

**RINGING AND TONE POWER PLANT**  
**841A (J87804)**  
**OPERATING METHODS**

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**1. GENERAL**

**1.01** The 841A (J87804A and J87804B) Ringing and Tone Power Plant provides interrupted and continuous ringing current, interrupted precise call progress tones, and signaling interruptions as required by the No. 2 Electronic Switching System. Twenty-Hz ringing current (not audible) is generated by duplicate transistorized dc-to-ac inverters. TOUCH-TONE® dial tone, audible ringing tone, call-waiting tone, high-tone, and busy tones are generated by duplicate transistorized tone generators, each consisting of four oscillators supplying 1-VA amplifiers in different combinations of one or two frequencies. All generators, both regular and

reserve, are continuously monitored for low voltage. The outputs of the low-voltage monitors are transmitted to ferrod sensors in the master scanner for system control and alarm indications. Solid state interrupters are driven by the two 20-Hz inverters to produce the various interruptions for interrupted ringing, tones, and signaling of 30, 60, and 120 ipm.

**1.02** This section is reissued to add procedures for locating grounds in external circuits, clarifying oscillator output voltage measurements, adding fuse checks for +48 volt circuits and to correct the List of Tools and Test Apparatus. This reissue does affect the Equipment Test List.

**1.03** The *J87804A AC-DC Ringing and Tone Power Plant* is used for 4-party semiselective and 10-party, 5-code ac-dc offices, while the *J87804B Superimposed Ringing and Tone Power Plant* is used for 8-party semiselective and 4-party full selective superimposed offices. The following items are furnished by these plants.

- (1) RINGING CURRENT—20 Hz, 0.5A, 84 to 88V and 102 to 110V ac for J87840A plants; or 20 Hz, 0.5A, 84 to 88V, 94 to 101V, and 102 to 110V ac for J87804B plants. **See Notes 1 and 2.**
- (2) TOUCH-TONE DIAL TONE—combined 350 and 440 Hz, 1VA, 1.20V ac.
- (3) AUDIBLE RINGING TONE—combined 440 and 480 Hz, 1VA, 0.36V ac. **See Note 2.**
- (4) CALL-WAITING TONE—440 Hz, 1VA, 0.48V ac.
- (5) HIGH-TONE—480 Hz, 1VA, 0.29V ac.

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Bell System except under written agreement

- (6) **BUSY TONE**—combined 480 and 620 Hz, 1VA, 0.20V ac. *See Note 3.*
- (7) **RECEIVER-OFF-HOOK TONE**—combined frequencies of 1400, 2060, 2450, and 2600 Hz.

**Note 1:** The plants provide, in ac-dc and superimposed offices, CODE 11 GEN BR1, BR2, and BR3, only. All code ringing is provided by ESS circuits.

**Note 2:** Provide three brushes interrupted at 10 ipm, 2 seconds on and 4 seconds off.

**Note 3:** Provide balanced distribution of continuous and interrupted tones at 60 and 120 ipm.

**Caution:** *The plant includes automatically controlled equipment. Care must be exercised to prevent transfer to those parts of the plant on which work is to be done. Before starting work on a ringing generator, tone oscillator, or interrupter, follow instructions outlined in 3.02 through 3.05 as required to prevent automatic transfer. If work is to be performed on the 400A tone generator (receiver-off-hook circuit), disconnect the input power by depressing the ROH PWR OFF key. When the work is completed, be sure to restore the circuits to normal.*

**1.04** During *normal* operation, power is on both groups, "0" and "1", of the ringing generators, tone generators, and interrupter. If an element of the unit supplying the load should fail, a signal is transmitted to the system control to determine which group, "0" or "1", of the ringing generators, tone generators, and interrupters will supply the load. The dc-to-ac inverter provides two 86-volt ac outputs and one 105-volt ac output. The 105-volt ac output of each inverter is monitored by a low-voltage alarm and an automatic transfer feature of the output of the emergency manual lines to transfer to the opposite inverter in the event of a failure. This feature is *not* under system control. Regardless of which inverter has been selected by system control, this feature will function to guarantee the emergency manual lines a 105-volt ac supply.

**1.05** In superimposed offices, the low side of one 86-volt ac output on the inverter is connected to -48 volts dc, while the other 86-volt ac output is connected to +48 volts dc. Then this 20-Hz superimposed ringing current is supplied from the high side on the inverter to diode board packages, which are equipped with a varistor string in series with the current load. During power failures when the battery is on discharge, control relays short out some of these varistors to hold the dc components voltage stable. The SUP + outputs of both inverters are checked by low-voltage monitors sending alarm signals to the system control via the master scanner. In order to be certain that 105-volt ac is present to emergency manual lines, an additional low-voltage monitor is provided. Each CODE 1 GEN BR1, BR2, and BR3 for both the dc-ac inverters is checked with a fast monitor, having a response time of less than 5 msec to set the ferrod sensors in the master scanner, so the system can determine that interrupted ringing is being provided.

**Note:** In this plant audible ringing tone is not superimposed on the 20-Hz ringing current but is distributed separately.

**1.06** In the J87804B Superimposed Ringing and Tone Power Plant, the input +48 volts dc required is obtained from the 610D dc-dc converter operating from -48 volts dc. All other inputs for -48 and +24 volts dc for either side of the plant are obtained from the power distributing frame of the regular battery supply. Power is furnished on an A and B bus basis for both voltages. The A bus supplies the "0" side of the plant, while the B bus supplies the "1" side. All generators are powered by -48 volts dc while the solid state interrupters are powered from +24 volts dc.

**1.07** The receiver-off-hook tone circuit consists of four oscillators, a pulse generator, amplifiers, and a tone-level alarm. The oscillators provide frequencies of 1400, 2060, 2450, and 2600 Hz of equal amplitude and are linearly combined to synthesize the desired tone. Reserve receiver-off-hook tone power is not provided.

**1.08** These plants also furnish 105-volt ac continuous ringing current for miscellaneous uses such as PBX feeders for manual switchboards. In addition, the J87804B (see Fig. 1) plant provides 97V continuous ringing current for dial long-line circuits.

