TD-3 MICROWAVE RADIO
ANTENNA ARRANGEMENTS
GENERAL
WAVEGUIDE-ANTENNA SYSTEM RESTORATION

This section describes a method of temporarily duplexing transmitters and receivers on the same antenna in a radio station, where separate receiving and transmitting antennas are normally used. Radio systems may be duplexed either on the receiving or transmitting antenna. This section is reissued to add a warning to Chart 1 relative to insertion of pads in the waveguide, to make a correction to Charts 2 and 4 and Fig. 3, and to add additional information to Chart 3.

These procedures may be used to temporarily restore or maintain service on TD-3 microwave radio when it is necessary to make repairs on a waveguide or an antenna system that impairs or interrupts transmission. These methods may also be used for any planned release of an antenna system. However, this arrangement should not be used as a restoration method for long-term usage. Other types of microwave radio systems may use the same antenna. If so, arrangements must be made for the other systems prior to performing any work on the antenna system in order to prevent service interruptions.

When transmitting and receiving on the same antenna, the output power of the duplexed transmitters is reduced by 10 dB to reduce adjacent channel interference in the duplexed receivers. The power received in the duplexed receivers will be reduced by up to 8 dB due to the loss from interconnecting cables and networks. The reduction in power in both directions will cause an increase in system noise and reduce system reliability.

Video channels may be degraded due to adjacent channel interference causing somewhat higher than normal high-frequency noise. This might be seen on television operating center monitors, but should not affect service.

Because of the significant reduction in fade margins, it is important that this work be scheduled when fading is at a minimum and that all protection channels be available while operating on one antenna.

Caution: An RF radiation hazard may exist during the hot patching of waveguide. See Sections 010-150-001 and 010-150-002.

CHART **PAGE**

CHART 1

PREPARATION FOR PROCEDURES

Equipment arrangements may vary from station to station. Therefore, the procedures described in this section are of a general nature. It is recommended that detailed procedures be developed for the particular station where the one-antenna operation will be used.

The one-antenna operation consists of duplexing both transmitting and receiving systems on the same antenna. This is done by connecting the receivers to the last channel combining networks in the transmitter bay lineup through some filter networks (Fig. 3). This connection is made for transmitters and receivers operating on the same polarization. The added filter networks consist of band reject filters, which attenuate the transmitters signals operating 40 MHz away on the same polarization as the receivers, and terminated bandpass filters, which absorb the opposite polarization transmitters 20 MHz away. The added filter networks are always required for one-antenna duplex operation using the procedures in this practice.

STEP	PROCEDURE
	Warning: If a hot patch is to be made on the receiver antenna, care must be exercised to bypass any pads in the receiver waveguide run since they will attenuate the transmitter signals and could be damaged by the duplexed transmitter power. These pads are usually installed in short hops.
1	As a part of the detailed procedure, the waveguide runs should be visually checked and marked as to the direction of transmission and polarization. Appropriate locations should be selected where the hot patches can be made, and these locations marked. These hot patches can be made only where flexible waveguide mates with a rigid waveguide section. The hot patch is performed by sliding the flexible waveguide section away from the rigid section and at the same time sliding in a waveguide transducer (Fig. 9). Note that the flexible waveguide is on the antenna side.
	Caution: An RF radiation hazard may exist during these hot patches. See Sections 010-150-001 and 010-150-002.

CHART 1 (Cont)

STEP	PROCEDURE
2	In order to make these hot patches, the flexible waveguide must be readily movable and ample clearance must be available to slide out the flexible waveguide and simultaneously slide in the transducer. This may require rearrangement of the waveguide supports and the support structure.
3	The waveguide flange types should be checked at the locations selected for the hot patch. A verification should be made that these flanges will mate with the transducers to be used and that fastening devices (screws and nuts) are available.
4	As a part of the detailed procedure, a verification should be made that all cords, tools, and other equipment are readily available. These shall be located in a convenient place readily accessible to the personnel performing the procedures. All cords and connectors should be checked for ample length and proper mating connectors. The ED-52011-30 microwave filters which will be used in making the connections from the receivers to the transmitting antenna should be checked for proper filter frequencies. The frequencies stamped on the filter containers shall not be relied upon, but the cases opened and the stamping of each filter checked. Refer to Fig. 6 for the filters required. These filters may be supported by the overhead framework with the straps provided. A suggested location is in the aisle between TD-3 lineups midway between the first and last bay of the lineup. ***Note:*** The frequencies of the band-reject filter shall be the same frequencies as the transmitters operating on the antenna polarization being connected. The bandpass filter frequencies shall be the same frequencies as the transmitters on the opposite polarity. If a TD auxiliary channel receiver is operating on the antenna, a band-reject filter for the auxiliary channel transmitter frequency is required. (See Fig. 6.)

CHART 2

TRANSMITTING ANTENNA COUPLING MEASUREMENT

The coupling loss between the horizontal and vertical polarizations of the system combining networks should be measured when both antenna polarizations are used. This coupling loss will determine the magnitude of the adjacent channel interference which will be present while operating on the transmitting antenna. Service must be removed from any receiver which will be subjected to excessive interference.

