

<i>TECHNICAL BULLETIN</i>	<i>TB-4922 CB</i>
<i>SUBJECT:</i> Bulletin 4922C.b Compact Static Reversing Controller for Movable Structures	<i>DATE ISSUED :</i> 3-Dec-94
<i>CLASSIFICATION:</i> Circuit and Systems Description	<i>SUPERSEDES:</i> 15-Feb-93
<i>DISTRIBUTION:</i>	<i>PAGE 1 OF 31</i>

1.0 General

The Type 4922C.b 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.

2.0 CIRCUIT DESCRIPTION

2.1.1 POWER CIRCUIT GENERAL

The incoming three phase power, L1, L2, L3 is connected to the main circuit breaker, MCB, and then to the main contactor, M, which provides motor power to the SCR bridges when the power contacts are closed. Current limit resistors are connected in series with overload relays, 1OL, 2OL, and 3OL to the power inputs of the 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. See Fig. 2.1.1.

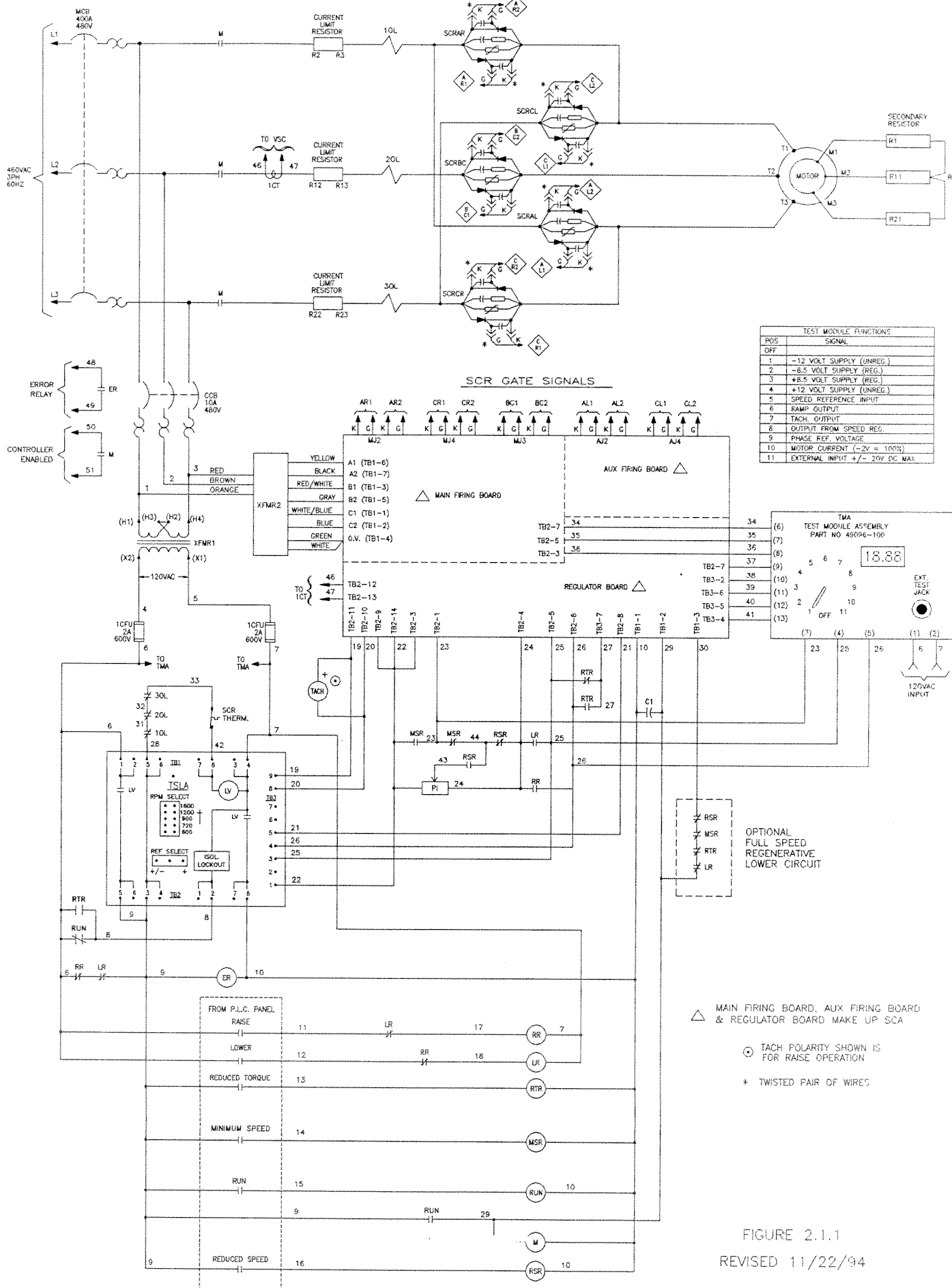
2.1.2 CONTROL CIRCUIT GENERAL

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. 2.1.1. Transformer XFMR2 supplies power and SCR synchronizing information to the Static Control Assembly, SCA, and the control power transformer XFMR1 supplies 120 volt power to the remaining control circuit.

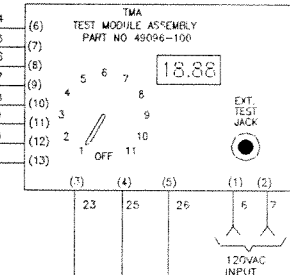
The 120 volt control circuit power from the control transformer is controlled by the LV relay located on the panel, or by the Tachometer Signal Loss Assembly, TSLA. When present, the panel mounted LV relay will pick-up when a circuit is established through the normally closed overload contacts of 1OL, 2OL, and 3OL, and the SCR bridge overtemperature switch mounted on the central SCR bridge assembly.

An LV relay is also present on the TLSA. The function of the TSLA is to compare the speed regulated system's tachometer speed feedback signal to the system's speed reference ramp signal. In normal speed regulated operation, these two signals will track due to the controlling action of the speed regulator. If a problem should develop with the tachometer feedback system, such as a broken or loose coupling, broken drive belt, or open tachometer signal circuit, the Tachometer Signal Loss Assembly will de-energize the LV relay on the assembly. A problem with

SCHEMATIC DIAGRAM



TEST MODULE FUNCTIONS	
POS	SIGNAL
OFF	
1	-12 VOLT SUPPLY (UNREG.)
2	-6.5 VOLT SUPPLY (REG.)
3	+6.5 VOLT SUPPLY (REG.)
4	+12 VOLT SUPPLY (UNREG.)
5	SPEED REFERENCE INPUT
6	RAMP OUTPUT
7	TACH. OUTPUT
8	OUTPUT FROM SPEED REG.
9	PHASE REF. VOLTAGE
10	MOTOR CURRENT (-2V = 100%)
11	EXTERNAL INPUT +/- 20V DC MAX.



△ MAIN FIRING BOARD, AUX FIRING BOARD & REGULATOR BOARD MAKE UP SCA
 ⊙ TACH POLARITY SHOWN IS FOR RAISE OPERATION
 * TWISTED PAIR OF WIRES

FIGURE 2.1.1
 REVISED 11/22/94

the speed regulating control system that results in the system speed not tracking the speed reference ramp signal will also cause the LV relay on the TSLA to de-energize.