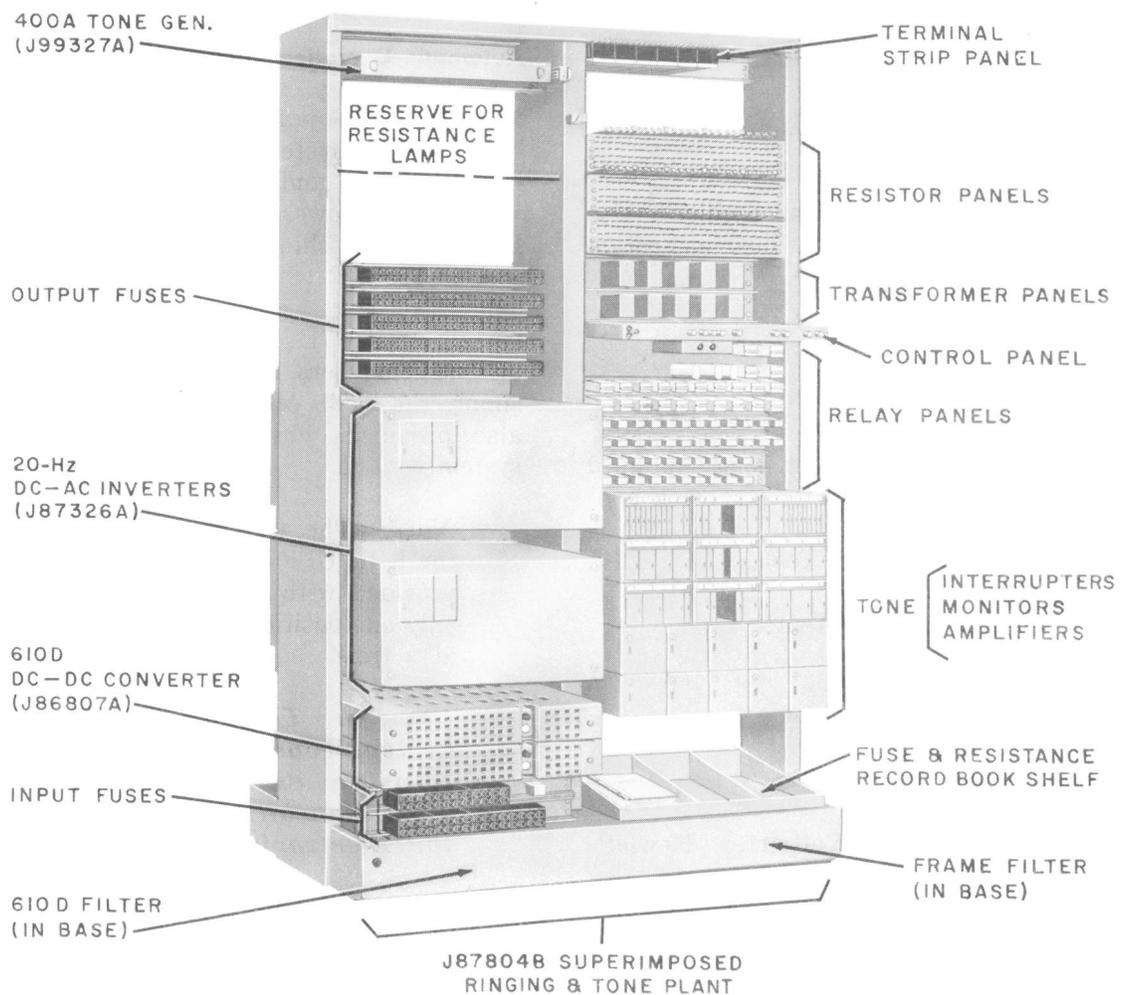


Fig. 1—J87804B Superimposed Ringing and Tone Plant

1.09 Instructions are based on the following drawings. For detailed description of the operation of individual circuits, refer to the corresponding circuit description.

SD-81571-01, Iss 12B—DC-to-DC Transistor Converter +48 Volts, 1-1/2 Ampere Output, -48 Volts Input, 610D Plant

SD-81870-01, Iss 9D—AC-DC to Superimposed Ringing No. 2 ESS Offices 841A Ringing and Tone Power Plant

SD-81885-01, Iss 19D—Circuit Pack Schematics

SD-81908-01, Iss 3—J87326A, 20-Hz DC-to-AC Inverter  $\pm 84$  to  $\pm 110$  Volt, 0.5 Ampere Output, -48 Volt Input

SD-99303-01, Iss 15B—400A Tone Generator (ROH)

1.10 For more detailed information on the operation and maintenance of individual equipment or apparatus, refer to the appropriate Bell System Practices. The relays should be adjusted, when required, in accordance with the sections and the circuit requirement tables of the schematic circuit drawings.

1.11 Refer to SD-81870-01 for the location of CIRCUIT PACKS in the power plant.

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
<b>TOOLS</b>	
—	Blocking Tools as required (Use and apply as outlined in Section 069-020-801.)
716C	Test Receiver
411C	Test Pick
W1AF	Cord (8-1/2 feet long equipped with one 360A tool at each end)
723	◆Circuit Pack Tool
731	Circuit Pack Tool
R-3322	Screwdriver◆
<b>TEST APPARATUS</b>	
—	True RMS Voltmeter, Hewlett-Packard Model 3400A
	or
—	True RMS Digital Voltmeter, Hickok Model 3310
KS-8039	Volt-Milliammeter
	or
—	Milliammeter, Clip-on, Hewlett-Packard Model 428B
—	Voltmeter-Vacuum Tube, Hewlett-Packard Model 400D
KS-14510	◆Volt-Ohm-Milliammeter
158A	Adapter (Board Extender)
169A	Adapter (Board Extender)◆

3. OPERATION

**Automatic Operation of Plant**

**3.01** The 841A power plant operates automatically under system control to supply ringing current, tones, and signaling interruptions at the voltage and power levels required by the No. 2 Electronic Switching System. With the NOR (S1) and ROH NOR (S2) located on the control panel depressed, the system control determines which group, "0" or "1", of the ringing generators, set of tone generators, and solid state interrupters will supply the load. Manual control (3.03 and 3.06) is also provided, which supersedes the automatic system control.

**Note:** The OFF-0—NOR—OFF-1 (S1) and the ROH OFF—ROH NOR (S2) keys are both provided with mechanical interlocks so that only one position of each key can be operated at a time.

**Caution:** *This power plant is under system control. Do not attempt any transfers or work operations without prior consultation with personnel of the Electronic Switching System.*

**Manual Operation of Plant**

**3.02** Remove from service the plant being tested. If work is to be performed on the "0" side of the plant, the load must be transferred to the "1" side of the plant prior to operation of any key on the control panel.

