

17

# J87211A AND B RECTIFIERS

## 48 AND 24 VOLTS, 11 AMPERES

### OPERATING METHODS

	CONTENTS	PAGE
1.	GENERAL . . . . .	1
2.	LIST OF TOOLS, TEST APPARATUS, AND MATERIALS . . . . .	2
3.	OPERATION . . . . .	2
4.	ROUTINE IN-SERVICE CHECKS . . . . .	3
5.	TROUBLES . . . . .	3
6.	POINT-TO-POINT VOLTAGES . . . . .	8

output of 0 to 11 amperes at 24 volts direct current. The dc output voltage regulation is  $\pm 1$  percent for output current of 0 to 11 amperes and including  $\pm 10$  percent line voltage variation. The rectifier utilizes a PNP device (SCR CR1) and a self-contained transistorized regulating circuit (J87214A) which controls the PNP device and automatically limits the output current.

#### 1. GENERAL

1.01 The J87211A and J87211B rectifiers, in conjunction with the J87214A regulator unit, are initially intended to automatically provide dc power from an ac source and to regulate the battery voltage in the 105E power plant.

1.02 This section is reissued for the reasons listed below. Revision arrows are used to emphasize the more significant changes.

- (a) To incorporate an addendum
- (b) To clarify and correct subparagraph 5.08(c)
- (c) To cover component changes on newer cards.

This reissue does not affect the Equipment Test List.

1.03 These rectifiers are adaptable for connection to a 105- to 125- or 200- to 250-volt 60-Hz, single-phase power source. The J87211A rectifier has a rated output of 0 to 11 amperes at 48 volts direct current. The J87211B rectifier has a rated

1.04 Options are provided for operation as follows. With any option the OUTPUT current (M1) meter is in the ground lead.

#### J87211A (See SD-81540-01)

- (a) For use in a 48-volt positive plant (negative ground, W option).
- (b) For use in a 48-volt negative plant (positive ground, X option).

#### J87211B (See SD-81567-01)

- (c) For use in a 24-volt positive plant (negative ground, W option).
- (d) For use in a 24-volt negative plant (positive ground, X option).

**⚡ Danger: ⚡ Voltages inside the rectifier case are over 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. Disconnect the AC supply before working on the rectifier except when necessary to make tests.**

1.05 Routine checks are intended to detect defects in the equipment and, insofar as possible, to guard against circuit failures. Checks should

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**SECTION 169-245-301**

be made during a period when they will not interfere with service.

**1.06** The instructions are based on drawings SD-81540-01, Iss 22B for J87211A rectifier, SD-81567-01, Iss 13D for J87211B rectifier, and SD-81541-01, Iss 10A for the associated J87214A regulator unit. For a detailed description of operation, see the corresponding circuit description.

**1.07** The abbreviations cw and ccw, used herein, refer to clockwise and counterclockwise respectively. The abbreviation CC, used in connection with a slidewire resistor, refers to constant current.

**1.08** For more detailed information on the operation and maintenance of individual equipment or apparatus, refer to the appropriate Bell System Practices.

**2. LIST OF TOOLS, TEST APPARATUS, AND MATERIALS**

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
—	3-Inch C Screwdriver
<b>TEST APPARATUS</b>	
KS-8039	Volt-Milliammeter
KS-20538	Volt-Ohm-Milliammeter
—	Model 535A Tektronix Oscilloscope or equivalent
—	1000-Ohm, 10-Watt Resistor
<b>MATERIALS</b>	
◆KS-6572	22.5 Volt Battery or equivalent
KS-7889	46.5 Volt Grid Battery or equivalent◆

**3. OPERATION**

**3.01 Preparing to Start:** Before placing the rectifier into service, check that:

- (a) The AC switch and CB1 circuit breaker are in the OFF position.

- (b) The proper size power supply fuses and F1 regulator lead fuse are in place.

- (c) All external connections are made in accordance with the SD drawing covering the associated circuit of which the rectifier is a part.

- (d) The option wiring is correct for the service to be used. (See 1.04.)

- (e) The T1 input transformer taps used are in accordance with the applicable SD for the power supply voltages as measured with a KS-8039 volt-milliammeter.

**◆Danger:◆** When using a KS-8039 volt-milliammeter, the leads should be carefully examined to make sure the insulation is undamaged and are properly connected to the meter.