APPARATUS:

1—J68392A or J68428A Transmitter-Receiver Test Set

1—ED-52011-30, Group 9 and 10 Antenna Duplexing Equipment

CHART 2 (Cont)

APPARATUS(Cont):

1—Microwave Receiver, Polarad Model R or TR

STEP	PROCEDURE
1	The test set must first be checked to ensure proper operation for the RF-to-RF mode of operation. Refer to Section 104-415-000 for the J68392A or Section 104-417-000 for the J68428A.
2	Operate the test set controls to the following positions:

CHART 2 (Cont)

STEP	PROCEDURE

J68392A Test Set

UNIT	CONTROL	POSITION
Power Meter	INPUT CHANNEL	RF
RF Sweep Oscillator (KS-19974 Alfred)	LINE FUNCTION-SWEEP SELECTOR MARKER AMPL ΔF	RF CW Max CCW 20
RF Sweep Oscillator (KS-19974 Hewlett-Packard)	LINE SWEEP SELECTOR FUNCTION ALC MARKER AMPL STOP/ΔF	RF CW ΔF PRESS (on) Max CCW 20
RF Sweep Oscillator (KS-20383)	BAND SELECTOR LINE MODE ΔF	3.7—4.2 GHz RF CW 20

J68428A Test Set

UNIT	CONTROL	POSITION
Power Meter	INPUT	RF
IF/RF Sweep Oscillator	RF ΔF (MHz) RF MODE RF POWER LEVEL BAND SELECTOR	20 CW Midrange 3.65—4.25 GHz

CHART 2 (Cont)

STEP	PROCEDURE
3	Set the RF sweep oscillator frequency control for an output at 3.850 GHz.
4	Zero the power meter.
5	Connect the RF sweep oscillator as shown in Fig. 4, option (X).
6	Adjust the output of the RF sweep oscillator to produce a power meter indication of −10 dBm.
7	Connect the output of the RF sweep oscillator to the input of the Polarad microwave receiver as in Fig. 4, option (Y).
8	Calibrate the microwave receiver in accordance with the instruction manual. Set the receiver to its widest bandwidth, adjust the frequency control for a maximum meter deflection, and adjust the attenuator in the receiver for a meter indication of −10 dB. Note the frequency dial indication. Correct all subsequent frequency settings by this difference between the dial indication and 3.850 GHz.
9	Remove the termination from arm 1 of the last ◗channel-combining◖ network in the horizontal transmitter lineup; or if a TD auxiliary channel is connected to this port, remove the termination from the unused port of the circulator in the auxiliary channel transmitter antenna circuit. Connect the microwave receiver through a 20-dB pad to this port, Fig. 4, option (Z).
10	Tune the microwave receiver to the frequency of each transmitter associated with the vertical polarizations. Record the meter indications on the Data Sheet, Fig. 1.
11	Connect the microwave receiver through a 20-dB pad to the last channel-dropping network, or auxiliary channel circulator, associated with the vertical polarization.
12	Tune the microwave receiver to the frequency of each transmitter associated with the horizontal polarization. Record the meter indications on the data sheet.
13	Compute the coupling at each transmitting frequency by subtracting 20 dB from the difference between the nominal transmitter output in dBm and the meter indication of the microwave receiver. See example in Fig. 1. ***Requirement:*** The coupling loss shall be greater than 25 dB.
14	If the loss is less than 25 dB, excessive interference may result in the receiving channel operating 20 MHz from the transmitter frequency. Service should be removed from this receiver. The protection channels cannot be used to reroute such service, as these channels are required to protect against fading. When service is removed from the receiver, it shall be locked out at the IF switching system.

CHART 3

ADDING IF FILTERS AND PADS

When interstitial channels are used, filters are added in the transmitter IF circuits. The power output of these transmitters is also reduced by 10 dB. This power reduction and the addition of IF filters is necessary to prevent adjacent channel interference.

Also, dc amplifiers are added in the alarm circuits to maintain the low microwave output power alarm operation while operating at reduced power output.

APPARATUS:

1—J68392A or J68428A Transmitter-Receiver Test Set

1—ED-52011-30, Group 9 and 10 Antenna Duplexing Equipment

1—KS-14510 Volt-Ohm-Milliammeter

STEP	PROCEDURE
1	Connect the two dc power supplies (part of ED-52011-30, GR 9 and 10) to a convenient ac receptacle. The dc power supplies are used to provide plus and minus 6 volts to the dc amplifiers.
2	Measure the plus and minus output of the dc power supply. ***Requirement:*** 6 $\pm$0.5 Vdc
3	Connect the plus and minus 6-volt outputs of each of the two power supplies to a power distribution box; then connect six amplifiers to each box.
4	Measure the plus and minus voltages of the power supply. ***Requirement:*** 6 $\pm$0.5 Vdc
5	Remove service from the TD-3 transmitter which will be operating on the duplexed antenna by making a manual switch to the protection channel.
6	Install the IF filter (Fig. 5A) at the input of the IF driver amplifier.
7	Make connections to the transmitter-receiver test set as shown in Fig. 5B.
8	Measure the power output of the transmitter. Determine the output by adding 1 dB for cable loss to the loss stamped on the directional coupler. Add this amount to the meter indication.

CHART 3 (Cont)

STEP	PROCEDURE
9	Adjust the attenuator which sets the input power to the TWT for a transmitter power output of +27 dBm ±0.5 dB, ▶10 dB down from the nominal +37 dBm.◀
10	Disconnect and restore to normal the connections which were made in Step 7 for measuring the power output.
11	Connect a dc amplifier in the alarm circuit as shown in Fig. 5C. Operate the switch on the transmitter control panel to TRMTR OUT and adjust the dc amplifier gain control for the TRMTR OUT meter indication posted on the control panel.
12	Restore service on the radio circuit by switching manually from protection to the regular working channel.
13	Repeat Steps 5 through 12 for all transmitters which will operate on the duplexed antenna.

CHART 4

HOT PATCH TO TRANSMITTING ANTENNA

The hot patch of the receivers to the transmitting antenna will remove service from the receiving antenna. This shall be performed only after the procedures in Charts 1, 2, and 3 have been completed.

APPARATUS:

4—ED-52011-30 Microwave Filters, Groups 1 through 8 as required

1—ED-52011-30, Group 9 and 10 Miscellaneous Equipment for Antenna Duplexing

STEP	PROCEDURE
1	Remove the termination from arm 1 of the last channel-combining network in the horizontal transmitter lineup. If a TD auxiliary channel is already connected to this port, remove the termination from the unused port of the circulator in the auxiliary channel transmitter antenna circuit.
2	Connect the ED-52011-30 filter networks to this port (in Step 1) in accordance with Fig. 6, option (X) or (S).

