

## KS-15885 RECTIFIER OPERATING METHODS

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### 1. GENERAL

1.01 This section covers the operation of the KS-15885 L1 through L4 semiconductor-type rectifiers with motor-driven raise-lower controls. These rectifiers are rated at 125 to 160 volts, 10 to 100 amperes direct current, and are suitable to float and charge storage batteries of 61 to 70 cells. The input power required for the rectifiers is 208, 230, or 240 volts  $\pm 5$  percent, 3-phase, 3-wire, 60  $\pm 3$  Hz.

**⚠ Danger: ⚠ Voltages inside the rectifier 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 as destructive or dangerous short circuits may occur. Before doing any work inside the rectifier, remove the rectifier from service in accordance with 5.02.**

1.02 This section is reissued to revise 3.02 and 4.04 to add information on the KS-20522 controller. This reissue does not affect the Equipment Test List.

1.03 Routine checks are intended to detect defects, particularly in infrequently operated parts of the equipment, and insofar as possible to guard against circuit failures which interfere with service. Checks and adjustments other than those required by trouble conditions should be made during a period when there will be minimum interference with service.

1.04 The instructions are based on the drawings listed below. For detailed descriptions of the operation of individual circuits, see the corresponding circuit descriptions.

SD-81016-01—Auxiliary Charging Circuit Used With L1 Rectifiers in 410B Plants

SD-81463-01—Rectifier Circuit, 130 Volts, 100 Amperes

SD-81477-01—700-Type Plant Rectifier Application Schematic

SD-81542-01—Auxiliary Charging Circuit Used With L4 Rectifiers in 410B Plants

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

1.06 An external test load may be required to make certain adjustments of the rectifier. If the rectifier is being installed in an existing plant where the plant load exceeds 115 amperes, the external test load is not required. If the rectifier is being installed in a new plant or a plant where the plant load is less than 115 amperes, use a test load sufficient to absorb the output of the rectifier (115 amperes), less any supplementary plant load. Refer to Section 171-123-101 covering test loads for power equipment.

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**1.07** The meter panel is secured to the frame with four screws which are located on the top and bottom flanges on the rear of the panel. To gain access to apparatus in back of the meter panel, first remove the rectifier from service in accordance with 5.02. Remove the screw on the right end of each flange using the R-1542 adjustable wrench. These screws are accessible through the opening at the right end of the panel. Through the opening at the left end of the panel, loosen the screw on the left end of each flange. Then swing the right end of the panel outward and to the left so that it pivots on the screws on the left.

- (a) The input transformer taps used are correct for the power supply voltage.
- (b) All external connections are made in accordance with the SD drawing covering the associated circuit of which the rectifier is a part.
- (c) An adequate office or external test load is available.
- (d) The following switch and keys are set to the positions indicated.

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

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
KS-6780 (2 reqd)	Connecting Clips
R-1542	Adjustable Wrench
—	Blocking and Insulating Tools, as Required. Use tools and apply, as covered in Section 069-020-801.

<b>MATERIALS</b>	
—	No. 18 SJO Cable, 3 Feet Long
<b>TEST APPARATUS</b>	
KS-14510	Volt-Ohm-Milliammeter
—	3-Wire Cord Connector, Hubbell Corp Part No. 5269 (or equivalent)
—	Parallel Polarized Plug, Hubbell Corp Part No. 6273-L (or equivalent)
—	W5HMT-S1 Variac, General Radio Co (or equivalent)

**3. OPERATION**

**Preparing to Start Initially**

**3.01** When putting the rectifier into service initially, check the following.

POSITION	SWITCH OR KEY
OFF	F-OFF-EC (if provided)
STOP	STOP-NOR
NOR	TEST-NOR
NOR	+130-NOR (if provided)
NOR	-130-NOR (if provided)

(e) The following rheostat and potentiometers are set to the position shown. (cw indicates clockwise and ccw indicates counterclockwise.)

RHEOSTAT OR POTENTIOMETER	POSITION
R25 (if provided)	Approximate midrange
OLA	Max cw
OLR	Max ccw

(f) Correct current rated fuses are in place.

