TYPE M4B MODEL C47
THYRISTOR POWER SYSTEM
FIELD START-UP PROCEDURES

I. INTRODUCTION

These instructions provide a step-by-step procedure for a first time start-up of a C47 Thyristor Power System used as an armature supply for main drive d-c motor application.

Non-standard functions such as special sequencing, director logic, interconnection with other drives, etc. which pertain to a specific application are covered by separate instructions.

The procedures should be followed in the specified sequence, checking each step against the schematic diagram. This will develop familiarity with the system and insure proper operation of the drive system when the sequence is completed. If difficulty is encountered at any step, the source of trouble and/or remedy may be obvious.

It should be possible to place the drive system in operation by following the start-up procedure as described, referring only to the applicable schematic diagrams. However, a more efficient and confident approach requires a knowledge of fundamental functions and relations which can be obtained by referring to the Instruction Leaflets (I.L.) listed in the Appendix.

II. BASIC SYSTEM

A. General

This section is devoted to a procedure for first time start-up of the basic C47 power supply system. The basic system consists of the following:

1. Basic Regulator Cage containing:

GPG	-	gate pulse generator system
GC	-	gate coordinator
VS	-	voltage sensor
CC/1	-	current controller
VC	-	voltage controller
OSC	-	oscillator and auxiliary supplies
FD	-	fault detector
CS	-	current sensor
PS	-	± 24V regulated power supply

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2. Gate pulse amplifier power supply and gate pulse amplifier.

3. C500 thyristor power case and load sharing reactors.

NOTE: For 12 phase systems, the inner voltage loop and current loop is to be set up as two individual 6 phase systems inclusive of the converter protection system.

4. a-c and d-c power circuits with standard protection and sequencing.

B. Start-Up Procedure

1. Test Equipment

1.1 Dual beam oscilloscope, such as a Tektronix 502, 545 or equivalent.

1.2 Two channel brush recorder.

1.3 Adjustable battery powered test supply, 0-22V, with reversing and turn-off switch. Use ±24V regulated power supply on drive if desired.

1.4 Load rack per thyristor cabinet (1000 ohms/case)

1.5 A multimeter with an internal impedance of 20,000 ohms/volt.

1.6 A gate pulse amplifier load box (S#1560A98G01). This is a handy tool for simulating the pulse transformer in the thyristor power case and quickly checks the pulse characteristics and phasing of the gate pulse generator and gate pulse amplifier as a complete unit.

2. Inspection and Preparation

2.1 Check for transportation damage

2.2 Inspect all cabinets for loose connections, loose hardware, etc.

2.3 Remove all blocking of relays and contactors.

2.4 Check all external wiring.

2.5 Make sure auxiliary a-c disconnect switches and a-c and d-c circuit breakers are open.

2.6 Thyristor Power Cases

2.61 Unpack power cases which were shipped separately from the cabinets.

2.62 Inspect for transportation damage.

2.63 Inspect for loose wires and hardware.

2.64 Place the cases in the thyristor cabinet but do not engage the power stabs or gate lead harness at this time.

2.7 Megger power bus 1U, and P, to ground, with 2KV d-c. (Repeat for 2U in case of a 12 Ø system).

3. Temporary Connections

3.1 Connect the load box a-c supply harness (U, V, W) to power busses 1U, 1V, 1W respectively (secondary phases of the power transformer) when checking out the (F1, R1) converter section.

NOTE: For a 12 Ø system, U, V, W of the load box harness must be connected to power busses 2U,2V,2W to check out the (F2,R2) converter section.

3.2 Disengage the current controller PC boards (CC/1) [cage position 08] from the basic regulator cage (1 CC/1 for a 6 Ø system; 2 CC/1's for a 12 Ø system).

3.3 Disengage the voltage sensor PC board (VS) [cage position 10] from each basic regulator cage (cage "A" for a 6 Ø system; cages "A" & "B" for a 12 Ø system).

3.4 Add a jumper between pins 35 and 41 on the voltage controller PC board (VC) edge connector [cage position 12] for each basic regulator.

3.5 Connect a jumper from pin 37 to PSC on each voltage controller PC board edge connector. (cage position 12)

3.6 Connect a test supply to pin 9 of the gate coordinator board (GC) [cage position 19]. Apply a +10V signal (with respect to PSC) to pin 9 to release the FORWARD pulse train and a -10V signal to release the REVERSE pulse train.

NOTE: This step may be omitted for single converter basic regulators.

ON ALL SUBSEQUENT STEPS THROUGHOUT THIS START-UP PROCEDURE IT IS ASSUMED THAT THE SERVICE ENGINEER WILL INVESTIGATE PREVENTATIVE INTERLOCKING CIRCUITS TO ENSURE THAT THE TEST FUNCTIONS CAN BE COMPLETED.

4. Apply auxiliary a-c power (460V 60 Hz or 380V 50 Hz) to the incoming terminals and check that the voltage tolerance does not exceed +10%, -5% and that the phase sequence is R-S-T.

NOTE: AN INCORRECT PHASE SEQUENCE OR SINGLE PHASING WILL CAUSE A GATE PULSE SUPPRESSION; RELAY 86Y WILL BE DE-ENERGIZED.

5. Close the "Auxiliary A-C Power" disconnect and check the following:

5.1 The thyristor fans start and their rotation is correct. If their rotation is correct, air should be exhausting out around the front of each case. If the rotation is incorrect, interchange any two leads of the fan main circuit feeder.

