TD-3 MICROWAVE RADIO
TRANSMITTER-RECEIVER BAY
RECEIVER TESTS USING PORTABLE TEST EQUIPMENT

1. GENERAL

1.01 This section describes procedures for making tests on the broadband receiver portion of the TD-3 radio system using portable test equipment.

1.02 The alignment is performed by supplying an RF signal from the Kruse Electronics IF-RF sweeper using the 5013-3 RF plug-in assembly. Overall gain and amplitude response measurements are made from the receiver modulator input to the IF main amplifier output. If the overall transmission requirements are not met, tests are made on the IF main amplifier and AGC amplifier before adjustments are made on the IF preamplifier.

2. APPLICATION

2.01 Section 411-400-501 should be completed prior to this section and the results used as a guide to possible trouble sources.

2.02 If IF RETURN LOSS tests are to be made, they should be done before beginning tests in this section.

2.03 Preliminary checks should be made on the microwave generator and voltage regulator per Section 411-402-900 LL to establish the correct levels before performing tests in this section.

3. PRECAUTIONS

3.01 These tests are to be performed on an out-of-service basis only.

4. CONTENTS

4.01

5. APPARATUS

5.01

IF TEST PANEL (J68425A-1)
POWER METER (GENERAL MICROWAVE 460-N420C)
OSCILLOSCOPE (HEWLETT PACKARD H02-1202A)
FREQUENCY COUNTER (SYSTRON DONNER 7018-8)
IF, RF SWEEPER (KRUSE-STORKE, 5000)
MISCELLANEOUS GENERAL PURPOSE TEST
COMPONENTS
IF MAIN AMPLIFIER (J68387S-1)

CHART 1

OVERALL GAIN-AMPLITUDE RESPONSE MEASUREMENTS
RF-IF

Note: If initial installation, perform Charts 2 and 3 and omit this chart.

STEP	PROCEDURE
1	Set up test equipment per Figure 2, Steps 2 through 11, to calibrate the IF TEST PANEL DETECTOR.
2	Set up test equipment per Figure 1.
3	Change RF OSC mode selector to ΔFx1 position and adjust scope offset for a display centered on the scope.
4	Adjust Horizontal CAL and position controls for a display 10 divisions wide.
5	Adjust the Scope Horizontal Position Control to center the 70 MHz marker.
6	Adjust markers with FC±ΔF vernier and Scope Horizontal Cal controls until markers are on extreme edges of scope face. For this one test the scope is calibrated for ±15 MHz horizontal deflection; use only 70 ±3-1/3 divisions for ±10 MHz.
7	Adjust oscilloscope DC BALANCE. While changing the IF test panel attenuator from 8 dB to 9 dB, adjust oscilloscope vertical sensitivity and vertical position controls for 10 divisions per dB. If necessary, change MV/DIV setting. The oscilloscope is now adjusted for a sensitivity of 0.1 dB per division.
8	Return ATTN to 8 dB and adjust MV/DIV control one step below setting determined in Step 7 and adjust vertical position for center of scope display. This is now REFERENCE. Scope is calibrated for 0.05 dB per division. ***Requirement:*** The trace shall be flat to within 0.03 dB over 60- to 80-MHz band. If this requirement is not met, proceed to Chart 2. If requirement is met, remove test connections, 24A transducer, and replace FL1. Press the AGC pushbutton on REC panel to extinguish manual lamp.

CHART 2

GAIN-AMPLITUDE RESPONSE MEASUREMENTS
IF-IF

The following steps provide for adjusting the IF main amplifier for a gain of 9 dB (in both MAN and AGC condition) with −8 dBm in, +1.0 dBm out, and an amplitude response flat to within 0.01 dB over the 60- to 80-MHz band.

STEP	PROCEDURE
1	At the IF main amplifier, disconnect the cables from the IF IN and IF OUT jacks.
2	On the receiver control panel set the AGC pushbutton to MANUAL.
3	Prepare the test set in accordance with Figure 2.
4	Adjust the MANUAL GAIN control on receiver control panel to bring trace to the reference on the scope established in Figure 2. ***Requirement:*** The amplitude response shall be essentially the same as in Figure 2, Step 11, ±0.01 dB over the 60- to 80-MHz band. If the requirement is not met, adjust SLOPE 1 and SLOPE 2 control on the IF main amplifier; maintain ***reference*** of the test trace with MANUAL GAIN control. If requirement still is not met, replace the IF main amplifier.
5	Decrease the input to the main amplifier by adding 35 dB (30 and 5 dB pads) between the 10 dB pad already there and IF IN jack on the main amplifier.
6	Turn the MANUAL GAIN control to maximum counterclockwise (maximum gain).
7	Adjust the AGC range control on the AGC amplifier for ***reference*** center on scope at 70 MHz. ***Requirement:*** The amplifier response shall be flat to within 0.5 dB over the 60- to 80-MHz band.
8	Adjust the MANUAL GAIN control to the maximum clockwise position (minimum gain).
9	Remove the 35 dB (30 and 5 dB pads) inserted in Step 5 and adjust the MANUAL GAIN control for reference on the scope.
10	Press the AGC REF pushbutton and record the panel meter reading. **AGC AMPLIFIER** The following steps provide the procedure for adjusting the AGC circuit to obtain the correct IF main amplifier output power (+1 dBm over an AGC range of 35 dB) and the proper AGC filter shape.