**Initial Adjustments**

**3.02 Ammeter Relay (AR)**

◆**Note:** The mechanical contacts of the AR ammeter relay may be replaced with the solid state contacts of the KS-20522 L2 or L3 controller. The high and low settings are adjustable by the L CONT (low) and H CONT (high) potentiometers on the controller. Clockwise adjustment of the L CONT or H CONT potentiometer increases the setting. Refer to Section 024-360-201 for additional information on the KS-20522 controller.

(a) If the rectifier is equipped with an ammeter relay, proceed as follows. If equipped with a KS-20522 controller, proceed to (b).⚡

- (1) Remove the ammeter relay cover. Grasp the low contact pointer at its lower insulated end and move the pointer below the zero indication on the scale.
- (2) Adjust the zero adjuster for a zero indication on the ammeter relay.
- (3) Position the low contact pointer at 5 amperes.
- (4) Adjust the high contact to make contact when the rectifier current is at rated full load (100 amperes).
- (5) Remount the ammeter relay cover.

(b) ⚡**KS-20522 Controller**

- (1) Adjust rectifier for 5-ampere load (12.5 millivolts across the ammeter relay shunt) and then adjust the L CONT potentiometer fully ccw, then adjust cw until the controller operates at 5 amperes.
- (2) Operate the DC OUT switch to OFF.
- (3) Adjust H CONT potentiometer fully cw.
- (4) Connect appropriate load, if required, and adjust rectifier for full load (100 amperes).
- (5) Adjust H CONT potentiometer ccw until controller operates.
- (6) Repeat the above adjustment until the desired high and low set point values are obtained.⚡

**3.03 Check of OL Relay Operation:**

Adjust the circuit operation of the OL relay as follows. (Cover must be on relay. Observe the OL1 relay to determine when OL relay operates.)

(a) Through a fuse, connect external test load (adjusted for minimum load) to the discharge bus bar associated with the rectifier.

(b) Check that the following switch, rheostats, and keys are set to the positions indicated.

POSITION	SWITCH, RHEOSTAT, OR KEY
STOP	STOP-NOR
NOR	TEST-NOR
MAX cw	OLA
MAX ccw	OLR
F	F-OFF-EC (if provided)
NOR	+130-NOR (if provided)
NOR	-130-NOR (if provided)

(c) Block nonoperated the 1 and 2B contacts on OL1 relay.

(d) Move high contact of ammeter relay to extreme right position or adjust H CONT potentiometer on the KS-20522 controller fully cw.

(e) Using the 0.3-volt dc scale, connect the KS-14510 volt-ohm-milliammeter across the ammeter relay shunt at the same points as the connection for the winding of the OL relay.

(f) Operate TEST-NOR key to TEST.

(g) Operate +130-NOR key (if provided) to +130.

(h) Operate STOP-NOR key to NOR.

**Note:** Operation of the RAISE or LOWER key will require an adjustment of the test load to maintain battery float voltage for the following tests.

(i) Operate RAISE key until meter indicates 287.5 millivolts (do not go beyond this value).

(j) Slowly rotate OLA rheostat ccw until OL relay operates.

(k) Operate LOWER key until meter indicates 262.5 millivolts and check that OL relay does not release.

(l) Operate LOWER key until meter indicates 212.5 millivolts and check that OL relay has released. If OL relay has not released, check OL relay circuit requirements. If the relay requirements are met and the relay does not release, cut the strap between OLA and OLR potentiometers. Then slowly rotate OLR potentiometer cw until OL relay releases.

(m) Recheck the operation of the OL relay as follows.

(1) Operate RAISE key until meter indicates 262.5 millivolts and check that OL relay does not operate.

(2) Operate RAISE key and check that OL relay operates when the meter indicates between minimum 275, maximum 287.5 millivolts.

(n) Operate LOWER key and verify that OL relay remains operated when meter indicates 262.5 millivolts.

(o) Operate LOWER key and verify that OL relay releases before meter indicates 212.5 millivolts.

(p) Operate LOWER key until rectifier output is at a minimum.

