

TRANSMISSION SYSTEMS
TD AND TH SWITCH-SECTION TESTS
"SCIENTIFIC-ATLANTA*" RADIO PERFORMANCE ANALYZER
COMMON MICROWAVE RADIO

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1. GENERAL

1.01 This section contains charts and related information required to enable the user of the SCIENTIFIC-ATLANTA Models 4680 or 4683 radio performance analyzer to perform certain switch-section system tests and two IF tests, either of which test may disclose related system problems. The system tests are baseband response, thermal noise and tones, and noise loading. The IF tests are cross-polarization discrimination (XPD) and carrier-to-interference (C/I) ratio.

1.02 This section is reissued to add new test procedures and charts for TD radio 1800-circuit loading and TH-3 radio 2400-circuit loading. Also to indicate that TD channels carrying 45 megabits per second (Mb/s) digital signals (TD-45A) are expected to meet 1500-circuit loading requirements. The Equipment Test List (ETL) is not affected. In addition to the above specific changes, this section has

been completely reorganized and is considered a general revision. As a result, revision arrows are not used.

1.03 The SCIENTIFIC-ATLANTA Model 4680 radio performance analyzer consists of the following units:

- 1— Model 4660 Baseband Noise Transmitter
- 1— Model 4670 IF/Baseband Analyzer
- 1— Model 4673 X-Y Recorder.

This equipment can be used to make switch-section tests on all TD- and TH-type radio channels carrying up to 1800 message-circuit loading.

1.04 Model 4683 radio performance analyzer manufactured by Scientific-Atlanta, Inc. comprises the following units;

- 1— Model 4661 Baseband Noise Transmitter
- 1— Model 4671 IF/Baseband Analyzer
- 1— Model 4673 X-Y Recorder.

This equipment can be used to make switch-section tests on all TD- and TH-type radio channels carrying up to 1800 message-circuit loading, and on TH-3 channels carrying 2400-circuit loading.

1.05 *Caution: If the Model 4661 baseband noise transmitter is equipped with crystal filters and is used with the Model 4670 IF/baseband analyzer, the analyzer must be manually swept very slowly through the noise slots when making noise load measurements. This is necessary because the automatic sweep of the Model 4670 analyzer in the noise power ratio (NPR) mode is too fast to properly follow the sharp characteristics of the crystal filter slots. Alternatively, the noise load run might be made with the baseband mode in the tone search position rather than NPR, as the tone search automatic sweep is much slower.*

Normally, the Model 4670 IF/baseband (BB) analyzer is used only with the Model 4660 baseband noise transmitter. This noise transmitter provides measurement capability for up to 1800 message-circuit

loading. For 2400 message-circuit loading tests, the Model 4661 baseband noise transmitter (part of the Model 4683 radio performance analyzer) may be used with the Model 4670 IF/baseband analyzer with the above caution.

1.06 The combining of all of the most used switch-section tests for all of the long-haul radio (TD-2, TD-3, TD-3A, TD-3D, TH-1, and TH-3) into one practice is a departure from the present dedicated (by type of radio) test practices. The decision to combine the information in this manner resulted from the desire to provide a practice that would allow the operator to more rapidly and easily identify within that practice, the location of specific test procedures and limits, no matter which type of radio channel is to be tested. The practice is designed for use by an inexperienced operator (detailed procedures) or an experienced operator (abbreviated procedures). The introduction of the analyzer, with its ease of operation, speed, and accuracy; and the conscientious use of this section, will be a valuable tool in clearing trouble and maintaining any radio channel within good performance limits with less testing time expended.

1.07 The test procedures of this section are designed as an alternate to the detailed information contained in the various existing individual radio system practices for switch-section maintenance. The most important switch-section test not performed with this analyzer is envelope delay distortion (EDD). However, once the channel has been properly delay equalized, the EDD test does not have to be made as long as the requirements in this section are being met. When performance deterioration makes adjustments necessary, or when looking for trouble, refer to the system practice for EDD for the type of radio system involved and perform the necessary chart. Charts in this section will also indicate those conditions when the EDD test must be performed. The other switch-section system tests not covered by this section are:

- (a) Impulse noise (now part of the system noise and tones section)
- (b) Carrier frequency measurement
- (c) Fade margin tests.

Fade margin tests are found in the bay maintenance procedures for the type of radio under test. Consider

(a), (c), and the EDD tests as trouble tests, but (b) as a mandatory work item, as given in the appropriate ETL.

1.08 The layout and content of this section is as follows:

- (a) **General:** This part contains the normal introductory paragraphs, followed by a description of the test set, the test concept, and familiarization with the controls.
- (b) **Baseband Tests:** This part contains detailed charts for performing baseband response, thermal noise and tones, and noise loading tests. It is laid out in the sequence in which the tests should be performed and is complete with limit tables and sample plots for guidance.
- (c) **Analysis of Switch-Section Transmission Performance Test Data:** This part contains much helpful information on various troubles which may be encountered; how and why they occur, and how to clear them.
- (d) **IF Tests:** This part contains charts for the use of the analyzer for XPD and C/I ratio tests. Limits, some background material, and sample plots for guidance are included.
- (e) **Abbreviated Test Procedures:** This part contains abbreviated charts which may be used by an experienced operator for performing baseband and IF tests.

1.09 The final completed test forms of the straight-away test, XPD measurements, and C/I measurements for each channel must be retained for one year. Also, the final completed back-to-back calibration test forms of the equipment manufactured by Scientific-Atlanta, Inc., and FM terminal equipment must be retained for one year.

1.10 Additional forms may be obtained from Western Electric Company, Inc. Form E-10109, IF TEST FORM, is used for all IF tests. Form E-10110, Sheet 1, BASEBAND RESPONSE, and Sheet 2, NPR AND TONE SEARCH, is used for all baseband tests.

1.11 The figures associated with this section are reproduced from actual tests made on various routes and are typical of what will be found.

1.12 All requirements in this Bell System Practice (BSP) are based on using the test set manufac-

tured by Scientific-Atlanta, Inc. and do not apply to measurements made with other test equipment. This is because the measuring techniques that are used with the SCIENTIFIC-ATLANTA test set are different from other test sets (for example, a de-emphasis network is used when measuring thermal noise and tones).

2. TEST CONCEPTS AND FAMILIARIZATION WITH CONTROLS

2.01 The SCIENTIFIC-ATLANTA IF/baseband analyzer with its X-Y recorder and baseband noise transmitter, provides a fast and accurate method of measuring and recording baseband response, noise load [noise power ratio (NPR)], and thermal noise and tones.

2.02 The demand maintenance program that replaced the conventional routine maintenance procedure requires the operator to quickly perform system tests and recognize gradual degradation of transmission parameters before they adversely affect the system. A valuable tool provided by this analyzer is the visual record of the performed test. Retention and careful analysis of these records will provide a very useful means to constantly monitor radio line performance.

2.03 Unlike earlier test concepts where the test results were analyzed and judged individually, the tests presented in this practice combine the baseband test data on two test forms, thus making the overall analysis of the transmission performance of an individual radio channel more accurate and uniform among radio channels, switch sections, etc.

2.04 The Series 4660 and 4661 (transmitters) and 4670 (analyzer) front panel controls, Fig. 1, 2, and 55, respectively, greatly simplify the switch-section test procedure. Testing time is reduced and human error is virtually eliminated. Operation of the control switches on the front panel of the analyzer automatically selects the proper frequency range (i.e., baseband or IF), analyzer filter bandwidth, amplitude display range, and scan time for each test.

2.05 Automatic baseband measurements (NPR, baseband response, and thermal noise and tone searches) provide an accurate and objective test of radio performance. Interlocking circuitry provides the capability of preventing an improper combination of control settings.

2.06 By using the automatic scan, the operator can record the existence of tones, while manual

operation can be used to verify their existence. Each switch, while depressed, illuminates a background light to indicate the mode of testing.

2.07 The results of each test are monitored on the analog and digital display meters and are permanently recorded on the X-Y plotter.

2.08 IF/baseband analyzer controls provide the selection of the proper mode of frequency tuning, a scan mode to work with the X-Y recorder, and a manual mode for amplitude measurement at specific frequencies.

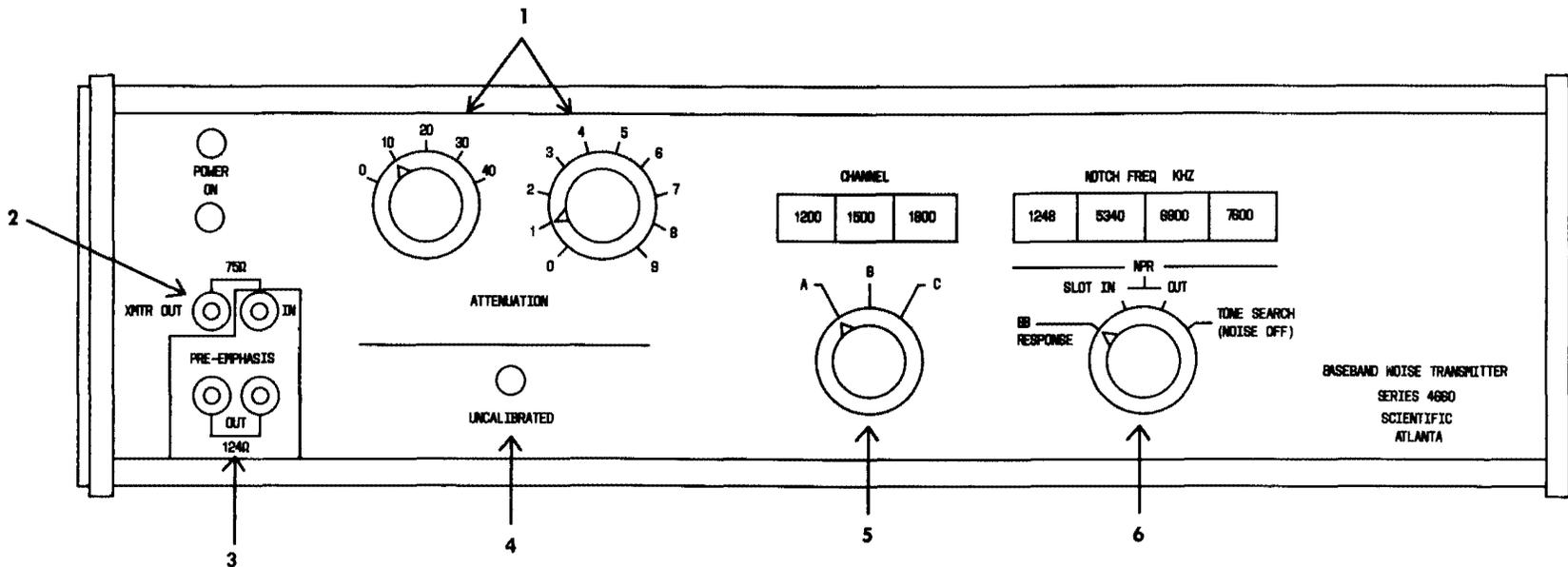
2.09 The Model 4661 baseband noise transmitter is designed for operation at 75 ohms unbalanced. The Model 4660 baseband noise transmitter and Model 4670 IF/baseband analyzer are designed for operation at either 75 ohms unbalanced or 124 ohms balanced. To reduce the test equipment setup time when performing the various baseband related tests, the 124-ohm balanced option is used. The pre-emphasis and de-emphasis networks are in the test circuit setup at all times, and once the test FM terminals are connected to the radio line, each of the transmission tests (baseband response, noise load, and thermal noise and tone) are performed through programmed switch functions and/or level changes on the test sets.

Note: The Model 4680 radio performance analyzer has built-in pre- and de-emphasis networks that are equivalent to the WE* 4208A and 4208B networks, respectively. These built-in networks are used when making TD (1200), TD (1500)/(45 Mb/s) and TH (1800). For TD (1800) and TH-3 (2400) tests, the required pre- and de-emphasis is obtained using WE cable assemblies 842731804 (pre-emphasis) and 842731812 (de-emphasis). These cable assemblies contain the 4208C and 4208D pre- and de-emphasis networks, respectively, that are used for these loadings.

2.10 For simplicity, two baseband related test forms (BASEBAND RESPONSE, Sheet 1 of 2, and NPR AND TONE SEARCH, Sheet 2 of 2) have been developed for use during all baseband related measurements. The proper use and calibration of the test forms are covered in the information pertaining to the individual baseband tests.

