MICROWAVE ANTENNA RETURN LOSS MEASUREMENTS THROUGH TD-2, TD-3, TD-3A, TD-3D, AND TH-3 TRANSMITTER-RECEIVER BAYS

CONTENTS PAGE

1. GENERAL

1.01 This section describes the procedure for making return-loss measurements on antenna and waveguide systems connected to TD-2, TD-3, TD-3A, TD-3D, and TH-3 microwave radio transmitter-receiver bays. The J68345A test set, the J68392A test set, the J68428A test set, the ED-50978-10 portable test arrangement, the KS-21140 test set, or the Scientific Atlanta Fault Locator (series 1691) may be used for this test. Refer to the following table for the test set used with each transmitter-receiver bay.

T/R RADIO BAY	TEST SET USED
TD-2	45A, 28A, TDR, SA
TD-3	92A, TDR, SA
TD-3A	92A, 28A, TDR, SA
TD-3D	45A, 92A, 28A, TDR, SA
TH-3	92A, 28A, ED, TDR, SA

45A—J68345A Test Set
92A—J68392A Test Set
28A—J68428A Test Set
ED—ED-50978-10 Portable Test Arrangement
TDR—KS-21140 Test Set
SA—Scientific Atlanta Fault Locator

The procedure for return-loss measurement through a TH-1 transmitter-receiver bay is given in Section 402-400-503. The general procedure for return-loss measurements, together with a brief outline of the necessary theory and ripple analyzation, is given in Section 402-400-100. This issue affects the Equipment Test List.

1.02 For measurements with each test set except the KS-21140 test set, the antenna and waveguide system is swept through a 20-MHz bandwidth at RF. Any impedance mismatches cause reflected signals that return to the signal source. In the test setups, using the Western Electric test sets, the reflected signals are combined with a portion of the incident signal, thereby creating a resultant signal that displays ripples versus frequency. The ripple pattern, displayed on an oscilloscope, is analyzed to determine the magnitude and location of the principal reflections. This method of measurement is very useful for locating one or possibly two major discontinuities in the waveguide system. However, if more than two discontinuities exist, the ripple pattern may be very difficult to interpret. As with the Western Electric sets, the Scientific Atlanta Fault Locator makes use of the magnitude of the reflected signal to determine the magnitude of the return loss at each discontinuity. However, the location of each discontinuity is determined by an entirely different means. Within the fault locator, the frequency of each reflected signal is compared, at each instant of time, with the frequency of the incident signal being applied to the antenna system at that same time. Because of the time delay difference between the source and the reflected signals, these frequencies will not be the same. The test set makes use of this frequency difference information to provide a readout on the location of each discontinuity in the waveguide system. The KS-21140 test set uses time domain techniques and inserts a pulse, modulated onto an RF carrier. Again, any impedance mismatches cause reflections of the pulse. These reflected signals are then evaluated to give return loss in dB at the point of reflections. The return loss obtained from these measurements provides a profile of the return loss of the entire antenna system. The return-loss objectives used in this section have been established for the ***entire*** antenna and waveguide system. Individual components encountered in the system (system combining networks, antennas, etc.) may or may not appear to meet their own specific return-loss requirements due to the effect of other reflections in the system. It is for this reason that the following return-loss requirements have been established: ***All reflections caused by irregularities should measure 30-dB return loss or better, except when measuring a systems combining network (1406A or 1407A) which should measure 25-dB return loss or better.*** Maximum return loss represents the best impedance match, as well as lowest possibility of intermodulation noise caused by echoes in the waveguide.

1.03 Because of the high-level test signal required to make return-loss measurements on receiving antenna systems, it is possible to cause interference to any receiving channel separated by only 20 MHz from the channel being used. Therefore, when adjacent channels are being employed, it is important to limit the test oscillator sweep width to ± 10 MHz.

1.04 Single antenna systems may be measured in the same way as normal 2-antenna systems as long as the requirement in 1.03 is met.

1.05 When return-loss measurements are made on a routine basis on TD-2, TD-3, TD-3A, or TH-3 radio bays, the channel ***closest*** to the antenna and waveguide system should be used to prevent the return loss of intermediate channel networks from complicating the interpretation of the results. With a TD-3D radio bay, however, circulators are provided as the means of adding and dropping the transmitting and receiving signals, and the channel closest to the antenna is the poorest choice. When return-loss measurements are made on a TD-3D receiving waveguide run, for instance, the test signal inserted into the circulator (incident signal) first travels toward the termination at the end of the bay lineup, where it would be absorbed by the termination. In this situation, the termination at the end of the waveguide run must be removed and a shorting plate installed. This permits the incident signal, upon reaching the end of the bay lineup, to be reflected back and out toward the antenna. When the signal encounters any discontinuities in the waveguide run toward the antenna, a portion of this signal is reflected back to the port of insertion and is detected. When return-loss measurements are made on a TD-3D transmitting waveguide run, the signal traverses the route described above in the opposite direction. The inserted signal first travels toward the antenna, and then any portion of the signal reflected back passes right through the circulator toward the termination at the end of the bay lineup. Here, too, the termination must be replaced by a shorting plate to permit the reflected signal to continue on to the detector at the output of the circulator. Because of the path of the signal, extra lengths of waveguide are introduced and must be accounted for. When return-loss measurements are made on TD-3D T/R bays, therefore, the last bay in the lineup ***closest*** to the shorting plate (termination) should be used. This minimizes any extra lengths of waveguide and makes them negligible.

1.06 Return-loss measurements may be made at frequencies other than those of the channels specified in 1.05. If a maintenance problem with a specific channel is being investigated, it is recommended to test at that channel frequency and to test from that channel's T/R bay. In this case, no matter what the radio system, the extra path length and path loss of the test signal through the additional channel networks or through the path involving the circulators described for TD-3D in 1.05 must be accounted for to achieve an accurate determination of the location and magnitude of any discontinuities. If the system can be fully turned down or if the bandpass filters and channel combining or dropping networks of a desired testing frequency are available, any frequency in the radio band may be used for the test except receiving channel frequencies of other routes at the same station. The test signal should be inserted into the waveguide run as close to the beginning of the bay lineup as possible without interrupting any channels in service.

2. RETURN LOSS MEASUREMENTS OF ANTENNA SYSTEMS

A. Required Test Equipment

2.01 The following test equipment is required according to ED-51731-10 for testing through 4-GHz T/R bays:

1—J68345A, J68392A, J68428A, KS-21140, or Scientific Atlanta Test Set

2.02 The following test equipment is required according to ED-51731-10 for testing through 6-GHz T/R bays:

1—J68392A, J68428A, ED-50978-10, KS-21140, or Scientific Atlanta Test Set

B. Test Equipment Setup

2.03 Prepare the test equipment as described in these charts:

Chart 1—J68345A Test Set

Chart 2—J68345A Test Set e/w Power Divider

Chart 3—J68392A Test Set

Chart 4—J68428A Test Set

Chart 5—TH-3 ED-50978-10 Portable Test Set

Chart 6—KS-21140 TDR Test Set

Chart 7—Scientific Atlanta Fault Locator

to connect to these T/R Bays:

Chart 8—TD-2

Chart 9—TD-3

Chart 10—TD-3A

Chart 11—TD-3D

Chart 12—TH-3

CHART 1

ANTENNA RETURN LOSS SETUP USING THE J68345A TEST SET

APPARATUS:

1—J68345A (45A) Test Set

1—1A Hybrid Junction

1—Movable Short Circuit, ED-64021-01, G1

1—8A or 19A Isolator

1—128S Precision Termination

1—Dumont Type 304-A or 304-AR Oscilloscope (optional)

STEP	PROCEDURE
	Warning: ***DO NOT leave waveguide unterminated. Possible radiation hazard may exist. DO NOT look into energized waveguides.***
1	Establish the test connections given in Fig. 8, option (X) and set AT1 to 3 dB, AT2 to 5 dB, and AT3 to 20 dB. ***Do not connect ARM 4 of the 1A Hybrid Junction to the system under test at this time.***
2	Adjust the RF frequency meter to the desired frequency. Adjust the RF sweep oscillator to sweep ±10 MHz with the pip of the frequency meter at approximately midband on the oscilloscope. (This is easier to do if two frequency meters are available to provide two pips, one at −10 MHz and one at +10 MHz on the sweep.) ***Note:*** It is important to limit the oscillator sweep width to ±10 MHz to prevent interference to adjacent channels.
3	Note the position of the SWEEP switch, then turn it to the OFF position and adjust the frequency by observing the dip of the trace caused by the frequency meter, using the FEEDBACK tuning control. Adjust the RF oscillator to the midband frequency of the channel under test.

CHART 1 (Cont)

STEP	PROCEDURE
4	Establish the test connections given in Fig. 8, option (Y). Position the MTR switch on the RF sweep oscillator to the RF DBM position and adjust the output level. The desired output, as indicated on the meter, is equal to +21 dBm minus the marked loss on the BRC output of the waveguide assembly. This establishes the output of the oscillator at +21 dBm.
5	Reestablish the test connections given in Fig. 8, option (X) and return the SWEEP switch to the position noted in Step 3. Use the pip of the frequency meter, with the X control on the oscilloscope, to adjust the horizontal gain on the oscilloscope to fit the 20-MHz sweep between the heavy vertical lines on the screen. This sets the frequency scale so that one small division on the oscilloscope equals 2 MHz.
6	Establish the test connections given in Fig. 8, option (Z) while maintaining option (X).
7	Connect the hybrid assembly to the system under test by following the procedure given in Chart 8 for TD-2 or Chart 11 for TD-3D.
8	Adjust the movable short circuit until the test trace is horizontal and at its highest point on the screen. This adjustment balances the hybrid and is important. ***This adjustment must not be disturbed*** until the test is finished.
9	Operate the ADJUST INPUT 1 control to make the two traces coincide. If the traces cannot be made to coincide, interchange the SW IN 1 and SW IN 2 connections.
10	Decrease the attenuation in AT1 by 1 dB and adjust the vertical gain (Y AMPLITUDE) of the oscilloscope to separate the two traces by 1 inch. This establishes a vertical scale calibration of 1 dB per inch.
11	Restore the attenuation in AT1 to 3 dB. The traces should again coincide. If they do not, repeat Steps 8 through 11.
12	Set AT3 to 0 dB. The ripple pattern that now appears on the oscilloscope is an indication of the return loss of the antenna system under test. Each ripple component must be analyzed to determine if an antenna system will meet the return-loss objectives. Refer to Part 3 for ripple pattern analyzation.

Procedure for Photographing the Oscilloscope Pattern

Note: If it is desirable to photograph the ripples obtained on the oscilloscope, the Dumont oscilloscope is more convenient for taking photographs than the KS-15586 oscilloscope on the J68345A test set because it has an illuminated scale, which is easier to read and shows well on the photographs. Its use requires only a very simple modification to blank out the retrace, as shown by the heavy lines in Fig. 1. The change can be made very quickly, on a temporary basis, and the oscilloscope returned to its normal condition after use. The only material required is a length of hookup wire. The Dumont oscilloscope can be connected in parallel with the oscilloscope on the 45A test set by making up a multiple patchboard

CHART 1 (Cont)

STEP	PROCEDURE

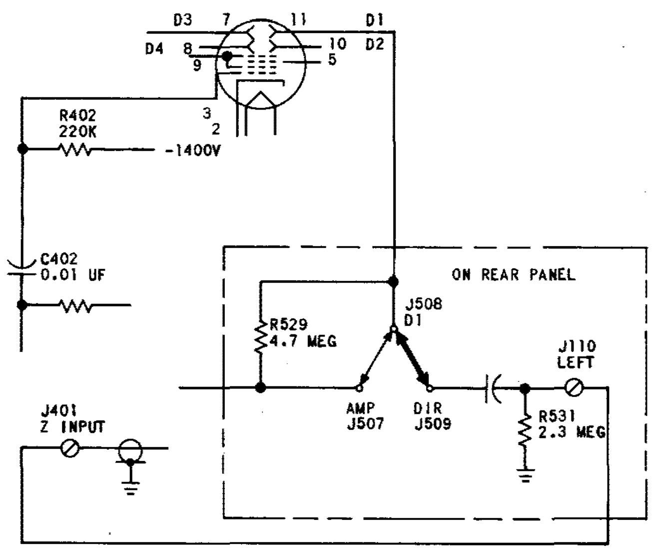


Fig. 1—Modifications for the Dumont Type 304-A or 304-AR Oscilloscope for Use in Antenna Return Loss Test

STEP	PROCEDURE
	with coaxial connectors, as shown in Fig. 2. Interconnections can then be made quickly and simply with patch cords made up from the RG-59B/U coaxial cable.
13	Make the modifications shown by the heavy lines in Fig. 1. The only material required is a length of hookup wire.
14	Establish the test connections shown in Fig. 2. This connects the Dumont oscilloscope in parallel with the 45A test set oscilloscope.
15	Adjust the Dumont oscilloscope trace brightness and the illuminated scale to normal viewing levels.
16	Drape a piece of paper over the test set to shield the oscilloscope face from overhead lights.
17	Use a Polaroid camera with 3000 speed film and a #3 close-up lens. Set the camera shutter to 10 (wide open) and set the camera focus to 3-1/2 feet.
18	Place or hold the camera 10-1/4 inches from the oscilloscope face.

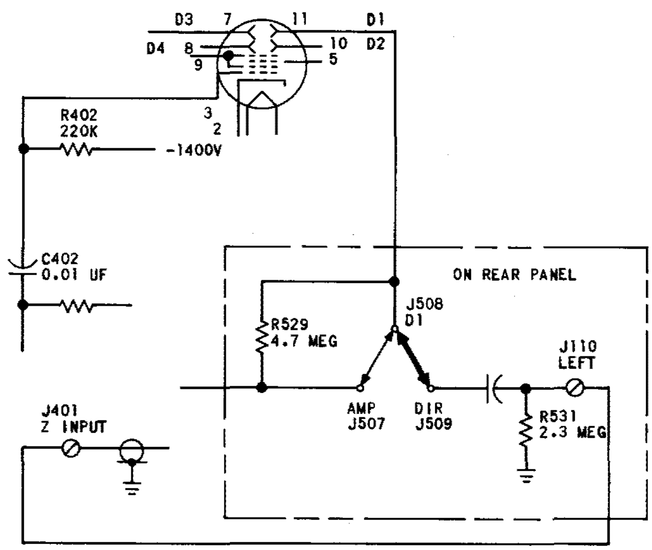
CHART 1 (Cont)

STEP	PROCEDURE
4	Establish the test connections given in Fig. 8, option (Y). Position the MTR switch on the RF sweep oscillator to the RF DBM position and adjust the output level. The desired output, as indicated on the meter, is equal to +21 dBm minus the marked loss on the BRC output of the waveguide assembly. This establishes the output of the oscillator at +21 dBm.
5	Reestablish the test connections given in Fig. 8, option (X) and return the SWEEP switch to the position noted in Step 3. Use the pip of the frequency meter, with the X control on the oscilloscope, to adjust the horizontal gain on the oscilloscope to fit the 20-MHz sweep between the heavy vertical lines on the screen. This sets the frequency scale so that one small division on the oscilloscope equals 2 MHz.
6	Establish the test connections given in Fig. 8, option (Z) while maintaining option (X).
7	Connect the hybrid assembly to the system under test by following the procedure given in Chart 8 for TD-2 or Chart 11 for TD-3D.
8	Adjust the movable short circuit until the test trace is horizontal and at its highest point on the screen. This adjustment balances the hybrid and is important. ***This adjustment must not be disturbed*** until the test is finished.
9	Operate the ADJUST INPUT 1 control to make the two traces coincide. If the traces cannot be made to coincide, interchange the SW IN 1 and SW IN 2 connections.
10	Decrease the attenuation in AT1 by 1 dB and adjust the vertical gain (Y AMPLITUDE) of the oscilloscope to separate the two traces by 1 inch. This establishes a vertical scale calibration of 1 dB per inch.
11	Restore the attenuation in AT1 to 3 dB. The traces should again coincide. If they do not, repeat Steps 8 through 11.
12	Set AT3 to 0 dB. The ripple pattern that now appears on the oscilloscope is an indication of the return loss of the antenna system under test. Each ripple component must be analyzed to determine if an antenna system will meet the return-loss objectives. Refer to Part 3 for ripple pattern analyzation.