- (f) Rotate the VOLT ADJ (R7) potentiometer in the associated regulator unit to the maximum ccw position.

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

- (a) Apply the input power by operating the AC (S1) switch to the ON position.

- (b) Operate the CB1 circuit breaker to the ON position.

- (c) Connect the KS-8039 volt-milliammeter across the REG VOLT J1 and J2 jacks and adjust the VOLT ADJ (R7) potentiometer, located in the associated regulator unit, until the voltage output of the rectifier is equal to the battery float voltage requirement of the associated power plant.

**Note 1:** The high-voltage shutdown value is factory set at 29 volts and 59 volts for the 24-volt and 48-volt rectifiers, respectively. The CB1 circuit breaker operates to shut down the rectifier. When option R is installed, CB1 circuit breaker applies ground to the RFA lead. If 230V AC service is provided by a J86840 inverter plant to J87211B regulated rectifier, CB2 circuit breaker also applies ground to the RFA lead.

**Note 2:** The CC potentiometer of the associated regulator unit is factory set for constant current of 11 amperes and requires no adjustment.

**3.03 Removing from Service:** To remove the rectifier from service, operate the AC input switch and the CB1 circuit breaker to the OFF position.

#### 4. ROUTINE IN-SERVICE CHECKS

**4.01** The ac input and dc output should be checked as often as local experience demands to make certain they are correct.

#### 5. TROUBLES

**5.01** Should a diode in the rectifier stack (CR2) become defective, replace the complete rectifier stack.

**5.02** Should any component of the regulator unit become defective, it is suggested that the complete regulator be replaced. However, individual components *may* be replaced in accordance with the appropriate Bell System Practices.

#### Trouble Chart

**5.03** Should any of the following troubles develop, check the possible causes listed. If the

trouble is not found, look for loose or open connections or short circuits due to foreign matter lying across wiring terminals.

**Note:** For all dc measurements given in the following troubleshooting procedures, the positive terminal is given first. Example: TS6; 7-Q1; 1 indicates the voltage from terminal strip 6, terminal 7 to Q1, terminal 1 with the positive at terminal 7.

**5.04 No DC Output:** When the AC switch and CB1 circuit breaker are in the ON position and the rectifier supplies no current to the connected battery and load, a "no dc output" condition exists. Before starting the troubleshooting procedure, turn the rectifier on (S1 and CB1 in ON position), rotate the VOLT ADJ (R7) potentiometer in the associated regulator unit cw, and check for an output current indication on M1 ammeter. If there is no output current, return the VOLT ADJ (R7) potentiometer to the midposition and proceed as follows.

**Note:** When the defective components have been located, **return the AC switch and CB1 circuit breaker to the OFF position and remove the REG FUSE (F1)** before replacing defective components.

## SECTION 169-245-301

STEP	MEASUREMENT	VOLTAGE OR IMPEDANCE READING	POSSIBLE CAUSE FOR INCORRECT READING
1	AC volts: input voltage	AC line voltage	No ac line input
2	AC volts: TS4; L1-L2	AC line voltage	Input fuses operated
3	AC volts: T1; term 1-2, 3, or 4	AC line voltage	S1 defective or open lead(s) from TS4 to TS1 primary
4	DC volts: TS3; BAT- GRD (W-option) GRD- BAT (X-option)	Battery voltage	Discharged battery (too low to start rectifier — See 5.08)
5	DC volts: J1-J2	Battery voltage	Operated REG FUSE (F1)
6	DC volts: CB1; “Line”- “Load” (X-option) “Load” - “Line” (W-option)	Zero volts	Defective CB1 circuit breaker (open)
7	DC volts: TS5; 5-6	Battery voltage	Open lead(s) between TS5 and TS6
8	AC volts: T1; term 5-6	83 volts $\pm 10\%$ (J87211A) 43 volts $\pm 10\%$ (J87211B)	T1 transformer defective, incor- rect tap used on T1 primary
9	DC volts: TS5; 7-6	Approx 75 volts (J87211A) Approx 39 volts (J87211B)	Defective CR2 rectifier stack
10	Scope: TS5; 4-GRD (VOLT ADJ potentiom- eter in max cw position)	SCR gate pulses (See 5.09)	SCR (CR1) diode defective — If no gate pulses are present, proceed to Step 11
<b>Regulator Circuit</b>			
11	DC volts: TS1; 7-5	Approx 36 volts (J87211A) Approx 21 volts (J87211B)	Operated REG FUSE (or Step 12 for J87211A)
12	DC volts: TS6; 2-3	12 volts	Z1, Z2 on high-voltage shutdown circuit card defective (J87211A only)
13	DC volts: Q3; 1-3	Approx 21 volts	Q3 transistor defective
14	DC volts: TS1; 7-8	7 to 12 volts	Z1, Z2 zener diodes defective
15	DC volts: Q2; 3-1 (Rotate R7 from max ccw to max cw)	15 to 25 volts	Constant reading of 22 volts indicates Q2 transistor defective (open)