CHART 4 (Cont)

STEP	PROCEDURE
	Note: Unless it has been done previously, verify that the correct filters are installed in this filter network by opening the filter cases and checking the stamping of each filter. The band-reject filter frequencies shall be the same as those assigned to the transmitters operating on the antenna polarization being connected. The bandpass filter frequencies shall be the same frequencies as the transmitters on the opposite polarity. If a TD auxiliary channel receiver is operating on the antenna, a band-reject filter for the auxiliary channel transmitter frequency is required as shown in Fig. 6, options ▶(S) or (T).◀ This shall be installed in the receiving polarization to which the auxiliary channel receiver is connected.
3	Establish an order-wire circuit to the IF switching equipment associated with the radio hop being worked on. Arrange to have someone monitor and report any alarms that occur. ***Note:*** While performing the next step, if any alarms occur which do not clear within 2 seconds, the waveguide connections being made should be restored to normal and all previous steps should be verified.
4	Make the hot patch by connecting the TD-3 horizontal receivers to the horizontal transmitting antenna while simultaneously disconnecting the receiving antenna. This is done by connecting Fig. 6, option (Y), and simultaneously disconnecting Fig. 6, option (U), using the method shown in Fig. 9A.
5	Remove the termination from arm 1 of the last channel-combining network in the vertical transmitter lineup. If a TD auxiliary channel is connected to this port, remove the termination from the unused port of the circulator in the auxiliary channel transmitter antenna circuit.
6	Connect the ED-52011-30 filter networks to this port (in Step 5). See Fig. 6, option (Z) ▶or (T).◀ Verify the frequencies as in Step 2 and add the auxiliary channel band-reject filter, if required per option (T).
7	Make the hot patch connecting the vertical receivers to the vertical transmitting antenna. This is done by connecting as in Fig. 6, option (W), and simultaneously disconnecting as in Fig. 6, option (V), using the method shown in Fig. 9A.

CHART 5

COUPLING MEASUREMENTS—RECEIVING ANTENNA

The coupling loss between the horizontal and vertical polarizations of the receiving system combining networks shall be measured if the transmitting antenna is to be released from service and both polarizations are used. This can be done only after procedures in Charts 1 through 4 have been completed. It is measured in order to determine the magnitude of the adjacent channel interference

CHART 5 (Cont)

which will be present while operating on the receiving antenna. Service will have to be removed from any receiver which will be subject to excessive interference.

APPARATUS:

1—J68392A or J68428A Transmitter-Receiver Test Set

1—ED-52011-30, Group 9 and 10 Antenna Duplexing Equipment

1—Microwave Receiver, Polarad Model R or TR

STEP	PROCEDURE
1	The test set must first be checked to ensure proper operation for the RF-to-RF mode of operation. Refer to Section 104-415-000 for the J68392A or Section 104-417-000 for the J68428A.
2	Operate the test set controls to the following positions:

CHART 5 (Cont)

STEP	PROCEDURE

J68392A Test Set

UNIT	CONTROL	POSITION
Power Meter	INPUT CHANNEL	RF
RF Sweep Oscillator (KS-19974 Alfred)	LINE FUNCTION-SWEEP SELECTOR MARKER AMPL ΔF	RF CW Max CCW 20
RF Sweep Oscillator (KS-19974 Hewlett-Packard)	LINE SWEEP SELECTOR FUNCTION ALC MARKER AMPL STOP/ΔF	RF CW ΔF PRESS (on) Max CCW 20
RF Sweep Oscillator (KS-20383)	BAND SELECTOR LINE MODE ΔF	3.7—4.2 GHz RF CW 20

J68428A Test Set

UNIT	CONTROL	POSITION
Power Meter	INPUT	RF
IF/RF Sweep Oscillator	RF ΔF (MHz) RF MODE RF POWER LEVEL BAND SELECTOR	20 ΔF Midrange 3.65—4.25 GHz

CHART 5 (Cont)

STEP	PROCEDURE
3	Set the RF sweep oscillator frequency control to the center frequency of a transmitter that will operate on the duplexed antenna.
4	Zero the power meter.
5	Connect the RF sweep oscillator as shown in Fig. 7, option (X).
6	Adjust the output of the RF sweep oscillator to produce a power meter indication of −10 dBm.
7	Connect the output of the RF sweep oscillator to the input of the Polarad microwave receiver as in Fig. 7, option (Y).
8	Calibrate the microwave receiver according to the instruction manual. Set the receiver to its widest bandwidth, adjust its frequency control for a maximum meter deflection, and adjust the attenuator in the receiver for a −10 dB meter indication.
9	Remove service from the transmitter operating on the frequency at which this measurement is being made by making a manual switch to the protection channel. Remove the coaxial input cable from the IF DR AMPL (IF DRIVER AMPL).
10	Connect the RF sweep oscillator to one receiving antenna port and the microwave receiver to the other, Fig. 7, option (Z). Record the microwave receiver meter indication on the Data Sheet, Fig. 2. Refer to Chart 2, Step 9.
11	Remove the connections to the receiving antenna waveguide.
12	Restore the coaxial input cable to the transmitter driver amplifier input and restore the transmitter to service by releasing the manual switch made in Step 9.
13	Repeat Steps 3 through 12 for each transmitter frequency which will be used on the receiving antenna.
14	Compute the coupling loss at each transmitting frequency. This is the difference between −10 dB and the microwave receiver meter indication. (A meter indication of −50 dB indicates a coupling loss of 40 dB.) See example in Fig. 2. ***Requirement:*** The coupling loss shall be greater than 25 dB.
15	If the loss is less than 25 dB, excessive interference will result in the receiving channel operating 20 MHz from the transmitter frequency. Service should be removed from this receiver. The protection channels cannot be used to reroute such service since these channels are required to protect against fading. When service is removed from the receiver, it shall be locked out at the IF switching system.

