

TJ/TM-1 MICROWAVE RADIO SYSTEM TESTS—TELEPHONE WITH DIVERSITY COMPARATOR TESTS AND ADJUSTMENTS

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1. GENERAL

1.01 This section describes procedures for checking and adjusting the adapter and comparator circuits in diversity switch units per J68374A when used in TJ/TM-1 radio applications.

1.02 This section is reissued for the following reasons:

- (a) To correct the referenced voltage tests section
- (b) To give the procedures in individual chart format
- (c) To delete the bi-stable operation
- (d) To institute the preferential operation.

This reissue does not affect Equipment Test Lists.

2. TESTS AND ADJUSTMENTS

2.01 The diversity switch and transmission unit provides the equipment required to perform

diversity switching for a pair of radio channels. This unit incorporates a 124-ohm balanced baseband connection between one of two radio receivers and two radio transmitters, in parallel, of a diversity pair with a provision for switching from one receiver to the other. The comparator circuit compares the relative strength of the RF signal at each receiver and sends information to the logic circuit, causing a baseband switch to take place when the fading in the active receiver reaches a predetermined level. The comparator input on the TJ side is a dc voltage drop across a network in series with the +200 volt plate supply lead for the main IF amplifier. Due to AGC action, the voltage rises and falls as the receiver RF input fades and restores. On the TM-1 side, the comparator input is derived from the TM-1 AGC voltage which differs considerably from the voltage obtained from the TJ. To render the TM-1 AGC signal comparable to that of the TJ, an adapter circuit is provided between the TM-1 AGC source and the comparator. This is a dc amplifier circuit with three potentiometers which are adjusted to obtain the desired match between the two comparator input signals. The adapter circuit may be adjusted for revertive or ▶preferential◀ operation. In the revertive mode, the adapter is adjusted so that the baseband switch always reverts to the TJ for the active radio channel whenever the TJ received RF signal is near normal. ▶In the preferential mode, the adjustment is such that the comparator will prefer the channel with the stronger signal. Unlike the revertive mode, the preferential mode will retain the forced switch feature while still taking advantage of the noise performance of the better radio channel. It is recommended that the preferential method be used in all cases except those in which there is a decided advantage in the TJ system.▶

Caution: This equipment uses voltages which can be fatal. Safety precautions outlined in Section 010-110-001 must be followed while testing this equipment.

SECTION 409-241-506

2.02 Before proceeding with these tests, the following requirements **MUST** be met:

(b) TJ and TM-1 receiver outputs equalized per Section 409-241-505

(a) Voltage tests per Section 409-201-503

(c) Relays checked per Section 409-230-501.

CHART 1

ADAPTER-COMPARATOR CIRCUIT BALANCE AND COMPONENT CHECK

APPARATUS:

- 1—J68376B IF Test Set
- 2—J99262AA TL Test Sets or Codeco 26A Attenuators
- 1—KS-14510, List 1 or List 5 Volt-Ohm-Milliammeter (VOM)
- 1—KS-15750, List 1 Tube Tester
- 4—P2AW Test Cords

The following procedure checks the performance of electron tubes V1, V2, and V3 and Sensitrol relay C under normal and simulated received signal levels of approximately -40 and -60 dBm. In making these tests, an attenuator of the J99262AA TL test set (or Codeco 26A attenuator) is inserted in the IF path of each of the two diversity radio receivers, ahead of the automatic gain control, to provide the equivalent of RF signal fades. The adapter circuit potentiometers BAL 1, BAL 2, and CLP are adjusted to produce the desired comparator balance and switching performance. The tests and adjustments must be made when both radio receivers of a diversity pair are receiving normal microwave input power levels. When making test connections, caution must be used to ensure that the IF interconnecting cable of the ACTIVE receiver is *not* disconnected.