The LV relay on the TSLA will pickup when a circuit is established through the external continuity loop composed of the normally closed overload contacts, 1OL, 2OL, and 3OL, and the SCR bridge over temperature switch mounted on the central common SCR bridge. The Error Relay, ER, will be energized and its output contacts closed whenever the LV relay is picked-up. The ER contact is provided for off panel monitoring of the controller status.

System operation is controlled by six remote command contacts:

1. Run
2. Raise
3. Lower
4. Minimum Speed
5. Reduced Speed
6. Reduced Torque

The Run command input contact operates the Run relay which in turn controls the main contactor, M, and provides the system permissive signal to the Static Control Assembly, SCA. The Raise and Lower command input contacts control the directional relays RR and LR. These relays supply +8.5 volts DC to the speed reference input of the SCA for the Raise operation and -8.5 volts DC for the Lower operation. The Minimum Speed command input contact controls the Minimum Speed Relay, MSR. This relay removes the signal from the speed reference input and causes the system to operate at the set minimum speed level. The Reduced Speed command input contact controls the Reduced Speed Relay, RSR. When the Reduced Speed Relay is picked up, the speed reference signal is reduced to a value determined by the setting of the panel mounted potentiometer, P1, and the system will operate the motor at the reduced speed setting. The Reduced Torque command input contact controls the Reduced Torque Relay, RTR. When this relay picks up, the system's second current limit value is selected. This function is typically used to provide reduced motor stall torque during structure seating operations.

2.2.1 PRIMARY SCR BRIDGE

The primary SCR bridge is an SCR/Heat Sink assembly with the power SCRs connected in inverse parallel, See Fig. 2.1.2. The function of the SCR bridge is to control the amount of voltage applied to the motor. The SCR, silicon controlled rectifier, is similar to standard rectifiers in that it will allow current to flow in one direction while blocking current in the reverse direction. However, SCRs will conduct current only when turned ON, or GATED ON. When two SCRs are connected as shown in Fig. 2.1.2, a controllable AC switch or contact is formed that will carry current in either direction but only when GATED ON. SCRs can react very quickly to gating signals, quickly enough to be able to control portions of half cycles of standard AC power. When the gating or firing signal is presented to the SCR very late in the half cycle, the SCR will block all of the cycle up to the time of firing. At the time the gating signal is applied, the SCR will turn ON and conduct the remaining portions of the half cycle to the load. See Fig. 2.1.3.

As the firing signal is presented earlier in the half cycle, the SCR will conduct more and more of the cycle on to the load. The extremes will be maximum firing when the SCR bridge passes all of the AC power on to the motor, and lockout, zero firing, when the SCR bridge blocks all of the AC power.

In static reversing controllers, the SCR bridges also perform a directional control function as well. As can be seen in Fig. 2.1.1, there are five SCR bridges, 2 Raise bridges, 2 Lower bridges, and 1 Common bridge. When a Raise operation is required, adjustable voltage three phase power is supplied to the motor via the two Raise bridges and the Common bridge. The three phase relationship of the applied motor power determines the direction of developed motor torque and rotation.

A Lower operation will be performed in one of two ways depending upon mechanical losses and the structure's counterbalance condition. First, adjustable voltage power is supplied to the motor via the two Lower bridges and the Common bridge to produce a driving lower operation. If the structure loading continues to require a driving lower torque, the system will supply lowering adjustable voltage power to meet the commanded speed condition. If an overhauling condition exists, a counter-torque lowering operation will occur where the Raise SCR bridges and the Common bridge provide motor power. True motor and power system

