

Technical Information for  
Solid State Starter Installation for  
LRS/LRV/LHM

**SOLID STATE STARTER INSTALLATION FOR LRS/LRV/LHM**

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## 1. Introduction

The Solid State Starter is a replacement for existing Across-the-Line, Inside-Delta, and Wye-Delta magnetic starter contactors. It is factory wired for installation on hydraulic motors with 6 or 12 lead motors. A minor field modification, described herein, is required to convert the starter for use with 3 or 9 lead motors.

Mainline power quality is an important consideration when replacing a magnetic contactor with a solid state starter. The solid state starter is designed for use with utility generated 3-phase power. It will not work where synthesized 3-phase power is provided by a rotary converter, static converter, add-a-phase, or similar single to 3-phase converters.

Wiring diagrams included in this TIP—Figures 4 through 10 and Figures 12 through 16— are typical drawings and should be used in conjunction with the job specific wiring diagram. The number of versions of LRS, LRV, and LHM controllers makes it impractical to include drawings from each. As such, the contract wiring diagram must be used when making any electrical circuit changes. This ensures that an installer is using the diagram that matches the equipment and any previous modifications are taken into consideration when performing this upgrade.

## 2. Job Step Summary

- A. Perform a jobsite survey to determine the main line voltage, motor horsepower, starting method (Inside-Delta, Wye-Delta or Across-the-Line), and controller wiring configuration.
- B. Choose a replacement solid state starter from Tables 1 through 4.
- C. Gather all tools, materials, and equipment necessary for the job.
- D. Perform a JHA.
- E. Gain control of the car.
- F. Disconnect and remove the existing starter and overloads.
- G. If the starting method is across-the-line, convert the new solid state starter to across-the-line configuration.
- H. Install the new starter and auxiliary control relays in the control cabinet.
- I. Connect the mainline power and motor leads to the new starter.
- J. Wire the starter control circuit and auxiliary relays.
- K. Check for wiring errors.
- L. Perform start-up voltage checks.
- M. Adjust the starter settings.
- N. Test and return the car to service.

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### 3. Jobsite Survey

#### 3.1 Motor Data

Mainline Voltage: L1 – L2 \_\_\_\_\_ L2 – L3 \_\_\_\_\_ L1 – L3 \_\_\_\_\_

Motor Horsepower: \_\_\_\_\_ HP

Motor Power Wire Size: \_\_\_\_\_ AWG

LRS, LRV, and LHM series of hydraulic controllers were provided with three types of starting methods: Across-the-Line, Inside-Delta, and Wye-Delta. Examples of each method are shown in Figures 4, 5, and 6.

Starting Method: ☐ Inside Delta or Wye-Delta ☐ Across-the-Line



***If there are three wires from the motor to the PMC contactor, the starting method is “across-the-line” (see figure 4). If there are six wires from the motor to the PMC contactor, the starting method is “inside Delta” (see Figure 5).***

Power Terminal Block in Controller: ☐ Yes ☐ No



***If the mainline is terminated directly to the overload, a power terminal block must be added and the feeders relocated. Do not terminate the main line supply at the Solid State Starter.***

#### 3.2. Determine Controller Wiring Configuration

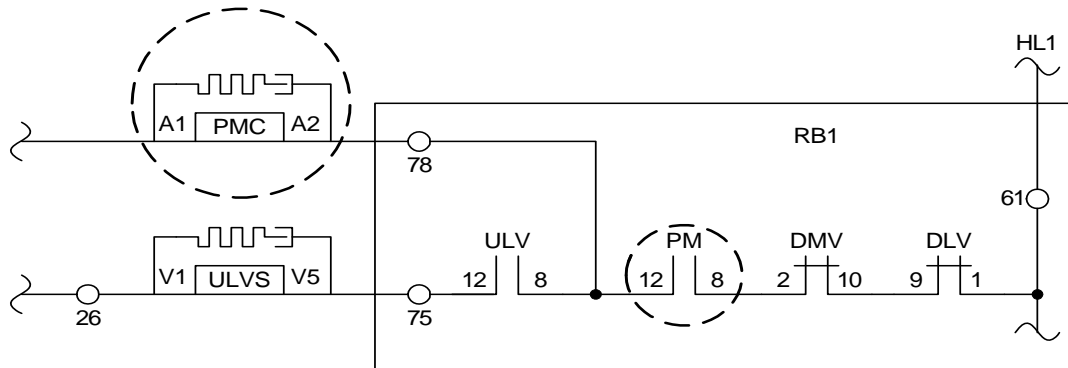
Microprocessor hydraulic controllers of this vintage used three distinctly different wiring schemes. The three arrangements are:

- Controller Type1 – N/O (normally open) PM contact on A2 side (120 V Rtn/HL1) of PMC or MC/LC
- Controller Type 2 – N/O PM contact on A1 side (120 VAC) of PMC or MC/LC
- Controller Type 3 – N/O PM contact on A1 side (120 VAC) of PMC or MC/LC with Cab Interface Board.

Compare the wiring diagrams shown in Figures 1 through 3 to the contract wiring diagram to determine the controller type as follows:

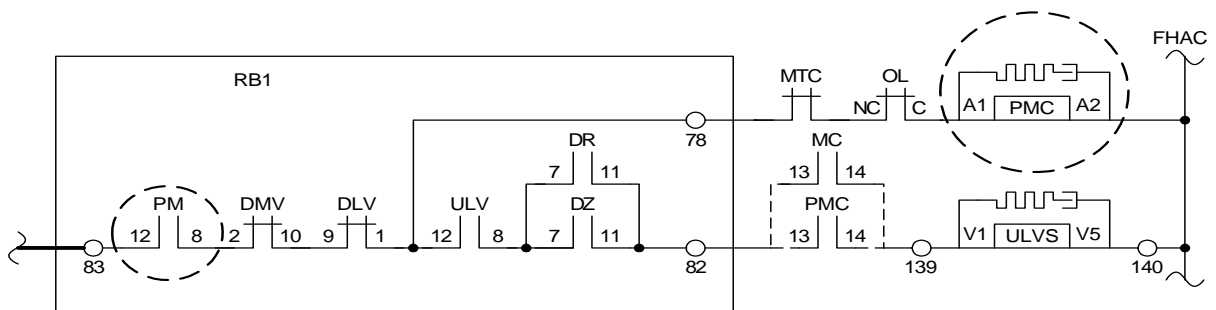
If the contract wiring diagram has a N/O PM contact on the A2 side of PMC or MC/LC as shown in Figure 1, it's a Type 1 controller.

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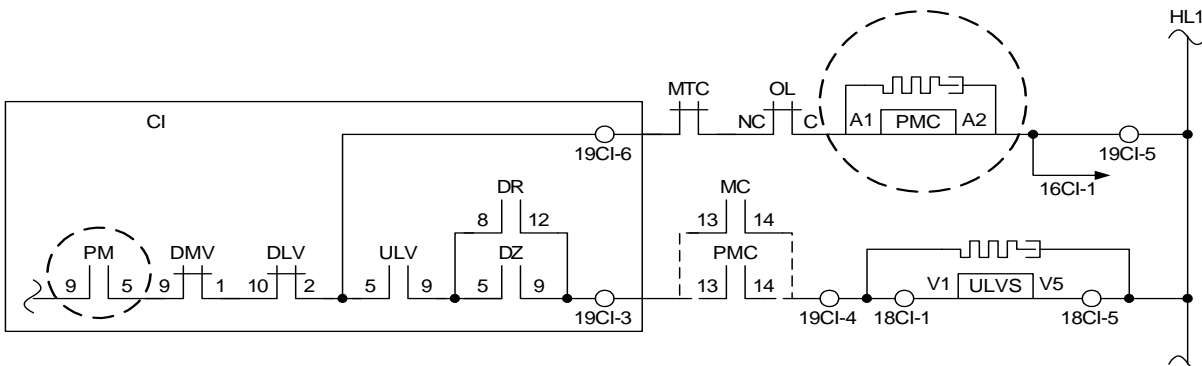
**Figure 1: N/O PM Contact on A2 side (120 V Rtn/HL1) of PMC or MC/LC (Controller Type 1)**

If the contract wiring diagram has a NO PM contact on the A1 side of PMC or MC/LC as shown in Figure 2, it's a Type 2 controller.