**Note:** The input and output messages to be used for plant transfer should be taken from No. 2 ESS input and output message manuals IM-2H200 and OM-2H200.

**3.03** Before removing power from the "0" side of the plant, make sure the "1" side is carrying the load. To remove power from the "0" side of the plant, depress the OFF-0 key. The OFF NOR, PWR OFF, and OS-O lamps light. With the OFF-0 key depressed, the "1" inverter (INV-1) tone generator (GEN 1), and interrupter (INT 1) supply the required ringing current, tones, and signal interruptions. The dc input power to the "0" units is disconnected. When work is completed, depress the NOR key. All lamps

extinguish. Do not depress the OFF-1 key when the "1" side of the plant is carrying the load.

**3.04** If the work is to be performed on the "1" side of the plant, the load must be transferred to the "0" side of the plant prior to the operation of any key on the control panel.

**Note:** The input and output messages to be used for plant transfer should be taken from No. 2 ESS input and output message manuals IM-2H200 and OM-2H200.

**3.05** Before removing power from the "1" side of the plant, make sure the "0" side is carrying the load. To remove power from the "1" side of the plant, depress the OFF-1 key. The OFF NOR, PWR OFF, and OS-1 lamps light. With the OFF-1 key depressed, the "0" inverter (INV-0) tone generator (GEN 0), and interrupter (INT 0) supply the required ringing current, tones, and signaling interruptions. The dc input power to the "1" units is disconnected. When work is completed, depress the NOR key. All lamps extinguish. **Do not depress the OFF-0 key when the "0" side of the plant is carrying the load.**

**3.06** To operate the plant automatically after operating manually, follow instructions outlined in 3.01. All lamps extinguish; audible alarms retire; and the plant is again under system control.

**3.07** The ROH NOR and the ROH PWR OFF keys are provided for connecting and disconnecting the input power to the receiver-off-hook generator. Depressing the ROH PWR OFF key removes the power to the generator, lights the OFF NOR and PWR OFF lamps, and transmits an alarm signal to the master scanner circuit.

#### 4. ROUTINE CHECKS AND ADJUSTMENTS

**4.01** The power failure package (PF), the tone low-voltage monitors, and the amplifiers are the only packages that require adjustments. These units are factory adjusted and should rarely require readjustments when in service. On most of the circuit packs the adjustments are internal to the packages; therefore, it is necessary to make use of a 158A or 169A adapter (circuit pack board extender).

**Warning:** Isolation of the voltmeter from ground produces a potentially hazardous condition and care should be exercised. Avoid direct bodily contact between the test instrument and other components or ground.

**Caution 1:** Use any suitable ac ground isolation plug to isolate the Hewlett Packard Model 3400A voltmeter from ground to prevent erroneous indications or damage to the equipment.

**Caution 2:** When it is necessary to remove or insert a circuit pack, turn off the -48 volt or +24 volt battery to the plant involved by depressing the OFF-0 and OFF-1 key as outlined in 3.03 or 3.05 respectively. Use 723 or 731 circuit pack tool for removal.

**Caution 3:** When the circuit packs are interchanged between the 0 and 1 sides of the plant, they must be checked and readjusted in the new locations before being switched on line.

**Caution 4:** Use a true RMS voltmeter that has dc input isolation to measure oscillator ac outputs. The use of any RMS voltmeter, which responds to the dc component as well as the ac, includes the bias voltage and gives an undesired value.

#### Tone Generators

#### 4.02 Tests of Oscillators ("0" side of plant)

(1) Verify that the "1" side of the plant is carrying the load (T1 relay is operated). If it is not, transfer the load to the "1" side of the plant as outlined in 3.03.

(2) Measure the ac signal output of each of the separate oscillator circuit packs; 350, 440, 480, and 620 Hz of GEN 0. Use the 10-volt ac scale of a capacitive coupled, True RMS Voltmeter, such as the 3400A Hewlett Packard, or equivalent. Depress the OFF-0 key. Place each oscillator, one at a time, on a 169A adapter.

Connect the test leads to pin jacks TP1 (grd) and TP2 (output) or to pin 14 (grd) and pin 12 (output) on the back of each of the four oscillator packs. Depress the NOR key and measure the output of each oscillator.⚡

**Requirement:** The voltmeter indicates between 4.0 and 4.6 volts rms on each of the four oscillators.

- (3) Depress OFF-0 key.
- (4) Disconnect the true RMS voltmeter from GEN 0.
- (5) Depress the NOR key on the control panel. All lamps extinguish.
- (6) Transfer the load to the "0" side of the plant as outlined in 3.04.

#### 4.03 Test of Oscillators ("1" side of plant)

- (1) Verify that the "0" side of the plant is carrying the load (TO relay is operated). If it is not, transfer the load to the "0" side of the plant as outlined in 3.04.
- (2) ⚡Measure the ac signal output of each of the oscillator circuit packs, 350, 440, 480, and 620 Hz of GEN 1. Use the 10-volt ac scale of a capacitive coupled true RMS voltmeter, such as the 3400A Hewlett Packard, or equivalent. Depress the OFF-1 key. Place each oscillator, one at a time, on the adapter (board extender). Connect the test leads to pin jacks TP1 (grd) and TP2 (output) or to pin 14 (grd) and pin 12 (output) on the back of each of the four oscillator circuit packs. Depress the NOR key and measure the output of each oscillator.⚡

**Requirement:** The voltmeter indicates between 4.0 and 4.6 volts rms on each of the four oscillators.

- (3) Depress OFF-1 key.
- (4) Disconnect the true RMS voltmeter from GEN 1.
- (5) Depress the NOR key on the control panel. All lamps extinguish.

#### 4.04 Tests and Adjustments of Amplifiers ("0" side of plant)

##### (a) Dial Tone—TT

- (1) Verify the "1" side of the plant is carrying the load (T1 relay is operated). If it is not, transfer the load to the "1" side of the plant as outlined in 3.02 through 3.03.

- (2) Depress the OFF-0 key.

- (3) Connect the true RMS voltmeter, using the 3-volt scale, to terminals 5 and 7 of transformer T1-0, GEN 0.

- (4) Remove the OSC-0, 440-Hz oscillator.

- (5) Depress the NOR key ⚡and measure voltage.⚡

**Requirement:** The voltmeter indicates  $0.85 \pm 0.05$  volt.

- (6) If the requirement is not met, adjust the ADJ 1 potentiometer on the TT-0 amplifier for a meter indication of 0.85 volt.