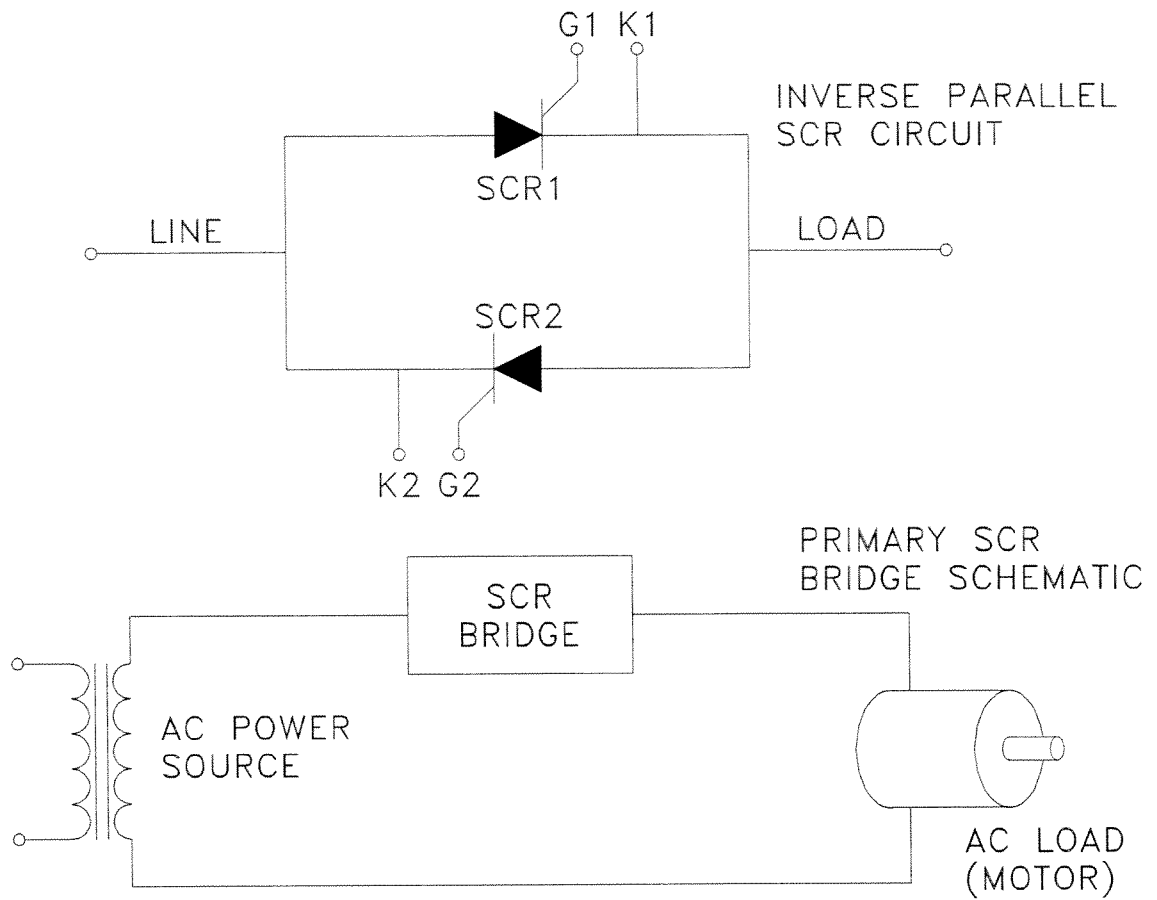


FIGURE 2.1.2

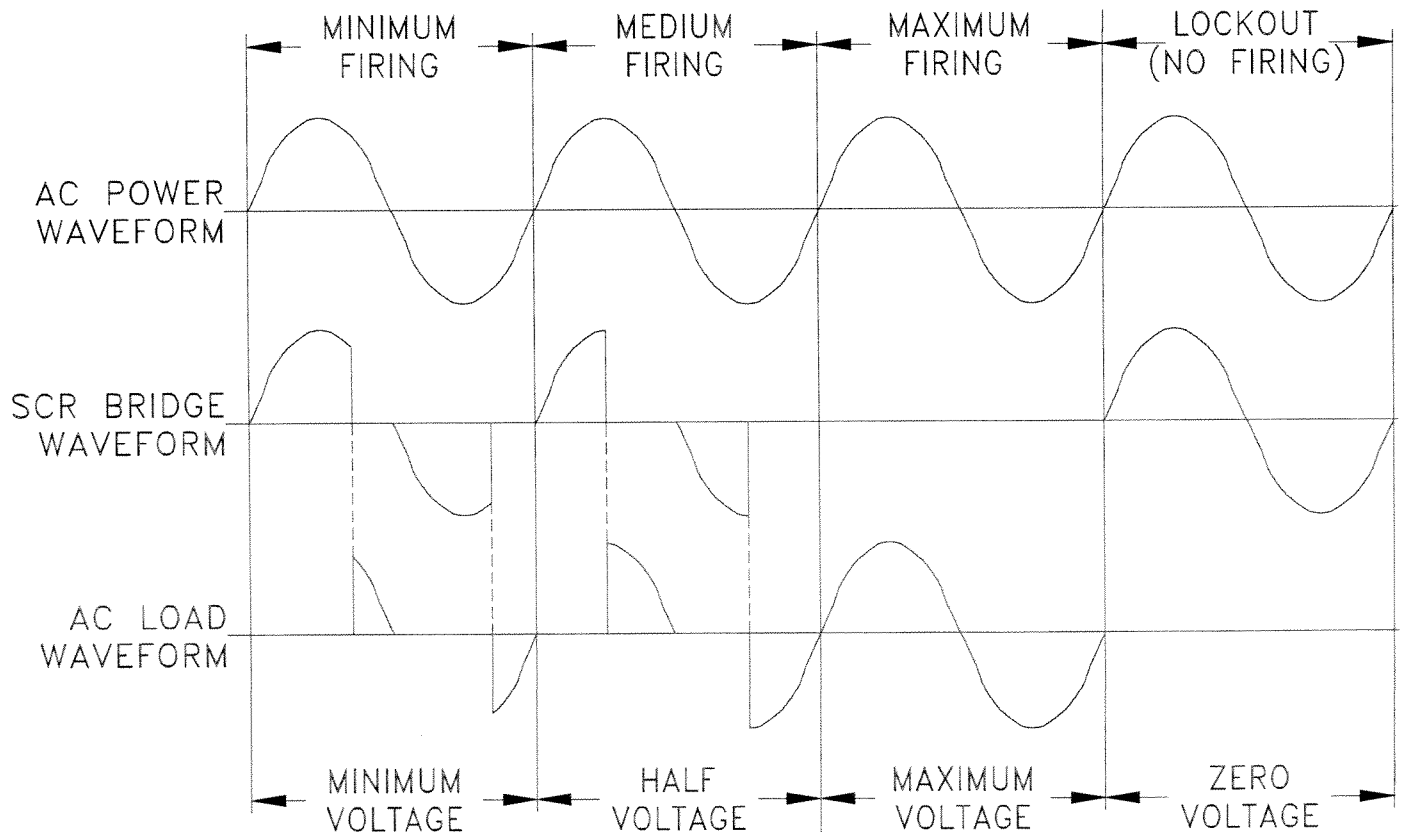


FIGURE 2.1.3

regeneration can be used, if desired, to control lowering overhauling loads at full speed. For this condition, the system turns the Lower SCR bridges and the Common SCR bridge fully on to supply full lowering voltage to the motor.

The transition from driving lower to counter-torque lower is automatic and is determined by the mechanical loading presented to the motor. The full speed regenerative lowering operation occurs only if the system is configured to provide this option. Full voltage regenerative lowering will produce lowering speeds 30% to 40% greater than full load raising speeds.

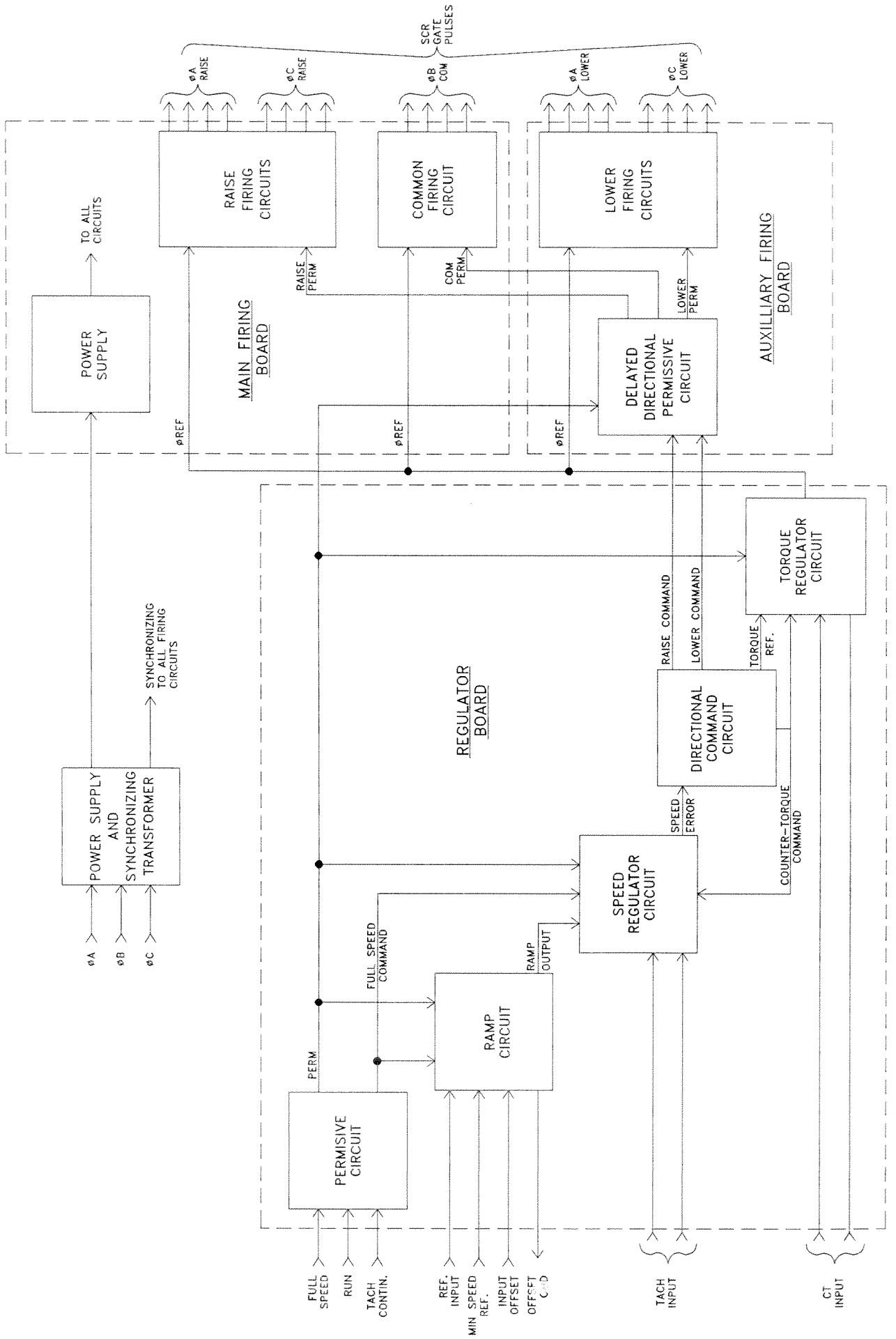
2.2.2 CONTROL CIRCUIT, STATIC CONTROL ASSEMBLY