2.11 In the IF mode, Model 4670 IF/baseband analyzer operates like a spectrum analyzer, exam-

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1. ATTENUATORS USED TO ADJUST THE NOISE OUTPUT TO THE DESIRED VALUE FOR EACH CIRCUIT LOAD.
2. 75 OHM UNBALANCED OUTPUT.
3. 124 OHM BALANCED OUTPUT PRE-EMPHASIS IN CIRCUIT WHEN CONNECTED TO THIS JACK.
4. UNCALIBRATED LIGHT:
 - LIGHT OFF, NORMAL CONDITION
 - LIGHT ON, CONDITION INDICATES LOW NOISE LEVEL FROM NOISE GENERATOR.
5. CHANNEL LOAD SELECTOR:
 - (A) 1200 POSITION PRODUCES A FLAT BAND OF NOISE 316-5600 KHz
 - (B) 1500 POSITION PRODUCES A FLAT BAND OF NOISE 316-7284 KHz
 - (C) 1800 POSITION PRODUCES A FLAT BAND OF NOISE 316-8160 KHz

6. FUNCTION SWITCH:

- BASEBAND RESPONSE (BB) POSITION PRODUCES A BAND OF NOISE FLAT BETWEEN 316-9000 KHz.
- SLOTS IN (NPR):

CHANNEL SWITCH POSITION

1200
1500
1800

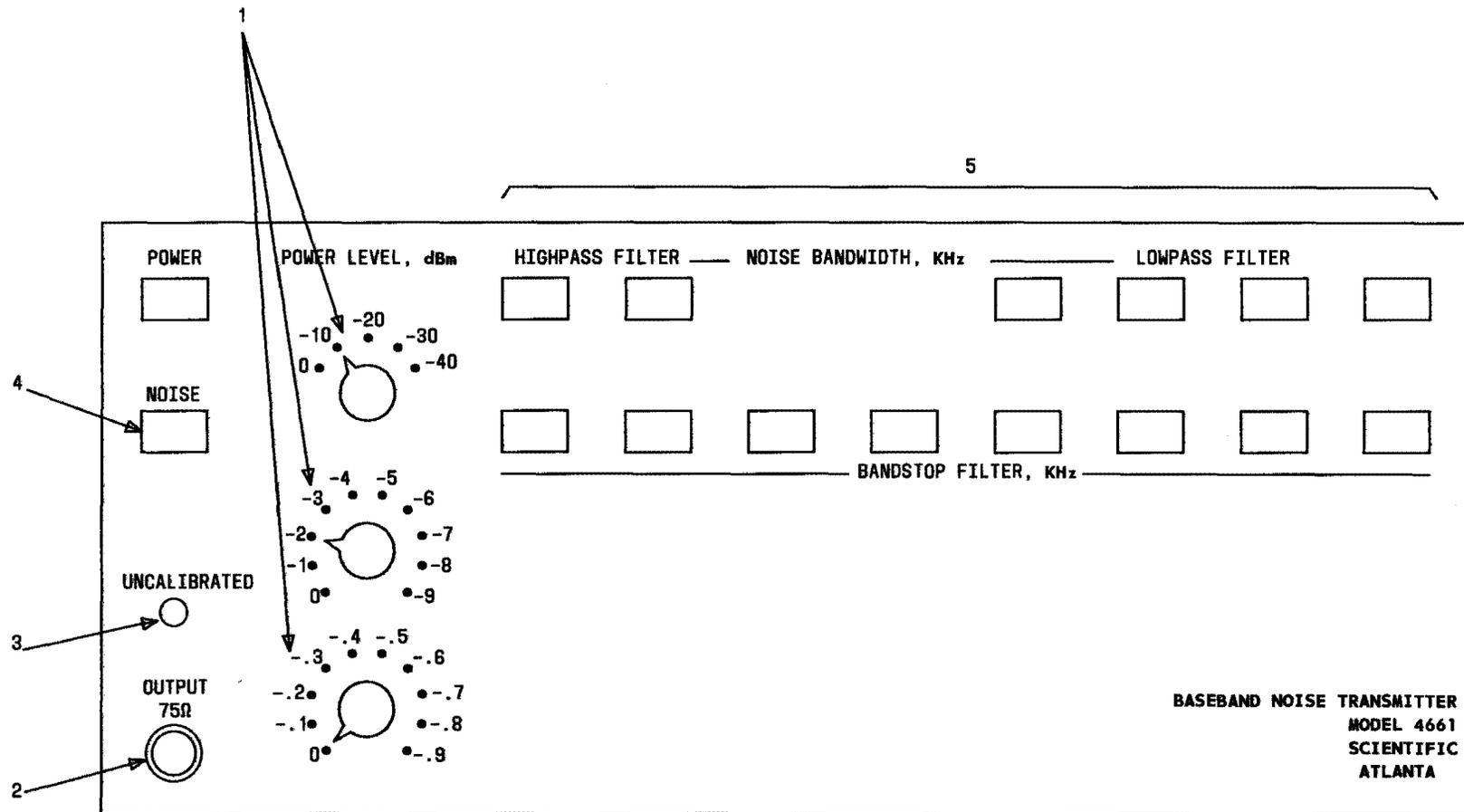
NOTCH FREQUENCY

1248 & 5340 KHz
1248, 5340 & 6900 KHz
1248, 5340 & 7600 KHz

- SLOTS OUT (NPR):
- ALL SLOTS ARE REMOVED
- TONE SEARCH (NOISE OFF)

THIS POSITION TERMINATES THE OUTPUT OF THE NOISE LOAD TRANSMITTER. (DURING THIS CONDITION, THE UNCALIBRATED LIGHT WILL BE ON.)

Fig. 1—Baseband Noise Transmitter—Series 4660—Front Panel Controls



1. ATTENUATORS USED TO ADJUST THE NOISE OUTPUT TO THE DESIRED VALUE FOR EACH CIRCUIT LOAD.
2. 75 OHM UNBALANCED OUTPUT.
3. UNCALIBRATED LIGHT:
 - LIGHT OFF, NORMAL CONDITION
 - LIGHT ON, CONDITION INDICATES LOW NOISE LEVEL FROM NOISE GENERATOR.
4. NOISE ON/OFF PUSHBUTTON.
5. HIGHPASS, LOWPASS AND BANDSTOP FILTERS.

Fig. 2—Baseband Noise Transmitter—Series 4661—Front Panel Controls

ining the frequency spectrum around the IF carrier frequency. The 70 ± 5 MHz range is for C/I measurements. The 70 ± 25 MHz and 70 ± 35 MHz ranges are used to evaluate XPD, side-to-side antenna coupling, and adjacent channel interference.

2.12 As in the baseband mode, the IF spectrum can be manually tuned or can be automatically scanned.

2.13 One test form (IF TEST FORM) has been developed for all IF related measurements.

2.14 Figure 56 of this section, Transmission Performance and Testing Trouble-Clearance Flowchart, should be studied carefully to obtain an overall view of the test concept. It can be referred to at any time by the person performing the tests to ensure that the proper sequences, documentation, and referrals are being followed.

2.15 An optional view light may be located in the test cart. The function of the view light is to provide a means for rapid analysis of individual radio channel test runs. The individual test run can be compared against a predrawn standard reference test sheet that represents the limits for the individual channel under test. The intent behind the view light concept is to: (a) permit the test set operator to mark directly on the original test data sheet the out-of-limit condition, and (b) give field personnel the capability of making standard reference test sheets (limit sheets) for individual switch-section characteristics which may or may not meet the standard scheme of objective and limit setting.

2.16 It is recommended that standard reference test sheets be drawn up for each type of radio channel and for individual switch sections. Also, during the initial layout of individual standard reference test sheets, care should be taken to include such factors as: (a) the type of FM terminals used, (b) variation in path length from the stated model, and (c) design characteristics of the channel involved. Care should also be taken to guard against unnecessary marks or writing on the standard reference test sheets. These sheets will be used to compare all future requirements.

2.17 The preparation of the standard reference test sheet is intended to be straightforward. The

only materials needed to prepare the reference test sheet are: (a) a blank baseband test sheet, (b) felt pen, and (c) specific radio switch-section transmission limits. The color of pen is optional; however, experience has shown that black is the best choice. The out-of-limit boundaries should be bold enough to stand out when the radio channel baseband test sheet is placed on top of the reference test sheet for comparison purposes. A few trial-and-error approaches will clearly indicate the proper preparation procedure for the reference test sheet.

2.18 With the view light illuminated, place the baseband test sheet on top of and against the reference test sheet and align the major grid divisions. Analyze each baseband test separately (baseband response, noise load, and thermal noise and tones), and mark the baseband test sheet to show the frequency and magnitude of any out-of-limit performance. The pen used for marking the baseband test sheet should not damage the reference test sheet.

3. BASEBAND TESTS

A. Chart 1—Back-to-Back Calibration Test Procedures for TD(1200), TD(1500)/(45 Mb/s), TD(1800), and TH(1800) SCIENTIFIC-ATLANTA Test Set Only (Detailed)

3.01 This chart is the first to be performed when arranging the apparatus for testing. By performing the baseband response, thermal noise and tone, and noise power ratio (NPR) tests with the transmitter and analyzer back to back, the operator verifies the performance quality of these two units and their associated X-Y recorder.

3.02 The following SCIENTIFIC-ATLANTA radio performance analyzer apparatus is required for this test:

1— Baseband Noise Transmitter (4660)

1— IF/BB Analyzer (4670)

1— X-Y Recorder (4673)

Cords and 443A Plugs as indicated.

STEP	PROCEDURE
1	<p>Arrange the test apparatus and set the controls as given in Fig. 3.</p> <p>Note: These back-to-back tests, made with the pre- and de-emphasis networks built into the SCIENTIFIC-ATLANTA set, serve to adequately check the operation of the set for all applications. However, all subsequent TD(1800) tests that include FM terminals will be made using a different pre- and de-emphasis shape that is required for that loading and which is obtained using WE cable assemblies 842731804 and 842731812 for the test connections as specified in the charts covering those tests.</p>
2	<p>Warning: Damage to the pen will result if pressure is applied directly to the pen or plastic arm.</p> <p>On the X-Y recorder:</p> <ul style="list-style-type: none">(a) Insert a BASEBAND RESPONSE test form against the left-hand side and the bottom paperguides of the X-Y recorder.(b) Operate the CHART HOLD/RELEASE switch to HOLD. (This applies a static charge to the X-Y recorder faceplate.)(c) Verify that a pen of the desired color is in place.(d) Adjust the X and Y ZERO controls until the pen is centered over the calibration dot within the small circle located on the 0-dB at 1-MHz point of the graph paper. <p>Note: For convenience, all back-to-back tests in this chart are made using the 71-dBrnc0 calibration point. It is not necessary, for the purposes of these tests, to use the 67-dBrnc0 calibration point that is specified in later charts when making TD(1800) NPR tests.</p> <ul style="list-style-type: none">(e) Use the index finger to apply enough downward pressure to the flat metal bar (located on top of the carriage bar) to cause the pen to make contact with the paper. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot. (This is the preferred method. An alternative method to accomplish this task is to operate the RECORD switch on the IF/baseband analyzer. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot.)(f) Restore the RECORD switch to normal. (The apparatus is now conditioned to plot the baseband response characteristic of the test arrangement.) <p>Baseband Scan (Baseband Response)</p>
3	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none">(a) Operate the (MODE) AUTO switch. (The pen shall rise and travel to the left side of the baseband test form.)(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the baseband response signal.)

STEP	PROCEDURE
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Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.

Requirement: The baseband response curve shall resemble the baseband response curve of Fig. 4. The maximum average response deviation between 0.5 and 9.0 MHz shall not be greater than ± 0.25 dB.

Test Set Operation for Baseband Thermal Noise and Tone Search

Note: This test should be conducted immediately after the baseband response test. Test connections are the same as for the baseband response test.

4 On the baseband noise transmitter:
(a) Position the function switch to TONE SEARCH (noise off).
(b) Set the attenuator for a total of 49.
(c) The UNCALIBRATED light shall be lit.

5 On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)

6 On the IF/baseband analyzer:
(a) Set the INPUT attenuator for a total of -20.
(b) Set the REF attenuator for a total of -40.
(c) Operate the TONE SEARCH switch.
(d) Operate the (MODE) MANUAL switch. (Adjust the frequency back to 1 MHz if it has drifted off.)

Requirement: The digital power meter shall indicate a noise level of less than -120 dBm.

7 On the X-Y recorder, set the slide switches as follows:
(a) PEN RECORD/LIFT switch to LIFT.
(b) SERVO ON/STANDBY switch to SERVO ON.
(c) CHART HOLD/RELEASE switch to CHART RELEASE.

8 On the X-Y recorder:
(a) Insert the NPR AND TONE SEARCH form against the left-hand side and bottom paperguides.

STEP

PROCEDURE

- (b) Operate the CHART HOLD/RELEASE switch to HOLD.
- (c) Observe the digital power meter indication on the IF/baseband analyzer. (This noise value will be used to calibrate the X-Y recorder.)
- (d) Using the X-Y controls, adjust the position of the pen for calibration at 1 MHz and the same -dBm value as indicated on the digital power meter in (c) above. [The far right-hand dBm scale of the graph paper (-130/-60) is used for this purpose.]
- (e) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)

Thermal Noise and Tone Scan

9 On the IF/baseband analyzer:

- (a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)
- (b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tone signal.)

Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.

Requirement: The thermal noise and tone response curve shall resemble the thermal noise and tone curve in Fig. 5. The thermal noise shall not be greater than -120 dBm, and no tone shall be greater than -115 dBm, across the 60-kHz to 12.5-MHz spectrum.

Test Set Operation for Noise Load (NPR)

Note: This test should be conducted immediately after the thermal noise and tone search. Test connections are the same as for baseband response and thermal noise and tone search.

10 On the baseband noise transmitter:

- (a) Set the function switch to NPR SLOTS IN.
- (b) The UNCALIBRATED light shall be extinguished.
- (c) Set the attenuators as indicated in Table A for the desired noise load. (It is recommended that all three noise loads be checked: TD 1200, TD 1500, TD and TH 1800.)

STEP	PROCEDURE
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TABLE A

RADIO	LOAD	CHANNEL SELECTOR	ATTENUATOR SETTING
TD	1200	A	0
TD	1500	B	4
TD	1800	C	1
TH	1800	C	1

- 11 On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)
- 12 On the IF/baseband analyzer:
- Operate the NPR switch.
 - Operate the (MODE) MANUAL switch. (Adjust the frequency back to 1 MHz if it has drifted off.)
 - Set the attenuators as indicated in Table B below for the various noise loads as selected.