CHART 2 (Cont)	
STEP	**PROCEDURE**
11	Set the Scope Vertical Sensitivity to 2 MV/DIV. While changing IF TEST PANEL ATTEN between 9 and 10 dB, adjust scope vertical sensitivity and position controls for 5 DIV/dB. This calibrates scope fo 0.2 dB/DIV.
12	Return IF TEST PANEL ATTEN to 9 dB and center trace to reference with vertical position control.
13	Press the AGC pushbutton to extinguish the lamp.
14	Adjust the IF LEVEL control on the AGC amplifier for ***reference*** on the scope at 70 MHz. ***Requirement:*** The filter characteristic shall be centered about 70 MHz with the 64 and 76 points as approximately equal levels. The difference in levels at 64 and 76 MHz shall be less than 1.5 dB. (See Display #2, Figure 2, for a typical filter characteristic.) If this requirement is not met, adjust C6 and C7 controls on the AGC amplifier (use a nonmetallic screwdriver). If the requirement still is not met, replace the AGC amplifier unit.
15	Reduce the input level to the IF MAIN AMP 35 dB, using 63A pads (30 and 5 dB). ***Requirement:*** The power shall not decrease by more than 0.5 dB as shown on scope.
16	Remove 35 dB pad (30 and 5 dB pads) and reestablish connection between the 63A (10 dB) pad and the input to the IF main amplifier per option (Z).
17	Adjust the RCVD SIG LEVEL ADJ control for a control panel meter indication of 70; RCVD SIG LEVEL.
18	Press the AGC pushbutton to turn on the MANUAL lamp.
19	Remove test connections from IF main amplifier and return normal connections.
20	Perform tests in Chart 3.

CHART 3

GAIN-AMPLITUDE RESPONSE MEASUREMENTS RF TO IF

Note: The tests in Chart 2 must be performed before the tests in this chart.

STEP	PROCEDURE
1	Set up the test equipment per Figure 1.
2	Change RF OSC Mode Selector to ΔFx1 position and adjust scope offset for a display centered on scope.
3	Adjust Horizontal Cal and position controls for a display 10 divisions wide.
4	Adjust Scope Horizontal position to center the 70 MHz marker on the scope.
5	Adjust markers with FC±F vernier and Scope Horizontal control until markers are on extreme edges of scope face. For this one test the scope is calibrated for ±15 MHz horizontal deflection; use only the portion of the trace between 70 ±3-1/3 divisions as this represents 10 MHz.
6	Adjust oscilloscope DC BALANCE. While changing the IF TEST PANEL attenuator from 8 dB to 9 dB, adjust oscilloscope vertical position and calibrate controls for 10 divisions per dB. If necessary, change MV/DIV setting. The oscilloscope is now adjusted for a sensitivity of 0.1 dB per division.
7	Return ATTEN in IF TEST PANEL to 8 dB, adjust MV/DIV control one step below the above setting, and adjust vertical position for center of scope display. This is now REFERENCE. Scope is now calibrated for 0.05 dB/DIV. ***Requirement:*** The trace shall be flat to within 0.03 dB over the 60- to 80-MHz band. If this requirement is not met, adjust the SHAPE and SLOPE controls on IF PREAMP while keeping reference at 70 MHz with the level control. If this requirement still is not met, refer to Section 411-404-503.
8	Set OSC MODE control to CW and change to option (Z). Note power meter reading.
9	Remove 8 dB pad (option W) and add option (T) and observe power meter reading. ***Requirement:*** Within ±1 dB of Step 8 above. If this requirement is not met, check the filters, equalizers, and cables in the interconnecting circuit.

