Hubbell Industrial Controls, Inc.

S²MC Compact Static Reversing Controller

4922c
Instruction Manual
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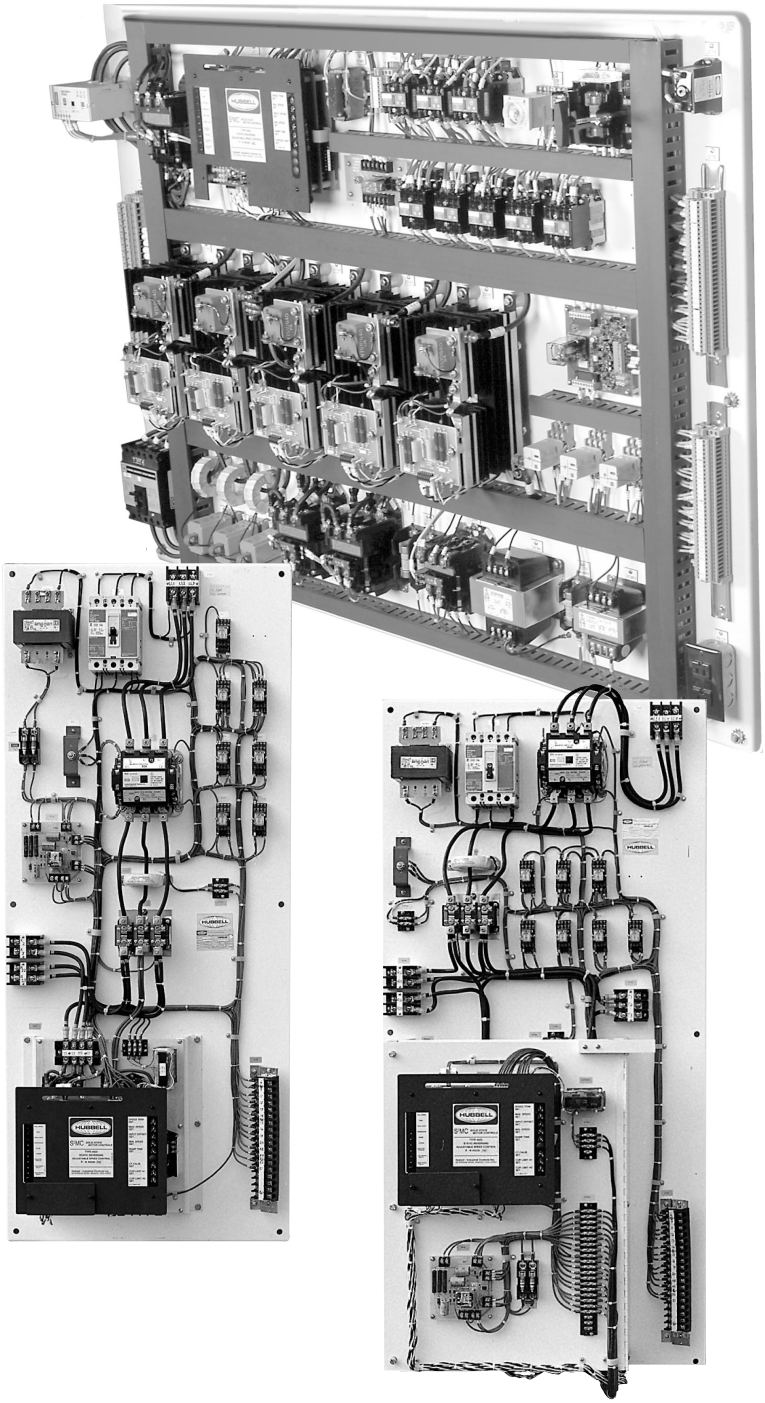
Hubbell Compact Static Reversing Controller for Hoists without Load Brakes



General Description

The Type 4922C Static Reversing Controller is a solid state adjustable speed motor controller utilizing compact unitized construction and providing speed regulated control of wound rotor motors. The motor speed is controlled by varying the motor primary voltage via primary SCR bridges, and the direction of motor rotation is controlled by selecting the appropriate SCR bridges for the commanded function. The adjustable speed control unit varies the SCR bridge firing signals and the SCR bridge selection in response to a changing motor speed reference signal. The retarding torque during the reduced speed lowering operation is provided by motor counter torque. The retarding torque during full speed lowering can be provided by true motor and system regeneration. Motoring to counter torque transitions and vice versa are automatic and are controlled by the adjustable speed control unit in response to motor loading conditions.

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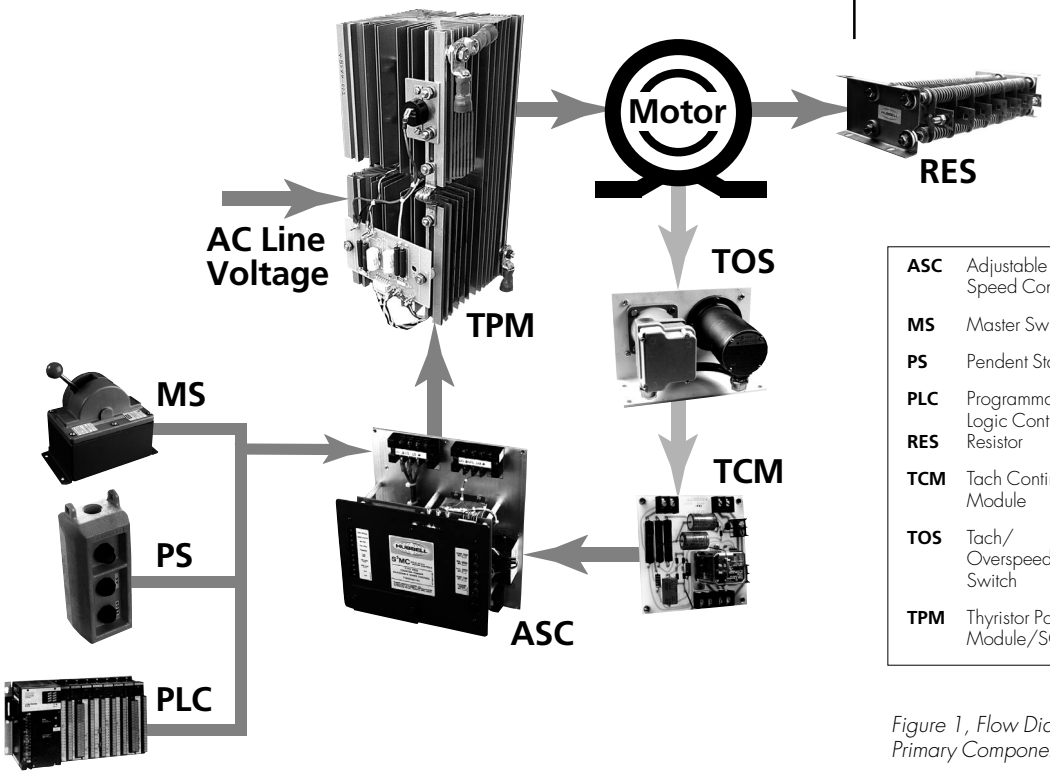
Static Control Panel Layout

The start-up adjustments of the 4922C Static Control Controller involve setting the control potentiometers and jumper plugs, verifying relay operation and wiring connections. Prior to installing and adjusting this equipment, it is important to fully understand the equipment, components, controls and adjustments.

This section will provide an understanding of the 4922C controller. On the following pages are a flow diagram of primary components, a control board with major components called out, and a detailed view and description of the Adjustable Speed Controller.



ASC	Adjustable Speed Control
MS	Master Switch
PS	Pendent Station
PLC	Programmable Logic Control
RES	Resistor
TCM	Tach Continuity Module
TOS	Tach/ Overspeed Switch
TPM	Thyristor Power Module/SCR

Figure 1, Flow Diagram of Primary Components

Adjustable Speed Controller

Following is a description of the adjustments and their functions located on the Adjustable Speed Controller. Refer to figure 2 for their respective locations.

Permissive Jumper (PERM)

This jumper has two positions. The left position is the "Setup" position and allows the ramp circuit adjustments to be made without operating the firing circuits. The right position is the normal "Run" position. In this position the firing circuit permissive signal is active and the firing circuits will operate. Note: with the jumper in the "Setup" position, the remaining control circuit will be active and holding brakes may be released when direction control commands are issued. To prevent unintended motion, disable the brake control circuit by removing the brake circuit fuses.

Ramp Select Jumper (RAMP SEL)

This jumper has two positions. The upper position, "Internal", is the most common position, and connects the internal ramp signal to the speed regulator circuit. The lower position, "External", is used when the speed regulator circuit is to operate with an outside reference signal such as when two or more drives are to be speed matched from a common ramp signal. Unless the application involves a speed matching function with two or more drives operating in a "Master/ Slave" arrangement, place the Ramp Select jumper in the "Internal" position.

RPM Select Jumper (RPM SEL)

This jumper has five positions, and provides the correct scaling factor for the system tachometer based on the synchronous speed of the driven motor.

The jumper positions available are: 1800, 1200, 900, 720 and 600 rpm

For systems not using a Tachometer/Overspeed Switch assembly, place the RPM Select jumper in the corresponding synchronous speed position for the motor used. If a Tachometer/Overspeed Switch assembly is used, place the RPM Select jumper in the 1200 rpm position. This is necessary because the incorporated tachometer is geared for 1200 rpm operation at motor synchronous speed.

Torque Select Jumper (T/L SEL)

This jumper is used to select the limited torque value supplied by the motor during counter-torque and plugging operations. The "HI" position, recommended for hoisting applications, limits motor torque to 200–250% during counter torque. The "MED" position limits torque to 150%, and the "ADJ" position provides an adjustable range of 50% to 150%. Initially place this jumper in the "HI" position.

Plugging/ Counter-Torque Relay Jumper (J10 J9)

This jumper is used to select the operation conditions for the external plugging/counter torque relay.

In the right position, "CNTR", the relay will operate whenever the motor is operating in counter-torque. In the left position, "PLUG", the relay will operate only during a commanded plugging direction change. Most applications will use the right counter torque position, "CNTR".

Speed Trim Potentiometer

The Speed Trim Potentiometer is used to make fine adjustments in system speed. In typical single motor applications or in multi-motor applications where the motors operate independently, this adjustment should be set to the "50" position. In "Master/Slave" speed matching applications with the Master drive set to the "50" position, this adjustment allows the "Slave" drive to be trimmed to match the speed of the "Master" drive. Initially, set this pot to the "50" position.

Minimum Speed Potentiometer

The Minimum Speed Potentiometer sets the minimum speed signal level out of the ramp circuit. Typically, this potentiometer is set at the "20" position.

Maximum Speed Potentiometer

The Maximum Speed Potentiometer determines the amount of scaling that is applied to the input speed reference signal. After the minimum speed signal level has been set, this adjustment will set the full speed level of the input speed reference signal. Typically, this potentiometer is set to the "80" position.

Input Offset Potentiometer

This potentiometer is used to remove residual first point master switch or pendant speed reference signal arising from a speed reference potentiometer without an off-point shorting band. Initially, this potentiometer should be set to the "35" position.

Ramp Time Potentiometer

The Ramp Time potentiometer sets the slope of the output ramp signal to the speed regulator circuit. The adjustment range is from 0.5 seconds at the full counterclockwise position to 10.0 seconds at the full clockwise "100" position. This adjustment determines how quickly the ramp output signal is allowed to increase or decrease. Initially, this potentiometer is set fully counterclockwise to the "0" position.

Torque Limit Set

This potentiometer sets the value of limited motor torque during counter-torque or plugging operations when the torque select jumper, described above, is placed in the "ADJ" position. The adjustment range is from 50% to 150%. Initially, set this potentiometer fully clockwise to the "100" position.