STEP	PROCEDURE
1	On the diversity switch and transmission unit, operate the LAMPS switch to ON and determine the ACTIVE receiver by the lamp indication.
2	Operate switch S1 to the ACTIVE receiver.
3	Operate the COMPARATOR switch from NORM to TEST. <i>Caution: In the following test, the voltage from jacks V1 and V2 to ground is hazardous. When measuring this voltage, DO NOT allow a meter test lead to come in contact with the diversity switch chassis while the other lead is connected to either jack V1 or V2.</i>

CHART 1 (Cont)	
STEP	PROCEDURE
4	<p>Arrange the VOM for dc measurement on the 3.0-volt scale and measure the voltage between test jacks V1 and V2 on the front panel.</p> <p>Requirement: 0 ± 0.2 volt.</p> <p>If this requirement cannot be met, check the 420A electron tubes of the comparator with the tube tester.</p> <p>Requirement: The transconductance of the 420A tubes must be within 300 micromhos of each other and each tube shall be not less than 900 micromhos.</p> <p>If this requirement cannot be met, replace either or both 420A electron tubes and repeat Steps 1 through 4.</p>
5	<p>Restore the COMPARATOR switch to NORM.</p>
6	<p>(a) Determine the normal received RF power for the TJ radio from the station log, and check that this is being received by observing the IF PLT CUR on the test meter on the meter panel. Record the actual reading for future reference.</p> <p>(b) Determine the normal received RF power for the TM-1 radio from the station log and check that this is being received by observing the RCVR AGC on the meter unit. (Connect this to the TST jack of the receiver control unit.) Record the actual reading for future reference.</p> <p>Note: To avoid hits in the active channel due to momentary IF attenuator openings, it is important to be aware, at each moment, of which radio receiver is active and which is passive, and which TL test set attenuator is associated with which receiver. To this end, it may prove helpful to use temporary markers of masking tape to identify the two "manual" positions of the S1 switch on the diversity drawer: "TM-1" for the "up" position, and "TJ" for the "down" position.</p>
7	<p>Force a switch to make TJ the active radio receiver by operating switch S1 to the TJ receiver position (down). Insert, as shown in Fig. 1, a TL test set attenuator in the IF path of the TM-1 receiver between the PREAMP OUT jack and IF IN jack of the receiver IF and baseband unit, using two P2AW cords. Temporarily remove all loss from this attenuator, and verify that the IF path loss is normal by observing that the RCVR AGC meter reading agrees with that obtained in Step 6(b).</p>

