

Notes on Wye Delta, Part Winding and Auto Transformer Type Reduced Voltage Starters

<u>Reduced Voltage Starter Type</u>	<u>Number of Power Contactors</u>	<u>Motor Wire Numbers</u>	<u>Notes</u>
<p>Wye Delta, Open transition, most common type. <u>see page 4&5</u></p> <p>Wye Delta, Closed Transition (rare) <u>See page 6</u></p>	<p>2 Main Contactors (1M & 2M) plus 1 Shorting contactor 1S</p> <p>1 timing relay</p> <p><u>Sizing of contactors</u> Let I_e = Motor Rated Current..So, size 1M = $0.58 \times I_e$ 2M = $0.58 \times I_e$ 1S = $0.34 \times I_e$ O/L = $0.58 \times I_e$</p>	<p>T1, T2, T3, T4, T5, T6</p> <p>T1&T6 connect to L1 T2&T4 connect to L2 T3&T5 connect to L3</p>	<p>This type of starting requires a special wye-delta motor. Both ends of the motor's three windings are brought out so they are accessible for reconnecting from wye to delta. At starting, the controller connects the motor in the wye configuration. After a timed interval, a second contactor connects the motor in a delta configuration. When using a Wye Delta starter, in the delta connection, the running current is shared between two contactors. As such, the thermal overloads for a wye delta starter must be sized for 58% of the motor rated current.</p>
<p>Part Winding @ Using 4 pole + 2 pole contactor <u>See page 9</u></p> <p>(b) Using 2-3 pole contactors <u>see page 7&8</u></p>	<p>2 Contactors: 1M & 2M plus 1 timing relay, max setting 2 secs</p> <p><u>Sizing of contactors</u> Let I_e = Motor Rated Current..So, size 1M = $0.5 \times I_e$ 2M = $0.5 \times I_e$</p>	<p>T1, T2, T3 T7, T8, T9</p>	<p>This type of starting requires that the motor winding be in two equal parts, and that at least six terminal leads be provided on the motor. At starting, the controller is arranged to connect one section of the winding to the supply lines. After a timed interval, a second contactor connects the other section of the motor winding to the supply lines, in parallel with the first.</p>
<p>Autotransformer Starter, 3 Coil <u>See page 2&3</u></p> <p>Autotransformer Starter, 2 Coil <u>see page 10</u></p>	<p>3 Contactors: 1S (Star), 2S (Transformer), and R (Main)</p> <p><u>Sizing of contactors</u> Let I_e = Motor Rated Current..So, size 1S = $0.55 \times I_e$ 2S = $0.8 \times I_e$ R = I_e</p>	<p>T1, T2, T3</p>	<p>At starting, three autotransformers (one for each phase) are automatically connected in series with the motor. The voltage at the motor is reduced to either 50%, 65% or 80% depending on which voltage tap was selected. After a timed interval, a contactor connects the motor across-the-line and shorts out the autotransformers</p>

Holland Industrial, 518 West Montgomery Street, Henderson, NC., 27536

Tel. 1-800-232-7541, Fax 1-252-492-2444, E-Mail: sales @ hollandindustrial.com

5 Autotransformer Controllers

Reduced Voltage Autotransformer - Size 1 To 7

Refer to the typical schematic diagram for NEMA Size 1 to 7 controllers shown in Figure 1.

If 3-wire control is used, connect the momentary start pushbutton between terminals 2 and 3; stop pushbutton between 1 and 2. If 2-wire control is used, jumper terminals 2 and 3 and connect the remote control contact between terminals 1 and 2.

