RECTIFIERS
J87439A, LISTS 1, 2, AND 4
+ OR -48 VOLTS, 200 AMPERES
OPERATING METHODS

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1. GENERAL

1.01 The J87439A rectifiers are designed for use in 111A, 303A, 326A, 326B, ▶153A, 155A, and 151B◀ power plants. The J87439A, List 1, rectifier operates from 208/240 volts, 3-phase, 60 ±3 Hz input. The J87439A, List 2, rectifier operates from 480 volts, 3-phase, 60 ±3 Hz input. ▶The J87439A, List 4, consists of components to modify List 1 and List 2 rectifiers for the end-cell charging capability. If end-cell charging capability is required, order List 1 or List 2 plus List 4.◀ List 1 and List 2 rectifiers provide positive or negative 48 volts direct current at 200 amperes output.

1.02 The reasons for reissuing this section are listed below. Revision arrows are used to emphasize the more significant changes.

(a) The addition of end-cell charging capability

(b) To add Option Q to Option N

(c) To update the section in general.

This reissue does not affect the Equipment Test List.

1.03 This section is based on drawing SD-82400-01, Issue ▶3B◀ and CD-82400-01, Issue ▶3B◀ . If this section is to be used with equipment or apparatus that is associated with a later issue of the drawing, reference should be made to the SD and CD to determine the extent of the changes and the manner in which the section may be affected.

1.04 The output polarity of the rectifiers is determined by Wiring Options Y and Z. Option Z is required for those applications in which the positive side of the battery is grounded. Option Y is required for those applications in which the negative side is grounded.

1.05 Regulation is obtained by the use of a controlled ferroresonant regulator, consisting of a ferroresonant transformer and an electronic control circuit. The control circuit acts upon the transformer so as to provide output voltage regulation against input voltage, frequency, and load current variations.

1.06 The rectifier has the following electronic features: electronic current limiting, inherent current limiting (if the output is shorted), and gradual increase in output (whenever the input contactor is operated). The rectifier also has automatic crossover to internal sense should external sense leads open. ▶The rectifier is capable of floating lead-acid cells at 2.17 volts per cell plus a 2-volt maximum battery feed-loop drop (if List 4 is supplied, this restriction does not apply) between rectifier and point of regulation. Manual adjustment of output volts, visual indication of rectifier failure, test jacks for reading output volts at the point of regulation, and an output current ammeter are

provided. The rectifier can be manually started by depressing the ON-OFF switch. Automatic shutdown controls are provided for selective high voltage, internal high voltage, fuse failure, and remote shutdown. The rectifier can be restarted from a remote location. A phase monitor circuit and alarm and a rectifier failure alarm are provided.

1.07 The following options and feature have been added:

(a) The J87439A rectifiers have EM-cell charging capability ordered as an option (under List 4). The option is designated as Option Q. Rectifiers without EM-cell charging capability are designated as Option N.

(b) Circuit breaker (CB1) has been replaced (List 4 only) with circuit breaker (CB1) and circuit breaker (CB2). Circuit breaker (CB2) is wired in parallel with circuit breaker (CB1). Circuit breaker (CB2) provides overcurrent protection when charging EM cells. An interlock device prohibits both circuit breakers from being closed at the same time.

Note: Rectifiers equipped with KS-21895, L1, circuit breaker will furnish an alarm in either the OFF or TRIP position. Rectifiers equipped with the KS-22012, L51, circuit breaker will give an alarm only in the TRIP positon.◀

1.08 The rectifiers, 84 inches high, 15.38 inches deep, and 13 inches wide, are fastened directly to the floor. Multiple units may be bolted side by side.

1.09 To simplify maintenance, the circuits associated with alarm, power control, voltage regulation, current limiting, voltage walk-in, and restart are mounted on replaceable circuit packs CPS SP1 and CPS SP2.

1.10 Input and output power connections, filter capacitors, ac contactor, dc breaker, and printed circuit packs are accessible through a door in the front of the cabinet.

1.11 On initial charge for new battery installations, the output voltage may be increased to 60 volts as described in paragraph 3.03.