CHART 3 (Cont)	
STEP	**PROCEDURE**
	Note: Typical losses of the IF components at 70 MHz are: 745A 0.6 dB 747A 2.6 dB 793A 5.4 dB 794A 5.0 dB
10	Adjust the LEVEL control on the IF PREAMP to bring the power meter indication to −7.0 dBm.
11	Remove test connections, 24A transducer, and replace FL1 previously removed.
12	Press AGC pushbutton on REC panel to extinguish MANUAL lamp.

CHART 4

RECEIVE SIGNAL STRENGTH MEASUREMENTS

STEP	PROCEDURE
1	Set ATTEN in IF TEST PANEL to 8 dB. On TD-3 receiver control panel, press AGC manual pushbutton, manual lamp should light up.
2	Connect the IF main amplifier output through the IF TEST PANEL ATTEN (8 dB) to the power meter.
3	Adjust manual gain on receiver control panel for −7 dBm on power meter.
4	Determine the normal received carrier power at the drop arm of the channel dropping network.
5	Set up Figure 1, option (U) and adjust RF OSC for a power meter reading 20 dB above normal received power. ***Example:*** If normal received level is −28 dB, set OSC level for a power meter reading of −8 dBm.
6	Remove 1322 filter between dropping network and 8A isolator. Place shorting plate on dropping network. Place 24A transducer on 8A isolator.

CHART 4 (Cont)

STEP	PROCEDURE
7	Using Table A to determine correct pad value, set up options (V, W, and R). Adjust Marker 2FC on RF OSC for a counter reading of 70 MHz $\pm$0.2 MHz.
8	Change option (R) to option (Z) and measure power. The difference between this reading and reading in Step 3 above is the difference between actual received level and calculated level. ***Requirement:*** This reading should be $\pm$5 dB of Step 3 above.

CHART 5

RECEIVER NOISE FIGURE MEASUREMENT

APPARATUS:

1—L-802190 Portable Test Arrangement

Caution 1: This test is performed on an out-of-service basis. Obtain a release from the designated control office and remove the channel from service as directed in Section 400-400-901 LL, Appendix 1.

Caution 2: When removing and replacing waveguide units, care should be exercised to prevent foreign matter from entering the waveguide. Handle all types of waveguide carefully in order to prevent damage to flange mating surfaces. When connecting waveguide units, flange mating surfaces must be carefully aligned and all screws tightened securely to avoid RF leakage.

STEP	PROCEDURE
1	Remove the KS-19748, L3 flexible waveguide ahead of the 1322-type receiver bandpass filter and install a 24A transducer on the filter. Terminate the drop arm of Z1. Make sure all connections are tight.
2	If the receiver is equipped with an IF main amplifier Type J68387F and an AGC unit Type J68387G, proceed to Step 3. If the receiver is equipped with an IF main amplifier Type J68387S, proceed to Step 5.
3	Operate the AGC pushbutton to the AGC position (lamp in switch should be extinguished).

CHART 5 (Cont)	
STEP	**PROCEDURE**
4	Remove the IF cable from the IF IN jack on the AGC amplifier. (This insures that the IF main amplifier gain will be at maximum.) Proceed to Step 6.
5	Position the IF main amplifier MAN-AGC switch to MAN. Adjust MAN GAIN control fully counterclockwise (maximum gain).
6	Determine that the RF oscillator power is ***turned off.*** Connect the test as given in Figure 3, option (Z). ***Caution: Do not connect the output of the leveling coupler to the power meter or circuit under test when the loop from the sweeper leveler EXT DET jack is open. Excessive levels may exist at the leveling coupler output when the loop is open.***
7	Adjust the IF TEST PANEL EXT IF AMPL GAIN control to obtain a power meter indication of −10.0 dBm.
8	Change the test apparatus arrangement to Figure 3, option (X).
9	Position the RF oscillator to deliver a CW signal at the receiver frequency. Turn on the power to the RF oscillator and adjust the level control until an indication is obtained on the frequency counter. Adjust the frequency control on the RF oscillator until the indication is 70 ±0.5 MHz. ***Caution: The frequency indicated on the RF oscillator should be within 40 MHz of the frequency of the receiver under test.***
10	Change the test apparatus arrangement to Figure 3, option (W). Do not adjust any controls on the RF oscillator except the level control.
11	The exact loss, at 4 GHz of the 30 dB pad used in Figure 3, is stamped on the body of the pad. Taking into account the calibrated value of the pad, adjust the RF oscillator output level to a value which will result in a level of −28.0 dBm being applied to the 24A transducer in Step 9. ***Example:*** If the 30 dB pad calibrated loss is 29.6 dB, adjust the output to obtain −28.0 dBm + 20.6 dB = +1.6 dBm.
12	Change the test apparatus arrangement to Figure 3, option (Y), and read the power meter. ***Requirement:*** Between −1.4 dBm and +2.6 dBm for bays equipped with the J68387P receiver modulator. Between −5.4 dBm and +2.6 dBm for bays equipped with the J68387C receiver modulator. ***Note:*** These powers correspond to maximum and minimum noise figures of 9 dB and 5 dB for bays equipped with the J68387P receiver modulators and 13 dB and 5 dB for bays equipped with the J68387C receiver modulator.

