point of Acceleration

TYPE S AC REVERSING MAGNETIC STARTERS

4. WIRING DIAGRAM
   ELEMENTARY DIAGRAM
   Sizes 00, 0 and 1, 2 Pole Reversing Starters Used with Single Phase, 3 Lead Motors

5. WIRING DIAGRAM
   ELEMENTARY DIAGRAM
   Sizes 00, 0 and 1, 3 Pole Reversing Starters Used with Single Phase, 4 Lead Repulsion Induction Motors
TYPE S AC REVERSING MAGNETIC STARTERS

Sizes 00, 0 and 1, 3 Pole Reversing Starters Used With Single Phase, 4 Lead Capacitor or Split Phase Motors

Sizes 00, 0, 1 and 2, 4 Pole, 2 Phase 4 Wire Reversing Starters

Sizes 00 - 4, 3 Pole, 3 Phase Reversing Starters
TYPE S AC REVERSING MAGNETIC STARTERS

1

WIRING DIAGRAM

ELEMENTARY DIAGRAM

Size 5, 3 Pole, 3 Phase Reversing Starter

TYPE S AC TWO SPEED MAGNETIC STARTERS

2

WIRING DIAGRAM

ELEMENTARY DIAGRAM

Sizes 0-4 Starters for Two Speed, Two Winding (Separate Winding), 3 Phase Motors

3

WIRING DIAGRAM

Size 5 Starter for Two Speed, Two Winding (Separate Winding), 3 Phase Motors

SQUARE D COMPANY
TYPE S AC TWO SPEED MAGNETIC STARTERS

1. **WIRING DIAGRAM**

2. **WIRING DIAGRAM**

3. **WIRING DIAGRAM**

4. **WIRING DIAGRAM**

Sizes 0, 1 and 2 Starters for Two Speed, One Winding (Consequent Pole), Constant or Variable Torque, 3 Phase Motor

Sizes 3 and 4 Starters for Two Speed, One Winding (Consequent Pole), Constant or Variable Torque, 3 Phase Motor

Size 5 Starter for Two Speed, One Winding (Consequent Pole), Constant or Variable Torque, 3 Phase Motor

Sizes 0, 1 and 2 Starters for Two Speed, One Winding (Consequent Pole), Constant Horsepower, 3 Phase Motor
TYPE S AC TWO SPEED MAGNETIC STARTERS

1

WIRING DIAGRAM

SPEED | L1 | L2 | L3 | OPEN TOGETHER
-------|----|----|----|------------------
LOW    | T1 | T2 | T3 | T4, T5, T6
HIGH   | T6 | T4 | T5 | T1, T2, T3

Size 3 and 4 Starters for Two Speed, One Winding (Consequent Pole),
Constant Horsepower, 3 Phase Motor

2

WIRING DIAGRAM

SPEED | L1 | L2 | L3 | OPEN TOGETHER
-------|----|----|----|------------------
LOW    | T1 | T2 | T3 | T4, T5, T6
HIGH   | T6 | T4 | T5 | T1, T2, T3

Size 0 Starter with HIGH-OFF-LOW Selector Switch (Form C7) for
Two Speed, One Winding (Consequent Pole), Constant Horsepower, 3 Phase Motor
ELEMENTARY DIAGRAMS OF SPECIAL CONTROL CIRCUITS
USED WITH TWO SPEED MAGNETIC STARTERS

1

Control Circuit Using a Compelling Relay,
Requiring the Motor to be Started in Low
Speed (Form R1)

2
Control Circuit Using an Accelerating Relay
Which Provides Timed Acceleration to
Selected Speed (Form R2)

3

Control Circuit Using both an Accelerating
Relay and a Decelerating Relay (Form R2R3)

4

Control Circuit Using Both a Compelling
Relay and a Decelerating Relay (Form R1R3)

5

Control Circuit Using a HAND-OFF-AUTO
Selector Switch and a HIGH-LOW
Push Button (Form A10C)

6

Control Circuit using a HAND-OFF-AUTO
Selector Switch and a HIGH-LOW
Selector Switch (Form CC17)
MULTISPEED MOTOR CONNECTIONS

NOTE: THE FOLLOWING DIAGRAMS ARE TYPICAL MOTOR CONNECTION ARRANGEMENTS, CONFORMING TO NEMA STANDARDS. NOT ALL POSSIBLE ARRANGEMENTS ARE SHOWN.
MULTISPEED MOTOR CONNECTIONS

NOTE: THE FOLLOWING DIAGRAMS ARE TYPICAL MOTOR CONNECTION ARRANGEMENTS, CONFORMING TO NEMA STANDARDS. NOT ALL POSSIBLE ARRANGEMENTS ARE SHOWN.