The Static Control Assembly, SCA, contains all of the control system responsible for the speed and current regulation functions of the movable structure 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 Fig. 2.1.1. This transformer provides low voltage AC power for the electronic power supply section and synchronizing information for the firing circuits. See Fig. 2.2.1.

The permissive circuit monitors the Run command input contact at the 120V AC control power level and converts this signal to an isolated low level signal compatible with the electronic system. In order for the Static Control Assembly system to operate, the control permissive signal from the Run command contact must be present. The permissive circuit also monitors the full speed command input if used. This input will enable full speed regenerative lower operation when this option is present.

The ramp circuit receives the speed reference signal from the directional and speed control relays 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 current reference signal



STATIC CONTROL ASSEMBLY
SYSTEM DIAGRAM
FIG. 2.1

via the directional command circuit. This increased signal results in more voltage being supplied to the motor via the current regulation loop and consequently more motor torque to increase system speed. If the system speed is above the speed reference level, the output of the speed regulator circuit reverses polarity. This action causes the directional command circuit to issue a plugging or counter torque command to slow the motor. The resulting counter torque command signal along with the current regulation loop provides controlled motor current and torque during the slow down interval.

The directional command circuit receives the bi-polar speed error signal and a bi-polar 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 Raise command signal to activate the Raise 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 torque regulator circuit receives the absolute value speed error signal from the directional command circuit and compares this signal with the motor current signal provided by a current transformer. The torque regulator circuit then produces an output to adjust motor current and torque to satisfy the system speed reference. The torque regulator circuit also provides an adjustable current limit function for acceleration, running, and deceleration. The range of this adjustment is 100% to 300% when the motor current transformer is properly selected and scaled. A second current limit adjustment is available and is selected via an external signal. This adjustment is used to provide a reduced current limit level during structure seating intervals.

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 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 output signal from the torque regulator circuit, and along with the synchronizing signals from the three phase synchronizing transformer and the delayed

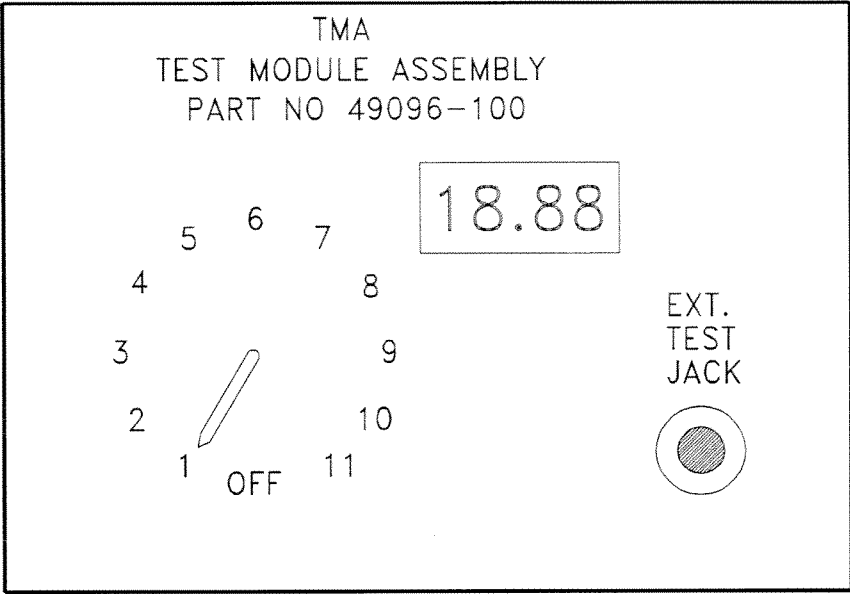
permissive signals from the delayed directional permissive circuit, produce the firing or gating signals required by the SCR bridges.

2.2.3 TEST MODULE ASSEMBLY

The Test Module Assembly allows on panel display of system voltages via a 3 1/2 digit digital meter. See Fig 2.2.2. The function switch selects 1 of 10 prewired signals and provides for an external 0 volt referenced general purpose DC signal input.

The prewired function switch signals are as follows:

1. -12v DC Supply (Unregulated)
2. -8.5v DC Supply (Regulated)
3. +8.5v DC Supply (Regulated)
4. +12v DC Supply (Unregulated)
5. Speed Reference Input to Ramp circuit
6. Ramp circuit output
7. +/- Tachometer output (Scaled 6.0v = Sync Speed)
8. Speed Regulator circuit output
9. Firing Circuit signal (5.0v = Full Conduction)
10. Motor current (Scaled 2.0v = 100% current)
11. External DC signal (+/- 20v DC max)



TEST MODULE FUNCTIONS	
POS	SIGNAL
OFF	
1	-12 VOLT SUPPLY (UNREG.)
2	-8.5 VOLT SUPPLY (REG.)
3	+8.5 VOLT SUPPLY (REG.)
4	+12 VOLT SUPPLY (UNREG.)
5	SPEED REFERENCE INPUT
6	RAMP OUTPUT
7	TACH. OUTPUT
8	OUTPUT FROM SPEED REG.
9	PHASE REF. VOLTAGE
10	MOTOR CURRENT (-2V = 100%)
11	EXTERNAL INPUT +/- 20V DC MAX

Fig. 2.2.2

3.0 SPECIFICATIONS

Input Power	230V, 460V, or 575V 60 Hz.
Horsepower Range	5 to 150 HP (230V) 5 to 350 HP (460V) 5 to 500 HP (575V)
Speed Range	Typical 10 to 1 with full speed = 80% sync.
Speed Regulation	Better than 1%
Control Configuration	Static Reversing
Temperature Range	-40°C to 55°C typical. -40°C to 70°C (Electronics)

3.1 INITIAL SET-UP STATIC CONTROL ASSEMBLY.

The start-up adjustments of the Static Control Assembly involve the Test Module Assembly and the setting of the control potentiometers and jumper plugs. Following is a description of these adjustments and their functions. Refer to figure 3.1 for their respective locations.