LSR Trim Potentiometer

This adjustment is located directly on the main regulator board and sets the motor speed value above which the "LSR" LED will light, and the LSR relay will pick up. The pickup adjustment range is 15% at full counterclockwise to 35% when fully clockwise. Set this potentiometer mid range for a 25% pickup.

HSR Trim Potentiometer

This adjustment is located directly on the main regulator board and sets the motor speed value above which the "HSR" LED will light, and the HSR relay will pick up. The pickup adjustment range is 85% at full counterclockwise to 100% when fully clockwise. Set this potentiometer fully counterclockwise.

Gain Potentiometer

This potentiometer is located on the main regulator board and is used to adjust system stability. Initially, set this potentiometer mid range.

Null Potentiometer

This potentiometer is located on the main regulator board and is used to adjust the speed regulator offset. This is a factory adjustment and needs no further attention. Should the setting of this potentiometer be disturbed, return the setting to a mid range position.

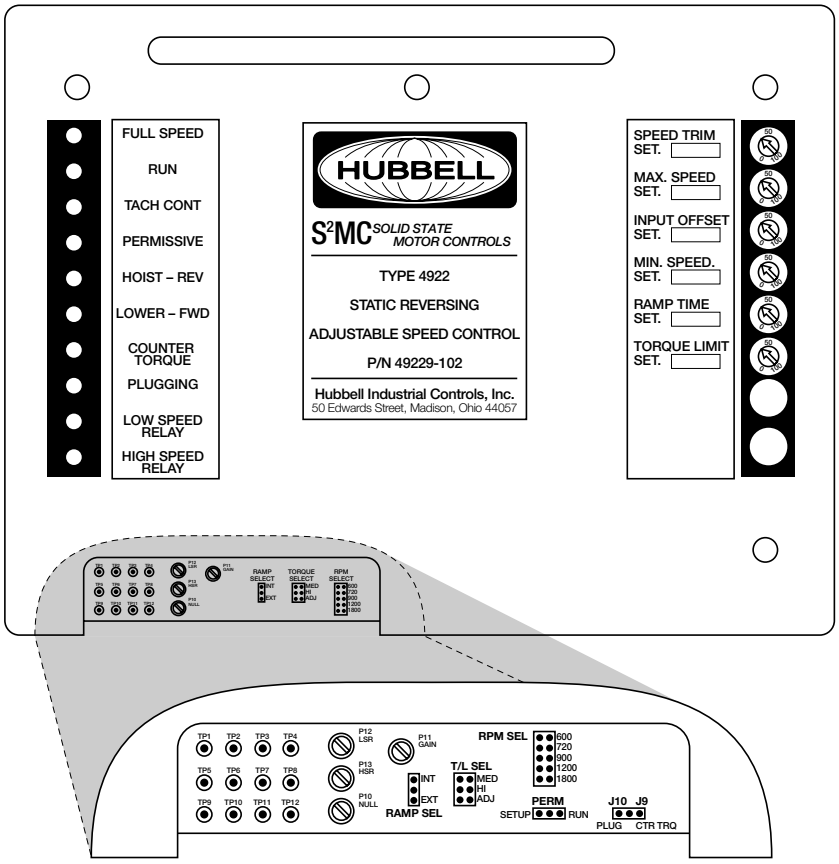
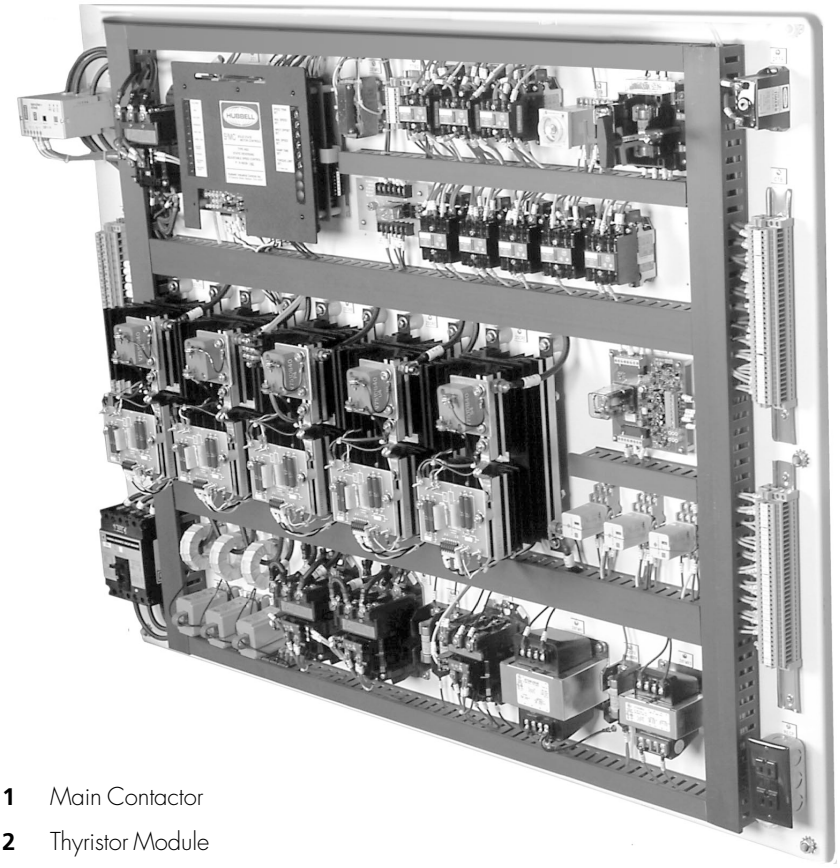
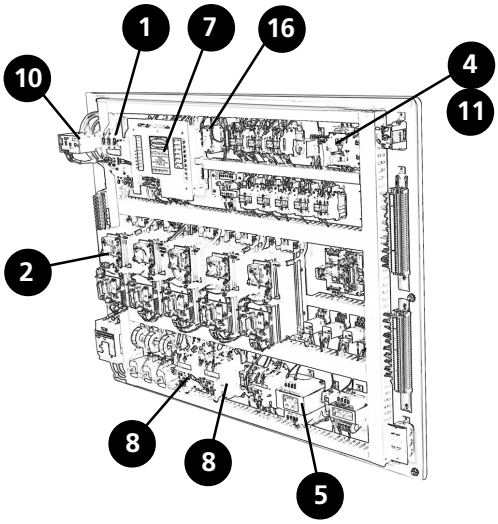


Figure 2, Variable Speed Controller Adjustments, Potentiometers, Test Points, Jumpers & LEDs

Major Components





Shown is a typical hoist application controller arrangement for motors in the 75–100 hp (460V) range.

1 Main Contactor

2 Thyristor Module

3 Main Circuit Breaker

4 Control Circuit Disconnect

5 Control Transformer

6 Tach. Continuity Module

7 Adjustable Speed Control Module

8 Secondary Contactor

9 Full Speed Contactor

10 Overload Relays

11 Fuses

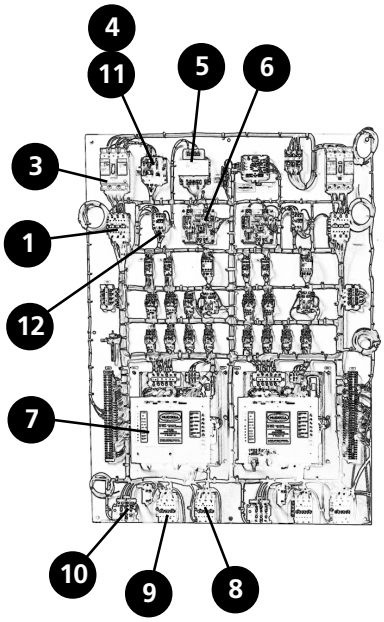
12 Brake Relay

13 Step Reference Board *(not shown)*

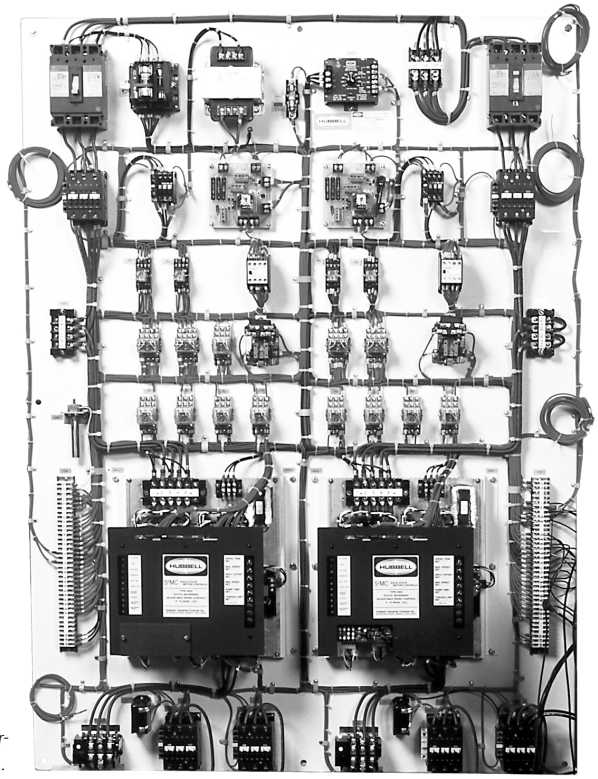
14 Main Knife Switch *(not shown)*

15 Control Knife Switch *(not shown)*

16 Synchronizing Transformers



Shown is a typical dual hoist application controller arrangement for motors in the 40–50 hp (460V) range.



Installation & Adjustment

Prior to attempting to fine tune the installation of this equipment, completely familiarize yourself with all the major components and adjustments discussed on the previous pages.

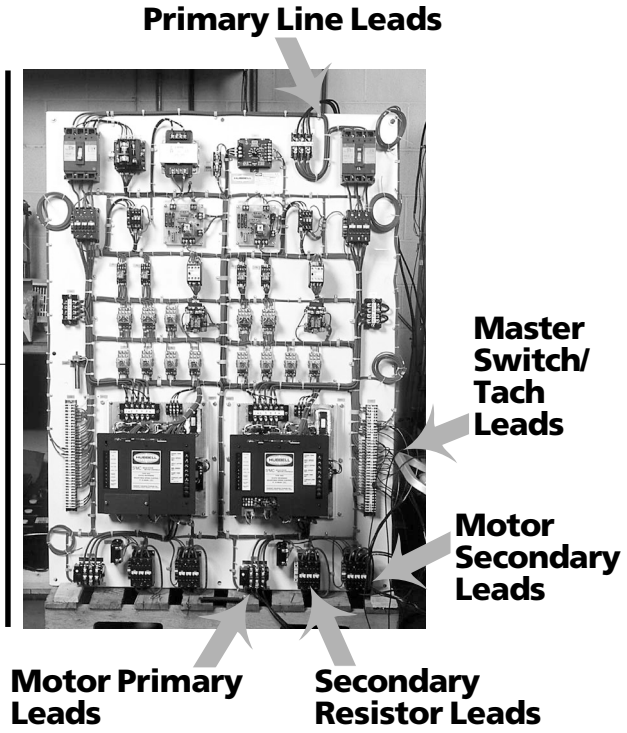
Note: The equipment as shipped from Hubbell's factory is fully tested and factory preset. This procedure is for fine tuning the installation. If a particular function or aspect of this panel is not operating properly, the problem is usually in the field wiring.