3 PHASE 3 SPEED
2 WINDING CONSTANT TORQUE

3 PHASE 3 SPEED
2 WINDING CONSTANT TORQUE

3 PHASE 3 SPEED
2 WINDING VARIABLE TORQUE

3 PHASE 3 SPEED
2 WINDING VARIABLE TORQUE

3 PHASE 4 SPEED
2 WINDING CONSTANT HORSEPOWER

3 PHASE 4 SPEED
2 WINDING CONSTANT TORQUE

3 PHASE 4 SPEED
2 WINDING VARIABLE TORQUE

3 PHASE 4 SPEED
2 WINDING VARIABLE TORQUE

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3, T7 ALL OTHERS
2ND T6 T4 T5 ALL OTHERS T1, T2, T3, T7
HIGH T7 T5 T6 ALL OTHERS

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3, T7 ALL OTHERS
2ND T6 T4 T5 ALL OTHERS T1, T2, T3, T7
HIGH T7 T5 T6 ALL OTHERS

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3 ALL OTHERS T4, T5, T6, T7
2ND T5 T1 T4 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3 ALL OTHERS T4, T5, T6, T7
2ND T5 T1 T4 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3, T5, T7 ALL OTHERS T4, T5, T6, T7
2ND T7 T6 T4, T5 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3, T5, T7 ALL OTHERS T4, T5, T6, T7
2ND T7 T6 T4, T5 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3 ALL OTHERS T4, T5, T6, T7
2ND T5 T1 T4 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3 ALL OTHERS T4, T5, T6, T7
2ND T5 T1 T4 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3, T5, T7 ALL OTHERS T4, T5, T6, T7
2ND T7 T6 T4, T5 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3 ALL OTHERS T4, T5, T6, T7
2ND T5 T1 T4 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3

SPEED L1 L2 L3 OPEN TOGETHER
LOW T1 T2 T3 ALL OTHERS T4, T5, T6, T7
2ND T5 T1 T4 ALL OTHERS T1, T2, T3, T7
HIGH T6 T4 T5 ALL OTHERS T1, T2, T3
SYNCHRONOUS MOTOR STARTERS - FULL VOLTAGE TYPE LOW VOLTAGE

Elementary Diagram of Full-Voltage Synchronous Starter

Motor Generator Set

Types of dc Excitation Supplies

SYNCHRONOUS MOTOR STARTERS - AUTOTRANSFORMER TYPE LOW VOLTAGE

Elementary Diagram of Reduced Voltage (Autotransformer Type) Synchronous Starter

Motor Generator Set

Types of dc Excitation Supplies

SQUARE COMPANY
AUTOMATIC TRANSFER SWITCHES

1

NORMAL SOURCE

ALTHERMATE SOURCE

UVI

UVI

TRANSFER TEST

FOR REMOTE INDICATION OF SOURCE

N

F

E

N

N

E

TO ENGINE START CIRCUIT

T1 T2

MECHANICAL INTERLOCK

LVADU

LUV1 - Undervoltage and transfer logic relay, engine start contact
N - Normal source contactor
E - Alternate source contactor

Elementary Diagram for a Single Phase, 2 Wire Electrically Held Automatic Transfer Switch

2

NORMAL SOURCE

ALTHERMATE SOURCE

UV2, UV3 - Undervoltage relays
UV1 - Undervoltage and transfer logic relay, engine start contact
NL & EL - Normal and alternate contactor latch coils
NU & EU - Normal and alternate contactor unlatch coils
N & E - Normal and alternate contactor coil clearing contacts
N & E - Normal and alternate contactor power poles and logic circuit contacts

Elementary Diagram for a 3 Phase, 4 Wire Mechanically Held Automatic Transfer Switch