**Figure 2: N/O PM Contact on A1 side (120 VAC) of PMC or MC/LC (Controller Type 2)**

If the contract wiring diagrams have a NO PM contact on the A1 side of PMC or MC/LC and use terminal designations for the controller interface board as shown in Figure 3, it's a Type 3 controller.



**Figure 3: NO PM contact on the A1 side of PMC or MC/LC with Controller Interface Board (Controller Type 3)**

**Controller Type:** ☐ Type 1 ☐ Type 2 ☐ Type 3

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## 4. Starter Selection

Use the data from the jobsite survey to choose the appropriate starter from Tables 1 through 4. Motors provided with Wye-Delta starters will be re-connected as Inside-Delta.

**NOTE:** Either a 6- or 12-lead motor is required for Inside-Delta starting.

**Table 1: Inside-Delta Connection, Mainline up to 480 VAC**

Mainline 200–220 VAC	Mainline 200–220 VAC	Mainline 220–240 VAC	Mainline 440–480 VAC	Motor Full Load Current Range (Amps)	Soft Starter P/N
hp @ 200 VAC	hp @208 VAC	hp @230 VAC	hp @ 460 VAC		
5	5	5	5 to 10	5 to 22	AAA21240AD11
7.5 to 20	7.5 to 20	7.5 to 20	15 to 50	17 to 68	AAA21240AD5
25	25	25	60	20 to 80	AAA21240AD6
30	30	30	75	26 to 105	AAA21240AD7
40	40	40	100	32 to 130	AAA21240AD8
50	50	50	125	39 to 156	AAA21240AD9
60 to 75	60 to 75	60 to 100	---	63 to 252	AAA21240AD10

**Table 2: Inside-Delta Connection, Mainline up to 600 VAC**

Mainline 550–600 VAC	Motor Full Load Current Range (Amps)	Soft Starter P/N
hp @ 575 VAC		
5 to 15	5 to 22	AAA21240AD11
20 to 30	9 to 35	AAA21240AD12
40	10 to 42	AAA21240AD13
50	14 to 55	AAA21240AD14
60	17 to 68	AAA21240AD15
75	20 to 80	AAA21240AD16
100	26 to 105	AAA21240AD17
125	32 to 130	AAA21250AD18

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**Table 3: Across-the-Line Connection, Mainline up to 480 VAC**

<b>Mainline 200–220 VAC</b>	<b>Mainline 200–220 VAC</b>	<b>Mainline 220–240 VAC</b>	<b>Mainline 440–480 VAC</b>	<b>Motor Full Load Current Range (Amps)</b>	<b>Soft Starter P/N</b>
<b>hp @ 200 VAC</b>	<b>hp @208 VAC</b>	<b>hp @230 VAC</b>	<b>hp @ 460 VAC</b>		
---	---	---	5 to 7.5	3 to 13	AAA21240AD11
5 to 10	5 to 10	5 to 10	10 to 25	10 to 39	AAA21240AD5
---	---	15	30	12 to 46	AAA21240AD6
15	15	20	40	15 to 60	AAA21240AD7
20	20	25	50	19 to 75	AAA21240AD8
25	25	30	60	23 to 90	AAA21240AD9
30 to 40	30 to 50	40 to 50	---	37 to 145	AAA21240AD10

**Table 4: Across-the-Line Connection, Mainline up to 600 VAC**

<b>Mainline 550–600 VAC</b>	<b>Motor Full Load Current Range (Amps)</b>	<b>Soft Starter P/N</b>
<b>hp @ 575 VAC</b>		
5 to 10	3 to 13	AAA21240AD11
15	5 to 20	AAA21240AD12
20	6 to 24	AAA21240AD13
25	10 to 31	AAA21240AD14
30	10 to 39	AAA21240AD15
40	12 to 46	AAA21240AD16
50	15 to 60	AAA21240AD17
60	19 to 75	AAA21250AD18

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### 5. Required Materials Checklist

- ☐ Type AAA21240AD Solid State Starter properly rated for the motor voltage, horsepower, and starting method.
- ☐ Solid State Starter instruction manual, ID 1.1.14-3, *Hydraulic Elevator Pump Motor Soft Starter Installation* (included with starter unit)
- ☐ 10 ft. of type THHN wire for starter mainline power; refer to jobsite survey for size
- ☐ Motor up to speed relay, MUSR (p/n AAA613DL31)
- ☐ RC suppressor for MUSR relay (p/n AAA613DL61)
- ☐ PM auxiliary relay, PMX (p/n AAA613CZ9); required for Controller Type 1 only
- ☐ Socket, for PMX (p/n AAA618AF6); required for Controller Type 1 only
- ☐ Power Terminal Block, PTB, 14 AWG to 2/0 (p/n 303DH16); if required per jobsite survey
- ☐ Cover for Terminal Block p/n 303DH16 (p/n 303DH4)
- ☐ Power Terminal Block, PTB, 6 AWG to 350 MCM (p/n 303DH12); if required per jobsite survey
- ☐ Cover for Terminal Block p/n 303DH12 (p/n 303DH2)
- ☐ 25 ft. of 18-gauge, 600 V wire for control wiring
- ☐ Butt splices to complete motor wiring as
- ☐ Labels, to tag wires
- ☐ 5/32 in., 13/64 in. drill bits
- ☐ 1/4-20, 10-32 taps and tap wrench
- ☐ Four each 10-32 x 1 inch screws, nuts, and washers
- ☐ Long and short nylon wire ties (p/n AAA652AA1 and AAA652AA2), as needed
- ☐ Hand tools, small drill motor, drop cord, lights, and tape measure

### Prepare the Work Area

1. **Remove the elevator from service and operate the main line disconnect switch. Lock out and tag out the main line disconnect, test and verify that the main line voltage has been removed from the controller.**
2. Locate the car lighting circuit. Remove power from the car lighting circuit by operating and locking the local disconnect or circuit breaker. **Test and verify that car lighting voltage has been removed from the controller.**



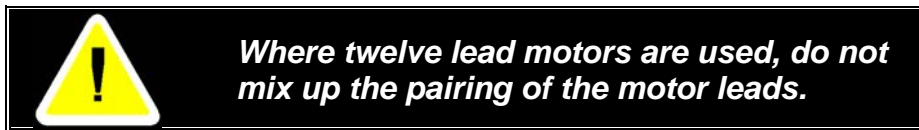
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3. If the controller is part of a duplex or group, to identify the location, source, and level of any interconnection voltage that may be present. If adequate local measures cannot be taken to ensure the safety of the installer from hazards presented by interconnection voltages, this process must be done with **all** interconnected cars turned off, **locked out and tagged out**.

### Remove Existing Starter

1. Refer to Figures 4, 5, 6, and 7. Identify, tag, and disconnect motor leads T1, T2, T3, T4 (T10), T5 (T11), and T6 (T12) from pump motor contactor(s). In some arrangements, the motor leads may be identified as MOT1, MOT2, etc.



2. Disconnect all heavy gauge wiring from the overload (identified as PTO or OL) terminals at both ends. Some arrangements will also have light gauge wires to the reverse phase relay and/or transformer that must be relocated to the power terminal block.
3. Refer to Figures 8, 9, and 10. Locate the connections from the motor thermal contact, MTC. Disconnect and tag both leads. Retain for use with the new starter.
4. Locate the overload contact, OL or PTO, and disconnect all wires.
5. Locate the pump motor contactor(s), PMC or MC, LC and timer, T if Wye-Delta; disconnect at the A2 terminal(s).
6. Locate the PMC and MC auxiliary contacts. Disconnect the wires at the contacts and tag according to the wiring diagram (MC-13, PMC-21, etc.). These wires will be re-connected to the "motor up to speed relay" (MUSR) that is used with the new starter.
7. Physically remove the pump motor contactor(s), PMC or MC, LC and timer, T if Wye-Delta starter. Remove the overload. Save the mounting hardware.
8. Unbolt the equipment ground block from the controller to get more working clearance, **but do not remove wires**.
9. Unbolt power terminal block (PTB), if present, to get more working clearance, **but do not remove wires**.

