OVER-THE-HORIZON RADIO SYSTEMS

ITTL 12A-1 OVER-THE-HORIZON RADIO SYSTEM

NUS 3298 RECEIVER

OPERATION AND MAINTENANCE

This section contains the procedures for placing the NUS 3298 receiver in and out of service while in either of the two modes of operation: dual diversity and quadruple diversity. In addition, this section contains receiver adjustment and maintenance procedures.

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APPARATUS:

1—KS-15658 Noise Figure Test Set

1—Kay Mega-Node Senior Noise Diode

1—568345 RF Sweep Oscillator

1—Oscilloscope, high impedance

APPARATUS (CONT):

1—Termination, 50 ohm

1—Signal Generator, GR10E1-AU

1—Power Supply, amplitude regulating GR1263-A

1—Hewlett-Packard Noise Source, 349A

1—Hewlett-Packard Noise Figure Meter, 342A

1—Hewlett-Packard Coaxial Termination, 908A

1—General Radio Co. Vacuum Tube Voltmeter, GR 1800-B (VTVM)

1—416B Tube Mount Shim, .006 in.

2—416B Tube Mount Shim, .012 in.

2—416B Tube Mount Shim, .015 in.

1—KS-14408 Tube Extractor

CHART 1

DUAL DIVERSITY OPERATION

This chart contains the procedures for placing dual diversity receivers in and out of service.

STEP	PROCEDURE
	Placing into Service
1	Set the DIVERSITY 2-4 switch to the 2 position.
2	Check that all fuses are inserted and all circuit breakers are operated on the dual diversity receiver.
3	Operate the FILAMENT switch to the ON position.
4	Operate the 117 Vac switch to the ON position.
	Note: At the beginning, the blower alarm light should be out. After a few seconds, the blower alarm light should operate indicating a proper supply of air.

CHART 1 (Cont)

STEP	PROCEDURE
5	Operate the HIGH VOLTAGE switch to ON position.
6	Operate the CONT switch to the AUTO position.
7	Set the meter switch to the 130V position (250 VFS). ***Requirement:*** The meter indicates 136 $\pm$2V.
8	Set the meter switch to the + BIAS (10 VFS) position on both receiver control units. ***Requirement:*** The meter indicates 7.5 $\pm$0.3V. ***Note:*** If the requirement is not met, adjust the BIAS potentiometer to obtain the specified indication. Perform this adjustment on both receiver control units if necessary.
9	On both receiver control units, check the crystal current at positions CR1 and CR2 (2.5 mA FS). ***Requirement:*** The average indication on each unit should be 1.0 mA. Indications should differ from each other by no more than 0.5 mA. ***Note:*** If the requirement is not met, refer to Chart 5.
10	Set both signal attenuators to zero.
11	Set the meter switch to the RCVR OUTPUT (2.5 VFS) position and adjust the AUTO control for an output of +9 dBm (approximately 1 volt).
12	Observe the RF ALARM relay. ***Requirement:*** The pointer should be in the center range. ***Note:*** If the requirement is not met, refer to Chart 6.
13	Push the PHASE LOCK ALARM RESET pushbutton switch.
14	Check the PHASE LOCK meter relays. ***Requirement:*** Neither of the relays make. ***Note:*** If either of the PHASE LOCK meter relays make, indicating an out-of-lock condition, and/or the dual combiner APC monitor is not at zero, refer to Chart 9.
15	Observe the IF OUTPUT alarm lamp. ***Requirement:*** The IF OUTPUT alarm lamp is lighted.

CHART 1 (Cont)

STEP	PROCEDURE
	Note: If the requirement is not met, no IF output or unequal IF outputs are indicated. Refer to Chart 8.
	Removal From Service
16	Set the HIGH VOLTAGE switch to the OFF position.
17	Set the FILAMENT switch to the OFF position.
18	Set the 117 Vac switch to the OFF position.

CHART 2

QUADRUPLE DIVERSITY OPERATION

This chart contains the procedures for placing quadruple diversity receivers in and out of service.

STEP	PROCEDURE
	Placing into Service
1	Set the DIVERSITY 2-4 switch to the 4 position.
2	Check that all fuses are inserted and all circuit breakers are operated on the dual diversity receiver.
3	Operate the FILAMENT switch to the ON position.
4	Operate the 117 Vac switch to the ON position.
	Note: At the beginning, the blower alarm light should be out. After a few seconds, the blower alarm light should operate indicating a proper supply of air.
5	Operate the HIGH VOLTAGE switch.
6	Operate the CONT switch to the AUTO position.
7	Set the meter switch to the 130V position (250 VFS).
	Requirement: The meter indicates 136 $\pm$2V.