3

NORMAL SOURCE

ALTHERMATE SOURCE

UV2, UV3 - Undervoltage relays
UV1 - Undervoltage and transfer logic relay, engine start contact
NL & EL - Normal and alternate contactor latch coils
NU & EU - Normal and alternate contactor unlatch coils
N & E - Normal and alternate contactor coil clearing contacts
N & E - Normal and alternate contactor power poles and logic circuit contacts
TEST - Form Y29 transfer test switch
OPTION "A" - Form K (1TR) - time delay alternate to normal
OPTION "R" - Form K' (1TR) - time delay normal to alternate
OPTION "C" - Form K2 (3TR) - time delay tripping of emergency generator
OPTION "D" - Form F2 (Norm) - pilot light on normal source
OPTION "E" - Form F1 (Alt) - Pilot light on alternate source
OPTION "F" - Form Y135 (Lol) - lockout of alternate source until engine generator reaches 0% of nominal voltage

Elementary Diagram for a 3 Phase, 4 Wire, Mechanically Held Automatic Transfer Switch with Optional Forms

SQUARE D COMPANY
**AC LIGHTING CONTACTORS - LOAD CONNECTIONS**

1. **SINGLE PHASE 2-WIRE (SINGLE LOAD)**
   \[ V_{load} = V_{line-to-line} \]

2. **SINGLE PHASE 2-WIRE (MULTIPLE LOADS)**
   \[ V_{load} = V_{line-to-line} \]

3. **SINGLE PHASE 3-WIRE (LOADS CONNECTED LINE-TO-NEUTRAL)**
   \[ V_{load} = V_{line-to-neutral} \]

4. **SINGLE PHASE 3-WIRE (LOAD CONNECTED LINE-TO-LINE)**
   \[ V_{load} = V_{line-to-line} \]

5. **THREE PHASE 3-WIRE (WYE-CONNECTED LOAD)**
   \[ V_{load} = V_{line-to-line} \]

6. **THREE PHASE 3-WIRE (DELTA-CONNECTED LOAD)**
   \[ V_{load} = V_{line-to-line} \]

7. **THREE 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.

\( \Delta \) FOR CONTACT RATINGS, REFER TO DIGEST.
ELECTRICALLY HELD CONTACTORS

"ON-OFF" PUSHBUTTON (FORM A12 MODIFICATION)

1. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

DIRECT CONTROL FROM PILOT DEVICE

2. WIRE PILOT DEVICE

1. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

"ON-OFF" SELECTOR SWITCH (FORM C6 MODIFICATION)

3. COIL

1. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

"HAND-OFF-AUTO" SELECTOR SWITCH (FORM C MODIFICATION)

4. 2 WIRE PILOT DEVICE

1. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

MECHANICALLY HELD CONTACTORS

"ON-OFF" PUSHBUTTON (FORM A3 MODIFICATION)

5. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

COIL CLEARING CONTACTS SUPPLIED

LATCH

6. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

UNLATCH

"ON-OFF" SELECTOR SWITCH (FORM C6 MODIFICATION)

7. COIL CLEARING CONTACTS SUPPLIED

8. LATCH

9. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

UNLATCH

10. 2 POLE PILOT DEVICE

11. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

12. 1 POLE PILOT DEVICE

13. TO A.C. COMMON OR SEPARATE CONTROL SUPPLY

14. COIL CLEARING CONTACTS SUPPLIED

CR

15. LATCH

16. CR

17. CR

18. UNLATCH

19. B
AC DUPLEX MOTOR CONTROLLERS

Elementary Diagram for Duplex Motor Controller with Electric Alternator

LIMIT SWITCHES

2 Pole

1 Pole

2 Pole Neutral Position

TYPE AW

Type AW-12, AW-18
MUST BE SAME POLARITY

Type AW-18
MUST BE SAME POLARITY

Type AW-18
MAY BE OPPOSITE POLARITY

Type AW-10
with Lever Arm Opposite Conduit Hole

Type AW-32, AW-42, AW-48

Type AW-36, AW-46

Type AW-38, AW-48

Type AW-39, AVI-49

If lever arm is placed at same end of box as conduit, then normally open contacts become normally closed and vice versa.