## ACROSS THE LINE STARTING

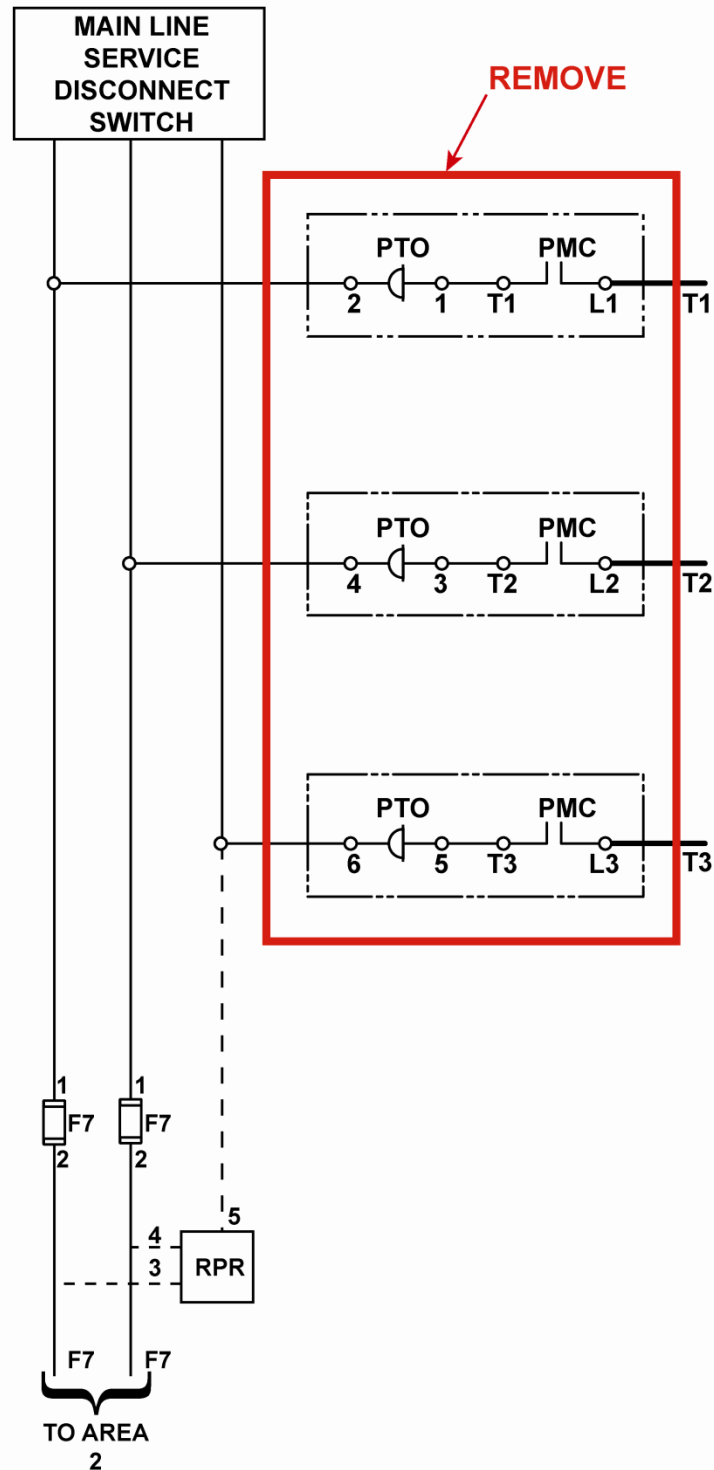


Figure 4: Removal of Across-the-Line Starter Overload and Motor Contactor

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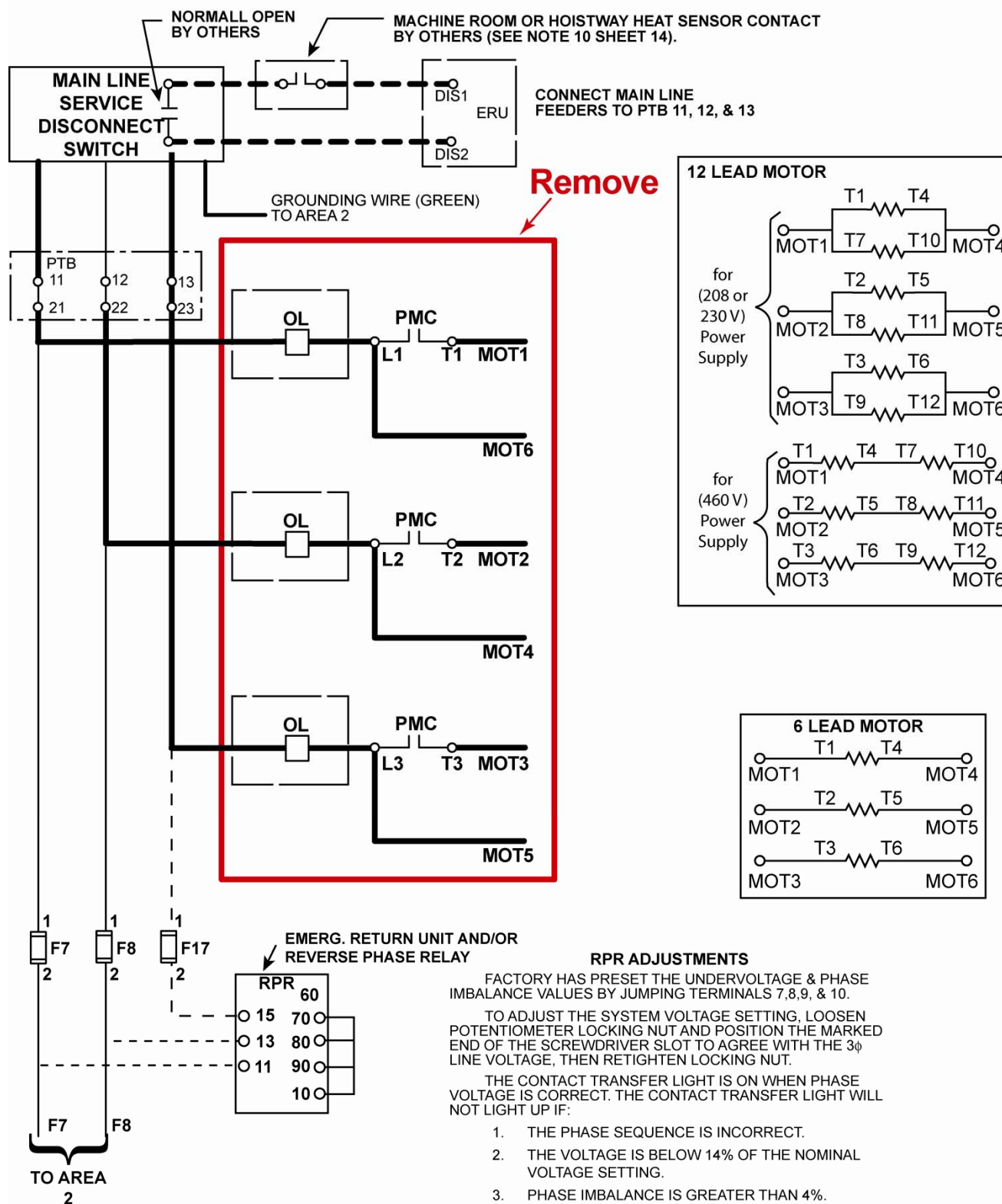