CHART 2 (Cont)

STEP	PROCEDURE
8	Set the meter switch to the + BIAS (10 VFS) position on the receiver control units. ***Requirement:*** The meter indicates 7.5 $\pm$0.3V. ***Note:*** If the requirement is not met, adjust the BIAS potentiometer to obtain the specified indication. Perform this adjustment on all receiver control units if necessary.
9	On each receiver control unit, check the crystal current at positions CR1 and CR2 (2.5 mA FS). ***Requirement:*** The average indication on each unit should be 1.0 mA. Indications should differ from each other by no more than 0.5 mA. ***Note:*** If the requirement is not met, refer to Chart 5.
10	Set the signal attenuators to zero.
11	Set the meter switch to the RCVR OUTPUT (2.5 VFS) position and adjust the AUTO control for an output of +9 dBm (approximately 1 volt).
12	Observe the RF ALARM relay. ***Requirement:*** The pointer should be in the center range. ***Note:*** If the requirement is not met, refer to Chart 6.
13	Push the PHASE LOCK ALARM RESET pushbutton switch.
14	Check the PHASE LOCK meter relays. ***Requirement:*** Neither of the relays make. ***Note:*** If either of the PHASE LOCK meter relays make, indicating an out-of-lock condition, and/or the quadruple diversity APC monitor is not at zero, refer to Chart 9.
15	Observe the IF OUTPUT alarm lamp. ***Requirement:*** The IF OUTPUT alarm lamp is lighted. ***Note:*** If the requirement is not met, no IF output or unequal IF outputs are indicated. Refer to Chart 8.
	Removal From Service
16	Set the HIGH VOLTAGE switch to the OFF position.

CHART 2 (Cont)

STEP	PROCEDURE
17	Set the FILAMENT switch to the OFF position.
18	Set the 117 Vac switch to the OFF position.

CHART 3

PROCEDURE FOR CHANGING FROM DUAL DIVERSITY OPERATION TO QUADRUPLE DIVERSITY OPERATION

This chart contains the procedure for changing from the dual diversity mode of operation to the quadruple diversity mode of operation.

STEP	PROCEDURE
1	Set the A-B switch to the desired position.
2	Set the appropriate receiver control unit to AUTO.
3	Set the DIVERSITY 2-4 switch to the 4 position.
4	Observe the three APC monitors. ***Requirement:*** Each meter indicates zero. ***Note:*** If the requirement is not met, adjust the oscillators until the specified indication is obtained. Refer to Chart 8 for additional information.
5	Set the meter switch of the appropriate receiver control unit to RCVR OUTPUT (2.5 VFS).
6	Adjust the AUTO control for +9 dBm (approximately 1.0 volt).

CHART 4

PROCEDURE FOR CHANGING FROM QUADRUPLE DIVERSITY OPERATION TO DUAL DIVERSITY OPERATION

This chart contains the procedure for changing from the quadruple diversity mode of operation to the dual diversity mode of operation.

STEP	PROCEDURE
1	Set the appropriate receiver control units to AUTO.
2	Set the DIVERSITY 2-4 switch to the 2 position.
3	Set the meter switch of the appropriate receiver control unit to RCVR OUTPUT (2.5 VFS).
4	Adjust the AUTO control for +9 dBm (approximately 1.0 volt).
5	Observe the dual combiner APC monitors. ***Requirement:*** Each meter indicates zero. ***Note:*** If the requirement is not met, adjust the oscillators until the specified indication is obtained. Refer to Chart 8 for additional information.

CHART 5

LOCAL OSCILLATOR ADJUSTMENT AND MAINTENANCE PROCEDURES

The following procedure will provide local oscillator power at the proper level and frequency into the mixer. This test is made with the unit operating in the receiver. In addition, this chart describes the procedure for replacing a 3CX100A5 tube.

STEP	PROCEDURE
1	Turn OUTPUT POWER CONTROL R19 fully counterclockwise.
2	Set the DIVERSITY 2-4 switch to 2. Determine which AGC amplifier is used as shown by the A1-A2 or B1-B2 switches, depending on whether a local oscillator of RCVR A or RCVR B is being checked.

CHART 5 (Cont)

STEP	PROCEDURE
3	Set the control of the RCVR CONT UNIT of the corresponding AGC amplifier noted in Step 2 to MAN. Set the metering switch to MAN. Adjust the MAN control fully clockwise to remove signals to the combiner.
4	Set the metering switch to the RCVR OUTPUT position (2.5 VFS). ***Requirement:*** The meter indication should be zero. ***Note:*** This indicates that no signal enters the combiner; therefore, zero correction voltage is fed back to the oscillator. It may be necessary to remove cables from the input to both IF main amplifiers.
5	Set the metering switch to TST B.
6	Insert the test probe from the RCVR CONT UNIT above into TP2B.
7	Adjust L1 until a maximum meter indication is obtained. ***Note:*** Make certain that the tuning is not too near to the side of the resonance current where the oscillator stops.
8	Insert the probe into TP3B. Adjust C16 for a maximum indication. The rise here will be slight.
9	Insert the probe into TB4B. Adjust C18 for a maximum indication. Repeat Steps 8 and 9 with the probe at TP4B.
10	Insert the probe into TP5B. Adjust C21 for a maximum indication.
11	If the capacitors were far out of tune, repeat Steps 9 and 10.
12	Remove the probe.
13	Set the metering switch to CR1 (2.5 mA FS). ***Caution: In the following adjustments do not allow the meter indications to go beyond half scale. Be sure that the 6-dB pad is connected to the LO input to the mixer.***
14	Set the micrometer marked CAVITY TUNE, protruding from the tuned circuit of V4, to the appropriate setting in Table A. Adjust for a maximum indication not exceeding half scale. ***Note 1:*** If the peak cannot be reached because the indication is going too high, turn the LOOP ADJ back of the micrometer for a lower output. Then adjust the micrometer for a peak indication.