TABLE B

RADIO	LOAD	ATTENUATORS		DIGITAL METER POWER LEVEL INDICATION
		INPUT	REFERENCE	
TD	1200	-12	-38	-49 ± 1 dBm
TD	1500	-15	-38	-54 ± 1 dBm
TD	1800	-12	-39	-51 ± 1 dBm
TH	1800	-12	-39	-51 ± 1 dBm

- The digital power meter shall indicate a noise level as indicated in (c) above.
 - Under normal conditions, the analog power meter shall indicate 0 dBm on the lower scale (0 through -70 dBm). Readjust the reference attenuator until the analog power meter indicates as closely to 0 dBm as possible.
- 13 On the X-Y recorder, set the slide switches as follows:
- PEN RECORD/LIFT switch to LIFT.
 - SERVO ON/STANDBY switch to SERVO ON.

STEP	PROCEDURE
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(c) CHART HOLD/RELEASE to RELEASE.

(d) LINE ON/OFF switch to LINE ON.

14 On the X-Y recorder:

(a) Insert an NPR AND TONE SEARCH test form against the left-hand side and bottom paperguides.

(b) Operate the CHART HOLD/RELEASE switch to the HOLD position.

(c) Adjust the X and Y ZERO controls until the pen is centered over the dot located at 1 MHz and 71 dBrc0.

Note: The use of the same calibration point for all loadings is done here to simplify the back-to-back checkout of the SCIENTIFIC-ATLANTA test set. All later tests that include FM terminals will specify a different calibration point for TD(1800).

(d) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)

Noise Power Ratio (NPR) Scan

15 On the IF/baseband analyzer:

(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)

(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the NPR signal.)

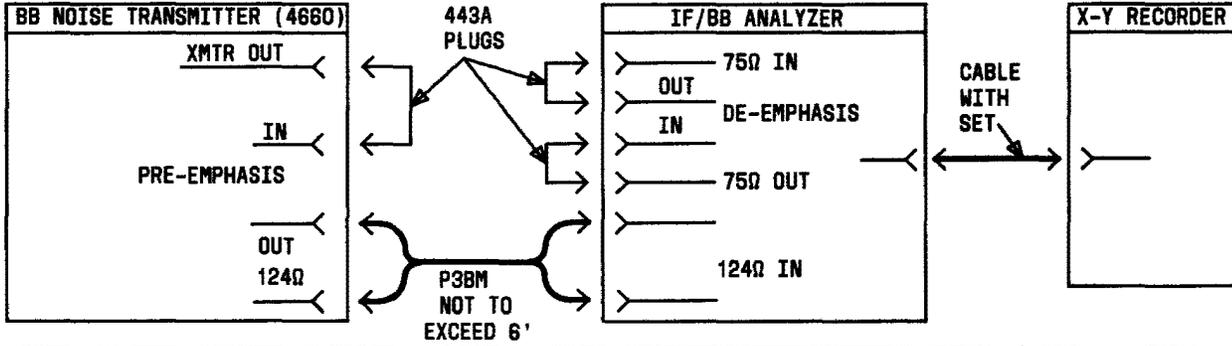
Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed.

Note 2: The following slots in Table C will appear in the noise spectrum for a specific noise load:

TABLE C

RADIO	LOAD	SLOT FREQUENCY (kHz)
TD	1200	1248/5340
TD	1500	1248/5340/6900
TD	1800	1248/5340/7600
TH	1800	1248/5340/7600

STEP	PROCEDURE
	<p data-bbox="407 394 1560 457">Requirement 1: The noise power ratio curve shall resemble the noise power ratio curves in Fig. 6 (1200); Fig. 7 (1500); and Fig. 8 (TD and TH 1800).</p> <p data-bbox="407 489 1560 579">Requirement 2: Each noise slot must be below the 11-dBrnc0 line. Also, the average signal line (located across the 71-dBrnc0 line) must average about the 71-dBrnc0 line for the bandwidth being tested.</p> <p data-bbox="407 615 1560 678">Note 3: Successful use of the dBrnc0 scale depends upon accurate calibration of the X-Y recorder pen at the 71-dBrnc0 (or 0 NPR) point.</p>



INITIAL CONTROL POSITIONS					
BB NOISE TRANSMITTER		IF/BB ANALYZER		X-Y RECORDER	
POWER	ON	POWER -	ON	POWER -	ON
ATTENUATION	TOTAL OF 9dB	INPUT -	TOTAL OF -20dB	RECORD/LIFT-	LIFT
CHANNEL	(NOT INVOLVED)	REF -	TOTAL OF -29dB	SERVO ON/STANDBY	SERVO ON
FUNCTION	BB RESPONSE	BB RESPONSE-	OPERATED	CHART HOLD/RELEASE	RELEASE
SWITCH		(MODE) MANUAL -	OPERATED		RETURN TO CHART
UNCALIBRATED	LAMP SHOULD BE EXTINGUISHED, IF NOT EXTINGUISHED INVESTIGATE TROUBLE	TUNING -	USE BOTH KNOBS TO ADJUST TO 1-MHZ		
		LEVEL dBm -	THE ANALOG POWER METER SHOULD INDICATE 0-dB ON THE TOP SCALE. READJUST REF AS NECESSARY UNTIL AS CLOSE TO 0-dBm AS POSSIBLE. THE DIGITAL POWER METER SHOULD INDICATE -49 ±1dBm		

Fig. 3—Test Arrangement, Back-to-Back Calibration for TD(1200), TD(1500)/(45 Mb/s), TD(1800), and TH(1800)—SCIENTIFIC-ATLANTA Test Set Only

RADIO CHANNEL NO. S/A SWITCH SECTION (FROM) BACK-TO-BACK (TO)
TYPE RADIO SYSTEM _____ NO. OF HOPS _____ CIRCUIT LOAD _____ DATE 1-26-77 TESTER WE