STEP	MEASUREMENT	VOLTAGE OR IMPEDANCE READING	POSSIBLE CAUSE FOR INCORRECT READING
16	Scope: Q1; 3-GRD	SCR gate pulses (See 5.09)	Q1 transistor either open or shorted — Check Steps 17 and 18 before replacing Q1
17	DC resistance: T1; 6-1 (CB1 and S1 OFF and F1 removed)	Less than one ohm	T1 transformer defective (open)
18	DC resistance: (CB1 and S1 OFF and F1 removed) T1; 5-2 (Neg of ohmmeter at term 2)	Less than one ohm	T1 transformer defective (open)
19	DC resistance: T1; 3-4 (CB1 and S1 OFF and F1 removed)	Less than one ohm	T1 transformer defective (open)

### 5.05 High-Voltage Output—Circuit Breaker

**Trips:** A high-voltage output failure condition is characterized by the CB1 breaker tripping as soon as it is switched to the ON position when there is an output current demand on the rectifier. The trouble may be located in either the regulator circuit (J87214A), the high-voltage shutdown circuit (Fig. 4 or 5 of SD-81567-01), or the main power circuit (Fig. 1 of SD-81567-01). As a preliminary check, rotate the VOLT ADJ (R7) potentiometer in the regulator unit to the extreme

ccw position. Switch the CB1 circuit breaker to the ON position. If the circuit breaker remains ON, readjust the VOLT ADJ (R7) potentiometer for the desired rectifier output voltage. If the circuit breaker continues to trip, proceed as follows in Steps 1 through 10. The AC switch should be in the ON position and the REG FUSE (F1) in place. When the trouble has been located, turn all switches to OFF and remove the F1 fuse before making repairs.

STEP	MEASUREMENT	VOLTAGE READING	POSSIBLE CAUSE FOR INCORRECT READING
1	DC volts: TS5; 5-6	Zero volts	CR1 diode defective (short)
2	DC volts: TS6; 2-4	Battery voltage	Open regulator sensing lead(s)
3	DC volts: (J87211A only) TS6; 2-3	12 volts approx	Z1, Z2 diodes in high-voltage shutdown circuit defective
4	DC volts: Q1; 1-TS6; 4	22.5 volts (J87211A) 12.6 volts (J87211B)	D2 diode defective
5	Place a short across R8 term 1-2 (J87211A); R10 term 1-2 (J87211B) (If slidewire type, short slider to right end terminal). Try to switch CB1 to ON position.		(a) Rectifier operates — CB1 does not trip — R8 (J87211A) or R10 (J87211B) defective  (b) CB1 trips — Q2 defective (short)
6	DC volts: TS1; 7-5	36 volts (J87211A) 24 volts (J87211B)	Open regulator sensing lead(s)
7	DC volts: R7;; 1-TS1; 5 (Rotate R7 potentiometer from max cw to max ccw)	17 to 35 volts (J87211A) (J87211B)	R7 potentiometer defective
8	DC volts: Q2; 3-GRD (Rotate R7 potentiometer from max cw to max ccw)	0 to 3 volts	Constant 10 volts indicates Q2 transistor shorted
9	DC volts: TS1; 7-8	Approx 12 volts	Z1, Z2 diodes defective (located on J87214A regulator card)
10	DC volts: TS1; 3-Q2; 1	Approx 6 volts	Z3 diode defective

### 5.06 High-Voltage Shutdown Circuit

**Inoperative:** As a preliminary check, load the rectifier to approximately 3 amperes and slowly rotate the R8 (J87211A) or R10 (J87211B) potentiometer ccw. If R8 or R10 potentiometer is of the slidewire type (Fig. 2, SD-81540-01 or SD-81567-01), operate S1 switch and CB1 circuit breaker to the OFF position and remove the REG FUSE (F1). Move the slider to the left end, replace the F1 fuse, operate the AC switch and CB1 circuit breaker to the ON position, and load the rectifier to approximately