CHART 5 (Cont)

STEP	PROCEDURE

Note 2: If the indication is too low to find a peak, advance the R19 increments, retuning each time until a peak is obtained.

TABLE A

RCVR FREQ MHz	LOW FREQ MHz	Cavity Tune Approximate Micrometer Setting
692	622	300
740	670	350
840	910	575
880	950	600

15 Adjust R19 for an average of 1-mA crystal current for CR1 and CR2.

Note: If the crystal currents are unbalanced by more than 1/2 mA, remove crystals from the mixer and IF preamplifier. Take care that the crystals do not drop into the space behind the IF preamplifier. Select a pair of good crystals that will give a proper balance. Be sure to observe polarity of the crystals.

16 Return the control to AUTO.

17 Check the automatic phase control adjustments in Chart 9.

Output Tube 3CX100A5 Replacement

18 Remove the power connector from J3.

19 Remove the plate supply cable from J1.

20 Disconnect the air supply from the cover marked V4 3CX100A5.

21 Loosen the two screws holding the cover in place and remove the cover by a slight twisting action. Do not force the cable.

22 Grasp the cooling fins of the 3CX100A5 and remove the tube with a pulling-twisting motion.

23 Insert the new 3CX100A5 with a pushing-twisting motion until firmly seated.

24 Replace the cover taking care to place the cable in the slot and to center the cover so as not to short the capacitor plate. Tighten the screws.

CHART 5 (Cont)

STEP	PROCEDURE
25	Reconnect the air supply.
26	Reconnect the power supply cable to J1.
27	Reconnect the power connector to J3.
28	Retune the local oscillator. The later stages need only be retuned if the output tube was all that was wrong. See Steps 1 through 17.

CHART 6

RF AMPLIFIER ADJUSTMENT

The RF amplifier consists of a single-stage grounded-grid triode amplifier with an input matching network and a double-tuned output bandpass network. The following procedure checks the amplifier gain and the receiver noise figure. In addition, this chart contains the RF level alarm adjustments and the procedure to use in replacing the 416B tube in the amplifier.

STEP	PROCEDURE
	GAIN TEST
1	Arrange the test equipment as shown in Figure 1. Use option (W) *Note:* The noise source should be located close to the RF amplifier using the shortest possible connecting cable from the noise source output terminal.
2	On the 342A noise figure meter, set the controls to the indicated positions:

CONTROL	POSITION
INPUT (MC)	70
POWER	ON
METER FUNCTION	2 MA
NOISE SOURCE	GAS TUBE
NOISE FIGURE (rear)	AUTO

CHART 6 (Cont)

STEP	PROCEDURE

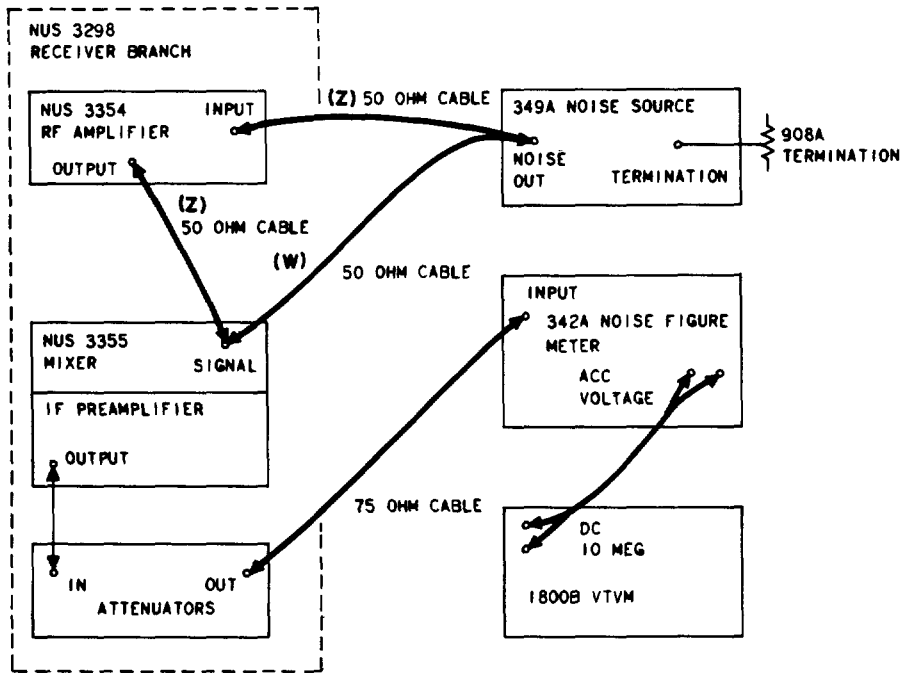


Fig. 1—RF Amplifier Gain and Receiver Noise Figure Measurements—Test Setup Diagram

3 On the 1800B VTVM, set the AC-DC switch to −DC and the VOLTAGE RANGE switch to 1.5.

4 Note the total value of the settings of the EQUAL ATTEN controls on the receiver chassis.

5 On the noise figure meter, adjust the CURRENT control to obtain a meter indication of 1.5 mA on the full-scale 2 mA range.