CHART 5 (Cont)

STEP	PROCEDURE
	If this requirement is not met, perform the following, in the sequence given, until the requirement is met. (a) Verify that all waveguide units in the receiver are properly aligned and the screws tightened securely. (b) Verify that the test apparatus is arranged properly and that the levels are correct. (c) Replace receiver modulator diode CR1 and perform the tests in accordance with Chart 1. (d) Replace the receiver modulator—IF preamplifier unit and retune as directed in Chart 3. (e) If the completion of (d) above does not result in meeting the requirement, reinstall the original receiver modulator—IF preamplifier and replace the IF main amplifier.
13	Remove the 24A transducer, reconnect flexible waveguide section, and restore all normal bay connections. On J68387S IF main amplifiers reset the MAN GAIN control to normal and position the MAN-AGC switch to AGC. If further tests are not scheduled, return the bay to service and notify the designated control office.

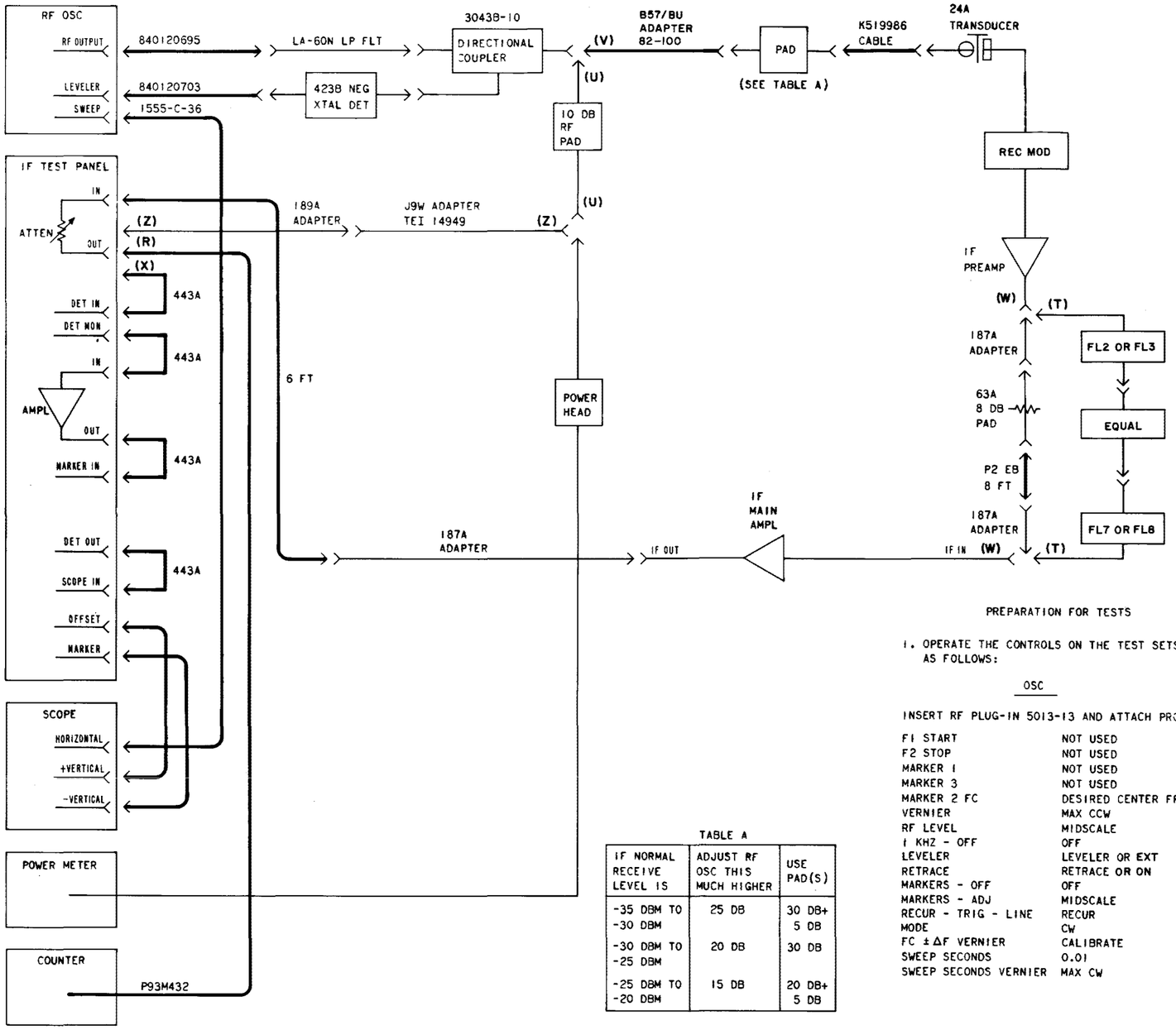


TABLE A

IF NORMAL RECEIVE LEVEL IS	ADJUST RF OSC THIS MUCH HIGHER	USE PAD(S)
-35 DBM TO -30 DBM	25 DB	30 DB+ 5 DB
-30 DBM TO -25 DBM	20 DB	30 DB
-25 DBM TO -20 DBM	15 DB	20 DB+ 5 DB

PREPARATION FOR TESTS

1. OPERATE THE CONTROLS ON THE TEST SETS AS FOLLOWS:

OSC

INSERT RF PLUG-IN 5013-13 AND ATTACH PROPER SCALE

F1 START	NOT USED
F2 STOP	NOT USED
MARKER 1	NOT USED
MARKER 3	NOT USED
MARKER 2 FC	DESIRED CENTER FREQ
VERNIER	MAX CCW
RF LEVEL	MIDSCALE
1 KHZ - OFF	OFF
LEVELER	LEVELER OR EXT
RETRACE	RETRACE OR ON
MARKERS - OFF	OFF
MARKERS - ADJ	MIDSCALE
RECUR - TRIG - LINE	RECUR
MODE	CW
FC ± ΔF VERNIER	CALIBRATE
SWEEP SECONDS	0.01
SWEEP SECONDS VERNIER	MAX CW