E-10110
(8-78)
SHEET 1 OF 2

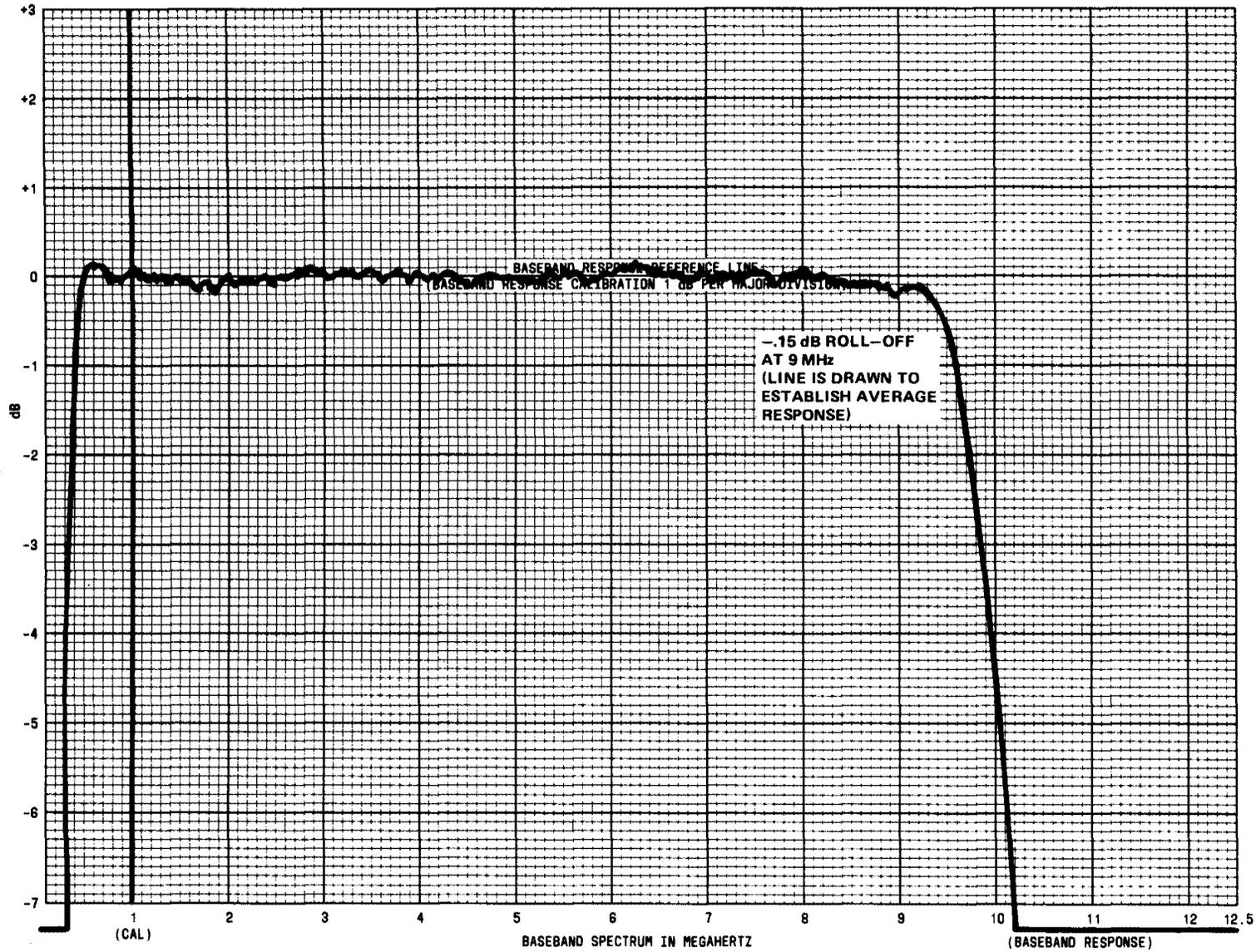


Fig. 4—Baseband Response—SCIENTIFIC-ATLANTA Test Set Back to Back

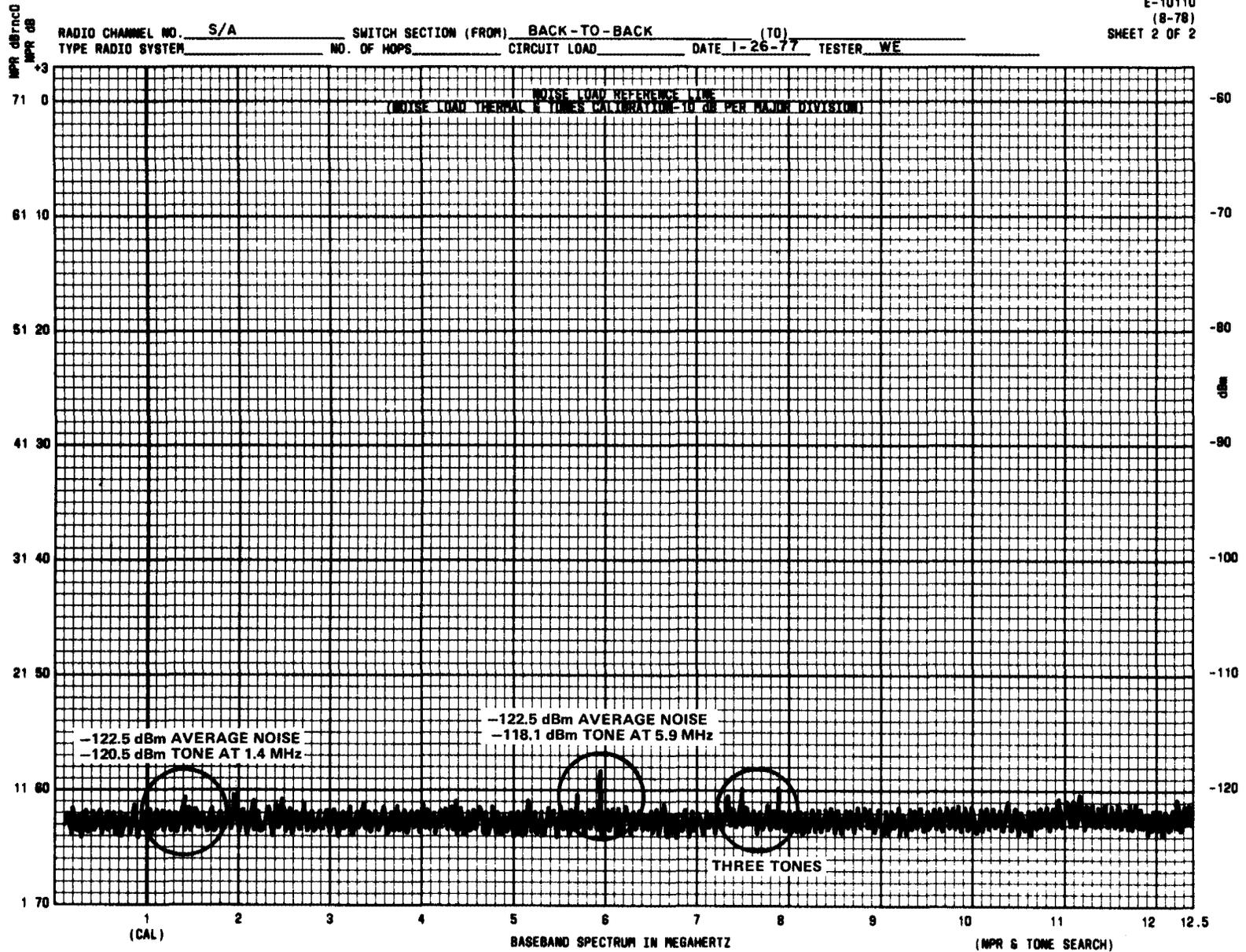


Fig. 5—Thermal Noise and Tone—SCIENTIFIC-ATLANTA Test Set Back to Back

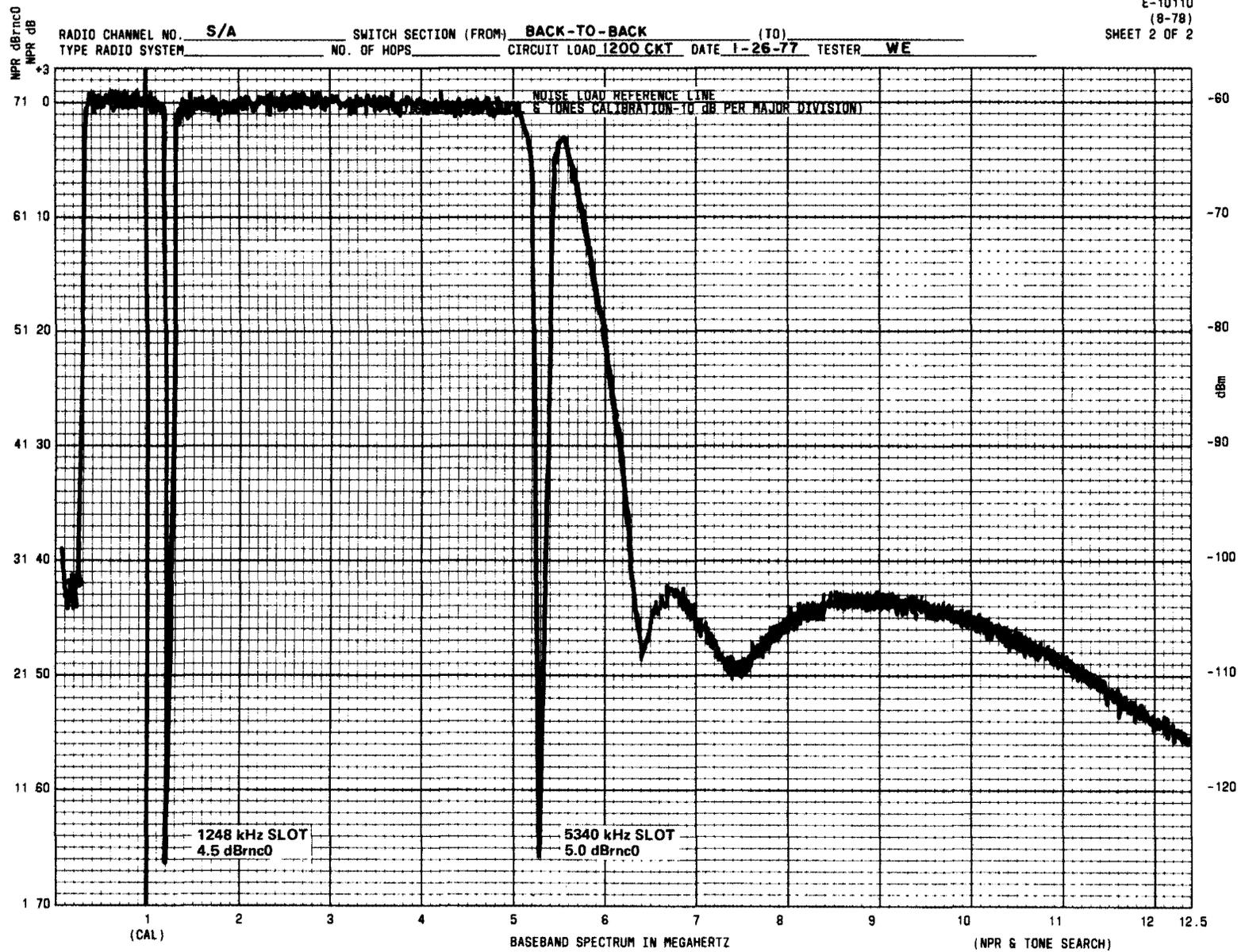


Fig. 6—Noise Load (1200)—SCIENTIFIC-ATLANTA Test Set Back to Back

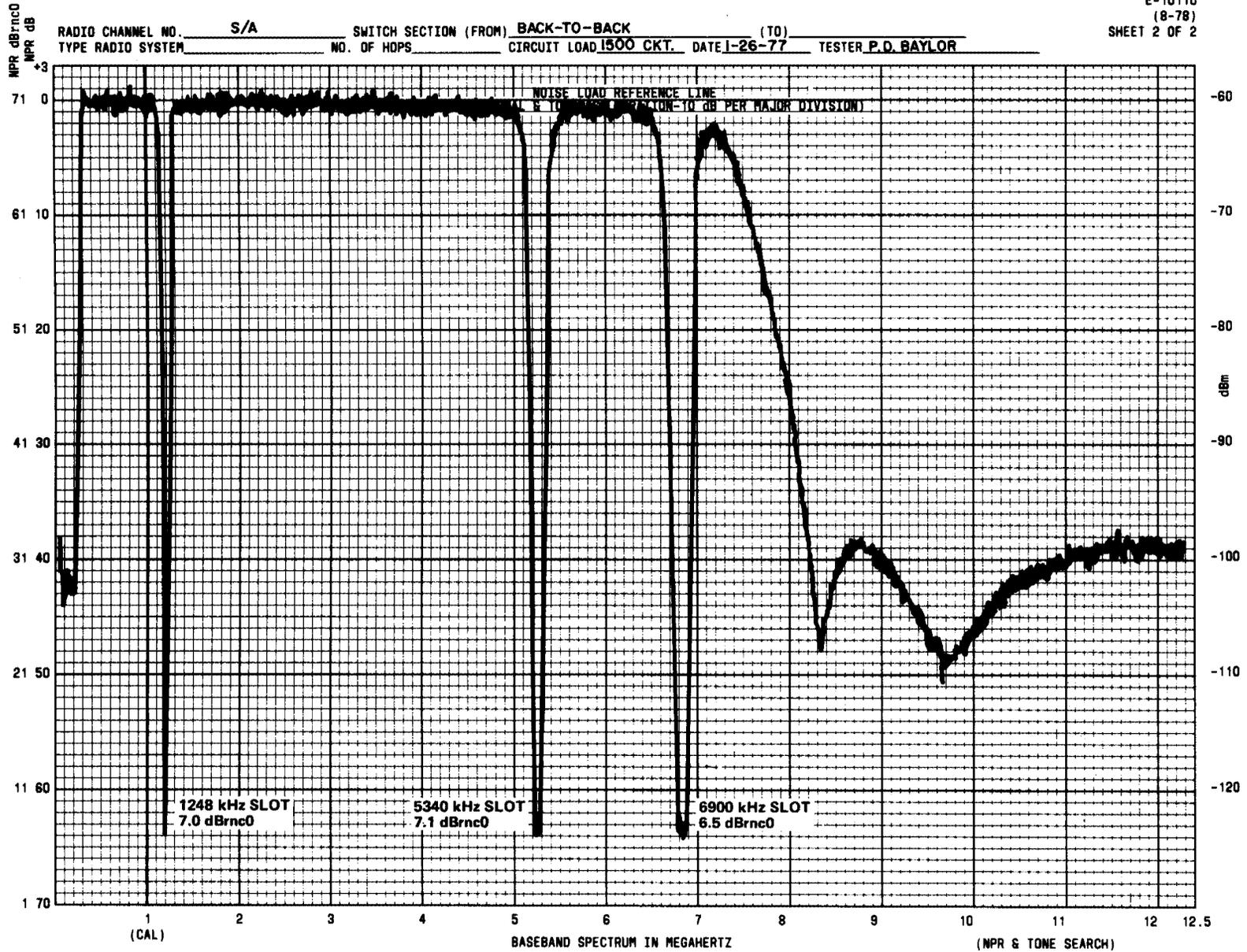


Fig. 7—Noise Load (1500)—SCIENTIFIC-ATLANTA Test Set Back to Back

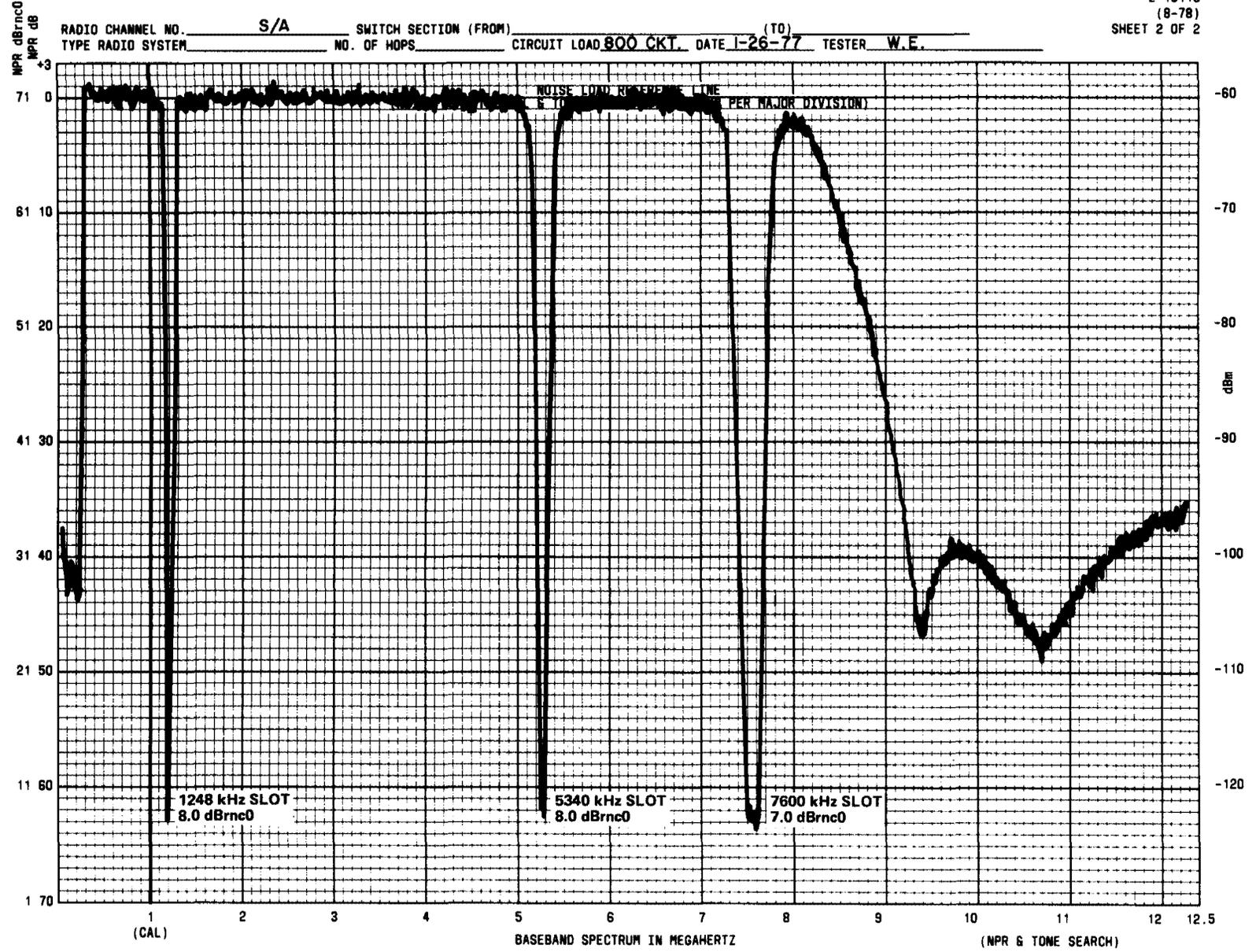


Fig. 8—Noise Load (TD and TH 1800)—SCIENTIFIC-ATLANTA Test Set Back to Back

B. Chart 2—Back-to-Back Calibration Test Procedures for TH(2400)—SCIENTIFIC-ATLANTA Test Set Only (Detailed)

3.03 This chart is the first to be performed when arranging the apparatus for testing. By performing frequency response, thermal noise and tone, and noise power ratio (NPR) tests with the transmitter and analyzer back to back, the operator verifies the performance of these two units and their associated recorder.

3.04 The following apparatus is required:

- 1— SCIENTIFIC-ATLANTA Radio Performance Analyzer
 - Baseband Noise Transmitter (4661)
 - IF/BB Analyzer (4670 or 4671)
 - X-Y Recorder (4673)
- Cords and 443A Plugs as indicated.

STEP	PROCEDURE
1	Caution: See paragraph 1.05 if using the Model 4670 IF/BB analyzer.
2	<p>Arrange the test apparatus and set the controls as given in Fig. 9.</p> <p>Note: These back-to-back tests, made without any pre- and de-emphasis networks, serve to adequately check the operation of the set for the TH(2400) application. However, all subsequent TH(2400) tests that include FM terminals will be made using the pre- and de-emphasis shape that is required for that loading and which is obtained using WE cable assemblies 842731804 and 842731812 for the test connections as specified in the charts covering those tests.</p>
3	<p>Warning: Damage to the pen tip will result if pressure is applied directly to the pen or plastic arm.</p> <p>On the X-Y recorder:</p> <ol style="list-style-type: none"> (a) Insert a BASEBAND RESPONSE test form against the left-hand side and the bottom paperguides of the X-Y recorder. (b) Operate the CHART HOLD/RELEASE switch to HOLD. (This applies a static charge to the X-Y recorder faceplate.) (c) Verify that a pen of the desired color is in place. (d) Adjust the X and Y ZERO controls until the pen is centered over the calibration dot within the small circle located on the 0-dB at 1-MHz point of the graph paper. <p>Note: For convenience, all back-to-back tests in this chart are made using the 71-dBrnc0 calibration point. It is not necessary, for purposes of these tests, to use the 67-dBrnc0 calibration point that is specified in later charts when making the TH(2400) NPR tests.</p> <ol style="list-style-type: none"> (e) Use the index finger to apply enough downward pressure to the flat metal bar (located on top of the carriage bar) to cause the pen to make contact with the paper. The pen shall

STEP**PROCEDURE**

now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot. (This is the preferred method. An alternative method to accomplish this task is to operate the RECORD switch on the IF/baseband analyzer. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot.)