Sequence Of Operations

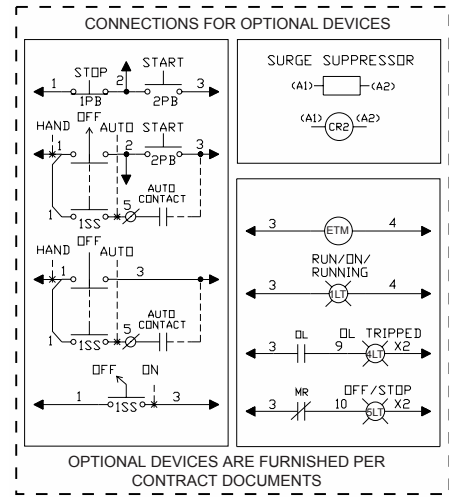
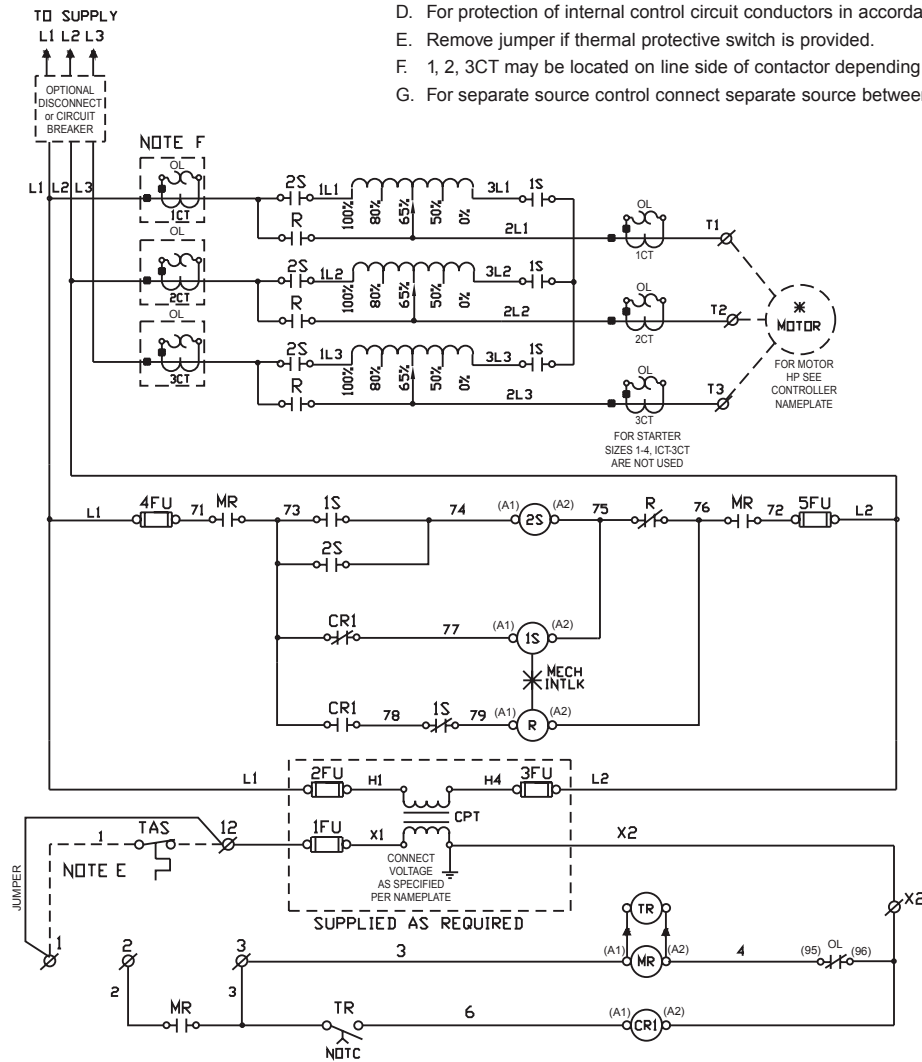
The (TR) and (MR) coils are energized by pressing the Start button. As (TR) is energized the timing sequence begins. When relay (MR) is energized, the normally open contacts of (MR) close energizing contactor coil (1S). As soon as (1S) contactor is energized the (2S) contactor coil is energized. Voltage is now

applied through (2S), the autotransformer, and the (1S) contactor to the motor stator windings.

The motor accelerates on reduced line voltage determined by the percentage tap used on the autotransformer. After a preset time the timing relay (TR) times out and energizes the (CR1) relay. As (CR1) is energized the (1S) coil is de-energized which in turn energizes the (R) contactor. When the (R) contactor is energized the (2S) contactor is de-energized. This leaves only the (R) contactor energized which puts the motor on full line

Notes:

- Class 36-branch circuit protection, fused disconnect or circuit breaker must be provided by installer since circuit breaker or fusible disconnect is not factory installed.
- Unwired auxiliary interlocks supplied in control relay (CR2) as specified by customer.
- Unwired auxiliary interlocks are not shown on diagram for the "R" starter.
- For protection of internal control circuit conductors in accordance with the N.E.C., use fuse kit 49MAFB4.
- Remove jumper if thermal protective switch is provided.
- 1, 2, 3CT may be located on line side of contactor depending on circuit design.
- For separate source control connect separate source between TB points 12 and X2.



- Legend: (Components supplied as required)
- R - Run Starter
 - 1S - No. 1 Start Contactor
 - 2S - No. 2 Start Contactor
 - CR1 - Time Delayed Relay
 - CR2 - Relay
 - TR - Starting Timer
 - TAS - Auto Transformer Over Temperature Switch
 - MR - Master Control Relay
 - Ø - Customer Connection Point
 - # - Device Termination Point

Figure 1

Autotransformer Duty Cycle

The autotransformers used in standard controllers conform to NEMA standards for medium duty and are suitable for general motor starting service.

The starting duty cycle rating based on a 65% tap, with tap current 300% of motor full-load current and a power factor of 50% or less as follows:

Duty Cycle	Motor Horsepower	
	To 200	Above 200 to 3000 inclusive
On	15 sec.	30 sec.
Off	3 min., 45 sec.	30 sec.
Repeat	14 times ^①	2 times ^②
Rest	2 hours	1 hour
Repeat	As above	As above

^① Total of 15 cycles

^② Total of 3 cycles

Table 2

If it is suspected or found that the acceleration period is longer than 15 seconds for 200hp and smaller motors or 30 seconds for larger motors, consult factory and motor manufacturer.