- (7) Depress the OFF-0 key.

- (8) Replace the OSC-0, 440-Hz oscillator and remove the OSC-0, 350-Hz oscillator.

- (9) Depress the NOR key.

**Requirement:** The voltmeter indicates  $0.85 \pm 0.05$  volt.

- (10) If the requirement is not met, adjust the ADJ 2 potentiometer on the TT 0 amplifiers for a meter indication of 0.85 volt.

- (11) Depress the OFF-0 key.

- (12) Replace the OSC-0, 350-Hz oscillator.

- (13) Depress the NOR key ⚡and measure voltage.⚡

**Requirement:** The voltmeter indicates  $1.20 \pm 0.08$  volts.

- (14) If the requirement is not met, repeat (3) through (13).

**(b) Call-Waiting Tone—MT1**

- (15) Depress the OFF-0 key.
- (16) Connect the true RMS voltmeter, using the 1-volt scale, to terminals 5 and 7 of transformer T2-0, GEN 0.
- (17) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.48  $\pm$ 0.03 volt.

- (18) If the requirement is not met, adjust the ADJ 1 potentiometer on the MT1-0 amplifier circuit pack as necessary for a meter indication of 0.48 volt.

**(c) Audible Ringing Tone—AR**

- (19) Depress the OFF-0 key.
- (20) Connect the true RMS voltmeter, using the 1-volt scale, to terminals 5 and 7 of transformer T3-0, GEN 0.
- (21) Remove the OSC-0, 480-Hz oscillator.
- (22) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.255  $\pm$ 0.015 volt.

- (23) If the requirement is not met, adjust the ADJ 1 potentiometer on the AR-0 amplifier circuit pack as necessary for a meter indication of 0.255 volt.
- (24) Depress the OFF-0 key.
- (25) Replace the OSC-0, 480-Hz oscillator and remove the OSC-0, 440-Hz oscillator.
- (26) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.255  $\pm$ 0.015 volt.

- (27) If the requirement is not met, adjust the ADJ 2 potentiometer on the AR-0

amplifier circuit pack as necessary for a meter indication of 0.255 volt.

- (28) Depress the OFF-0 key.
- (29) Replace the OSC-0, 440-Hz oscillator.
- (30) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.36  $\pm$ 0.025 volt.

- (31) If the requirement is not met, repeat (19) through (30).

**(d) Busy Tone—BT**

- (32) Depress the OFF-0 key.
- (33) Connect the voltmeter, using the 1-volt scale, to terminals 5 and 7 of transformer T4-0, GEN 0.
- (34) Remove the OSC-0, 620-Hz oscillator.
- (35) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.14  $\pm$ 0.005 volt.

- (36) If the requirement is not met, adjust the ADJ 1 potentiometer on the BT-0 amplifier circuit pack as necessary for a meter indication of 0.14 volt.
- (37) Depress the OFF-0 key.
- (38) Replace the OSC-0, 620-Hz oscillator and remove the OSC-0, 480-Hz oscillator.
- (39) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.14  $\pm$ 0.005 volt.

- (40) If the requirement is not met, adjust the ADJ 2 potentiometer on the BT-0 amplifier circuit pack as necessary for a meter indication of 0.14 volt.
- (41) Depress the OFF-0 key.

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- (42) Replace the OSC-0, 480-Hz oscillator.
- (43) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.20  $\pm$ 0.01 volt.

- (44) If the requirement is not met, repeat (33) through (44).

(e) **High Tone—HT**

- (45) Depress the OFF-0 key.
- (46) Connect the true RMS voltmeter, using the 1-volt scale, to terminals 5 and 7 of transformer T5-0, GEN 0.
- (47) Depress the NOR key and measure voltage.

**Requirement:** The voltmeter indicates 0.29  $\pm$ 0.15 volt.

- (48) If the requirement is not met, adjust the ADJ 1 potentiometer on the HT-0 amplifier circuit pack as necessary for a meter indication of 0.29 volt.

- (49) Depress the OFF-0 key.
- (50) Disconnect the true RMS voltmeter from GEN 0.
- (51) Depress the NOR key on the control panel. All lamps extinguish.
- (52) Follow procedure outlined in 3.06 to transfer the load to the "0" side of the plant.

**4.05 Tests and Adjustment of Amplifiers ("1" side of plant)**

- (1) Verify that the "0" side of the plant is carrying the load (TO relay operated). If it is not, transfer the load to the "0" side of the plant as outlined in 3.04.

- (2) Repeat similar tests as outlined in 4.04(2) through (50) for GEN 1.

- (3) When tests and adjustments are complete, depress the NOR key on the control panel. All lamps extinguish.

- (4) Follow procedure outlined in 3.03 to transfer the load to the "1" side of the plant.

**4.06 Tone Monitor Checks ("0" Side of Plant)**

(a) **Dial Tone**

- (1) Verify that the "1" side of the plant is carrying the load (T1 relay operated). If it is not, transfer the load to the "1" side of the plant as outlined in 3.03.

- (2) Depress the OFF-0 key.
- (3) Remove the 350-Hz oscillator.
- (4) Depress the NOR key.

**Requirement:** The LV relay on the TTLV-0 tone low voltage monitor is released. (CPA751)

**Note:** If the requirement is met, proceed to (7); If the requirement is not met, continue with (5) and (6).

- (5) Rotate the LV ADJ (R1) potentiometer on the TTLV-0 tone low voltage monitor fully ccw.
- (6) Very slowly rotate LV ADJ (R1) potentiometer cw until the LV relay just operates. Then slowly rotate R1 potentiometer ccw until the LV relay just releases.
- (7) Operate the OFF-0 key.
- (8) Reinsert the 350-Hz oscillator.
- (9) Depress the NOR key.

**Requirement:** The LV relay operates when the oscillator circuit pack is replaced.

- (10) If the requirement is not met, repeat (2) through (9).

(b) **Audible Ring**

- (11) Depress the OFF-0 key.

(12) Remove the 440-Hz oscillator.

(13) Depress the NOR key.

**Requirement:** The LV relay on the ARLV-0 tone low voltage monitor is released.

**Note:** If the requirement is met, proceed to (16). If the requirement is not met, continue with (14) and (15).

(14) Rotate the LV ADJ (R1) potentiometer on the ARLV-0 tone low voltage monitor fully ccw.