(f) Restore the RECORD switch to normal. (The apparatus is now conditioned to plot the baseband response characteristic of the test arrangement.)

Baseband Scan (Baseband Response)

4 On the IF/baseband analyzer:

(a) Operate the (MODE) AUTO switch. (The pen shall rise and travel to the left side of the baseband test form.)

(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the baseband response signal.)

Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.

Requirement: The baseband response curve shall resemble the baseband response curve of Fig. 10. The maximum average response deviation between 0.5 and 10.0 MHz shall not be greater than ± 0.30 dB.

Test Set Operation for Baseband Thermal Noise and Tone Search

Note: This test should be conducted immediately after the baseband response test. Test connections are the same as for the baseband response test.

5 On the baseband noise transmitter:

(a) Set the NOISE pushbutton to the IN position (noise off).

(b) Set the POWER LEVEL, dBm attenuator for a total of -49 .

(c) The UNCALIBRATED light shall be lit.

6 On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)

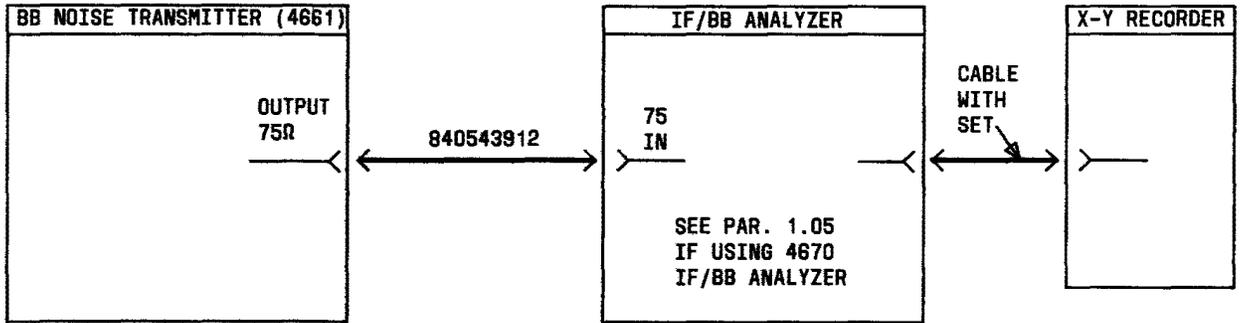
7 On the IF/baseband analyzer:

(a) Set the INPUT attenuator for a total of -20 .

STEP	PROCEDURE
	<ul style="list-style-type: none">(b) Set the REF attenuator for a total of -40.(c) Operate the TONE SEARCH switch.(d) Operate the (MODE) MANUAL switch. (Adjust the frequency back to 1 MHz if it has drifted off.)
	<p>Requirement: The digital power meter shall indicate a noise level of less than -120 dBm.</p>
8	<p>On the X-Y recorder, set the slide switches as follows:</p> <ul style="list-style-type: none">(a) PEN RECORD/LIFT switch to LIFT.(b) SERVO ON/STANDBY switch to SERVO ON.(c) CHART HOLD/RELEASE switch to CHART RELEASE.
9	<p>On the X-Y recorder:</p> <ul style="list-style-type: none">(a) Insert the NPR AND TONE SEARCH form against the left-hand side and bottom paperguides.(b) Operate the CHART HOLD/RELEASE switch to HOLD.(c) Observe the digital power meter indication on the IF/baseband analyzer. (This noise value will be used to calibrate the X-Y recorder.)(d) Using the X-Y controls, adjust the position of the pen for calibration at 1 MHz and the same $-dBm$ value as indicated on the digital power meter in (c) above. [The far right-hand dBm scale of the graph paper ($-130/-60$) is used for this purpose.](e) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)
	<p>Thermal Noise and Tone Scan</p>
10	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none">(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tone signal.)
	<p>Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may</p>

STEP	PROCEDURE
	<p>cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>Requirement: The thermal noise and tone response curve shall resemble the thermal noise and tone curve in Fig. 5. The thermal noise shall not be greater than -120 dBm, and no tone shall be greater than -115 dBm across the 60-kHz to 12.5-MHz spectrum.</p> <p>Test Set Operation for Noise Load (NPR)</p> <p>Note: This test should be conducted immediately after the thermal noise and tone search. Test connections are the same as for baseband response and thermal noise and tone search.</p>
11	<p>On the baseband noise transmitter:</p> <ul style="list-style-type: none"><li data-bbox="423 814 1539 873">(a) Set the BANDSTOP FILTER, kHz 1248, 5340, and 10,840 pushbuttons to their in-circuit position.<li data-bbox="423 905 1539 963">(b) Set the NOISE pushbutton to the OUT position (noise on). The UNCALIBRATED light shall be extinguished.<li data-bbox="423 995 1089 1022">(c) Set the POWER LEVEL, dBm attenuator to -12.0.
12	<p>On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)</p>
13	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none"><li data-bbox="423 1205 776 1232">(a) Operate the NPR switch.<li data-bbox="423 1264 1539 1323">(b) Operate the (MODE) MANUAL switch. (Adjust the frequency back to 1 MHz if it has drifted off.)<li data-bbox="423 1354 883 1381">(c) Set the INPUT attenuator to -12.<li data-bbox="423 1413 854 1440">(d) Set the REF attenuator to -39.<li data-bbox="423 1472 1317 1499">(e) The digital power meter shall indicate a noise level of -50.5 ± 1 dBm.<li data-bbox="423 1530 1539 1627">(f) Under normal conditions, the analog power meter shall indicate 0 dBm on the lower scale (0 through -70 dBm). Readjust the reference attenuator until the analog power meter indicates as closely to 0 dBm as possible.
14	<p>On the X-Y recorder, set the slide switches as follows:</p> <ul style="list-style-type: none"><li data-bbox="423 1719 927 1747">(a) PEN RECORD/LIFT switch to LIFT.<li data-bbox="423 1778 1036 1806">(b) SERVO ON/STANDBY switch to SERVO ON.<li data-bbox="423 1837 1065 1864">(c) CHART HOLD/RELEASE switch to RELEASE.

STEP	PROCEDURE
15	<p data-bbox="285 390 773 411">(d) LINE ON/OFF switch to LINE ON.</p> <p data-bbox="253 453 509 474">On the X-Y recorder:</p> <p data-bbox="285 516 1398 573">(a) Insert an NPR AND TONE SEARCH test form against the left-hand side and bottom paperguides.</p> <p data-bbox="285 611 1187 632">(b) Operate the CHART HOLD/RELEASE switch to the HOLD position.</p> <p data-bbox="285 674 1398 730">(c) Adjust the X and Y ZERO controls until the pen is centered over the dot located at 1 MHz and 71 dBrnc0.</p> <p data-bbox="253 768 1398 825">Note: It is not necessary, for the purposes of these back-to-back tests, to use the 67-dBrnc0 calibration point that is specified in later charts when making TH(2400) NPR tests.</p> <p data-bbox="285 863 1398 951">(d) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)</p>
16	<p data-bbox="253 989 594 1010">Noise Power Ratio (NPR) Scan</p> <p data-bbox="253 1052 618 1073">On the IF/baseband analyzer:</p> <p data-bbox="285 1115 1398 1171">(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)</p> <p data-bbox="285 1209 1398 1266">(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the NPR signal.)</p> <p data-bbox="253 1304 1398 1360">Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed.</p> <p data-bbox="253 1398 1398 1455">Note 2: The 1248, 5340, and 10,840 slots will appear in the noise spectrum for the 2400 noise load.</p> <p data-bbox="253 1493 1398 1549">Requirement 1: The noise power ratio curve shall resemble the noise power ratio curves in Fig. 11 (TH 2400).</p> <p data-bbox="253 1587 1398 1675">Requirement 2: Each noise slot must be below the 11-dBrnc0 line. Also, the average signal line (located across the 71-dBrnc0 line) must average about the 71-dBrnc0 line for the bandwidth being tested.</p> <p data-bbox="253 1713 1398 1770">Note 3: Successful use of the dBrnc0 scale depends upon accurate calibration of the X-Y recorder pen at the 71-dBrnc0 (or 0 NPR) point.</p>



INITIAL CONTROL POSITIONS					
BB NOISE TRANSMITTER		IF/BB ANALYZER		X-Y RECORDER	
POWER	ON	POWER -	ON	POWER -	ON
POWER LEVEL, dBm	TOTAL OF -22.2	INPUT -	TOTAL OF -20dB	RECORD/LIFT-	LIFT
NOISE	OUT (ON)	REF -	TOTAL OF -29dB	SERVO ON/STANDBY	SERVO ON
HPF 316	OUT	BB RESPONSE-	OPERATED	CHART HOLD/RELEASE	RELEASE
LPF 11404	IN	(MODE) MANUAL -	USE BOTH KNOBS		RETURN TO CHART
BSF:		TUNING -	TO ADJUST TO		
1248	OUT		1-MHZ		
5340	OUT	LEVEL dBm -	THE ANALOG		
10840	OUT		POWER METER		
UNCALIBRATED	LAMP SHOULD BE EXTINGUISHED, IF NOT EXTINGUISHED INVESTIGATE TROUBLE		SHOULD INDICATE 0-dBm ON THE TOP SCALE.		
			READJUST REF AS NECESSARY UNTIL AS CLOSE TO 0-dBm AS POSSIBLE. THE DIGITAL POWER METER SHOULD INDICATE -49 ±1dBm		

Fig. 9—Test Arrangement—Back-to-Back Calibration for TH (2400)—SCIENTIFIC-ATLANTA Test Set Only

RADIO CHANNEL NO. _____ SWITCH SECTION (FROM) _____ (TO) _____
TYPE RADIO SYSTEM _____ NO. OF HOPS _____ CIRCUIT LOAD _____ DATE _____ TESTER _____