Transition Timer Setting

The timing cycle of the transition timer relay (TR) should be set to obtain transfer after motor has accelerated to its maximum speed on reduced voltage. For proper setting of this timer, refer to the start-up section of this instruction book.

Starting voltage tap settings should be selected so that the motor will start turning and accelerate smoothly to full speed in the allowable starting time.

CAUTION

Under normal operating conditions the transfer time should not exceed the duty cycle of the autotransformer.

Allow cooling between trials if above duty cycle timer setting is used.

6 Wye Delta Controllers

Reduced Voltage Wye-Delta Open And Closed Transition

These controllers are applicable only to motors wound for wye-delta starting and with all six leads brought out into the motor junction box. Motors should be suitable for starting with windings in wye connection and normal running with windings in delta connection. Such motors would normally be marked with locked rotor KVA Code A.

Open Transition

Refer to the typical schematic diagram shown in Figure 2.

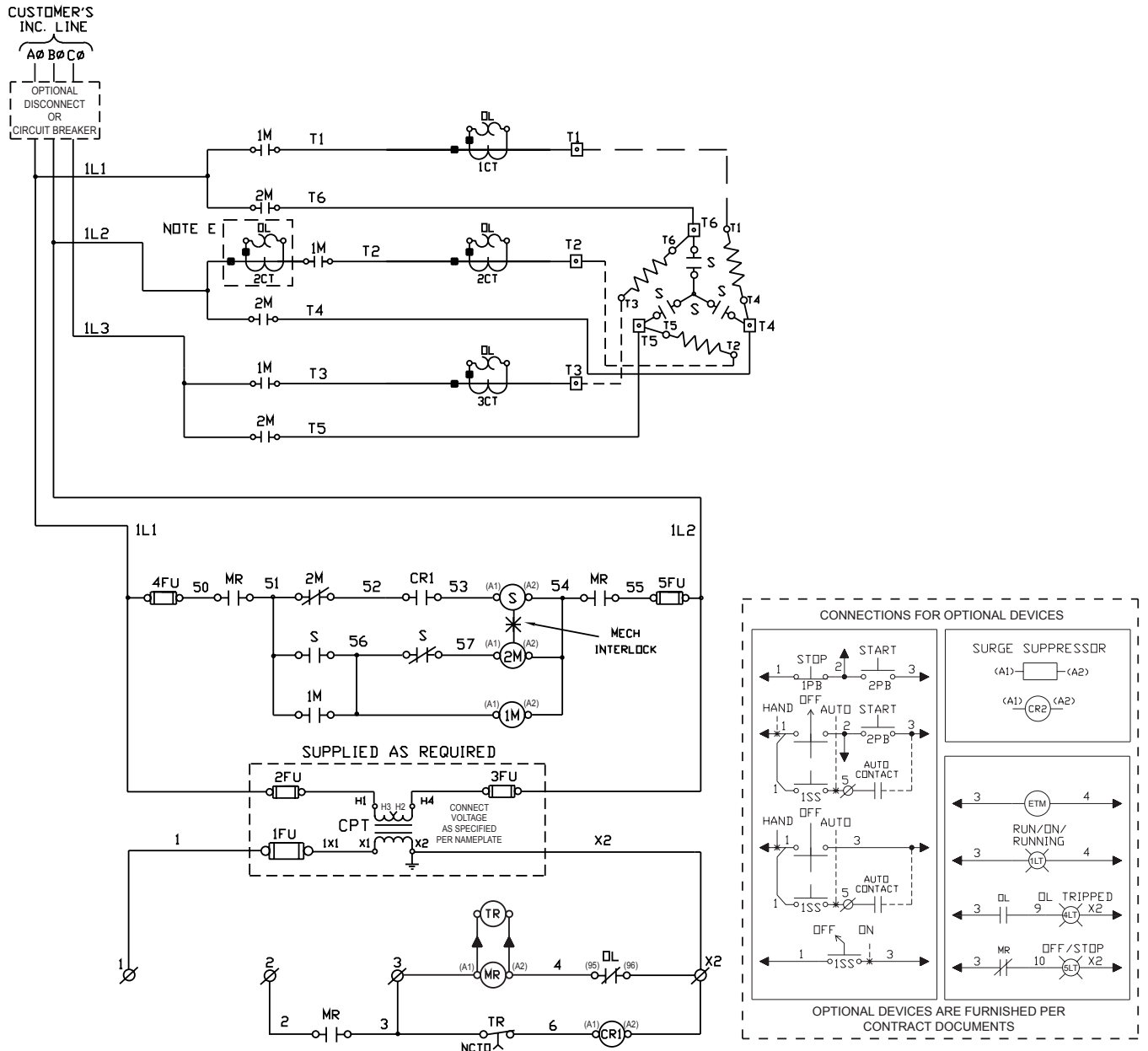
If 3-wire control is used, connect the momentary start pushbutton between terminals 2 and 3; stop pushbutton between 1 and 2. If 2-wire control is used, jumper terminals 2 and 3 and connect a remote control contact between terminals 1 and 2.