Permissive Jumper

This jumper has two positions. The left position is the "Set-up" 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 "Set-up" position, the remaining control circuit will be active and machinery 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.*

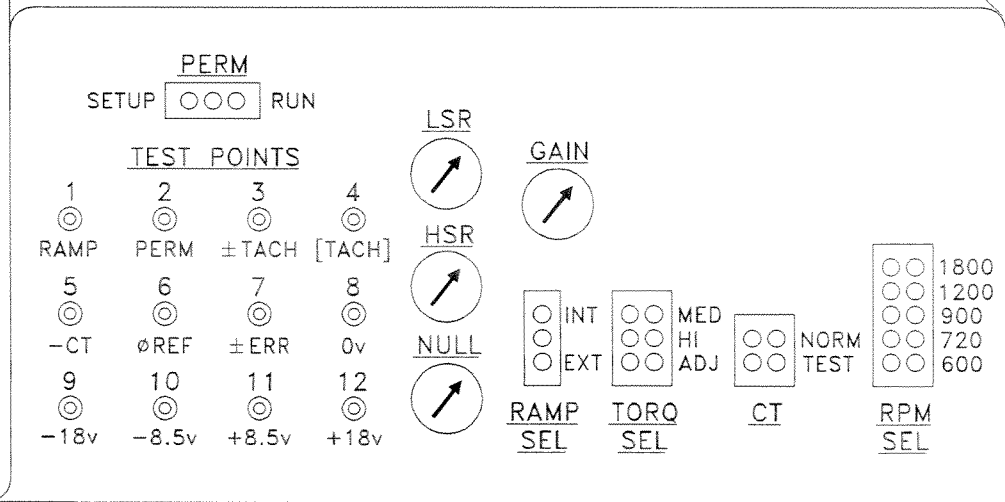
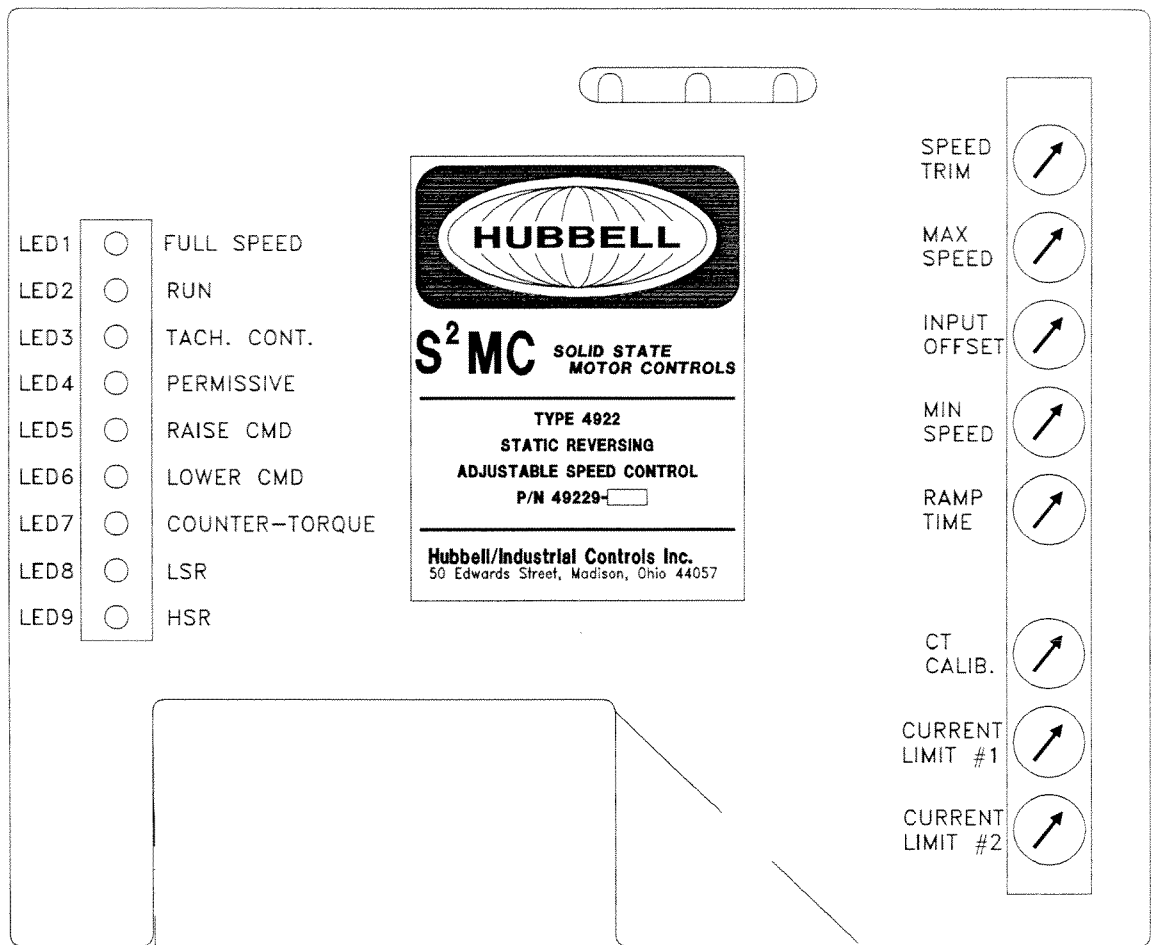


FIG. 3.1

Ramp Select Jumper

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

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:

1. 1800 RPM
2. 1200 RPM
3. 900 RPM
4. 720 RPM
5. 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 Hubbell 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.

CT Jumper

This jumper is used to provide a calibration signal to the current transformer scaling circuit during initial set-up. This jumper must be in the "Normal" position during system operation.

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. Initially, this potentiometer is set fully counter-clockwise to the "0" 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. Initially, this potentiometer is set fully clockwise to the "100" position.

Input Offset Potentiometer

This function is typically not used for movable structure applications. Set this potentiometer fully counter-clockwise to the "0" 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 counter-clockwise 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 counter-clockwise to the "0" position.

CT Calibration Potentiometer

The CT Calibration Potentiometer allows the current transformer feedback signal to be scaled. This adjustment matches the system current transformer to the driven motor. Initially, this potentiometer should be set mid range to the "50" position.

Current Limit #1 Potentiometer

For movable structure applications, the #1 Current Limit Potentiometer sets the acceleration, running, and deceleration current limit value. The adjustment range is 100%, fully counter-clockwise at "0", to 300%, full clockwise at "100". Initially, this potentiometer is set mid range to the "50" position.

Current Limit #2 Potentiometer

For movable structure applications, the #2 Current Limit Potentiometer sets the reduced torque current limit value used during the stalled seating interval. The adjustment range is 100%, fully counter-clockwise at "0", to 300%, fully clockwise at "100". Initially, this potentiometer is set fully counter-clockwise to the "0" position.

LSR Trim Potentiometer

This function is typically not used on movable structure applications. This adjustment is located directly on the main regulator board and sets the motor speed value above which the "LSR" LED will light. The adjustment range is 5% at full counter-clockwise to 25% when fully clockwise. Set this potentiometer mid range.

HSR Trim Potentiometer

This function is typically not used on movable structure applications. This adjustment is located directly on the main regulator board and sets the motor speed value above which the "HSR" LED will light. The adjustment range is 75% at full counter-clockwise to 95% when fully clockwise. Set this potentiometer fully counter-clockwise.

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.

3.2 SET-UP ADJUSTMENTS

Section 3.1 above described the system adjustments and the initial settings of these adjustments. This section describes the procedure by which the system can be set-up. Refer to Figure 3.1 for control adjustment locations.