CHART 6

HOT PATCH TO RECEIVING ANTENNA

A hot patch of the transmitter and receivers to the receiving antenna will be required if service is to be removed from the transmitting antenna. This can be done only after Charts 1 through 5 have been completed.

APPARATUS:

1—ED-52011-30, Group 9 and 10 Miscellaneous Equipment for Antenna Duplexing

STEP	PROCEDURE
1	Connect a cable equipped with transducers to the horizontal receiving antenna port, Fig. 8, option (X).
2	Establish an order-wire circuit to the IF switching equipment associated with the radio hop being worked on. Arrange to have someone monitor and report any alarms that occur. ***Note:*** While performing the next step, if any alarms occur which do not clear within 2 seconds, the waveguide connections being made should be restored and all previous steps should be verified.
3	Make the hot patch by connecting the horizontal transmitter and receiver to the horizontal receiving antenna. Connect Fig. 8, option (Y), and simultaneously disconnect option (Z) using the method shown in Fig. 9B.
4	Repeat Steps 1, 2, and 3 for the vertical polarization.

CHART 7

RESTORATION TO THE 2-ANTENNA ARRANGEMENT

The procedures in this chart restore the circuit to normal.

STEP	PROCEDURE
1	Arrange to have someone monitor and report any alarms which occur on the switching system.

CHART 7 (Cont)

STEP	PROCEDURE
	Note: While performing the next steps, if any alarm is reported which does not clear in 2 seconds, the waveguide connections being made should be restored and all previous steps should be verified.
2	If the receiving antenna is being used, hot patch the vertical polarity transmitters and receivers to the vertical transmitting antenna by connecting as shown in Fig. 8, option (Z), and simultaneously disconnecting option (Y). (See note in Fig. 9A or 9B.)
3	Repeat Step 2 for the horizontal polarities by hot patching the horizontal polarity transmitters and receivers to the horizontal transmitting antenna.
4	Disconnect according to Fig. 8, option (X), if Steps 2 and 3 were required.
5	Hot patch the horizontal polarity receivers to the horizontal receiving antenna by disconnecting as shown in Fig. 6, option (Y), and simultaneously connecting option (U). (See note in Fig. 9A or 9B.)
6	Hot patch the vertical polarity receivers to the vertical receiving antenna by connecting as shown in Fig. 6, option (V), and simultaneously disconnecting option (W). (See note in Fig. 9A or 9B.)
	Note: The IF filters and pads which were added in Chart 3 must be removed. This is accomplished in the steps that follow.
7	Remove the RF filter networks shown in Fig. 6, options (S) and (T), or (X) and (Z). Replace the terminations at the end of the transmitter lineup.
8	Remove service from the TD-3 transmitter by making a manual switch to the protection channel.
9	Remove the filter and pads and restore the IF connections to normal (Fig. 5A).
10	Remove the dc amplifiers and restore the alarm connections to normal (Fig. 5C).
11	Operate the switch on the transmitter control panel to TRMTR OUT and adjust the attenuator which sets the input level to the TWT for the posted meter indication. (Attenuators are marked AT3, AT4, or ATT, depending upon the transmitter type.)
12	Restore the transmitter to service by releasing the switch made in Step 8.
13	Repeat Steps 7 through 12 for all transmitters.
14	Restore all equipment and patches to normal.

(A)		(B)	(C)	(D)	(E)
VERT PO TRMTR		TRMTR PWR OUTPUT	MWV RCVR READING–HOR WG	DIFF BET. COL B AND C	COUPLING–COL D MINUS 20 dB
DESIG.	FREQUENCY				
R					
R					
R					
R					
R					
R					

(F)		(G)	(H)	(I)	(J)
HOR PO TRMTR		TRMTR PWR OUTPUT	MWV RCVR READING–VERT WG	DIFF BET. COL G AND H	COUPLING–COL I MINUS 20 dB
DESIG.	FREQUENCY				
R					
R					
R					
R					
R					
R					

Example:

R201	3710	+37 dBm	−18 dB	55 dB	35 dB

Fig. 1—Data Sheet—Transmitter Coupling Loss

(A)		(B)	(C)
TRANSMITTER		MWV RCVR MTR READING	COUPLING: DIFF BETWEEN -10 dB AND COL B
DESIG.	FREQUENCY		
R			
R			
R			
R			
R			
R			
R			
R			
R			
R			
R			
R			

Example:

R101	3710	-45 dB	35

Fig. 2—Data Sheet—Receiving Antenna Coupling Loss

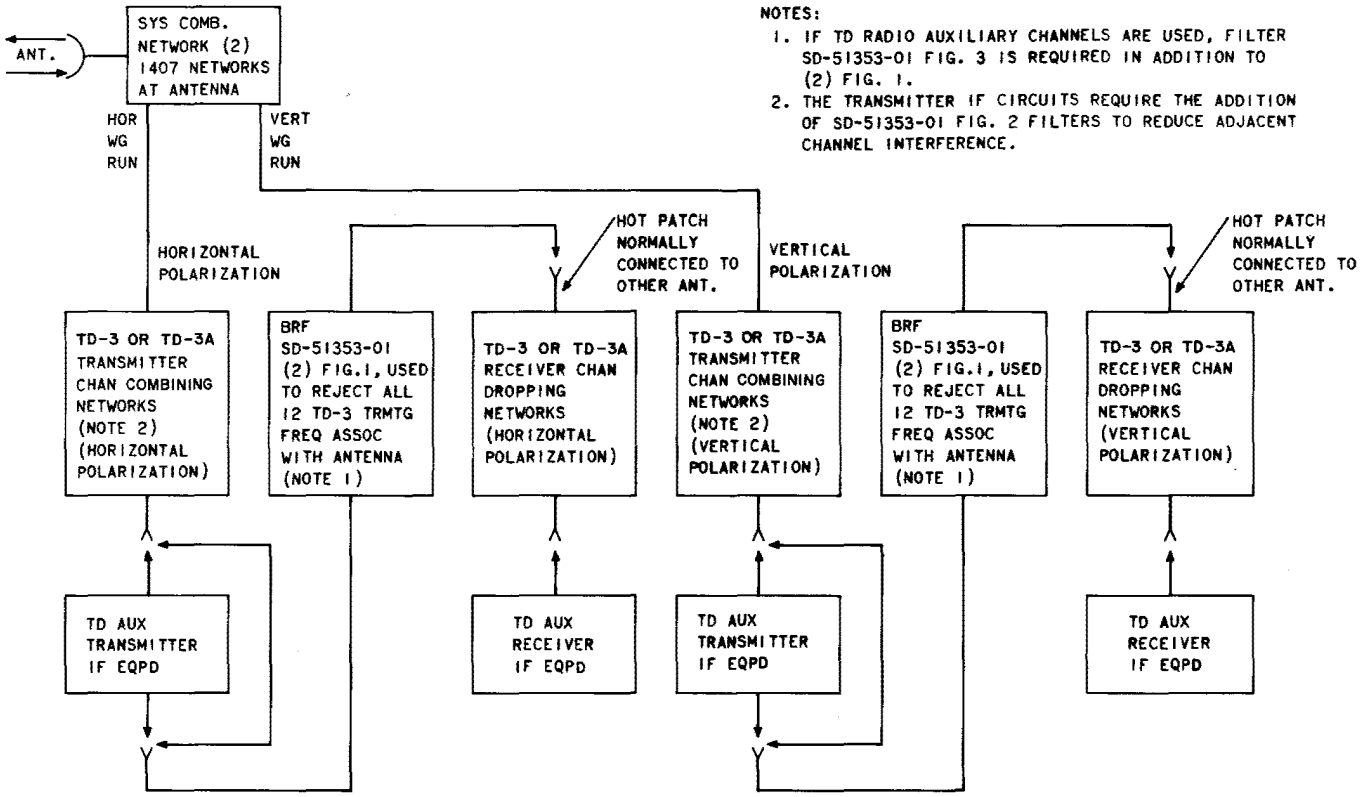


Fig. 3—Duplex Operation—Simplified Diagram

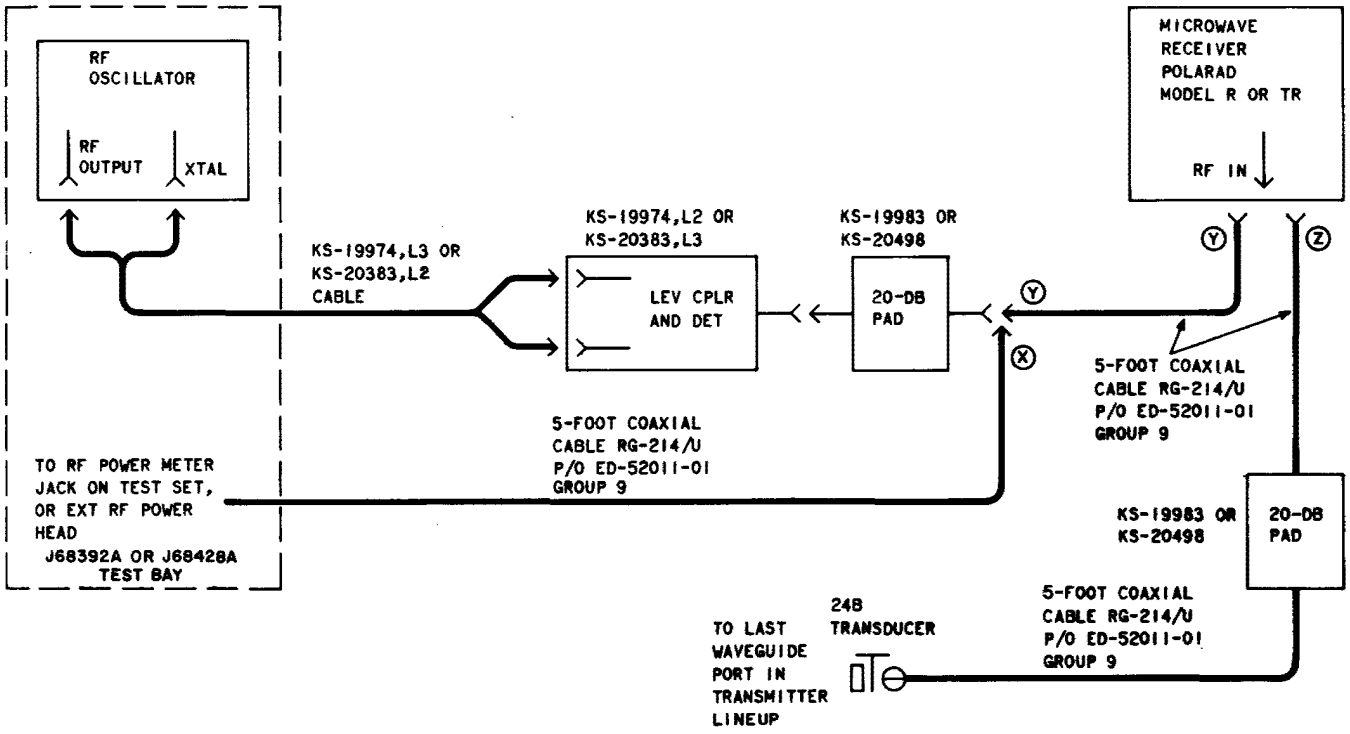
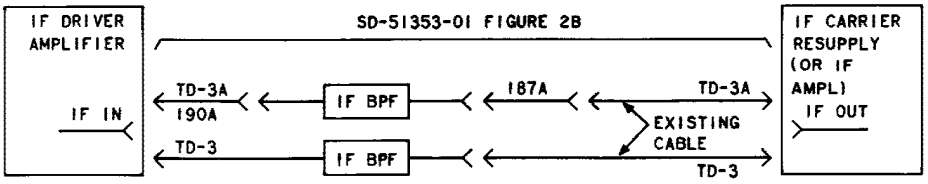
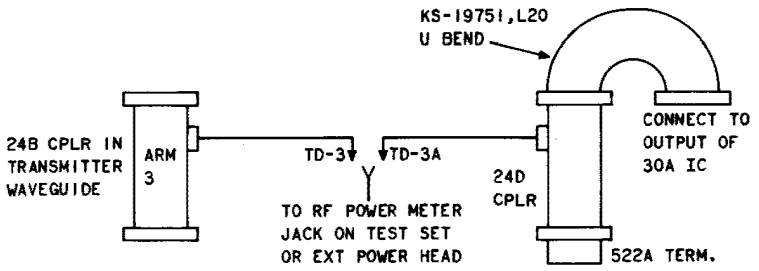