Sequence Of Operation - Open Transition Wye Delta (Sizes 1 - 7)

Pressing the start button energizes the (CR1) relay, (TR) timer, and (MR) relay. As soon as (CR1) and (MR) are energized the

normally open contacts close energizing the (S) contactor. With (S) contactor energized the (1M) contactor energizes. The (S) and (1M) contactors remain energized while timer (TR) times out. When the timing sequence ends (CR1) is de-energized which opens the (CR1) contact, de-energizing the (S) contactors. As soon as the (S) contactors is de-energized the (2M) contactor is energized which connects the circuit to the motor in Delta. Pressing stop, or overload relay trip, will de-energize all contactors and remove the motor from the line.

The wye-delta starter overload relays are connected in the motor phase circuits in series with the (1M) contactor. Therefore, the overload relay current is 58% of the motor line current.



- Legend
- ∅ - Customer Connection Point
 - 1M - First Main Contactor
 - 2M - Second Main Contactor
 - S - Shorting Contactor
 - MR - Master Control Relay
 - CR1 - Time Delayed Relay
 - CR2 - Relay
 - TR - Timer
 - OL - Main Starter O/L Relay
 - (#) - Device Termination Point

- Notes:
- A. Class 36-branch circuit protection, fused disconnect or circuit breaker must be provided by installer since circuit breaker or fusible disconnect is not factory installed.
 - B. For protection of internal control circuit conductors in accordance with the N.E.C., use fuse kit 49MAFB4.
 - C. Set TR for transition time required.
 - D. For separate control voltage connect source to terminals 1 and X2.
 - E. 2CT may be located on line side of contactor depending on circuit design.
 - F. Unwired auxiliary interlocks are not shown on diagram for the 1M starter.

Figure 2

Closed Transition - Wye Delta

Refer to the typical schematic diagram shown in Figure 3.

If 3-wire control is used, connect the momentary start pushbutton between terminals 2 and 3; stop pushbutton between 1 and 2. If 2-wire control is used, jumper terminals 2 and 3 and connect a remote control contact between 1 and 2.

Closed transition wye-delta controllers contain all the components used in open-transition plus a 3-pole transition contactor (1A) a set of resistors (RES) to maintain continuity of the motor connection to the line during transition.

As in open-transition starting, pressing the start button energizes the (MR) relay, and (TR) timer. Relay (CR1) is energized as soon a power is applied to the control circuit. As soon as (MR) relay is energized (S) contactor is energized and in turn (1M) contactor is energized. At the point of transition the timed contact (TR)

contactor (1A) is energized which in turn de-energizes the (S) contactor. With (1A) contactor energized the transition resistors are connected in wye (parallel) with the motor windings. A normally closed auxiliary contact of (S) closes and energizes contactor (2M). As soon as (2M) is energized a normally closed auxiliary contact opens removing power from contactors (1A) and (S). With (2M) energized the resistors are bypassed forming the final delta connection of the motor to the line.

Note: Transition Timer Setting

The timing cycle of the transition timing relay (TR) should be set to obtain transfer after the motor has accelerated to its maximum speed on reduced voltage. For proper setting of this timer, refer to the start-up section of this instruction book.