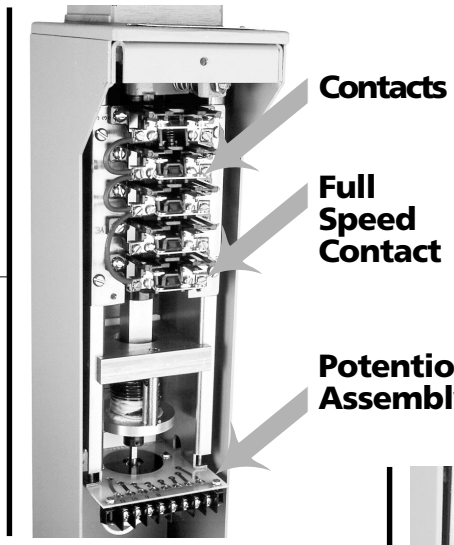
Initial Inspection & Installation

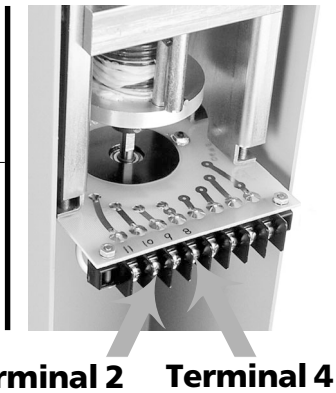
1. Upon receipt, check each item. If shipping damage is evident, contact the carrier immediately.
2. Maximum storage temperature should not exceed 70°C (158°F). Typical operating ambients should not exceed 55°C (131°F). Minimum ambient temperature must not be less than –40°C (–40°F). Avoid contaminated atmospheres.
3. Install resistors. Exercise caution when wiring as the resistor element operates at 375 °C (707°F).
4. Install the master switch(es), pendant and/or radio receiver.
5. Wire equipment per wiring diagrams. Observe local code for correct wire size, grounding, etc.

Master Switch, Pendant, and/or Radio Control Setup

6. Become familiar with the various wiring connections coming into the panel. Identify the main power leads, master switch leads, "T" & "M" motor leads, overload relays and any control options provided with the system.
7. Remove the cover from the Master Switch, pendant, and/or open the radio control cabinet.
8. Check that all the contacts in the master switch or pendant are free and moving properly. If so equipped, check that the radio control output relay contacts are closing in the correct sequence.
9. Identify the full speed contacts. Verify that they are the last to close when the master switch, pendant, and/or radio control transmitter lever is moved to the last speed point in each direction.
10. The Type 4216 Master Switch is typically supplied with a 2kΩ, 0° dead band, center tapped speed reference potentiometer. Check the off-point position of the Master Switch potentiometer by measuring the resistance between Terminals 2 and 4 on the potentiometer assembly. The off-point resistance should be 0–5Ω. If this resistance range is not present, mechanical adjustment will be needed:



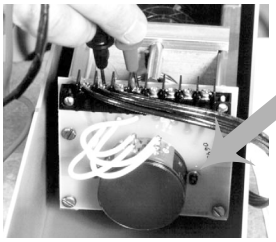




a. Use a $^{3}/_{32}$" allen wrench to slightly loosen the two allen screws that clamp the potentiometer to the potentiometer assembly.

b. While reading the resistance between Terminals 2 & 4, carefully rotate the potentiometer until an ohmmeter reading of 0–5Ω is obtained.

c. Carefully tighten the allen screws and reverify the ohmmeter reading on Terminals 2 & 4 of the potentiometer assembly.



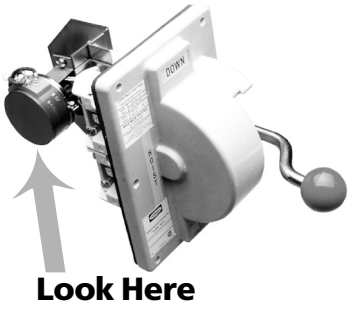
11. Type 4211 Master Switches or PBC/WPBC Pendant inserts are typically suppled with a single 2kΩ, 0° dead band, center tapped belt drive speed reference potentiometer. Check the off-point position of the insert potentiometer by measuring the resistance between Pins 2 and 4 on the potentiometer body. The off-point resistance should be 0–5Ω. If this resistance range is not present, mechanical adjustment will be need.

a. Use a $^{3}/_{32}$" allen wrench to slightly loosen the circumferential potentiometer clamp.

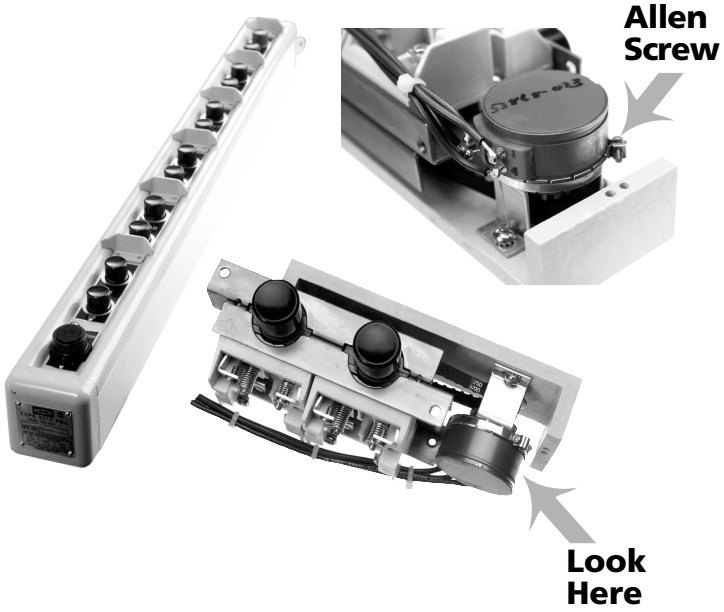
b. While reading the resistance between Pins 2 & 4, carefully rotate the potentiometer until an ohmmeter reading of 0–5Ω is obtained.

c. Carefully tighten the potentiometer clamp and reverify the ohmmeter reading on Pins 2 & 4 of the Pendant insert or 4211 Master Switch potentiometer.

Type 4211 Master Switch Potentiometer Locations



PBC/WPBC Pendant Potentiometer Locations



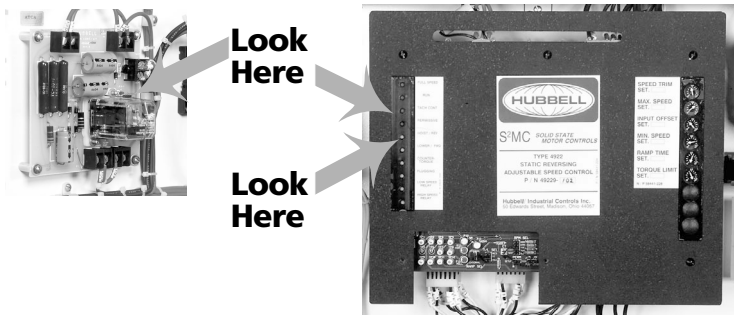
12. For Radio/Pendant or Radio/Cab installations, the remaining start-up instructions should be followed using the Pendant or Master Switch as the control device. At the end of the procedure, the Radio Receiver speed output signal can then be set to match the Pendant or Master Switch speed signal. This start-up sequence results in uniform speed range performance for all controlling methods.

Controller Power and Off-Point Sequence

13. Set the Off-Point Timer (if equipped) for a minimum time delay.

14. Using a digital voltmeter, check the three phase power at the Circuit Breaker.

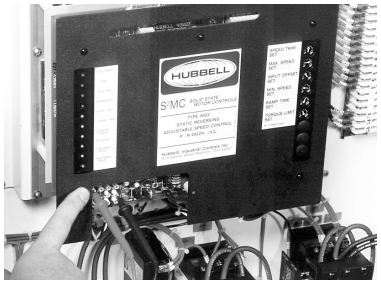
15. Close the Circuit Breaker and then the Control Knife Switch. The "Tach Continuity" LED, and either the "Hoist" or "Lower" LED should light up on the Adjustable Speed Control (ASC) module. If the control has a Tach Continuity Module, the LED on this assembly should be lit. If these LEDs aren't lit check/replace the fuses in the Control Knife Switch, check the Tachometer wiring and connections, check the Overload Contacts, and check the wiring into the Circuit Breaker.



Controller Speed Reference Setup and Sequence

16. Turn off the power by turning off the Circuit Breaker and Control Knife Switch.

17. Remove the access cover from the ASC. Using a digital voltmeter (DVM) set to read 20VDC, place the black common meter probe tip into TP8. Place the red meter probe tip into TP1.



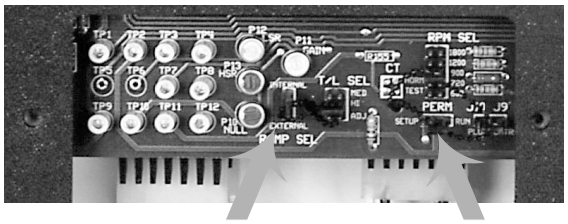
TP Locations

TP1 RAMP	TP2 PERM	TP3 +TACH	TP4 I TACH I
TP5 –CT	TP6 0 REF	TP7 ±ERR	TP8 0V
TP9 –18V	TP10 –8.5V	TP11 +8.5V	TP12 +18V

18. Move the "Permissive" jumper from the "RUN" position to the "SETUP" position.

Note: Holding brakes may be released during the remaining setup procedure. To prevent unintended movement, disable the brake control circuit by removing the brake circuit fuses.

19. Verify that the "Ramp Select" jumper on the ASC is set "INT" position.



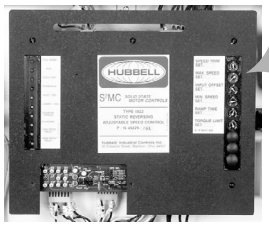
Ramp Select Jumper

Permissive Jumper

20. Verify that the adjustment potentiometers are set to the factory initial/typical positions. (see Typical Setting table or factory preset label)

21. Close the Circuit Breaker and then the Control Knife Switch. The "Tach Continuity" LED should light again on ASC.

22. The speed reference voltage from the Master Switch or Pendant should be positive for the Hoist direction and negative for the Lower direction. Select the Lower direction with the Master Switch or Pendant. The voltage readings on the DVM should be negative. When the Hoist direction is selected, the voltage should be positive. If the DVM readings are reversed, reverify and correct the wiring between the 4922C Control Panel and the Master Switch/Pendant.



Verify These Settings

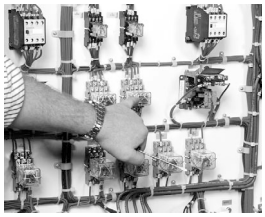
Typical Settings

Potentiometer	Setting
Speed Trim	50
Max. Speed	80
Input Offset	35
Min. Speed	20
Ramp Time	0
Torque Limit	100

23. Verify the control sequence by operating the Master Switch or Pendant. Observe the "Permissive" lights on the ASC and the contactor/relay operation on the panel. (see Control Sequence table)

The following setup will use Lower commands, therefore, a negative voltage on the digital voltmeter is expected.

Control Sequence



Speed Point	Full Sp.	Run	Tach	Perm	Hoist	Lower	Off Pt.	Main	Brake
Off-Point			●				✕	○	○
Any Stepless Speed Lower		●	●	●		●	○	○	○
Full Speed Lower	●	●	●	●		●	○	○	○
Any Stepless Speed Hoist		●	●	●	●		○	○	○
Full Speed Hoist	●	●	●	●	●		○	○	○

○ – *Relay active/closed* ● – *LED illuminated* ✕ – *Time delay drop-out when re-entering off-point position*

24. A typical speed range is 10 to 1 with maximum stepless speed equal to 5.0V, and minimum speed equal to 0.5V.

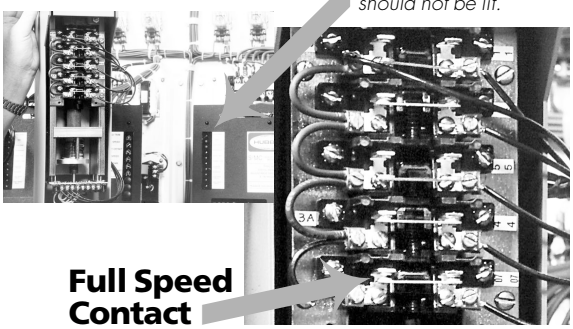
25. Move the Master Switch or depress the Pendant button until first point Lower is obtained. The "Run", "Permissive", and "Lower" LEDs should light.