(q) Restore rectifier to the normal stop condition as follows.

(1) Operate STOP-NOR key to STOP.

(2) Remove the block from the 1 and 2B contacts of the OL1 relay.

(3) Reset ammeter relay high contact to make at 100 amperes.

(4) Disconnect test meter and test load.

(5) Operate TEST-NOR key to NOR.

(6) Operate +130-NOR key to NOR (if provided).

(7) Operate STOP-NOR key to NOR.

#### 4. ROUTINE CHECKS

**4.01** The contactor and relays should be inspected for adjustment and condition of contacts, as often as local experience indicates, to make sure that they are in accordance with the circuit requirement table and BSP sections which apply.

**4.02** Regularly clean the ventilating passages and rectifier cells to prevent excessive heating.

#### 4.03 Voltmeter (OUTPUT VOLTS) Accuracy

(a) Check that STOP-NOR and TEST-NOR keys are at NOR.

(b) Using the 300-volt dc scale, connect the KS-14510 volt-ohm-milliammeter across the OUTPUT VOLTS meter of the rectifier.

(c) In a 702C plant, operate F-OFF-EC switch to F and, if the rectifier is a reserve unit, also operate the +130-NOR key to +130.

(d) Compare the indications of the OUTPUT VOLTS and KS-14510 meter. If they are not in agreement, adjust the OUTPUT VOLTS meter to agree with the KS-14510 meter by means of the zero adjusting device on the OUTPUT VOLTS meter.

(e) Disconnect the KS-14510 meter.

(f) In a 702C plant, operate F-OFF-EC switch to OFF and, if the rectifier is a reserve unit, also operate the +130-NOR key to NOR.

#### 4.04 Ammeter Relay (AR) Accuracy

**Note:** The following check applies to the ammeter relay or the KS-20522 controller, whichever is provided.

(a) Check that the following switch and keys are at the positions indicated.

POSITION	SWITCH OR KEY
F	F-OFF-EC (if provided)
STOP	STOP-NOR
TEST	TEST-NOR
NOR	+130-NOR (if provided)
NOR	-130-NOR (if provided)

- (b) Through a fuse, connect a test load to the discharge bus associated with the rectifier. In the case of a 720C plant reserve unit, make the connection to the +130 volt battery.
- (c) Using the 0.3-volt dc scale, connect a KS-14510 volt-ohm-milliammeter across the AR relay shunt.
- (d) Operate the STOP-NOR key to NOR.
- (e) Operate and hold RAISE key operated until the output indicated on the test meter is 250 millivolts.
- (f) Release RAISE key. Adjust test load as necessary to maintain battery at float voltage.
- (g) AR ammeter should indicate output of minimum 98, maximum 102 amperes.
- (h) Operate LOWER key until RL relay releases. Adjust test load as necessary to maintain battery at float voltage.
- (i) Operate STOP-NOR key to STOP.
- (j) Disconnect meter and test load.
- (k) Operate TEST-NOR key to NOR.

**4.05 Lamp and OUTPUT VOLTS Meter Indications—702C Plant**

- (a) Check that the following switch and keys are set in the positions indicated.

POSITION	SWITCH OR KEY
OFF	F-OFF-EC
STOP	STOP-NOR
NOR	TEST-NOR
NOR	+130-NOR (if provided)
NOR	-130-NOR (if provided)

- (b) Operate F-OFF-EC switch to F.

- (c) In the case of a reserve unit, also operate -130-NOR key to -130.
- (d) The OUTPUT VOLTS meter should indicate battery voltage and the BAT lamp should light.
- (e) Operate F-OFF-EC switch to EC.
- (f) The OUTPUT VOLTS meter should indicate the total of battery voltage plus emergency cell voltage and the EM cell lamp should light.
- (g) Operate F-OFF-EC switch to OFF.
- (h) In the case of a reserve unit, also operate -130-NOR key to NOR.
- (i) Lamp should extinguish and OUTPUT VOLTS meter should read zero.
- (j) In the case of a reserve unit, operate +130-NOR key to +130 and repeat (a) through (i), operating the +130-NOR key instead of the -130-NOR key in (h).