Procedure for Photographing the Oscilloscope Pattern

Note: If it is desirable to photograph the ripples obtained on the oscilloscope, the Dumont oscilloscope is more convenient for taking photographs than the KS-15586 oscilloscope on the J68345A test set because it has an illuminated scale, which is easier to read and shows well on the photographs. Its use requires only a very simple modification to blank out the retrace, as shown by the heavy lines in Fig. 1. The change can be made very quickly, on a temporary basis, and the oscilloscope returned to its normal condition after use. The only material required is a length of hookup wire. The Dumont oscilloscope can be connected in parallel with the oscilloscope on the 45A test set by making up a multiple patchboard

CHART 1 (Cont)

STEP	PROCEDURE
	
	Fig. 1—Modifications for the Dumont Type 304-A or 304-AR Oscilloscope for Use in Antenna Return Loss Test
	with coaxial connectors, as shown in Fig. 2. Interconnections can then be made quickly and simply with patch cords made up from the RG-59B/U coaxial cable.
13	Make the modifications shown by the heavy lines in Fig. 1. The only material required is a length of hookup wire.
14	Establish the test connections shown in Fig. 2. This connects the Dumont oscilloscope in parallel with the 45A test set oscilloscope.
15	Adjust the Dumont oscilloscope trace brightness and the illuminated scale to normal viewing levels.
16	Drape a piece of paper over the test set to shield the oscilloscope face from overhead lights.
17	Use a Polaroid camera with 3000 speed film and a #3 close-up lens. Set the camera shutter to 10 (wide open) and set the camera focus to 3-1/2 feet.
18	Place or hold the camera 10-1/4 inches from the oscilloscope face.

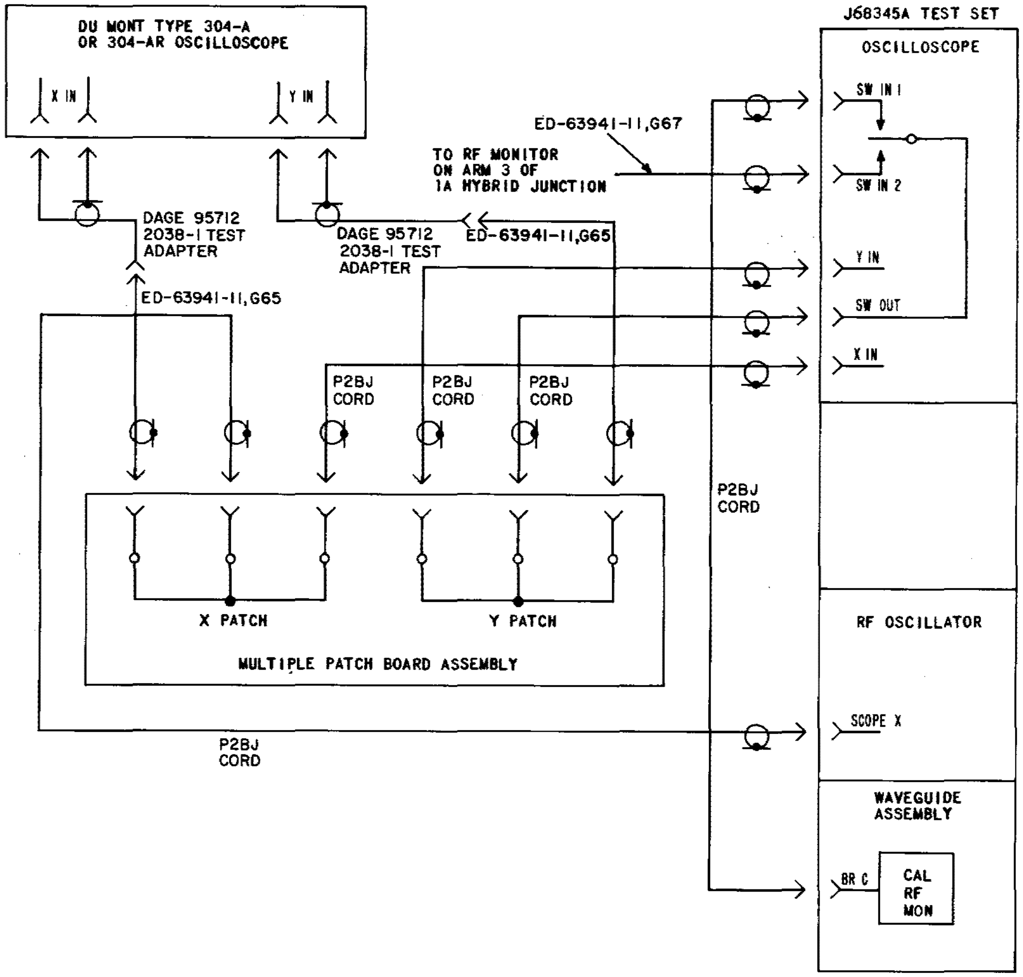


Fig. 2—Test Arrangement for Using the Dumont Type 304-A Oscilloscope and Multiple Patchboard

---

CHART 2

ANTENNA RETURN LOSS SETUP USING THE J68345A TEST SET, AND THE KS-21099 L1 RF POWER DIVIDER, (TD-3D ONLY)

APPARATUS:

1—J68345A (45A) Test Set

1—RF Power Divider Weinshel Model 1506 or KS-21099, L1

1—15-dB RF Pad

1—Dumont Type 304A or 304AR Oscilloscope (Optional)

CHART 2 (Cont)

STEP	PROCEDURE
	Warning: Do not leave waveguide unterminated. Possible radiation hazard may exist. Do not look into energized waveguides.
1	Establish the test connections given in Fig. 9, option (X) and set AT1 to 3 dB.
2	Adjust the RF frequency meter to the desired frequency. Adjust the RF sweep oscillator to sweep ±10 MHz with the pip of the frequency meter at approximately midband on the oscilloscope. (This is easier to do if two frequency meters are available to provide two pips, one at −10 MHz and one at +10 MHz on the sweep.)
	Note: It is important to limit the oscillator sweep width to ±10 MHz to prevent interference to adjacent channels which are in service.
3	Note the position of the SWEEP switch, then turn it to the OFF position and adjust the frequency by observing the dip of the trace caused by the frequency meter, using the FEEDBACK tuning control. Adjust the RF oscillator to the midband frequency of the channel under test.
4	Establish the test connections given in Fig. 9, option (Y). Position the MTR switch on the RF oscillator to the RF DBM position and adjust the output level. The desired output as indicated on the meter, is equal to +21 dBm minus the marked loss on the BRC output of the waveguide assembly. This establishes the output of the oscillator at +21 dBm.
5	Reestablish the test connections given in Fig. 9, option (X) and return the SWEEP switch to the position noted in Step 3.
	Use the pip of the frequency meter, with the X control on the oscilloscope, to adjust the horizontal gain on the oscilloscope to fit the 20-MHz sweep between the heavy vertical lines on the screen. This sets the frequency scale so that one small division on the oscilloscope equals 2 MHz.
6	Establish the test connections given in Fig. 9, option (Z) while maintaining option (X).
7	Operate the ADJUST INPUT control to make the two traces coincide. If the traces cannot be made to coincide, interchange the SW IN 1 and SW IN 2 connections.
8	Decrease the attenuation in AT1 by 1 dB and adjust the vertical gain (Y AMPLITUDE) of the oscilloscope to separate the two traces by 1 inch. This establishes a vertical scale calibration of 1 dB per inch.
9	Restore the attenuation in AT1 to 3 dB. The traces should again coincide. If they do not, repeat Steps 7 through 9.
10	Disconnect the 15-dB RF pad and connect the power divider assembly to the system under test by following the procedure given in Chart 11 for TD-3D.

CHART 2 (Cont)

STEP	PROCEDURE
11	Set AT3 to 0 dB. The ripple pattern that now appears on the oscilloscope is an indication of the return loss of the antenna system under test. Each ripple component must be analyzed to determine if an antenna system will meet the return-loss objectives. Refer to Part 3 for ripple pattern analyzation.
	Procedure for Photographing the Oscilloscope Pattern
	Note: If it is desirable to photograph the ripples obtained on the oscilloscope, the Dumont oscilloscope is more convenient for taking photographs than the KS-15586 oscilloscope on the J68345A test set because it has an illuminated scale, which is easier to read and shows well on the photographs. Its use requires only a very simple modification to blank out the retrace, as shown by the heavy lines in Fig. 1. The change can be made very quickly, on a temporary basis, and the oscilloscope returned to its normal condition after use. The only material required is a length of hookup wire. The Dumont oscilloscope can be connected in parallel with the oscilloscope on the 45A test set by making a multiple patchboard with coaxial connectors, as shown in Fig. 2. Interconnections can then be made quickly and simply with patch cords made up from the RG-59B/U coaxial cable.
12	After the return-loss measurements are completed, remove the test equipment and return the radio system to normal.

CHART 3

ANTENNA RETURN LOSS SETUP USING THE J68392A TEST SET

APPARATUS:

1—J68392A Test Set

STEP	PROCEDURE
	Warning: DO NOT leave waveguide unterminated. Possible radiation hazard may exist. DO NOT look into energized waveguides.
1	Position the test set controls as given in the following table:

UNIT	CONTROL	POSITION
RF AND IF Sweep Control Unit	FUNCTION	RF-RF
Oscilloscope Time Base Unit	POSITION and POSITION-VERNIER MAGNIFIER SWEEP-TIME VERNIER SWEEP TIME SINGLE-NORMAL	Midrange X10 Midrange EXT NORMAL
Oscilloscope Differential Amplifier	POSITION BANDWIDTH (KC) AMPLIFIER SENSITIVITY SENSITIVITY-VERNIER + INPUT – INPUT	Midrange 4 DC 10MV/CM Midrange DC OFF
Power Meter	INPUT CHANNEL POWER RANGE DBM	RF +5
KS-19974 RF Oscillator (4 GHz Only)	LINE FUNCTION-SWEEP SELECTOR MARKER AMPLITUDE CW (Note) Δ F POWER LEVEL	RF CW Midrange Desired Frequency 20 MHz Fully CCW
HP E02-692D RF Oscillator (4 GHz Only)	LINE SWEEP SELECTOR FUNCTION pushbutton AMPL MOD ALC START/CW (Note) STOP/ Δ F POWER LEVEL	RF AUTO Δ F Released MARK 1 Depressed MARK 2 Depressed Depressed Desired Frequency 20 Fully CCW
KS-20383 RF Oscillator (4 & 6 GHz)	LINE BAND SELECTOR CW (Note) MODE Δ F POWER LEVEL	ON 3.65-4.25 or 5.9-6.5 GHz, as required Desired Frequency CW 20 Fully CCW

Note: If the microwave radio system has been fully turned down, any frequency can be used. If only one channel can be turned down, the frequency selected must correspond to the frequency of that channel turned down.

CHART 3 (Cont)

STEP	PROCEDURE
2	Establish the test connections given in Fig. 10, option (X) for 4-GHz systems, or Fig. 11, option (X) for 6-GHz systems. Adjust the POWER LEVEL control for an indication of 0 on the power meter (+5 dBm at output of RF pad).
3	Establish the test connections given in Fig. 10, option (Y) for 4-GHz systems or Fig. 11, option (Y) for 6-GHz systems.
4	On the RF oscillator, change the MODE switch to ΔF. On the RF and IF sweep control unit, adjust the TEST TRACE controls to center the test trace vertically on the oscilloscope and adjust the REF TRACE controls to bring the reference trace into coincidence with the test trace at center frequency.
5	On the oscilloscope time base unit, adjust the POSITION and SWEEP TIME-VERNIER controls for a horizontal test trace display of approximately 10 centimeters. ***Note:*** It is important to limit the oscillator sweep width to ±10 MHz to prevent interference to adjacent channels when measuring antenna return loss. Ensure that ΔF (or STOP/ΔF) control is set at 20 MHz.
6	If the test set is equipped with a KS-20383 RF oscillator, proceed to Step 8. If the test set is equipped with a KS-19974 RF oscillator, adjust M1 (MARKER 1) control to 10 MHz less than the selected frequency; adjust M2 (MARKER 2) control to 10 MHz above the selected frequency.
7	On the RF oscillator, adjust the ΔF (STOP/ΔF) and CW (START/CW) controls to place the markers at the end of the sweep. Use the MARKER AMPLITUDE control on the RF oscillator to adjust the markers to the desired size.
8	***In Fig. 10 for 4-GHz systems,*** increase the attenuation in the variable pad by 0.5 dB. On the oscilloscope differential amplifier, adjust the POSITION and SENSITIVITY-VERNIER controls for a 5-centimeter vertical separation between the reference trace and the test trace. ***In Fig. 11 for 6-GHz systems,*** increase the attenuation in the 41A ATTEN by 0.5 dB. On the oscilloscope differential amplifier, adjust the POSITION and SENSITIVITY-VERNIER controls for a 5-centimeter vertical separation between the reference trace and the test trace. Return the attenuator setting in Fig. 10 or Fig. 11 to its original setting. This calibrates the oscilloscope for 0.1 dB per centimeter.
9	Establish the test connections given in Fig. 10, option (Z) or Fig. 11, option (Z). To recenter the trace on the oscilloscope display, adjust the POWER LEVEL control ***only.*** ***Note:*** The POWER LEVEL control should not be moved from this position or else calibration will be lost.
10	Connect the test equipment to the system under test by following the procedure in Chart 9 for TD-3, Chart 10 for TD-3A, Chart 11 for TD-3D, or Chart 12 for TH-3.

CHART 3 (Cont)

STEP	PROCEDURE
11	The ripple pattern that now appears on the oscilloscope is an indication of the return loss of the antenna system under test. Each ripple component must be analyzed to determine if an antenna system will meet the objectives for return loss. Refer to Part 3 for ripple pattern analyzation.
12	After the return-loss measurements are completed, remove the test equipment, and return the radio system to normal.

CHART 4

ANTENNA RETURN LOSS SETUP USING THE J68428A TEST SET

APPARATUS:

1—J68428A Test Set

STEP	PROCEDURE
	Warning: DO NOT leave waveguide unterminated. Possible radiation hazard may exist. DO NOT look into energized waveguides.
1	Position the test set controls as given in the following table:

UNIT	CONTROL	POSITION
Oscilloscope	VOLTS/DIV	10mV
Frequency Counter	FUNCTION	PLUG-IN
Power Meter	INPUT MODE	RF ZERO
Sweep Oscillator	RF BAND SELECTOR RF CENTER FREQ RF ΔF (MHZ) RF MODE RF POWER LEVEL	3.65-4.25 GHz or 5.9-6.5 GHz Desired Frequency 20 CW Midrange

CHART 4 (Cont)

STEP	PROCEDURE
2	Zero the power meter by adjusting the ZERO control for an indication of 000 on the digital display. Set the MODE switch to POWER METER.
3	If a microwave frequency counter is provided, check the frequency. Establish the test connections given in Fig. 12, option (W) for 4-GHz systems or Fig. 13, option (W) for 6-GHz systems. Adjust the RF CENTER FREQ control to the desired frequency of this test.
	Note: If the system has been fully turned down, any frequency can be used. If only one channel can be turned down, the frequency selected must correspond to the frequency of that channel turned down.
4	Establish the test connections given in Fig. 12, option (X) for 4-GHz systems or Fig. 13, option (X) for 6-GHz systems and adjust the RF POWER LEVEL control on the IF/RF sweep oscillator for an indication of +5 dBm on the power meter.
5	Establish the test connections as given in Fig. 12, option (Y) for 4-GHz systems or Fig. 13, option (Y) for 6-GHz systems and position the MODE switch on the RF sweeper to ΔF.
	Note: It is important to limit the oscillator sweep width to $\pm$10 MHz to prevent interference to adjacent radio channels when measuring antenna return loss.
6	Center the trace on the oscilloscope using the TEST TRACE control on the control unit and adjust the horizontal POSITION and DISPLAY WIDTH controls on the oscilloscope horizontal amplifier so that the trace extends the entire width of the oscilloscope display (approximately 10 centimeters).
7	***For 4-GHz systems*** increase the attenuation in the variable pad by 0.5 dB. On the oscilloscope, adjust the vertical VOLTS/DIV and VERNIER to give a 5-centimeter deflection of the trace. ***For 6-GHz systems*** increase the attenuation in the 41A ATTEN by 0.5 dB. On the oscilloscope, adjust the vertical VOLTS/DIV and VERNIER to give a 5-centimeter deflection of the trace. In each case, return the attenuator to its original setting. Center the test trace with the TEST TRACE control on the control unit. This calibrates the oscilloscope for 0.1 dB per centimeter.
8	Establish the test connections given in Fig. 12, option (Z) or Fig. 13, option (Z). To recenter the trace on the oscilloscope display, adjust the RF POWER LEVEL control ***only.***
	Note: The RF POWER LEVEL control should not be moved from this position or else calibration will be lost.
9	Connect the test equipment to the system under test by following the procedure in Chart 8 for TD-2, Chart 10 for TD-3A, Chart 11 for TD-3D, or Chart 12 for TH-3.
10	The ripple pattern that now appears on the oscilloscope is an indication of the return loss of the antenna system under test. Each ripple component must be analyzed to determine

	CHART 4 (Cont)
STEP	**PROCEDURE**
	if an antenna system will meet the objectives for return loss. Refer to Part 3 for ripple pattern analyzation.
11	After the return-loss measurements are completed, remove the test equipment and return the radio system to normal.