5.2 The voltage across CX and CY is 115V + 10V, -5V.

5.3 Amber light indicates gate control is reset; pushlight goes OFF when held down and LIGHTS when released.

5.4 Red lights on the basic regulators indicate PSP, PSN, and RP are energized. Use a multimeter and check the following d-c voltages with respect to PSC:

PSP = +24V ± 1V

PSN = -24V ± 1V

RP = +24V + 4V, -2V

NOTE: 1. If there are two basic regulators per drive (12 Ø system), there should be no electrical connections between PSP, PSN, and RP of the two basic regulators. However, PSC must be common to all regulator cages.

2. No PSP or PSN power is to leave the basic regulator cage.

5.5 Check the PSR relay sequence by using temporary jumpers across any normally open interlock contacts in the PSR circuit. Depress the POWER SUPPLY ON pushbutton. KEEP PSR ENERGIZED.

5.6 The voltage from pin 35 to PSC of the oscillator board (OSC) [cage position 04] is +25V ± 2V.

NOTE: This voltage must be present to allow pulsing.

5.7 The output meters (3M & 4M) of the voltage controller of each basic regulator should read 0V.

5.8 The outputs at pins 53 & 55 of the voltage controller should read +7.0V ± 0.6V.

6. Gate Pulse Distribution System

Energize the main a-c supply to the thyristor drive power transformer and check the pulse distribution system as follows: (Cases are still disconnected)

6.1 6 Phase System (F1, R1) Power Section

6.1.1 Make sure the load box a-c supply is connected as per step 3.1

6.1.2 Connect one probe (channel 2) of a dual beam oscilloscope to the OUTPUT PULSE terminal of the load box and the other probe (channel 1) to the A-C PHASE REFERENCE terminal with the probe ground leads of each channel connected to the black terminals of the load box. Connect an external trigger lead from the appropriate scope terminal to the A-C PHASE REFERENCE terminal of the load box. NOTE: MAKE SURE SCOPE IS UNGROUNDED.

6.1.3 Plug the load box GPA harness into the top plug socket of the thyristor cabinet (next to the regulator cabinet). All six gate pulse amplifier lights should come on.

6.1.4 Establish a horizontal line on the oscilloscope graticule to represent zero volts. The crossover of this line by the a-c voltage wave form now gives the 0-degree and the 180 degree points of the a-c wave.

NOTE: Make sure the time base of the scope is properly calibrated for 1/2 cycle (180°) of the a-c wave. The following time values should be observed: 60 Hz -8.3 ms; 50 Hz -10 ms.

6.1.5 The output pulse channel to the oscilloscope shows GPA output pulse trains as selected by the selector switch. With the oscilloscope set on alternating mode and (+) external triggering, observe that for each position of the load box selector switch (1 thru 6) that a pulse train will appear and the delay angle can be read in milliseconds as the time between the 0° crossover of the a-c wave and the leading edge of the pulse train. Refer to Fig. 1 in the Appendix. The pulse train initiates thyristor conduction and is identified by the color code with thyristor firing sequence as follows:

1TH BROWN	4TH YELLOW
2TH RED	5TH GREEN
3TH ORANGE	6TH BLUE

The delay angle should be 142° ±6° which corresponds to 6.6 ±0.3 milliseconds for 60 cycle applications and 7.9 ±0.3 milliseconds for 50 cycle applications. The magnitude of the leading edge of the pulse train should be +7.5V ± 1.5V and the pulse train should return to zero at approximately 240°.

NOTE: 1. When switching from position 1 thru 6, similar traces should be observed; the trace will not shift across the oscilloscope.

2. Disregard the negative magnitude of the pulse train.

6.1.6 Disregard position 7 of the load box.

6.1.7 Since we now have established that all pulse trains are present at the proper delay angle and magnitude at the top case plug socket, it is now only necessary to check that the pulse trains are present at the remaining plug sockets of the thyristor cabinet. Progressively move the load box harness to each plug moving from the top to the bottom of the cabinet verifying that the pulse distribution has the same delay angle for all cases of one section. A magnitude check is not required.

EXCEPTION: If a thyristor cabinet contains both FORWARD and REVERSE cases, the first case socket associated with each "direction" should be checked as specified in step 6.1.5 above to make sure that both the "forward" and "reverse" GPA pulse trains are present of correct magnitude and position. Then proceed with step 6.1.7 above.

6.2 12 Phase System (F1,R1 and F2,R2)

6.2.1 Connect load box as in step 6.1.1 and test power section (F1,R1) thyristor cabinets per steps 6.1.2 through 6.1.7.

6.2.2 Reconnect the load box a-c supply to the secondary (2U,2V,2W) of the (F2, R2) power transformer and check pulsing per steps 6.1.2 through 6.1.7.

6.3 Press the POWER SUPPLY OFF button to drop out PSR.

6.4 Replace the following PC boards and remove temporary jumpers as follows:

6.4.1 Replace the voltage sensor PC boards.

6.4.2 Remove the jumper between pins 35 and 41 and the jumper from pin 37 to PSC on the voltage controller board (s).

6.4.3 Remove the test supply from pin 9 of the gate coordinator board.

6.5 Open the main a-c supply breaker.

7. Inner Voltage Loop

7.1 6 Phase System (F1, R1) Power Section

7.1.1 Remove the main a-c power.

7.1.2 Make sure the d-c power loop is open and remains open.

7.1.3 Add the load rack (1000 ohms/case) across the P and N bus of the (F1,R1) converter section.

Example: Thyristor cabinet (1F1) contains five 700V DC power cases. Load rack should be 1000/5 = 200 ohms @ $\frac{(700)^2}{200}$ = 2450 watts.