E-10110
(8-78)
SHEET 1 OF 2

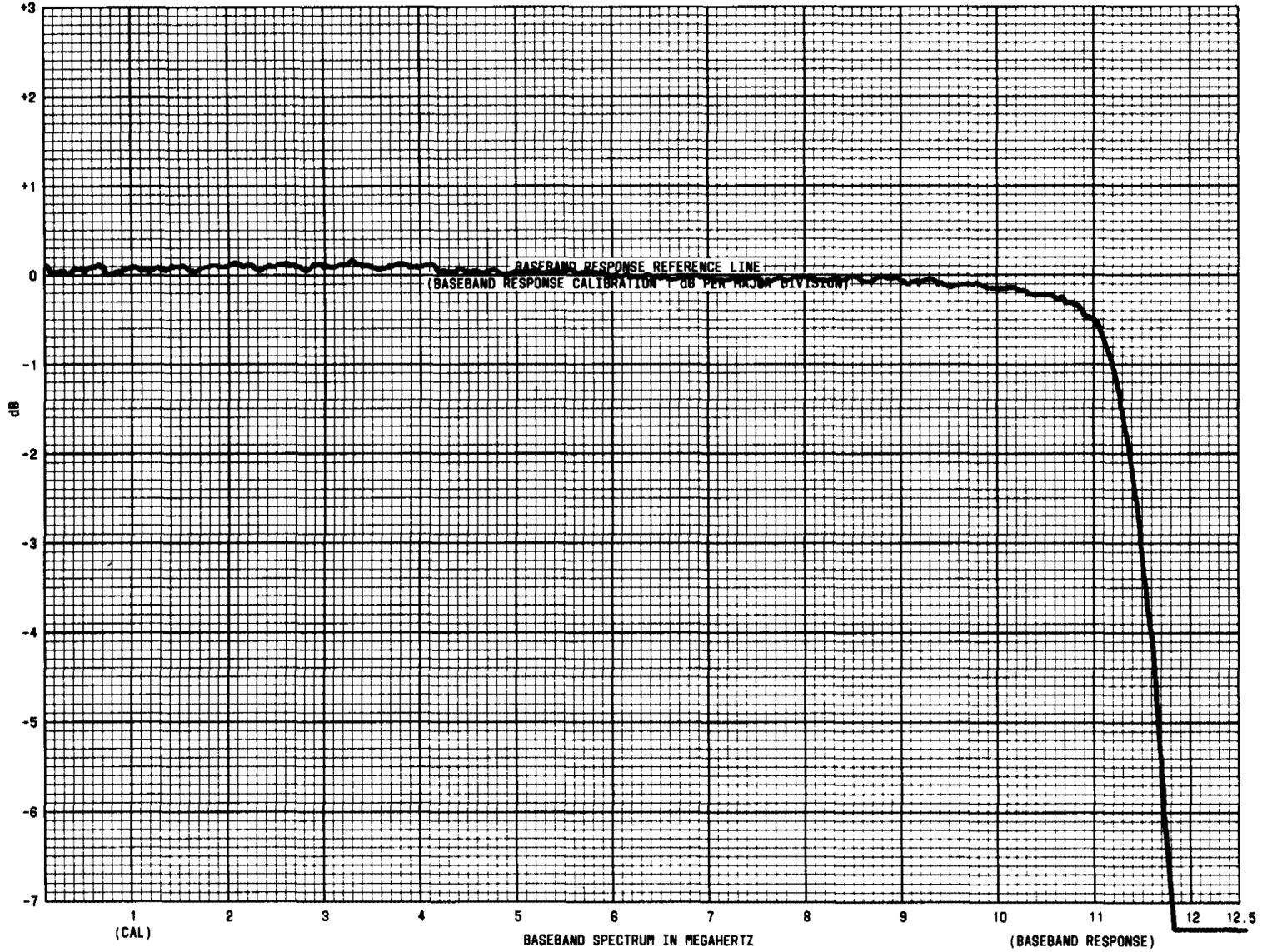


Fig. 10—Baseband Response for TH (2400)—SCIENTIFIC-ATLANTA Test Set Back to Back

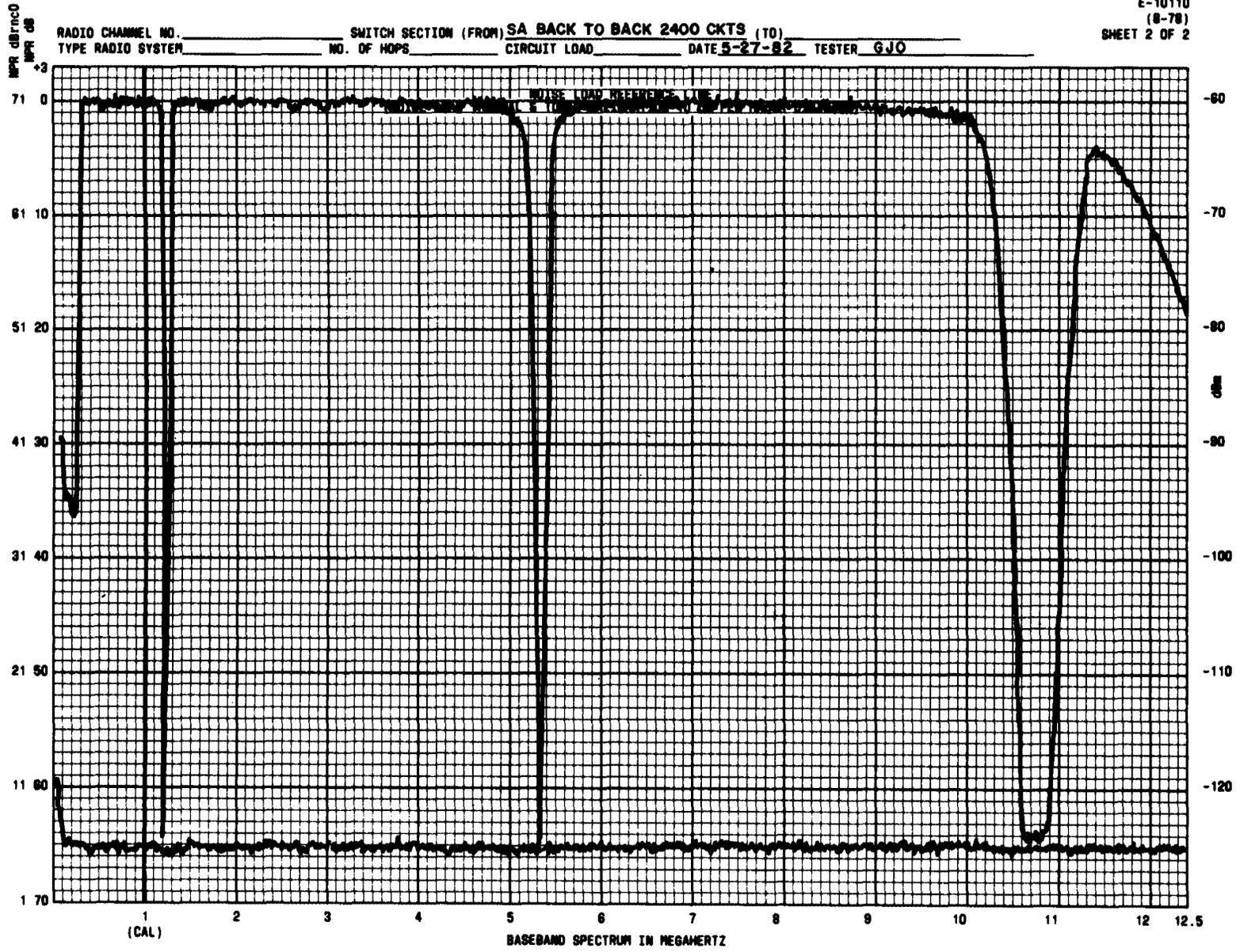


Fig. 11—Noise Load for TH (2400)—SCIENTIFIC-ATLANTA Test Set Back to Back

C. Chart 3—Back-to-Back Calibration Test Procedures for TH(1200), TD(1500)/(45 Mb/s), TD(1800) and TH(1800)—SCIENTIFIC-ATLANTA Test Set and FM Terminals Only (Detailed)

3.05 By testing the SCIENTIFIC-ATLANTA test set and the FM terminals back to back, the operator can determine the overall test arrangement's performance quality before involving the distant office. This arrangement provides an excellent training model that more nearly duplicates the arrangement used when testing radio channels. This arrangement has the capability of performing baseband response, noise load (NPR), and thermal noise and tone search (baseband related) tests. Field experience shows that time-saving advantages are possible when these tests are conducted in a specific sequence. Therefore, it is recommended that the sequence in Table D be observed whenever possible.

3.06 The following apparatus is required:

1— SCIENTIFIC-ATLANTA Radio Performance Analyzer

Baseband Noise Transmitter (4660)

IF/BB Analyzer (4670)

X-Y Recorder (4673)

1— 3- or 4-Type FM Terminal (A or B, depending upon type of radio system to be tested.)

Cords and Coaxial Pads as indicated.

TABLE D

TEST	SEQUENCE	FOR EXAMPLE REFER TO FIGURE
Baseband Response	1 of 4	15
Thermal Noise and Tone Search	2 of 4	16
Noise Load (NPR)	3 of 4	}17, 18, or 19
Thermal Noise Plot	4 of 4	

STEP	PROCEDURE
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Note: When testing at TD 1800 circuit loading, only the 4A terminal may be used.

Test Sequence 1 of 4—Baseband Response

- 1 Arrange the test apparatus and follow the Initial Control Positions instructions as given in Fig. 57, option (X) for TD 1200, TD 1500, and TH 1800 or option (Y) for TD 1800.
- 2 **Warning: Damage to the pen tip will result if pressure is applied directly to the pen or plastic arm.**

STEP	PROCEDURE
	<p>On the X-Y recorder:</p> <ul style="list-style-type: none">(a) Insert a BASEBAND RESPONSE test form against the left-hand side and the bottom paperguides of the X-Y recorder.(b) Operate the CHART HOLD/RELEASE switch to HOLD.(c) Verify that a pen of the desired color is in place.(d) Adjust the X and Y ZERO controls until the pen is centered over the calibration dot within the small circle located on the 0-dB at 1-MHz point of the graph paper.(e) Use the index finger to apply enough downward pressure to the flat metal bar (located on top of the carriage bar) to cause the pen to make contact with the paper. The pen shall now be against the paper and moving above the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot. (The foregoing is the preferred method. An alternative method is to operate the RECORD switch on the IF/baseband analyzer. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot.)(f) Restore the RECORD switch to normal. (The apparatus is now ready for the baseband response plot.)
	<p>Baseband Scan (Baseband Response)</p>
3	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none">(a) Operate the (MODE) AUTO switch. (The pen shall rise and travel to the left side of the baseband test form.)(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the baseband response signal.) <p>Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p>
	<p>Requirement: The baseband response curve shall resemble the baseband response curve in Fig. 12. Specific baseband response requirements are shown in Table E.</p>

STEP

PROCEDURE

TABLE E

FM TERMINALS		BB RESPONSE LIMITS
FMT	FMR	BASEBAND RESPONSE RELATIVE TO 1 MHz
3A	3A	Within 0.3 dB, .05 thru 8 MHz
4A	3A	Within 0.4 dB, 0.5 thru 9 MHz, Option (X) Within 0.6 dB, 0.5 thru 9 MHz, Option (Y)
4A	4A	Within 0.4 dB, 0.5 thru 9 MHz, Option (X) Within 0.6 dB, 0.5 thru 9 MHz, Option (Y)
4B	4B	Within 0.4 dB, 0.5 thru 9 MHz
3B	3B	Within 0.4 dB, 0.5 thru 9 MHz

Test Sequence 2 of 4—Thermal Noise and Tone Search

Note: This test should be conducted immediately after the baseband response test. Test connections are the same as for the baseband response test.

- 4 On the baseband noise transmitter:
 - (a) Position the function switch to TONE SEARCH (noise off).
 - (b) Set the attenuator for a total of 49.
 - (c) The UNCALIBRATED light shall be lit.
- 5 On the X-Y recorder, operate the SERVO ON/STANDBY switch to STANDBY. (This step eliminates unnecessary noise.)
- 6 On the IF/baseband analyzer:
 - (a) Set the INPUT attenuator for a total of -20.
 - (b) Set the REF attenuator for a total of -40.
 - (c) Operate the TONE SEARCH switch.
 - (d) Operate the (MODE) MANUAL switch. (Adjust the frequency back to 1 MHz if it has drifted off.)

STEP	PROCEDURE
7	<p>On the X-Y recorder, set the slide switches as follows:</p> <ul style="list-style-type: none">(a) PEN RECORD/LIFT switch to LIFT.(b) SERVO ON/STANDBY switch to SERVO ON.(c) CHART HOLD/RELEASE switch to CHART RELEASE.
8	<p>On the X-Y recorder:</p> <ul style="list-style-type: none">(a) Insert an NPR AND TONE SEARCH form against the left-hand side and bottom paperguides.(b) Operate the CHART HOLD/RELEASE switch to HOLD.(c) Observe the digital power meter indication on the IF/baseband analyzer. (This noise value will be used to calibrate the X-Y recorder.)(d) Using the X-Y ZERO controls, adjust the position of the pen for calibration at 1 MHz and the same $-dBm$ value as indicated on the digital power meter in (c) above. [The far right-hand dBm scale of the graph paper ($-130/-60$) is used for this purpose.](e) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y ZERO controls may be necessary to arrive at the desired calibration point.) <p>Thermal Noise and Tone Scan</p>
9	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none">(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tone signal.) <p>Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>Requirement: The thermal noise and tone response curve shall resemble the thermal noise and tone curve in Fig. 13. Specific thermal noise and tone requirements are shown in Table F.</p>

STEP

PROCEDURE

TABLE F

THERMAL NOISE AND TONES dBm (1.74-kHz EFFECTIVE NOISE BANDWIDTH)									
FM TERMINALS		BASEBAND FREQUENCY IN MEGAHERTZ							
FMT	FMR	0.5	1	3	6	7	8	9	10
3A	3A	-102	-102	-102	-101	-100	- 99	- 99	- 99
4A	3A	-107	-108	-110	-110	-110	-109	-108	-108
4A	4A	-108	-108	-112	-113	-113	-112	-112	-112
4B	4B	See 4A Pair							
3B	3B	See 3A Pair							
Tone Requirement: No tones greater than -98 dBm from 0.5 to 11 MHz.									

Test Sequence 3 of 4—Noise Load (NPR)

Note: This test should be conducted immediately after the thermal noise and tone search. Test connections are the same as for baseband response and thermal noise and tone search.

10 On the baseband noise transmitter:

- (a) Set the function switch to NPR SLOTS IN.
- (b) The UNCALIBRATED light shall be extinguished.
- (c) Set the attenuators as indicated in Table G for the desired noise load.

TABLE G

RADIO	LOAD	CHANNEL SELECTOR	ATTENUATOR SETTING (NOTE)
TD	1200	A	15
TD	1500	B	20
TD	1800	C	22
TH	1800	C	17

Note: The attenuator settings establish the wideband average power inputs to the FM transmitter as shown in Table H.

STEP	PROCEDURE
------	-----------

TABLE H

RADIO	LOAD	WIDEBAND POWER AT FMT INPUT
TD	1200	-23.5 dBm
TD	1500	-26.5 dBm
TD	1800	-31.8 dBm
TH	1800	-23.0 dBm

- 11 On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)
- 12 On the IF/baseband analyzer:
- Operate the NPR switch.
 - Set the attenuators as indicated in Table I for various noise levels as selected on the baseband noise transmitter.

TABLE I

RADIO	LOAD	ATTENUATORS		DIGITAL POWER LEVEL
		INPUT	REFERENCE	
TD	1200	-11	-38	-48.0 ± 1 dBm
TD	1500	-15	-38	-53.5 ± 1 dBm
TD	1800	-20	-38	-58.5 ± 1 dBm
TH	1800	-12	-39	-51.5 ± 1 dBm

- Operate the (MODE) MANUAL switch. (Adjust the frequency if other than 1 MHz.)
 - The digital power meter shall indicate a noise level as indicated in (b) above.
 - Under normal conditions, the analog power meter shall indicate 0 dBm on the lower scale (0 through -70 dBm). Readjust the reference attenuator until the analog power meter indicates as closely to 0 dBm as possible.
- 13 On the X-Y recorder, set the slide switches as follows:
- PEN RECORD/LIFT switch to LIFT.
 - SERVO ON/STANDBY switch to SERVO ON.