CHART 5

ANTENNA RETURN LOSS SETUP USING THE ED-50978-10 PORTABLE TEST SET

APPARATUS:

1—ED-50978-10 Portable Test Set

1—RF Power Divider, Weinshel Model 1506 or KS-21099, L1 (specified in ED-51731-10 for antenna return-loss testing)

STEP	PROCEDURE
	Warning: DO NOT leave waveguide unterminated. Possible radiation hazard may exist. DO NOT look into energized waveguides.
1	Zero the power meter by positioning the RANGE control to the lowest scale and adjusting the METER ZERO control for an indication of 0 on the power meter. Return the RANGE control to +10 dBm.
2	Establish the test connections given in Fig. 14, option (W) and position the test set controls as given in the following table:

CHART 5 (Cont)

STEP	PROCEDURE

KRUSE/SYSTRON DONNER 5000 OR 5000A SWEEP GENERATOR MAIN FRAME		OSCILLOSCOPE HEWLETT-PACKARD H02 - 1202A		5014-1 KRUSE PLUG-IN	
CONTROL	**POSITION**	**CONTROL**	**POSITION**	**CONTROL**	**POSITION**
PUSH-ON-OFF	ON	Vertical:		Markers	Markers (ON)
Sweep Seconds	0.01	Position	Midrange	Retrace	Retrace (ON)
Sweep Seconds		Sensitivity	2 MV/DIV	Leveler	Leveler (Int'l)
Vernier	Clockwise	+Input	DC	1 kHz	OFF
RECUR-TRIG-LINE	RECUR	-Input	DC		
Vernier	0	BW Limit	IN		
Mode	CW	Horizontal:			
FC ± ΔF Vernier	CALIB	Position	Midrange		
Ext/Int'l Sweep		Ext Horiz	0.5 V/DIV		
(Rear)	Int'l	Mode	NORM		
		Coupling	DC		
		Offset:			
		Input Select	OFF		

3 Adjust the RF LEVEL control on the sweeper for a power meter indication of −5 on the power meter.

4 Set the controls on the sweeper as follows:

MARKER 1 at 10 MHz below channel frequency

MARKER 2 at channel frequency

MARKER 3 at 10 MHz above channel frequency.

Note: If the system has been fully turned down, any channel frequency can be used. If only one channel can be turned down, the channel frequency selected must correspond to the frequency of that channel turned down.

5 Change the test connection as given in Fig. 14, option (X) and position the MODE switch on the sweeper to ΔF X 1. Use the setting on the lower portion of the scale to establish the ±10 MHz sweep and the upper portion of the scale to set the channel center frequency.

6 Adjust the FC ±ΔF VERNIER to adjust the sweep width to the end of the markers.

7 Center the trace on the oscilloscope.

CHART 5 (Cont)

STEP	PROCEDURE
8	Increase the attenuation in the 41A ATTEN by 0.5 dB. On the oscilloscope, adjust the vertical CAL control and the vertical sensitivity control to give a 5-centimeter deflection of the trace. Return the attenuator to its original setting. This calibrates the oscilloscope for 0.1 dB per centimeter.
9	Establish the test connections given in Fig. 14, option (Y). To recenter the trace on the oscilloscope display, adjust the RF LEVEL control ***only.*** ***Note:*** The RF LEVEL control should not be moved from this position or else calibration will be lost.
10	Connect the test equipment to the system under test by following the procedure given in Chart 12 for TH-3.
11	The ripple pattern that now appears on the oscilloscope is an indication of the return loss of the antenna system under test. Each ripple component must be analyzed to determine if an antenna system will meet the objectives of return loss. Refer to Part 3 for ripple pattern analyzation.
12	After the return-loss measurements are completed, remove the test equipment and return the radio system to normal.

CHART 6

ANTENNA RETURN LOSS SETUP USING THE KS-21140 WAVEGUIDE TDR TEST SET

APPARATUS:

1—KS-21140 Waveguide TDR Test Set

STEP	PROCEDURE
	Warning: DO NOT leave waveguide unterminated. Possible radiation hazard may exist. DO NOT look into energized waveguides.
	Initial Preparation of Test Equipment
1	Establish the test connections given in Fig. 15.
2	Connect the test equipment to a 110V ac power source and momentarily position the OPERATE switch to the 4- or 6-GHz position. The control will return to the neutral position when released.
3	Position the test set controls as given in the following table:

UNIT	CONTROL	POSITION
1207A Signal Source	POWER MODULATOR SELECTOR SQ WAVE FM AMPLITUDE ΔF	ON RF OFF Counterclockwise Counterclockwise 0
8403A Modulator	LINE PULSE (INT) SQ WAVE (INT) AM (EXT) RATE CPS (Switch) RATE CPS (Variable) DELAY μSEC (Switch) DELAY μSEC (Variable) WIDTH μSEC (Switch) WIDTH μSEC (Variable)	Depressed Depressed Released Released X1000 50 X.1 MAX CW X.1 MAX CW
Control Panel	ATTENUATOR X10 ATTENUATOR X1 FREQUENCY METER OPERATION	2 (20 dB) 5 (5 dB) Center of Test Bay Neutral
HP 180D Oscilloscope equipped with 1810A Sampler	LINE A POSITION B POSITION MODE DISPLAY (NORMAL-FILTERED) DISPLAY (on main frame) mVOLTS/DIV (SWITCH CH A and B) mVOLTS/DIV (VARIABLE CH A and B) POLARITY (CH A) POLARITY (CH B) HORIZ POSITION (COARSE AND FINE) TIME/DIV (switch) TIME/DIV (VERNIER) EXPANDED-DIRECT TRIG INPUT TRIGGER LEVEL MANUAL-SWEEP TRIG SLOPE (switch) MAGNIFIER SCAN NORM-AUTO HOLD OFF	ON Center of range Center of range A TRIG ALT FILTERED INT 50 CAL (UNCAL lamp extinguished -UP -UP Adjust to center display horizontal 50 nSEC CAL (UNCAL lamp extinguished) DIRECT EXT Center of range SWEEP (–) minus X1 3/4 turn clockwise NORM NORM (MAX counter-clockwise)
1177H03-005 TWT Amplifier	POWER READY (Lamp) RF	ON ON OFF

CHART 6 (Cont)

STEP	PROCEDURE
	Verifying Operation of the Test Set
	Check of PIN Modulator Bias
4	Connect a 2249-C-12 cord between the left PULSE OUTPUT jack on the modulator and the DC MA METER – (minus) jack on the control panel. Connect another 2249-C-12 cord between the DC MA METER + (plus) jack and the 4- or 6-GHz PULSE INPUT jack. Observe the meter indication.
	Requirement: 9 ±1 mA
	If the requirement is not met, adjust the ON/OFF ADJ control on the rear of the modulator to meet the requirement. If the requirement still cannot be met, a problem may exist in the PIN modulator and it will be necessary to make a replacement.
	Note: This check assures the proper setting of the ON/OFF ADJ control and it also provides a check on the condition of the PIN modulator. It is not necessary to readjust the ON/OFF ADJ control once it has been set.
5	Reestablish the normal test connections given in Fig. 15.
	Accuracy Check
6	Using the procedure for setting the frequency and level of the test set given in Steps 12 through 19, tune the test set to a frequency of 6.175 GHz.
7	On the TWT amplifier, set the RF switch to the OFF position. Remove the short circuit from the junction assembly and connect a 1A transducer with a 504D termination to the junction assembly. Set the RF switch on the TWT amplifier to the ON position.
	Note: The 504D termination will provide approximately 15 dB of mismatch to the circuit.
8	Make a return-loss measurement as described in Steps 29 through 32. The return loss is obtained by subtracting the value of AT #1 from AT #2.
9	Compare the value obtained in Step 8 with the value for 6.175 GHz stenciled on the body of the 504D termination.
	Requirement: The return-loss value in Step 8 should be within ±0.5 dB of the value on the 504D termination.
	Note: The two checks provided above are considered adequate for checking the TDR providing the oscilloscope is in reasonably good condition. The accuracy of the measurement of the distance to the reflection will depend entirely on the time base calibration of the oscilloscope which normally cannot be checked or adjusted in the field. Special equipment and procedures are required to calibrate the time base of the oscilloscope.

CHART 6 (Cont)

STEP	PROCEDURE
10	Position the MODULATION SELECTOR control on the signal source to the RF OFF position and the RF switch on the TWT amplifier to OFF position. Remove the 504D termination from the 1A transducer.
	TDR Measurements
	Preliminary Setup
11	Establish the test connections given in Fig. 15.
	Setting the Test Frequency and Level
12	Connect a short circuit on the junction assembly as shown in Fig. 15. Position the signal source MODULATION SELECTOR control to CW and the RF switch on the TWT amplifier to ON. Adjust the TRIGGER LEVEL control for a stable presentation.
	Requirement: Incident pulse should be the only pulse displayed on the oscilloscope.
13	Adjust the vertical sensitivity control (mV/DIV) on the oscilloscope to maintain an on-scale indication on the oscilloscope throughout the frequency setting procedure.
14	Set the FREQUENCY GHz control on the signal source to the desired frequency.
	Note: If the microwave radio system has been fully turned down, any frequency in the band of interest can be used. If only one channel can be turned down, the frequency selected must correspond to the frequency of that channel turned down.
15	Adjust the ATTENUATOR located on the signal source to obtain a maximum pulse amplitude display on the oscilloscope. Adjust the oscilloscope vertical sensitivity control (mV/DIV) to maintain an on-scale indication.
16	Adjust the FREQUENCY METER on the control panel to the desired frequency.
17	Readjust the FREQUENCY GHz control on the signal source until a dip in pulse amplitude occurs. This sets the frequency of the signal source to the desired frequency.
18	With the signal source set to the desired frequency, set the FREQUENCY METER to a point outside the band being tested. Adjust the tunable detector on the junction assembly for maximum pulse amplitude.
19	Examine the incident pulse displayed on the oscilloscope. The pulse shall be symmetrical and free from distortion or clipping. Adjust the ATTENUATOR on the control panel to obtain the most symmetrical, distortion free pulse available. The ATTENUATOR can be set anywhere between 20 and 30 dB to satisfy this condition. Always set the ATTENUATOR to the nearest multiple of 5 ***above*** the value which produces a distortion free pulse. ***Record***

CHART 6 (Cont)

STEP	PROCEDURE
	this value for later use. ***This adjustment of signal level is important and is intended to prevent the TWT amplifier from being overdriven.***
	Note: If an accuracy check of the test set is being performed, return to Step 7; if a return-loss measurement is being performed, proceed with Step 20.
20	Set the RF switch on the TWT amplifier to the OFF position.
	TDR Test Trace
21	Remove the short circuit from the junction assembly, and connect a coaxial-to-waveguide transducer to the output of the junction assembly. For 4-GHz systems, connect a 24A transducer; for 6-GHz systems, connect a 1A transducer. For TD-3D radio systems, connect the probe assembly to the output of the junction assembly.
22	Connect the transducer to the system under test by following the procedure in Chart 8 for TD-2, Chart 9 for TD-3, Chart 10 for TD-3A, Chart 11 for TD-3D, or Chart 12 for TH-3.
23	Position the RF switch on the TWT amplifier to ON.
24	Set the channel A and B POLARITY switches to the -UP position. Adjust the HORIZONTAL POSITION and TIME POSITION controls to horizontally center the test trace and the A POSITION control to vertically center the test trace.
25	Adjust the vertical sensitivity mV/DIV to obtain a presentation of the entire test trace. Leave the TIME/DIV variable control in the calibrated position (UNCAL indicator extinguished). Set the TIME/DIV control to 50 NSECs per division when testing waveguide up to 150 feet long or 0.1 microsecond when testing waveguide up to 300 feet long.
26	Adjust the TRIGGER LEVEL control for a stable presentation.
27	When the entire test trace has been established on the oscilloscope, examine the display and identify the pulse which represents the antenna, the incident pulse, and any reflected pulses which may be observed. See Fig. 17.
	Note: The incident pulse can easily be identified by manipulation of the short circuit and observation of the test trace.
28	Adjust the vertical sensitivity control (mV/DIV) on the oscilloscope to display the amplitude of the largest reflected pulse approximately full scale.
	Measuring Return Loss of Reflections
29	Mark the peak of the largest reflected pulse, either mentally or physically, on the face of the oscilloscope.

CHART 6 (Cont)

STEP	PROCEDURE
	Note: One method of establishing a reference mark is to employ the base-line trace of the unused channel on the oscilloscope. Adjust the B POSITION control to superimpose the base-line trace on the peak of the pulse being measured.
	Caution: DO NOT change any of the gain or positioning controls associated with the sampling unit on the oscilloscope once the reference has been established or the measurement will be useless.
30	***Record*** the value of the ATTENUATOR setting on the control panel as obtained in Step 19. This value will be designated AT #1 for this measurement. Now set the ATTENUATOR for maximum attenuation (79 dB).
31	Set the RF switch on the TWT amplifier to the OFF position and remove the transducer from the junction assembly. Now connect the short circuit to the junction assembly. Set the RF switch on the TWT amplifier to the ON position.
32	Remove attenuation in the ATTENUATOR on the control panel until a pulse appears at the incident location on the test trace. Continue to remove attenuation until the pulse amplitude coincides with the reference mark established in Step 29. The value of the ATTENUATOR setting will be designated AT #2. ***Record*** this value.
	Note: If an accuracy check of the test set is being performed, return to Step 8; if not, proceed with Step 33.
33	Subtract the AT #1 value from the AT #2 value to determine the reflected pulse level relative to the incident pulse level. This value gives the return loss in dB of the reflected pulse. Refer to Part 4 for an interpretation of the TDR presentation.
34	If the measured return loss was less than 30 dB, repeat Steps 20 through 33 for the next largest pulse, if any.
35	After the return-loss measurements are completed, remove the test equipment and return the radio system to normal.

CHART 7

ANTENNA RETURN LOSS SETUP USING THE SCIENTIFIC ATLANTA FAULT LOCATOR, SERIES 1691

APPARATUS:

1—Scientific Atlanta Fault Locator, Series 1691 provided with 4- and 6-GHz frequency ranges

CHART 7 (Cont)

APPARATUS(Cont):

1—Scientific Atlanta Model 1591-20 Return Loss Profile Recorder (optional)

1—Frequency Counter capable of measuring 4 and 6 GHz

Adapters and accessories as required for 4- or 6-GHz measurements

STEP	PROCEDURE
	Warning: DO NOT leave waveguide unterminated. Possible radiation hazard may exist. DO NOT look into energized waveguides.
1	Verify that the fault locator is operating properly by following the Performance Verification in the manufacturer's instruction manual.
	Caution: The fault locator begins emitting RF signals immediately when power is applied. Appropriate precautions should be taken to prevent interference with other equipment.
2	Position the BAND switch to the desired band indicated on the FREQUENCY-GHz scale.
	Note: A lamp on the FREQUENCY-GHz scale will light to indicate the selected band.
3	Operate the FREQUENCY control to the desired channel frequency.
	Note: If the microwave radio system has been fully turned down, any frequency can be used. If only one channel can be turned down, the frequency selected must correspond to the frequency of that channel turned down.
4	Establish the test connections given in Fig. 3, option (X) and position the OPERATE/FREQUENCY MEASURE switch to the FREQUENCY MEASURE position. Adjust the FREQUENCY control for the desired indication on the frequency counter.
5	Position the OPERATE/FREQUENCY MEASURE switch to OPERATE.
6	Adjust the fault locator for a ±10 MHz sweep.
	Note: An internal adjustment is provided for this procedure. Refer to the manufacturer's maintenance manual for the location of this control and instructions on its adjustments.