1.12 Keep ventilating passages of the rectifier unobstructed to ensure adequate cooling during operation.

1.13 If the rectifier is held in stock or otherwise out of service for a period exceeding 30 months, the polarized electrolytic capacitors should be checked and serviced in accordance with Section 032-110-701.

2. LIST OF TEST APPARATUS

CODE OR SPEC NO	DESCRIPTION
KS-20599, L4	Digital Multimeter or
KS-8039	Volt-Milliammeter
▶*KS-20538	Volt-Ohm-Milliammeter

*The KS-20538 meter should be used for measuring the input ac voltage on the J87439A, List 2, rectifier.◀

3. OPERATION

3.01 ***Prepare the Rectifier for Service:*** When preparing to start the rectifier, proceed as follows: (See Fig. 1 for location of components.)

(1) Operate ON-OFF switch (S1) to OFF. Check that plant connector J1 is removed from circuit pack CPS SP1 and that circuit breaker (CB1) is off. ▶Circuit breaker (CB2) (List 4 only) must also be off.◀

Danger: Voltages inside the rectifier may exceed 150 volts to ground. Avoid all contact with terminals. Do not allow the test pick to touch two metal parts at the same time since destructive and dangerous short circuits may occur.

(2) Rotate the OUTPUT VOLTS ADJ control fully counterclockwise (ccw).

(3) Apply power to the input terminals of the rectifier. Check that the associated input power fuses are installed in the ac power service cabinet.