Figure 5: Removal of Inside-Delta Starter Overload and Motor Contactor

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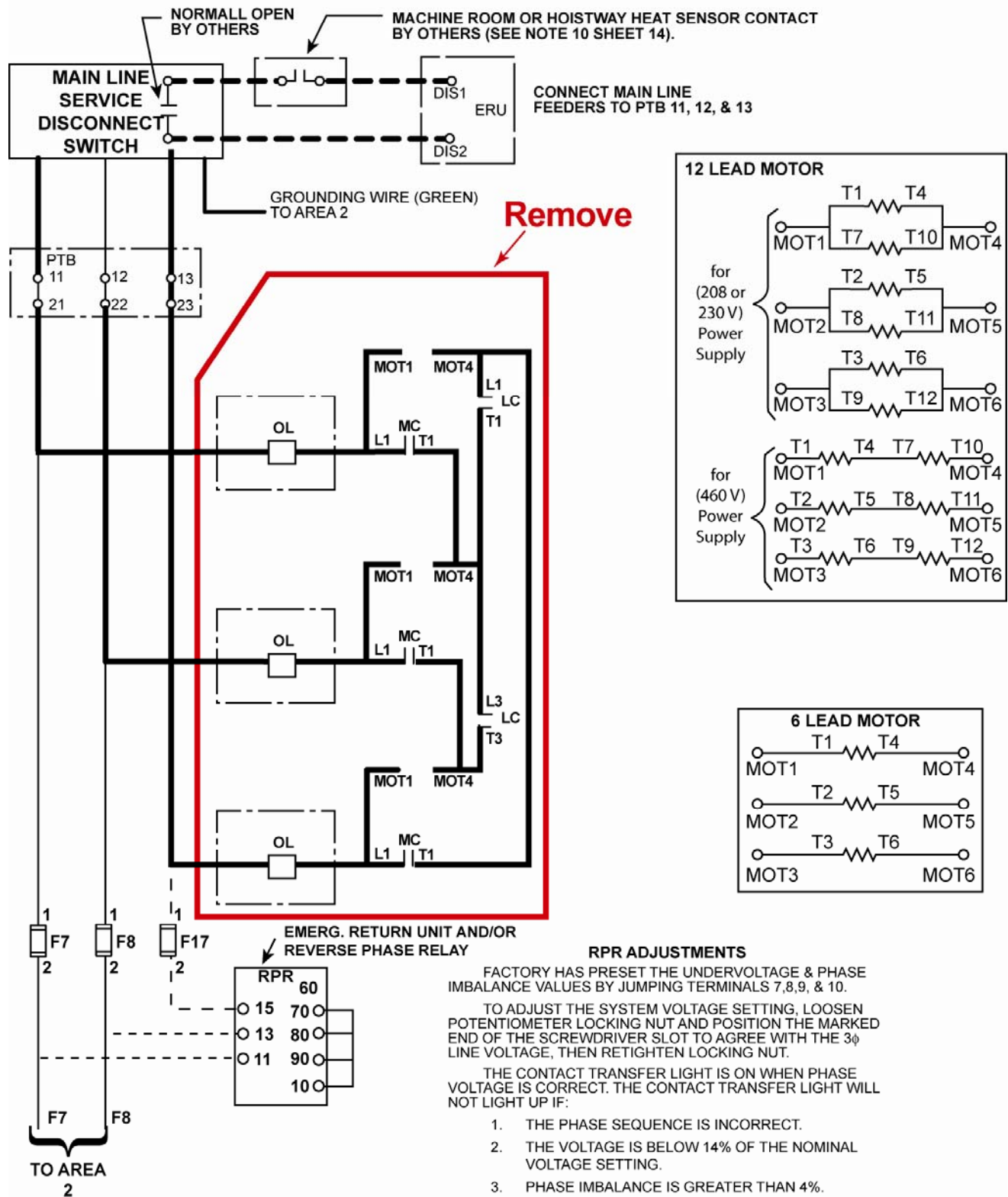


Figure 6: Removal of WYE-DELTA Motor Contactors and Overload



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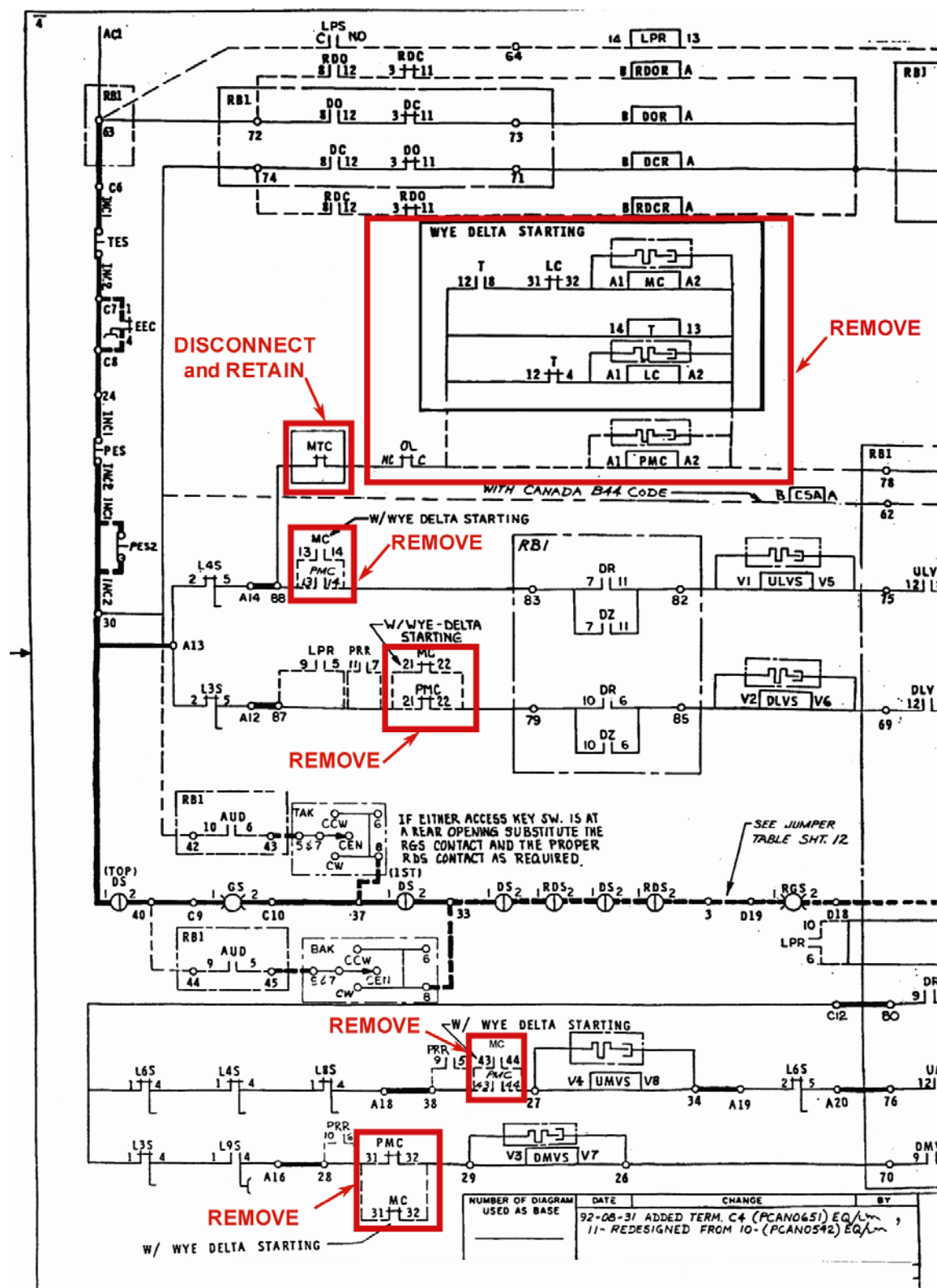
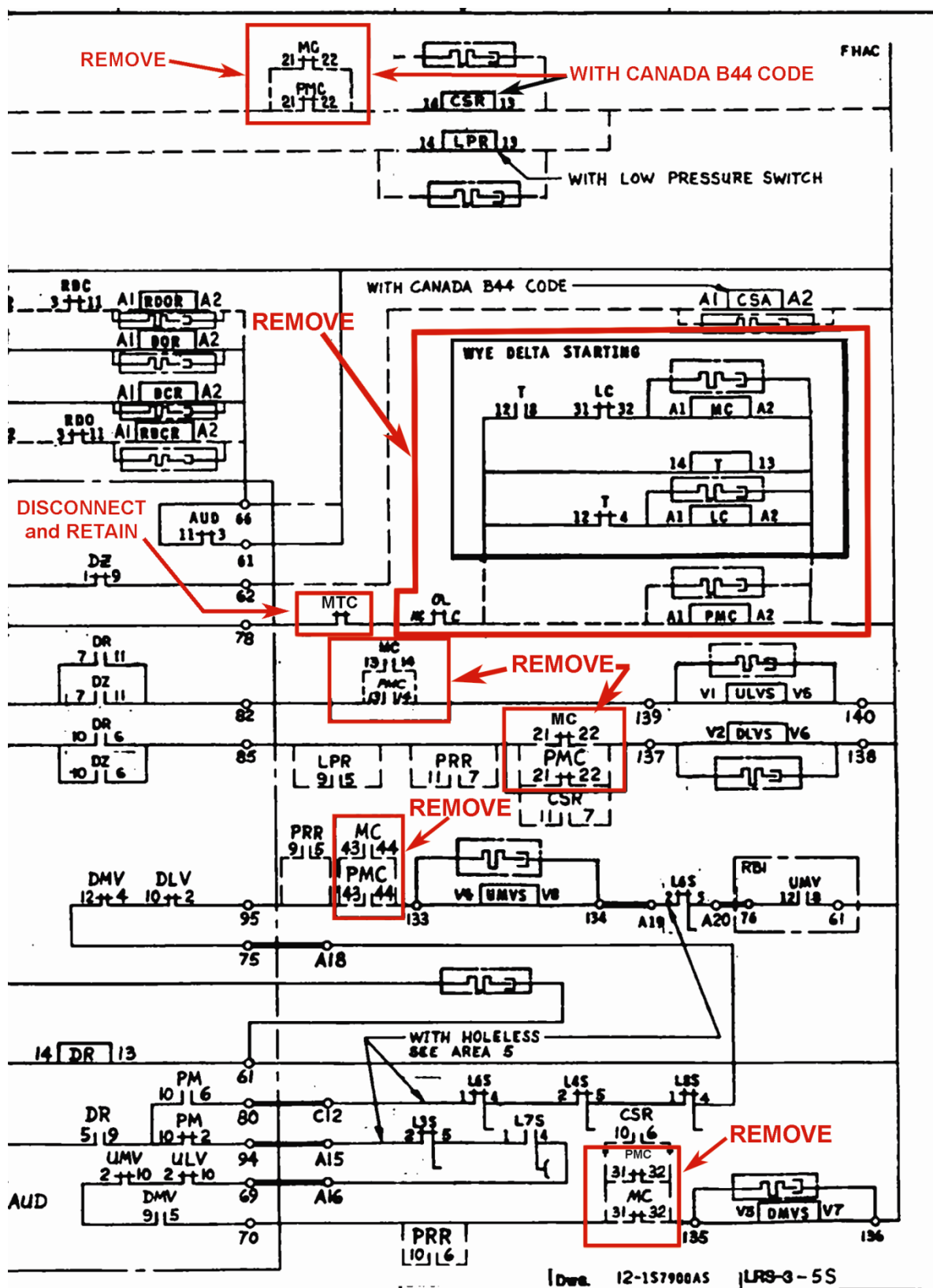