6 On the noise figure meter, operate the METER FUNCTION switch to CALIBRATION-ZERO and adjust the ZERO control to obtain a zero meter indication.

7 Operate the METER FUNCTION switch to CALIBRATION-INF and adjust the INF control to place the meter indication at INF.

8 Operate the METER FUNCTION switch to NOISE FIGURE.

9 Temporarily short the input terminals of the vacuum tube voltmeter and adjust the zero control to zero the meter. Remove the short and note the VTVM meter indication.

CHART 6 (Cont)

STEP	PROCEDURE
10	Insert the RF amplifier in the test circuit as shown in Figure 1, option (Z).
11	Adjust the receiver EQUAL ATTEN controls to obtain a VTVM indication closest possible to that noted in Step 9. ***Requirement:*** The gain of the RF amplifier, which is equal to the sum of the attenuator control settings, should be 12 dB or more. ***Note 1:*** If the requirement is not met, the RF amplifier tube V1 should be replaced as described in Chart 4, Section 403-413-503. ***Note 2:*** If the requirement is met, retain the test arrangement and continue this test to determine the receiver noise figure.
12	Restore the settings of the EQUAL ATTEN controls to the value noted in Step 4.
	RECEIVER NOISE FIGURE TEST
13	Verify that the test equipment is arranged as shown in Figure 1, option (Z) and that the test equipment controls are adjusted to the positions used at the conclusion of the RF amplifier gain test.
14	Note the figure meter indication on the GAS TUBE meter scale. Compute the overall noise figure of the RF amplifier, receiving mixer, and IF preamplifier by adding the constant 0.4 dB to the indicated noise figure value. ***Requirement:*** The receiver noise figure should be a value less than 9.5 dB. ***Note:*** If the requirement is not met, proceed to Step 15; if the requirement is met, proceed to Step 16.
15	Failure to meet the requirement in Step 14 can be due to any of a number of reasons, a defective RF amplifier tube being the most likely cause. Other possible causes of failure to meet the noise figure requirement are listed below: (a) Incorrect mixer crystal current adjustment. (b) Defective mixer crystals. (c) Improper RF amplifier alignment. (d) Defective RF amplifier components or connectors. (e) Environmental noise or interference. (Environmental noise or interference can affect the indicated noise figure but not the true receiver noise figure.)

CHART 6 (Cont)

STEP	PROCEDURE
16	Dismantle the test arrangement and restore the receiver to operating condition.
	RF Level Alarm Adjustment
	Note: This alarm indicates when the RF signal is too high or too low for the AGC amplifiers to handle. In addition, the alarm indicates a signal failure. A signal attenuator is provided on the RF panel to control RF level.
	Adjustment of Alarm Limits
17	Set the DIVERSITY 2-4 switch to 2.
18	Disconnect all IF main amplifier input cables.
19	Set the control of the appropriate RCVR CONT UNIT to MAN.
20	Set the meter to MAN BIAS (5 VFS).
21	Adjust the MAN bias for an indication of 1.9 volts (0.95 on lower scale).
22	Adjust the RF LEVEL SENSITIVITY on the left of the alarm and power distribution panel fully clockwise.
23	Adjust the RF LEVEL CENTERING potentiometer through the hole on the right of the alarm and power distribution panel for centering of the RF LEVEL meter relay pointer.
24	Adjust MAN to 1.3 volts (0.65 on lower scale).
25	Adjust the left potentiometer until the left contact RF LEVEL meter barely makes.
	Note: The RF LEVEL meter will now contact at 1.3 volts for low signals and at 2.5 volts for high signals. Experience will determine the best settings for Steps 23 and 25.
26	Reconnect IF main amplifier input cables.
27	Set the control to AUTO.
	Adjustment for High and Low Signals
28	Observe which contact of the RF LEVEL meter relay is making at the time of the alarm.
	Note: The left contact denotes low signal and the right one high signal.
29	Operate the BUZZER DISABLE switch.

CHART 6 (Cont)

STEP	PROCEDURE

30 Refer to Step 28 to determine if the signal is high or low.

(a) For a ***high*** signal, add identical attenuation with the signal attenuators to all four receivers on quadruple diversity or to both receivers on dual diversity.

(b) For ***low*** signal, remove identical attenuation from the signal attenuators until the RF LEVEL meter is in the normal range.

Caution: Do not change equal attenuator settings. Also, use as little attenuation as possible. For a normal signal, no attenuation is necessary, and if attenuation is required, readjust alarm limits.

RF Amplifier Tube 416B Replacement

31 On the receiver alarm and power distribution panel, operate the 2500 Vdc circuit breaker associated with the receiver under test to the OFF position.

32 Disconnect all cables and the air hose from the RF amplifier. Remove the amplifier assembly from the receiver.

33 Remove the amplifier assembly bottom cover to expose the tube socket. Note the position of the tube base locating pin (the pin with the largest diameter).

34 Carefully lift the tube socket from the tube base. Position the socket in a manner which permits use of the tube extractor at the tube base.

35 Grasp the tube base with the tube extractor. Turn the tube in a counterclockwise direction while holding the cathode ring until the tube is disengaged from the threaded mounting hole. Remove any shims which are found under the tube flange.

