

**ALIGNMENT OF VOLTAGE REGULATOR
WITH FIELD CROSSOVER**

Westinghouse tests and aligns these drives systems before they leave the factory, so that only a minimum of start-up adjustment is usually required to assure that the drive system performs satisfactorily. If, however, suspicion of system misalignment arises, either during start-up or while in normal service, the following procedure should be used to realign the drive.

It is not necessary to go through the complete alignment procedure for the drive when only one or two alignment adjustments of a component is required. Use only the applicable instructions, but always read the entire procedure prior to making any changes to be sure that any relevant information or important instructions in proceeding parts is not overlooked.

If the quick-slowdown function is supplied, eliminate its possible nuisance effects during the alignment procedure by temporarily jumpering terminals 4 and 5 on the quick-slowdown module or if necessary disconnect the resistor circuit from across the motor armature. After completing the alignment procedure, reactivate the quick-slowdown function by removing the jumper and reconnecting the resistor circuitry. If alignment of the quick-slowdown function is required refer to I.L. 5656-5.

A. TEST EQUIPMENT RECOMMENDED FOR USE IN ALIGNMENT OF THE S-56 BASIC VOLTAGE REGULATOR

1. Volt-ohm-milliammeter with an input impedance of at least 20,000 ohms per volt. (Simpson 260 or equivalent)
2. DC ammeter with range for 200% of rated full-load current of the DC motor or motors.
3. Oscilloscope, Tektronic 502 or equivalent.
4. S-56 Universal printed-circuit extender board.
5. Power resistor, for insertion in place of the dc motor armature during the checkout of AC phasing and basic adjustments. 20 ohms, 1000 watts for nominal 240 VDC drives, 40 ohms, 2000 watts for nominal 480 VDC drives or Series connected incandescent lamps, two 100 watt lamps for 240 VDC drives and four 100 watt lamps for 480 VDC drives.

B. ALIGNMENT AND TEST

1. Phasing

- a. To avoid possible damage to thyristors, diodes, amp-traps and other components, be sure that the incoming AC power is connected to the drive in the correct R, S, T phase sequence. Interchange any two of the three incoming AC power leads to correct for improper AC phasing.

2. Regulator + 24 VDC Power Supply
 - a. Check the power supply voltages on the basic regulator cage terminal block. The voltages should be:
 - (1) Terminal 11 (PSP) to terminal 4 (PSC)
24 + 1 VDC, terminal 11 positive to 4.
 - (2) Terminal 10 (PSN) to terminal 4 (PSC)
24 + 1 VDC, terminal 4 positive to 11.

3. Gate Pulse Generator Bias E01 Board
 - a. Open the incoming ac circuit breaker or disconnect switch.
 - b. Disconnect the DC motor armature leads, (all motor armature leads if multi-motor).
 - c. Connect in a dummy resistor load or an array of incandescent lamps, in place of the motor armature.
 - d. Connect the scope across TP to TN.
CAUTION: BE SURE THAT THE SCOPE IS NOT GROUNDED AT THE line plug or elsewhere. When the AC power is applied, the scope will be "hot" (above the AC line).
If the "Differential Input" mode is available on the scope, this differential input can be used for connecting terminals P & N while the scope is grounded.

If a dual trace scope with "ALGEBRAIC ADD" mode is available, terminals P & N can be connected to inputs at channel #1 and channel #2 respectively. This will allow for safe "grounding" of the scope.
 - e. Remove the current controller board E02 (CC); disconnect one end of jumper 1J. Replace the board in the basic regulator cage.
 - f. Remove the ramp function generator board E04 (RFG).
 - g. Remove the voltage controller board E03 (VC).
 - h. Remove the gate pulse generator board E01 (GPG), use the extender board to make board E01 accessible. Jumper terminals 37 to 39 on the extender board place the extender board and the E01 board in the basic regulator cage.
 - i. E03 and E04 boards remain out of the basic regulator cage.
 - j. If the quick slowdown function is included in the drive, jumper terminals 4 to 5 on the quick slowdown module.
 - k. Phase off the TPM by adjustment of right angle BIAS potentiometer 6P on E01 using the scope adjust pot 6P until the last pulse just disappears. DO NOT OVERBIAS E01, to avoid late firing and consequent poor control.
 1. Turn off the AC power.
Remove the extender board and replace the E01 board in the regulator cage. Replace jumper 1J on the E02 board and replace the board in the regulator cage.
 - m. Turn on the AC power.
 - n. Adjust pot 6P on the E02 board to check that the GPG, E01, board can

be phased full on. Return 6P to just cause the pulses to just disappear or to minimum magnitude.