SQUARE D COMPANY
CLASS 9039
AC AND DC AUTOMATIC ELECTRIC ALTERNATORS
FOR DUPLEX PUMP INSTALLATIONS

Elementary Diagram for Electric Alternator for Duplex Pump Installations

CLASS 9050
PNEUMATIC TIMING RELAYS TYPES A AND H

TYPE A

ON Delay

OFF Delay

SPDT ELECTRICAL INTERLOCK (when furnished)

DPDT ELECTRICAL INTERLOCK (when furnished)

SPDT ELECTRICAL INTERLOCK (when furnished)

DPDT ELECTRICAL INTERLOCK (when furnished)

TYPE H

ON DELAY

OFF DELAY

SQUARE D COMPANY
SOLID STATE TIMING RELAYS

WIRING DIAGRAMS

ON AND OFF DELAY

TIMES OUTPUT CONTACT

INITIATING CONTACT

INSTANTANEOUS OUTPUT CONTACT

AC INPUT

X1 L1 P1 X2 L2 P2 X4

X5 X8

R1 R2

L1 L2

FOR REMOTE TIME
ADJUST CONNECT
RHEOSTAT AND
REMOVE JUMPER R1-R2

TYPES
TO-10D1.2&R3
TO-10E1.2&R3

REPEAT CYCLE

OUTPUT CONTACT

INITIATING CONTACT

AC INPUT

X1 L1 P1 X2 L2 P2 X4

X5 X8

R1 R2

L1 L2

FOR REMOTE TIME
ADJUST CONNECT
RHEOSTAT AND
REMOVE JUMPER R1-R2

TYPES
TO-10R3

TYPICAL ELEMENTARY DIAGRAMS

ON DELAY or, INTERVAL, MAINTAINED START

L1 L2

TR

TR

TR

TR

TR

TR

FUSE LOAD 1

FUSE LOAD 2

FUSE LOAD 3

FUSE LOAD 4

SOLID STATE TIMING RELAY

OFF DELAY

L1 L2

TR

TR

TR

TR

TR

FUSE LOAD 1

FUSE LOAD 2

FUSE LOAD 3

FUSE LOAD 4

SOLID STATE TIMING RELAY

REPEAT CYCLE

L1 L2

TR

FUSE LOAD

SOLID STATE TIMING RELAY

INITIATING CONTACT

CLOSURE OF INITIATING CONTACT RESULTS IN INSTANTANEOUS TRANSFER OF CONTACT TR.
### DIGITAL SOLID STATE TIMER

#### TYPE X

<table>
<thead>
<tr>
<th>ON DELAY (Maintained Initiating Contact)</th>
<th>Comments</th>
<th>Timing Sequence Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initiating contact closure begins time delay. Timed contacts are activated at end of time delay. Timer resets whenever the initiating contact opens. Caution: Do not connect load(s) between terminals 10 and L2 or between terminals 11 and L2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="image1.png" alt="Diagram" /></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ON DELAY (Using 3-Wire Control)</th>
<th>Comments</th>
<th>Timing Sequence Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Start Button contact closure begins time delay. Timed contacts are activated at end of time delay. Timer resets whenever the stop button contact opens. Caution: Do not connect load(s) between terminals 10 and L2 or between terminals 11 and L2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="image2.png" alt="Diagram" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERVAL MOMENTARY START (Momentary Initiating Contact)</th>
<th>Comments</th>
<th>Timing Sequence Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Momentary initiating contact closure begins time delay and activates instantaneous contacts. At end of time delay period, timer resets automatically. Caution: Do not connect load(s) between terminals 10 and L2 or between terminals 11 and L2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="image3.png" alt="Diagram" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SEQUENCING TWO LOADS (Using Two Timers)</th>
<th>Elementary Diagrams</th>
<th>Timing Sequence Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Caution: Do not connect load(s) between terminals 10 and L2 or between terminals 11 and L2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="image4.png" alt="Diagram" /></td>
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</tbody>
</table>
### DIGITAL SOLID STATE TIMER