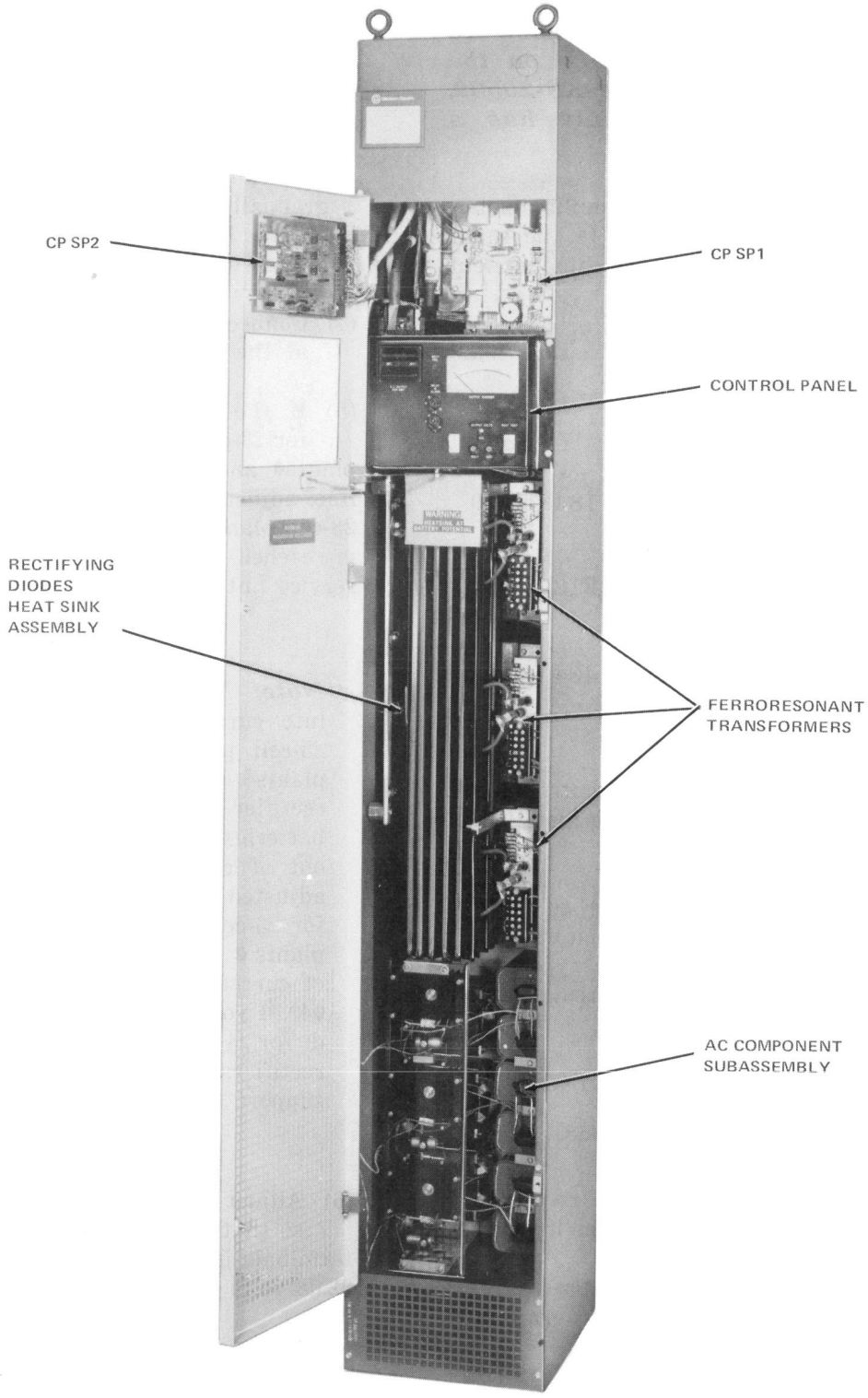

Fig. 1—J87439A Rectifier—Front View

Warning: ***The KS-20599, L4, digital multimeter should not be used to measure the input ac voltage on the J87439A, L2, rectifier. The KS-20599, L4, digital multimeter only has a range to 500 volts ac.***

(4) Connect the KS-20538 volt-ohm-milliammeter, set to the 1000-volt ac scale, to the input terminals located inside the upper compartment of the rectifier.

Requirement: The input ac voltage shall measure as follows:

RECTIFIER	NOMINAL VOLTAGE	LIMITS
J87439A List 1	208 (L1 Option S)	184 to 220
J87439A List 1	240 (L1 Option S)	212 to 254
J87439A List 2	480 (L2 Option T)	434 to 508

(5) Check that the regulation and control circuit fuses F1 (+V) and F2 (-V) are installed in the rectifier.

(6) Operate ON-OFF switch (S1) to ON to precharge the electrolytic capacitors.

(7) After 30 seconds, operate the circuit breaker (CB1) to ON.

(8) Operate ON-OFF switch (S1) to OFF.

(9) Connect plant connector J1 to CPS SP1 circuit pack.

3.02 ***Starting:*** To place the rectifier in service, proceed as follows:

(1) Verify that the procedures in paragraph 3.01 have been completed.

(2) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to test jacks REG(-) and REG(+) on the front panel.

(3) Operate ON-OFF switch (S1) to ON.

Requirement: The KS-20599, L4, digital multimeter should indicate less than ▶49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants.◀

Note: The rectifier has a walk-in feature that causes the output dc voltage to increase gradually. Wait at least 30 seconds after turnon before measuring and adjusting the output voltage.

(4) Connect the KS-20599, L4, digital multimeter at the battery bus bars.

(5) If the meter reads above ▶49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants◀ and there are other rectifiers on the line, adjust them down until ▶49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants◀ is reached. Adjust the rectifier being put into service until it picks up load.

Note: If the rectifier being adjusted goes into current limit and ▶49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants◀ is not reached, do not adjust the rectifier any further. Allow time for the batteries to charge and the rectifier to drop out of current limit before the rectifier is adjusted to pick up load at ▶49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants.◀ If the rectifier does not drop out of current limit after a reasonable time and ▶49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants◀ is not reached, additional rectifiers must be connected to the plant to support the load.

(6) Adjust the OUTPUT VOLTS ADJ control so that the voltage measured at the battery terminals is ▶49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants◀ (2.17 volts per cell).

3.03 ***Initial Charge:*** For new battery installations where the batteries will receive an initial charge of 60 volts, proceed as follows:

(1) Operate ON-OFF switch (S1) to OFF.

(2) Remove connector J1 from circuit pack CPS SP1 and remove the circuit pack from the rectifier.

(3) Disable the internal high-voltage shutdown by connecting a strap (clip lead) between the anode of diode CR7 and the ground junction between capacitors C2 and C4 on circuit pack CPS SP1.