26. The DVM should read –0.5V ±0.05V.

27. Move the Master Switch to the Full Lower position or completely depress the "Lower" Pendant button. The "Full Speed" LED on the ASC should light.

28. Back off the Master Switch handle or Pendant "Lower" button position until the full speed contact in the Master Switch or Pendant opens. The "Full Speed" LED on the ASC should go out.

Full Speed LED
should not be lit.



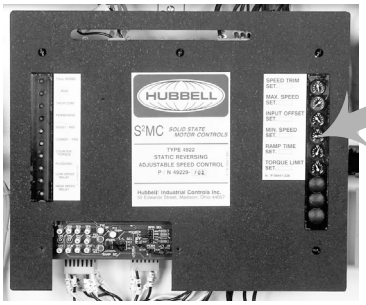
Full Speed Contact
should be open.

29. The voltage reading on the DVM should be –5.0V ±0.05V.

30. If the readings in Step 26 and Step 29 are not obtained proceed with Step 31. If the readings are correct, skip to Step 39.

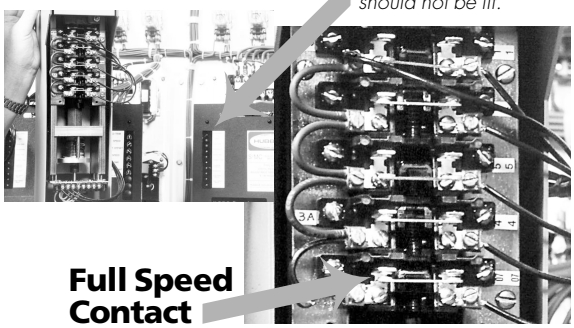
31. Move the Master Switch or depress the Pendant button until first point Lower is obtained. The "Run", "Permissive", and Lower" LEDs should light.

32. Set the "Min Speed" potentiometer full counterclockwise. Rotate the "Input Offset" potentiometer on the ASC until the DVM reads 0V ±0.05V.



33. Move the Master Switch fully in the Lower direction or depress the Lower pendant button. The "Full Speed" LED on the ASC should go on.

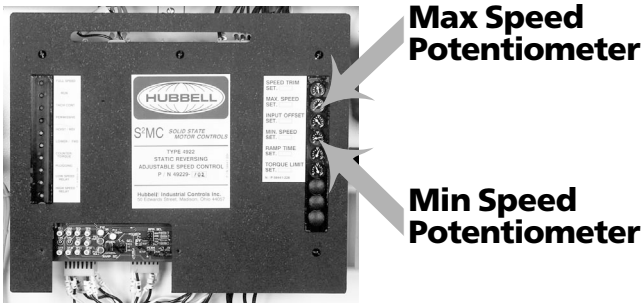
34. Back off on the handle of the Master Switch or the Pendant button from the lower position until the full speed contact just opens up. It is very important to move the handle or the button until the full speed contact just breaks open. The "Full Speed" LED on the ASC should be out.



35. Adjust the "Max Speed" potentiometer on the ASC until a reading of –4.5V ±0.05V is obtained on the DVM.

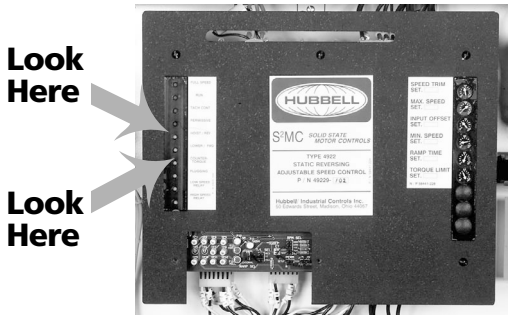
36. Repeat steps 31–35 until no further adjustments are necessary. Typically, three or four iterations are required to obtain a 0V ±0.05V reading at first speed point, and a –4.5V ±0.05V setting at the maximum stepless position.

37. Move the Master Switch handle or depress the Lower Pendant button until first point Lower is obtained. Rotate the "Min Speed" potentiometer clockwise until a –0.5V ±0.05V reading is obtained on the DVM.



38. Move the Master Switch handle or depress the Lower Pendant button to the maximum position. The DVM should read –5.0V ±0.05V.

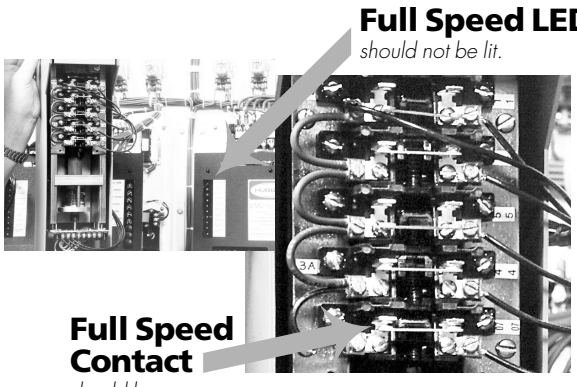
39. Check the minimum speed and maximum speed points in the Hoist direction. Move the Master Switch or the Pendant through the various speed points in the Hoist direction. The "Lower" LED on the ASC should go off and the "Hoist" LED should come on.



40. At the first speed point for Hoist direction the DVM should read +0.5V ±0.05V.

41. At full speed hoist (handle fully in the Hoist position) the "Full Speed" LED on the ASC should be lit.

42. Back off on the handle of the Master Switch from the hoist position until the full speed contact on the Master Switch or Pendant just opens up. The "Full Speed" LED should go out. The DVM should read +5.0V ±0.05V.

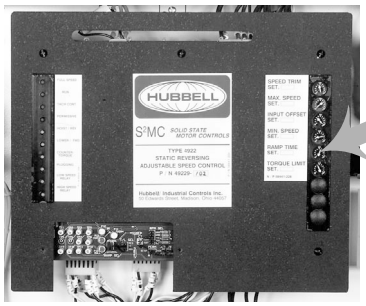


43. Return the Master Switch or the Pendant button to the Off position. The DVM should read 0.0V.

Controller Ramp and Tachometer Signal Adjustments

44. Turn off the power by turning off the Circuit Breaker and Control Knife Switch.

45. Determine the required system accelerated ramp time required for the application. The "Ramp Time" potentiometer on the ASC can provide times from 0.5 seconds (set at 0) to 10 seconds (set at 100). Rotate the "Ramp Time" potentiometer to the desired time setting. Hoist applications typically use short acceleration times of 0.5 to 2.0 seconds for good response.



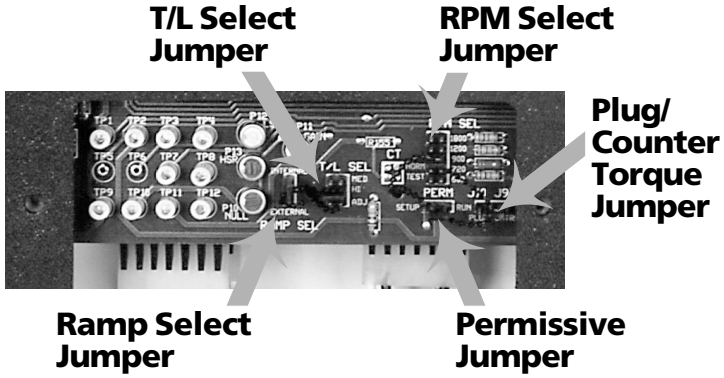
46. Determine the relative synchronous speed of the system tachometer. Move the "RPM Select" jumper on the ASC to the RPM position corresponding to the tachometer synchronous speed value.

Note: When a Hubbell Tachometer/Overspeed Switch Assembly is used, the "1200 RPM" position must be selected.

47. Set the "T/L Select" jumper on the ASC to "HI".

48. Move the "Permissive" jumper on the ASC from the "SETUP" position to the "RUN" position. Restore operation to the holding brake circuit by reinstalling the brake circuit fuses.

49. Set the "Plug/Counter Torque" jumper on the ASC to "CNTR" position.



Initial Motor Direction Verification and Gain Adjustment

50. Close the Circuit Breaker and then the Control Knife Switch. The motor control system will now be able to operate the motor.

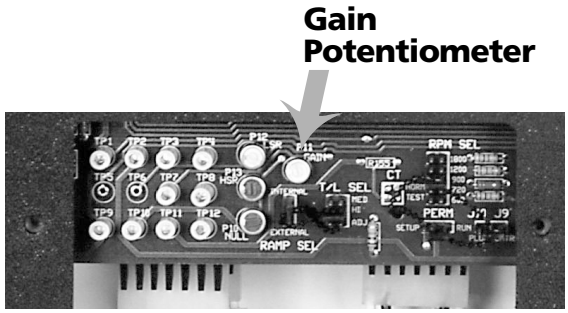
Remember: The following steps are done with the crane motor energized. Please follow all safety precautions applicable for operating the crane system.

51. Check the phase of the power by bumping the motor with the Master Switch or pendant in the Lower direction. If the motors turns in the Hoist direction change the wiring between the motor and the controller. Bump the motor again and check the rotation. Important — don't change the Circuit Breaker wiring in the controller to correct phase problems.

52. Assuming that the hook is in the UP position, attempt to operate the motor at first point Lower by moving the Master Switch or by depressing the pendant Lower button. The hook should descend at minimum speed. If the motor appears to be running at full speed, stop the control and reverse the Tachometer leads.

53. Turn the "Gain" potentiometer on the ASC to the fully counterclockwise minimum gain position.

54. When the ASC is set at minimum "Gain", the controller will be sluggish to changes in direction. With too much "Gain", the controller will be quick at speed changes but could be unstable; bouncing back and forth between directions.



55. Move the Master Switch or Pendant button between minimum and mid-speed positions. Observe the operation of the motor to changes in speed reference. The "Lower" and "Hoist" LEDs should change as the handle is moved and the incandescent lights on the ASC circuit boards will change intensity.

56. Adjust the "Gain" potentiometer on the ASC so that when the Master Switch or Pendant button is moved from Hoist to Lower or vice-versa the controller changes directions with minimal bouncing between the "Hoist" and "Lower" LEDs on the ASC. When the "Gain" is correctly adjusted, the incandescent lights on the ASC circuit boards will glow evenly and change smoothly when the handle is moved on the Master Switch. They will not flicker back and forth. Additionally, the crane motor will produce a smooth, even running sound when the direction is changed and will not be sluggish in changing directions.

LSR and HSR Setup/Adjustment

57. Place the black common DVM probe tip into TP8. Place the red meter probe tip into TP4.

58. Set both the "HSR" and "LSR" potentiometers on the ASC fully clockwise.

59. Move the handle on the Master Switch or the Pendant button in the Hoist position until the DVM reads +1.2V ±0.05V. Hold the handle at this position throughout the next adjustment.

60. Adjust the "LSR" potentiometer counterclockwise until the "Low Speed" LED on the ASC turns on.

61. Move the handle on the Master Switch or the Pendant button in the Hoist direction until the DVM reads +4.8V ±0.05V. Hold the handle at this position throughout the next adjustment.