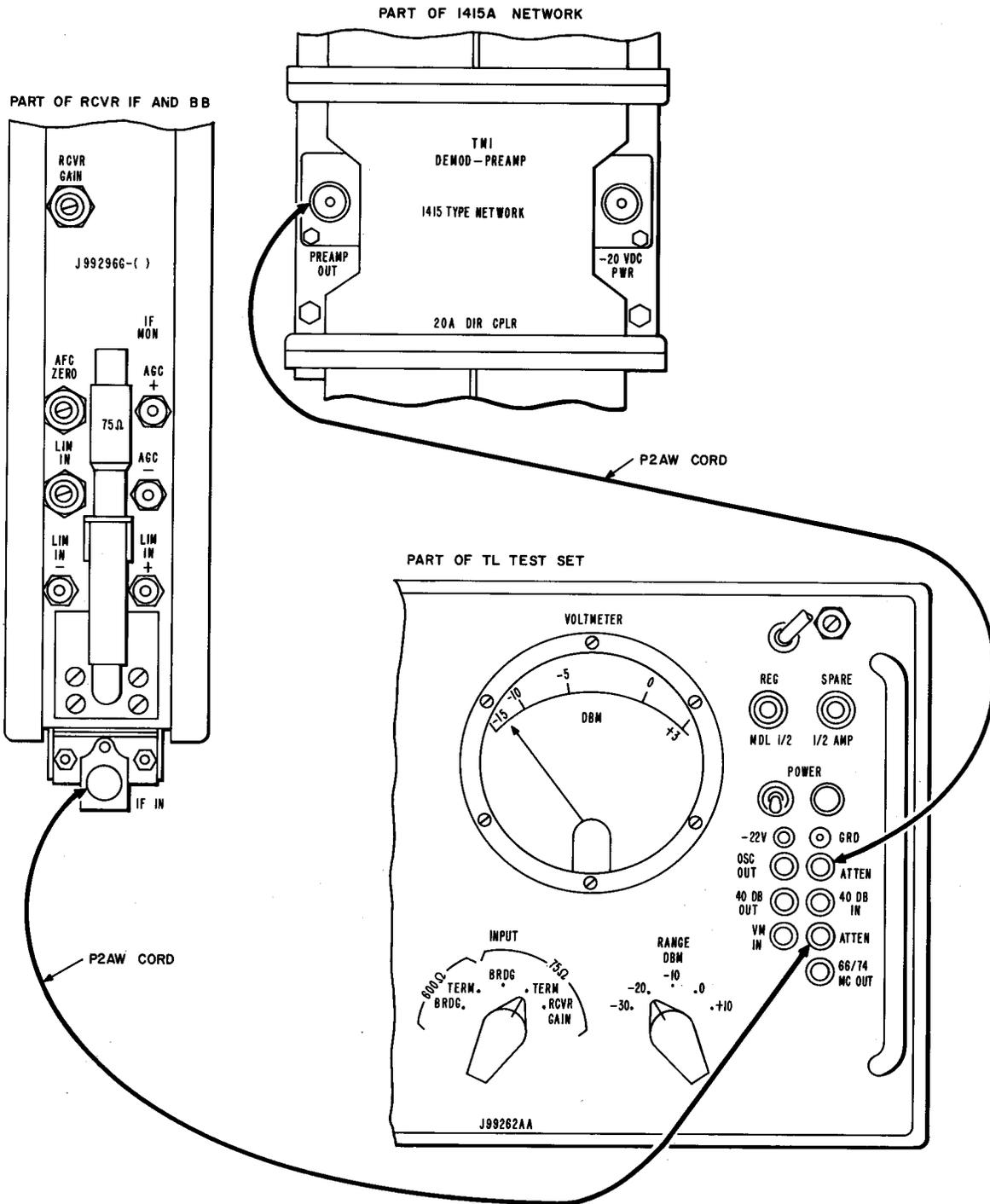


Fig. 1—Inserting Loss Pads in TM-1 IF Paths for Adjusting Diversity Switch Comparator and Adapter Circuits

CHART 1 (Cont)

STEP	PROCEDURE
8	Operate switch S1 to make TM-1 the active radio receiver by turning it to the TM-1 position (up), and insert the attenuator of another TL test set (as shown in Fig. 2) in the IF path of the TJ receiver between the IF preamplifier OUT jack and the IF main amplifier IN jack with two P2AW cords. Temporarily remove all loss from this attenuator and verify that the IF path loss is normal by observing that the TJ IF PLT CUR meter reading agrees with that obtained in Step 6(a).