(15) Very slowly rotate the LV ADJ (R1) potentiometer cw until the LV relay just operates. Then slowly rotate R1 potentiometer ccw until the LV relay just releases.

(16) Depress the OFF-0 key.

(17) Reinsert the 440-Hz oscillator and depress the NOR key.

**Requirement:** The LV relay operates when the oscillator circuit pack is replaced. If the requirement is not met, repeat (11) through (17).

(c) **Busy Tone**

(18) Depress the OFF-0 key.

(19) Remove the 480-Hz oscillator.

(20) Depress the NOR key.

**Requirement:** The LV relay on the BTLV-0 tone low voltage monitor is released.

**Note:** If the requirement is met, proceed to (23). If the requirement is not met, continue with (21) and (22).

(21) Rotate the LV ADJ (R1) potentiometer on the BTLV-0 tone low voltage monitor fully ccw.

(22) Very slowly rotate the LV ADJ (R1) potentiometer cw until the LV relay just operates. Then slowly rotate R1 potentiometer ccw until the LV relay just releases.

(23) Depress the OFF-0 key.

(24) Reinsert the 480-Hz oscillator.

(25) Depress the NOR key.

**Requirement:** The LV relay operates when the oscillator circuit pack is replaced.

(26) If the requirement is not met, repeat (18) through (25).

(d) **High Tone**

(27) Depress the OFF-0 key.

(28) Connect the 3400A voltmeter, using the 1-volt scale, to terminals 5 and 7 of transformer T5-0, GEN 0.

(29) Depress the NOR key.

(30) Adjust the ADJ 1 (R1) potentiometer on the HT-0 amplifier until the voltmeter indicates 0.2 volt.

**Requirement:** The LV relay on the HTLV-0 tone low voltage monitor should be released.

**Note:** If the requirement is met, proceed to (33). If the requirement is not met, continue with (31) and (32).

(31) Rotate the LV ADJ (R1) potentiometer on the LT LV-0 tone low voltage monitor fully ccw.

(32) Very slowly rotate the LV ADJ (R1) potentiometer cw until the LV relay just operates. Then slowly rotate R1 potentiometer ccw until the LV relay just releases.

(33) Readjust the ADJ 1 (R1) potentiometer on the HT-0 amplifier until the voltmeter indicates 0.29 volt.

**Requirement:** The LV relay operates.

(34) If the requirement is not met, repeat (27) through (33).

(35) Depress the OFF-0 key.

(36) Disconnect the 3400A voltmeter from the T5-0 transformer.

(37) Depress the NOR key.

(e) **Call Waiting Tone**

(38) Depress the OFF-0 key.

(39) Connect the 3400A voltmeter, using the 1-volt scale, to terminals 5 and 7 of transformer T2-0, GEN 0.

(40) Depress the NOR key.

(41) Adjust the ADJ 1 (R1) potentiometer on the MT1-0 amplifier until the voltmeter indicates 0.38 volt.

**Requirement:** The LV Relay on the MT LV-0 tone low voltage monitor should be released.

**Note:** If the requirement is met, proceed to (44). If the requirement is not met, continue with (42) and (43).

(42) Rotate the LV ADJ (R1) potentiometer on the **MTLV-0** tone low voltage monitor fully ccw.

(43) Very slowly rotate the LV ADJ (R1), potentiometer cw until the LV relay just operates. Then slowly rotate R1 potentiometer ccw until the LV relay just releases.

(44) Readjust the ADJ 1 (R1) potentiometer on the MT1-0 amplifier until the voltmeter indicates 0.48 volt.

**Requirement:** The LV relay operates.

(45) If the requirement is not met, repeat (38) through (44).

(46) Depress OFF-0 key.

(47) Disconnect the 3400A voltmeter from the T2-0 transformer.

(48) Depress the NOR key on the control panel. All lamps extinguish.

(49) Transfer the load to the "0" side of the plant as outlined in 3.06.

**4.07 Tone Monitor Checks ("1" Side of Plant)**

(1) Verify that the "0" side of the plant is carrying the load (TO relay is operated). If it is not, transfer the load to the "0" side of the plant as outlined in 3.04.

(2) Repeat similar tests as outlined in 4.06(2) through (47) for GEN 1.

(3) When tests and adjustments are complete, depress the NOR key on the control panel. All lamps extinguish.

**Ringling Generator Monitor**

**4.08 PFO Monitor Checks (Superimposed Offices Only)**

(1) Verify that the "1" side of the plant is carrying the load (T1 relay is operated). If it is not, transfer the load to the "1" side of the plant as outlined in 3.03.

(2) Depress OFF-0 key.

(3) Using the 75-volt dc scale of the KS-8039 volt-milliammeter, connect the negative lead to the TP1 jack of the PFO circuit and the positive lead to ground.

(4) Depress the NOR key.

(5) Operate and hold the S1 switch.

(6) Rotate the PF TST (R1) potentiometer on the PFO circuit pack until the meter indicates -48 volts.

(7) Rotate the PF ADJ (R4) potentiometer on the PFO circuit pack cw until the PFO relay releases; then slowly rotate the PF ADJ (R4) potentiometer ccw until the PFO relay just operates.

(8) Release the S1 switch.

**Requirement:** The PFO relay releases.

- (9) Disconnect the KS-8039 volt-milliammeter from PFO circuit.
- (10) Depress the NOR key on the control panel. All lamps extinguish.
- (11) Transfer the load to the "0" side of the plant as outlined in 3.06.

#### 4.09 PF1 Monitor Checks (Superimposed Office Only)

- (1) Verify that the "0" side of the plant is carrying the load (TO relay is operated). If it is not, transfer the load to the "0" side of the plant as outlined in 3.04.
- (2) Depress the OFF-1 key.
- (3) Using the 75-volt dc scale of the KS-8039 volt-milliammeter, connect the negative lead to the TP1 jack of the PF1 circuit pack and the positive lead to ground.
- (4) Depress the NOR key.
- (5) Operate and hold the S1 switch.
- (6) Rotate the PF TST (R1) potentiometer on the PF1 circuit pack until the meter indicates -48 volts.
- (7) Rotate the PF ADJ (R4) potentiometer on the PF1 circuit pack cw until the PF1 relay releases; then slowly rotate the PF ADJ (R4) potentiometer ccw until the PF1 relay just operates.
- (8) Release the S1 switch.