62. Adjust the "HSR" potentiometer counterclockwise until the "High Speed" LED on the ASC turns on.

Final Load Test and Off-Point Timer Adjustment

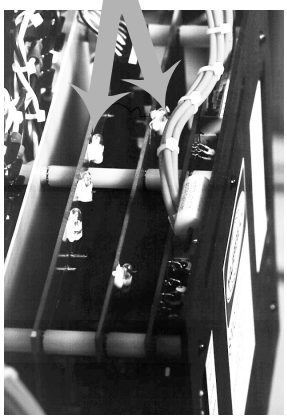
63. Now load the hook with a safe working load and prepare the crane for operation utilizing full safety operating rules and standards for this facility.

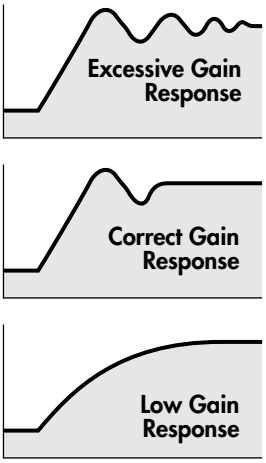
64. Raise and Lower the load using various speed conditions. The motor should continue to operate smoothly through the speed and direction changes. Final "Gain" adjustment can be made at this time for smooth acceleration and direction changes.

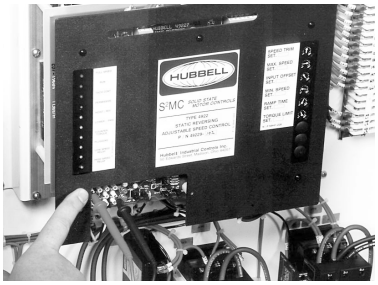
65. Determine the time required for the control to slow a descending load from full speed to minimum speed. This time will be the "Ramp Time" setting. Set the Off-Point Timer for this slow down time period.

66. Open the Circuit Breaker and then the Control Knife Switch. Replace the cover on the Master Switch or Pendant. Replace the access cover on the ASC. This completes the set up of the motor control system.

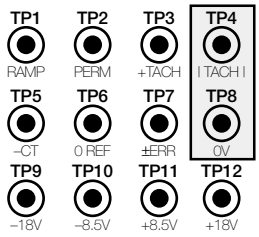
Incandescent Lights



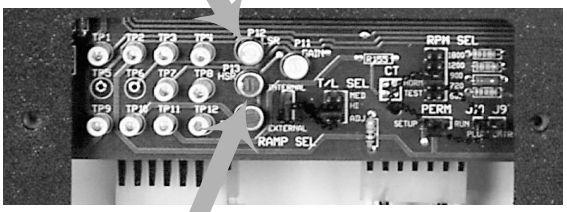




TP Locations

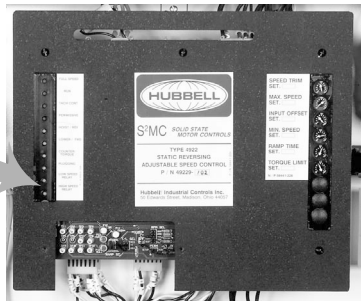


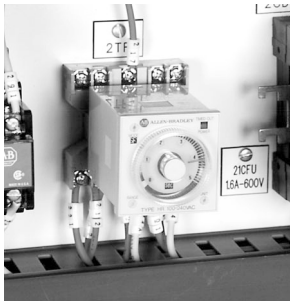
LSR Potentiometer



HSR Potentiometer

Low Speed & High Speed LEDs





Circuit Description

Power Circuit

The incoming three phase power, L1, L2, L3 is connected to the main circuit breaker, MCB, and then to the main contactor, M. Power is supplied to the SCR bridges through the overload relays, 10L, 20L, and 30L, when the power contacts of M are closed. Current limit resistors are connected in series with the power inputs of the Lowering SCR bridges. The current limit resistors control SCR fault currents should they occur. The SCR bridge outputs provide adjustable voltage power to the motor primary windings, T1, T2, T3, through the Power Limit Switch, LS. The limit switch transformer, LSXFMR, monitors one of the limit switch power contacts, and removes power from the brake panel should the monitored power contact open. See Fig. 4 (pg. 13) and Fig. 5 (pg. 14).

Control Circuit

The three phase power from the main circuit breaker, MCB, is also connected to the control circuit breaker, CCB. The control circuit breaker supplies power to the synchronizing transformer, XFMR2, and the control power transformer, XFMR1. See Fig. 4 and Fig 5. Transformer XFMR2 supplies power and SCR synchronizing information to the Static Control Assembly, SCA, and the control power transformer XFMR1 supplies 120V power to the remaining control circuit.

The 120V control circuit power from the control transformer is controlled by the UV relay located on the tachometer continuity assembly, TCA. The function of the TCA is to verify continuity in the Tachometer/ Overspeed Switch circuit. The UV relay will pickup when continuity is established through the tachometer circuit and the control circuit continuity loop composed of the normally closed overload contacts, 10L, 20L, and 30L. The SCR bridge over temperature switch, mounted on the central common SCR bridge, is also included in the control circuit continuity loop along with 1CR and 2CR contacts which are present when the Float option is supplied.

The master switch or pendant station controls the Hoist and Lower Relays, HR and LR, the Off-Point Timing Relay, TR, and the Full Speed Contactor, FS. The brake relay, BR, supplies power to the brake panel and is controlled by HR, LR and the Limit Switch Transformer. HR and LR also operate the Main Contactor, M, through the controlling Master Switch or Pendant contacts. The M Contactor and the initiating directional relay will remain energized when the Master Switch or Pendant is returned to Off-Point to allow the motor to slow the load before removing power and setting the holding brake. The Off-Point Timing Relay, TR, and the Low Speed Relay, LSR, perform this function. Normally, LSR will open at minimum speed to set the brake and remove power. However, should a system problem prevent normal slowdown, the TR contact acts as a backup and removes power and sets the brake after a preset minimum time. See Fig. 4.

The Master Switch or Pendant also provides a bipolar adjustable voltage DC speed reference signal from an internal potentiometer. A positive signal represents the hoisting direction, and a negative signal represents the lowering direction. In this way, the Master Switch handle or Pendant button determines the direction of motion and establishes a voltage reference level by which motor speed will be controlled.

Figure 5 shows the addition of the SC contactor which is used when the extended slow speed option is required. During normal speed hoisting operations, the Low Speed Relay, LSR, will be picked up, and the Counter-Torque Relay, CTR, will remain deenergized. This causes the SC contactor to close and supply normal 0.1 E/I motor secondary impedance in the rotor circuit. During slow, minimum speed operations, when LSR is dropped out, or during counter-torque operations, when CTR is picked up, the SC contactor will remain open, and the extended 0.3 E/I secondary impedance will be in the rotor circuit to reduce slow speed and counter-torque motor currents.

Figure 5 also shows the addition of the Float option components which are, 1FR, 1CR, 2CR, FTR, and the Float Relay Assembly. The Float option is used when very slow or zero speed load position control is required. The Float mode is entered by depressing and holding the Master Switch thumb button while the Master Switch is in the Off position. This mode limits the full travel Master Switch speed value to ±10% with smooth load control through zero speed.

Control Circuit, Static Control Assembly

The Static Control Assembly, SCA, contains all of the control system responsible for the speed regulation function of the Static Reversing Controller. The system also determines the motor's operating mode by controlling which set of SCR bridges is supplying the power. The Static Control Assembly receives its three phase power from the synchronizing transformer, XFMR2. See Figs. 4 and 5 (page 13 &14). This transformer provides low voltage AC power for the electronic power supply section and synchronizing information for the firing circuits. See Fig. 3 (page 12).

The permissive circuit monitors the Permissive command input from the M contactor coil at the 120V AC control power level and converts this signal to an isolated low level signal compatible with the electronic system. The permissive circuit also monitors a tachometer continuity signal originating on the Tachometer Continuity Assembly. In order for the Static Control

Assembly system to operate, the tachometer continuity signal must be present along with the control permissive signal from the M contactor circuit. The permissive circuit also monitors the Full Speed command input. This input will enable full speed regenerative lower operation.

The ramp circuit receives the speed reference signal from the Master Switch or Pendant potentiometer and conditions the signal such that it is allowed to change only at a preset rate. This function provides for controlled acceleration and deceleration.

The speed regulator circuit receives the tachometer signal and compares it to the system speed reference signal from the ramp circuit. If the system speed is below the speed reference level, the output of the speed regulator circuit increases to provide more phase reference signal via the directional command circuit. This increased signal provides more voltage to the motor via the firing circuits and consequently more motor torque to increase system speed. If the system speed is above the speed reference level, the speed regulator output reverses polarity. This action causes the directional command circuit to issue a counter torque command to slow the motor. The resulting counter torque command signal causes the speed regulator circuit to provide a clamped or limited phase reference voltage to the firing circuits to control motor current and torque during the slow down interval.

The directional command circuit receives the bipolar speed error signal and a bipolar tachometer signal from the speed regulator circuit and compares these signals to determine the operational mode of the system motor. The directional command circuit issues a Hoist command signal to activate the Hoist and Common SCR bridges via the delayed directional permissive circuit, or a Lower command signal to activate the Lower and Common SCR bridges in a similar fashion.

The delayed directional permissive circuit receives the directional command signals from the directional command circuit and generates firing circuit permissive signals that are delayed by 4 $\frac{1}{2}$ cycles of the 60 hz line. The delay is inserted in the permissive signals to prevent firing circuits that control the previously OFF SCR bridges from turning ON before the SCR bridges which are currently ON have stopped conducting. Shoot through faults are prevented by this delay.

The firing circuits receive the phase reference signal and, along with the synchronizing signals from the three phase synchronizing transformer and the delayed permissive signals from the delayed directional permissive circuit, produce the firing or gating signals required by the SCR bridges.

Specifications

Input Power	230V or 460V, 3 phase, 60 hz
Horsepower Range (at 460V)	5–40 hp (compact construction); 50–250 hp with external SCRs
Speed Range	Typical 10 to 1 with full speed ≈ 80% sync.
Speed Regulation	Better than 1%
Control Configuration	Static Reversing
Temperature Range	-40°F (-40°C) to 131°F (55°C) (typical) -40°F(-40°C) to 158°F (70°C) (electronics)