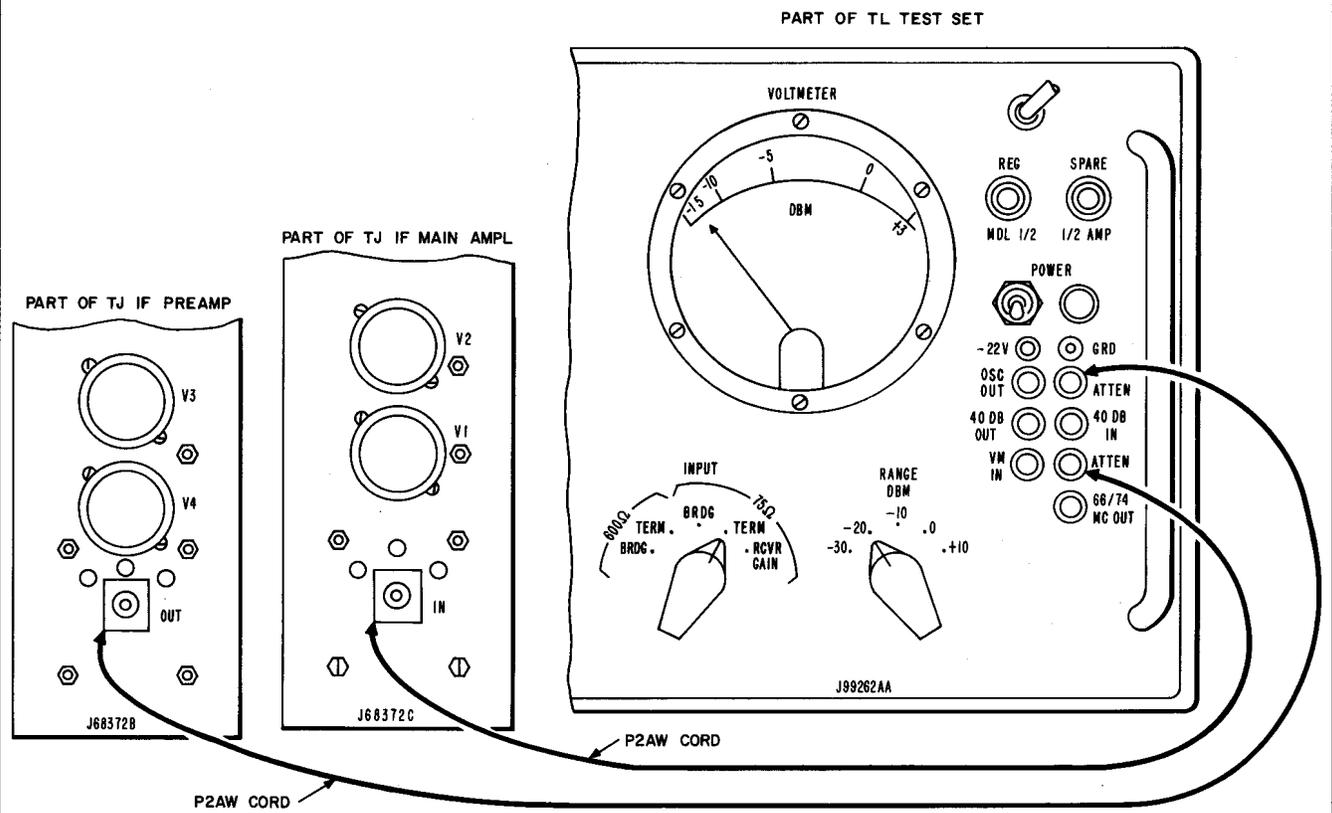


Fig. 2—Inserting Loss Pads in TJ IF Paths for Adjusting Diversity Switch Comparator and Adapter Circuits

9	Slide the diversity switch and transmission unit drawer under test forward sufficiently to furnish access to the adapter unit controls BAL 1, BAL 2, and CLP. (This unit is at the rear right-hand corner.) Turn the CLP potentiometer fully clockwise.
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CHART 1 (Cont)

STEP	PROCEDURE
10	<p>◆If the revertive operation is to be used and◆ the station log indicates that the normal TJ received RF power is stronger than -35 dBm, use the S1 switch to force a switch to TM-1, and add sufficient loss in the TL test set attenuator in the TJ IF path to provide the equivalent of -35 dBm. Then force a switch to TJ. Add this same amount of loss in the IF path of the TM-1 receiver as shown in Fig. 1 ◆and proceed to Step 12. For preferential operation, proceed to Step 11.◆</p> <p>Example: Suppose the station log indicates that the normal receiver input RF power for the TJ system is -28 dBm.</p> <p>Then the amount of loss to be added in both attenuators is $35 - 28 = 7$ dB.</p> <p>(If the normal TJ power is -35 dBm or weaker, no added loss is necessary at this point.)</p>
11	<p>◆If preferential operation is to be used, add sufficient attenuation in the TL test set connected to the system having the stronger received signal to make it equal the received signal of the weaker (refer to station log for signal levels). Record the attenuator setting.</p> <p>Requirement: The necessary attenuation should not exceed 10 dB.◆</p>
12	<p>Turn the SENS potentiometer on the front panel of the diversity drawer fully clockwise.</p> <p>Note: In the following procedure, it is desired to achieve a comparator balance as indicated by a voltage null (or zero) at the comparator test jacks V1 and V2 at each of two levels of IF power 20 dB apart. This involves a series of several adjustments of the adapter potentiometers BAL 1 and BAL 2 as the desired two-point null is approached. The number of steps will be minimized, and unnecessary hits in the active channel will be avoided by carefully following the procedure described.</p>
13	<p>With the VOM connected to pin jacks V1 and V2, adjust the adapter BAL 1 potentiometer to obtain a null ($0 \pm .05$ volt) as read on the 3-volt dc scale of the meter.</p>
14	<p>Use the S1 switch to force a switch to the TJ receiver and add 20 dB of loss in the TL test set attenuator in the TM-1 IF path.</p>
15	<p>Force a switch to the TM-1 receiver and add 20 dB of loss in the TL test set attenuator in the TJ IF path.</p>
16	<p>Observe the reading of the VOM connected to jacks V1 and V2. If this voltage is not $0 \pm .05$ volt dc, observe the polarity and adjust potentiometer BAL 2 to obtain a reading of approximately 2-1/2 times the reading observed, but of OPPOSITE polarity, and then adjust potentiometer BAL 1 for a null ($0 \pm .05$ volt).</p>
17	<p>Remove the 20-dB loss inserted in the TJ IF path in Step 15.</p>