COUNTER

TIME	MAX CCW
GAIN	MAX CW
FREQUENCY	1 MS
INPUT B	INT OSC
COUNT A	NORMAL

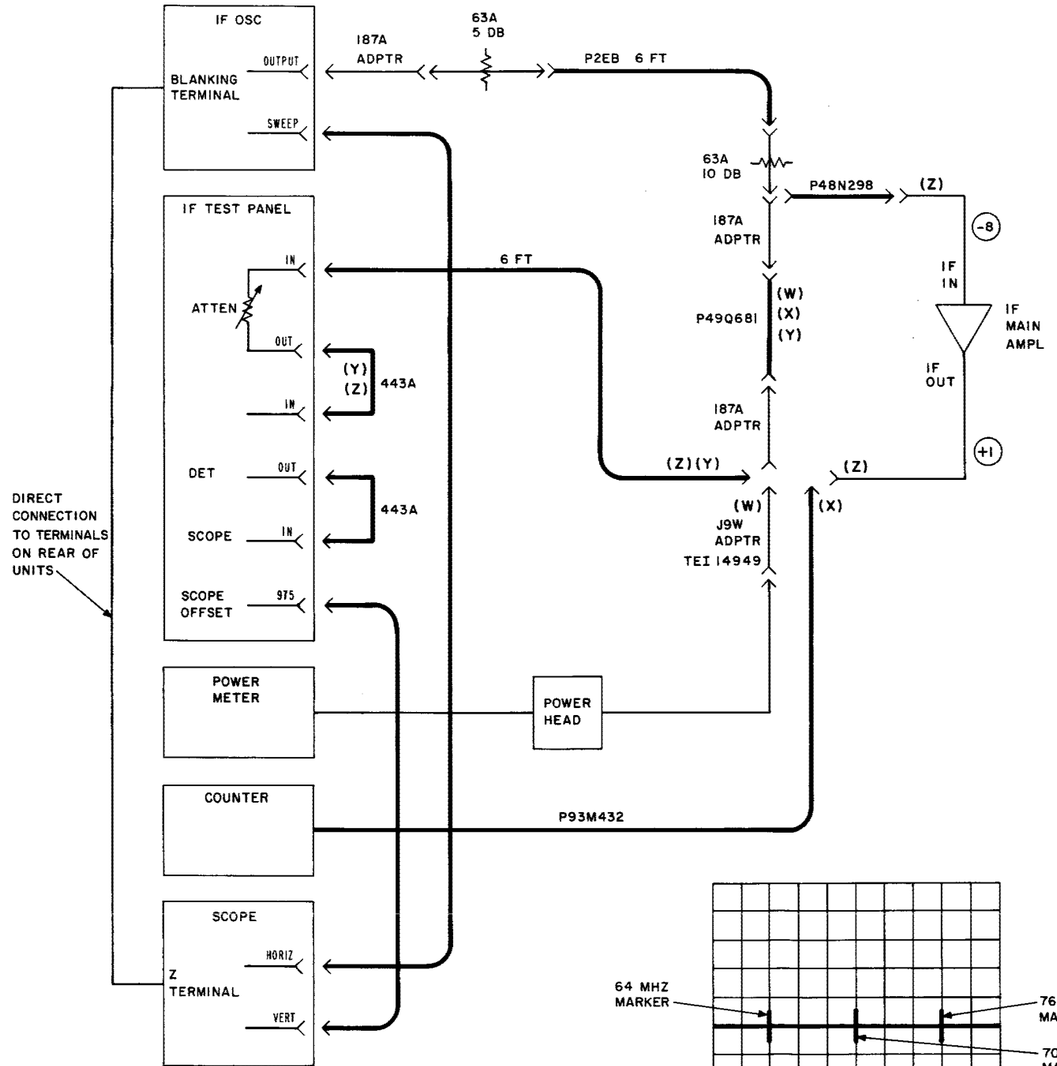
1202 A SCOPE

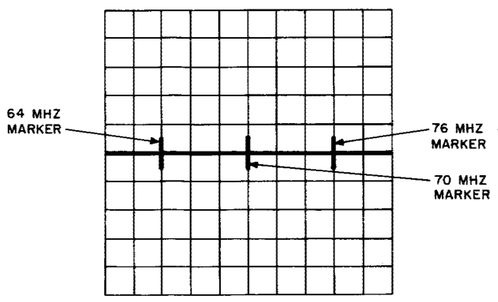
VERTICAL	MIDSCALE
OFFSET COURSE	MIDSCALE
HORIZONTAL	MIDSCALE
INPUT SELECTOR +	DC
INPUT SELECTOR -	DC
BANDWIDTH - LIMIT	DEPRESSED
VERTICAL SENSITIVITY	2 MV/DIV
POLARITY + -	+
INPUT SELECTOR	+
MODE	NORMAL
SLOPE	+
TRIGGER LEVEL	MAX CCW
COUPLING	DC
SOURCE	INTERNAL
HORIZ SELECTOR (OUTER)	EXT HORIZ 0.5
HORIZ SELECTOR (MIDDLE)	ANY
HORIZ SELECTOR (INNER)	MIDRANGE

POWER METER

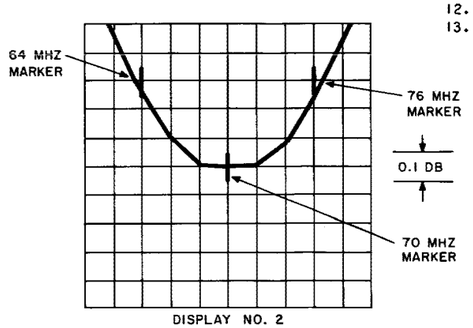
1. SET THE METER RANGE TO THE -25 DBM SCALE. ADJUST THE ZERO ADJUST CONTROL FOR ZERO (BLACK SCALE). RESET THE METER RANGE TO THE -5 DBM SCALE.