4. Polarity of Transducer Current Signals

- a. To check the polarity of the current signals from the transducer measure the voltage between terminals 17 and 4, and 15 and 4, on the basic regulator cage terminal blocks. Terminal 4 should be positive to terminal 17, and terminal 15 should be positive to terminal 4. The magnitude of these voltage is quite small, polarity is important.

5. Current Controller Check

- a. Remove the AC power. See I.L. 16-800-106.
- b. Disconnect the DC motor shunt field.
- c. If the motor has a series field, disconnect or remove it.
- d. If a dummy resistor load or an array of incandescent lamps is connected in place of the DC motor armature disconnect them and reconnect the DC motor armature (without series field).
- e. Gate Pulse Suppression
 - a. Turn on the AC power.
 - b. This part of the alignment must be done quickly since the DC motor and IPM will be subjected to very high currents.
 1. Set pots 3P and 6P on E02 in their maximum CCW position.
 2. Set pot 1P on E02 in its maximum CW position.
 3. Slowly adjust pot 6P on E02 CW until the required gate pulse suppression current as shown on the schematic is reached. (This is usually 125% of the current limit setting).
 4. Slowly adjust pot 1P on E02 CCW until the controller trips out, this sets 1P at the desired gate pulse suppression current level.
 5. Reset the gate pulse suppression circuit, depress reset pushbutton. Check the gate pulse suppression by slowly adjusting pot 6P on E02 board CW until gate pulse suppression functions, trim pot 1P on E02 if necessary. Reset pot 6P on E02 to its maximum CCW position. Reset gate pulse suppression circuit.
- f. Current limit
 - a. Slowly adjust pot 6P on the E02 board to obtain the specified current limit setting as shown on sheet 7 of schematic diagram or on sheet showing dc motor armature.
- g. Adjustment of Current Regulator Response.
 - a. Record the setting of 6P on E02 for future use and then reset 6P to its maximum CCW position.
 - b. Remove AC power
 - c. Remove E02 board from regulator cage and:
 1. Connect 4J jumper to terminal 1 on the board (Low gain range). Replace the E02 board in the cage.
 2. Reapply AC power, close the drive contactor and adjust 6P for approximately 75% full load current.
 3. Connect the chart recorder to the output of the current transducer, and observe the current rise when the drive contactor is closed.
 4. Increase 3P on the E02 board until the current reaches 65% of its final value in 40 milliseconds.
 5. If 3P reaches its extreme CW position before the response is fast enough, remove the board and move jumper 4J to position 2. Reset 3P on E02 to its extreme CCW position and repeat step 4.
 6. Reset 6P on E02 to the setting recorded in step 6.g.a.

6. Ramp Function Generator Check

It is not necessary to have the motor armature circuit energized while checking out the RFG, board E04.

- a. With "0" volts reference input the output of the RFG should be "0" volts.

Input is to basic regulator terminal blocks 4 and 5, 5 being positive to terminal 4.

(1) If for "0" volts input the output terminals 6 to 4 on the basic regulator (6 would be positive) an output exists the RFG is not balanced. Refer to I.L. 16-800-108. To balance the RFG proceed as follows:

1. Remove AC power.
 2. Remove the E04 board, insert it into the extender board and replace in the basic regulator cage.
 3. Turn on power.
 4. Adjust the flat pot 8P on the E04 board to balance the RFG.
 5. Turn of power remove the extender board and replace board E04 in the basic regulator cage.
 6. Turn on power.
- b. If possible apply a 10V step input into the RFG terminals 5 to 4, 5 positive to 4. Adjust accel pot 5P to obtain the desired acceleration rate. Adjust decel pot 6P to obtain the desired deceleration rate when the step input is removed.
- c. The RFG terminal marked QS on sheet 10 of the schematic is usually connected through interlocking contactors to discharge the RFG capacitors when the drive is stopped, or for quick stopping such as "E" stop.