#### TYPE X

#### 9050

<table>
<thead>
<tr>
<th>OFF DELAY</th>
<th>Comments</th>
<th>Timing Sequence Chart</th>
</tr>
</thead>
</table>
| **1**     | Closure of the limit switch contact energizes the motor starter (M1). This opens the normally closed M1 contact, resets the timer, closes the NCTO contact and energizes the lube pump starter. When the limit switch opens, the motor starter M1 drops out instantly closing the M1 contact and initiating the timer. At the end of the preset time period, the NCTO contact opens de-energizing the lube pump starter.  
Caution: Do not connect load(s) between terminals 10 and L2 or between terminals 11 and L2. | ![Timing Sequence Chart 1](image1) |
| **2**     | Closure of the limit switch contact energizes the CR relay and the motor starter (M1). This opens the normally closed CR contact, resets the timer, closes the NCTO contact and energizes the lube pump starter. When the limit switch opens, the CR relay and the motor starter M1 drop out instantly closing the CR contact and initiating the timer. At the end of the preset time period, the NCTO contact opens de-energizing the lube pump starter.  
Caution: Do not connect load(s) between terminals 10 and L2 or between terminals 11 and L2. | ![Timing Sequence Chart 2](image2) |
| **3**     | Closure of the limit switch contact energizes the motor starter (M1), resets the timer, closes the NCTO contact and energizes the lube pump starter. When the limit switch opens, it drops out motor starter M1 and initiates the timer. At the end of the preset time period, the NCTO contact opens de-energizing the lube pump starter.  
Caution: Do not connect load(s) between terminals 10 and L2 or between terminals 11 and L2. | ![Timing Sequence Chart 3](image3) |

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*SQUARE COMPANY*
### DIGITAL SOLID STATE PRESET COUNTER
#### TYPE C

<table>
<thead>
<tr>
<th>MODE OF OPERATION</th>
<th>USER CONNECTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 HARD CONTACT INPUTS MANUAL PRESET</td>
<td><img src="image1.png" alt="Diagram" /></td>
<td>Counter will preset to the number shown on the thumbwheel switches when the preset switch is opened. Preset switch must be opened to initially preset the counter after L1-L2 power is applied. Preset switch must be closed before counting can commence and must remain closed during counting. Each closure of the count switch advances the counter one count.</td>
</tr>
<tr>
<td>2 HARD CONTACT INPUTS AUTOMATIC PRESET</td>
<td><img src="image2.png" alt="Diagram" /></td>
<td>Counter will preset to the number shown on the thumbwheel switches when the preset switch is opened, or 1. the count of 000 is reached (when counter is in the down counting mode), or 2. the count of 999 is reached (when counter is in the up counting mode). Preset switch must be opened to initially preset the counter after L1-L2 power is applied. Preset switch must be closed before counting can commence and must remain closed during counting. Each closure of the count switch advances the counter one count.</td>
</tr>
<tr>
<td>3 NORPAK INPUTS MANUAL PRESET</td>
<td><img src="image3.png" alt="Diagram" /></td>
<td>Counter will preset to the number shown on the thumbwheel switches when the output of NOR B is a logic &quot;0.&quot; Output of NOR B must be a logic &quot;0&quot; to initially preset the counter after L1-L2 power is applied. Output of NOR B must be a logic &quot;1&quot; before counting can commence and must remain a logic &quot;1&quot; during counting. The counter will advance one count each time the output of NOR A switches from a logic &quot;0&quot; to a logic &quot;1.&quot; Signals marked with * must be &quot;bounce free.&quot; When required, use an anti-bounce circuit as shown to remove &quot;bounce&quot; from an Input Signal.</td>
</tr>
<tr>
<td>4 NORPAK INPUTS AUTOMATIC PRESET (using form N9)</td>
<td><img src="image4.png" alt="Diagram" /></td>
<td>Counter must first be converted to Form N9 by substituting a Class 9050 Type XA-5 Logic Output Interface Module for the plug-in output relay. Counter will preset to the number shown on the thumbwheel switches when the output of NOR B is driven to a logic &quot;0&quot; by the * input, or 1. the count of 000 is reached (when counter is in the down counting mode), or 2. the count of 999 is reached (when counter is in the up counting mode). Output of NOR B must be driven to a logic &quot;0&quot; by its * input in order to initially preset the counter after L1-L2 power is applied. Output of NOR B must be a logic &quot;1&quot; before counting can commence and must remain a logic &quot;1&quot; during counting. The counter will advance one count each time the output of NOR A switches from a logic &quot;0&quot; to a logic &quot;1.&quot; Signals marked with * must be &quot;bounce free.&quot; When required, use an anti-bounce circuit as shown to remove &quot;bounce&quot; from an Input Signal. Four additional units of NORPAK logic load are available to the user at terminal 3.</td>
</tr>
</tbody>
</table>