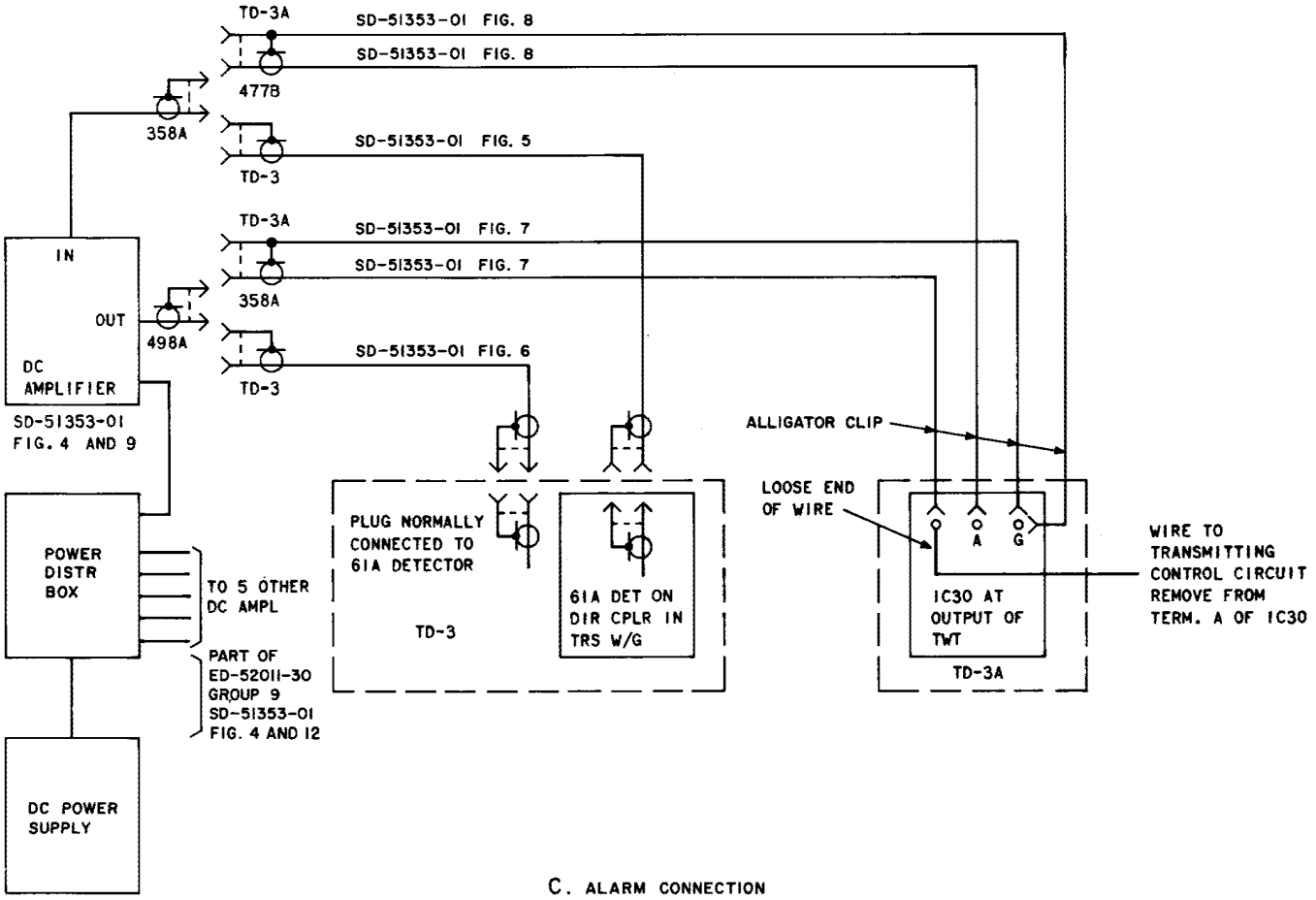
Fig. 4—TD-3 Transmitting Antenna Coupling Measurement