- I. Set the function switch on the Test Module Assembly to position 6, Ramp output. For Raise commands from the controlling system, the output voltage should be positive. For Lower commands, the output should be negative. The following set-up will use Lower commands, therefore, a negative voltage on the Test Module Assembly display is expected.
- II. Move the Permissive Jumper from the “Run” position to the “Set-up” position. The firing circuits are now disabled.

Note.. Machinery brakes may be released during the remaining set-up procedure. To prevent unintended machinery movement, disable the brake control circuit by removing the brake circuit fuses.

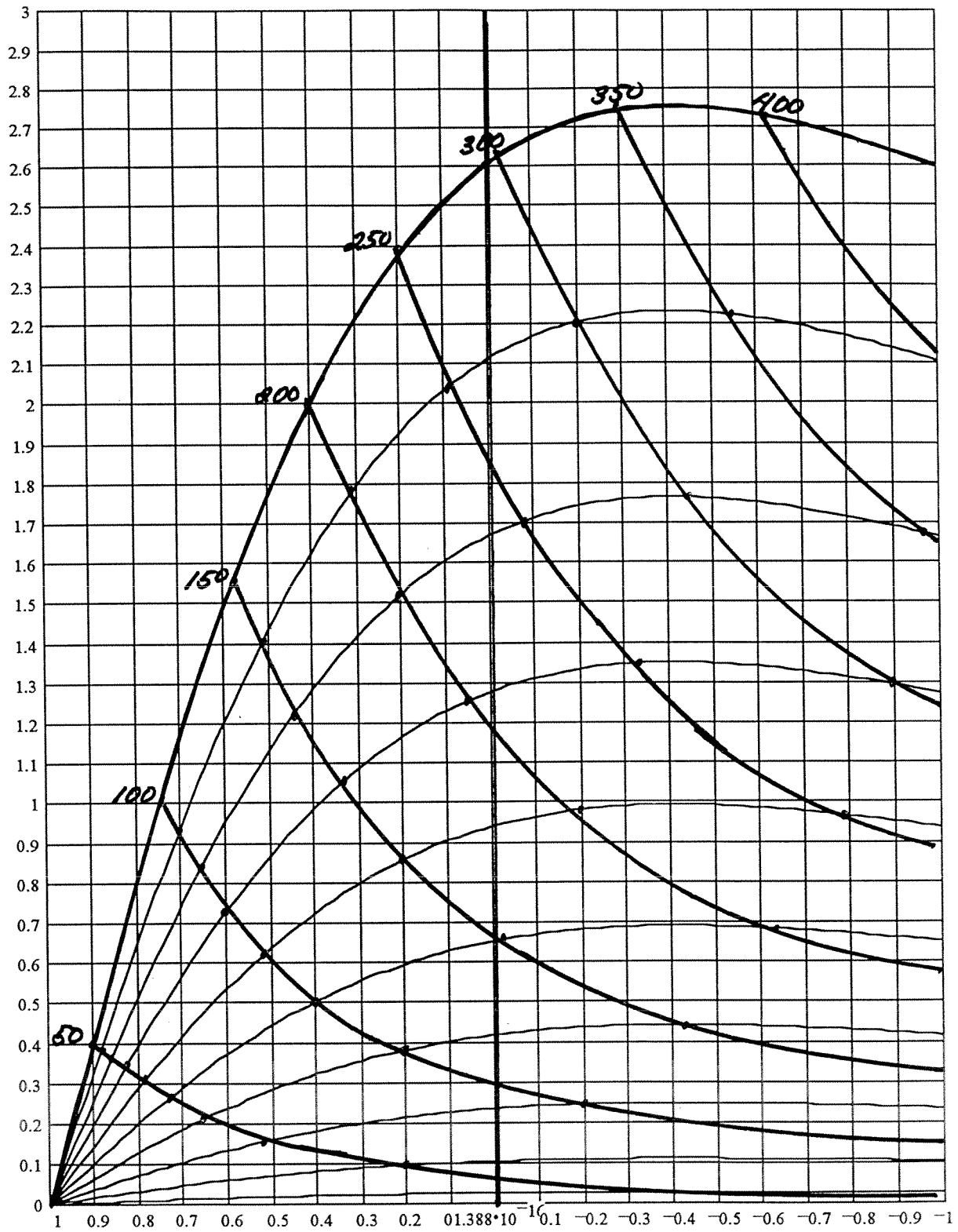
- III. Close the Main and Control circuit breakers and apply 3 phase system power. The “Tach Continuity” LED should light on the SCA.
- IV. A typical speed range is 10 to 1 with full speed equal to 5.0 volts, and minimum speed equal to 0.5 volts. Assuming a typical speed range, proceed as follows:
 - A. Close the Minimum Speed, Lower, and Run command input contacts. The “Run”, “Perm”, and “Lower” LEDs should light.
 - B. Rotate the Minimum Speed potentiometer clockwise until the reading on the Test Module Assembly indicates -0.5 volts.
 - C. Open the Minimum Speed command input and allow the Ramp output to climb. Rotate the Maximum Speed potentiometer counter clockwise until the Test Module Assembly indicates -5.0 volts.
 - D. Close the Reduced Speed command input. Determine the reduced speed value as a percentage of Full speed and adjust the external panel mounted Reduced Speed potentiometer, P1 on Figure 2.1.1, until the Test Module Assembly indicates the appropriately scaled voltage. A typical value might be -2.0 volts which represents 40% of full speed. Open the Reduced Speed command input contact.
 - E. Check the minimum speed point in the Raise direction by opening the Lower command input contact and closing the Raise and Minimum Speed command input

contacts. The "Lower" LED should go off and the "Raise" LED should come on. The Test Module Assembly should indicate +0.5 volts. f. Open the Minimum Speed command input contact and allow the Ramp output to climb. The Test Module Assembly should indicate +5.0 volts.

- F. Close the Reduced Speed command input. The Test Module Assembly should indicate a positive voltage equal in magnitude to the negative value set in step D above.
- G. Open the Reduced Speed and Run command inputs. The "Run", "Perm", and "Raise" LEDs should go off. The Test Module Assembly should indicate 0.0 volts. Determine the required system speed ramp time. The Ramp can provide times to full output from 0.5 seconds to 10 seconds. Rotate the Ramp Time adjustment potentiometer clockwise and close the Run command input contact. Time the rising output voltage displayed on the Test Module Assembly. If the time to 5.0 volts is too long or too short, rotate the Ramp Time adjustment potentiometer clockwise to increase the time and counter-clockwise to decrease the time. Open and reclose the Run command input contact and recheck the Ramp time. Repeat step g until the correct ramp time is achieved.
- V. Determine the relative synchronous speed of the system tachometer. Move the RPM Select jumper to the RPM position corresponding to the tachometer synchronous speed value. NOTE: When a Hubbell Tachometer/Overspeed Switch Assembly is used, the 1200 RPM range must be selected.
- VI. Move the CT Jumper on the regulator board from "Norm" to "Test". Set the function switch on the Test Module assembly to position 10, "Motor Current".
- A. Determine the motor primary full load current and the system current transformer rating in amps.
- B. Calculate the system calibration voltage as follows:
- $$volts = \frac{C.T. Amps}{3 \times F.L. Amps} \times -2.0$$
- C. Adjust the CT Calibration potentiometer until the Test Module Assembly indicates the voltage calculated in step B above. Move the CT Jumper back to its original "Normal" position.
- D. Set the #1 Current Limit potentiometer to a mid-point setting of "50". This sets the running current limit value to about 200% for acceleration, running, and counter torque operations. See figure 3.2.