**NOTE:** Form N9 may also be used when operating the counter in the Manual Preset mode.

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30072-252-15-B

SQUARE D COMPANY
## DIGITAL SOLID STATE PRESET COUNTER TYPE C

<table>
<thead>
<tr>
<th>MODE OF OPERATION</th>
<th>USER CONNECTION</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>
| **1** COS/MOS INPUTS MANUAL PRESET | ![Diagram](image1.png) | $V_{SS}$ must be -12 to -15 VDC. $V_{DD}$ is GND. COS/MOS logic elements are CMOS inverters. Resistors are 1500 ohm, ±10%, 1/2 watt. Counter will preset to the number shown on the thumbwheel switches when the output of inverter B is HIGH (-0.5 volt or more positive).
Output of inverter B must be HIGH to initially preset the counter after L1-L2 power is applied. Output of inverter B must be LOW (-10 volts or more negative) before counting can commence and must remain LOW during counting.
The counter will advance one count each time the output of inverter A switches from HIGH to LOW.
Signals marked with * must be "bounce free." |
| **2** FILTERED DC VOLTAGE INPUTS MANUAL PRESET | ![Diagram](image2.png) | Voltages $V_1$ and $V_2$ must be bounce-free, filtered DC voltages with polarity as shown.
Counter will preset to the number shown on the thumbwheel switches when $V_2$ is 0-0.5 VDC.
$V_2$ must be 0-0.5 VDC to initially preset the counter after L1-L2 power is applied. $V_2$ must be 10-20 VDC before counting can commence and must remain 10-20 VDC during counting.
The counter will advance one count each time $V_1$ switches from 0-0.5 VDC to 10-20 VDC.
Typical sources for $V_1$ and $V_2$ are photocells, transistors, and transducers with solid state outputs. |
| **3** EXTERNAL SWITCH AND LOGIC SIGNAL INPUTS MANUAL PRESET | ![Diagram](image3.png) | Counter will preset to the number shown on the thumbwheel switches when the output of NOR B is a logic "0."
Output of NOR B must be a logic "0" to initially preset the counter after L1-L2 power is applied. Output of NOR B must be a logic "1" before counting can commence and must remain a logic "1" during counting.
Signals marked with * must be "bounce free." When required, use an anti-bounce circuit as shown to remove "bounce" from an Input Signal.
Each closure of the count switch advances the counter one count. |
| **4** EXTERNAL SWITCH AND LOGIC SIGNAL INPUTS AUTOMATIC PRESET | ![Diagram](image4.png) | Counter will preset to the number shown on the thumbwheel switches when the preset switch is opened, or
1. the count of 000 is reached (when counter is in the down counting mode), or
2. the count of 999 is reached (when counter is in the up counting mode).
Preset switch must be opened to initially preset the counter after L1-L2 power is applied. Preset switch must be closed before counting can commence and must remain closed during counting.
The counter will advance one count each time the output of NOR A switches from a logic "0" to a logic "1."
Signals marked with * must be "bounce free." When required, use an anti-bounce circuit as shown to remove "bounce" from an Input Signal. |
ENCLOSURE SELECTION GUIDE

The tables below may be used as guides in selecting enclosures for specific applications. The various types of enclosures available for each device are listed in the table headings of this Catalog Digest. DF Catalog and GHC Catalog. However, if local code requirements or unusual operating conditions require a different or modified type of enclosure, consult your local Square D Field Office with specific details. Special care should be used in the selection of enclosures for hazardous locations.