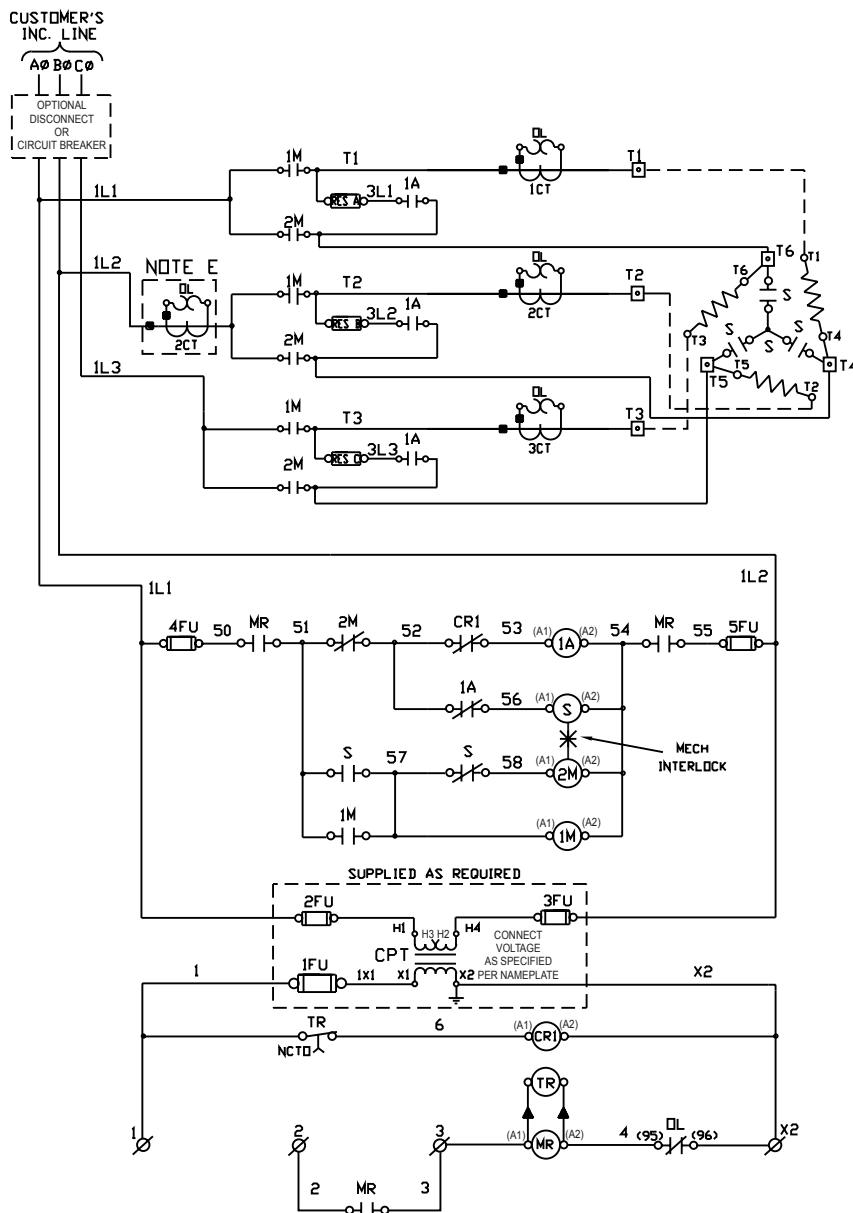


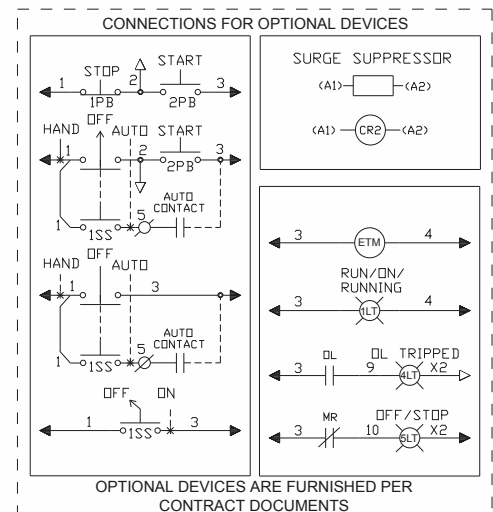
Figure 3

Legend

- Ø - Customer Connection Point
- 1M - First Main Contactor
- 2M - Second Main Contactor
- S - Shorting Contactor
- 1A - Resistor Contactor
- MR - Master Control Relay
- CR1 - Time Delayed Relay
- CR2 - Relay
- TR - Timer
- OL - Main Starter OL Relay
- (#) - Device Termination Point

Notes:

- A. Class 36-branch circuit protection, fused disconnect or circuit breaker must be provided by installer since circuit breaker or fusible disconnect is not factory installed.
- B. For protection of internal control circuit conductors in accordance with the N.E.C., use fuse kit 49MAFB4.
- C. Set TR for transition time required.
- D. For separate control voltage connect source to terminals 1 and X2.
- E. 2CT may be located on line side of contactor depending on circuit design.
- F. Unwired auxiliary interlocks are not shown on diagram for the 1M starter.



7 Part Winding Controllers

Reduced Voltage Part-Winding

Part-winding controllers are applicable only to induction motors having stator windings divided into two or more equal parts with the terminals of each part available for external connection. Since every two-winding motor is not necessarily suitable for part-winding starting, the applicability to a particular motor should be checked with the motor manufacturer.

Refer to the typical schematic diagram shown Figure 4. Upon starting, contactor (1M) closes, connecting one winding, or one half of the motor to the incoming line. The current drawn is approximately 65% of that which would be drawn if the whole motor were connected to the incoming line. (Actual current drawn is a function of motor design).

Correspondingly, less than half of the motor starting torque is produced. After a short time delay of approximately 1-5 seconds, con-

tactor (2M) closes, thus connecting the full motor to the incoming line. Part winding controllers are inherently closed transition.

Part-winding controllers are generally of the increment type in that the motor may not begin to accelerate on the first step. The current drawn from the incoming line of a part-winding motor at the first step is typically 65% of the full winding locked rotor current. When the transition to the second step occurs the current will rise to a value equal to or slightly less than the full-winding locked rotor current, depending on whether or not the motor has started to rotate. However, the maximum value is reached in two increments separated by a short time interval which is sufficient to meet some power company requirements.