7.1.4 Remove all the "reverse" gate pulse generator boards from the basic regulator.

NOTE: Remove all the gate pulse generator boards from the (F2,R2) basic regulator if used.

7.1.5 Make sure that the current controller board (s) are still disengaged.

7.1.6 Connect an adjustable battery test supply (set at 0 volts) to pin 37 ,-V(B)*, of the voltage controller (cage position 12) located in the (F1, R1) basic regulator.

7.1.7 Plug in the gate harness and engage the power stabs of the power cases of the "first" FORWARD case group thyristor cabinet (1F1).

7.1.8 Energize the main a-c supply to the power transformer.

7.1.9 Press the POWER SUPPLY ON button.

7.1.10 Using the test voltage source, gradually adjust the voltage applied to pin 37, -V(B)*, of the VC board over the range from 0 to 10 volts and observe the corresponding smooth change on the armature voltmeter. Voltage sensor output -V(B), as indicated by a miniature panel meter (2M), changes smoothly from 0 to -9.6 volts and output +V(B) measured at terminal 3 of the basic regulator is the same as -V(B) except opposite prolarity. Voltage -V(C) and +V(C), as indicated by miniature panel meters 3M and 4M respectively, are -7 to -8 volts and +7 to +8 volts respectively at maximum output voltage. Voltages V(C)'F and V(C)'R measured at pins 55 and 53 of the voltage controller are -8 to -9 volts and +12 to +15 volts respectively.

7.1.11 Observe the output waveform with the oscilloscope connected across 1VN and 1VP. Use differential input technique on scope, or make sure that scope is properly insulated to ground. In the latter case, scope will be hot! The scope trace should show that six pulses are present and are 60° apart. The pulses should be stable and of equal amplitude over the voltage range with no random jitter. Figures 2 and 3 in the Appendix show typical waveforms at 50% and at rated voltage.

7.1.12 Place a temporary jumper across terminals 22-23 on the (F1,R1) basic regulator to jumper out the normally open 86Y contact. While operating at rated volts, depress the GATE CONTROL RESET button and observe that the output voltage goes to zero while the button is depressed and returns to rated voltage when the button is released.

7.1.13 Remove temporary jumper from terminals 22-23. Momentarily depress the GATE CONTROL RESET button while operating at rated voltage. Note that relay PSR drops out and the output voltage goes to zero.

7.1.14 Remove the main a-c power.

7.1.15 Return all the "first" FORWARD case group power cases to their "test position", i.e. case retracted 2 inches from its normal engaged position but with gate harness still connected.

7.1.16 Plug in gate harness and engage the power stabs of the power cases of the "second" FORWARD case group thyristor cabinet (2F1) [if used] and test as before in items 7.1.7 through 7.1.14.

7.1.17 Return all the "second" FORWARD case group power cases to their "test position".

7.1.18 Test any remaining thyristor cabinets of the (F1) forward converter section in a similar manner.

7.1.19 Remove the "forward" (F1) gate pulse generator boards from the (F1,R1) basic regulator and replace the "reverse" (R1) gate pulse generator boards.

7.1.20 Reverse the polarity of the adjustable battery test supply (+ on pin 37 of the VC board of (F1,R1) basic regulator).

7.1.21 Plug in the gate harness and engage the power stabs of the power cases of the first REVERSE case group thyristor cabinet (1R1) and test as before in items 7.1.7 through 7.1.14. Performance should duplicate that previously observed except with all polarities reversed.

NOTE: V(C)'F and V(C)'R will now read +12 to +15 volts and -8 to -9 volts respectively at maximum output voltage.

7.1.22 Return all the "first" REVERSE case group power cases to the "test position".

7.1.23 Plug in the gate harness and engage the power stabs of the power cases of the "second" REVERSE case group thyristor cabinet (2R1) [if used] and test as before in item 7.1.7 through 7.1.14.

7.1.24 Return all the "second" REVERSE case group power cases to their "test position".

7.1.25 Test any remaining thyristor cabinets of the (R1) reverse converter section in a similar manner.

7.2 <u>12 Phase System (F2, R2) Power Section</u>

Test the (F2,R2) converter section of the drive in a similar manner as above with the following changes:

7.2.1 Connect the adjustable battery test supply to pin 37 of the VC board of the (F2,R2) basic regulator.

7.2.2 Reconnect the load rack to be across the P and N bus of the (F2,R2) converter section.

7.2.3 Remove all the gate pulse generator boards from the (F1,R1) basic regulator.

7.3 <u>Voltage Limit Adjustment</u>

7.3.1 Disconnect the test voltage from pin 37 of the VC board and reconnect the original wiring to this point.

7.3.2 Plug in all gate pulse generator boards, current controllers, and engage all power cases.

7.3.3 The bus voltage is now to be set for <u>each</u> converter section (F1,R1) and (F2,R2) independently. For this purpose, the board producing -V(B)* (commonly the current controller) is driven into saturation and the bus voltage adjust pot (3P mounted on the basic regulator meter - pot panel) is trimmed to obtain <u>106% of rated bus voltage for speed regulated drives</u> or <u>104% of rated bus voltage for voltage regulated drives</u>. For dual converters, check the reverse bus voltage to be the same as the forward bus voltage within ±2%.