STEP

PROCEDURE

(c) CHART HOLD/RELEASE switch to RELEASE.

(d) LINE ON/OFF switch to LINE ON.

14 On the X-Y recorder:

(a) Insert an NPR AND TONE SEARCH test form against the left-hand side and bottom paperguides.

(b) Operate the CHART HOLD/RELEASE switch to the HOLD position.

(c) Adjust the X and Y ZERO controls until the pen is centered over the applicable vertical calibration point at 1 MHz as specified in Table J.

TABLE J

RADIO	1-MHz CALIBRATION POINT
TD (1200)	71 dBrnc0 (Dot)
TD (1500)/ (45 Mb/s)	
TH (1800)	
TD (1800)	67 dBrnc0 (4 divisions below dot)

(d) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X and Y ZERO controls may be necessary to arrive at the desired calibration point.)

Noise Power Ratio (NPR) Scan

15 On the IF/baseband analyzer:

(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)

(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the NPR signal.)

Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.

Note 2: The slots will appear in the noise spectrum for a specific noise load as shown in Table K.

STEP	PROCEDURE
------	-----------

Note 3: Successful use of the dBrc0 scale depends upon accurate calibration of the X-Y recorder pen at the point specified in Table J.

TABLE K

RADIO	LOAD	SLOT FREQUENCIES (kHz)
TD	1200	1248/5340
TD	1500	1248/5340/6900
TD	1800	1248/5340/7600
TH	1800	1248/5340/7600

Requirement: The noise load curve shall resemble the noise power ratio curves in Fig. 14 (TD 1200); Fig. 15 (TD 1500); or Fig. 16 (TD and TH 1800). Specific noise load requirements are shown in Table L.

TABLE L

NOISE LOAD LIMITS					
FM TERMINALS		WORST SLOT NOISE dBrc0 (NOTE)			
FMT	FMR	TD 1200	TD 1500	TD 1800	TH 1800
3A	3A	21	19	—	—
4A	3A	19	19	—	21
4A	4A	18	18	16	20
4B	4B	—	—	—	19
3B	3B	19	21	—	24

Note: Successful use of the dBrc0 scale depends upon accurate calibration of the X-Y recorder pen at the 71-dBrc0 (or 0 NPR) point.

Test Sequence 4 of 4—Noise Load With Thermal Noise Plot

Note: The thermal noise plot, for best results, must be conducted immediately after the noise load test. The instructions below assume that the thermal noise plot is being conducted immediately after the noise load plot.

- 16 On the baseband noise transmitter, operate the selector switch to the TONE SEARCH (noise off) position.

STEP	PROCEDURE
17	<p>On the IF/baseband analyzer, operate the (MODE) RECORD switch. The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tones underneath the noise load plot. See Fig. 14 (TD 1200); Fig. 15 (TD 1500); or Fig. 16 (TD and TH 1800).</p> <p>Note: This test sequence (4 of 4) is conducted to determine the noise and tone characteristic in the area of a specific noise load slot.</p>
18	<p>Analysis of the thermal floor area near the noise load slot will reveal:</p> <ul style="list-style-type: none"><li data-bbox="280 667 1227 693">(a) If the noise load slot is thermal noise or intermodulation noise controlled<li data-bbox="280 730 1114 756">(b) If there is a balance in thermal noise and intermodulation noise<li data-bbox="280 793 1333 819">(c) If the noise load slot is influenced by an undesirable tone near the noise load slot. <p>Note: See Fig. 14 (TD 1200); Fig. 15 (TD 1500); or Fig. 16 (TD and TH 1800) for general analysis of test data. For more detailed analysis, see Part 4 of this section.</p>

RADIO CHANNEL NO. 4A FMR/FMT SWITCH SECTION (FROM) BACK-TO-BACK (TO) _____
 TYPE RADIO SYSTEM _____ NO. OF HOPS _____ CIRCUIT LOAD _____ DATE 1-26-77 TESTER WE

E-10110
 (8-78)
 SHEET 1 OF 2

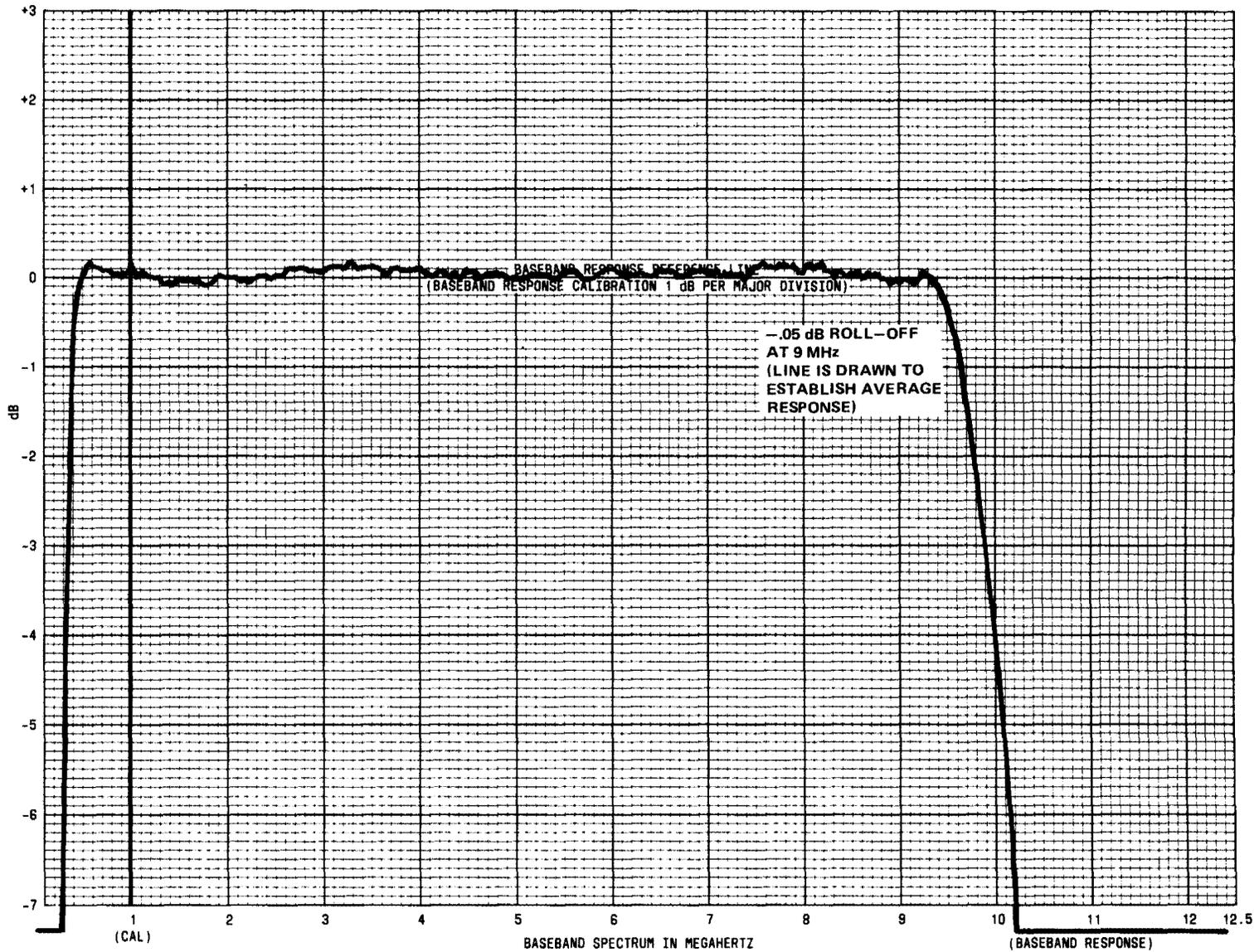


Fig. 12—Baseband Response TD (1200), TD (1500), TD (1800), and TH (1800)—SCIENTIFIC-ATLANTA Test Set and FM Terminal Back to Back

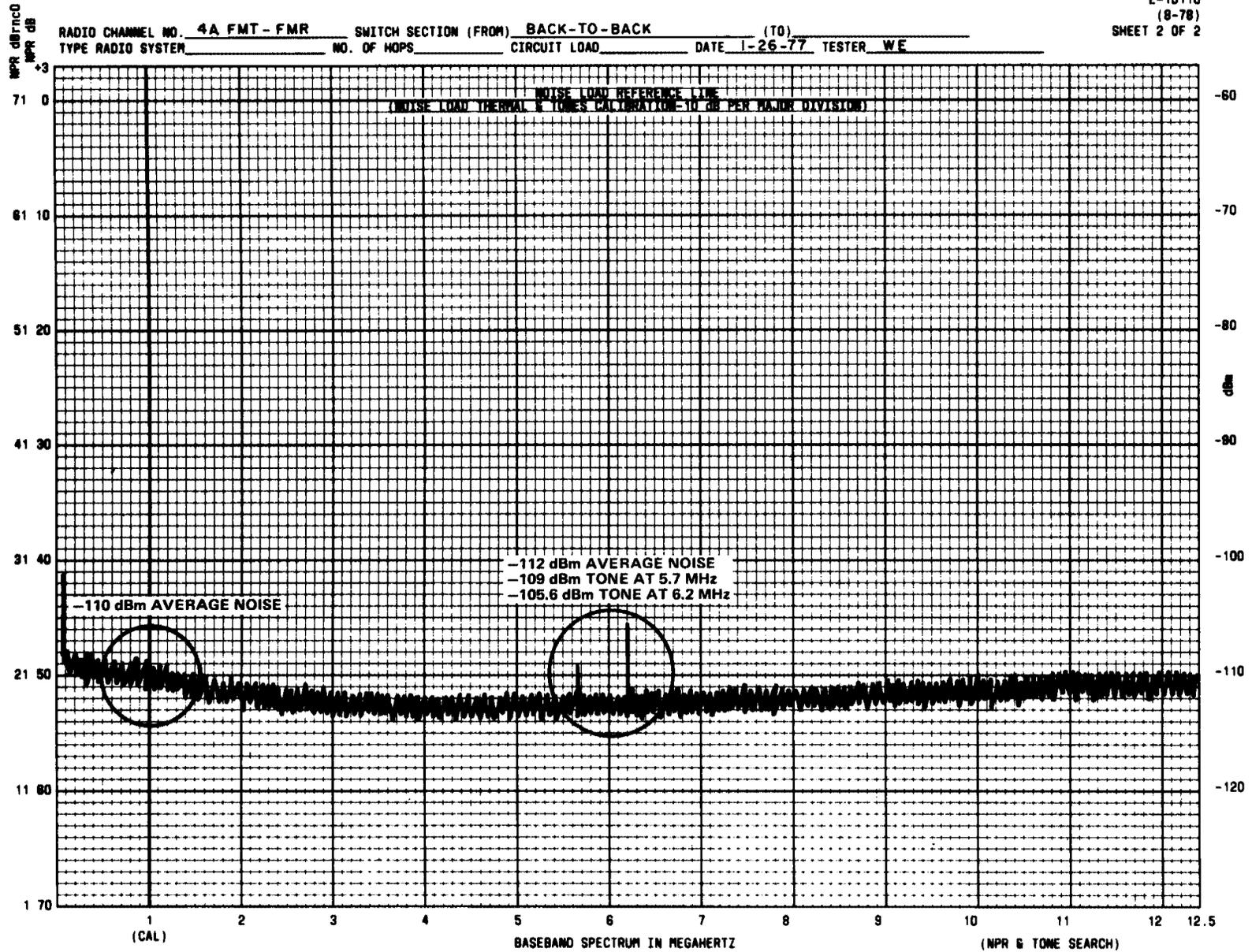


Fig. 13—Thermal Noise and Tones (TD 1200, TD 1500, TD 1800, and TH 1800)—SCIENTIFIC-ATLANTA Test Set and FM Terminal Back to Back