During the running condition, each contactor is carrying one-half of the motor full load current. See page 15 for the overload relay setting instructions.

At starting however, one of the contactors must carry approximately 65% of the full-winding locked rotor current. Since NEMA horsepower ratings are based on full load and locked rotor current, the horsepower rating for a given NEMA size starter is somewhat less than twice the individual contactor rating (typically 1.5 - 1.75 x contactor horsepower rating depending on contactor size). NEMA horsepower ratings for part-windings starters are based on single-winding locked rotor currents corresponding to 65% of the full-winding values.

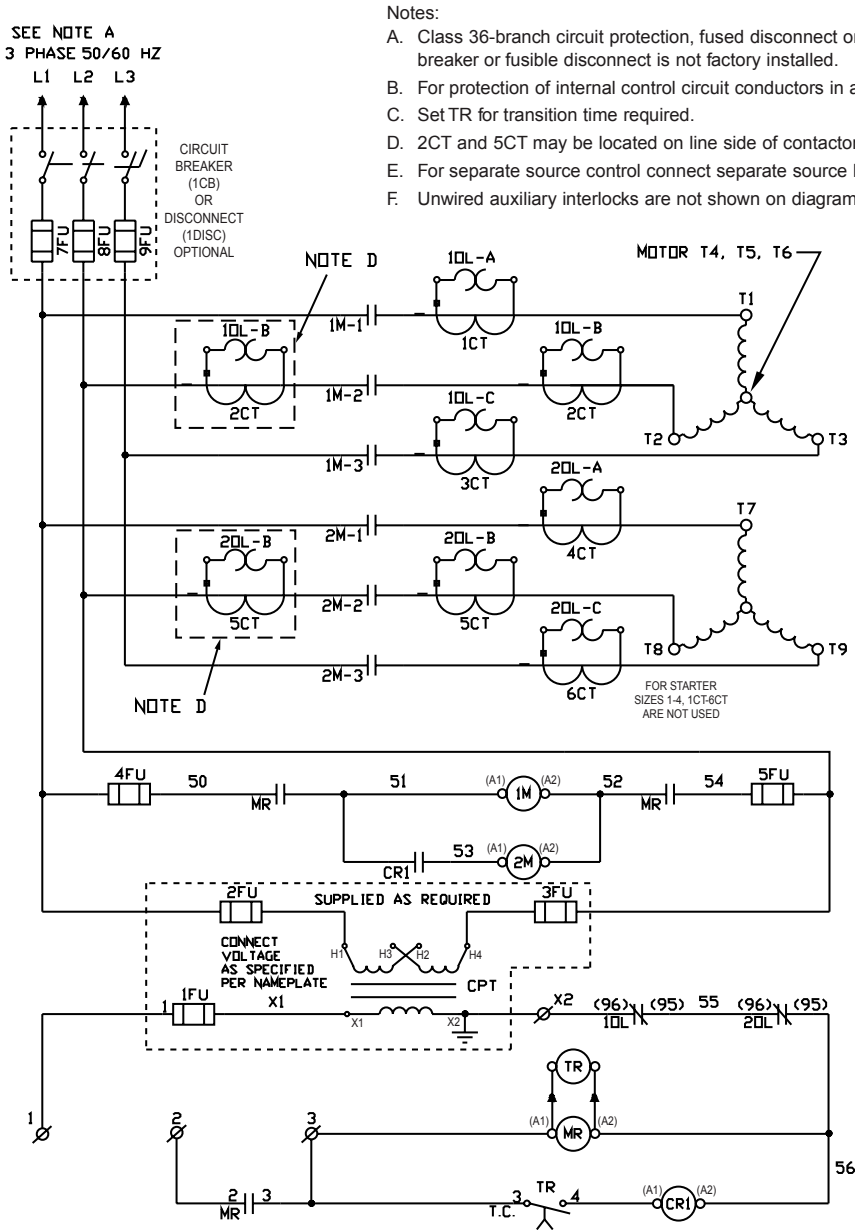
Sequence Of Operation - 1 To 7 Part Winding

Pressing the start button energizes the relay (MR) and timer (TR). As (MR) is energized the normally open contacts close which energizes contactor (1M). After a short timing sequence the normally open contact of (TR) closes energizing relay (CR1).

As soon as (CR1) coming in the normally open contact of this

Note: Transition Timer Setting

The transition timing relay (TR) is normally set at 1 second; refer to the start-up section of this instruction book.