**Requirement:** The PF1 relay releases.

- (9) Disconnect the KS-8039 volt-milliammeter from PF1 circuit.
- (10) Depress the NOR key on the control panel. All lamps extinguish.
- (11) Transfer the load to the "1" side of the plant as outlined in 3.03.

#### Receiver-Off-Hook Generator

#### 4.10 Pulsing Signal Output Check

- (1) Verify that the ROH NOR key is depressed.
- (2) Connect the Hewlett-Packard model 400D voltmeter between terminals 17 (TB1) and 27 (TB1) of the 400A tone generator.

**Warning:** Isolation of the voltmeter from ground produces a potentially hazardous condition and care should be exercised. Avoid direct bodily contact between the test instrument and other components or ground.

**Caution:** Use any suitable ac ground isolation plug to isolate the Hewlett-Packard Model 400D voltmeter from ground and prevent erroneous indications or damage to the equipment.

- (3) Set the gain by adjusting the R313 potentiometer to produce an output of +6.8 on the volume-indicating meter.
- (4) Disconnect the voltmeter.

#### 4.11 Tone Signal Alarm Check

- (1) Clip the current probe of the Hewlett-Packard model 428B milliammeter around the cable lead of T.S.A. terminal 25 at the top of the bay. Measure the current.

**Requirement:** The milliammeter indicates between 5.0 and 12.0 MA.

**Note:** Steps (2) and (3) temporarily remove the on-line ROH plant from service and generate a TTY alarm message. Perform ROH tone signal alarm check during periods of light loads to minimize service reaction.

- (2) Depress the ROH PWR OFF key. The OFF NOR and PWR OFF lamps light. Observe the current.

**Requirement:** The milliammeter drops to 0.

- (3) Operate the ROH NOR key. The lamps extinguish. Measure the current.

**Requirement:** The milliammeter indicates between 5.0 and 12.0 MA.

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- (4) Manually operate the H key. Observe the current.

**Requirement:** The milliammeter drops to 0.

- (5) Disconnect the milliammeter.

each distribution resistor using the test points designated in Table A.

- (3) Transfer the load to the "1" side of the plant as outlined in 3.03. Recheck the outputs at the centerpoint of each distribution resistor listed in Table A.

**Miscellaneous Circuits and Alarms**

**TABLE A**

**4.12 Interrupter Follow Relay Checks**

- (1) Verify that the "0" side of the plant is carrying the load (TO relay is operated). If it is not, transfer the load to the "0" side of the plant as outlined in 3.04.

**Requirement:** The 30-0, 60-0, and 120-0 relays operate following the interrupter (INTO).

- (2) Using the KS-14510 volt-ohm-milliammeter set on the RX1000 ohm range, check for 30 ipm between each set of 30A and 30B leads, 60 ipm between each set of 60A and 60B leads, and 120 ipm between each set of 120A and 120B leads. See CADS 2, 3, and 4 of SD-81870-01 for terminal numbers.

- (3) Transfer the load to the "1" side of the plant as outlined in 3.03.

**Requirement:** The 30-1, 60-1, and 120-1 relays operate following the interrupter (INT1).

- (4) Repeat the procedure outlined in (2).
- (5) Disconnect the ohmmeter and depress the NOR key on the control panel. All lamps extinguish.
- (6) Transfer the load to the "0" side of the plant as outlined in 3.06.

**4.13 Distribution Circuit Check**

- (1) Verify that the "0" side of the plant is carrying the load. If it is not, transfer the load in accordance with 3.04.
- (2) Using a test receiver with the HRG (TP4), pin jack (12K ohms) in series with the test lead, check the outputs at the centerpoint of

DISTRIBUTION RESISTORS		SIGNALS	INTER- RUPTIONS
TTT-	TTR-	TOUCH-TONE DIAL TONE	
MT1-T-	MT1-R-	CALL WAITING TONE	
AR1T-	AR1R-	AUDIBLE RINGING TONES	10 IPM
AR2T-	AR2R-		
AR3T-	AR3R-		
ROHT	ROHR	RECEIVER-OFF-HOOK-TONE	
HTT-	HTR-	HIGH TONE	
BT1T-	BT1R-	BUSY TONES	
BT2T-	BT2R-		60 IPM
BT3T-	BT3R-		120 IPM

- (4) Using the KS-14510 volt-ohm-milliammeter, set on the 60V dc scale, test for interruptions at 2 seconds on and 4 seconds off (10 ipm) with test leads connected to +24V and terminal 9 of the BR1-, BR2-, or BR3- relay.

- (5) Transfer the load to the "0" side of the plant as outlined in 3.06 and repeat (4).

- (6) Depress the NOR key on the control panel. All lamps extinguish.

- (7) Transfer the load to the "1" side of the plant as outlined in 3.03.

#### 4.14 **Battery Distribution Fuse Alarm Check**

- (1) Verify that the "0" side of the plant is carrying the load. If it is not, transfer the load to the "0" side of the plant as outlined in 3.04.
- (2) Using the W1AF cord equipped with the 411C test pick and a connecting clip, connect the clip of the cord to +24 volts and then insert the test pick through the aperture in front of the fuse holder of fuses F1-F5 and F9-F13.

**Requirement:** The FA1 relay operates each time.

- (3) Remove the connecting clip of the W1AF cord from +24 volts and connect it to -48 volts and then insert the test pick through the aperture in front of the fuse holders of fuses F17-23, F25, F33-F41.

**Requirement:** The FA1 relay operates each time.

- (4) Remove the connecting clip of the W1AF cord from the -48 volts and connect it to +48 volts. Insert the test pick through the aperture in front of the fuse holders of fuses 49 and 51.

**Requirement:** The FA1 relay operates each time.

- (5) Depress the NOR key on the control panel. All lamps extinguish.
- (6) Transfer the load to the "1" side of the plant as outlined in 3.03.

#### 4.15 **Ringling Distribution Fuse Alarm Check**

- (1) Verify that the "0" side of the plant is carrying the load. If it is not, transfer the load to the "0" side of the plant as outlined in 3.04.

**Note:** After the following checks are completed, replace the blown fuses with original fuses.

- (2) Insert a blown fuse into one of the spare CODE 1 GEN BR1, CODE 1 GEN BR2, CODE 1 GEN BR3 fuse mounts.

**Requirement:** The FA4 relay operates, which operates the FA1 relay.

- (3) Insert the blown fuse into one of the spare ac-dc fuse mounts.