CHART 7 (Cont)

STEP	PROCEDURE

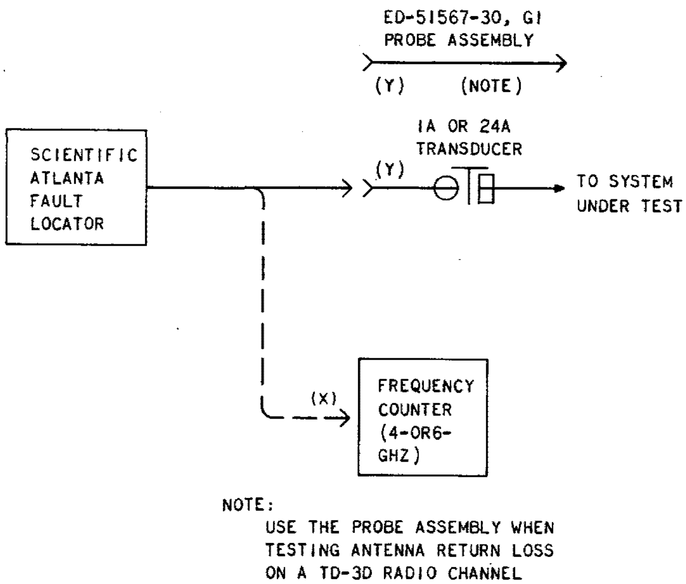


Fig. 3—Block Diagram of Test Setup Showing Interconnection for the Scientific Atlanta Test Set

7 Set the PROPAGATION CONSTANT VP/C for the relative velocity of propagation characteristic of the waveguide under test. Refer to the following table:

CHART 7 (Cont)

STEP	PROCEDURE

WAVEGUIDE NUMBER	FREQ (GHZ)	PROPAGATION CONSTANT VP/C
WR 229	3.700	0.71756
	3.750	0.72646
	3.800	0.73491
	3.850	0.74294
	3.900	0.75058
	3.950	0.75786
	4.000	0.76481
	4.050	0.77144
	4.100	0.77777
	4.150	0.78383
	4.200	0.78963
WR 159	5.950	0.78159
	6.000	0.78571
	6.050	0.78971
	6.100	0.79359
	6.150	0.79736
	6.200	0.80102
	6.250	0.80457
	6.300	0.80803
	6.350	0.81139
	6.400	0.81466
	6.450	0.81784

Note: This setting does not take into account the circular waveguide that is included in the waveguide run to the antenna. The distance indication on the fault locator will still be accurate enough to determine discontinuities in the antenna and waveguide run.

8 Perform the adjustments given in ZERO SET ADJUSTMENT in the manufacturer's instruction manual.

9 Position the RECORDER DISTANCE switch to the desired position (500 ft/250 ft).

10 Ensure that the fault locator is in the manual mode by depressing and releasing the AUTO SCAN pushbutton until the AUTO and SCAN lamps are extinguished. This cycle takes two to three seconds to complete.

11 The fault locator and recorder (if provided) can now be connected to the system under test. Establish the test connections given in Fig. 3, option (Y) and follow the procedure

CHART 7 (Cont)

STEP	PROCEDURE
	given in Chart 8 for TD-2, Chart 9 for TD-3, Chart 10 for TD-3A, Chart 11 for TD-3D, or Chart 12 for TH-3.
12	If the fault locator is to be used in the automatic mode, perform Step 13. If the fault locator is to be used in the manual mode, perform Step 14.
	Note: On the recorder, manually operate pen position to pen down before auto scan step.
13	Depress the AUTO SCAN pushbutton on the fault locator.
	Requirement 1: AUTO and SCAN lamps will be lighted.
	Requirement 2: If a recorder is provided, the pen will raise, move to zero, the pen will lower, and the fault locator will perform a scan for the selected DISTANCE range. At the end of the scan, the pen will raise, and the SCAN lamp will extinguish.
	Requirement 3: Refer to Part 5 for analyzation of the results of the measurement and for a sample calculation of return loss.
14	Depress and release the AUTO SCAN pushbutton until the AUTO and SCAN lamps are extinguished. This will take two to three seconds for operation to complete cycle.
15	Rotate the DISTANCE control while observing the meter indication.
	Requirement: Refer to Part 5 for analyzation of the results of the measurement and for a sample calculation of return loss.
16	After the return-loss measurements are completed, remove the test equipment and return the radio system to normal.

CHART 8

TEST CONNECTIONS TO A TD-2 T/R BAY

APPARATUS:

1—128S Precision Termination

1—4-GHz Shorting Plate (used when a 2A circulator is encountered in the antenna common waveguide run)

CHART 8 (Cont)

STEP	PROCEDURE
	Warning: Possible radiation hazard. DO NOT leave waveguide unterminated. DO NOT look into energized waveguides.
1	Remove the radio channel ***closest*** to the antenna waveguide run from service (see 1.06) by following the release procedures given in Section 400-400-004. De-energize the TD-2 transmitter by removing the IF drive to the transmitter or by pulling the plate fuse in the microwave generator.
2	Observe whether the common waveguide run to the antenna is equipped with an 8A isolator or a 2A circulator. If equipped with an 8A isolator, proceed with Step 3; if equipped with a 2A circulator, proceed to Step 5.
3	The 8A isolator must be physically removed from the waveguide run. Remove the waveguide screws that fasten the isolator to the waveguide run.
4	Remove the isolator from the waveguide run by sliding it in a direction that is perpendicular to the wide side of the waveguide. Refer to Fig. 4. A section of waveguide must now be inserted in the same manner for the return-loss measurement.
5	When a 2A circulator is used, the circulator may be electrically removed by removing the 520B termination and replacing the termination with a shorting plate.
6	If the measurement is to be performed on a receiver bay, connect the test equipment directly to the waveguide section feeding the 1400-type network. This is done by removing the receiver modulator and IF preamplifier. In older receiver bays, the test equipment is connected directly to the receiver beat frequency rejection filter.

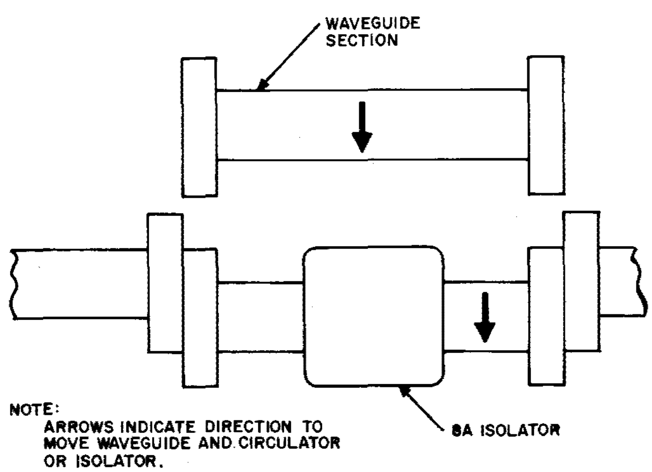


Fig. 4—Method of Removing 8A Isolator and Inserting Waveguide Section

CHART 8 (Cont)

STEP	PROCEDURE
	Note: Excessive slope may be encountered when the test equipment is connected to the receiver beat frequency rejection filter. If this happens, proceed to Step 8.
7	If the measurement is to be performed on a transmitter bay, connect the test equipment directly to the output monitor directional coupler. The transmitting amplifier must be removed to make this connection. When using the J68345A test set, this connection cannot be made directly, so a transducer assembly must be used. The cable length of the transducer assembly should be as short as possible (less than 12 inches). ***Use a sling to prevent any damage to the equipment.***
	Note: Excessive slope may be encountered when the test equipment is connected to the transmitter output monitor. If this happens, proceed with Step 8.
8	Remove the tuners (with the exception of the 400A tuner associated with the 1400- and 1401-type networks), filter, etc, from the 1400- or 1401-type network and check again directly into the 1400- or 1401-type network.
9	If the slope now disappears, check the filter and tuner assemblies as given in Step 10. If the slope is still evident, a defect probably exists within the first 25 feet of waveguide. Investigate the cause of the defect.
10	To check the receiver beat frequency rejection filter assemblies or transmitter output monitor and tuner, prepare the test equipment as given in Chart 1 or Chart 3. If Chart 1 is used, establish the connections given in Fig. 8, with AT3 set to 20 dB and a 128S termination on the output of AT3. If Chart 4 is used, connect a 24A transducer to the output of the 20-dB RF pad with a 128S termination.
11	In Chart 1, repeat Steps 8 through 12; in Chart 4, repeat Steps 7 and 8. When AT3 (Chart 1) is set to 0 dB, the test trace will be slightly elliptical.
12	Connect the suspect beat frequency rejection filter (or transmitter output monitor and tuner) between AT3 and the 128S termination or between the 24A transducer and the 128S termination.
13	If the assembly is properly tuned, the test trace will not change from what it was in Step 11. If the test trace opens up (in comparison with the test trace in Step 11) or the slope exceeds 0.1 dB, this indicates that one or more pieces of the assembly are misaligned. It will be necessary to check each piece individually or to arrange for replacement of the assembly.
	Note: Under no circumstances should receiver beat **frequency filters, transmitter output monitors, or tuners be adjusted or tuned in the field.**

CHART 9

TEST CONNECTIONS TO A TD-3 T/R BAY

APPARATUS:

None

STEP	PROCEDURE
	Warning: Possible radiation hazard. DO NOT leave waveguide unterminated. DO NOT look into energized waveguides.
1	Remove the radio channel ***closest*** to the antenna waveguide run from service (see 1.06) by following the release procedure given in Section 400-400-004. De-energize the TD-3 to transmitter by pulling the IF drive to the transmitter driver amplifier.
	Note: In some few instances, an isolator or circulator may have been inserted in the common waveguide run to the antenna. If so, it must be removed for the return loss measurement. An isolator must be physically removed and replaced with a section of waveguide. A circulator may be electrically removed by removing the 520B termination and replacing it with a shorting plate.
2	To measure a receiving antenna and waveguide system, connect the test equipment to the output of the receiving 1322- or 1336-type bandpass filter by breaking the waveguide connection between the 8A or 19A isolator and the bandpass filter. Silence the audible alarm.
	Note: If excessive slope is encountered when the test equipment is connected, a defect probably exists within the first 25 feet of waveguide. Investigate the cause of the defect.
3	To measure a transmitting antenna and waveguide system, connect the test equipment to the input of the transmitting 1322- or 1336-type bandpass filter located on the output side of the TWT amplifier by breaking the waveguide connection between the 24B directional coupler and the bandpass filter.
	Note: If excessive slope is encountered when the test equipment is connected, a defect probably exists within the first 25 feet of waveguide. Investigate the cause of the defect.

CHART 10

TEST CONNECTIONS TO A TD-3A T/R BAY

STEP	PROCEDURE
	Warning: Possible radiation hazard. DO NOT leave waveguide unterminated. DO NOT look into energized waveguides.
1	Remove the radio channel ***closest*** to the antenna waveguide run from service (see 1.06) by following the release procedure given in Section 400-400-004. De-energize the TD-3A transmitter by pulling the IF drive to the transmitter driver amplifier.
	Note: In some few instances, an isolator or circulator may have been inserted in the common waveguide run to the antenna. If so, it must be removed for the return-loss measurement. An isolator must be physically removed and replaced with a section of waveguide. A circulator may be electrically removed by removing the 520B termination and replacing it with a shorting plate.
2	To measure a receiving antenna and waveguide system, connect the test equipment to the output of the receiving 1433-type channel bandpass filter (part of the 1433-type channel separating network) by breaking the waveguide connection between the 19A isolator and the channel bandpass filter. Silence the audible alarm.
	Note: If excessive slope is encountered when the test equipment is connected, a defect probably exists within the first 25 feet of waveguide. Investigate the cause of the defect.
3	To measure a transmitting antenna and waveguide system, connect the test equipment to the input of the transmitter 1432-type channel combining network by breaking the waveguide connection at this point.
	Note: If excessive slope is encountered when the test equipment is connected, a defect probably exists within the first 25 feet of waveguide. Investigate the cause of the defect.

CHART 11

TEST CONNECTIONS TO A TD-3D T/R BAY

APPARATUS:

3—ED-51568-30, G2 Shorting Plates

1—ED-51567-30, G1 Probe Assembly

CHART 11 (Cont)

STEP	PROCEDURE
	Warning: Possible radiation hazard may exist. DO NOT leave waveguide unterminated. DO NOT look into energized waveguides.
1	Remove the termination at the ***end*** of the bay line-up common waveguide run and replace it with a shorting plate. This is done on both the receiving and transmitting waveguide runs.
2	Remove the radio channel ***closest*** to the shorting plate (installed in Step 1) from service (see 1.06) according to the release procedures given in Section 400-400-004. De-energize the TD-3D transmitter by pulling the IF drive to the transmitter driver amplifier.
	Note: In some few instances, an isolator or circulator may have been inserted in the common waveguide run to the antenna. If so, it must be removed for the return-loss measurement. An isolator must be physically removed and replaced with a section of waveguide. A circulator may be electrically removed by removing the 520B termination and replacing it with a shorting plate.
3	To measure a receiving antenna and waveguide system, remove the plug from port B on the ED-52277-30, G2 monitor shutter and insert the ED-51567-30, G1 probe assembly. Remove the holding screws on the coverplate on the left side of the monitor shutter. Insert three ED-51568-30, G2 shorting plates into the three slides of the monitor shutter. Silence the audible alarm. Secure the screws on the shorting plates. Connect the test equipment to the probe assembly.
4	To measure a transmitting antenna and waveguide system, remove the 76A detector from port B on the ED-52277-30, G1 monitor shutter. Silence the audible alarm. Insert the ED-51567-30, G1 probe assembly into port B. Remove the holding screws on the coverplate on the right side of the monitor shutter and insert three ED-51568-30, G2 shorting plates into the three slides of the monitor shutter. Secure the screws on the shorting plates. Connect the test equipment to the probe assembly.

CHART 12

TEST CONNECTIONS TO A TH-3 T/R BAY

APPARATUS:

None

STEP	PROCEDURE
	Warning: Possible radiation hazard. DO NOT leave waveguide unterminated. DO NOT look into energized waveguides.
1	Remove the radio channel ***closest*** to the antenna waveguide run from service (see 1.06) by following the release procedure given in Section 400-400-004. De-energize the TH-3 transmitter by pulling the IF drive at the IF IN jack of the IF limiter amplifier and terminate the end of this cable with a 20-dB, 63A pad or 188A adapter and a 20-dB, 19A pad.
	Note: When TH-3 is arranged in a hot standby configuration, the common waveguide run to the antenna should be equipped with a 6B isolator. This must be physically removed and replaced with a section of waveguide for the duration of the return-loss measurement.
2	To measure a frequency diversity receiving antenna and waveguide system, connect the test equipment to the output of the 1426-type channel separating network by removing the test access section of waveguide. Silence the audible alarm.
	Note: If excessive slope is encountered when the test equipment is connected, a defect probably exists within the first 25 feet of waveguide. Investigate the cause of the defect.
3	To measure a hot standby receiving antenna and waveguide system, place a 504C termination on the output port of the 20A or D510 directional coupler (in the waveguide circuit) which is connected to the standby (STBY) receiver. In the REG receiver, remove the 61A bend (waveguide twist). Connect the test equipment to port 2 of the channel dropping network and proceed with the return-loss measurement of the REG receiver.
	When the measurement is completed for the REG receiver, remove the 504C termination from the output port to the STBY receiver and connect it to the output port to the REG receiver and reconnect the waveguide from the STBY receiver to the directional coupler. In the STBY receiver, remove the 61A bend (waveguide twist). Connect the test equipment to port 2 of the channel dropping network and proceed with the return-loss measurement of the STBY receiver.
4	To measure a space diversity regular receiving antenna and waveguide system, remove the 61A bend (waveguide twist) from the regular receiver of the channel dropping network and proceed with the return-loss measurement.
5	To measure a space diversity standby antenna and waveguide system, remove the 61A bend (waveguide twist) from the standby receiver. Connect the test equipment to port 2 of the channel dropping network and proceed with the return-loss measurement.
	Note: If excessive slope is encountered when the test equipment is connected, a defect probably exists within the first 25 feet of waveguide. Investigate the cause of the defect.