Figure 8: Removal of PMC or MC/LC with PM Contact on HL1 (120 V RTN) Side of PMC or MC/LC



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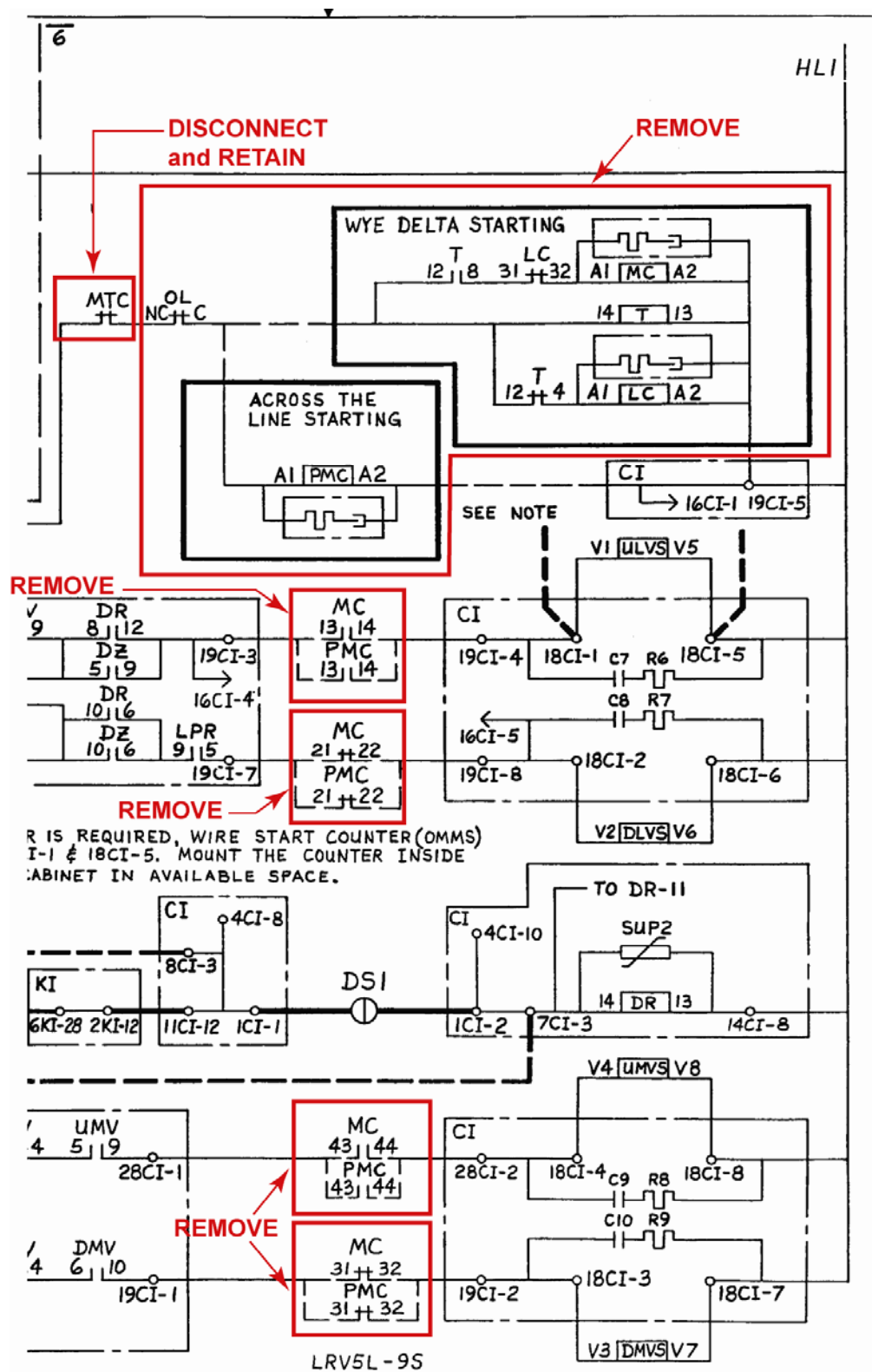
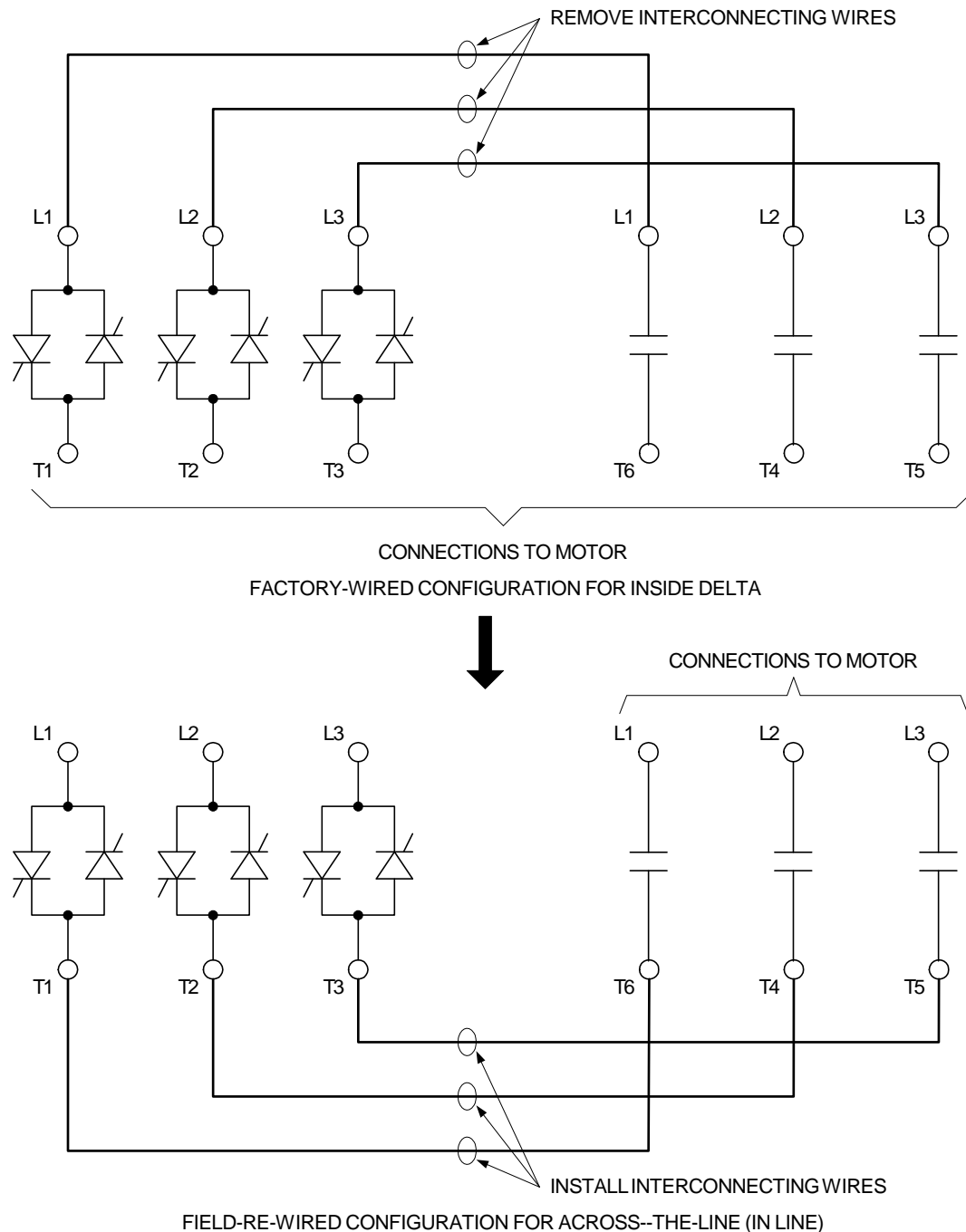