Since this I.L. is for alignment of an S-56 voltage regulated drive with motor shunt field crossover (S56F) it will be necessary to perform part of the alignment of the motor shunt field exciter regulator before completing the alignment of the voltage controller E03 board.

7. Check the DC power supply voltage from the motor S-56F regulator power supply. This should be checked on the regulator cage terminals 7, 8, and 9, with terminal 8 being common (PSC). The voltage terminal 7 to 8 should be 24 ± 1 volt with terminal 7 (PSP) positive to terminal 8 (PSC). The voltage terminal 9 to 8 should be 24 ± 1 volt with terminal 8 (PSC) positive to terminal 9 (PSN).
8. Check the transformer voltages for the DC motor shunt field S56F regulator TPM.
9. If motor field economy is included check the dc motor excitation for approximately 50% full watts, or for 70 to 75% rated shunt field amps.

10. S-56F Alignment

- a. Preliminary voltage controller check.
 - (1) Remove AC power. See I.L. 16-800-107A.
 - (2) Remove the E03 board if still in the basic regulator cage, use the extender board, jumper pins 31, 33, 41, 43, 51 and 57 together on the extender board. Jumper pin 47 to 53 on the extender board. Insert the extender board with the E03 board into the basic regulator cage.
 - (3) The motor armature should be replaced by a dummy load while making the check.
 - (4) Apply AC power.
 - (a) Connect the scope between terminals 53 and 55 on the extender board.
 - (b) The E03 amplifier board should be balanced at "0" volts and should require no balancing adjustments, if balancing is required the following procedure should be followed;
 1. Pot 7P on the E03 board should be balanced to obtain "0" volts on the scope. The scope must be set for high sensitivity.
 2. Connect the scope across 53 and 41 on the extender board, if unbalanced adjust pot 8P on the E03 board to obtain balance.
 3. Remove AC power.
 4. Remove the extender board and replace the E03 board on the basic regulator.
- b. Depress the "START" pushbutton. (Sequencing necessary to initiate the closing of the TPM armature loop. The TPM output voltage should quickly change from the normal TPM output voltage as set by the minimum speed potentiometer.
- c. Since the I.L. is for alignment of a S56 voltage regulated drive with motor shunt field crossover it will be necessary to perform part of the alignment of the motor shunt field regulator before completion of the armature voltage basic regulator alignment can be completed.
- d. The speed adjustment potentiometer must cover both the armature voltage control range (constant torque) and the motor shunt field control range (constant horsepower). The portion of the CW rotation of the speed potentiometer required to cover only the constant torque speed control range is calculated as follows:

$$\text{Speed pot setting \% CW rotation} = \frac{\text{Base Speed RPM}}{\text{Max. Speed RPM}} \times 100$$
- e. With the speed pot set at 0% CW rotation proceed to set-up the motor shunt field regulator.
 - (1) Set pot 2P on the field function generator board E08 at 50% CW rotation.
 - (2) Set pots 4P and 5P on E08 at 100% CW rotation.
 - (3) Set pot 3P on the field current controller E06 at 100% CW rotation (If 3 P is included in the circuitry).
 - (4) Remove the lead to terminal 14 to drop-out relay ICR on the E06 board.
 - (5) Adjust pot 1P on E06 to obtain the rated motor shunt field current per the schematic diagram or motor nameplates.
 - (6) Jumper terminal 15 to 14 on the motor field regulator cage and pick-up relay ICR on the E06 board.
 - (7) Adjust pot 4P on the E06 board to obtain approximately 70% of