CHART 12 (Cont)

STEP	PROCEDURE
6	To measure a frequency diversity transmitting antenna and waveguide system, disconnect the P46Y334 waveguide twist from the transmitter test access port and disconnect the KS-20349, L1 flexible waveguide from port 2 of the channel combining network. Remove this section of waveguide from the bay. Connect the test equipment to port 2 of the channel combining network and proceed with the return-loss measurement. *Note:* Cover the open waveguide space to prevent foreign material from entering the waveguide.
7	To measure a hot standby transmitting antenna and waveguide system, disconnect OSM connector from ports 1, 2, and 3 of the RF switch. Remove the D40-10 microwave research transducer from port 2 of the channel combining network (CCN). Remove the P46Y334 waveguide twist from the transmitter test access port and cover the open waveguide spacer to prevent foreign material from entering the waveguide. Connect the test equipment to the port of the CCN and proceed with the return-loss measurement.

3. RIPPLE METHOD INTERPRETATION

A. General

3.01 In order to determine if an antenna system will meet the objectives for return loss, it is necessary to separate the ripple pattern into individual components. Frequently, irregularities at different locations in the antenna system result in several waveguide echoes. Echoes from different sources will have different amplitude and phase relationships on the transmission system. The ripple pattern must be analyzed by observing the peak-to-peak amplitude and frequency spacing between peaks of the individual ripples which comprise the ripple pattern within the 20-MHz bandwidth. Once determined, the amplitude and frequency spacing of the ripple cycle can be compared with the return-loss objectives given in 1.02.

B. Distance to Reflection Points

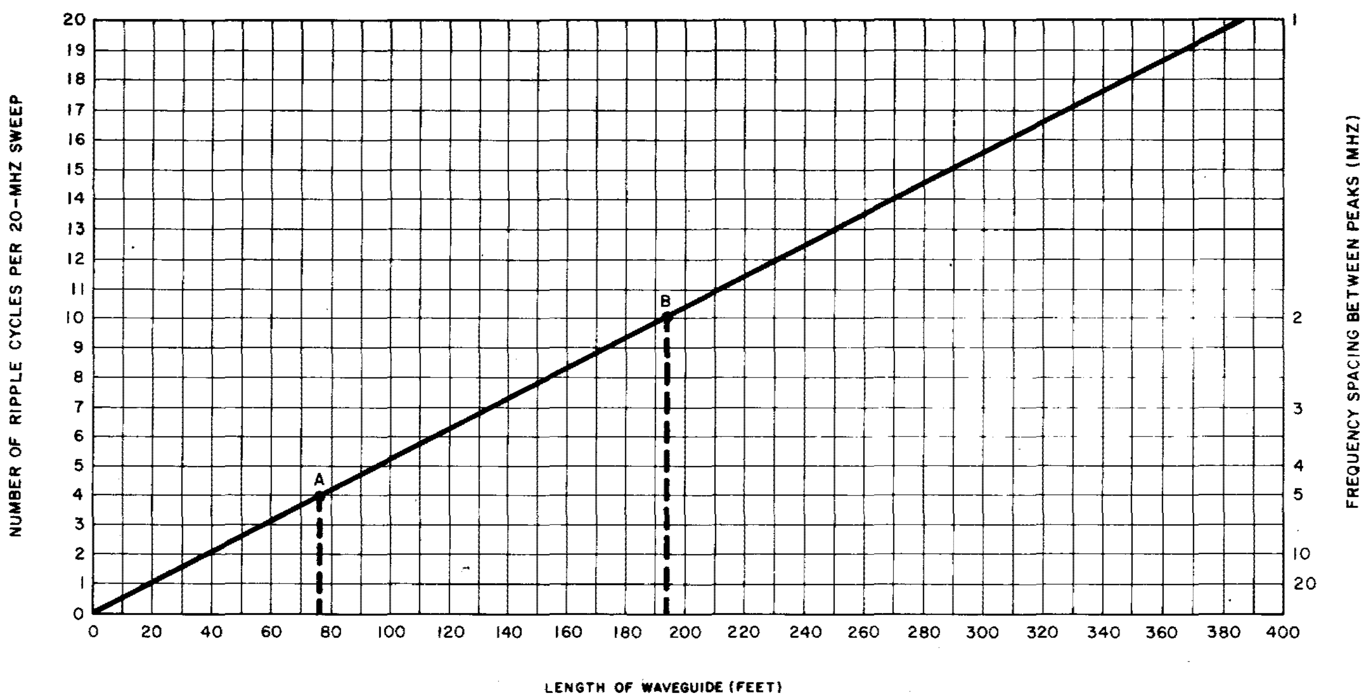
3.02 Once the ripple pattern is analyzed to determine the number of ripple cycles within the 20-MHz bandwidth, the distance to the reflection point can be determined. Two methods are available for determining the distance:

(1) Determine the number of ripples for each ripple component in the 20-MHz bandwidth and use the part of Fig. 5 designated NUMBER OF RIPPLE CYCLES versus LENGTH OF WAVEGUIDE. This may be difficult if the waveform is complicated.

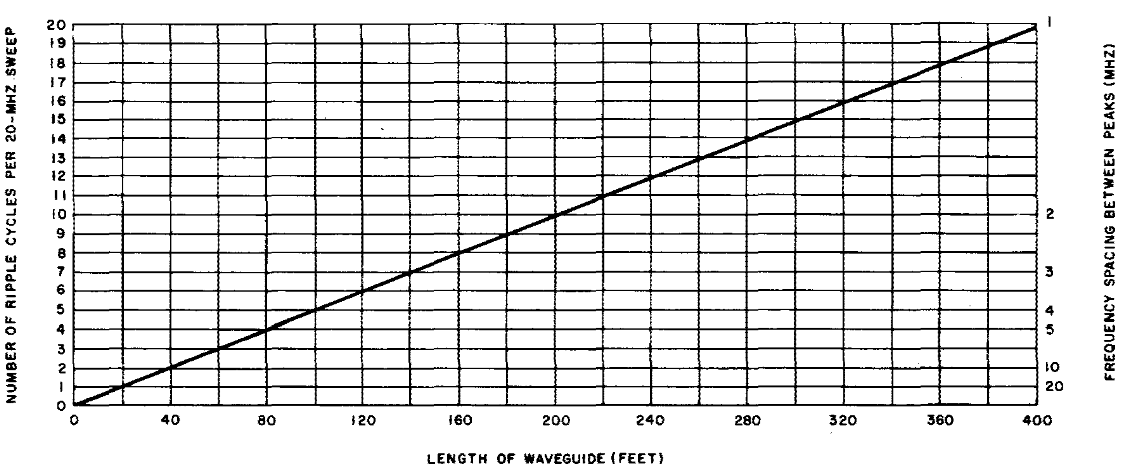
(2) Determine the frequency spacing between peaks of each ripple component and use the part of Fig. 5 designated FREQUENCY SPACING BETWEEN PEAKS versus LENGTH OF WAVEGUIDE.

C. Return Loss at the Point of Reflection

3.03 To determine the return loss of the reflections, the ripple pattern is analyzed to determine the amplitude of each ripple and then convert it to return loss in dB by using Fig. 6. This return loss figure derived from Fig. 6 is the return loss at the point of measurement and appears to give the antenna and waveguide system a better return loss than the return loss at the point of reflection. For this reason, it is necessary to calculate the return loss at the point of reflection instead of the point of measurement. The ripple amplitude is affected by waveguide losses and other losses due to networks encountered in the waveguide. Refer to Part 6 for the procedure for accounting for waveguide and network losses and electrical lengths introduced by networks.



A. 4-GHZ SYSTEMS



B. 6-GHZ SYSTEMS

Fig. 5—Number of Ripples Versus Distance to Mismatch—4- or 6-GHz Systems

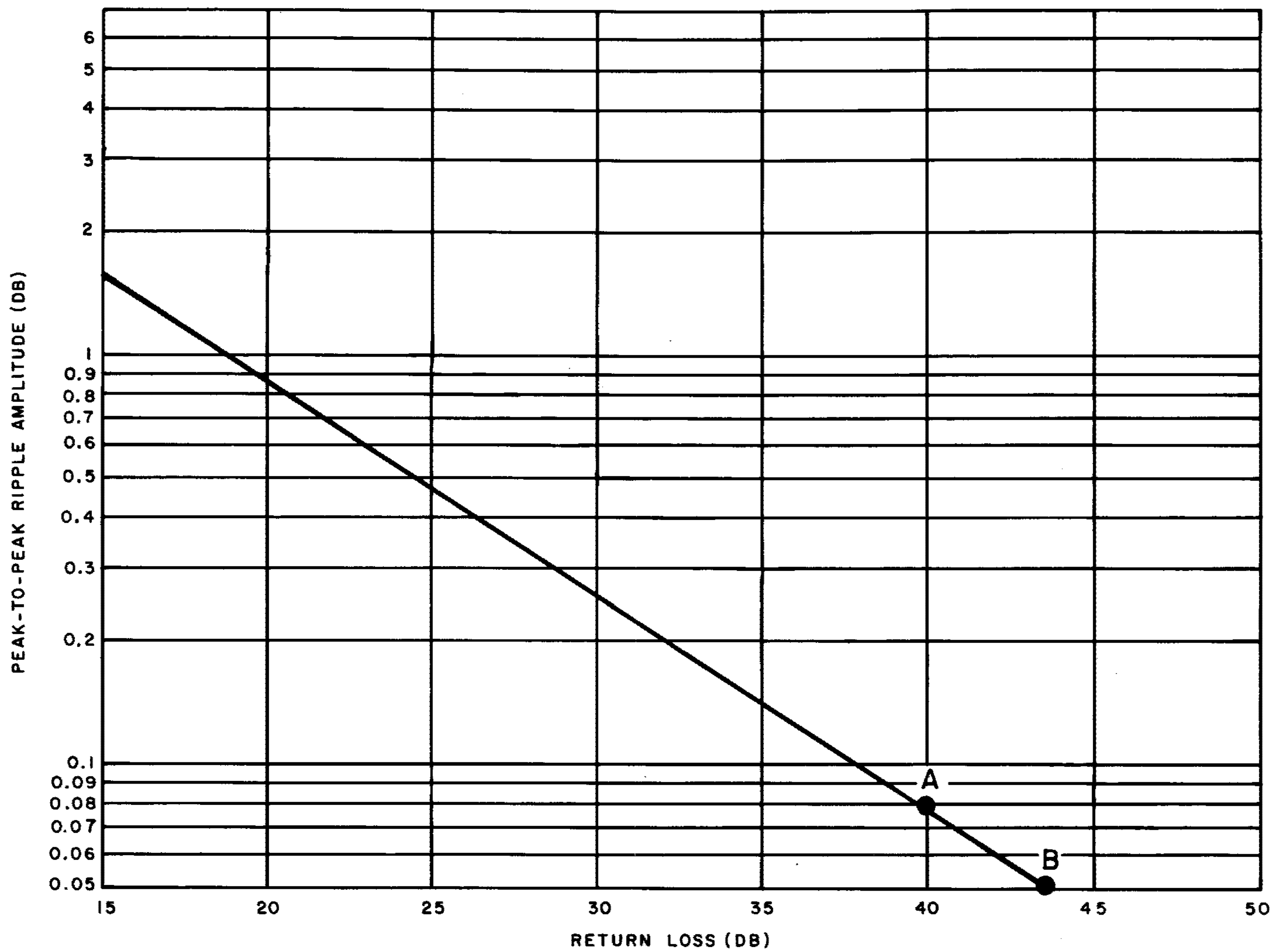


Fig. 6—Return Loss Versus Peak-to-Peak Ripple Amplitude

D. Sample Calculation

3.04 This sample calculation is based upon a typical oscilloscope presentation, Fig. 7, of a return-loss test on a TD-3 radio receiving antenna and waveguide run with a vertically polarized signal. The test is made on the radio bay closest to the waveguide run to the antenna. The waveguide run consists of 100 feet of rectangular waveguide (WR229) and 100 feet of circular waveguide (WC281). For this example, two points of reflection (represented by F1-F2 and F3-F4) have been used. These points of reflection have been represented by points A (F1-F2) and B (F3-F4) in Fig. 5 and 6. The oscilloscope has been set up to give a horizontal spacing of 2 MHz per horizontal division and vertical spacing of 0.1 dB per vertical division. Perform the return-loss calculations as follows:

(a) Determine the frequency spacing between peaks of each ripple component by using Fig. 7.

F1-F2—approximately 5 MHz
F3-F4—approximately 2 MHz

(b) Determine the peak-to-peak amplitude of each individual ripple component by using Fig. 7.

F1-F2—approximately 0.08 dB
F3-F4—approximately 0.05 dB

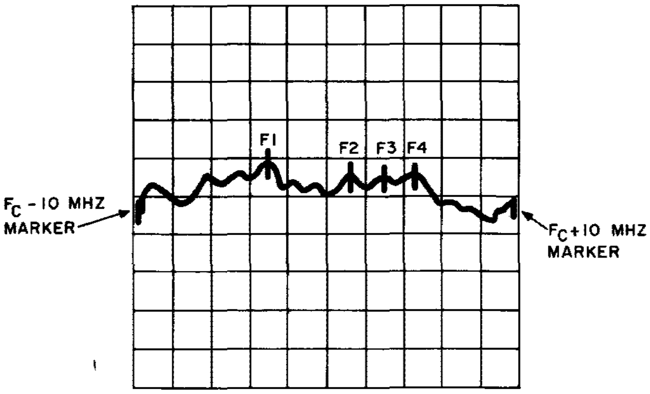


Fig. 7—Typical Oscilloscope Presentation for Antenna Return Loss

(c) Use the peak-to-peak amplitude of each ripple component, 3.04(a), and convert it to return loss by using Fig. 6.

F1-F2 (point A)—approximately 40 dB
F3-F4 (point B)—approximately 44 dB

(d) Use the frequency spacing between ripple peaks for each ripple component, 3.04(b), and convert it to distance to the reflection point using Fig. 5. This distance includes the mechanical length of the waveguide plus the electrical length introduced by the TD-3 channel separating network (45 feet).

F1-F2 (point A)—approximately 75 feet
F3-F4 (point B)—approximately 195 feet

(e) Determine the losses due to waveguide, networks, and in-path waveguide attenuators by following the procedure in Part 6.

Waveguide and network losses for F1-F2 are:
Waveguide losses = 1.35 dB
Network losses = 2 dB
Total losses of waveguide and network = 3.35 dB

Waveguide and network losses for F3-F4 are:
Waveguide losses = 3.01 dB
Network losses = 3.2 dB
Total losses of waveguide and network = 6.21 dB

(f) Determine the actual return loss at the points of reflection by subtracting the losses due to waveguide and networks, 3.04(e), from the return loss in 3.04(c).

F1-F2—40 dB minus 3.35 dB = 36.65 dB
F3-F4—44 dB minus 6.21 dB = 37.79 dB

(g) Determine the actual distance to the points of reflection by subtracting the electrical length introduced by the channel separating network, Table A in Part 6, from the distance determined in 3.04(d).

Distance to F1-F2—75 feet − 45 feet = 30 feet
Distance to F3-F4—195 feet − 45 feet = 150 feet

(h) Determine if each point of reflection meets the return-loss objectives given in 1.02 by using the values obtained in 3.04(f) and 3.04(g). If the objectives cannot be met, investigate the cause of the reflection and repeat the return loss procedure.

4. KS-21140 TEST SET INTERPRETATION OF RESULTS

A. General

4.01 The oscilloscope presentation provides the information for measuring return loss and information for determining the distance to any point of reflection. Each irregularity is displayed as a separate reflection and the amplitude and location of each reflection has no influence on another reflection. Once the return loss and distance has been determined, the reflection can be compared with the return-loss objectives given in 1.02.