CHART 1 (Cont)	
STEP	PROCEDURE
18	Force a switch to the TJ receiver and remove the 20-dB loss inserted in the TM-1 IF path in Step 14.
19	Again observe the reading of the VOM. The desired reading is a null ($0 \pm .05$ volt). If this value is not obtained, adjust to this value with the BAL 1 potentiometer.
20	Repeat Steps 14 through 19 as many times as necessary to meet the following requirement. Requirement: The voltage between pin jacks V1 and V2, as read on the 3-volt scale of the VOM, shall be $0 \pm .05$ volt with and without the added 20 dB in both IF attenuators without further adjustment of the adapter potentiometers. If this requirement cannot be met, replace any or all of tubes V1, V2, and V3 and repeat Steps 12 through 20.
21	If preferential operation of the baseband switch is specified, proceed as described in Chart 2. If revertive operation is specified, proceed to Chart 3, "Revertive Margin and Switching Differential."
CHART 2	
PREFERENTIAL SWITCHING DIFFERENTIAL	
APPARATUS:	
1—J68376B IF Test Set	
2—J99262AA TL Test Sets or Codeco 26A Attenuators	
1—KS-14510, List 1 or List 5 Volt-Ohm-Milliammeter (VOM)	
1—KS-15750, List 1 Tube Tester	
4—P2AW Test Cords	
<p>The following procedure is intended to determine whether the baseband switch will function to cause a switch from TJ to TM-1 (and vice versa) with suitable margin or "switching differential." It is extremely important that both receivers of the diversity pair are receiving normal microwave power, and that their baseband output signals have been equalized as described in Section 409-241-505. Equally important, these tests should not be performed during periods of fading. In making the tests, loss is inserted in the radio IF path by using the attenuator of a TL test set and is increased until the K1 relay operates or releases, indicating closure of the comparator C relay contacts C and L or C and H. During this part of the tests a switch is forced, by means of switch S1, so that</p>	

CHART 2 (Cont)

the passive receiver is the one with the added IF path loss. For switching purposes, inserting this attenuation is equivalent to fading the received RF signal by the same amount. The tests must be performed in the sequence outlined to avoid unnecessary hits in the active channel. It is assumed that the comparator balance adjustments covered by Steps 13 through 20, Chart 1, have been successfully carried out, and that TL test set attenuators have been inserted in both radio receiver IF paths per Steps 7 and 8, Chart 1.