- E. Set the #2 Current Limit potentiometer fully counter- clockwise to "0". This sets a current limit value of about 100% for the seating operation. At minimum speed or stall, 100% current represents approximately 30% motor torque. See figure 3.2.
- VII. Open the Main and Control circuit breakers and remove system power. Move the Permissive Jumper on the regulator board from the "Set-up" position to the "Run" position. ***Restore operation to the machinery brake circuit by reinstalling the brake circuit fuses.*** Close the main and control circuit breakers. The motor control system will now be able to operate the span motor.
- VIII. Assuming the span is in it's closed position, attempt to operate the span motor by closing the Raise and Run command input contacts. Observe the "Plugging" LED on the SCA. If this LED comes on during a motoring Raise operation, reverse the tachometer leads. This LED indicates counter torque operation and should only be on during lowering operations and during speed changes when entering slow down periods.
- IX. Observe the operation of the span motor to changes in speed reference. This can be accomplished by closing and reopening the Minimum Speed command input contact in a repetitive manner during a normal speed operation. This causes the Ramp output to reduce and then increase. Watch the directional "Lower" and "Raise" command LEDs for direction command changes and the incandescent lights on the Firing Circuit boards for relative performance and stability. One change in the directional command LEDs is normal indicating the slow down operation. If "back and forth" oscillation of the direction LEDs or repetitive flickering of the Firing Circuit Lights occurs, adjustment of the "Gain" potentiometer on the regulator board will be required. The best performance will be obtained when the Gain potentiometer is adjusted to provide smooth steady response to speed reference changes without repetitive flickering of the firing circuit lights or continued oscillation of the direction command LEDs.
- X. Refer to TB-49232 for the adjustment procedure of the Tachometer Signal Loss Module if used.
- XI. Open the Run and Minimum Speed command input contacts and open the Control and Main circuit breakers. Turn the function control switch on the Test Module Assembly to "Off". This completes the set up of the span motor control system.

Torque



— Torque

Speed

4.0 TROUBLE SHOOTING

The following section is a trouble shooting section that should locate most common problems. When the instructions require an AC voltage measurement, a hand held DVM set to the appropriate AC scale should be used. When the instructions involve a common referenced DC voltage of +/- 20 volts or less, the Test Module assembly may be used by setting the function switch to the appropriate position or by selecting position 11 and inserting a banana plug test lead into the Ext. Test jack. 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

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
1.0 Span control does not operate, will not respond to command inputs.	1.1 No power to controller. 1.2 Main circuit breaker or control circuit breaker open	1.1.1 Restore power. 1.2.1 Close circuit breakers
2.0 The LV Relay on the TSLA is not energized. There is power to the control.	2.1 There is no control power present from TB1-1 to TB1-4 on the TSLA. 2.2 Continuity loop TB1-5 to TB1-8 is open.	2.1.1 Check the control circuit fuses. Replace if open. Investigate the control circuit for the cause of the fault. 2.2.1 Measure the voltage from terminal 1 to terminal 2. The normal voltage should be 0V AC. A 120V AC reading indicates an open condition. Check the following: a. Normally closed overload relay contacts. b. The thermostat located on the center SCR bridge.
3.0 Span Control will not respond to command inputs. The LV relay on the TCA is operative.	3.1 Defective command input control wiring. 3.2 One or more control relays not operating. 3.3 M contactor not operating 3.4 Defective Static Control Assembly.	3.1.1 Check wiring continuity. Correct Problem. 3.2.1 Faulty relay or relays. Replace relay or relays. 3.3.1 Check M power contacts. Replace if necessary. 3.3.2 Open contactor coil. Replace coil or complete contactor. 3.4.1 The adjustable speed control unit is not responding to the command inputs. See Sec. 5.0.

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE ACTION</i>
4.0 Span operates but runs at full speed in either direction. No speed control.	4.1 Loss of tachometer feedback signal	4.1.1 Monitor the tachometer voltage. If the motor is operating and the voltage is zero: <ul style="list-style-type: none"> 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 tachometer/overspeed unit.
5.0 The Static Control Assembly is not functioning.	5.1 No control power to the notStatic Control Assembly. 5.2 Control circuit permissive signal is not present.	5.1.1 Carefully check for the presence of 3 phase power on the primary leads of transformer XFMR2. If the proper voltages are not present, restore power. 5.2.1 Measure the following AC voltages: <ul style="list-style-type: none"> SCA term. Raise Off Lower TB1-1 to TB1-2 120V 0V 120V a. If the above readings are not observed, check the affected control wiring and correct the problem. b. See Sec. 3.1 and 3.3. c. See Sec. 2.0.

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
	<p>5.3 Speed reference signal is not present.</p>	<p>5.3.1 Set the Test Assembly selector switch to position 5. The voltage should be +8.5v when the raise command input is present without the Minimum Speed Input. The voltage should fall to 0 volts when the Minimum Speed input command is present The voltage should be -8.5 volts when the Lower command input is present without the Minimum Speed input command. The voltage should be between 0V and +/-8.5V depending upon the Reduced Speed value with the Reduced Speed input command present.</p>

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
6.0 Internal problem with the Static Control Assembly.	6.1 Defective 3 phase power transformer XFMR2	<p>6.1.1 Measure the AC voltages from TB1-4 on the Main Firing Board to each of the secondary leads of the Transformer.</p> <ul style="list-style-type: none"> a. TB1-4 to TB1-6 (YEL) 10V AC +15% b. TB1-4 to TB1-2 (BLU) 10V AC +15% c. TB1-4 to TB1-3 (RED/WHT) 10V AC +15% d. TB1-4 to TB1-7 (BLK) 10V AC +15% e. TB1-4 to TB1-1 (WHT/BLU) 10V AC +15% f. TB1-4 to TB1-5 (GRA) 10V AC +15% <p>If any of the voltage readings are incorrect, replace transformer XFMR2.</p>
	6.2 Defective Power Supply.	<p>6.2.1 Set the Test Assembly selector switch to the indicated positions and verify the following voltages:</p> <ul style="list-style-type: none"> a. Position 1 >-12V DC b. Position 2 -8.5V DC c. Position 3 +8.5V DC d. Position 4 >+12V DC <p>If any of the voltage readings are incorrect, replace the Main Firing Board.</p>

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
	<p>6.3 Defective Permissive Circuit</p>	<p>6.3.1 Observe LED1 - LED4 on the Regulator Board.</p> <ul style="list-style-type: none"> a. LED1 Full Speed Permissive. On only when full speed regenerative lower is used. Typical systems have LED1 always off. b. LED2 should be on with 120V AC from TB1-1 to TB1-2 of the SCA. (M contactor closed) See Sec. 5.3.1. c. LED3 should be on with 0V from TB2-9 to TB2-14. of the SCA regulator board. See Sec. 5.2.1. d. LED4 should be on when LED2 and LED3 are on. With LED4 on, measure the voltage from TB3-1 to 0V. The voltage should read >+12V DC. Permissive jumper must be in the "RUN" position. <p>If any of the above conditions are not observed, replace the SCA regulator board.</p>