Figure 10: Removal of PMC or MC/LC with PM Contact on 120 VAC Side of PMC or MC/LC and Cab Interface Board



## 8. Wye-Delta to Across-the-Line Conversion

Check the job site survey (in section 3) to verify the starting method. If the starting method is across-the-line, the solid state starter needs to be re-wired as shown in Figure 11, *Starter Conversion From Inside-Delta to Across-the-Line*. Remove the heavy gauge interconnecting wires and re-connect as shown in Figure 11. Refer to ID 1.1.14-3, *Soft Starter Installation Manual*, section 3.4.2 for additional information.



**Figure 11: Starter Conversion from Inside-Delta to Across-the-Line**

## 9. Install the New Starter and Associated Components

1. Place the new Solid State Starter in the controller, clearing wires as necessary. It may be necessary to relocate the transformer (TR) to gain enough mounting space. When the starter is centered and aligned, mark the back of the controller through the mounting holes on the starter base plate. Drill and tap holes for the original (1/4-20) mounting hardware.
2. Mount the new starter in the controller using 1/4-20 hardware.
3. Re-install the equipment ground block to controller.
4. Install a power terminal block, PTB, if not provided in the existing controller. Label the terminal block PTB; number one side 11, 12, and 13; number the opposite side 21, 22, and 23. Locate the PTB such that the mainline supply can be connected without splicing.
5. Mount p/n AAA613DL31, motor up to speed relay, in the controller as space allows. Label the relay "MUSR".
6. For Controller Type 1 only (refer to section 3.2), mount p/n AAA618AF6, relay socket, as space allows. Install p/n AAA613CZ9, PM auxiliary relay in the socket. Label the relay as "PMX".

## 10. Solid State Starter Power Wiring

1. Refer to Figures 12 and 13. If a PTB power terminal block was added, terminate the mainline at PTB-11, 12, and 13.
2. Connect the new Solid State Starter to the power terminal block (PTB) as follows:
  - PTB-21 to starter unit L1
  - PTB-22 to starter unit L2
  - PTB-23 to starter unit L3
3. For Across-the Line starting (Figure 12) connect:
  - Motor lead T1 (or MOT 1) to starter unit (contactor side) L1
  - Motor lead T2 (or MOT 2) to starter unit (contactor side) L2
  - Motor lead T3 (or MOT 3) to starter unit (contactor side) L3
4. For Inside-Delta starting (Figure 13) connect:
  - Motor lead T1 (or MOT 1) to starter unit T1
  - Motor lead T2 (or MOT 2) to starter unit T2
  - Motor lead T3 (or MOT 3) to starter unit T3
  - Motor lead T4 (or MOT 4) to starter unit T4
  - Motor lead T5 (or MOT 5) to starter unit T5

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- Motor lead T6 (or MOT 6) to starter unit T6

Figure 12: Power Wiring to Motor and Solid State Starter for Across-the-Line Starting