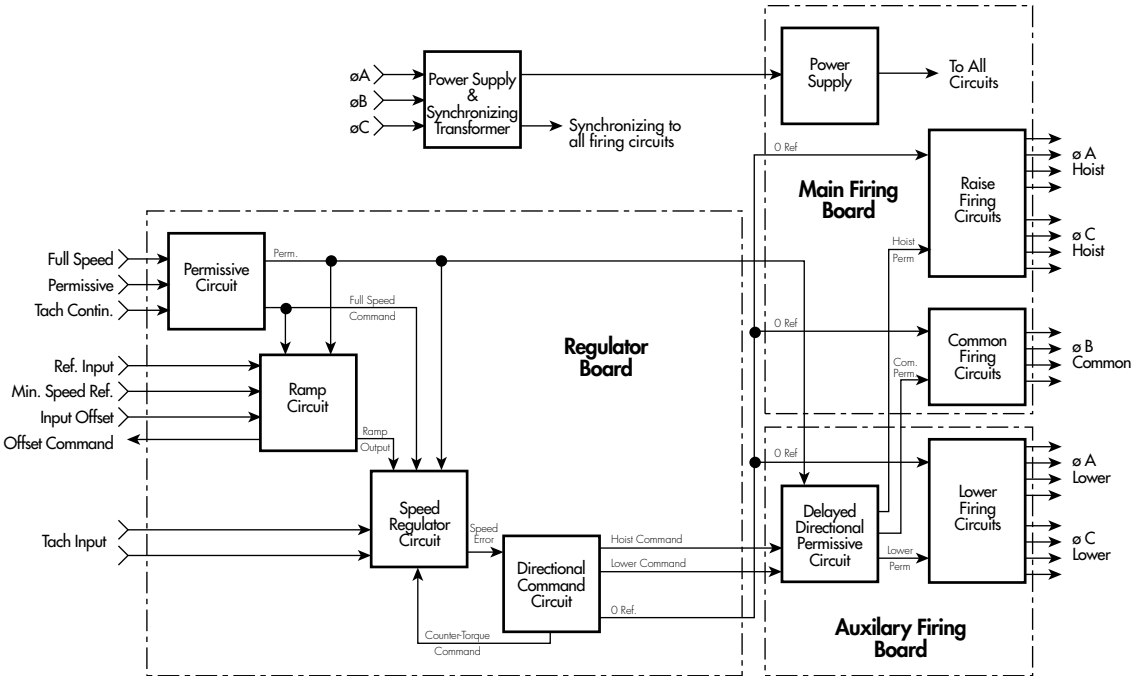


Figure 3 — Static Control Assembly System Block Diagram

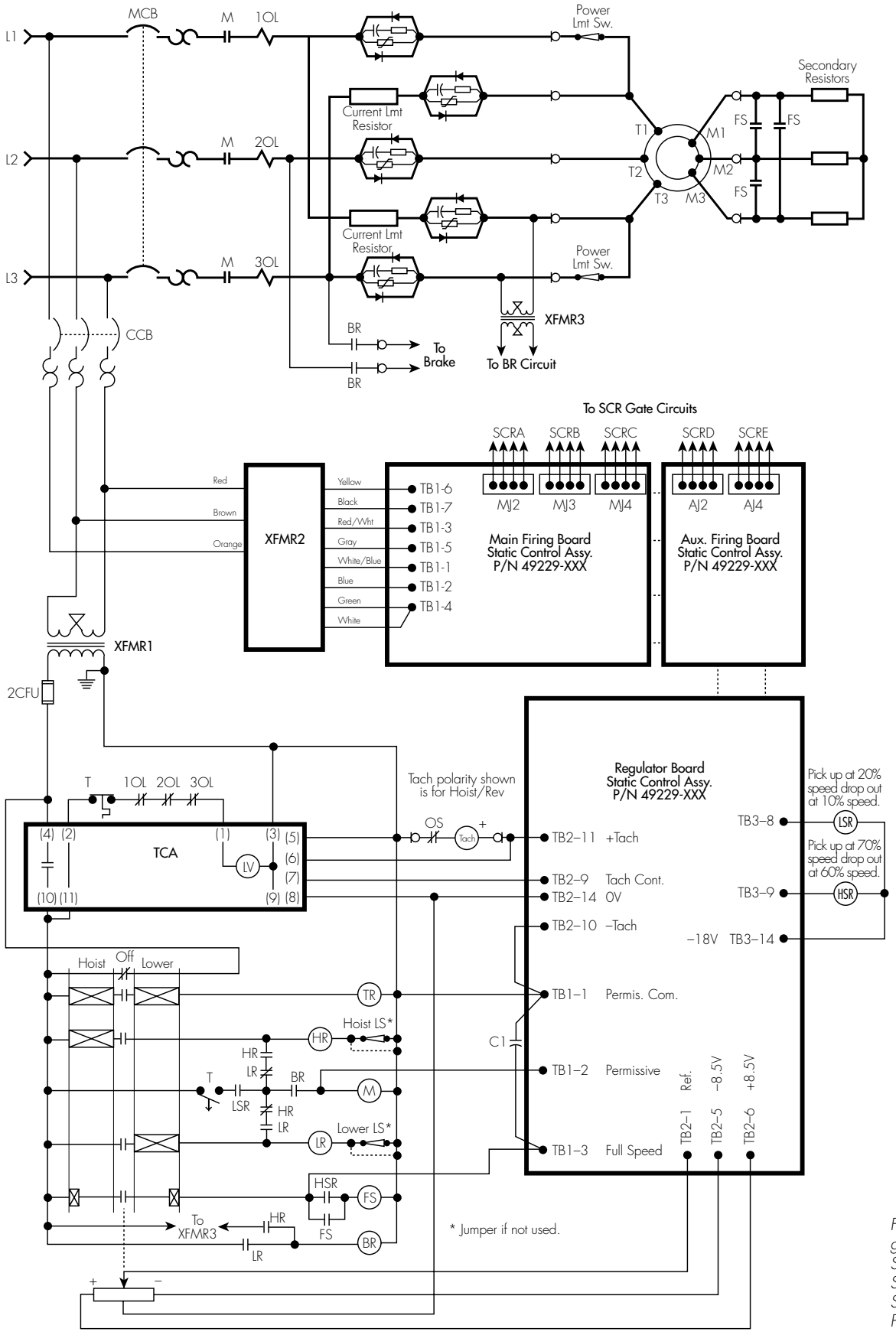


Figure 4 — Schematic Diagram of Compact Primary Static Reversing Hoist Control Speed Regulated with Full Speed Contactor and Off-Point Counter Torque

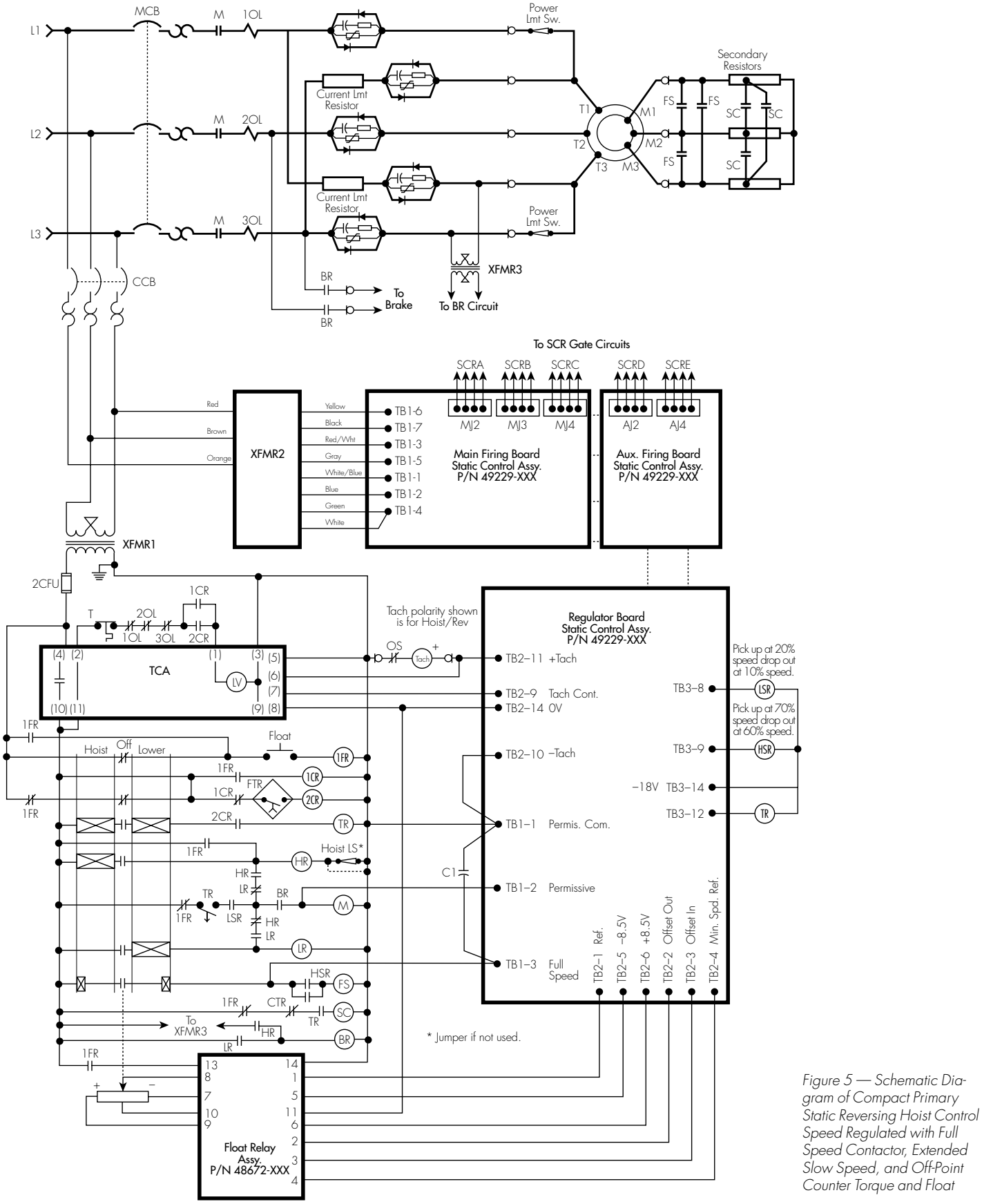
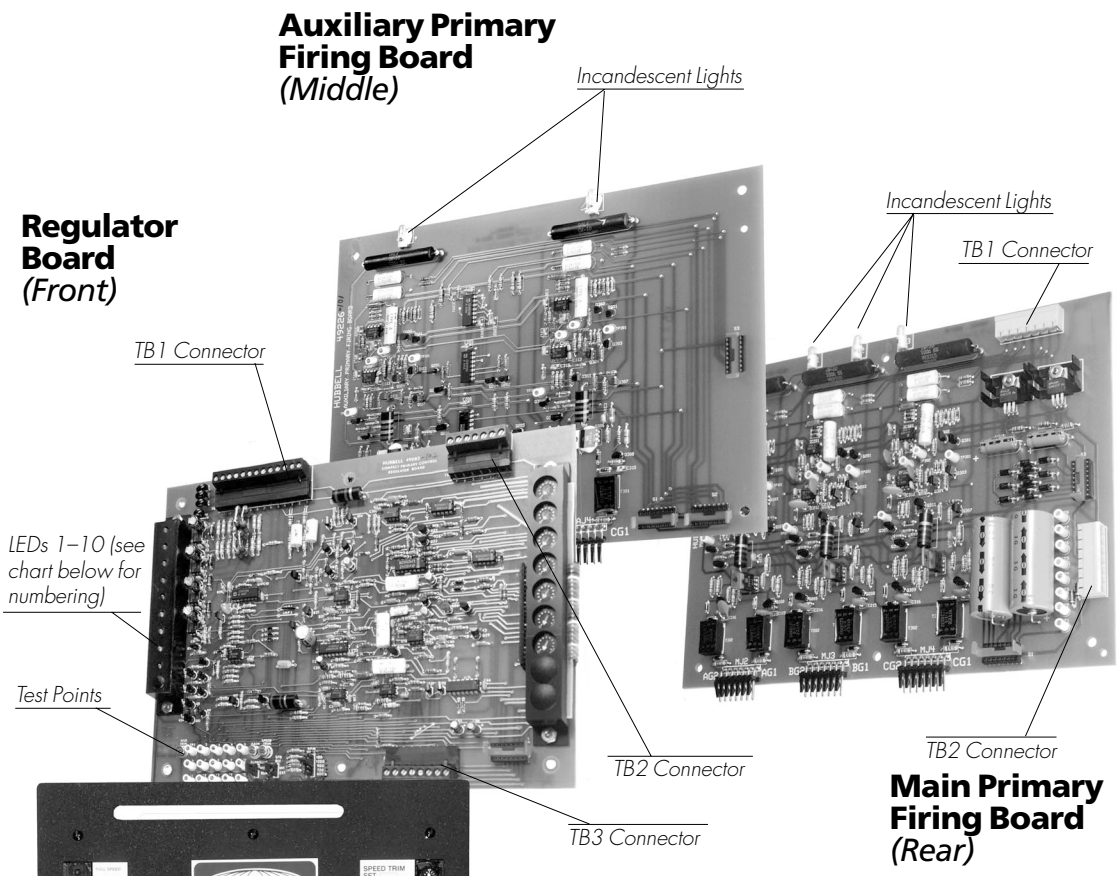
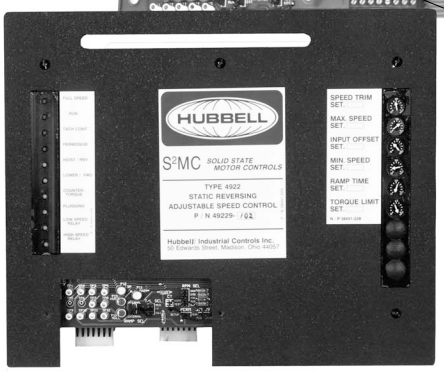