36 Insert the replacement tube through the cathode ring. While holding the cathode ring stationary, screw the tube into the threaded mounting hole until firmly seated.

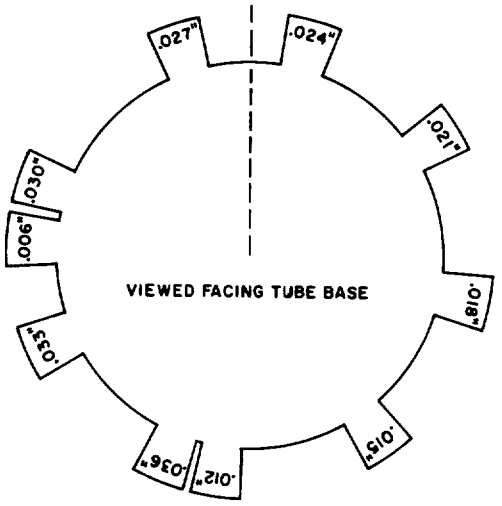
37 Note the position of the replacement tube locating pin in relation to the position noted for the locating pin on the tube which was removed. If necessary, remove and reinstall the new tube shims under the mounting flange to correct for misalignment of the locating pin. Figure 2 indicates the angular corrections which are obtainable using combinations of .006 inch, .012 inch, and .015 inch tube shims.

Note 1: The angular position of the tube when it is firmly seated should be such as to permit connecting the tube socket to the tube base without placing unreasonable strain on components.

Note 2: The shims provided cannot correct for all misalignment possibilities. Some tubes will be unsuited for use in the amplifier.

CHART 6 (Cont)

STEP	PROCEDURE



METHOD OF OBTAINING ANGULAR ALIGNMENT OF AMPLIFIER TUBE IN SOCKET

1. SEAT TUBE IN THREADED HOLE USING NO SHIMS.
2. NOTE ANGLE OF MISALIGNMENT BETWEEN TUBE LOCATING PIN AND TUBE SOCKET LOCATING PIN HOLE. FROM CHART, DETERMINE SHIMS NEEDED TO CORRECT MISALIGNMENT. THE SHIMS PROVIDED CANNOT CORRECT ALL POSSIBLE ERRORS; SOME TUBES ARE UNSUITED FOR USE IN THE AMPLIFIER.
3. REMOVE TUBE FROM MOUNTING HOLE. RE-INSTALL TUBE USING THE REQUIRED SHIMS UNDER THE MOUNTING FLANGE.

Fig. 2—Tube Mounting Angular Alignment Correction Possibilities Using Flange Shims

38 Connect the socket to the tube base.

39 Replace the bottom cover on the amplifier assembly and mount the amplifier in the receiver.

40 Connect the air hose and cables.

41 On the alarm and power distribution panel, operate the 250 Vdc circuit breaker associated with the receiver branch under test to the ON position.

42 Align the RF amplifier as described in Chart 2, Section 403-413-503.

CHART 7

RECEIVER NOISE FIGURE MEASUREMENT

This chart contains the procedure to determine the receiver noise figure.

The receiver must meet its gain frequency characteristics and gain requirements before this procedure is used.

CHART 7 (Cont)

STEP	PROCEDURE
1	Connect the test equipment as shown in Fig. 3.
2	The input of the RF amplifier must be disconnected from the RF filter and connected by means of a short cable of known loss to the mega-node senior noise diode. Record the cable loss. The signal attenuator, equalizing attenuator, and the delay equalizer should be