2. DETERMINE THE NORMAL RECEIVED CARRIER POWER AT THE DROP ARM OF THE CHANNEL DROPPING NETWORK.
3. SET UP OPTION (U) AND REFER TO TABLE A TO DETERMINE THE PROPER LEVEL ABOVE NORMAL RECEIVED POWER TO ADJUST THE RF OSC. ADJUST RF OSC FOR A POWER METER READING EQUAL TO THIS LEVEL.
   EXAMPLE: IF NORMAL RECEIVED LEVEL IS -28 DBM, TABLE A INDICATES A RF OSC LEVEL 20 DB ABOVE OR -8 DBM. ADJUST LEVEL FOR A READING OF -8 DBM ON THE POWER METER.
4. SET IF TEST PANEL ATTENUATOR TO 8 DB.
5. SET THE IF MAIN AMPLIFIER MAN/AGC CONTROL ON MAN.
6. SET UP OPTIONS (V,W AND R). ON RF OSC ADJUST MARKER 2FC FOR COUNTER READING OF 70 MHZ ± 0.2 MHZ.
7. SET UP OPTIONS (V,W AND Z). SET POWER METER TO -5 DBM SCALE. ADJUST LEVEL CONTROL OF IF PREAMP FOR A POWER METER READING OF -7 DBM.
8. CHANGE FROM OPTION (Z) TO OPTION (x).