**4.06 Rectifier Shutdown and Rectifier Alarms:** Routine checks on rectifier shutdown operation and associated alarms are covered in Section 167-705-301 for the 702C plant and Section 167-643-302 for the 401B plant.

**4.07** Periodically check the operation of the OL relay as covered in 3.03.

**5. TROUBLES**

**General**

**5.01** The items most likely to become defective with use are the electrolytic capacitors and the rectifier cells.

**5.02** Before doing any work inside the rectifier, remove the rectifier from service as follows.

**⚠Danger:⚠ Voltages from the battery to the terminals of the F-OFF-EC switch, CHG fuses, and CONT fuses may be over 150 volts to ground. Avoid all contact with terminals which connect the leads from the battery. If work is to be done inside the rectifier, wrap live parts with canvas**

*or tape as required to avoid possible short circuits or shock.*

- (a) Operate the STOP-NOR key to STOP.
- (b) Disconnect the rectifier from the commercial ac power.
- (c) Operate the F-OFF-EC rotary switch to OFF. If the rectifier is not provided with an F-OFF-EC switch, remove the 70-type CHG fuse and CHG fuse in that order.
- (d) Remove the CONT fuse or fuses.

**5.03** Selenium semiconductor rectifier cells (in the line voltage regulator) are subject to aging which increases the resistance of the cell. With some cells and on some applications, aging may develop quite slowly; with other cells, particularly during the first month of use, it may develop more rapidly. Poor ventilation, operation near hot equipment, etc, are undesirable. High voltages, long periods of current overload, high temperatures, or poor ventilation may even cause the cells to break down electrically, rendering them useless. Corrosive fumes, such as those from sulphuric acid or mercury vapor, may also cause aging or breakdown of the cells.

**5.04** To avoid unbalance in the rectifying element when the rectifying element consists of more than one stack, replacements should be made as follows.

- (a) When replacing a defective stack or stacks in a multiple stack rectifying element, all other stacks in the rectifying element that have been in service 2 years or longer should also be replaced.
- (b) Do not combine stacks of different list numbers or those produced by different manufacturers. In no case should any attempt be made to replace part of the rectifier cells in a stack or bolt assembly which is part of a rectifying element.

**5.05** Troubles may be due to faulty relay operation.

**5.06** The control potentiometers and circuit breakers should be replaced if they become defective in any respect.

**5.07 Line Voltage Regulator** (booster) (if provided): The line voltage regulator (booster) reduces the effect of commercial line voltage variations on rectifier output and also decreases powerstat operation (jitter) during sudden line voltage dips. The R25 potentiometer in the voltage regulator is adjusted by the manufacturer and normally should not require any readjustment. If rectifier output voltage or current variations are considered excessive, do not change the R25 potentiometer adjustment until all other possible causes have been investigated.

**(a) Adjustment of R25 Potentiometer**

- (1) Through a fuse, connect a test load (adjusted for minimum load) to the discharge bus bar associated with the rectifier.
- (2) Using the 300-volt ac scale, connect the KS-14510 volt-ohm-milliammeter across LL and LL1 leads at the secondary terminals 6 and 9 of main T1 transformer.
- (3) Operate the following switch and keys to the positions indicated.

POSITION	SWITCH OR KEY
F	F-OFF-EC
NOR	STOP-NOR
TEST	TEST-NOR
NOR	+130-NOR (if provided)
NOR	-130-NOR (if provided)

- (4) Operate RAISE key and hold operated until ammeter relay pointer is at approximately 50 amperes. Then release key.
- (5) Adjust test load, as required, to maintain battery within float limits.
- (6) Adjust R25 potentiometer until volt-ohm-milliammeter indicates 70 volts.
- (7) Disconnect the meter and check line voltage regulator as covered in (b).