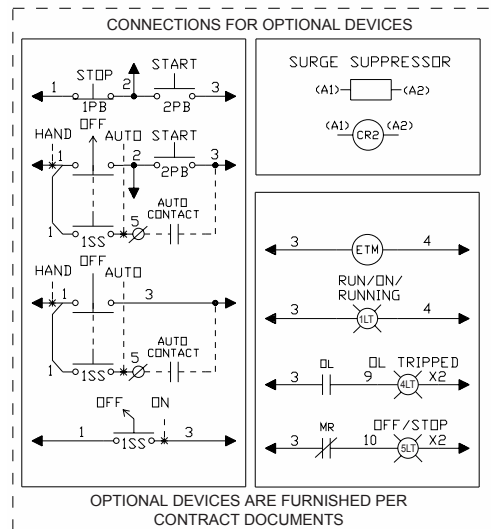


Notes:

- A. Class 36-branch circuit protection, fused disconnect or circuit breaker must be provided by installer since circuit breaker or fusible disconnect is not factory installed.
- B. For protection of internal control circuit conductors in accordance with the N.E.C., use fuse kit 49MAFB4.
- C. Set TR for transition time required.
- D. 2CT and 5CT may be located on line side of contactor depending on circuit design.
- E. For separate source control connect separate source between TB points 1 and X2.
- F. Unwired auxiliary interlocks are not shown on diagram for the "1M starter.

Legend

- 1M - No. 1 Starter
- 2M - No. 2 Starter
- CR1 - Relay
- CR2 - Relay
- TR - Starting Timer
- MR - Master Control Relay
- Ø - Customer Connection
- (#) - Device Termination Point



OPTIONAL DEVICES ARE FURNISHED PER CONTRACT DOCUMENTS

Figure 4

Class 8600 Reduced Voltage Starters

Part Winding Starters

Starter Description

Class 8640 Starter description

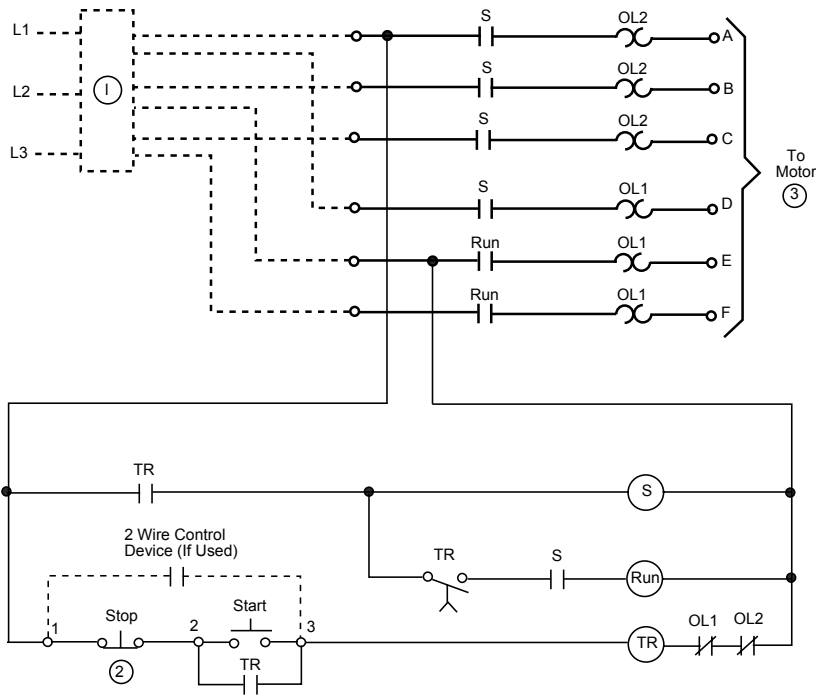
Class 8640 Part Winding Starters are provided with a pneumatic timing relay (TR) and two NEMA rated contactors with overload relays (S and R). The start contactor S is energized following a start command. After a set time delay, typically no longer than 2 seconds, the run contactor R is energized and the motor operates as it would at full voltage.

Part winding motor are available with 6 or 9 leads and may be connected in wye or delta configurations and may utilize either 1/2 or 2/3 of the motor windings during the start mode. In order to allow the user to choose between a 1/2 winding and 2/3 winding start mode, Class 8640 Part Winding starters size 1 through 4 are provided with a four pole start contactor and 2 pole run contactor.

Connection Table

The load side terminals of a part winding starter are labeled A through F. In accordance with NEMA standards, the appropriate motor connection depends on the type of motor and connection scheme as shown in the following table:

Number of Motor Leads	Motor Connection	Terminal Letter					
		A	B	C	D	E	F
6	1/2 Y or □	T1	T2	T3	T7	T8	T9
	2/3 Y or □	T1	T2	T9	T7	T8	T3
9 (Connect terminals T4, T5, & T6 together at terminal box)	1/2 Y	T1	T2	T3	T7	T8	T9
	2/3 Y	T1	T2	T9	T7	T8	T3
9 (Connect T4 & T8, T5 & T9, T6 & T7 in separate pairs at terminal box)	1/2 □	T1	T8	T3	T6	T2	T9
	2/3 □	T1	T4	T9	T6	T2	T3



Size 1 PW - 4 PW Part Winding Starter

Optional disconnect means

Optional control operators

See connection table



Class 8600 Reduced Voltage Starters Autotransformer Starters Starter Description

Class 8606 Starter description

Class 8606 Autotransformer starters are provided with a NEMA rated medium duty autotransformer with taps to provide 50% , 65% or 80% of line voltage to start the motor. Three NEMA rated contactors (1S, 2S and RUN) and a pneumatic timing relay (TR) are required to achieve the start and run connections.