3 amperes. If the rectifier shuts down, readjust the potentiometer or slidewire for the desired shutdown value. Should the rectifier fail to shut down, leave the potentiometer in the extreme ccw position (slidewire in left position). Proceed as in Steps 1 through 3 with the rectifier operating at approximately 3 amperes output current. Turn the AC switch and CB1 circuit breaker to OFF and remove REG FUSE (F1) before replacing a defective component.

STEP	MEASUREMENT	VOLTAGE READING	POSSIBLE CAUSE FOR INCORRECT READING
1	DC volts: Q1; 1-TS6; 4	22.5 volts (J87211A) 12.6 volts (J87211B)	D2 diode defective (open)
2	DC volts: TS6; 5-7	Less than 0.5 volt	Q2 transistor defective (open)
3	DC volts: TS6; 7-Q1; 1	Less than 0.5 volt	Q1 transistor defective (open)

If a correct reading is obtained in Step 3, CB1 circuit breaker is defective.

**5.07 Current Limit Inoperative:** Current limit failure occurs when the rectifier output current exceeds the current limit value determined by the setting of the R5 CC slidewire resistor, or output current cannot be increased beyond 3 amperes. As a preliminary step, check that the slidewire resistor is properly adjusted as outlined in CD-81541-01. Should the rectifier still fail to current limit properly, set the slider in approximately its midposition on

the resistor and proceed with Steps 1 and 2. The REG FUSE (F1) should be in place and S1 switch and CB1 circuit breaker should be in the ON position with the rectifier supplying approximately 6 amperes output current if possible. When the trouble has been located, operate the S1 switch and CB1 circuit breaker to the OFF position and remove the REG FUSE before replacing components.

STEP	MEASUREMENT	VOLTAGE READING	POSSIBLE CAUSE FOR INCORRECT READING
1	DC volts: TS1; 4-6	Approx 1 volt at 6 amperes current	Open D or G lead(s)
2	Short the slider arm to the right end tab on R5 slidewire resistor		(a) Output current decreases to or remains at 3 amperes — R5 slidewire is defective  (b) Output current remains at 6 amperes — Q3 transistor is defective (open)

**5.08 Restoration After Deep Discharge:**

Should the connected battery voltage fall below 35 volts (J87211A) or 15 volts (J87211B), the following procedures must be observed to restart the rectifier:

- (a) Before attempting to start the rectifier, remove the plant load and check for reversed polarity on any of the connected battery cells. Short any reversed cells and measure the connected battery at J1-J2 jacks. If the measured voltage is now greater than 35 volts (J87211A) or 15 volts (J87211B), start the rectifier and remove the shorts from reversed cells. If the connected

battery voltage is still lower than the required starting voltage, proceed as in (b), (c), or (d).

- (b) Momentarily short CR1 diode with a 1000-ohm 10-watt resistor. To accomplish this, operate the S1 switch and CB1 circuit breaker to the OFF position. Clip the 1000-ohm 10-watt resistor from anode to cathode of CR1. Operate the S1 switch and CB1 circuit breaker to the ON position. When the rectifier starts, remove the 1000-ohm resistor and the shorts across reversed cells. The rectifier should now continue to charge the batteries.

(c) ♦As an alternate method for restarting the rectifier, remove the REG FUSE F1 and connect a 46.5 volt grid battery (to the J87211A) or a 22.5 volt grid battery (to the J87211B), using proper polarity, in the REG VOLT jack on the rectifier. If there are no defective components, the rectifier will start and work properly. After a few moments remove the battery (46.5 or 22.5) and install the REG FUSE F1. The rectifier should now continue to charge the batteries.

(d) If previous attempts to restart the rectifier have failed, this may indicate the voltage is too low for the regulator control circuit to deliver the threshold voltage required to turn on thyristor CRI. Restart can be accomplished by **momentarily** shorting the anode to cathode of CRI (TS5 terminals 7 and 3) with a "jumper" of 14-gauge wire.