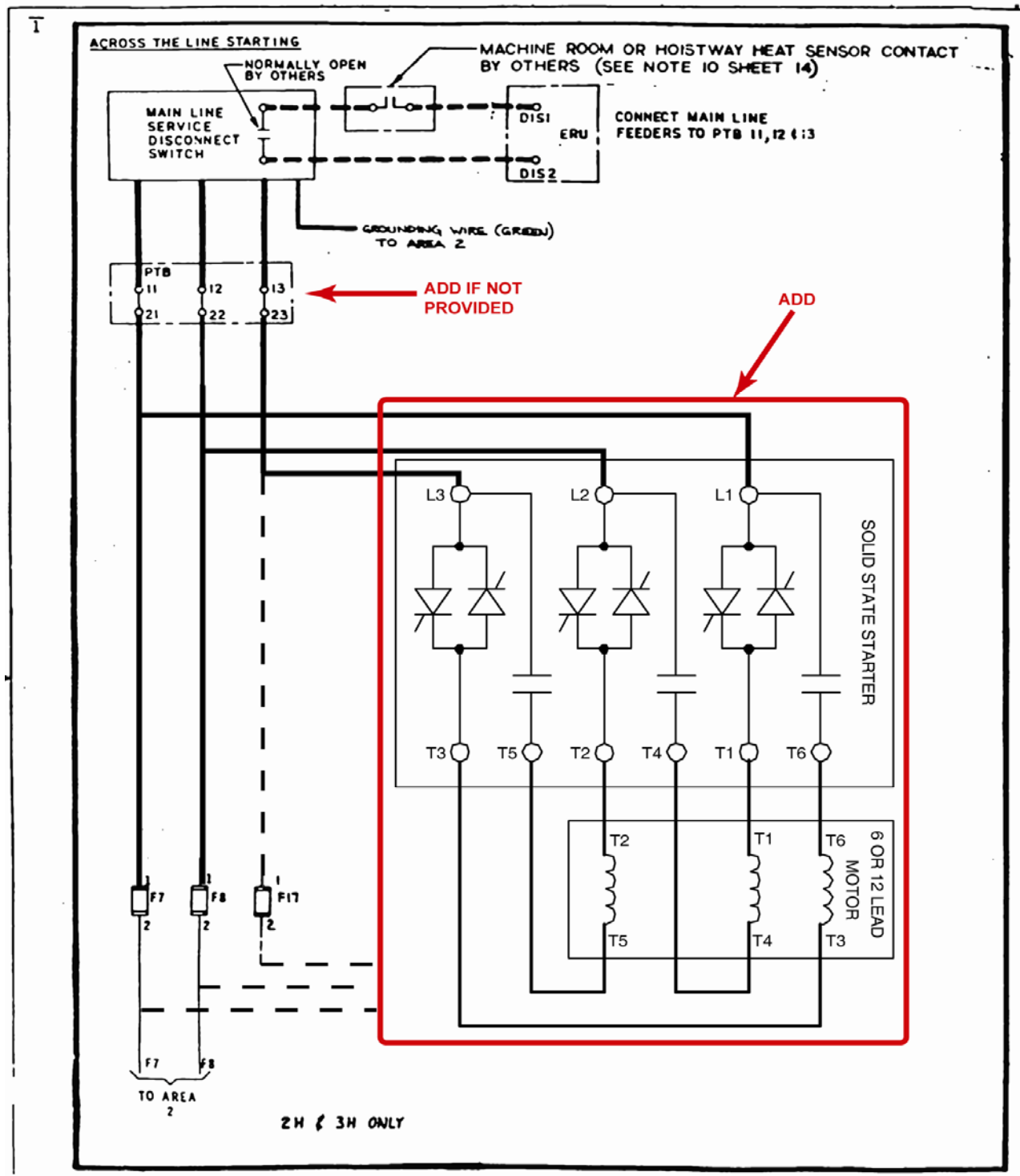


Figure 13: Power Wiring to Motor and Solid State Starter for Inside-Delta Starting

## 11. Controller Type 1 PMX Relay Wiring

Refer to Figure 14.

- Connect PMX-13, 14 between RB1-78 and RB1-83.
- Jump PMX-9 to PMX-10.
- Connect PMX-5 to PMX-14.
- Connect PMX-6 to Solid State Starter A1.

## 12. Starter control Circuit and MUSR Relay Wiring

- For Controller Type 1, refer to Figure 14.
- For Controller Type 2, refer to Figure 15.
- For Controller Type 3, refer to Figure 16.

Also refer to ID 1.1.14-3, *Soft Starter Installation Manual*, section 3.5, for a description of control signals, terminal layout, and a typical wiring diagram.

### 12.1 Starter Wiring

- a) Install p/n AAA613DL61, suppressor, between MUSR-A1 and A2.
- b) Connect MUSR-A1 to solid state starter-18 and MUSR-A2 to solid state starter-B2.
- c) Jump solid state starter-B1 to 17 and 17 to 27.
- d) Connect one side of the MTC contact to solid state starter-B1.
- e) Connect the other side of MTC to AC1/120 VAC downstream of the PES. Refer to the contract wiring diagram to find a suitable terminal.
- f) Connect solid state starter-B2 to HL1/120 V rtn. Refer to the contract wiring diagram to find a suitable terminal.

### 12.2 MUSR Wiring

The new motor up-to-speed relay (MUSR) interlocks the hydraulic control valve with the solid state starter. It is used to prevent a load from being applied to the motor before it is up to speed. The MUSR contacts replace existing PMC or MC auxiliary contacts that interlocked the UP and DOWN valves with the existing starter. Some arrangements of controllers did not have PMC or MC interlock contacts in series with each valve. If this is the case, an MUSR contact will be added and wired in series with the valve on the 120 VAC supply side as shown in Figures 14, 15, and 16.

For controllers that had PMC or MC auxiliary contacts in series with each valve (ULVS, UMLS, DLVS, DMVS) valves:

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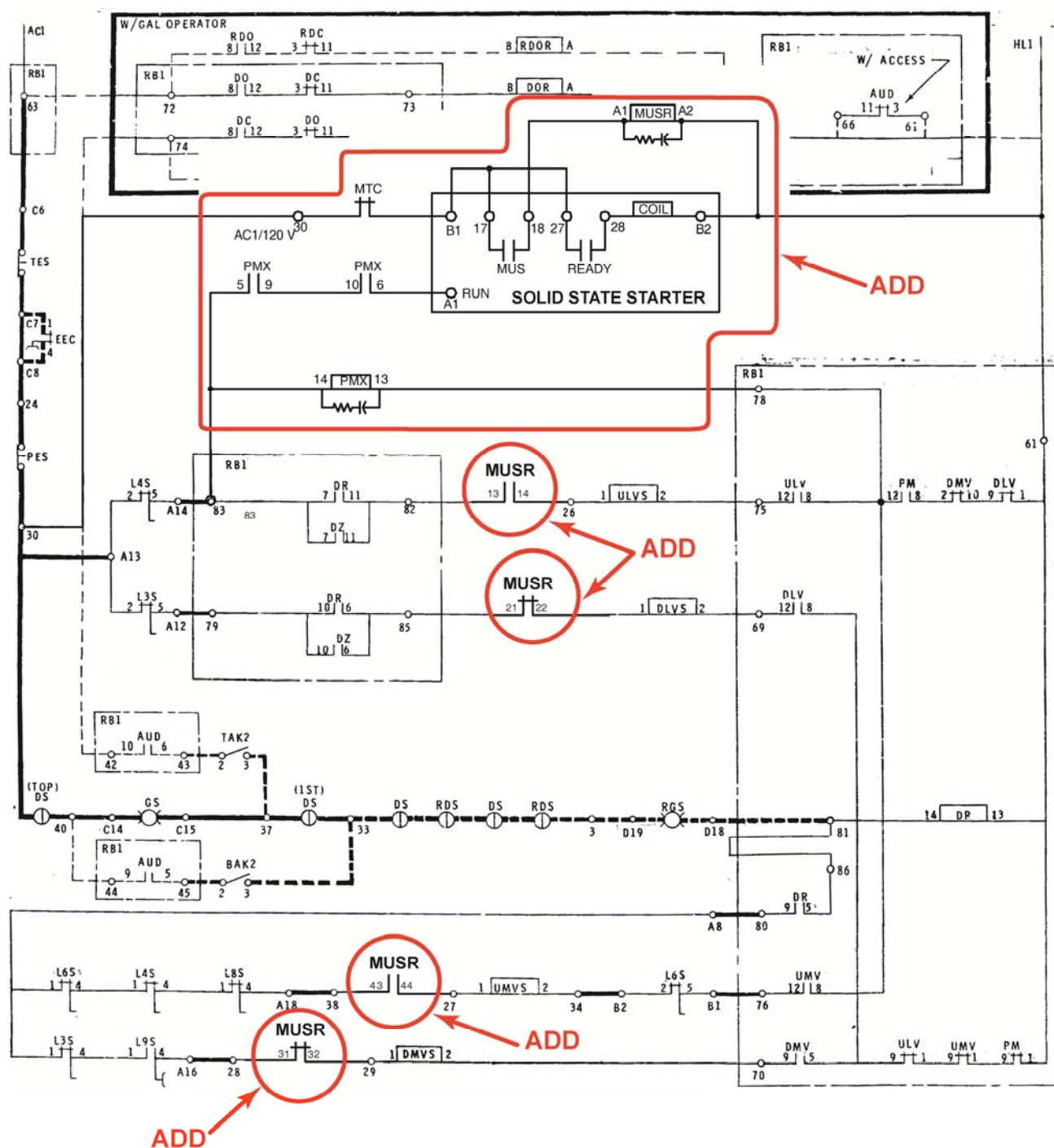


Figure 14: Solid State Starter, PMX, and MUSR with PM Contact on HL1 (120 V RTN)  
Side of Run Input