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
	<p>6.4 Defective Ramp Circuit</p>	<p>6.4.1 Set the Test Assembly selector switch to position 6. The following voltages should be read:</p> <ul style="list-style-type: none"> a. Min. Speed Raise = +0.5V b. Max. Speed Raise = +5.0V c. Min Speed Lower = -0.5V d. Max. Speed Lower = -5.0V e. Reduced Speed = +2.5V Raise typical f. Reduced Speed = -2.5V Lower typical <p>The voltage readings will rise and fall slowly. If the above conditions are not observed, check the set-up of the Ramp Circuit. If the circuit fails to set-up properly as described in the technical bulletin Sec. 3.2, the circuit is defective. Replace the regulator board.</p>
	<p>6.5 Defective Speed Regulator</p>	<p>6.5.1 Set the Test Assembly selector switch to position 7. The following voltages should be read:</p> <ul style="list-style-type: none"> a. 0 to -5.0 volts for Raise. b. 0 to +5.0 volts for Lower. <p>This is the scaled tachometer signal.</p>

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
		<p>6.5.2 Set the Test Assembly selector switch to position 8. This signal is the Speed Error signal, and will vary from 0.5V to 5.0V depending upon motor loading. 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 6.0 volts.</p> <p>If the output does not vary or remains saturated when the system should be regulating, the speed regulator circuit is probably defective. Replace the SCA regulator board.</p>
	<p>6.6 Defective Directional Command Circuit</p>	<p>6.6.1 Observe LED5, LED6, and LED7 on the SCA regulator board. LED5 should be on during raise operations.</p> <p>LED6 should be on during driving lower or seating operations.</p> <p>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 SCA regulator card.</p>

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
	6.7 Defective Torque Regulator	6.7.1 Set the Test Assembly selector switch to position circuit 10. This voltage is the scaled motor current signal and it should always be negative with $-2.0V = 100\%$ motor current.
		6.7.2 Set the Test Assembly selector switch to position 9. This voltage is the torque error signal to the Firing Circuit cards and should be $+1.5V$ to $+5.0V$ when the Firing Circuits are operating. If the motor is not operating and there is no current feedback signal, this output will quickly saturate ($+6.5V$) in response to any torque reference input. If the output does not vary or remains saturated when the system is operating, check the current transformer for proper output. If the current transformer tests OK, then replace the SCA regulator board.

<i>SYMPTOM</i>	<i>POSSIBLE CAUSE</i>	<i>DIAGNOSIS/CORRECTIVE: ACTION</i>
	<p>6.8 Defective Firing Circuits</p>	<p>6.8.1 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.</p> <p>a. 3 lights on the rear Main Firing board will illuminate during Raise and Counter Torque Lower operations.</p> <p>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 or during seating.</p> <p>c. Open the main and control circuit breakers and examine the SCR gate signal connectors on the lower edges of the Firing Circuit boards. These connectors should be seated firmly. If the above conditions are not observed, correct the problem or replace the affected board</p>

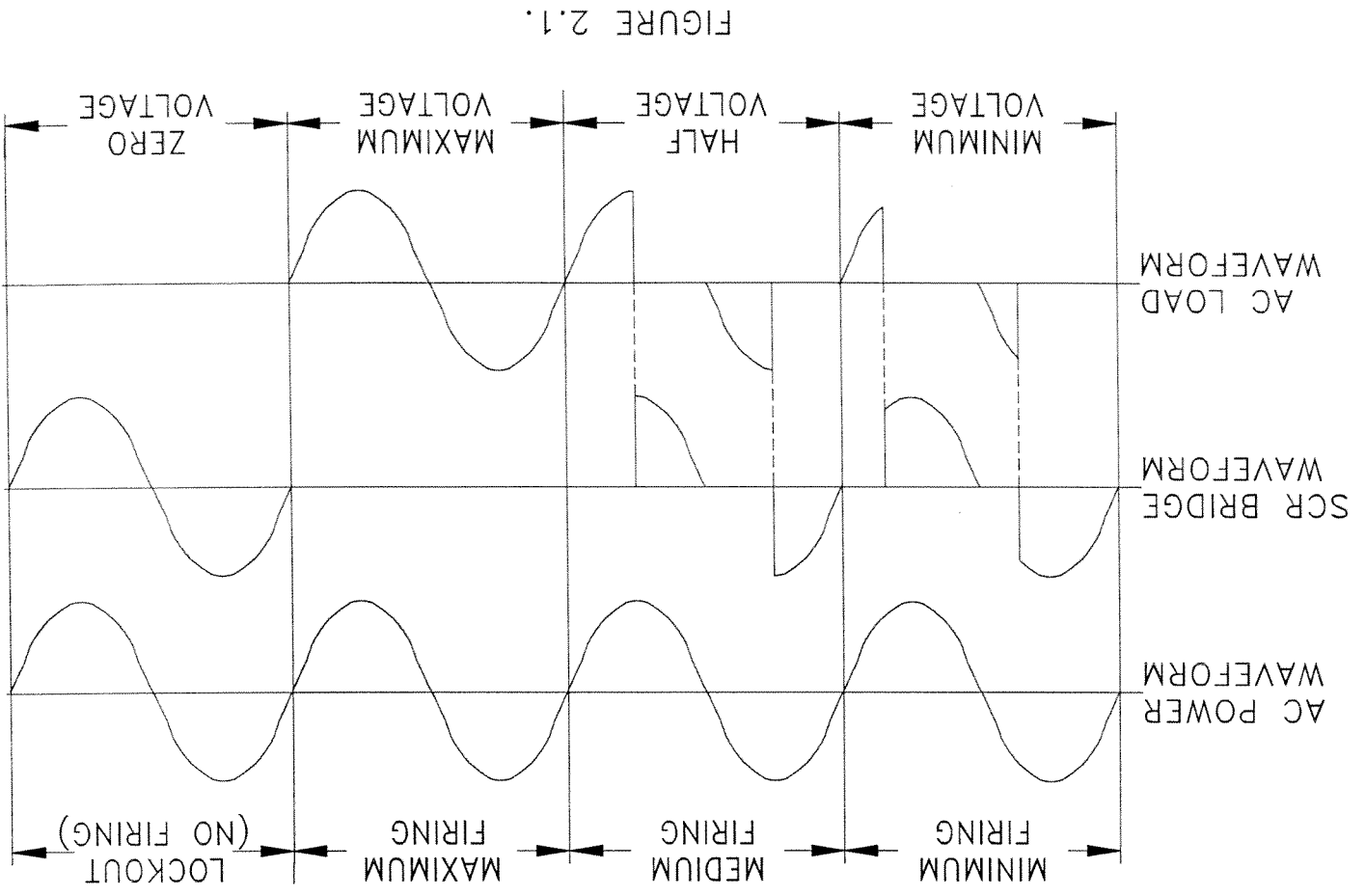


FIGURE 2.1.

FIGURE 2.1.