STEP	PROCEDURE
1	Operate switch S1 to force a switch to the TJ radio receiver, and remove all loss from the TL test set attenuator in the TM-1 IF path.
2	Operate switch S1 to force a switch to the TM-1 receiver and remove all loss from the TL test set attenuator in the TJ IF path.
3	<p>Operate switch S1 to select the system with the <i>weaker</i> received signal (the unpadded system of Chart 1, Step 11).</p> <p>If the TM-1 signal is the weakest (this is the usual case), proceed to Step 4.</p> <p>If the TJ signal is the weakest (this will be the case when TMA-1 is used in conjunction with TM-1), proceed to Step 12.</p>
4	Check the position of relay K1 in the diversity switch drawer under test. If it is operated, release it by carefully pressing against the armature with an orange stick.
5	<p>Insert loss, in 1-dB steps, by means of the TL test set attenuator associated with the TJ IF path until relay K1 operates, indicating that the comparator C relay contacts C and L have closed. Because this operation may have been due to the momentary false opening of the attenuator switch contacts, it will be necessary to release relay K1 again manually, and observe whether it will reoperate with the same attenuator settings. If not, continue to increase the loss in 1-dB steps until the K1 relay re-operates, and repeat the manual release procedure. The TJ IF path loss in the TL test set attenuator at which relay K1 will just reoperate after manual release is the TJ switching differential.</p> <p>Requirement: The TJ switching differential shall be 12 to 20 dB <i>plus</i> the TJ attenuator setting of Chart 1, Step 11.</p> <p>If this requirement is not met, replace any or all of tubes V1, V2, and V3. Check the relays by referring to Sections 409-230-501 and 409-230-503. Perform any necessary relay adjustments, and repeat Steps 3 through 5.</p>
6	Restore the TL test set attenuation in the TJ IF path to zero dB loss, and verify that the IF path is normal by observing that the TJ IF PLT CUR meter reading is normal (compare with that obtained in Step 6(a), Chart 1).
7	Operate switch S1 to force a switch to the TJ receiver.

CHART 2 (Cont)	
STEP	PROCEDURE
8	Check the position of relay K1. If it is released, carefully operate it by pressing the armature against the core with an orange stick.
9	<p>Insert loss in the TM-1 IF path with the TL test set attenuator, in 1-dB steps until relay K1 releases, indicating that the comparator C relay contacts C and H have closed. Because this releasing may have been due to a momentary false opening of the attenuator contacts, it will be necessary to reoperate relay K1 manually, and observe whether it will release again with the same attenuator setting. If not, continue to increase the loss in 1-dB steps until the relay releases, and repeat the manual operate procedure. The TM-1 IF path loss in the TL test set attenuator for which relay K1 will just release after manual operate is the TM-1 switching differential.</p> <p>Requirement: The TM-1 switching differential shall be 12 to 20 dB <i>minus</i> the TJ attenuator setting of Chart 1, Step 11.</p> <p>If this requirement is not met, replace any or all of tubes V1, V2, and V3. Check the relays by referring to Sections 409-230-501 and 409-230-503. Perform any necessary relay adjustments, and repeat Steps 7 through 9.</p>
10	Restore the TL test set attenuation in the TM-1 IF path to zero dB loss, and verify that the IF path is normal by observing that the TM-1 RCVR AGC meter reading agrees with that obtained in Chart 1, Step 6(b).
11	Operate switch S1 to the AUTO position restoring the switch to normal operation, and slide the diversity switch drawer back into its normal position in the auxiliary bay.
12	Check the position of relay K1. If it is released, carefully operate it by pressing the armature against the core with an orange stick.
13	<p>Insert loss in the TM-1 IF path with the TL test set, in 1-dB steps, until relay K1 releases, indicating that the comparator C relay contacts C and H have closed. Because this releasing may have been due to a momentary false opening of the attenuator contacts, it will be necessary to reoperate relay K1 manually, and observe whether it will release again with the same attenuator setting. If not, continue to increase the loss in 1-dB steps until the relay releases, and repeat the manual operate procedure. The TM-1 IF path loss in the TL test set attenuator for which relay K1 will just release after manual operate is the TM-1 switching differential.</p> <p>Requirement: The TM-1 switching differential shall be 12 to 20 dB <i>plus</i> the TM-1 attenuator setting of Chart 1, Step 11.</p> <p>If this requirement is not met, replace any or all of tubes V1, V2, and V3. Check the relays by referring to Sections 409-230-501 and 409-230-503. Perform any necessary relay adjustments and repeat Steps 3, 12, and 13.</p>

CHART 2 (Cont)