7.3.4 Remove the main a-c power.

8. <u>Check Current Sensor</u>

8.1 Disconnect motor shunt field from excitation supply.

8.2 Disengage the current controller boards again.

8.3 Reconnect motor armature circuit. Provide a test voltage for -V(B)*. Make sure it is set at zero volts. Set GPS potentiometers 1P and 2P located on the basic regulator meter-pot panel 25% from their extreme CCW position. Apply a-c power.

8.4 Press the POWER SUPPLY ON button and recheck that the output voltage is zero.

8.5 Using the Master Control circuit, close the d-c armature loop and observe that the output voltage holds at zero volts and the motor remains at standstill.

8.6 Slowly increase the negative (-) test voltage while observing the motor armature current until approximating 50% rated current is obtained.

CAUTION: All changes in test voltage must be made slowly since the current feedback loop is open under these conditions and the current is only limited by the armature resistance. Less than 0.5V is required to reach required current. Take care to monitor speed of drive and prevent it from taking off.
See CAUTION ON STALLED ROTOR TESTS Page 18.

8.7 Check polarity and magnitude of current sensor output +I(A) and -I(A) at terminals 1 and 2 respectively of the basic regulator (s) with respect to PSC. A miniature voltmeter on the basic regulator meter-pot panel indicates +I(A) signal. For forward motoring and accelerating conditions, the polarity of terminal 1, +I(A), should be positive and terminal 2, -I(A), should be negative. Both voltages should be of equal magnitude. For reverse motoring currents, the polarities are reversed.

The following is a listing of current limit range of the system, CT ratios, the maximum steady state current they can carry, and the corresponding output voltage of the current sensor.

FORWARD CURRENT LIMIT AMPS	CT RATIO	FORWARD RATED AMPS NOT TO EXCEED	VOLTAGE OUTPUT OF CURRENT SENSOR @ C.L. AMPS +I(A) VOLTS
800-1600	800:5	1000	8-16
1200-2400	1200:5	1500	8-16
2000-4000	2000:5	2500	8-16
3000-6000	3000:5	3750	8-16
4000-8000	4000:5	5000	8-16
6000-12000	6000:5	7500	8-16

NOTE: 1) The CT's for forward and reverse current sensing on dual converters are always equal

8.8 Check the polarity of the current feedback signals at the input terminals of the current controller board. Compare with those specified on the schematic.

8.9 Reduce test voltage to zero and shut down the drive.

8.9.1 For 6 Ø dual converter systems repeat the above procedure starting at 8.6 with a positive test supply voltage.

8.9.2 For a 12 Ø system, repeat the above procedure using the (F2, R2) basic regulator instead of the (F1,R1) basic regulator.

III. CURRENT LOOP

1.0 Make sure current controller board is disengaged. Turn pots 5P (CC/1) and 4P (on the basic regulator meter- pot panel) full CCW and place jumper 1J (CC/1) on pin 1.

2.0 Check Basic Regulator Polarities

Apply a variable voltage source to the inner voltage loop reference -V(B)*. Apply power to the thyristor cases and slowly increase the reference until the machine just turns over. Connect a multimeter to PSC and with the other lead check the polarity of the current feedback -I(A) and the reference feeding the inner voltage loop -V(B)*. These must be of the same polarity. Reduce the reference to zero, de-energize the thyristor power supply.

CAUTION: The following tests are carried out without field on the motor. Take care to continually monitor the speed of the drive to prevent it from taking off. See CAUTION ON STALLED ROTOR TESTS Page 18.

3.0 Adjustment of Inner Current Loop

3.1 Remove the motor field supply and remove leads from terminal 5 and 8 of the basic regulator.

3.2 Energize thyristors and static relays 1CR & 2CR on the current controller.

3.3 Apply +10 volt signal into Pot 4P on the basic regulator meter-pot panel (BMPP).

3.4 Slowly increase 4P (BMPP) CW until continuous current is flowing in armature. Observe that the ripple on the current feedback has six pulses per cycle (50 or 60 hertz) of nearly equal amplitude.

3.5 Turn 5P (CC/1) CW and move jumper 1J (CC/1) toward pin 4 until the current pulses become suddenly radically unequal (every second or third pulse is larger than others which indicates an instability of two or three times basic frequency). Put jumper 1J (CC/1) one position toward pin 1.

3.6 The current is now dyanmically adjusted.

3.7 Turn pot 4P (BMPP) full CCW.

4.0 Adjustment of Gate Pulse Suppression

NOTE: IF A HIGH SPEED D-C CIRCUIT BREAKER IS USED, OMIT THIS STEP AND SUBSTITUTE STEP IV A OR IV B ON PAGE 10 OR 12 RESPECTIVELY.

See CAUTION ON STALLED ROTOR TESTS Page 18.

4.1 Turn gate pulse suppression pots 1P (BMPP) and 2P (BMPP) full CW.

4.2 Apply +15 volts into Pot 4P (BMPP) and increase CW until 120% current limit is reached.

4.3 Turn gate pulse suppression pot 1P (BMPP) (Forward Converter) slowly CCW until gate pulse suppression occurs as indicated by "FORWARD FAULT" LED, I(A)F, of the FD board.