- rated motor shunt field current, 50% watts for field economy (If 4P is included in the circuitry). Remove the jumper between terminals 14 and 15 added previously.
- f. Slowly increase the setting of the speed pot up to the setting calculated earlier in this section 5. Armature voltage across the dummy load should increase toward base voltage.
 - (1) Connect a multimeter between terminals 3 and 2 on the motor regulator cage, 3 positive to terminal 2. Adjust pot 1P on the E08 board to obtain 10 volts on the multimeter. Slowly adjust pot 2P on the E08 board until the voltage on the multimeter just starts to decrease.
 - (2) With 10 volts on the multimeter the armature voltage should be rated base armature voltage with rated full field excitation on the motor shunt field. Trim pot 2P on the E08 board to obtain rated armature voltage.
 - (3) Adjust pot 4P on the E08 board CCW until the motor shunt field starts to weaken this sets the crossover between the constant torque and constant horsepower ranges.
 - (4) Slowly adjust the speed pot CW up to 100% CW rotation. Armature voltage should remain near constant at rated armature voltage, the motor shunt field should have weakened.
 - (5) Adjust pot 5P on the E08 board to obtain the motor shunt field current required for the specified motor RPM. See the schematic diagram for this information.
 - (6) Recheck the operation of the motor shunt field exciter by repeating steps contained in section 10 of this I.L.
 - g. The rate at which the TPM voltage builds-up and the motor shunt field excitation is reduced is determined by the type of acceleration and deceleration control included with each specific drive.
 - h. Acceleration can be controlled in several ways, however, the preferred methods with the S-56 regulator system are:
 - (1) Time limit rate controlled by a ramp function generator, which is part of the basic regulator E04 board. See I.L. 16-800-108.
 - (2) Time limit rate controlled by a special ramp function generator mounted external to the S-56 basic regulator cage. See I.L. 16-800-13.
 - (3) Current limit as set by the current limit potentiometer on the basic regulator E02 board. See I.L. 16-800-106.
 - (4) Motor operated potentiometer, MOP, mounted external to the basic regulator cage. This device is usually incorporated when multiple speed control locations are required.
 - i. Depress the "STOP" pushbutton, the motor shunt field excitation should build-up to rated full field excitation and the armature voltage should quickly decay toward "0" volts and then return to the normal open circuit TPM voltage level. Open the main AC circuit breaker or disconnect switch.
 - ◆ Remove the dummy load from the armature circuit.

Reconnect in the dc motor armature or armatures if a multimotor drive.

11. Speed Control Check

- a. Minimum speed is set by a potentiometer located in the mixer module, see schematic diagram.
- b. Maximum speed by armature voltage is set by a ref set pot located on the mixer module, see the schematic diagram.
- c. The input into the voltage controller terminals 1 to 4 on the basic regulator cage terminal blocks should not exceed 10 volts DC, terminal 1 positive or amplifier saturation may result.
- d. The speed adjust rheostat should increase armature voltage when rotated CCW. The maximum signal from the speed adjust potentiometer should never exceed 10VDC whether a ramp function generator is used or not.

TABLE A
BALANCING DATA

| TO BALANCE BOARD | REMOVE BOARD | ATTACH EXTENDER BOARD TO | JUMPER TOGETHER PINS | ADJUST POT | FOR ZERO VOLTS BETWEEN PINS | REMARKS |
|------------------|--------------|--------------------------|-----------------------------|--------------|-----------------------------|--|
| E03 | E04 | E03 | 31,33,41, 43,51,57 | 7P on E03 | 53 & 55 | Adjust 7P first |
| E03 | E04 | E03 | 31,33,41, 43,51,57 | 8P on E03 | 53 & 55 | Use load resistor per step 8C to replace motor armature when adjusting pots 7P and 8P. |
| E04 | NONE | E04 | 47 & 57 | 8P on E04 | 57 & 55 | Adjust pot 8P first disconnect all leads from basic regulator cage terminal 5. |
| E04 | NONE | E04 | 31,35,37, 47 33 to 39 | 7P on E04 | 39 & 47 | Adjust 7P second. DO NOT CONNECT E04 PINS 33 & 39 TO OTHER JUMPERED PINS |

AFTER EACH ADJUSTMENT, REMOVE ALL JUMPERS EXTENDER BOARD, AND RECONNECT WIRE PER SCHEMATIC DIAGRAM.