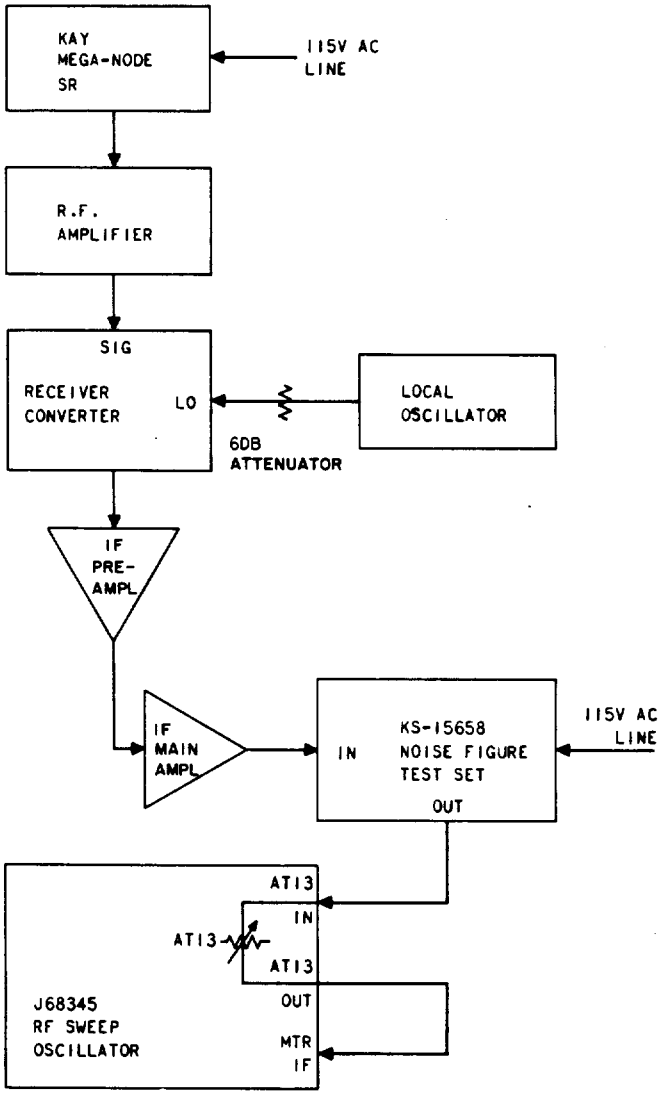


Fig. 3—Receiver Noise Figure Test—Test Setup Diagram

CHART 7 (Cont)

STEP	PROCEDURE

removed from the circuit by a direct patch from the IF preamplifier output to the IF main amplifier input.

3 See that the OSCILLATOR switch on the RF sweep oscillator in the test set is turned off.

4 Set the DIVERSITY 2-4 switch to 2. Operate the CONT switch of the appropriate receiver control unit to MAN, and operate the MAN gain control to the clockwise limit for minimum gain.

5 With the equipment set up as shown in Fig. 3, set AT13 to 3 dB. Turn the LEVEL control of the mega-node senior noise diode fully counterclockwise. Operate the POWER switch.

6 Operate the MTR switch on the RF sweep oscillator panel to IF DBM. Adjust the MAN gain control for a power meter indication as close to 0 dBm as possible.

Note: Record this power meter indication.

7 Increase the attenuation of AT13 by 3 dB.

Caution 1: Do not allow the noise diode current to exceed full scale deflection.

Caution 2: Make the test as short as possible in order to preserve the life of the diode.

Note: The OUTPUT CUT-OFF can be used to turn off the diode current temporarily.

8 Push the OPERATE button on the mega-node senior noise diode. Then advance the LEVEL control clockwise until the power meter indication is identical to the indication recorded in Step 6. Read the noise figure directly from the calibrated scale.

9 Using the center frequency of the receiver under test, determine the correction factor from the scale on the noise set.

10 Apply the correction of Steps 9 and 2 to the indication of Step 8 to determine the true noise figure.

Requirement: The noise figure shall be less than 9.5 dB.

CHART 8

AUTOMATIC GAIN CONTROL ADJUSTMENT

In order to realize the improvement that diversity operation can provide, the AGC of the receivers must be properly matched and adjusted. The following procedure provides for proper matching and the proper operating range for the automatic gain control. The gain frequency and gains of the receiving components must be proper.

STEP	PROCEDURE
1	Set the DIVERSITY 2-4 switch to 4.
2	Disconnect the inputs of the RF amplifiers and connect a 50-ohm load to each input.
3	Locate the SLOPE ADJ potentiometer above connector J2 on the front of the rear panel of the receiver control unit. Turn the potentiometers on all four units fully counterclockwise.
4	Set the signal attenuators and equalizing attenuators to zero.
5	Disconnect the input cables from all IF main amplifier inputs.
6	Set the control to MAN on the appropriate receive control unit.
7	Adjust the MAN control for 0 volt bias (fully counterclockwise).
8	Set the appropriate metering switch to RCVR OUTPUT (2.5 VFS).
9	Reconnect the cables to the inputs of the IF main amplifiers one at a time. Determine the receiver with the lowest gain and note the level.
10	One at a time, adjust the equalizing attenuators of the three higher gain receivers until the same output is obtained as the weakest in Step 9. Check that the equalizing attenuator of the lowest gain receiver is always set to zero. If more than 8 dB is required for any receiver, check all gains.
11	Remove 50-ohm loads from the RF amplifier inputs and reconnect the IF main amplifier inputs.
12	Adjust the MAN control for maximum bias (fully clockwise).
13	Insert a normal signal into one receiver.

RECEIVER	NORMAL SIGNAL LEVEL
692 and 740 MHz	−46 dBm
840 and 880 MHz	−44 dBm

CHART 8 (Cont)

STEP	PROCEDURE
14	Adjust the MAN control to give about 1/2 volt on the RCVR output (2.5 VFS). Now insert the nominal signal into each receiver, one at a time. Determine the receiver with the **highest** gain. Set the output of this receiver by means of the MAN control to give an output of 3 dBm out of the quadruple combiner as shown by the meter monitoring RCVR output (approximately 0.5 volt).
15	Without changing the MAN bias control, adjust the SLOPE ADJ potentiometers of the three lower gain receivers until the same output as the strongest in Step 14 is obtained. Check that at least one SLOPE ADJ potentiometer is always set to zero.
16	Set the appropriate receive control unit control to AUTO. Adjust AUTO to give an output of +9 dBm (approximately 1.0 volt) as shown by the indication at the RCVR output (2.5 VFS).
17	Perform Step 16 for the remaining three RCVR control units. The A-B, A_1-A_2, and B_1-B_2 switches are operated to select the desired amplifiers.
18	Set the switches on the switching panel to the desired combination and restore to service by reconnecting all RF amplifier cables.