4.4 Turn 4P (BMPP) full CCW.

For dual converter drives

4.5 Apply (-) 15 volt signal to pot 4P (BMPP) and increase CW to 120% current limit.

4.6 Turn gate pulse suppression pot 2P (BMPP) (Reverse Converter) slowly CCW until gate pulse suppression occurs as indicated by "REVERSE FAULT" LED, I(A)R, of the FD board.

4.7 Turn 4P (BMPP) full CCW.

4.8 Remove reference from Pot 4P (BMPP)

4.9 Replace leads on terminals 5 and 8 of the basic regulator.

5.0 Current Limit Adjustment

5.1 Fixed Current limit

5.1.1 Apply - 10 volts to an input terminal of the major loop controller (usually the VRC or SC).

5.1.2 Energize clamping relay 1CR on the major loop controller and check output terminal for 10 volts ± 1 volts.

5.1.3 Turn 4P (BMPP) slowly CW till the desired current limit is reached.

For dual converter drives

5.1.4 Reverse the polarity of the reference to the input of the major loop controller.

For symmetrical dual converter drives

5.1.5 Check that the reverse current limit is ±5% of step 5.1.3.

For asymmetrical dual converter drives

5.1.6 Adjust the REVERSE current limit pot for the desired reverse C.L.

IV. HIGH SPEED D-C CIRCUIT BREAKER

A. AEG My Rapid Breaker (Type MR-1000 and MR-2000)

1. Remove the converter fault current sensor (50A) switch leads from terminals 6 and 7 of the MR breaker trip module.

2. Remove the connection from terminal 12 of the basic regulator (Trip module signal to gate pulse suppression circuit). Depress the pushbutton on the MR breaker trip module and observe that the breaker trips out.

3. Adjust gate pulse suppression as follows:

CAUTION: See CAUTION ON STALLED ROTOR TESTS Page 18
Observe fuse lights during test.

3.1 Turn gate pulse suppression pots 1P and 2P, (BMPP) full CW.

3.2 Turn the current reference pot 4P (BMPP) full CW.

3.3 Apply +15 volts into current reference pot 4P and turn it CW until 120% of current limit amps is reached.

3.4 Turn the forward gate pulse suppression pot 1P slowly CCW until gate pulse suppression occurs as indicated by the "FORWARD FAULT" LED, I(A)F, of the FD board.

3.5 Turn the current reference pot 4P full CCW.

For Dual Converter Drives

3.6 Apply (-) 15 volt signal into current reference pot 4P and turn it CW until 120% of current limit amps is reached.

3.7 Turn the reverse gate pulse suppression pot 2P slowly CCW until gate pulse suppression occurs as indicated by the "REVERSE FAULT" LED, I(A)R, of the FD board.

3.8 Remove thyristor power.

3.9 Check circulating current sensor as follows:

3.9.1 Open the d-c armature loop. Remove leads -I(F) and -I(R) at the current sensor PC board of the (F1,R1) basic regulator.

3.9.2 Tie the above leads -I(F) and -I(R) together to a negative side of an adjustable test supply.

3.9.3 Increase the voltage until gate pulse suppression occurs as indicated by the CIRCULATING CURRENT LED on the fault detector board. The above voltage should be -5V ± 1.5V.

NOTE: For a 12Ø system, repeat the above steps for the (F2,R2) basic regulator.

3.9.4 Reconnect leads -I(F) and -I(R) to the CS boards.

4. Calibration of Converter Fault Current Sensor (50A)

4.1 Check to make sure the converter fault current sensor is of the proper size as determined from table 1 below.

TABLE 1

FWD CURRENT LIMIT (AMPS)	MAX FWD RATED CURRENT (AMPS)	FAULT CURRENT SENSOR SIZE	SENSOR STYLE NO.
800 - 1600	1000	1	1448A77G01
1200 - 2400	1500	2	1448A77G02
2000 - 4000	2500	3	1448A77G03

NOTE: On asymmetrical dual converters, the sensor is selected on basis of "forward" current limit amperes.

4.2 Reconnect wire to terminal 12 of basic regulator and reconnect input leads to terminals 6 and 7 of the MR breaks trip module. Mark the setting of the forward gate pulse suppression pot 1P and then move it 1 major division CW.

4.3 Apply +15 volts into current reference pot 4P (BMPP) and turn it CW until 120% of current limit amps of the forward converter section in reached.

NOTE: The breaker will probably trip out before 120% C.L. amps is obtained because the fault current sensor magnetic reed switch has been set at it most sensitive position at the factory, i.e. edge of reed switch case where leads exit is the sensitivity reference point and should be set at 3.5 on the scale provided.

CAUTION: Before working on the fault current sensor with the bus energized, connect the magnetic reed switch mounting panel temporarily to ground.

4.4 Desensitize the switch by moving it toward 7 on the scale. By using a trial and error procedure and curves 1 thru 5 as a guide, the appropriate setting should be obtained. If the breaker continues to trip out below the 120% C.L. point, the magnetic switch unit should be moved one position further away from the reactor core (increasing X dimension) and the above procedure repeated.

4.5 When the correct setting has been obtained, check to make sure that the trip module causes a gate pulse suppression. (GATE CONTROL light will go out and FAULT CURRENT RATE LED of the FD board will come on).

NOTE: In a 12 Ø systems, make sure that the trip module causes a gate pulse suppression in both the (F1,R1) and (F2,R2) basic regulators. (Both 86Y relays must be deenergized.