**(b) Check Line Voltage Regulator** (booster)

- (1) Operate STOP-NOR key to STOP.
- (2) Operate F-OFF-EC switch to OFF.
- (3) Block nonoperated ST relay.
- (4) Adjust test load, as required, to maintain battery within float limits.
- (5) Allow sufficient time for the capacitors in the circuit to drain to approximately 15 volts as indicated on the OUTPUT-VOLTS meter on the rectifier. Then tag and disconnect the LL and LL1 leads from terminals 6 and 9 of the T1 transformer.
- (6) Connect the parallel blades of a 3-wire Hubbell cord connector to terminals 6 and 9 of T1 transformer using two No. 18 SJO cables.
- (7) Connect the line cord of a W5HMT-S1 Variac to the cord connector. [See (6).]
- (8) Connect the LL and LL1 leads to the output of the Variac using two No. 18 SJO cables equipped with a No. 6273-L Hubbell parallel polarized plug at one end and two KS-6780 connecting clips at the other. Check that the LL1 lead connects directly (through the common side of the Variac) to terminal 6 of T1 transformer.
- (9) Using the 300-volt ac scale, connect the KS-14510 volt-ohm-milliammeter across the output of the Variac (pin jacks on top of Variac).
- (10) Position the Variac dial at midrange.
- (11) Remove blocking tool from ST relay.
- (12) Operate F-OFF-EC switch to F.
- (13) Operate STOP-NOR key to NOR.
- (14) Operate RAISE key and release the key when the AR ammeter pointer is off low contact.
- (15) Adjust the Variac connected to the LL and LL1 leads for a reading of 70 volts on the associated meter.
- (16) Block nonoperated the Rl and RR relays.
- (17) Remove CHG ALM and CHG fuses.
- (18) Reset Variac to read 70 volts on the associated meter.
- (19) Measure and record the voltage between F1 and F2 AMP TRAP fuses, using the 300-volt ac scale of the KS-14510 volt-ohm-milliammeter.
- (20) Lower the output of the Variac to 66.5 volts.
- (21) Measure the voltage between F1 and F2 AMP TRAP fuses using the 300-volt ac scale of the KS-14510 volt-ohm-milliammeter. This should be approximately 10 percent above the value measured in (19).
- (22) Return the rectifier to the normal stop condition as follows.
  - (a) Remove blocking tool from RL relay.
  - (b) Operate and hold LOWER key operated until RL relay releases.
  - (c) Remount CHG and CLG ALM fuses.
  - (d) Operate STOP-NOR key to STOP.
  - (e) Operate F-OFF-EC switch to OFF.
  - (f) Block nonoperated ST relay.
  - (g) Disconnect KS-14510 volt-ohm-milliammeter.
  - (h) Disconnect external test load.
  - (i) Disconnect Variac.
  - (j) Reconnect LL and LL1 leads to terminals 9 and 6, respectively, of T2 transformer.
  - (k) Remove blocking tool from ST relay.
  - (l) Remove blocking tool from RR relay.
  - (m) Operate TEST-NOR key to NOR.

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(n) Operate F-OFF-EC switch to F.

found, look for loose or open connections or short circuits due to foreign matter lying across wiring terminals.

**Trouble Chart**

**5.08** If trouble develops, the possible causes listed should be checked. If the trouble is not

TROUBLE	POSSIBLE CAUSE	TROUBLE	POSSIBLE CAUSE
(a) No dc output current	Faulty connections	(c) High dc output current	Blown F1, F2, or F3 fuse (only one blown)
	Blown CHG fuse		R25 potentiometer incorrectly adjusted
	Failure of AC contactor		Improper operation of T5 powerstat or associated controls
	Blown ac input supply fuse		OLA and OLR rheostats incorrectly adjusted
	CB1 circuit breaker in OFF position		OL and OL1 relays incorrectly adjusted
	Failure of ac input power		R25 potentiometer incorrectly adjusted
(b) Low dc output current	Blown F1, F2, or F3 fuse (two or more blown)	(d) Erratic dc output current or voltage	Loose connections
	Failure of D1 rectifier		Intermittent open or short in any component
	Low input voltage		Faulty operation of line voltage regulator (booster) (if provided)
	Faulty connections		
Improper operation of T5 powerstat or associated controls	Incorrect T1 transformer taps used		