Figure 5 — Schematic Diagram of Compact Primary Static Reversing Hoist Control Speed Regulated with Full Speed Contactor, Extended Slow Speed, and Off-Point Counter Torque and Float

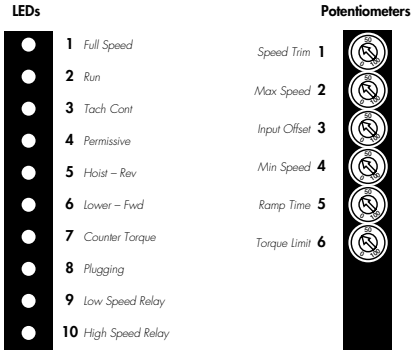
ASC Diagrams & Call-Outs





ASC Cover
front view

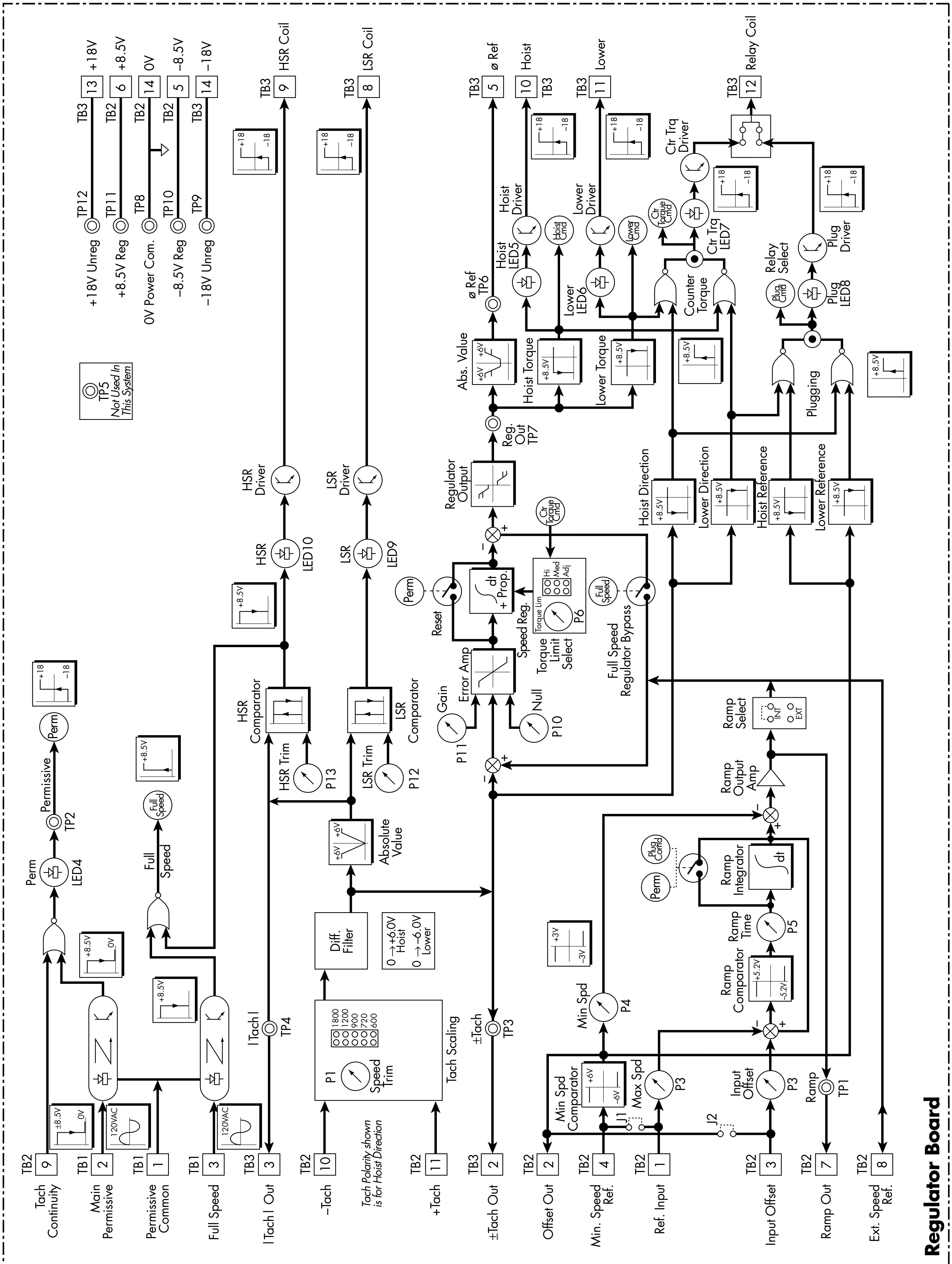
Exploded Assembly View

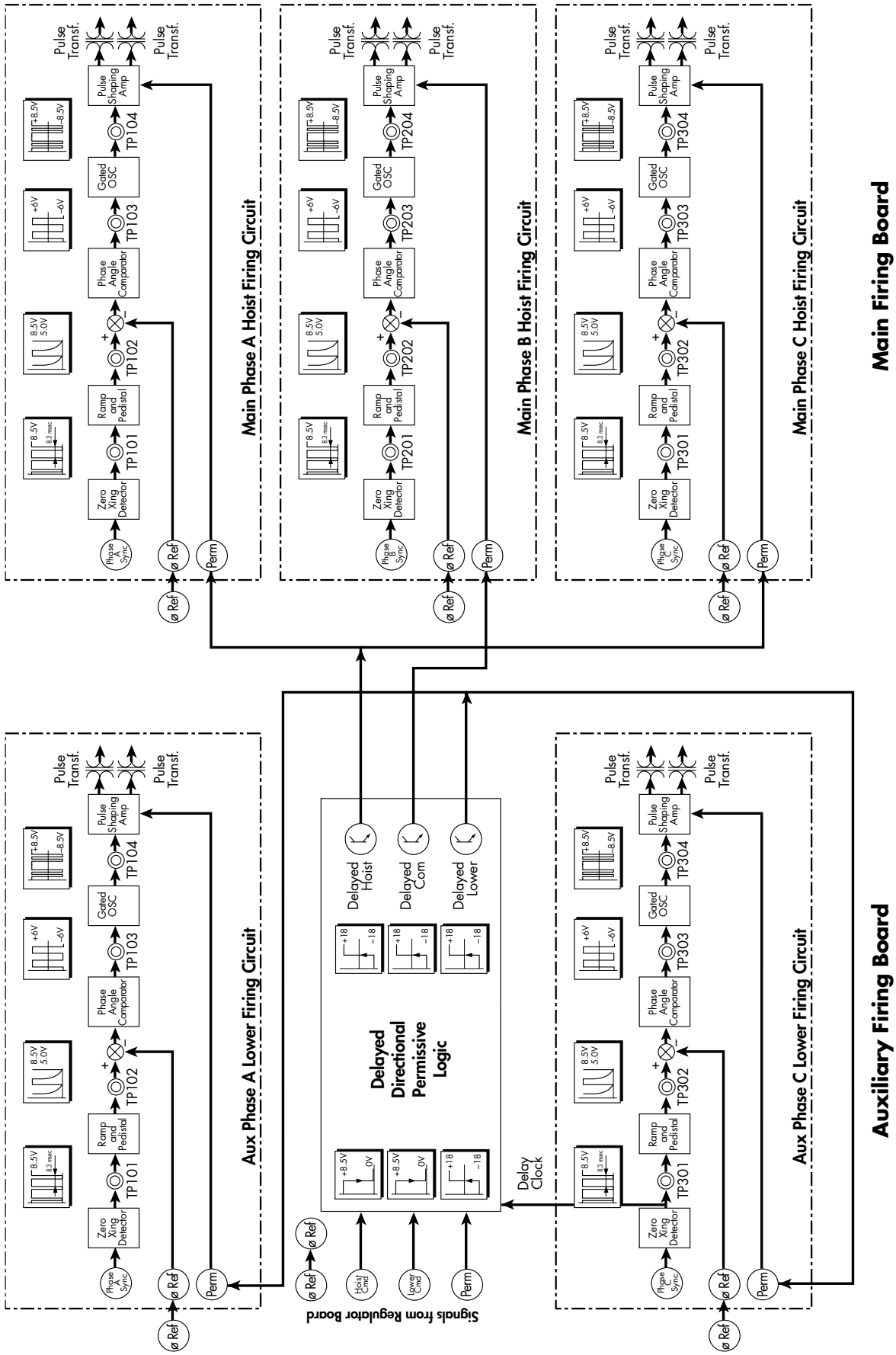


LED/Potentiometer Numbers and Function

The Adjustable Speed Control module is made up of three circuit boards — Regulator Board, Auxiliary Firing Board and the Main Primary Firing Board. They are stacked from front to back in this same order. If access to any of these boards is required during troubleshooting, be careful when removing and reinstalling the ribbon cable assemblies, paying particular attention not to bend the dual in-line connector plug pins.

To the left is exploded view of the ASC module for board location and clarity. On the following two pages are graphic representations of the logic diagram for the ASC module. The logic diagrams expands on the system block diagram presented earlier, and identifies system circuit function and signal levels by test points.


Regulator Board
Tach Continuity
Main Permissive
Permissive Common
Full Speed
|Tach| Out
–Tach
Tach Polarity shown is for Hoist Direction
+Tach
±Tach Out
Offset Out
Min. Speed Ref.
Ref. Input
Input Offset
Ramp Out
Ext. Speed Ref.
Tach Scaling
Speed Trim
Diff. Filter
0 → +6.0V Hoist
0 → –6.0V Lower
Absolute Value
HSR Comparator
LSR Comparator
HSR Trim
LSR Trim
HSR Driver
LSR Driver
HSR Coil
LSR Coil
Permissive
Perm
Full Speed
Error Amp
Gain
Null
Speed Reg.
Torque Limit Select
Full Speed Regulator Bypass
Regulator Output
Reg. Out
Abs. Value
ø Ref
Hoist Torque
Lower Torque
Hoist Driver
Lower Driver
Hoist
Lower
Counter Torque
Ctr Trq Driver
Relay Coil
Relay Select
Plug Driver
Plugging
Hoist Direction
Lower Direction
Hoist Reference
Lower Reference
Ramp Select
Ramp Output Amp
Ramp Integrator
Ramp Time
Ramp Comparator
Min Spd
Max Spd
Min Spd Comparator
Input Offset
Ramp
+18V Unreg
+8.5V Reg
0V Power Com.
–8.5V Reg
–18V Unreg
Not Used In This System


Main Firing Board
Main Phase A Hoist Firing Circuit
Main Phase B Hoist Firing Circuit
Main Phase C Hoist Firing Circuit
Auxiliary Firing Board
Aux Phase A Lower Firing Circuit
Aux Phase C Lower Firing Circuit
Delayed Directional Permissive Logic
Delayed Hoist
Delayed Com
Delayed Lower
Delay Clock
Signals from Regulator Board
Zero Xing Detector
Ramp and Pedistal
Phase Angle Comparator
Gated OSC
Pulse Shaping Amp
Pulse Transf.
TP101
TP102
TP103
TP104
TP201
TP202
TP203
TP204
TP301
TP302
TP303
TP304
ø Ref
Perm

Troubleshooting

The following section is a trouble shooting section that should locate most common problems. When the instructions require a voltage measurement, a hand held DVM set to the appropriate AC or DC scale should be used.