5. Remove the connection from terminal 12 of the basic regulator. Trip breaker again by circulating 120% C.L. amps. The breaker should trip with a sound indicating current interruption in the arc chute.

6. Reconnect the lead to terminal 12 of the basic regulator and reset the forward gate pulse suppression pot 1P to its set marked position.

NOTE: In a 12 Ø system, repeat the above procedure for the (F2, R2) power converter section.

7. At this point calibrate the motor fault current sensor (50A) [if used] in a similar manner as described in step 4. above except it should be set at 130% of current limit amps of the motor.

B. SIEMENS Breaker (Type R892)

1. Remove the converter fault current sensor (50A) switch leads from terminals 3 and 4 of the fault current sensor and remove the rate coil (50 R) leads from terminals 1 and 2 of the fault current sensor.

2. Set the forward gate pulse suppression pot 1P full CCW and jumper out all 86Y relay contacts in the PSR control circuit. Apply a + 15V test supply to current reference pot 4P and increase forward converter amps until the breaker trips. (Make sure motor does not turn).

NOTE: Breaker should trip befor 150% of the converter section rated current is reached. Remove the 86Y relay jumpers.

3. Adjustment of gate pulse suppression. Set as described in section A3. above.

4. Calibration of R892 Breaker Trip Module.

4.1 Check to make sure the converter fault current sensor is of the proper size as determined from the table 2 below

TABLE 2

FWD CURRENT LIMIT (AMPS)	MAX FWD RATED CURRENT (AMPS)	FAULT CURRENT SENSOR SIZE	SENSOR STYLE NO.
2000 - 4000	2500	3	1448A77G03
3000 - 6000	3750	4	1448A76G01
4000 - 8000	5000	5	1448A76G02

NOTE: On asymmetrical dual converters the sensor is selected on basis of "forward" current limit amperes.

4.2 Reconnect leads to terminals 1 and 2 of the fault current sensor. Set tap switches 1TS and 2TS on the R892 breaker trip module to position 1. Circulate rated "forward" converter section current. Circuit breaker must trip on ripple.

4.3 Calculate the rate of current equivalent to 80 times the rated "forward" converter section current per second. Set the tap switch on the trip module, per table 3 below, to the nearest value above the calculated value.

TABLE 3

Rate of Rise of Forward Converter Section Current (amps/ms)

Sensor Size	Trip Module Tap Switch Position 1	2	3	4	5	6
3		60	85	120	170	240
4		100	142	200	283	400
5		150	212	300	425	600

Example: Drive is rated 2300 amps (F1 amps).
C. L. amps is 2 X 2300 = 4600 amps.
From table 2, fault current sensor is size 4.
Rate of rise = 80 X 2300 = 184,000 amps/sec = 184 amps/msec

From table 3, set tap switch on trip module to position 4.

NOTE: The setting of 80 units of current/sec may be too sensitive in some applications with a high rate of change of armature current. In no case, however, should the ultimate tap switch setting necessary be more than one position higher than the one chosen according to the above procedure.

5. Verification of Rate Trip Valve

5.1 Disengage the CC/1 board and substitute a finely adjustable negative test source (0-1V) for -V(B)*.

5.2 Apply small steps of the test source and observe the current rate on a memory oscilloscope or visicorder. Increase the supply voltage until breaker trips to check actual rate trip value.

6. Calibration of Converter Fault Current Sensor (50A)

6.1 Remove the rate control leads from terminals 1 and 2 of the fault current sensor and reconnect the reed switch leads to terminals 3 and 4 of fault current sensor. Mark the setting of the forward gate pulse suppression pot 1P and then move it 1 major division CW.

6.2 Proceed as in steps A4.3 thru A4.5 except use a brush recorder.

7. Remove the connection from terminal 12 of the basic regulator. Trip the breaker again by circulating 120% C. L. amps. The breaker should trip with a sound indicating current interruption in the arc chute.

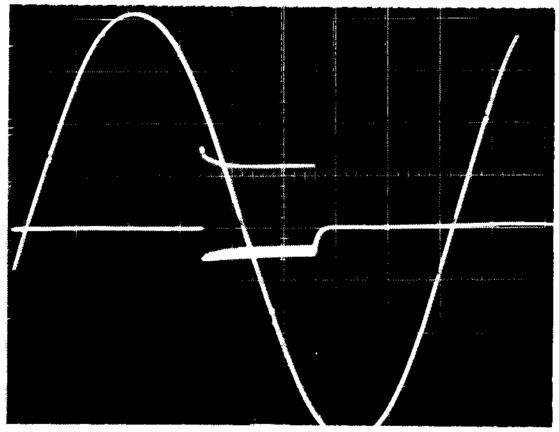
8. Reconnect the lead to terminal 12 of the basic regulator and reconnect the leads to terminals 1 and 2 of the fault current sensor. Reset the forward gate pulse suppression pot 1P to its set marked position.

NOTE: In a 12 Ø system, repeat the above procedure for the (F2, R2) power converter section.

9. At this point calibrate the motor fault current sensor (50A) [if used] in a similar manner as described in step A4. above except it should be set at 130% of current limit amps of the motor.