STEP	PROCEDURE
14	Restore the TL test set attenuation in the TM-1 IF path to zero dB loss. Verify that the IF path is normal by observing that the TM-1 RCVR AGC meter reading agrees with that obtained in Chart 1, Step 6(b).
15	Operate switch S1 to force a switch to the TM-1 receiver.
16	Check the position of relay K1 in the diversity switch drawer under test. If it is operated, release it by carefully pressing against the armature with an orange stick.
17	<p>Insert loss in the TJ IF path with the TL test set attenuator, in 1-dB steps, until relay K1 operates, indicating that the comparator C relay contacts C and L have closed. Because this operation may have been due to the momentary false opening of the attenuator switch contacts, it will be necessary to release relay K1 again manually, and observe whether it will reoperate with the same attenuator settings. If not, continue to increase the loss in 1-dB steps until relay K1 reoperates, and repeat the manual release procedure. The TJ IF path loss in the TL test set attenuator at which relay K1 will just reoperate after manual release is the TJ switching differential.</p> <p>Requirement: The TJ switching differential shall be 12 to 20 dB <i>minus</i> the TM-1 attenuator setting of Chart 1, Step 11.</p>
18	If this requirement is not met, replace any or all of tubes V1, V2, and V3. Check the relays by referring to Sections 409-230-501 and 409-230-503. Perform any necessary relay adjustments, and repeat Steps 15 through 17.
19	Restore the TL test set attenuation in the TJ IF path to zero dB loss, and verify that the IF path is normal by observing that the TJ IF PLT CUR meter reading is normal (compare with that obtained in Step 6(a), Chart 1).
20	Operate switch S1 to the AUTO position, restoring the switch to normal operation, and slide the diversity switch drawer back into its normal position in the auxiliary bay.♦

CHART 3

REVERTIVE MARGIN AND SWITCHING DIFFERENTIAL

APPARATUS:

- 1—J68376B IF Test Set
- 2—J99262AA TL Test Sets or Codeco 26A Attenuators
- 1—KS-14510, List 1 or List 5 Volt-Ohm-Milliammeter (VOM)
- 1—KS-15750, List 1 Tube Tester
- 4—P2AW Test Cords

CHART 3 (Cont)

It is assumed in the following steps that the TL test set attenuators are inserted in the IF paths of the two radio receivers operating in diversity, that the procedures in Chart 1 have been carried out, and that the requirements have been met. Further, it is pointed out that adjustment for revertive action may not be possible at combinations of strong TJ RF received levels and weak TM-1 levels. This limitation is reflected in the note associated with Step 6 and the limits given in Table A.

STEP	PROCEDURE
1	If the TL test set attenuator in the TM-1 IF path is set at a value other than zero dB, force a switch to TJ, using the S1 switch, and reduce the TM-1 IF attenuator to zero.
2	Use the S1 switch to force a switch to TM-1, and set the attenuator in the TL test set in the TJ IF path to 2 dB. (This is to provide approximately 2 dB revertive margin.)
3	Check the position of relay K1. If it is released, manually operate it.
4	Carefully turn the CLP potentiometer on the adapter unit counterclockwise until the K1 relay just releases.
5	Increase the loss in the attenuator in the TJ IF path to 6 dB and manually reoperate relay K1. It should remain operated. If not, it indicates that the CLP potentiometer was turned too far counterclockwise in Step 4 and that Steps 2, 3, and 4 should be repeated more carefully.
6	Reduce the loss in the TJ IF path, 1 dB at a time, until relay K1 just releases. The attenuator setting at this point is the revertive margin.
	<p>Requirement: The revertive margin shall be 1 dB minimum; 4 dB maximum.</p>
	<p>Note: Adjustment for revertive action may not be possible when the normal TJ RF input is stronger than -35 dBm while the normal RF input of the TM-1 operating in diversity is weaker than -40 dBm.</p>
	<p>If this requirement is not met, repeat the procedure of Steps 1 through 6, exercising more care in the adjustment of the CLP potentiometer.</p>
	<p>If the requirement still is not met, replace any or all of tubes V1, V2, and V3. Then check the relays per Sections 409-230-501 and 409-230-503 (adjusting where necessary), and repeat Steps 1 through 6.</p>

CHART 3 (Cont)