Fig. 1—TD-3 RF to IF Amplitude Response Setup





DISPLAY NO. 1



DISPLAY NO. 2

PREPARATION FOR TESTS

1. SET THE CONTROLS ON THE TEST SETS AS FOLLOWS:

OSC

INSERT IF PLUG-IN 5007-1 AND ATTACH PROPER SCALE

F1 START	60MC
F2 STOP	80MC
MARKER 1	64MC
MARKER 3	76MC
MARKER 2FC	70MC
VERNIER	MAX CCW
RF LEVEL	MIDSCALE
1KHZ-OFF	OFF
LEVELER-EXT	LEVELER
RETRACE-OFF	RETRACE
MARKERS-OFF	MARKERS
MARKERS ADJ	MIDSCALE
RECUR-TRIG-LINE	RECUR
MODE	CW
FC ±ΔF VERNIER	CALIBRATE
SWEEP SECONDS	0.01
SWEEP SECONDS VERNIER	MAX CW

POWER METER

SET THE METER RANGE TO THE -25 DBM SCALE.
ADJUST THE ZERO ADJUST CONTROL FOR ZERO (BLACK SCALE).
RESET THE METER RANGE TO THE -5 DBM SCALE.

COUNTER

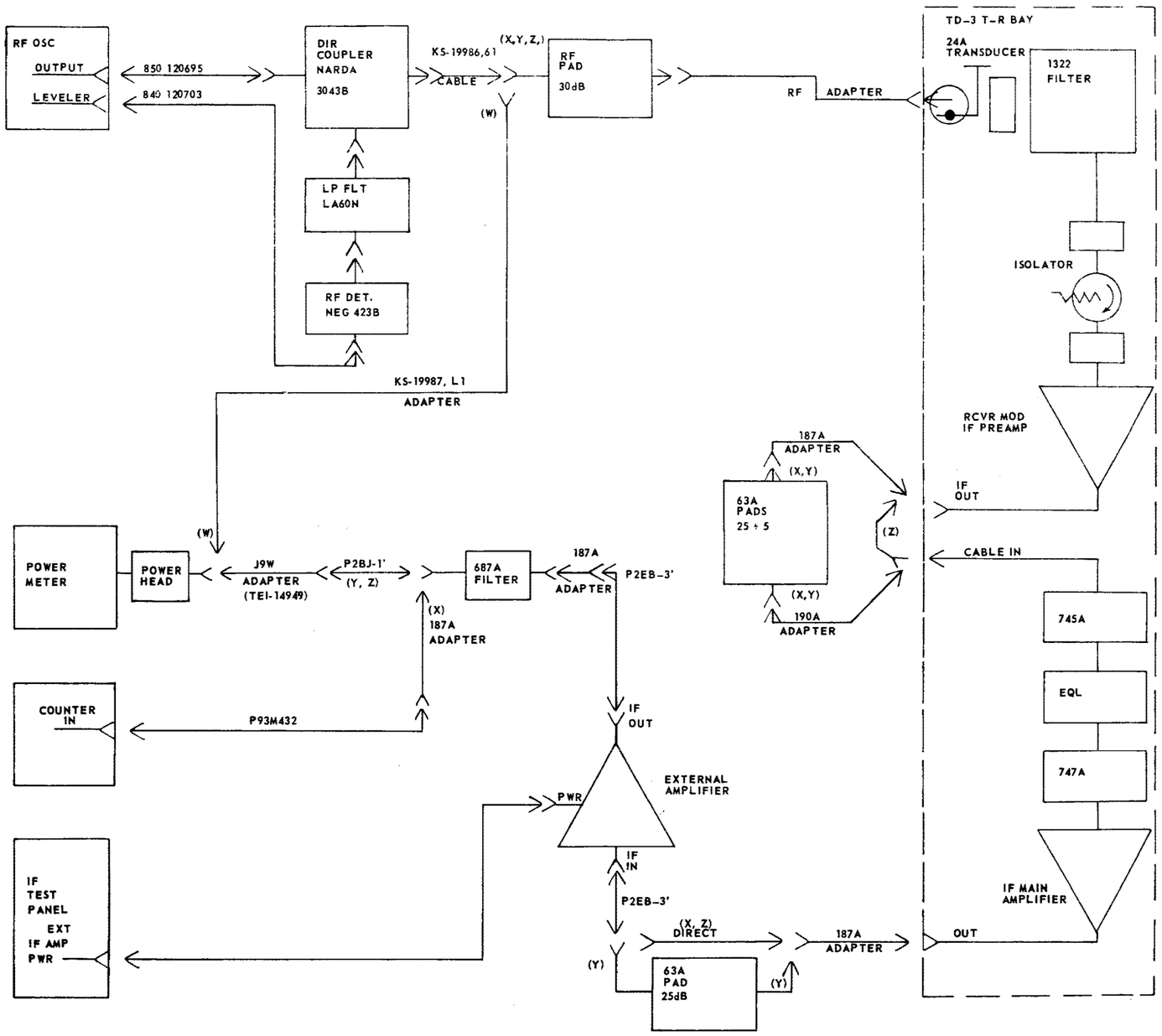
TIME	MAX CCW
GAIN	MAX CW
FREQUENCY	1MS
INPUT B	INT OSC
COUNT A	NORMAL

1202 A SCOPE

VERTICAL	MIDSCALE
OFFSET COURSE	MIDSCALE
HORIZONTAL	MIDSCALE
INPUT SELECTOR +	DC
INPUT SELECTOR -	OFF
BANDWIDTH LIMIT	DEPRESSED
VERTICAL SENSITIVITY	2 MV/DIV
POLARITY + -	+
INPUT SELECTOR	+
MODE	NORMAL
SLOPE	+
TRIGGER LEVEL	MAX CCW
COUPLING	DC
SOURCE	INTERNAL
HORIZ SELECTOR (OUTER)	EXT HORIZ 0.5
HORIZ SELECTOR (MIDDLE)	ANY POSITION
HORIZ SELECTOR (INNER)	MIDRANGE
INTENSITY	MIDRANGE (INITIALLY)

2. SET UP OPTION (W).
3. ADJUST IF OSC (RF LEVEL) FOR A POWER METER READING OF -8 DBM.
4. SET UP OPTION (X) AND ADJUST IF OSC MARKER 2 FC FOR 70 ± 0.2 MHZ ON THE COUNTER.
5. SET OSC MODE TO WIDE F1-F2.