(4) Install circuit pack CPS SP1 in the rectifier. Leave connector J1 disconnected.

(5) Precharge the electrolytic capacitors by operating circuit breaker (CB1) to OFF. ⧫Circuit breaker (CB2) (List 4 only) must be in the OFF position also.⧫ Operate ON-OFF switch (S1) to ON. After 30 seconds, operate circuit breaker (CB1) to ON.

(6) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, at the battery ⧫bus bars.⧫

(7) Operate ON-OFF switch (S1) to ON.

(8) Adjust the OUTPUT VOLTS ADJ for an output of 60 volts measured on the KS-20599, L4, digital multimeter.

(9) Continue the 60-volt initial charge for the required time. Operate ON-OFF switch (S1) to OFF.

(10) Restore the internal high-voltage shutdown as follows: Remove circuit pack CPS SP1. Remove the clip lead installed in (3). Reinstall the circuit pack.

(11) Reconnect the plant high-voltage shutdown by replacing connector J1 on CPS SP1.

(12) Rotate the OUTPUT VOLTS ADJ control ccw to the stop.

(13) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to the terminals of the battery.

(14) Operate ON-OFF switch (S1) to ON. Check that the output circuit breaker (CB1) is closed.

(15) Adjust the manual OUTPUT VOLTS ADJ to obtain ⧫49.91 volts dc for 23-cell plants or 52.08 volts dc for 24-cell plants⧫ at the terminals of the battery.

(16) Disconnect the KS-20599, L4, digital multimeter.

3.04 ***Stopping:*** To stop the rectifier, operate ON-OFF switch (S1) to OFF.

3.05 ***Taking Rectifier Out of Service:*** To take the rectifier out of service, proceed as follows:

(1) Operate ON-OFF switch (S1) to OFF.

(2) Operate output circuit breaker (CB1) to OFF. ⧫Circuit breaker (CB2) (List 4 only) must be in OFF position also.⧫

Danger: Battery voltage is still present on the output terminals of the rectifier after the output circuit breaker has been opened, as long as the rectifier is connected to the dc bus bars of the plant and connector J1 is still plugged into circuit pack CPS SP1.

(3) Remove the associated ac input fuses from the power service cabinet.

(4) Disconnect connector J1 from CPS SP1.

⧫Danger: Battery voltage is present at heat sink for the negative ground option.⧫

4. ROUTINE CHECKS AND ADJUSTMENTS

4.01 Routine checks and adjustments are intended to detect and correct defects and abnormal operating conditions that may cause service interruptions. Routine checks should be made when they will not interfere with service.

Note: For normal operation, the rectifier must be supplying at least one-half ampere current to the load when checks and adjustments are made.

Danger: Voltages inside the rectifier may exceed 150 volts to ground. Avoid all contact with terminals. Do

not allow a test pick to touch two metal parts at the same time since destructive and dangerous short circuits may occur.

4.02 ***Output Voltage Adjustment:*** To adjust the output voltage, proceed as follows:

(1) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to the ▶rectifier output test jacks REG (-) and REG (+).◀

(2) Adjust the OUTPUT VOLTS ADJ for ▶49.91 volts dc for 23-cell plants and 52.08 volts dc for 24-cell plants at the terminals of the battery.◀

Note: Turning the OUTPUT VOLTS ADJ control clockwise (cw) causes the output voltage to increase rapidly up to the terminal voltage of the battery. Above this level, the voltage increases only slightly, and the current measurement is a more sensitive indication of output.

4.03 ***Voltage Regulation Check:*** To check the voltage regulation, proceed as follows:

(1) Connect the KS-20599, L4, digital multimeter, set to the 100-volt dc scale, to test jacks REG(-) and REG(+) on the front panel.

(2) Check that ON-OFF switch (S1) is operated to ON and that output circuit breaker (CB1) is closed. ▶Circuit breaker (CB2) (List 4 only) must be in the OFF position also.◀

(3) Operate the NL/FL test key (S2) to the NL position.