CHART 9

AUTOMATIC PHASE CONTROL ADJUSTMENT

This chart contains adjustments that will provide properly phased signals into each of the three combiners suitable for proper combining. It is assumed that all local oscillators are adjusted and the automatic gain control adjustments have been made.

STEP	PROCEDURE
1	Check that the signal input level is normal for each receiver.

RECEIVER	NORMAL SIGNAL LEVEL
692 and 740 MHz	−46 dBm
840 and 880 MHz	−44 dBm

CHART 9 (Cont)

STEP	PROCEDURE
	Dual Diversity Phase Control Adjustment
2	Set the DIVERSITY 2-4 switch to 2.
3	Set the control of the appropriate RCVR control unit to AUTO.
4	Monitor the RCVR OUTPUT position (2.5 VFS). Set the signal output to be +9 dBm (approximately 1.0 volt).
5	Check the PHASE LOCK ALARM light. If the light is off, push the PHASE LOCK ALARM RESET. If the light fails to remain on, check the PHASE LOCK ALARM RELAY to determine that the relay is making. If the relay is made, the signals are out of lock.
	Caution: Note the direction and amount of rotation on the following adjustment.
6	Turn the tuning screw of L1 on a local oscillator until the dual combiner APC monitor shows a reversing action. Set to zero and note amount of rotation. Turn this L1 one-half way back to the original setting.
	Note: If the lock is far off, which it may be when initially setting up, monitor pin 2 to ground of JCT TB on the IF main amplifier panel with a high-impedance oscilloscope. The oscilloscope will monitor the beat frequency and assist in approaching zero beat when out of lock.
7	Turn L1 of the other local oscillator until a phase lock is indicated by the reversing action of the dual diversity APC monitor. Adjust L1 for a zero centering on the meter.
8	Push the PHASE LOCK ALARM RESET.
	Quadruple Diversity Phase Control Adjustment
9	Perform the dual diversity phase control adjustments on RCVR A and RCVR B that are contained in Steps 1 through 8.
10	Set the DIVERSITY 2-4 switch to 4.
11	Monitor the RCVR OUTPUT on the appropriate receiver control unit. The signal output should be approximately 1 volt for +9 dBm.
12	Check the PHASE LOCK ALARM light on RCVR A. If the light is off, push the PHASE LOCK ALARM RESET. If the light fails to stay on, check the COMBINER C PHASE LOCK alarm relay for the quadruple combiner to determine that the relay is making. If the relay is making, the signals are out of lock.

CHART 9 (Cont)

STEP	PROCEDURE
13	With a high-impedance oscilloscope, monitor pin 11 of TB1 or TB3 to ground for the A-B switch in position A or B, respectively. A 75-ohm monitor detector may be plugged into AB of the left WE223B coaxial relay. ***Note:*** The oscilloscope will monitor the beat frequency and assist in reaching a zero beat when out of lock.
14	Remove the cables from the input of the right-hand IF main amplifier on each receiver. ***Caution: Note the direction and amount of rotation on the following adjustment.***
15	Turn the tuning screw of L1 on one of the upper oscillators of RCVR A or RCVR B until the quadruple diversity APC monitor shows a reversing action. Set to zero and note the amount of rotation. Turn this L1 one-half way back to the original setting.
16	Set the DIVERSITY 2-4 switch to 2.
17	Slightly adjust the tuning screws of the L1's on the lower oscillators until the dual combiner APC monitors are set to zero.
18	Set the DIVERSITY 2-4 switch to 4.
19	Slightly turn all L1's until zero is obtained on all three APC monitors, distributing the adjustments of the L1's as equally as possible.
20	Push the PHASE LOCK ALARM RESET.
21	Return to service.

CHART 10

FILTER ASSEMBLY ADJUSTMENT

This chart contains the filter assembly adjustment procedures. This procedure is not intended to be a field adjustment. The method is described in sufficient detail to enable the skilled individual to make the adjustments. Ordinarily, in the absence of physical damage or some other disaster, the filter assembly should require no adjustment, providing the micrometers are set and locked to the settings supplied with the filters. Also, it should be noted that the filters ***cannot*** be adjusted for maximum signal by simply adjusting each micrometer for maximum signal. A severely distorted bandpass response will result.

CHART 10 (Cont)

STEP	PROCEDURE

Adjustment of Micrometers

1 Check the settings in the filter assembly tuning table against the actual settings.

Note: The filter assemblies are numbered on the diplexer and the filter numbers appear on the filters and the chassis mounting. The input filter element is called A, the center B, and the output C. See Table B.

TABLE B

FILTER ASSEMBLY TUNING TABLE

Filter Assy and Diplexer No.	Frequency	Filter No.	Micrometer Setting		
			A	B	C
1	692	1	317	400	310
1	740	3	290	401	298
2	692	2	315	405	304
2	740	4	306	382	300
3	840	5	278	352	278
3	880	7	308	349	308
4	840	6	281	346	281
4	880	8	323	369	323

2 If any indications disagree, loosen the lock screws and make the correct settings.

3 Tighten all lock screws. The assembly is ready for service.

Adjustment of the Complete Assembly

Caution: The following procedure is not intended to be a field adjustment and should be performed only by an engineer or technician skilled in slotted line techniques. Do not adjust the filters unless it is absolutely certain that they are defective. Read the whole filter adjustment section before starting.