10. Proceed to step III 5.0.

V. APPENDIX



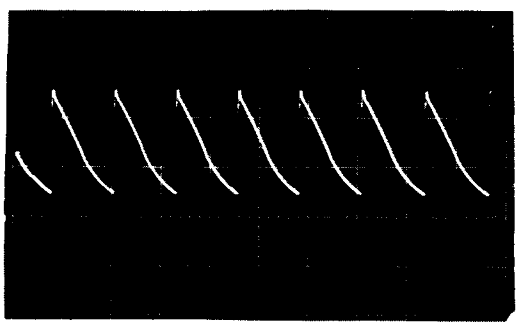
0 OUTPUT PULSE & PHASE REF.

5V/cm - Pulse Train
10V/cm - Sine Wave

2 ms/cm

FIG. 1

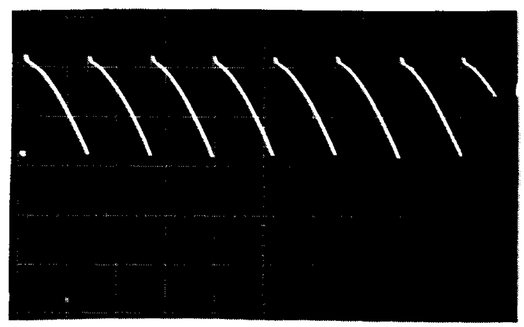
GPA Output Pulse Train with 142° Delay Angle



0

50% VOLTAGE 2ms/cm

FIG. 2



0

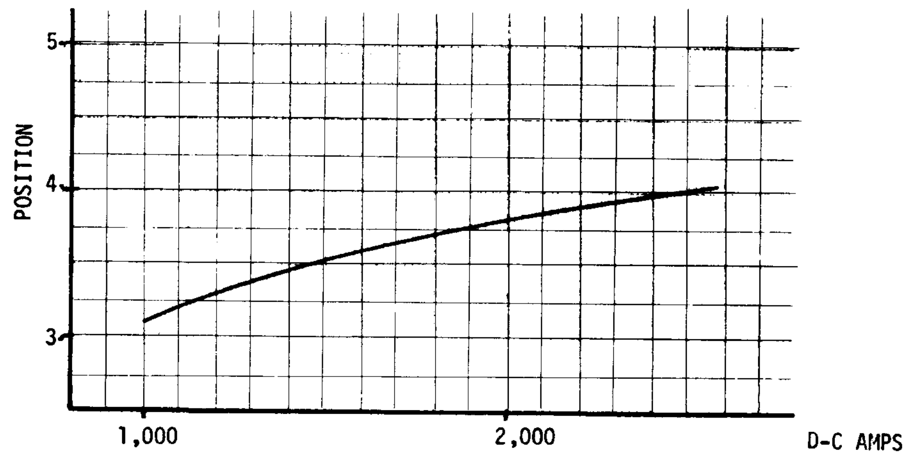
RATED VOLTAGE 2ms/cm

FIG. 3

FAULT CURRENT SENSOR TYPICAL CALIBRATION CURVES

CURVE 1 SIZE 1

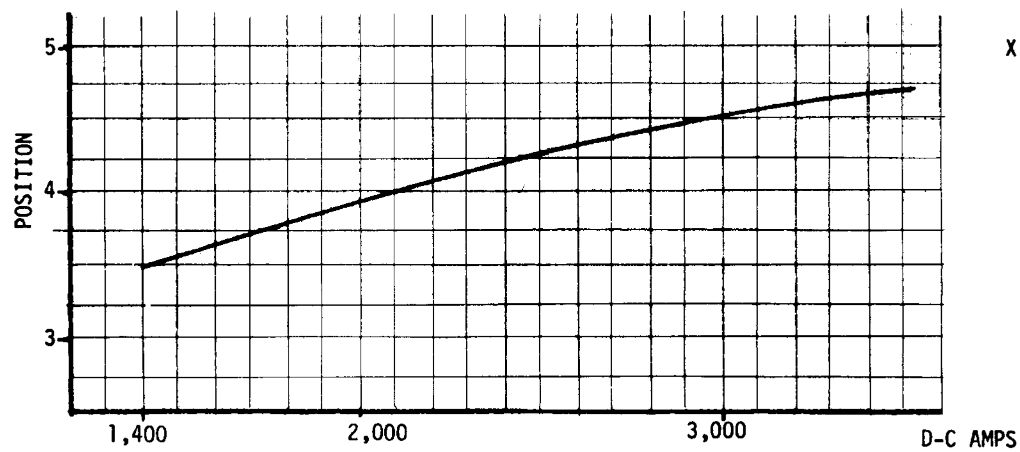
REED SWITCH 1482A50G02



X = .98 IN.