Requirement: The output dc current measured on OUTPUT CURRENT meter (M1) should show a slight decrease. The output voltage measured on the KS-20599, L4, digital multimeter should show a decrease of only about one-fourth volt. ▶This requirement may vary slightly if other recitifiers are operating in parallel.◀

(4) Operate the NL/FL test key (S2) to the FL position.

Requirement: The output dc current meaured on the OUTPUT CURRENT meter (M1) should show a slight increase. The output voltage measured on the KS-20599, L4, digital multimeter should show an increase of only about one-fourth volt. ▶This requirement may vary slightly if other rectifiers are operating in parallel.◀

(5) Release the NL/FL test key.

(6) Disconnect the digital meter from test jacks REG(-) and REG(+).

5. TROUBLES

5.01 The possible causes of troubles in the rectifier and the corrective actions to be taken are given in the following chart. In addition to the action specified, check for loose or open connections and plugs. Check for short circuits due to foreign matter lying across wiring terminals.

5.02 If the trouble is not corrected by following the trouble chart, refer to the circuit schematic drawing for further information. Refer to Section 032-173-301 for testing, replacing, and storing circuit packs and semiconductor devices.

TROUBLE CHART

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
No output. (RECT FAIL lamp illuminated)	(1) No input power. AC Power failure	Locate and correct fault. Restore input power.
	(2) Input fuses blown in ac power service cabinet	Locate and correct cause of blown fuses. Replace fuses.
	(3) Input power relay ST1 does not close	Check relay ST2 make contacts 5 and 7 for S option and 3 and 5 for T option.
	(4) Relay ST2 does not close:	
	(a) Diode CR7 shorted	Replace CP SP1.
	(b) TR relay (K3) operated. Remote shutdown ground signal on terminal Y of P1 on CP SP1	Remove unwanted ground signal.
	(5) Relay RFA (K2) operated:	
	(a) Internal high-voltage shutdown circuit activated by excess output voltage (60 volts dc or more). Manual OUTPUT VOLTS ADJ set too high	Adjust manual OUTPUT VOLTS ADJ for output less than 60 volts dc.
	(b) External voltage sense leads disconnected from load	Restore load voltage leads to REG (+) and REG(—) terminals.
	(c) Defective components in external selective high-voltage shutdown circuit: R6, CR9, CR10, U3, C7, R20, Q6, R18, R19	Replace CPS SP1.
	(d) Other defective components in external high-voltage shutdown circuit: CR26, IC4, R30, R29	Replace CPS SP2.
	(e) Fuse F1 or F2 in internal voltage sensing leads open	Determine cause of fuse failure. Replace CPS SP2 to correct trouble. Replace fuse.
	(f) Output circuit breaker CB1 open	Close output circuit breaker CB1.
	(g) Transformer T4 defective	Replace transformer T4.

TROUBLE CHART (Contd)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
No output. (RECT FAIL lamp illuminated) (Contd)	(h) Failure of components on CPS SP1 [other than those listed in (c)]	Replace CPS SP1.
	(6) Output circuit breaker tripped open	Close output circuit breaker.
	(7) Rectifier/filter circuit components defective: diodes CR1 through CR6, L4, C7	Locate and replace defective components.
Output current low	(1) NL/FL switch in NL position	Release NL/FL switch. Check to see that the switch is not defective.
	(2) OUTPUT VOLTS ADJ (R11) potentiometer shorted or out of adjustment	Adjust OUTPUT VOLTS ADJ (R11) potentiometer or replace. See paragraph 4.02.
	(3) Defective IC1 or IC2 on CPS SP2	Replace CPS SP2.
	(4) One of three input power line phases open. (May be indicated by phase monitor relay PH (K1) closure.) May be caused by open input power fuse in power service cabinet	Locate and correct cause of blown fuse. Replace fuse.
	(5) Voltage walk-in circuit components defective on CPS SP2: C12, R36, R37, R56, CR8, CR21, C15, R36, CR25	Replace CPS SP2.
	(6) Triac Q1, Q2, or Q3 defective or shorted	Replace defective triac Q1, Q2, or Q3.
	(7) Loose connections on transformers T1, T2, or T3	Tighten loose connections.
Output current high	(1) NL/FL switch held in FL position	Release NL/FL switch. Check to see that switch is not defective.
	(2) OUTPUT VOLTS ADJ (R11) potentiometer open or out of adjustment	Adjust OUTPUT VOLTS ADJ (R11) potentiometer or replace.
	(3) External voltage sense leads open	Check external voltage sense leads and connections.