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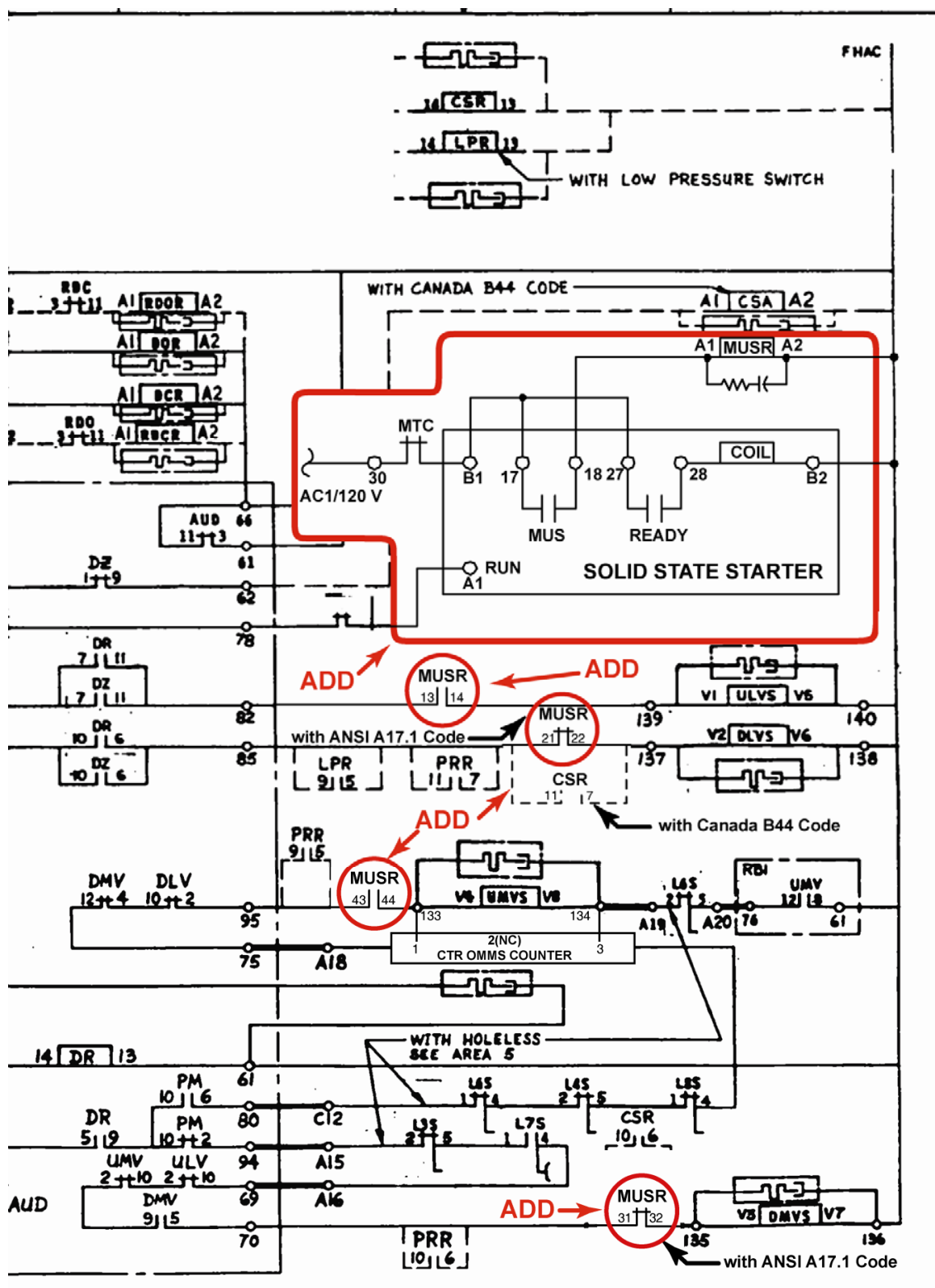


Figure 15: Solid State Starter and MUSR with PM Contact on 120 VAC Side of Run Input



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- Connect the wires tagged MC or PMC-13, MC or PMC-14 to MUSR-13, 14 (NO).
- Connect the wires tagged MC or PMC-21, MC or PMC-22 to MUSR-21, 22 (NC).
- Connect the wires tagged MC or PMC-31, MC or PMC-32 to MUSR-31, 32 (NC).
- Connect the wires tagged MC or PMC-43, MC or PMC-44 to MUSR-43, 44 (NO).

For controllers that did not have a PMC or MC auxiliary contact in series with each valve, wire an MUSR contact on the 120 VAC supply side of ULVS, UMVS, DLVS, and DMVS. Use Figures 14, 15, and 16 as examples.

- Connect MUSR-13, 14 (NO) in series with ULVS.
- Connect MUSR-21, 22 (NC) in series with DLVS.
- Connect MUSR-31, 32 (NC) in series with DMVS.
- Connect MUSR-43, 44 (NO) in series with UMVS.

### 13. Final Assembly

1. Remove all debris from the controller cabinet. Inspect for metal chips, nuts, bolts, washers, and other hardware that could affect operation.
2. Inspect the installation checking for wiring errors, loose connections and wire strands. Dress the wires into neat bundles with wire ties. Route the power connections to the starter from the mainline and motor.
3. Turn on the mainline power. Measure the voltages listed in Table 5:

**Table 5: Startup Voltage Measurements**

Measurement	Expected Value
Starter L1 – L2	Site Survey L1 – L2
Starter L2 – L3	Site Survey L2 – L3
Starter L1 – L3	Site Survey L1 – L3
Starter B1 – B2	120 VAC +/- 10 %

### 14. Starter Adjusting

Refer to ID 1.1.14-3, *Soft Starter Installation Manual*, section 4, enclosed with the starter unit for setup, adjusting, and troubleshooting instructions. The motor full load current is required to set the overload. Use a value from Table 6 if the full load current is not listed on the motor nameplate or is otherwise not accessible.



**SOLID STATE STARTER INSTALLATION FOR LRS/LRV/LHM****Table 6: Full Load Current in 3-Phase AC Motors\***

HP	200 VAC	208 VAC	230 VAC	460 VAC	575 VAC
5	17.5	16.7	15.2	7.6	6.1
7.5	25.3	24.2	22	11	9
10	32.2	30.8	28	14	11
15	48.3	46.2	42	21	17
20	62.1	59.4	54	27	22
25	78.2	74.8	68	34	27
30	92	88	80	40	32
40	120	114	104	52	41
50	150	143	130	65	52
60	177	169	154	77	63
75	221	211	192	96	77
100	285	273	248	124	99
125	359	343	312	156	125
150	414	396	360	180	144

\* From National Electric Code Table 430.250

## 15. Test and Return to Service

1. Verify the display on the starter reads "Motor Status Stopped". If not, refer to the troubleshooting guide in the starter instruction manual.
2. Use a temporary jumper to apply 120 VAC to starter terminal A1 to run the motor. The motor should start and after a couple of seconds the display change to "Motor Up To Speed". The motor-up-to-speed relay (MUSR) should pick. Remove the jumper from starter-A1.
3. Attempt to move the car in the up and down directions. If the car fails to move in the up direction when the motor is running, check the voltage on ULVS-(V1 or 1) and UMVS-V4 or 1). It should be 120 VAC. If not, check the wiring at MUSR 13, 14 and MUSR 43, 44. If the car fails to move in the down direction when the motor is stopped, check the voltage on DLVS-(V2 or 1) and DMVS-(V3 or 1). It should be 120 VAC. If not, check the wiring at MUSR 21, 22 and MUSR 31, 32.
4. Place full load in the car and make a normal run up. If the car shuts down on the up run and the starter display reads "Fault Overload", verify the starter parameter "Overload Amps" is set to the full load current value listed in Table 6 for the correct motor HP /voltage.
5. Notify the customer the job is complete and return the car to service.

## Appendix A: Part Numbers

Table 7 lists all part numbers this document mentions.

**Table 7: Related Part Numbers**

<b>Description</b>	<b>Part Number</b>
Adhesive Label, 0.25 in. x 1.50 in.	102NC1
Cover (for p/n 303DH12)	303DH2
Cover (for p/n 303DH16)	AAA303FT100
Motor Up to Speed Relay	AAA613DL31
PMX Relay, 4 form C	AAA613CZ9
RC Suppressor	AAA613DL61
Socket, for PMX	AAA618AF6
Solid State Starter	AAA21240AD
Terminal Block, PTB (14 AWG to 2/0)	303DH16
Terminal Block, PTB (6 AWG to 350 MCM)	303DH12
Wire Tie, 5.5 in. Long	AAA652AA2
Wire Tie, 7 in. Long	AAA652AA1

## Appendix B: Related Documents

Table 8 lists all documents this document mentions, as well as documents that contain further information on the topics in this TIP.

**Table 8: Related Documents**

Document ID	Title
1.1.14-3	<i>Hydraulic Elevator Pump Motor Soft Starter Installation (included with starter unit)</i>