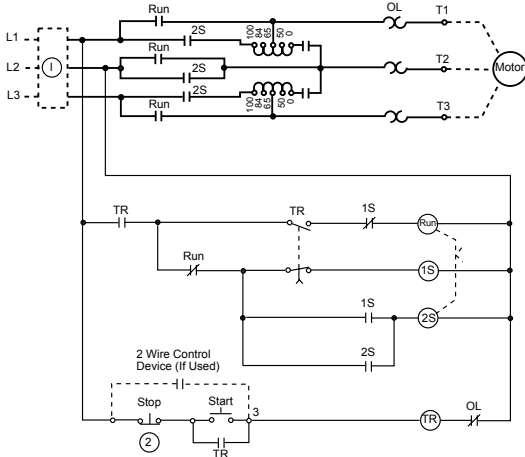
In the start mode, the 1S and 2S contactors are energized. The 1S contactor is energized from an instantaneous contact on the timing relay following a start command. A normally closed interlock on the 1S contactor then picks up the 2S coil making the connection across the autotransformer.

After a preset time delay, the timed contacts on TR change states and the 1S contactor drops out. With the 1S contactor open, the windings of the autotransformer temporarily act as a reactor through the 2S contactor.

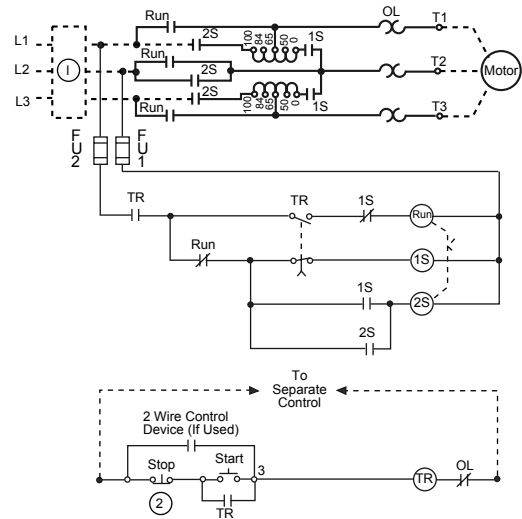
After the 1S contactor has dropped out, the RUN contactor then closes. For maximum safety, the RUN and 1S contactors are mechanically and electrically interlocked. The RUN contactor then shorts out the autotransformer windings and the 2S contactor is dropped out.

Sequence of operation

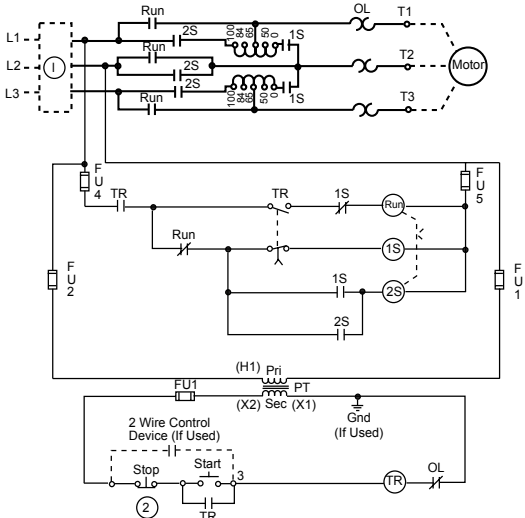
OPERATION	CONTACTOR		
	1S	2S	RUN
Start	X	X	
Transition		X	
Run			X



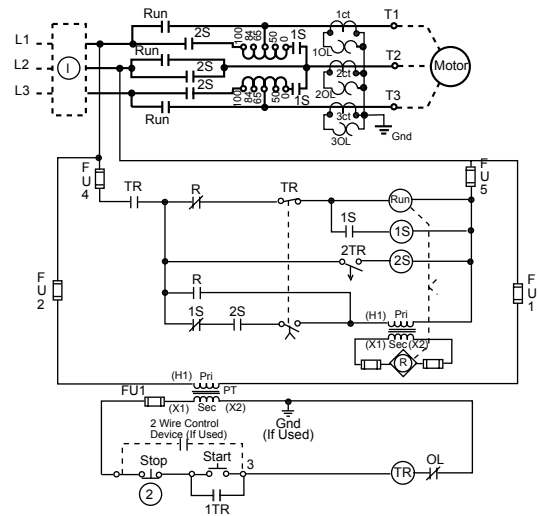
Size 2-5 Autotransformer starter with common control (standard)



Size 2-5 Autotransformer starter with separate control (Form S)



Size 2-5 Autotransformer starter with fused CPT (Form FF4T)



Size 6 Autotransformer starter (standard)

- ① Optional Disconnect means
- ② Optional Start/Stop control operators