**Requirement:** The FA7 relay operates, which operates the FA1 relay.

- (4) Insert the blown fuse into one of the spare 104V  $\pm$  fuse mounts.

**Requirement:** The FA3 relay operates, which operates the FA1 relay.

- (5) \*Insert the blown fuse into one of the spare SUP+ fuse mounts.

**Requirement:** The FA8 relay operates, which operates the FA1 relay.

- (6) \*Insert the blown fuse into one of the spare SUP- fuse mounts.

**Requirement:** The FA2 relay operates, which operates the FA1 relay.

- (7) Insert the blown fuse into one of the spare SUP+ (97V) fuse mounts.

**Requirement:** The FA6 relay operates, which operates the FA1 relay.

- (8) \*Insert the blown fuse into one of the spare SUP- (97V) fuse mounts.

**Requirement:** The FA5 relay operates, which operates the FA1 relay.

- (9) \*Insert the blown fuse into one of the spare +TRP fuse mounts.

**Requirement:** The FA1 relay operates.

- (10) Insert the blown fuse into one of the spare -TRP fuse mounts.

**Requirement:** The FA1 relay operates.

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- (11) Remove the blown fuse and operate the NOR key on the control panel. All lamps extinguish.
- (12) Make sure all blown fuses are replaced with original fuses.
- (13) Transfer the load to the "1" side of the plant as described in 3.03.

**Note:** \*Indicates superimposed offices.

### 5. TROUBLES

**5.01** Trouble in the plant is normally detected by the system control of the ESS office. The outputs of low-voltage monitors are supplied to ferrod sensors in the master scanner to provide

signals for automatic transfer. There is no automatic transfer logic in the power plant, other than the automatic transfer feature of the emergency manual lines (see 1.04). Failure of an interrupter is also indicated by the system control. Failure of a dc input fuse or ringing-distribution fuse lights the PWR OFF lamp on the plant control panel and transmits a fuse alarm signal to the system control.

### Trouble Chart

**5.02** The possible causes of trouble in a unit and the action to be taken are given in the following chart. In addition to the action specified, check for loose or open connections or short circuits due to foreign matter lying across associated wiring terminals.

TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
(1) No ringing	No -48 volt input to dc-ac inverter (SD-81908-01)	Check for -48 volts at TB1 terminal 2 of inverter, P2 (INV0) or P3 (INV1) relay, contacts LA and L2B, fuse F17 (INV0) or F33 (INV1), fuse RTA (INV0) or RTD (INV1).
(2) No CODE 1 GEN BR1, BR2, or BR3	Defective mercury relay BR1-, BR2-, or BR3-	Use KS-14510 meter set on 60V dc scale and test for interruptions at 2 seconds on and 4 seconds off (10 IPM) with test leads connected to +24V and terminal 6 of the BR1-, BR2-, or BR3- relay (see SD-81737-01). Replace defective relay and reset.
	Defective gate in interrupter timing circuit	Use KS-14510 meter set on 60V dc scale and test for interruptions at 2 seconds on and 4 seconds off (10 IPM) with test leads connected to +24V and gates of G8-, G9-, or G10-. Replace defective circuit pack and retest.
	No 105± volt input to interrupter timing circuit	Use KS-14510 meter set on 300V ac scale and test for continuous ±105V with test leads connected to ground and terminal 27 of the Z1 network of CPA752.
(3) Low or no voltage of 105± volt supply	DC-AC inverter failure (SD-81908-01); see note	Verify that AT0 (RING G0), AT1 (RING G1), and AT2 (additional low-voltage monitor to emergency lines) relays are operated when NOR key is depressed. If AT0 relay is released, check output of INV0, TB2 terminal 5, or INV1, TB2 terminal 5 if AT1 relay is released. Check dc-ac inverter in accordance with 161-249-301.
	Low-voltage monitors out of adjustment	Verify that the G or H tone alarm checking relays are not operated. If voltage is within limits and one of the AT0, AT1, or AT2 relays is released, adjust in accordance with circuit requirement tables and Section 040-502-701.

*Note:* The 105± (EML) supply is derived from inverter INV0 regardless of which inverter has been selected by system control, unless there is a failure of INV0.

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TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
(3) Low or no voltage of 105± volt supply	No +24 volt supply to ferrod sensors of master scanner	Check fuses F1 and F9 and the RTC (INV0) and RTB (INV1) fuses at the power distribution frame.
	Defective diode board, DB0-0 or DB0-1 (open varistors)	Using a KS-14510 volt-ohm-milliammeter on the 60V dc scale, measure the output of CPA745 terminal 18 for -40 volts dc. Replace defective board and retest.
	AC power failure, PF0 and PF1 relays operated (low -48 volt input)	During ac power failure, when main -48 volt battery is on discharge, the PF0 and PF1 relays operate to short-out some of the varistors in the diode boards to hold the dc components between 36 to 40 volts.
(4) Low or no SUP- voltage (super-imposed offices)	Defective PF0 or PF1 circuit pack	Replace PF0 or PF1 (CPA746) circuit pack and check monitor as outlined in 4.08 and 4.09.
	Defective dc-to-ac inverter (SD-81908-01)	Check output of dc-to-ac inverter at TB2 terminal 8 for 86± volts and -48 volts. Check dc-to-ac inverter in accordance with 161-249-301.
	Defective dc-to-dc converter (SD-81571-01)	Using a KS-14510 volt-ohm-milliammeter on the 60V dc scale, connect the positive lead to fuses F49 and F51 in turn and the negative lead to ground. Output should indicate +48 volts dc. Check dc-to-dc converter in accordance with Section 167-684-304.
(5) Low or no SUP+ voltage (super-imposed offices)	Defective diode board DB1-0 or DB1-1 (open varistors)	Using a KS-14510 volt-ohm-milliammeter on the 60V dc scale, measure the output of CPA745 terminal 7 for +40 volts dc. Replace defective board and retest.
	Low-voltage monitor out of adjustment	Verify that the G or H tone-alarm checking relays are not operated. If voltage is within limits and the LV0 or LV1 relay is released, adjust in accordance with circuit requirement tables and Section 040-502-701.

TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
(5) Low or no SUP+ voltage (superimposed offices)	Defective dc-to-ac inverter (SD-81908-01)	Check output of dc-to-ac inverter at TB2 terminal 9 for $86\pm$ volts and +48 volts. Check dc-to-ac inverter in accordance with Section 161-249-301.
(6) Low or no AC-DC voltage	Defective dc-to-ac inverter (SD-81908-01)	Same output leads as SUP- supply; see (4).
(7) Low or no SUP- (97V) superimposed offices only	Defective dc-to-ac inverter (SD-81908-01)	Check output of dc-to-ac inverter at TB2 terminal 1 for $97V\pm$ volts and -48 volts. Check dc-to-ac inverter in accordance with Section 161-249-301.
(8) Low or no SUP+ (97V) superimposed offices only	Defective dc-to-ac inverter (SD-81908-01)	Check output of dc-to-ac inverter at TB2 terminal 3 for $97V\pm$ volts and +48 volts. Check dc-to-ac inverter in accordance with Section 161-249-301.
(9) Low or no TRP- voltage	Open or blown fuse	Check input fuses F18 and F34.
	Transfer relays not operated K00 or K10, Contacts 9	Operated from T0 or T1 relay under control of Pulse Distributor PD0 or PD1.
(10) Low or no TRP+ voltage	Open or blown fuse	Check input fuses F49 and F51.
	Transfer relays not operated K00 or K10, Contacts 11	Operated from T0 or T1 relay under control of Pulse Distributor PD0 or PD1.
	Defective dc-to-dc converter (SD-81571-01)	Check dc-to-dc converter in accordance with 167-684-304.
(11) Low or no Dial tone - TT	Defective 350- or 440-Hz oscillator (CPA747 and CPA748)	Test oscillators in accordance with 4.02; replace defective oscillator and retest.
	No -48 volt input to oscillators	Check fuses F21 and F37. Verify that P0 and P1 relays are operated.
	Defective TT- amplifier (CP264A)	Test amplifier in accordance with 4.04(a); replace defective amplifier and retest.
	No -48 volt input to amplifier	Check fuses F22 and F38.

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TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
(11) Low or no Dial tone — TT	Grounded T1- transformer (indicated by ground detection test in master scanner)	Check TT-T- and TT-R- leads from T1- transformer of generator in trouble, to TTT- and TTR- load resistors for false ground. ♦Using the H. P. 428B clip-on milliammeter, a false ground will be indicated by a dc current flow in excess of 3 ma.♦
(12) Low or no call-waiting tone — MT1	Defective 440-Hz oscillator ♦(CPA748)♦	Test oscillator in accordance with 4.02 or 4.03; replace defective oscillator and retest.
	No —48 volt input to oscillator	Check fuses F21 and F37. Verify that P0 and P1 relays are operated.
	Defective MT1- amplifier (CP264A)	Test amplifier in accordance with 4.04(b). Replace defective amplifier and retest.
	No —48 volt input to amplifier	Check fuses F22 and F38.
	Grounded T2- transformer (indicated by ground detection test in master scanner)	Check MT1-T- and MT1-R- leads from T2- transformer of generator in trouble to TTT- and TTR- load resistors for false ground. ♦Using the HP 428B clip-on milliammeter, a false ground will be indicated by a dc current flow in excess of 3 ma.♦
(13) Low or no audible ringing tone — AR	Defective 440- or 480- Hz oscillator (CPA748 and CPA749)	Test oscillators in accordance with 4.02 or 4.03. Replace defective oscillator and retest.
	No —48 volt input to oscillators	Check fuses F21 and F37. Verify that P0 and P1 relays are operated.
	Defective AR- amplifier (CP264A)	Test amplifier in accordance with 4.04(c). Replace defective amplifier and retest.
	No —48 volt input to amplifier	Check fuses F22 and F38.
	Grounded T3- transformer (indicated by ground detection test in master scanner)	Check AR-T-, AR-R- leads from T3- transformer of generator in trouble to AR1-, AR2-, and AR3- relay contact 3 and 5 and then to AR1T-, AR1R-, AR2T-, AR2R-, AR3T-, and AR3R- load resistors for false ground. ♦Using the HP 428B clip-on milliammeter, a false ground will be indicated by a dc current flow in excess of 3 ma.♦

TROUBLE CONDITION	PROBABLE CAUSE	REMEDY
(14) Low or no busy tone — BT	Defective 480- or 620- Hz oscillator (CPA749 and CPA750)	Test oscillators in accordance with 4.02 or 4.03. Replace defective oscillator and retest.
	No —48 volt input to oscillators	Check fuses F21 and F37. Verify that P0 and P1 relays are operated.
	Defective BT- amplifier (CP264A)	Test amplifiers in accordance with 4.04(d). Replace defective amplifier and retest.
	No —48 volt input to amplifiers	Check fuses F22 and F34.
(15) Low or no high tone — HT	Defective 480-Hz oscillator (CPA749)	Test oscillator in accordance with 4.02 or 4.03. Replace defective oscillator and retest.
	No —48 volt input to oscillator	Check fuses F21 and F37. Verify that P0 and P1 relays are operated.
	Defective HT- amplifier (CP264A)	Test amplifier in accordance with 4.04(e). Replace defective amplifier and retest.
	No —48 volt input to amplifier	Check fuses F22 and F34.
(16) Receiver-off-hook generator, low or no output voltage	Grounded T4- transformer (indicated by ground detection test in master scanner)	<p>Check BT-T-, BT-R- leads from T4 transformer to 60-00, 60-10, 120-00, and 120-10 relays, contacts 3 and 5, and then to BT1T-, BT1R-, BT2T-, BT2R-, BT3T-, and BT3R- load resistors for false ground.</p> <p>→ Using the HP 428B clip-on milliammeter, a false ground will be indicated by a dc current flow in excess of 3 ma. ←</p>
	No —48 volt input	Check that ROH NOR key is depressed. Check fuse F40.
	Component failure in generator	Check the pulse generator, oscillator, and amplifier as outlined in 4.06 and 4.07.

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<b>TROUBLE CONDITION</b>	<b>PROBABLE CAUSE</b>	<b>REMEDY</b>
(17) Interrupter fails to produce output tones or signals	No 105± volt input to interrupter timing circuit	Check dc-to-ac inverters TB2 terminal 5.
	No +24 volt input to interrupter timing circuit	Check fuses F2 and F10.
	Defective interrupter switches and follow relays	Substitute capsulated mercury relay after isolating relay in trouble.
	Defective circuit packs in interrupter timing circuit	Check output at gates G5-, G6-, G7-, G8-, G9-, and G10; then substitute associated circuit packs.