TROUBLE CHART (Contd)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Output current high (Contd)	(4) Current control circuit components defective: IC1, IC2	Replace CPS SP2.
	(5) Broken or open lead going to triac. (May be indicated by rectifier not turning on.)	Locate and repair or replace triac.
Output current not limited to 220 amperes maximum	(1) R13 or R14 open (each end of meter M1 shunt R18)	Replace R13 or R14.
	(2) Defective components in current limiting circuit: IC3, C11, R46, R47, R49	Replace CPS SP2.
Rectifier will not restart	(1) Restart circuit components defective: Q7, R10, R12, R11, R21, RV1, C5, CR6, K2	Replace CPS SP1.
	(2) External restart leads disconnected or restart switch defective. No closure across terminals B to C of J1 on CPS SP1	Repair external restart closure circuit.
Internal high-voltage shutdown circuit inoperative or operates at level other than 60 volts.	(1) Defective components in internal high-voltage shutdown circuit on CPS SP1: R14, R15, C6, Q8, CR8, U4, RFH relay	Replace CPS SP1.
	(2) Internal high-voltage shutdown circuit disabled by test strap between CR7 and C4(+) of CPS SP1 (see paragraph 3.03)	Remove test strap from CPS SP1.
Selective high-voltage shutdown circuit, with external sense, inoperative.	(1) Rectifier not delivering 10 amperes, or more, dc output	Operation is normal. Circuit operable only when output current is 10 amperes or more
	(2) External high-voltage shutdown signal (ground) not applied to CPS SP1, J1 terminal W	Check external high-voltage shutdown signal connections. Repair as required.
	(3) Components of output current monitoring circuit defective: IC4, CR26, R29, R30	Replace CPS SP2.

TROUBLE CHART (Contd)

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Selective high-voltage shutdown circuit, with external sense, inoperative. (Contd)	(4) Components of high-voltage shutdown circuit defective: R6, U3 optoisolator, CR9, CR10, C7	Replace CPS SP1.
Rectifier remote shutdown inoperative.	(1) External battery not connected to terminal X of CPS SP1	Connect battery to terminal X of CPS SP1.
	(2) On shutdown, ground closure not applied to terminal A of CPS SP1	Repair shutdown closure circuit between terminal A of CPS SP1 and ground.
	(3) Network Z1 shorted	Replace CPS SP1.
	(4) TR relay (K3) does not operate.	Replace CPS SP1.
Phase monitor circuit operates, and indicates trouble. (PH relay K1 on CPS SP1 operates)	(1) Input power line phase one open. (May be caused by open input power fuse in ac power service cabinet)	Locate and correct cause of blown fuse. Replace fuse.
	(2) Phase monitor circuit components defective. L1 shorted, C8 open. (Input power fuses good)	Replace CPS SP1.
Phase monitor circuit inoperative.	Phase monitor circuit components defective: L1 open, C8 shorted, CR4 open, PH relay (K1) open, CR5 shorted	Replace CPS SP1.
Walk-in circuit disabled. Output current appears suddenly when power is applied.	Walk-in circuit components defective: CR8, CR21, C15, R36, CR25, R37, C12, R56	Replace CPS SP2.
NL/FL test switch does not cause change in output current when operated. NO REGULATION.	(1) Defective NL/FL switch	Replace NL/FL switch.
	(2) Defective R16 or R17 across NL/FL switch	Replace defective resistors R16 or R17.
	(3) Defective components of voltage regulator circuit on CPS SP2: IC1, IC2, C10, R38, R39, R40, R45, R49, R50, R53, R55, CR22, CR28	Replace CPS SP2.
	(4) R(+) or R(—) sense lead disconnected from load or from P4 of CPS SP1 terminals A and E	Check and reconnect sense leads.