6. SET IF TEST PANEL ATTENUATOR TO 0.
7. SET UP OPTION (Y) AND ADJUST THE IF TEST PANEL SCOPE OFFSET FOR A DISPLAY SIMILAR TO NO. 1 ABOVE.
8. ADJUST THE SCOPE HORIZONTAL POSITION CONTROL TO CENTER THE 70 MHZ MARKER.
9. ADJUST THE OSCILLOSCOPE DC BALANCE, WHILE CHANGING ATTEN FROM 0 TO 1 DB ADJUST SCOPE VERTICAL SENSITIVITY AND VERTICAL POSITION FOR 10 DIVISIONS PER DB.
10. WHEN CALIBRATED FOR 1 DB PER 10 DIVISIONS, CHANGE SENSITIVITY TO 0.2 MV/DIV.
11. ADJUST THE IF TEST PANEL DET SLOPE TO WITHIN 0.01 DB. THIS IS NOW REFERENCE.
12. SET IF TEST PANEL ATTENUATOR TO 9 DB.
13. CHANGE TO OPTION (Z).

Fig. 2—TD-3 IF to IF Amplitude Response Setup



PREPARATION FOR TESTS

1. SET THE CONTROLS ON THE TEST SET AS FOLLOWS:

OSCILLATOR

INSERT RF PLUG W 5013-13 AND ATTACH PROPER SCALE	
POWER ON-OFF	OFF
MARKER	DESIRED CENTER FREQUENCY
MODE	CW
MODE VERNIER	CALIBRATE
VERNIER	0
RECUR TRIG LINE	RECUR
SWEEP SECONDS VERNIER	MAX CW
SWEEP SECONDS	.01
MARKERS	OFF
RETRACE	RETRACE OR ON
LEVELER	LEVELER OR EXT.
IKHZ	OFF
RF LEVEL	MAX CCW

POWER METER

SET THE METER RANGE TO THE 25 DBM SCALE. ADJUST THE ZERO METER CONTROL FOR ZERO (BLACK SCALE). RESET THE METER RANGE TO THE -5 DBM SCALE

POWER HEAD

% EFF — FOR 4 GHZ (REFER TO CHART ON POWER HEAD)

COUNTER

FREQ A	10 M.S.
DISPLAY TIME	MIN.
INPUT B INT OSC	INT OSC
GAIN	MAX
NOR-TST	NOR

Fig. 3—TD-3 Receiver Noise Figure Measurement