B. Return Loss at the Point of Reflection

4.02 Once the return loss of the largest pulse has been determined as given in Chart 6, Steps 29 through 33, the return loss of this reflection point must be calculated. The return-loss value obtained by subtracting AT #1 from AT #2 is the return loss at the point of ***measurement***. Waveguide and network losses must be subtracted from this value to give the return loss at the point of

reflection. Refer to Part 6 for the procedure for accounting for waveguide and network losses. It is not necessary to actually measure every reflected pulse observed. After the largest reflected pulse has been measured, determine if any of the remaining pulses need to be checked. (See Chart 6, Step 34.) The number of dB/DIV of return loss can be used to estimate the value of any of the remaining pulse. This estimation will give an indication as to which pulse may need to be checked.

C. Distance to the Reflection Point

4.03 The separation between the incident pulse and the reflected pulse determines the distance (in feet) to each irregularity or mismatch causing the reflection. For each TIME/DIV setting on the oscilloscope, a ft/DIV factor is used to convert the round trip time in nanoseconds to one way distance in feet. The conversion factor for each oscilloscope setting is given as follows: 10 nsec/DIV—4 ft/DIV, 20 nsec/DIV—7.5 ft/DIV, 50 nsec/DIV—19 ft/DIV, 100 nsec/DIV—39 ft/DIV, and 200 nsec/DIV—78 ft/DIV. The distance to a reflection is obtained by multiplying the value listed by the number of divisions (separation) between the incident and the reflected pulse.

D. Sample Calculation

4.04 This sample calculation is based upon a return-loss test made on a TD-3 radio receiving antenna and waveguide run with a vertically polarized signal. This test is made on the radio bay closest to the waveguide run to the antenna. The waveguide run consists of 100 feet of rectangular waveguide (WR229) and 100 feet of circular waveguide (WC281) to the antenna. The TIME/DIV setting on the oscilloscope is set at 100. The return-loss value obtained from subtracting AT #1 from AT #2 is 42 dB. The reflected pulse of interest is separated from the incident pulse by 4 divisions. Perform the calculation as follows:

(a) Determine the distance to the reflection by multiplying the number of divisions that separate the incident pulse from the pulse of interest by the conversion factor given in 4.03. Use the value from 4.03 for the 100 nsec/DIV setting. Distance (in feet) to reflection = 4 divisions × 39 ft/DIV = 156 feet

(b) Determine the losses due to waveguide and networks by following the procedure in Part 6.

Waveguide losses = 2.7 dB
Network losses = 2 dB
Total losses of waveguide and network = 4.7 dB

(c) Determine the actual return loss at the point of reflection by subtracting the loss due to waveguide and networks, 4.04(b), from the value obtained from subtracting AT #1 from AT #2 (42 dB).

Return loss = 42 dB minus 4.7 dB = 37.3 dB

(d) Determine the actual distance to the point of reflection by subtracting the electrical length introduced by the 1418( ) network, Table A in Part 6, from the distance determined in 4.04(a).

Distance to reflection point = 156 feet minus 45 feet = 111 feet

(e) Determine if the reflection point meets the return-loss objectives given in 1.02 by using the values obtained in 4.04(c) and 4.04(d). If the objectives cannot be met, investigate the cause of the reflection and repeat the return loss procedure.

5. SCIENTIFIC ATLANTA FAULT LOCATOR INTERPRETATION OF RESULTS

A. General

5.01 The return-loss indications and distance indications obtained from the Scientific Atlanta test set, either manually operated or automatic operation with a recorder, gives a profile look of the entire antenna and waveguide system. Each reflection is separated from the others and has no influence on each other. However, these indications are at the point of measurement and must be converted to the point of reflection to determine if the antenna and waveguide system will meet the return-loss objectives given in 1.02.

B. Return Loss at the Point of Reflection

5.02 Once the return loss of each reflection has been determined by the fault locator, the return loss at the point of reflection must be determined. Waveguide and network losses must be subtracted from the return-loss value or else the antenna and waveguide system will appear to have a better return loss than it actually has. Refer to Part 6 for the procedure for accounting for waveguide and network losses.

C. Distance to Reflection Point

5.03 The distance indication obtained from the fault locator is the total length of waveguide encountered plus any electrical length introduced by the channel separating or combining networks. Therefore, the electrical length introduced by these networks must be subtracted from the distance indication to locate the irregularity or mismatch. Refer to Table A in Part 6 for this electrical length.

D. Sample Calculation

5.04 This sample calculation is based upon a return-loss test made on a TD-3 radio receiving antenna and waveguide run with a vertically polarized signal. This test is made on the radio bay closest to the waveguide run to the antenna. The waveguide run consists of 100 feet of rectangular waveguide (WR229) and 100 feet of circular waveguide (WC281) to the antenna. For this example, an irregularity or mismatch at 175 feet with a return loss of 42 dB will be used. Perform the calculation as follows:

(a) Determine the losses due to waveguide and networks by following the procedure in Part 6.

Total losses due to waveguide and networks = 6.05 dB

(b) Determine the actual return loss at the point of reflection by subtracting the losses due to waveguide and networks, 5.04(a), from the return loss indication on the fault locator.

Return Loss = 42 dB minus 6.05 dB = 35.95 dB

(c) Determine the actual distance to the point of reflection by subtracting the electrical length introduced by the 1418( ) network, Table A in Part 6, from the distance indication on the fault locator.

Distance to reflection point = 175 feet minus 45 feet = 130 feet

(d) Determine if the reflection point meets the return-loss objectives given in 1.02 by using the values obtained in 5.04(b) and 5.04(c). If the objectives cannot be met, investigate the cause of the reflection and repeat the return loss procedure.

6. ACCOUNTING FOR WAVEGUIDE AND NETWORK LOSSES AND ELECTRICAL LENGTHS INTRODUCED BY CHANNEL NETWORKS

A. Waveguide and Network Losses

6.01 The return-loss value obtained in the test measurement is at the point of measurement. Since the return loss is affected by waveguide and network losses, these losses must be subtracted from the return-loss value to give the return loss at the point of reflection. It is sufficiently accurate to assume a loss for rectangular waveguide of 0.009 dB/ft for WR229 waveguide or 0.013 dB/ft for WR159 waveguide. The loss due to circular waveguide (WC281) is 0.004 dB/ft for 4 GHz or 0.003 dB/ft for 6 GHz. System combining networks and channel separating and combining networks also introduce loss to the signal. Refer to Table A for losses due to radio channel networks and to Fig. 15 for losses due to system combining networks.

B. Electrical Lengths Introduced by Networks

6.02 When the test signal is inserted in the radio channel bay, the channel combining network or the channel separating network will introduce an additional electrical length of waveguide. The distance indication obtained in the test measurement consists of the mechanical length of the waveguide and the electrical length of waveguide introduced by the network in the radio bay. Since the test signal must travel out to the reflection point and back again, the total length of waveguide to be accounted for is twice the distance to the reflection point. This distance will be used to obtain the loss value due to waveguide. Refer to Table A for the electrical length introduced by the particular network. The table gives one-way distance for each channel network. Once the loss value has been obtained and subtracted from the measured return loss value, the distance to the reflection point can be determined by subtracting the one-way electrical distance introduced by the network from the distance indication from the test measurement.

TABLE A

NETWORK	COUPLING LOSS	INSERTION LOSS	ELECTRICAL DISTANCE OF COUPLING PATH
1400( ) or 1401( ) TD-2 Network	0.5 dB	0.2 dB	9 feet of WR229 waveguide
Receiver Beat Freq Rejection Filter	—	0.2 dB	2 feet of WR229 waveguide
1418( ) TD-3 Network	0.5 dB	0.1 dB	45 feet of WR229 waveguide
1322( ) Filter TD-3	—	0.5 dB	—
1433( ) TD-3A Network	0.6 dB	0.07 dB	29 feet of WR229 waveguide
1432( ) TD-3A Network	0.4 dB	0.05 dB	23 feet of WR229 waveguide
1426( ) TH-3 Network	1.3 dB	0.03 dB	37 feet of WR159 waveguide
1340( ) TH-3 Network	0.65 dB	0.03 dB	19 feet of WR159 waveguide
1355( ) Filter TD-3D	—	0.4 dB	18.5 feet of WR229 waveguide
2A Circulator TD-3D	—	0.1 dB	—
20A Directional Coupler TH-3	3 dB	3 dB	—
D510 Directional Coupler TH-3	12.5 dB	0.25 dB	—

C. Sample Calculation

6.03 This sample calculation is based upon a return-loss measurement made on a TD-3 radio receiving antenna and waveguide that has a vertically polarized signal. The waveguide run consists of 100 feet of rectangular waveguide (WR229) and 100 feet of circular waveguide (WC281) to the antenna. In this example, the test equipment indicates a point of reflection at 175 feet from the signal source. Perform the calculation as follows:

(a) Subtract the electrical length introduced by the 1418( ) network (Table A) from the distance indication from the test equipment. The resulting value will be the actual waveguide in the antenna run.

Waveguide Distance = 175 feet − 45 feet = 130 feet

(b) Determine the loss due to waveguide. Since the signal travels out and back, the result is a round trip loss.

(100 feet × 2) × 0.009 dB/ft = 1.8 dB
(30 feet × 2) × 0.004 dB/ft = 0.24 dB

Total loss due to waveguide = 1.8 dB + 0.24 dB = 2.04 dB

(c) Determine the loss due to the electrical distance introduced by the channel network. This is also a round trip loss.

Loss due to network distance = (45 feet × 2) × 0.009 dB/ft = 0.81 dB

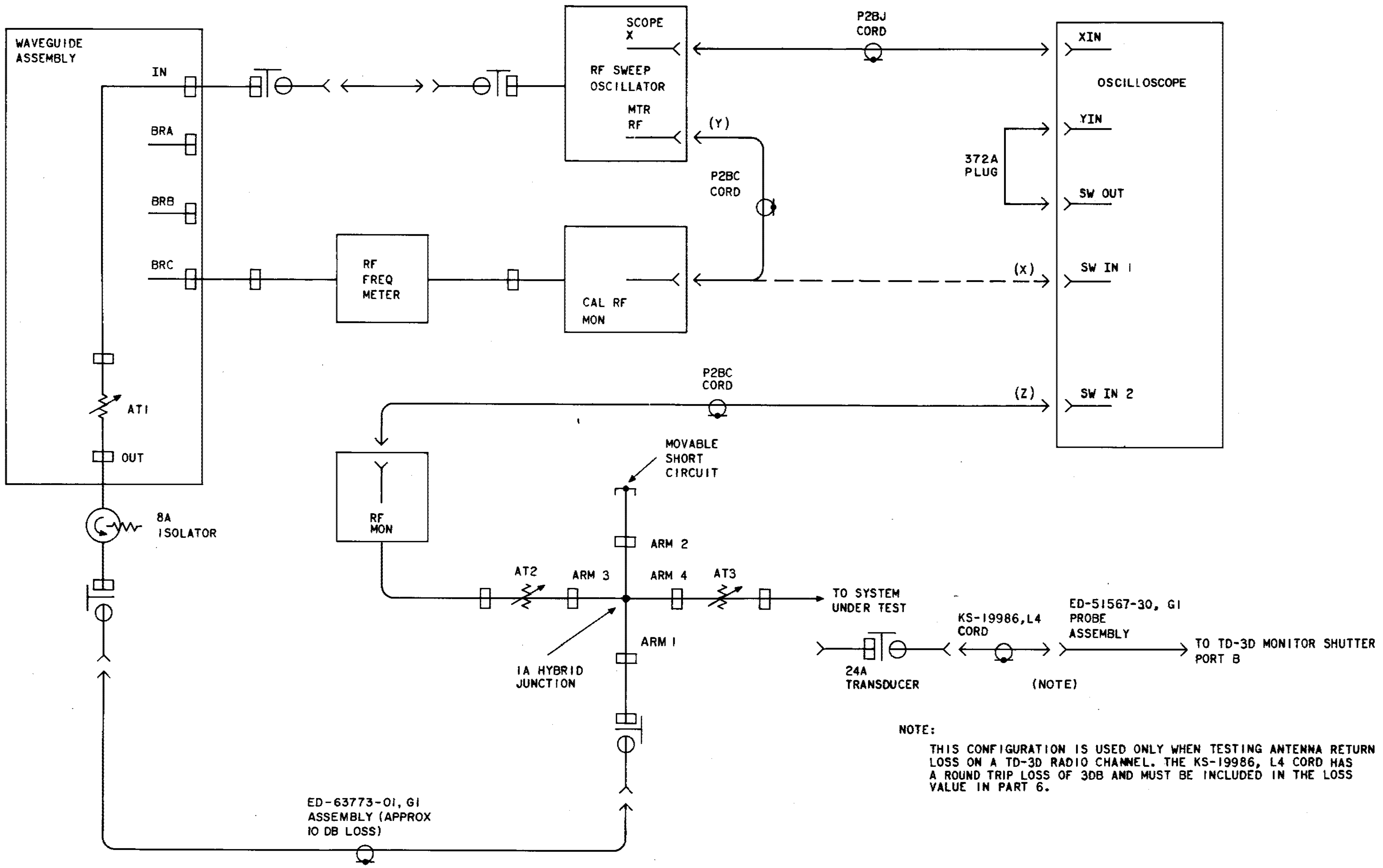
(d) Determine the coupling losses and insertion losses due to the networks. This is also a round trip loss. Refer to Fig. 15 and Table A.

1418( ) network—coupling loss = 0.5 dB × 2 = 1 dB
1322( ) filter—insertion loss = 0.5 dB × 2 = 1 dB
1407A network—coupling loss = 0.4 dB × 2 = 0.8 dB
1407A network—insertion loss = 0.2 dB × 2 = 0.4 dB
Total loss due to networks = 3.2 dB

(e) Determine the total losses due to waveguide and networks by adding the value in 6.03(b), 6.03(c), and 6.03(d)

Total loss due to networks and waveguide = 2.04 dB + 0.81 dB + 3.2 dB = 6.05 dB

This value is now subtracted from the return-loss value obtained from the test equipment to give the return loss at the point of reflection.



NOTE:

THIS CONFIGURATION IS USED ONLY WHEN TESTING ANTENNA RETURN LOSS ON A TD-3D RADIO CHANNEL. THE KS-19986, L4 CORD HAS A ROUND TRIP LOSS OF 3DB AND MUST BE INCLUDED IN THE LOSS VALUE IN PART 6.