**Note:** If this attempt fails, the shorting operation should be repeated, maintaining the short a moment longer. If the short is maintained too long, the high-voltage shutdown circuit will shut down the rectifier.♦

**5.09** Typical waveforms found in properly operating J87211A and J87211B rectifiers are shown in Fig. 1. To observe these waveforms, use a grounded oscilloscope and attach the ground lead on the probe to rectifier ground. Adjust the sweep rate to 5 milliseconds per division. All photos are taken at 4 amperes output current.

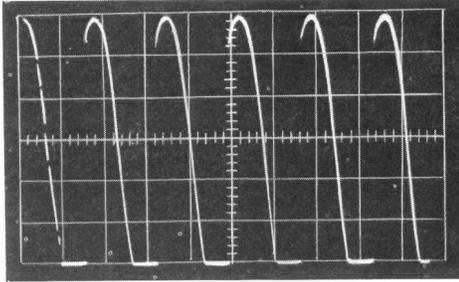
## 6. POINT-TO-POINT VOLTAGES

**6.01** The voltage readings in Table A are to be taken with a KS-20538 volt-ohm-milliammeter. The AC switch and CB1 circuit breaker are in the OFF position and the REG FUSE connected. All other external connections are to be properly made.

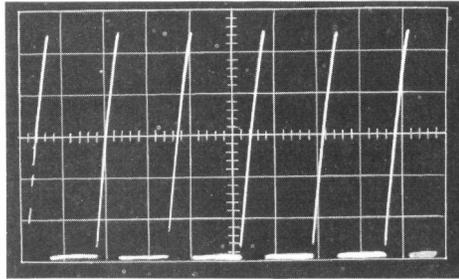
TABLE A — POINT-TO-POINT VOLTAGES

CIRCUIT	MEASUREMENT MADE		KS-20538 METER				
	FROM PIN JACK	TO PIN JACK	SCALE AC OR DC	J87211A (48 VOLT)		J87211B (24 VOLT)	
				RANGE (VOLTS)	READING (VOLTS)	RANGE (VOLTS)	READING (VOLTS)
Rectifier							
TS2	REG BAT*	REG GRD	DC	60	Bat. Volts	60	Bat. Volts
TS3	BAT*	GRD	DC	60	Bat. Volts	60	Bat. Volts
TS4	L1	L2	AC	300	Line Volts	300	Line Volts
High Voltage Shutdown							
TS6	5	1	DC	3	0	3	0
	2	3	DC	60	12 ±1.2	3	0
	2	4	DC	60	Bat. Volts	60	Bat. Volts
	5	4	DC	60	Bat. Volts	60	Bat. Volts
D2 Zener	2	1	DC	60	22 ±2	60	12 ±1.2
Regulator							
TS1	H	J	DC	60	12 ±1.2	60	12 ±1.2
	A	D	DC	3	0	3	0

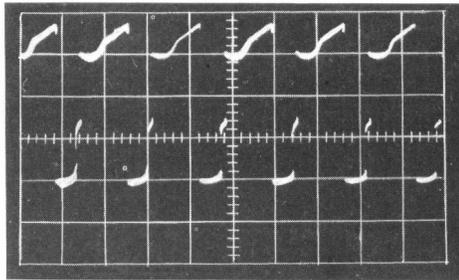
\*For positive output, reverse meter leads.



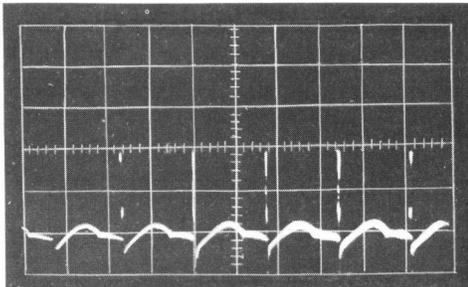
**Frame 1:** Fly back diode (D1) voltage waveform. The amplitude is approximately 117 volts (J87211A) or 61 volts (J87211B). TS5; 6-GRD.



**Frame 2:** SCR (CR1) voltage waveform. The amplitude is approximately 110 volts (J87211A) or 55 volts (J87211B) at 3 amperes output current TS5; 7-GRD.



**Frame 3:** Zener diode (Z3) voltage. The amplitude is approximately 8 volts. TS1; 3-GRD.



**Frame 4:** SCR gate pulses. The amplitude is approximately 6 volts for either rectifier. TS5; 4-GRD.

Fig. 1—Typical Rectifier Waveforms