### ENCLOSES FOR NON-HAZARDOUS LOCATIONS

<table>
<thead>
<tr>
<th>Type of Enclosure</th>
<th>NEMA Type 1</th>
<th>NEMA Type 3E</th>
<th>NEMA Type 3RE</th>
<th>NEMA Type 4</th>
<th>NEMA Type 4X</th>
<th>Type 5</th>
<th>NEMA Type 12</th>
<th>NEMA Type 12K</th>
<th>NEMA Type 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accidental contact with 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>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>Dust, lint, fibers and flying</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>Horizontal and splashing water</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>
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<tr>
<td>Oil and coolant storage</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>Oil and coolant spraying and splashing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Corrosive agents</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>
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<tr>
<td>Rain, snow and sleet</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Windblown dust</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>
</tbody>
</table>

### ENCLOSES FOR HAZARDOUS LOCATIONS

<table>
<thead>
<tr>
<th>Type of Enclosure</th>
<th>NEMA Type 1</th>
<th>NEMA Type 3E</th>
<th>NEMA Type 3RE</th>
<th>NEMA Type 4</th>
<th>NEMA Type 4X</th>
<th>Type 5</th>
<th>NEMA Type 12</th>
<th>NEMA Type 12K</th>
<th>NEMA Type 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen, manufactured gas</td>
<td>1</td>
<td>B</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>Ethyl ether, ethylene, cyclopropane</td>
<td>1</td>
<td>C</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>Gasoline, hexane, naphtha, benzine, butane, propane, alcohol, acetone, benzol, natural gas, lacquer solvent</td>
<td>1</td>
<td>D</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Yes</td>
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<tr>
<td>Metal dust</td>
<td>1</td>
<td>E</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Carbon black, coal dust, coke dust</td>
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<td>F</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Flour, starch, grain dust</td>
<td>1</td>
<td>G</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Omitted for outdoor use.*

*Implied for indoor and outdoor use.*

*Square D Industrial Control design NEMA Type 12 enclosures may be used for outdoor applications.

*Square D Industrial Control design NEMA Type 4 enclosures provide protection against these environments.

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### 1978 NATIONAL ELECTRICAL CODE — WIRE & CONDUIT TABLES

**Conductors 600 Volts, Nominal or Less (Based on Ambient Temperature of 30°C, 86°F)**

TRADE SIZE OF CONDUIT OR TUBING BASED ON 1978 NEC CHAPTER 9, TABLE 1 FOR 40% FILL AND TABLES 3A, 3B — NEW WORK OR REWIRING. REFER TO 1978 NEC CHAPTER 9 FOR MAXIMUM NUMBER OF CONDUCTORS IN TRADE SIZES OF CONDUIT OR TUBING.

(UNDERLINED INSULATION TYPE INDICATES DRY LOCATION ONLY RATINGS)

<table>
<thead>
<tr>
<th>Table</th>
<th>Table 310-19</th>
<th>Table 310-19</th>
<th>Table 310-19</th>
<th>Table 310-19</th>
<th>Table 310-19</th>
<th>Table 310-19</th>
<th>Table 310-19</th>
<th>Table 310-19</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ampacity</td>
<td>Insulated</td>
<td>50°C (140°F)</td>
<td>THW, THHW, XHHW</td>
<td>75°C (167°F)</td>
<td>THW, THHW, XHHW</td>
<td>75°C (167°F)</td>
<td>THW, THHW, XHHW</td>
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<tr>
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<td>Copper</td>
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</table>

† Ratings for 3-wire, single-phase residential services using RH, RHH, RHW, THW & XHHW conductors

‡ On a 4-wire, 3-phase wye circuit where the major portion of the load consists of electric-discharge lighting, the ampacity of the conductors shall be reduced to 80%.

§ XHHW requires 1 conduit for 300 4W

§§ THW & THHW requires 1 conduit for 3W.

© Special 90°C rating for THW (14-8) within electric discharge lighting equipment per NEC Article 410-31

★ For panelboard branch circuits, wire size should be no smaller than shown above for 75°C wire. 90°C wire should be used for locations where ambient temperature above 30°C is expected.

**NEC 220-2 (a) Continuous Loads.**

The continuous load supplied by a branch circuit shall not exceed 80 percent of the branch-circuit rating.

**NEC 220-10 (b) Continuous and Noncontinuous Loads.**

Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, neither the ampacity rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the noncontinuous load plus 125 percent of the continuous load.

**NEC 430-22 (a) Single Motor Circuit Conductors.**

Branch-circuit conductors supplying a single motor shall have an ampacity not less than 125 percent of the motor full-load current rating.
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