CHART 10 (Cont)

STEP	PROCEDURE

Method of Individual Q Adjustment

4 Q here denotes the doubly-loaded Q and is measured on each cavity looking for the frequencies which give Y_0 ($1 \pm j2$). Q is then f_0/f_2-f_1 where:

f_0 = resonant frequency

f_1 = low frequency 3-dB point

f_2 = high frequency 3-dB point

5 The desired Q's and the approximate heights of the tops of the tape above the shorted end of the cavity are tabulated in Table C.

TABLE C

f MHz	A		B		C	
	Q	HGT in	Q	HGT in	Q	HGT in
692	9.4	.776	18.7	.547	9.4	.776
740	9.6	.710	19.3	.504	9.6	.710
840	10.7	.595	21.4	.417	10.7	.595
880	11.4	.551	22.8	.415	11.8	.551

Note: The tap heights must be measured with an accurate depth gauge from the open end of the cavity. The 8-flange screws of the cavity are slightly loosened. The whole cavity is moved until the proper dimensions are obtained. Be sure that the taps are not skewed by checking heights near the inner conductor and outer conductor on both taps. Use the type N connector on the unused filter for measurement. Adjust the tuning micrometer until a minimum VSWR is obtained on the slotted line. This should be less than 1.05 VSWR. If this cannot be obtained, the taps are probably skewed. Look for the frequencies at which the VSWR is 5.83 ($1 \pm j2$ points). Determine Q and readjust if necessary until the proper Q is obtained. Record the heights of the taps and micrometer settings.

6 Connect the filters together with short interconnecting lines and adjust to previous settings. Use a type N connector on the cavities A and C. Use a good load (VSWR less than 1.05) on the output of C and measure VSWR at A. The center of VSWR should be less than

CHART 10 (Cont)

STEP	PROCEDURE

1.1, preferably 1.06 or less. The 0.1 dB points are noted by a 1.36 VSWR. The following equation gives any desired point for the reflection loss:

$$L = \frac{(S + 1)^2}{4S}$$

where: L = power loss ratio (for dB use 10 log L)

S = VSWR

Note: The VSWR should continue to increase from the center frequency to beyond the 3-dB point. Otherwise, a ripple in the response would indicate an overcoupled response. The 0.1-dB bandwidth should be 14-20 MHz wide and the 3-dB bandwidth should be about 35 to 40 MHz. The design bandwidths are 20 MHz and 38 MHz for the 0.1-dB and 3-dB points, respectively.

7 Measure the input impedance into the filter at the other receiver frequency. From this measurement, determine the mechanical length of the diplexer line to make this filter appear as an open circuit at the center of the T junction, taking into account the location of the short, the Teflon beads in the input connector on the filter, and the Telfon bead or beads in the diplexer. No change in electrical length of diplexer arm should be necessary.

8 After both filters are checked, connect to the diplexer. Connect a matched load on each output. The VSWR at the center frequency of each filter should be less than 1.1. ***Slight*** adjustment of the center cavity of each filter should bring the VSWR down to less than 1.1 if it is a little larger. Measure the 0.1-dB bandwidth using the technique of Step 6.

Requirement: 0.1-dB bandwidth shall be between 14 and 20 MHz with no ripple.

9 Perform insertion loss checks on each filter. See Table D. Be sure that well-matched attenuators (VSWR 1.05 or less) are used on each side of where the filter is inserted for losses less than 3 dB. Attenuators of 1.5 VSWR will be satisfactory for off band insertion loss. In the high loss region, the pads may be left out, provided the detector has a VSWR less than 1.5 or is tuned with a stub tuner at each frequency, and the generator is within the 1.5 VSWR. Record all settings.

Requirement: 3-dB bandwidth, 35-40 MHz

CHART 10 (Cont)

STEP	PROCEDURE

TABLE D

ATTENUATION CHART

Filter f MHz	692 MHz dB	740 MHz dB	840 MHz dB	880 MHz dB
692	< 1/2	> 20	> 50	> 55
740	> 20	< 1/2	> 45	> 50
840	> 50	> 45	< 1/2	> 20
880	> 55	> 50	> 20	< 1/2

Alternate Tuning Procedure

10 If it is felt that the mechanical adjustments are approximately correct, the filter may be tuned by placing a resistor card with a resistance anywhere from 25 to 100 ohms per square 1-3/4 inches by 4 inches long inside the center cavity so as to load this cavity and give more than 20-dB attenuation. The pads on the generator side and the detector side of the filter must be less than 1.05 VSWR.

11 Tune the end cavities for the maximum output to a detector. Remove the resistor card. Tune the center cavity for maximum. Repeat this procedure several times. It will be necessary to carefully average the micrometer settings for the responses 0.1 dB or so down from the maximum so as to get the position of the maximum accurately.

12 Perform Steps 6 through 9.

13 If the 0.1-dB bandwidth is too narrow, lower the tap points of the end cavities a few thousandths. This will raise the end cavity Q's. If the 0.1-dB bandwidth is too wide, do the opposite. If the 3-dB points are improper, adjust Q up if too wide (lower tap point) and vice versa if too narrow. These will not affect each other for small changes (few thousandths).

14 Repeat Steps 10 through 13.