Fig. 8—Block Diagram of Test Setup Showing Interconnections for the J68345A Test Set

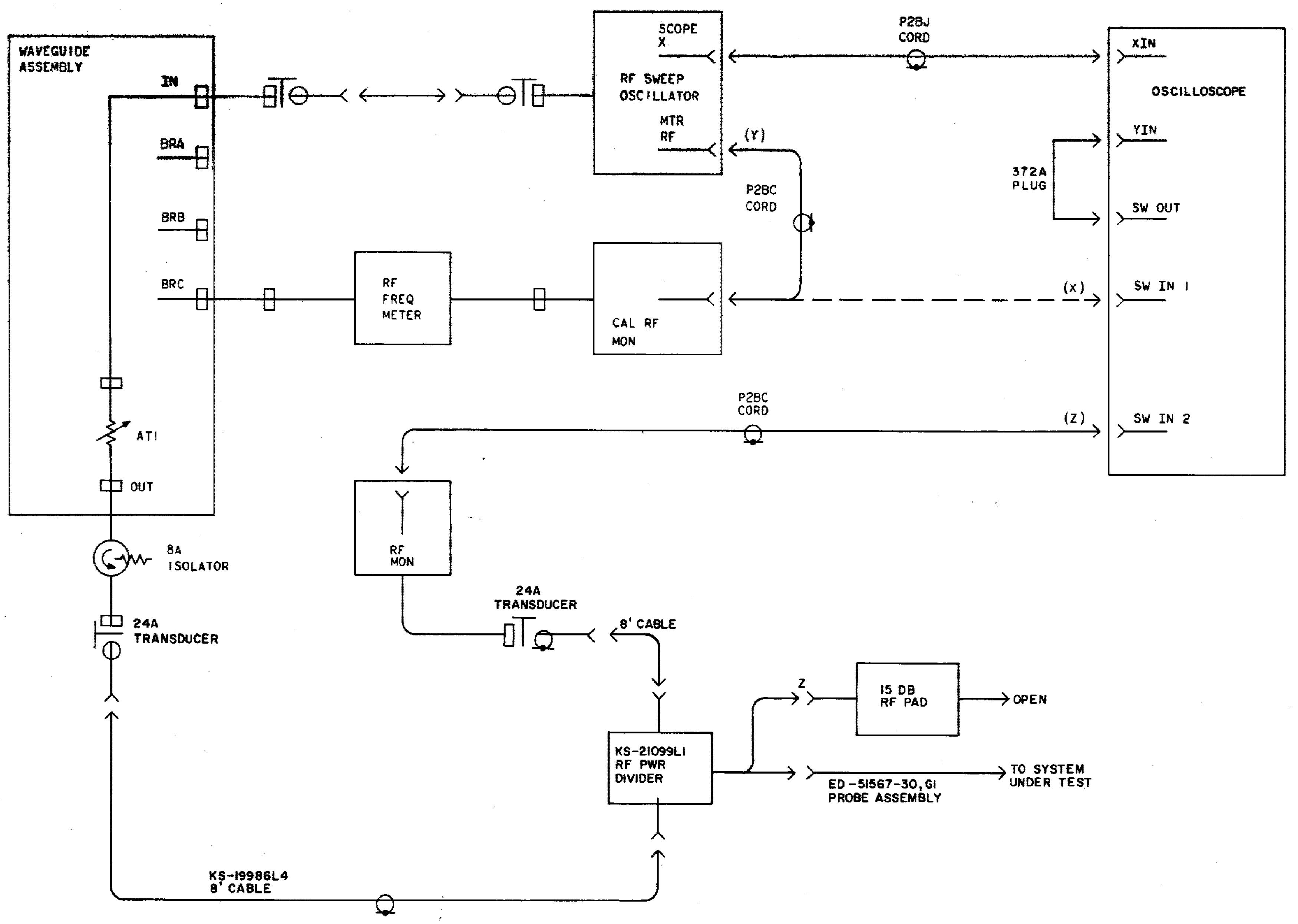


Fig. 9—Block Diagram of Test Setup Showing Interconnections for the J68345A Test Set Using the KS-21099, L1 Power Divider

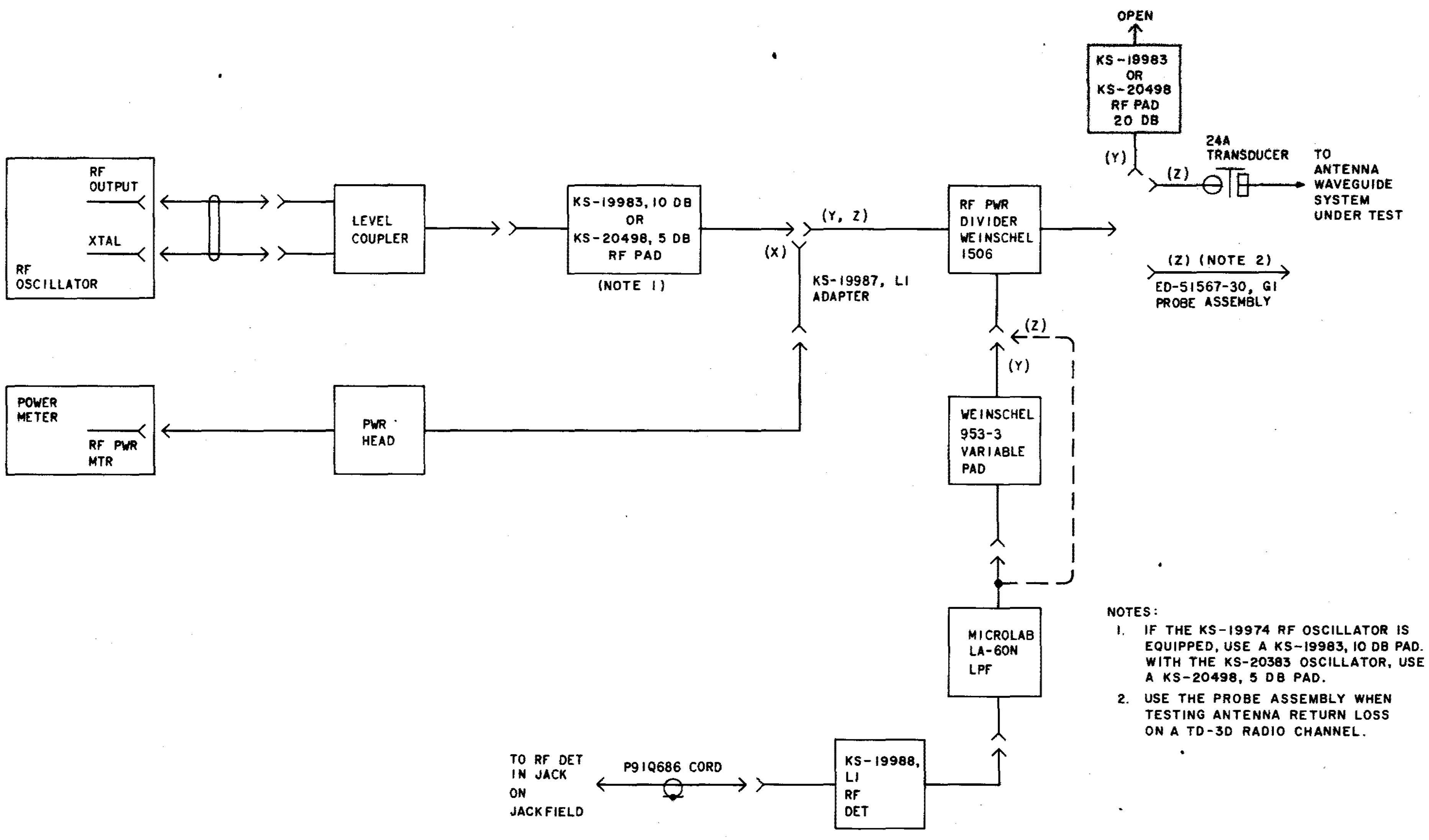
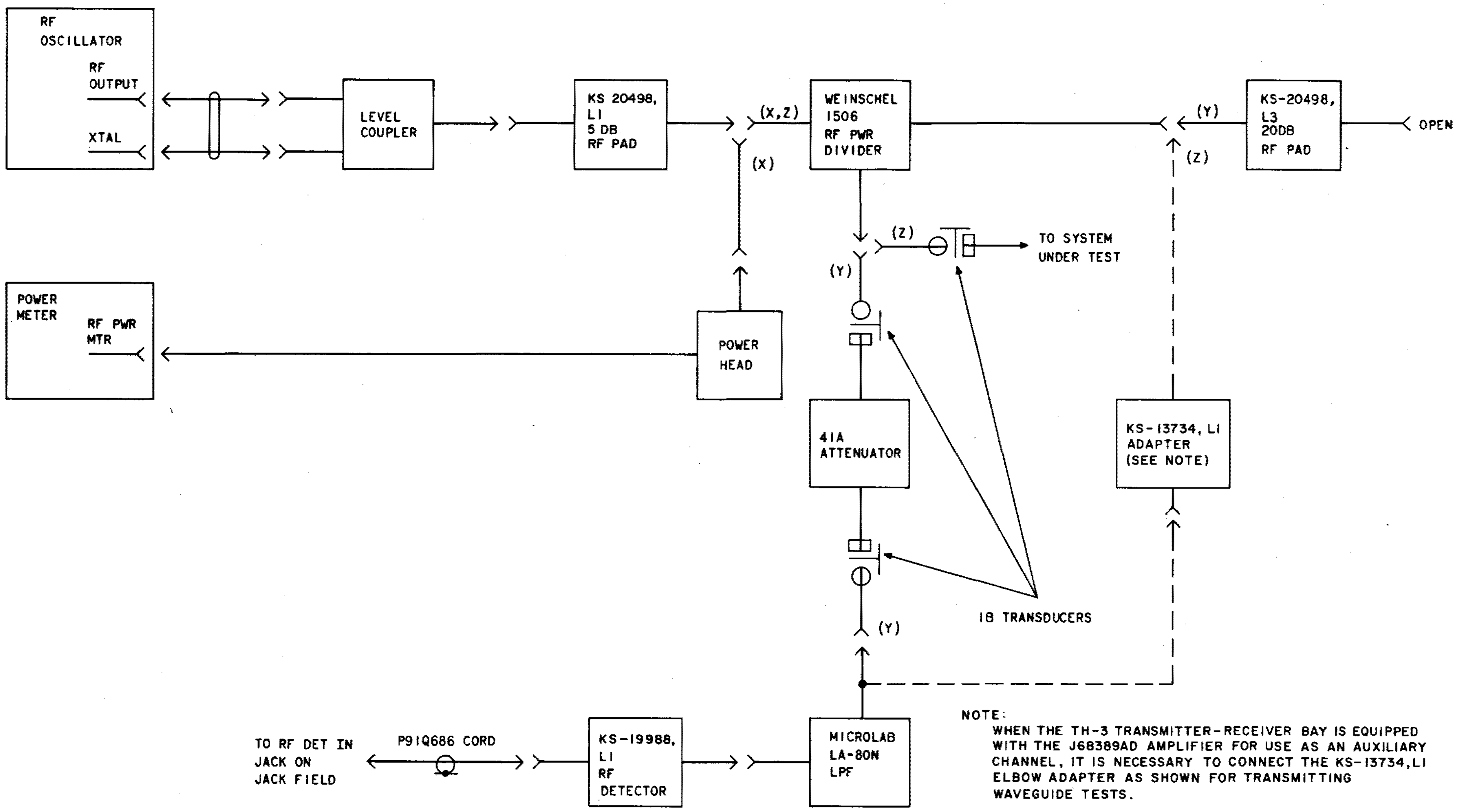


Fig. 10—Block Diagram of Test Setup Showing Interconnections for the J68392A Test Set—4-GHz Systems



NOTE:
WHEN THE TH-3 TRANSMITTER-RECEIVER BAY IS EQUIPPED WITH THE J68389AD AMPLIFIER FOR USE AS AN AUXILIARY CHANNEL, IT IS NECESSARY TO CONNECT THE KS-13734,L1 ELBOW ADAPTER AS SHOWN FOR TRANSMITTING WAVEGUIDE TESTS.

Fig. 11—Block Diagram of Test Setup Showing Interconnections for the J68392A Test Set—6-GHz Systems

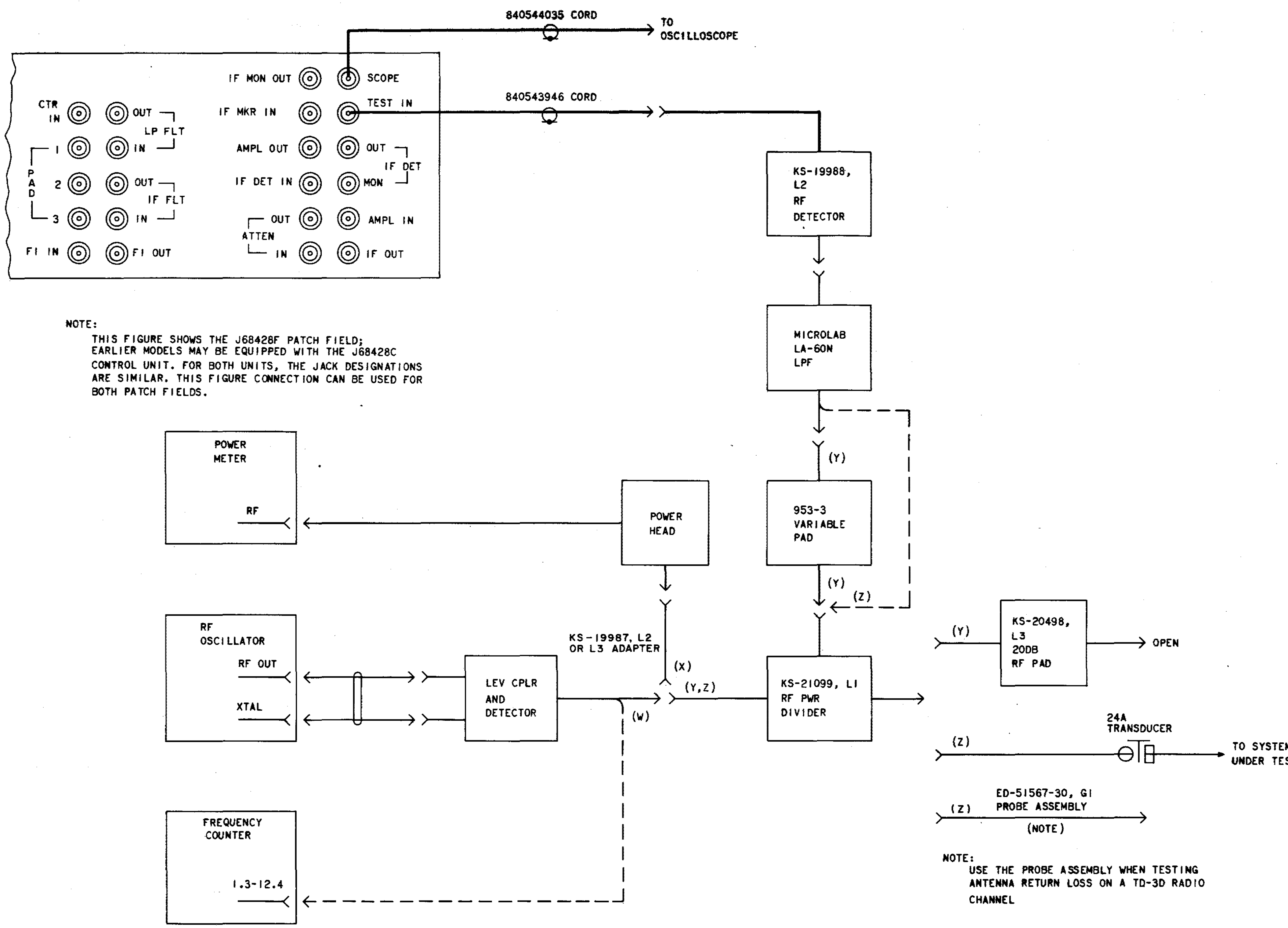
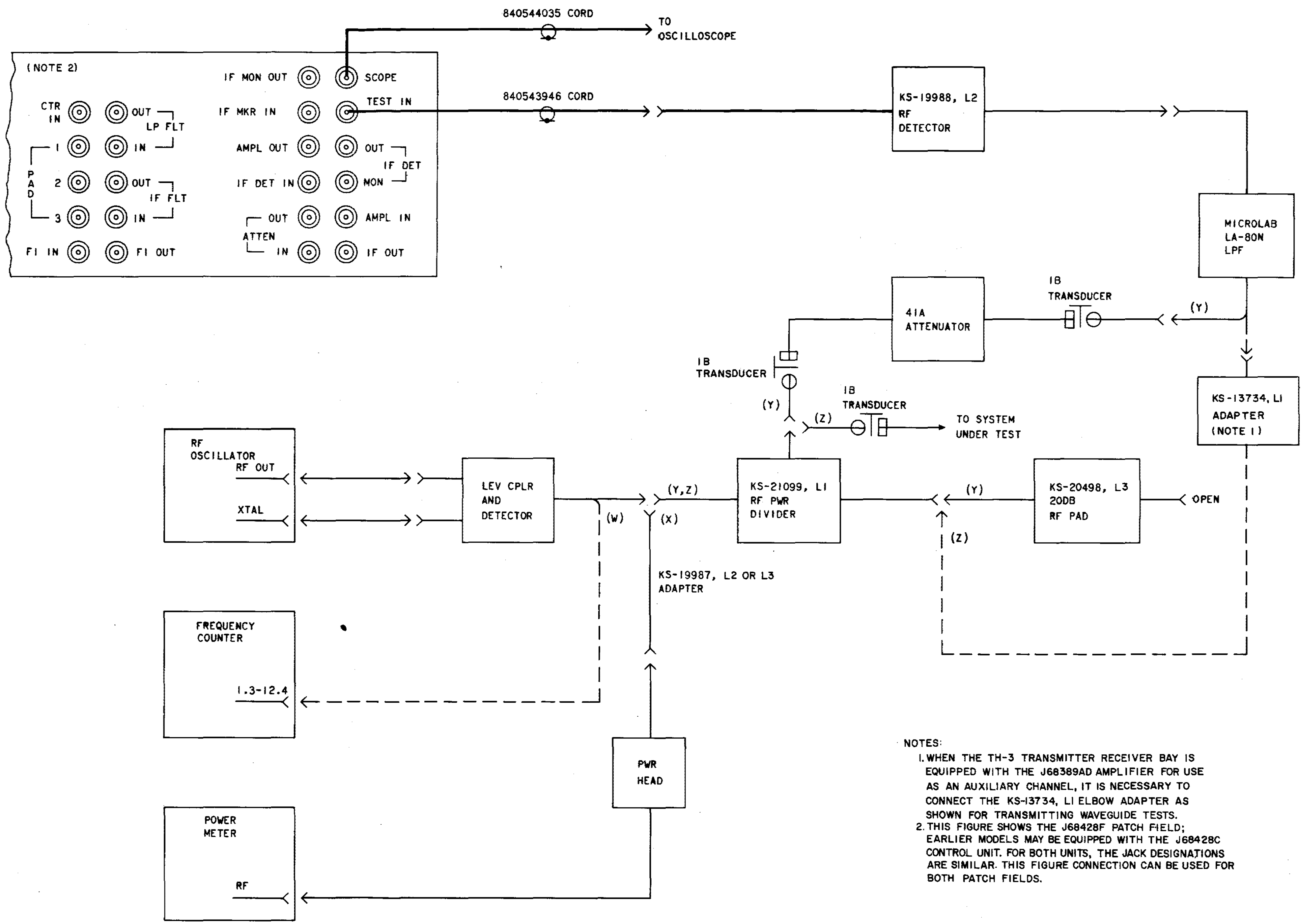
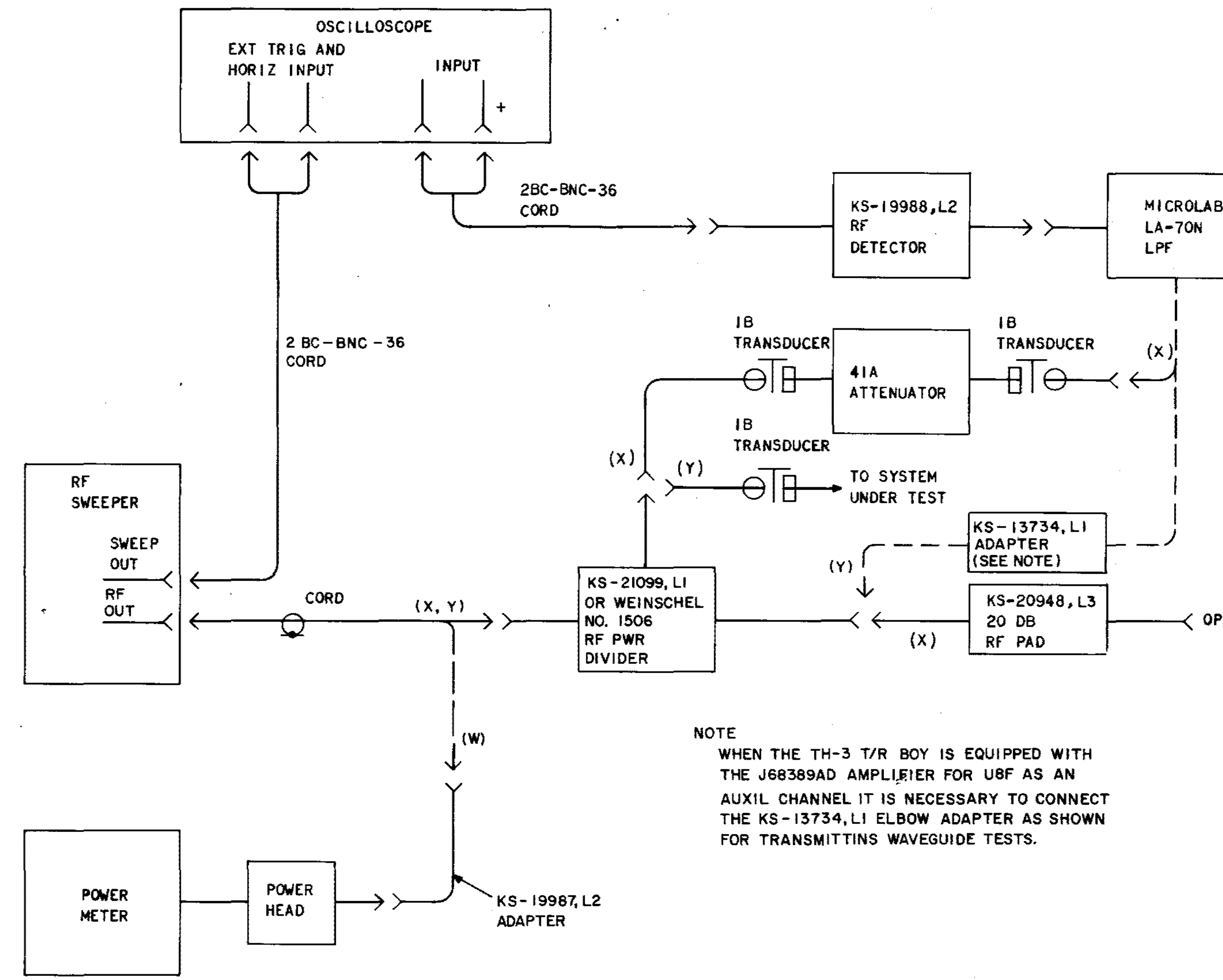