STEP	PROCEDURE																												
7	<p>Set the TJ IF path loss at 6 dB, manually release relay K1, and continue to increase the loss in this attenuator in 1-dB steps until relay K1 operates, indicating closure of the comparator C relay contacts C and L. Because this operation may have been due to a momentary false opening of the attenuator contacts, it will be necessary to release relay K1 again manually, and observe whether it will reoperate with the same attenuator setting. If not, continue to increase the loss in 1-dB steps until relay K1 operates, and repeat the manual release procedure. The TJ IF path loss in the TL test set attenuator at which relay K1 will just operate after manual release is the TJ revertive switching differential.</p> <p>Requirement: The TJ revertive switching differential shall be as specified in Table A</p> <p>If this requirement is not met, replace any or all of tubes V1, V2, and V3. Then check the relays per Sections 409-230-501 and 409-230-503 (adjusting where necessary), and repeat Step 7.</p> <table border="1" data-bbox="235 892 1380 1543"> <thead> <tr> <th colspan="4" data-bbox="235 892 1380 945">TABLE A</th> </tr> <tr> <th colspan="4" data-bbox="235 945 1380 1008">Revertive — TJ Switching Differential</th> </tr> <tr> <th colspan="2" data-bbox="235 1008 893 1071">WHEN THE NORMAL RECEIVER INPUT RF POWER IS WITHIN THESE LIMITS:</th> <th colspan="2" data-bbox="893 1008 1380 1071">THE TJ SWITCHING DIFFERENTIAL SHALL BE:</th> </tr> <tr> <th data-bbox="235 1071 560 1123">TJ</th> <th data-bbox="560 1071 893 1123">TM-1</th> <th data-bbox="893 1071 1136 1123">MIN</th> <th data-bbox="1136 1071 1380 1123">MAX</th> </tr> </thead> <tbody> <tr> <td data-bbox="235 1123 560 1228">Between -25 dBm and -30 dBm</td> <td data-bbox="560 1123 893 1228">Between -35 dBm and -40 dBm</td> <td data-bbox="893 1123 1136 1228">21 dB</td> <td data-bbox="1136 1123 1380 1228">29 dB</td> </tr> <tr> <td data-bbox="235 1228 560 1396">Greater than -30 dBm but not greater than -35 dBm</td> <td data-bbox="560 1228 893 1396"></td> <td data-bbox="893 1228 1136 1396">19 dB</td> <td data-bbox="1136 1228 1380 1396">26 dB</td> </tr> <tr> <td data-bbox="235 1396 560 1543">Greater than -35 dBm but not greater than -50 dBm</td> <td data-bbox="560 1396 893 1543">Between -35 dBm and -50 dBm</td> <td data-bbox="893 1396 1136 1543">14 dB</td> <td data-bbox="1136 1396 1380 1543">23 dB</td> </tr> </tbody> </table>	TABLE A				Revertive — TJ Switching Differential				WHEN THE NORMAL RECEIVER INPUT RF POWER IS WITHIN THESE LIMITS:		THE TJ SWITCHING DIFFERENTIAL SHALL BE:		TJ	TM-1	MIN	MAX	Between -25 dBm and -30 dBm	Between -35 dBm and -40 dBm	21 dB	29 dB	Greater than -30 dBm but not greater than -35 dBm		19 dB	26 dB	Greater than -35 dBm but not greater than -50 dBm	Between -35 dBm and -50 dBm	14 dB	23 dB
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8	<p>With switch S1 still in the TM-1 position, remove the TL test set attenuator from the TJ radio IF path, and restore the P2AW cord previously removed from the TJ IF PREAMP IN jack. Verify that the IF path is normal by observing that the IF PLT CUR meter reading agrees with that obtained in Step 6(a), Chart 1.</p>																												

CHART 3 (Cont)	
STEP	PROCEDURE
9	Turn switch S1 to the TJ position, remove the TL test set attenuator from the TJ radio IF path, and restore the P2AW cord previously removed from between the TM-1 PREAMP OUT jack and the receiver IF and baseband IF IN jack. Verify that the IF path is normal by observing that the RCVR AGC reading on the meter unit (connected to the receiver control unit) agrees with the reading obtained in Step 6(b), Chart 1.
10	Turn switch S1 to the AUTO position, restoring the switch to normal operation, and slide the diversity switch drawer back into its normal position in the auxiliary bay.