CURVE 2 SIZE 2

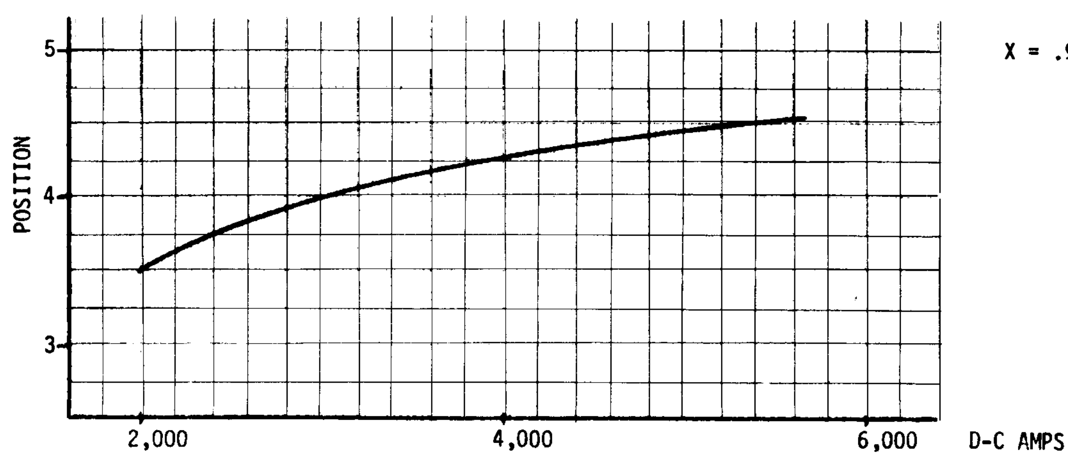
REED SWITCH 1482A50G02



X = 1.48 IN.

CURVE 3 SIZE 3

REED SWITCH 1482A50G03



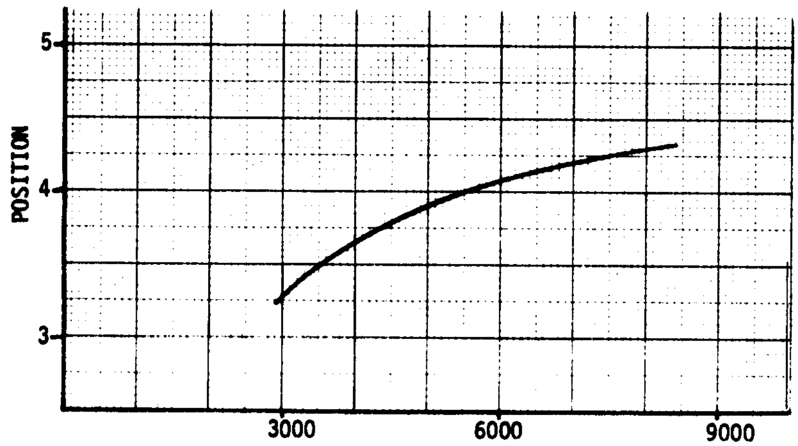
X = .98 IN.

X = DISTANCE FROM EDGE

FAULT CURRENT SENSOR TYPICAL CALIBRATION CURVES

CURVE 4 SIZE 4

REED SWITCH 1482A50G04

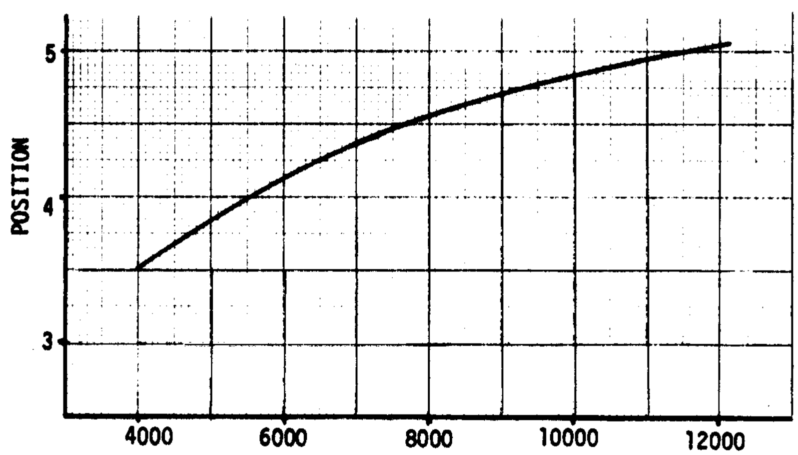


X = .98 IN.

D-C AMPS

CURVE 5 SIZE 5

REED SWITCH 1482A50G04



X = 1.48 IN.

D-C AMPS

X = DISTANCE FROM EDGE

INSTRUCTION LEAFLETS (REFERENCE)

The following instruction leaflets (I.L.) describe the C47 system and its standard components

C47 THYRISTOR POWER SYSTEMS

I.L. 16-800-238

STANDARD COMPONENTS

I.L. 16-800-164 C-500 Thyristor Power Case.

CAUTION ON STALLED ROTOR TESTS

CAUTION: As a general policy no appreciable current should be applied to commutators of d-c machines when their rotors are at stand still. The minimum damage that can result will be raised commutator bars under the brushes which will cause poor commutation and brush wear.

WHEN MAKING TESTS WITH THE ROTOR AT STAND STILL MAKE SURE ALL ARMATURE BRUSHES ARE DOWN AND DO NOT PASS CURRENT THROUGH THE COMMUTATOR LONGER THAN THE TIMES SPECIFIED BELOW FOR BUFFALO MACHINES.

100%	RATED CURRENT	-	40 SECONDS
200%	RATED CURRENT	-	20 SECONDS
300%	RATED CURRENT	-	5 SECONDS

ALLOW TIME FOR THE ARMATURE TO COOL IF THE TEST MUST BE REPEATED.

VI. SERVICE

Personnel familiar with electrical equipment utilizing semiconductors can isolate most problems using an oscilloscope, multimeter, and information contained in the instruction leaflet.

Semiautomatic equipment is available at the factory to test static and dynamic performance of all edge-connected printed circuit boards. Generally, repair of boards is facilitated by returning them to:

Westinghouse Electric Corporation
Industrial Systems Division
P. O. Box 225
Buffalo, New York 14240