Fig. 12—Block Diagram of Test Setup Showing Interconnections for the J68428A Test Set—4-GHz Systems



NOTES:
1. WHEN THE TH-3 TRANSMITTER RECEIVER BAY IS EQUIPPED WITH THE J68389AD AMPLIFIER FOR USE AS AN AUXILIARY CHANNEL, IT IS NECESSARY TO CONNECT THE KS-13734, L1 ELBOW ADAPTER AS SHOWN FOR TRANSMITTING WAVEGUIDE TESTS.
2. THIS FIGURE SHOWS THE J68428F PATCH FIELD; EARLIER MODELS MAY BE EQUIPPED WITH THE J68428C CONTROL UNIT. FOR BOTH UNITS, THE JACK DESIGNATIONS ARE SIMILAR. THIS FIGURE CONNECTION CAN BE USED FOR BOTH PATCH FIELDS.

Fig. 13—Block Diagram of Test Setup Showing Interconnections for the J68428A Test Set—6-GHz Systems



NOTE
WHEN THE TH-3 T/R BOY IS EQUIPPED WITH THE J68389AD AMPLIFIER FOR U8F AS AN AUXIL CHANNEL IT IS NECESSARY TO CONNECT THE KS-13734,L1 ELBOW ADAPTER AS SHOWN FOR TRANSMITTINS WAVEGUIDE TESTS.

Fig. 14—Block Diagram of Test Setup Showing Interconnections for the ED-50978-10 Portable Test Arrangement

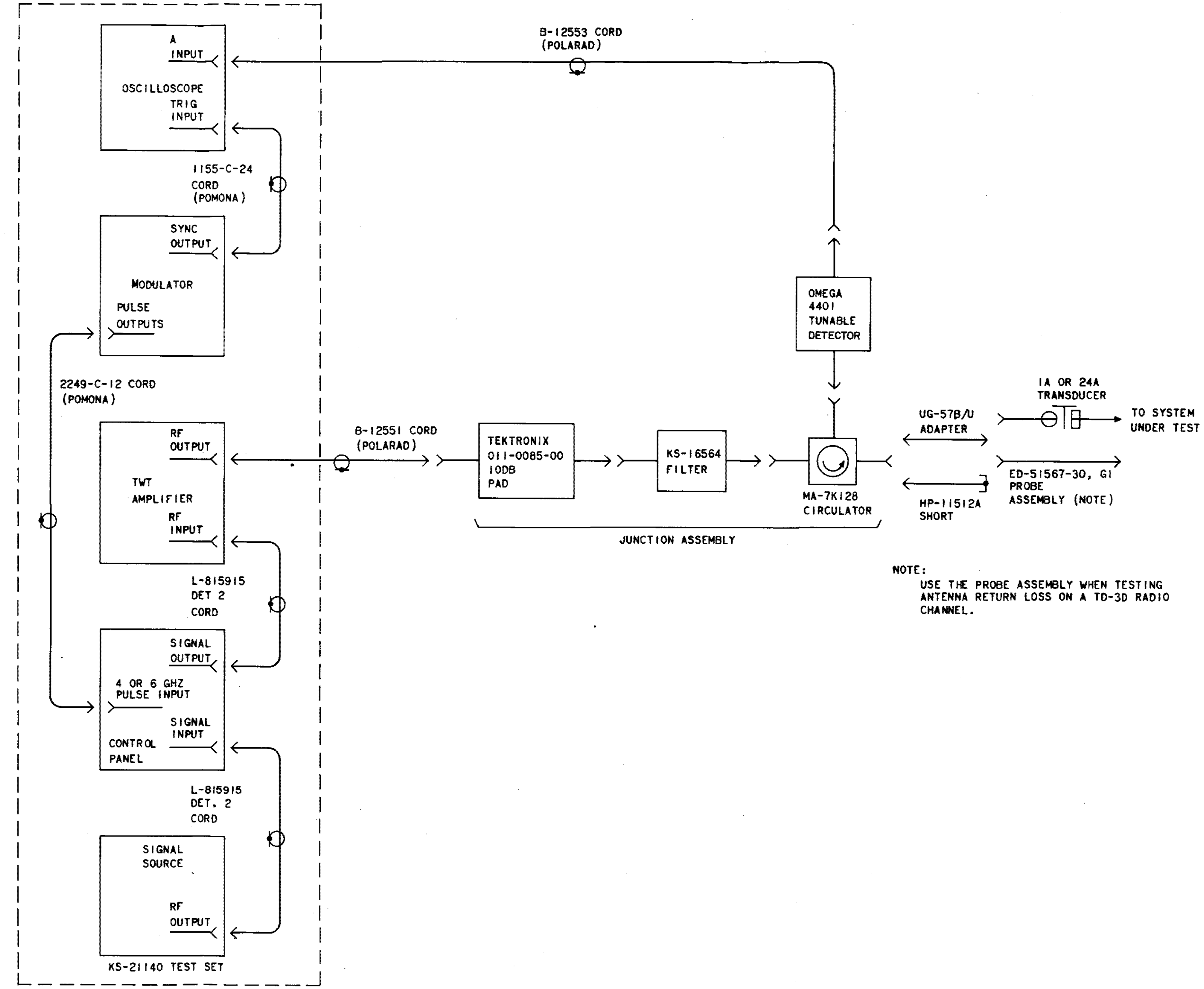


Fig. 15—Block Diagram of Test Setup Showing Interconnections for the KS-21140 Test Set

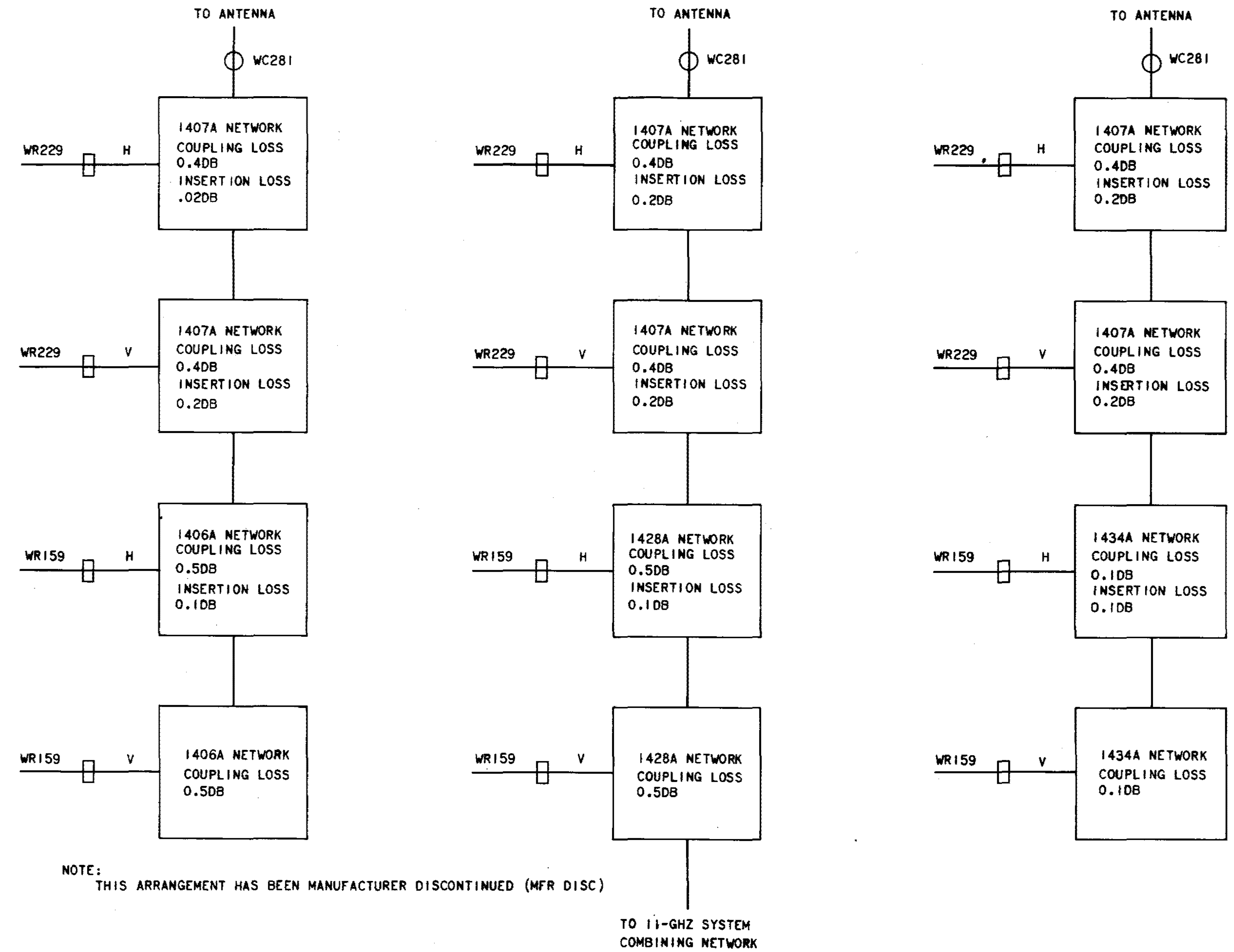


Fig. 16—System Combining Network Losses

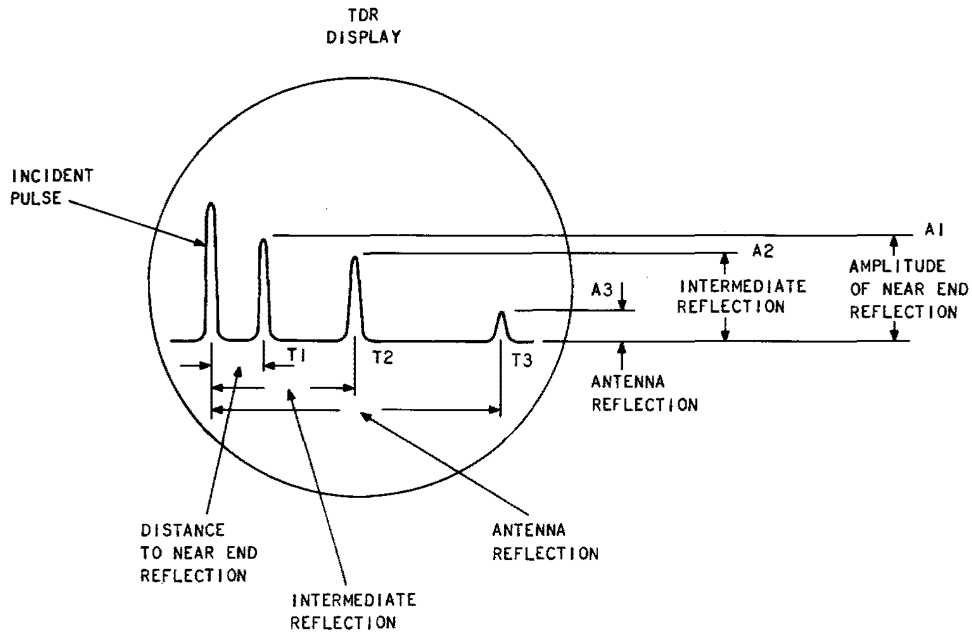


Fig. 17—Time Reflectometry Display