A. IF FILTER



B. TRANSMITTER POWER MEASUREMENT



C. ALARM CONNECTION

Fig. 5—Transmitter Modifications for Antenna Duplexing

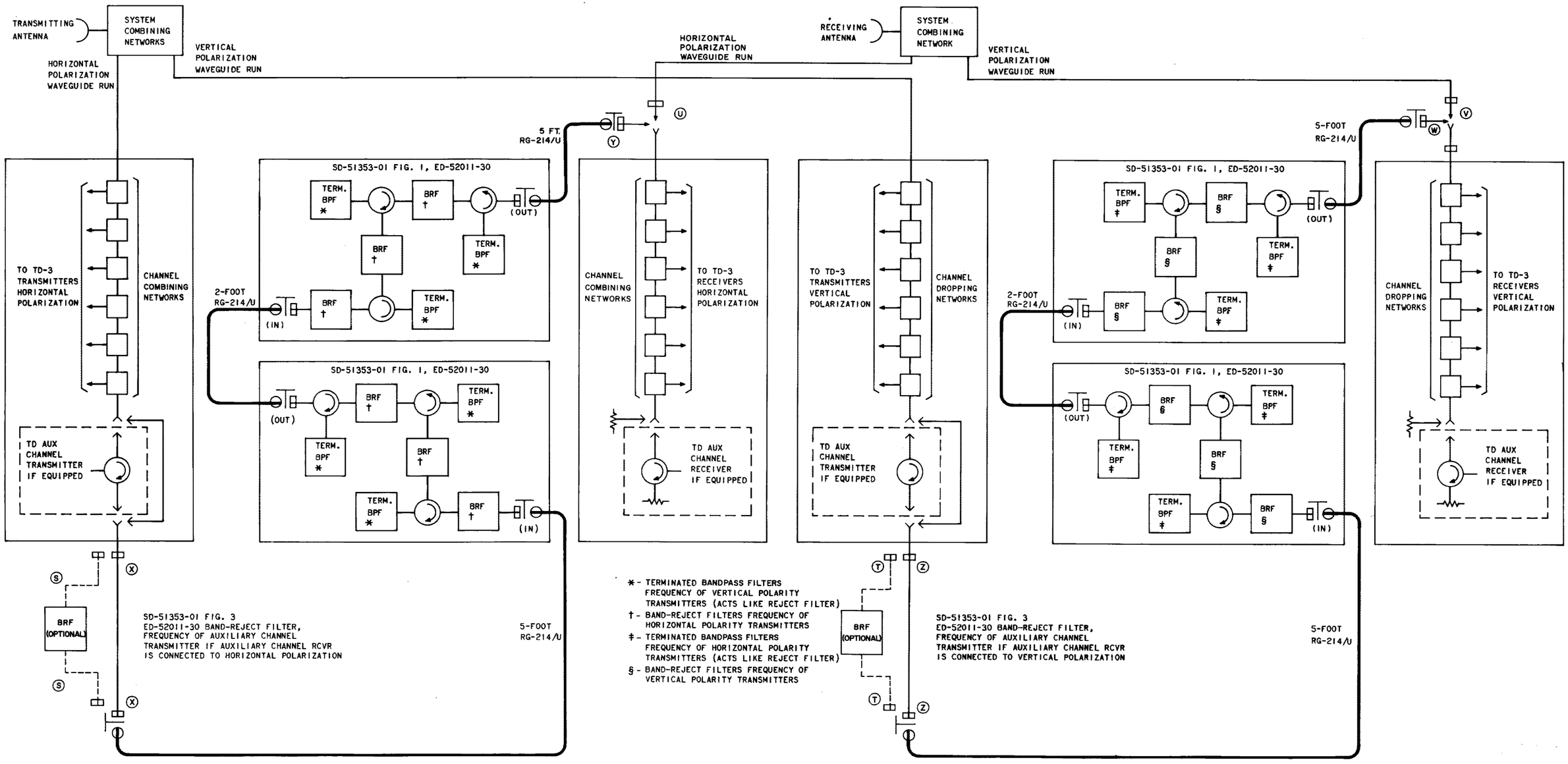


Fig. 6—Antenna Duplexing for TD-3

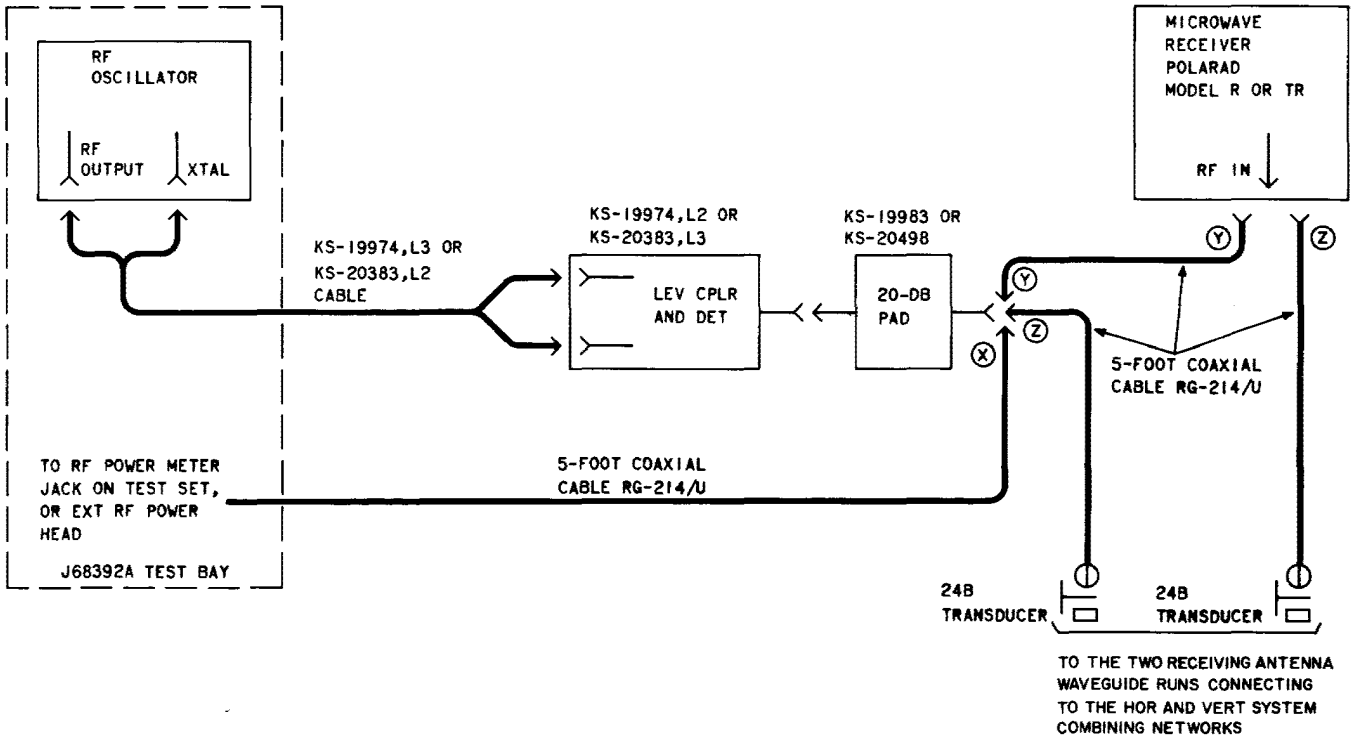


Fig. 7—Receiving Antenna Coupling Measurements

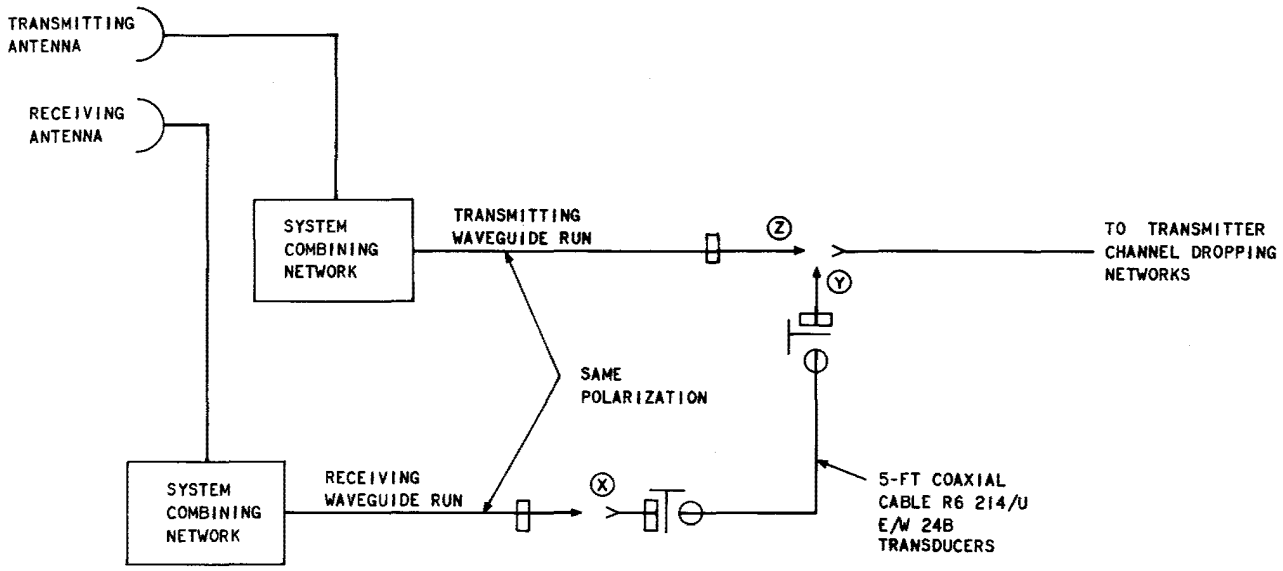
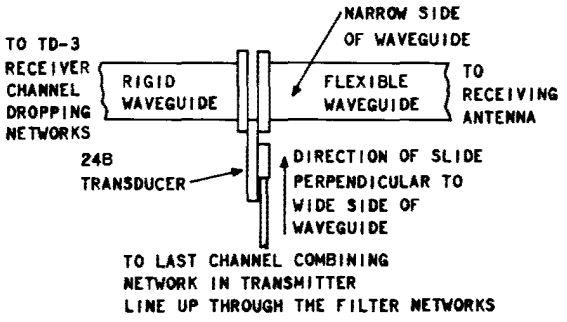


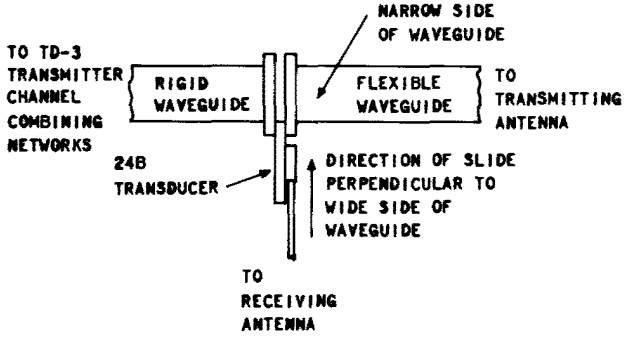
Fig. 8—Hot Patch to Receiving Antenna

NOTE:
TO PERFORM HOT PATCH, SLIDE THE TRANSDUCER AND FLEXIBLE WAVEGUIDE UNTIL THE TRANSDUCER MATES WITH THE RIGID WAVEGUIDE. KEEP ALL FLANGES PARALLEL. WHEN RESTORING CONNECTIONS, REVERSE THE DIRECTION OF SLIDE.
CAUTION: SAFETY HAZARD. SEE SECT 010-150-001 AND 010-150-002.



A. HOT PATCH TO TRANSMITTING ANTENNA

NOTE:
TO PERFORM HOT PATCH, SLIDE TRANSDUCER AND FLEXIBLE WAVEGUIDE UNTIL TRANSDUCER MATES WITH RIGID WAVEGUIDE SECTION. KEEP ALL FLANGES PARALLEL. WHEN RESTORING CONNECTIONS, REVERSE THE DIRECTION OF SLIDE.
CAUTION: SAFETY HAZARD. SEE SECT 010-150-001 AND 010-150-002.



B. HOT PATCH TO RECEIVING ANTENNA

Fig. 9—Hot Patch to Receiving and Transmitting Antennas