When the instructions involve a common referenced DC voltage, insert the black common test lead of the digital voltmeter into test point 8, 0V, and measure the indicated test point voltage with the red meter test lead.

When the instructions involve PC board replacement, the adjustment potentiometers, if any, on the replacement board should be set to the approximate positions indicated on the old board.

Control does not operate, will not respond to command inputs.

➥ **No power to controller.**
Restore power.

➥ **Main circuit breaker or control circuit breaker**
Close circuit breakers. (See Major Components, page 4, for location.)

The UV Relay on the Tach Continuity Assembly (TCA) is not energized. There is power to the control.

➥ **There is no control power present from Terminal 3 to Terminal 4** (see figure right) **on the TCA.**
Check the control circuit fuses. Replace if open. (See Major Components, page 4, for location.) Investigate the control circuit for the cause of the fault.

➥ **Continuity loop Terminal 1 to Terminal 2 is open.**
Measure the voltage from Terminal 1 to Terminal 2. The normal voltage should be 0VAC. A 120VAC reading indicates an open condition. Check the following:
a. Normally closed overload relay contacts.
b. The thermostat located on the center SCR bridge.

➥ **Open tachometer, overspeed switch or tachometer signal wiring**
Measure the voltage from Terminal 5 to Terminal 6 on the TCA. A normal reading will be 5V to 10VAC. A 120VAC reading indicates an open circuit. Check the Tachometer/Overspeed switch wiring.

A reading of 0V from Terminal 5 to Terminal 6 of the TCA indicates one of the following:
a. No power to the TCA, and/or
b. Shorted tachometer or tachometer wiring, and/or
c. Faulty TCA.

Control will not respond to command inputs. The UV relay on the TCA is operative.

➥ **Defective command input control wiring.**
Check wiring continuity. Correct Problem. (See Major Components, page 4, for location.)

➥ **M contactor not operating**
Check M power contacts. (See Major Components, page 4, for location.) Replace if necessary.

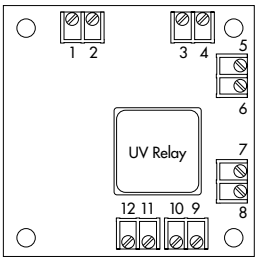
Open contactor coil. Replace coil or complete contactor.

➥ **Defective Static Control Assembly.**
The adjustable speed control unit is not responding to the command inputs. See Troubleshooting, page 19, "The ASC module is not functioning."

Motor operates but runs at full speed in either direction. No speed control.

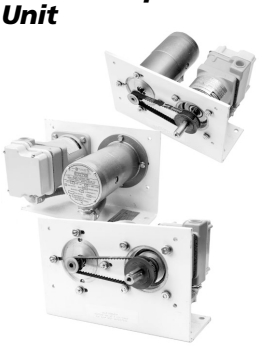
➥ **Loss of tachometer feedback signal.**
Monitor the tachometer voltage. If the motor is operating and the voltage is zero:
a. Check the tachometer/overspeed unit. The driving belt may be loose or broken.
b. The tachometer/overspeed unit driving coupling may be loose.
c. The tachometer may be defective. Replace the tachometer or the tach/overspeed unit.

TCA Terminals and Major Components



TCA Terminals and Relay Location. (Outline above, photograph below)

Tach/Overspeed Unit



The Adjustable Speed Control (ASC) module is not functioning.

➥ **No control power to the ASC.**

Carefully check for the presence of 3 phase 460V or 230V on the primary leads of transformer XFMR2. If the proper voltages are not present, restore power.

➥ **No tachometer continuity signal from the Tachometer Continuity Assembly (TCA).**

Set the digital voltmeter to a 20VDC scale. Measure the voltage on TB2–9 on the ASC. The voltage should read 0V.

a. If the voltage reads +8.5V, the tachometer continuity signal is absent. If the UV relay on the TCA is energized with this condition, the TCA is defective. Replace the TCA.
b. If the voltage reads +8.5V and the UV relay on the TCA is deenergized see Troubleshooting, page 18, "The UV relay on the TCA is not energized…".
c. If the voltage reads 0V the ASC power supply may be defective. Set the digital voltmeter to read 20VDC. Measure the following test points on the ASC and verify the voltages:

TP8 to TP9	–12VDC to –18VDC
TP8 to TP10	–8.5VDC ±0.5V
TP8 to TP11	+8.5VDC ±0.5V
TP8 to TP12	+12VDC to +18VDC

Look here for info on TP Locations

If any of the voltage readings are incorrect, replace the Main Firing Board.

➥ **Control circuit permissive signal is not present.**

Set the digital voltmeter to read 120VAC. Measure the following AC voltages on the regulator board on the ASC *(for location see ASC Diagrams page 15)*:

ASC terminals	*Raise*	*Off*	*Lower*
TB1–1 to TB1–2	120V	0V	120V

a. If the above readings are not observed, check the control wiring and correct the problem.
b. Check command input control wiring. Correct any problems.
c. If the UV relay on the TCA is deenergized see Troubleshooting, page 18, "The UV relay on the TCA is not energized…".

➥ **Speed reference signal is not present.**

Read the voltage at TB2–1 to TP8 with the digital voltmeter. The voltage should be positive when the Hoist direction is chosen. The output should be approximately 1.0–7.0V for the stepless range, and 8.0V for full speed. The voltage should be negative when the Lower direction is chosen. The voltage should be approx. –1.0V to –7.0V for the stepless range, and –8.0V for full speed.

Internal problem with the Static Control Assembly.

➥ **Defective 3 phase power transformer XFMR2.**

Set the digital voltmeter to read 20VAC. Measure the AC voltages from TB1–4 on the Main Firing Board of the ASC to each of the secondary leads of the Transformer XFMR2. *(For location see ASC Diagrams page 15)*

a. TB1–4 to TB1–6	(YEL)	10VAC ±15%
b. TB1–4 to TB1–2	(BLU)	10VAC ±15%
c. TB1–4 to TB1–3	(RED/WHT)	10VAC ±15%
d. TB1–4 to TB1–7	(BLK)	10VAC ±15%
e. TB1–4 to TB1–1	(WHT/BLU)	10VAC ±15%
f. TB1–4 to TB1–6	(GRA)	10VAC ±15%

If any of the voltage readings are incorrect, replace transformer XFMR2.

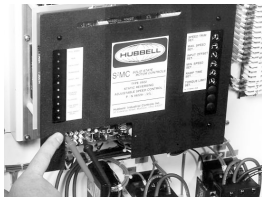
➥ **Defective Power Supply**

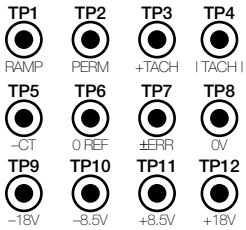
Set the digital voltmeter to read 20VDC. Measure the indicated test points on the ASC Regulator Board and verify the following voltages:

TP8 to TP9	–12VDC to –18VDC
TP8 to TP10	–8.5VDC ±0.5V
TP8 to TP11	+8.5VDC ±0.5V
TP8 to TP12	+12VDC to +18VDC

If any of the voltage readings are incorrect, replace the Main Firing Board.

ASC TP Locations





For specific locations of various LEDs, Test Points and/or Connections in reference to the Adjustable Speed Control (ASC) module see page 15, ASC Diagrams & Call Outs.

➥ **Defective Permissive Circuit**

Observe LED1–LED4 on the Regulator Board of the ASC.

a. LED1 Full Speed Permissive. On only when full speed hoist or regenerative lower is used.
b. LED2 should be on with 120VAC from TB1–1 to TB1–2 of the Regulator Board of the ASC. M contactor should be closed. If this is not true see Troubleshooting, page 19, "Control circuit permissive signal is missing."
c. LED3 should be on with the Tach Continuity signal present from the TCA and 0V from TB2–9 to TB2–14 of the Regulator Board of the ASC. If this is not true see Troubleshooting, page 18, "No tachometer continuity signal from the TCA."
d. LED4 should be on when LED2 and LED3 are on. With LED4 on, measure the voltage from TB3–1 to TP8. Both of these connections are on the Regulator Board of the ASC. The voltage should read +12VDC to +18VDC. The permissive jumper must be in the "RUN" position.

If any of the above conditions are not observed, replace the ASC Regulator Board.

➥ **Defective Ramp Circuit**

Measure the DC voltage between TP1, Ramp, and TP8, 0V, of the Regulator Board on the ASC. The following voltages should be read:

a. Min. Speed Hoist +0.5V
b. Max. Stepless Hoist +5.0V
c. Max. Speed Hoist +6.5V
d. Min. Speed Lower –0.5V
e. Max. Stepless Lower –5.0V
f. Max. Speed Lower –6.5V

The voltage readings will rise and fall slowly. If the above conditions are not observed, check the setup of the Ramp Circuit. If the circuit fails to setup properly as described earlier in steps 31-38 on page 8, the circuit is defective. Replace the Regulator Board on the ASC.

➥ **Defective Speed Regulator**

Measure the voltage between TP3, ±Tach, and TP8, 0V, of the Regulator Board on the ASC. The following voltages should be read:

a. –0.5V to –5.0V for a stepless Hoist operation.
b. +0.6V to +5.0V for a stepless Lower operation

This is the scaled tachometer signal.

Measure the voltage at TP7, ±Err, and TP8, 0V, of the Regulator Board on the ASC. This signal is the Speed Error signal, and will vary from ±0.5V to ±5.0V depending upon motor load. If the motor is not operational and there is no tachometer feedback signal, any speed reference signal will cause this error signal to quickly saturate to ±6.0V.

If the output does not vary or remains saturated when the system should be regulating, the speed regulator circuit is probably defective. Replace the ASC Regulator Board.

➥ **Defective Directional Command Circuit**

Observe LED5, LED6, and LED7 on the ASC Regulator Board. LED5 should be on during hoist operations. LED6 should be on during driving lower operations. LED7 should be on during slowdown or counter torque lowering operations. If LED7 is on continuously during Raise operations or fails to come on during slowdown or counter torque lowering operations, replace the ASC Regulator Board. ***Note:*** If the polarity of the tachometer signal is not consistent with the Raise operation, LED7 will be on in both directions. Check tach wiring and reverse if necessary.

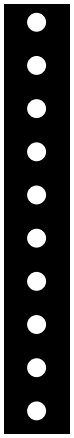
➥ **Defective Firing Circuits**

Observe the incandescent lights on each of the Firing Circuit boards. The lights should vary in brilliance as the drive operates. Three lights at a time should be illuminated, equal in brilliance.

a. 3 lights on the rear Main Firing board will illuminate during Hoist and Counter Torque Lower operations.
b. The 2 lights on the central Aux. Firing board and the central light on the Main Firing board will illuminate during Driving Lower operations.

If the above conditions are not observed, correct the problem or replace the affected board.

LEDs



1 *Full Speed*
2 *Run*
3 *Tach Cont*
4 *Permissive*
5 *Hoist – Rev*
6 *Lower – Fwd*
7 *Counter Torque*
8 *Plugging*
9 *Low Speed Relay*
10 *High Speed Relay*

LED Numbers and Function