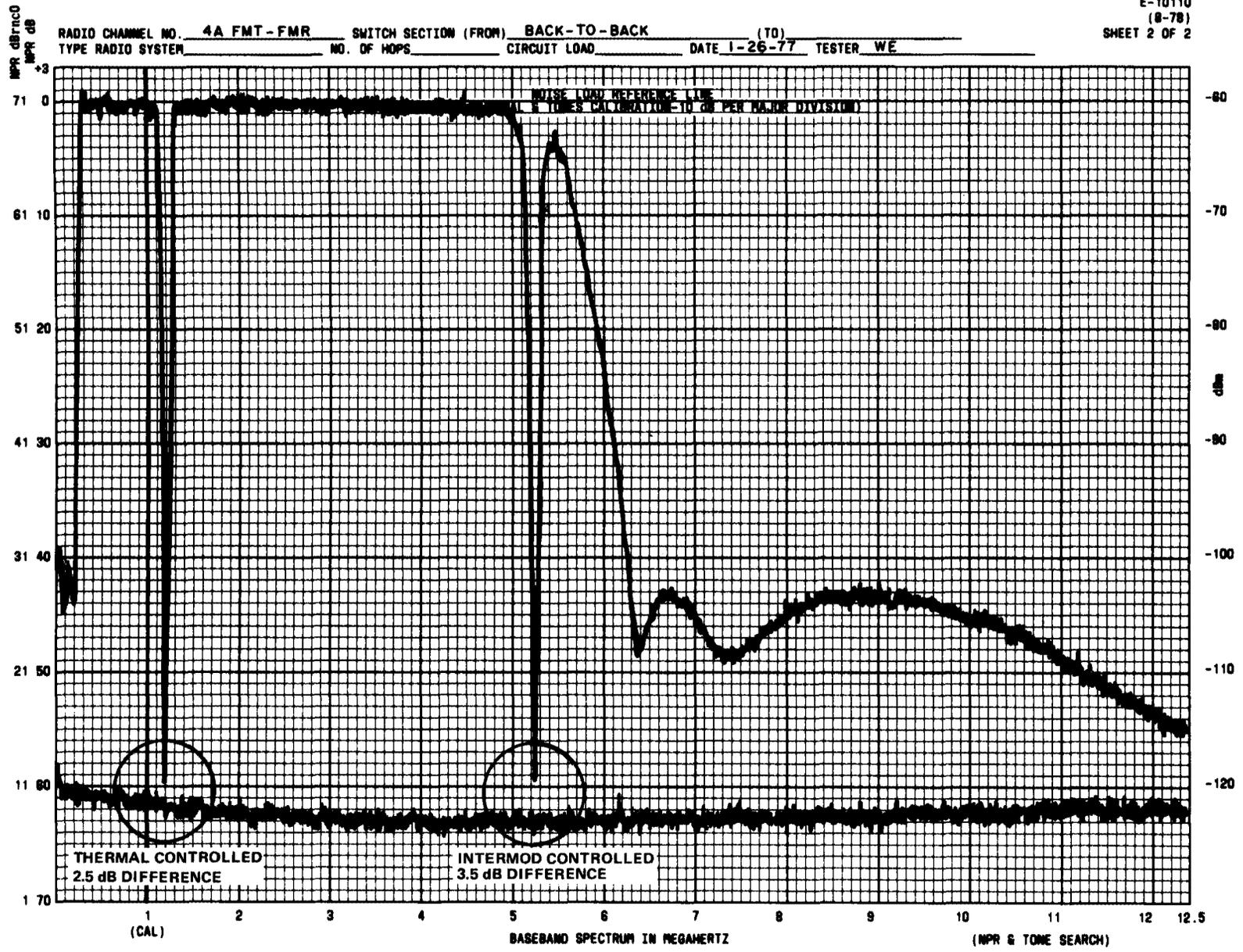


Fig. 14—Noise Load (TD 1200) With Thermal Noise Plot—SCIENTIFIC-ATLANTA Test Set and FM Terminal Back to Back

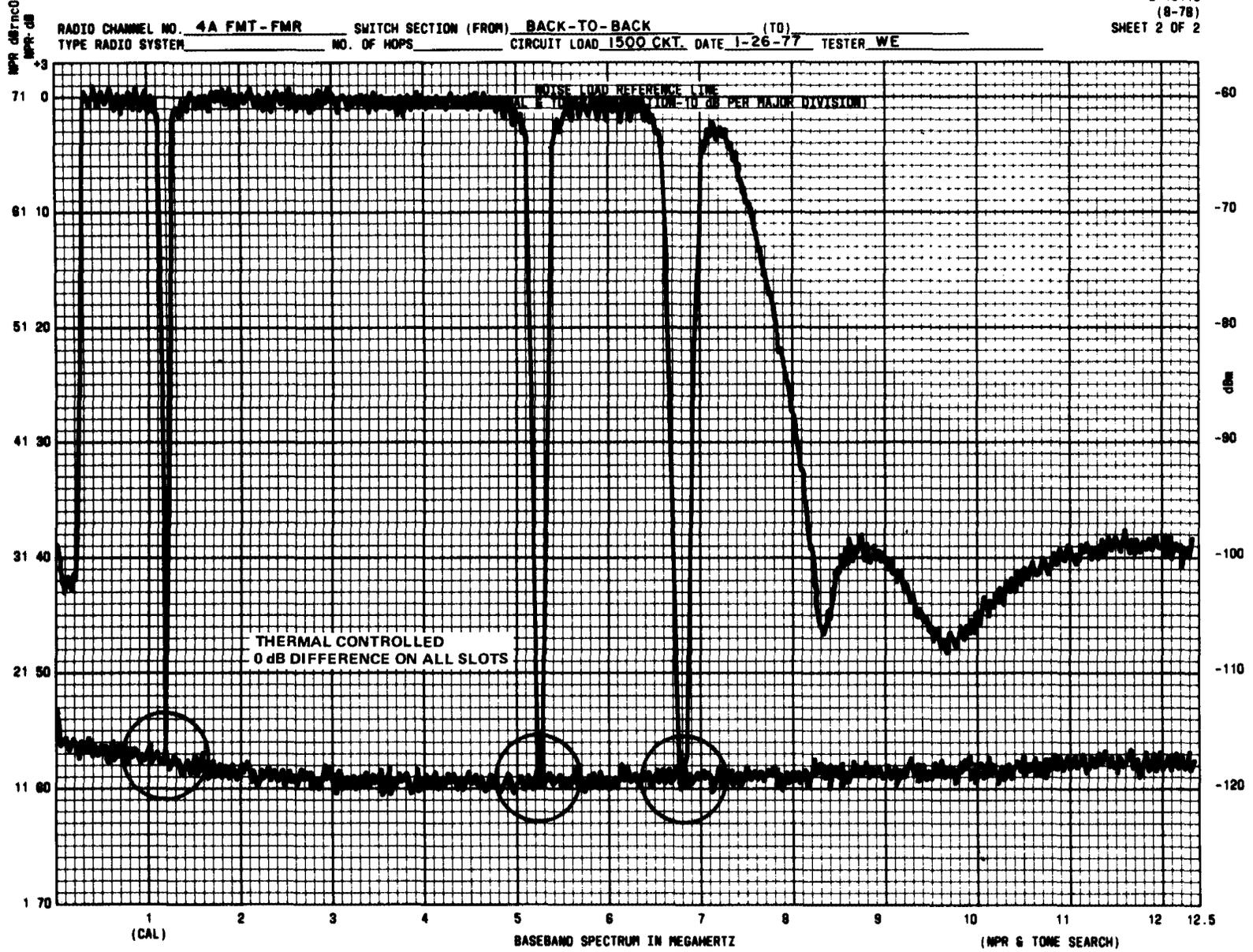


Fig. 15—Noise Load (TD 1500) With Thermal Noise Plot—SCIENTIFIC-ATLANTA Test Set and FM Terminal Back to Back

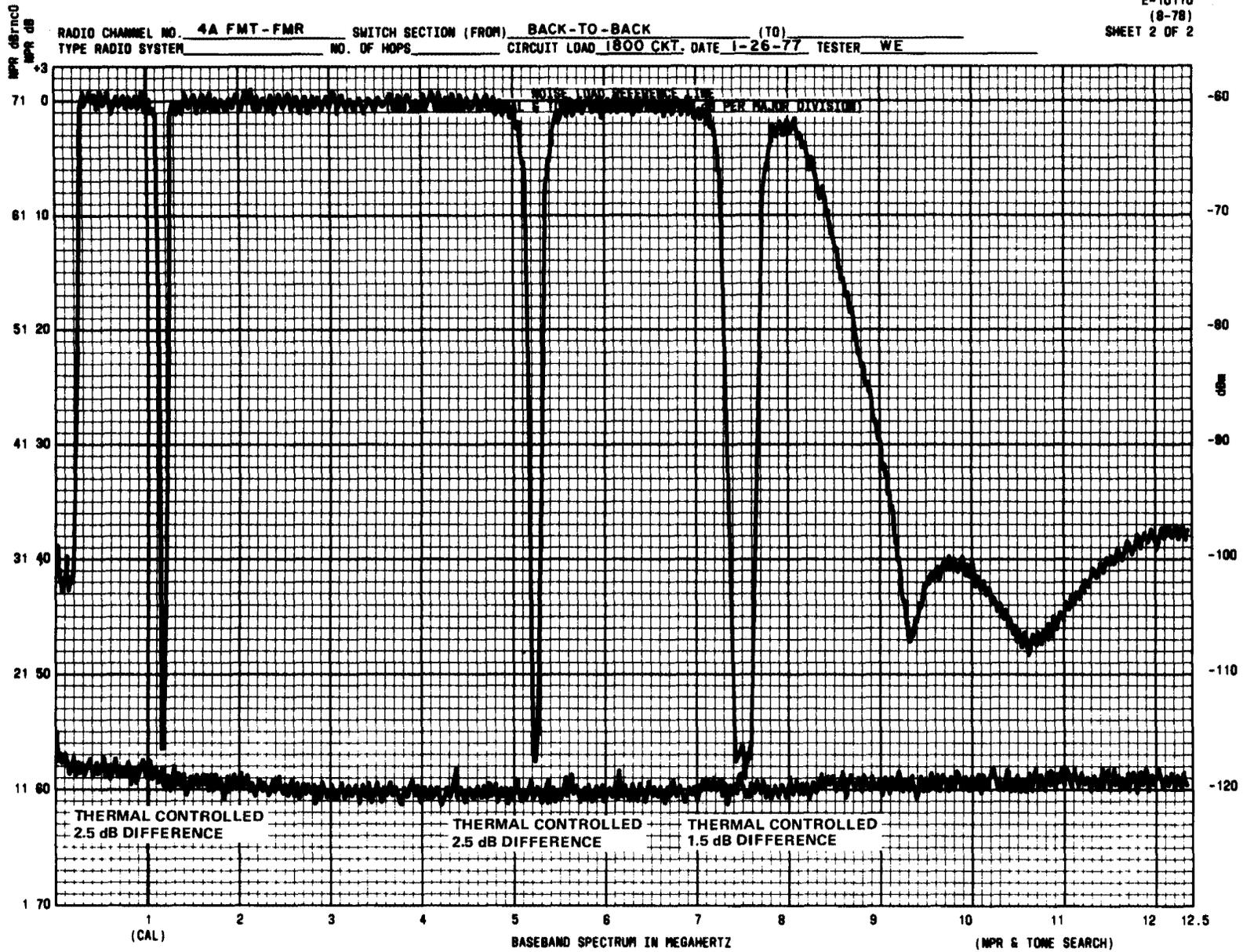


Fig. 16—Noise Load (TD and TH 1800) With Thermal Noise Plot—SCIENTIFIC-ATLANTA Test Set and FM Terminal Back to Back

D. Chart 4—Back-to-Back Calibration Test Procedure for TH(2400)—SCIENTIFIC-ATLANTA Test Set and FM Terminals Only (Detailed)

3.07 By testing the SCIENTIFIC-ATLANTA test set and the FM terminal back to back, the operator can determine the overall test arrangement's performance quality before involving the distant office. This arrangement provides an excellent training model that more nearly duplicates the arrangement used when testing radio channels. This arrangement has the capability of performing baseband response, noise load (NPR), and thermal noise and tone search (baseband related) tests. Field experience shows that time-saving advantages are possible when these tests are conducted in a specific sequence. Therefore, it is recommended that the sequence in Table M be observed whenever possible.

3.08 The following apparatus is required:

1— SCIENTIFIC-ATLANTA Radio Performance Analyzer

Baseband Noise Transmitter (4661)

IF/BB Analyzer (4670 or 4671)

X-Y Recorder (4673)

1— 4A FM Terminal

Cords and 443A Plugs as indicated.

TABLE M

TEST	SEQUENCE	FOR EXAMPLE REFER TO FIGURE
Baseband Response	1 of 4	15
Thermal Noise and Tone Search	2 of 4	16
Noise Load (NPR)	3 of 4	} 22
Thermal Noise Plot	4 of 4	

STEP	PROCEDURE
------	-----------

1 **Caution: See paragraph 1.05 if using the Model 4670 IF/BB analyzer.**

Test Sequence 1 of 4—Baseband Response

2 Arrange the test apparatus and follow the Initial Control Positions instruction as given in Fig. 17.

3 **Warning: Damage to the pen tip will result if pressure is applied directly to the pen or plastic arm.**

On the X-Y recorder:

(a) Insert a BASEBAND RESPONSE test form against the left-hand side and the bottom paperguides of the X-Y recorder.

(b) Operate the CHART HOLD/RELEASE switch to HOLD.

STEP	PROCEDURE
	<p>(c) Verify that a pen of the desired color is in place.</p> <p>(d) Adjust the X and Y ZERO controls until the pen is centered over the calibration dot within the small circle located on the 0-dB at 1-MHz point of the graph paper.</p> <p>(e) Use the index finger to apply enough downward pressure to the flat metal bar (located on top of the carriage bar) to cause the pen to make contact with the paper. The pen shall now be against the paper and moving above the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot. (The foregoing is the preferred method. An alternative method is to operate the RECORD switch on the IF/baseband analyzer. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot.)</p> <p>(f) Restore the RECORD switch to normal. (The apparatus is now conditioned to plot the baseband response characteristic of the test arrangement.)</p>
	<p>Baseband Scan (Baseband Response)</p>
4	<p>On the IF/baseband analyzer:</p> <p>(a) Operate the (MODE) AUTO switch. (The pen shall rise and travel to the left side of the baseband test form.)</p> <p>(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the baseband response signal.)</p> <p>Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>Requirement: The baseband response curve shall resemble the baseband response curve in Fig. 18. The maximum average response deviation between 0.5 and 10 MHz shall not be greater than ± 0.6 dB.</p> <p>Test Sequence 2 of 4—Thermal Noise and Tone Search</p> <p>Note: This test should be conducted immediately after the baseband response test. Test connections are the same as for the baseband response test.</p>
5	<p>On the baseband noise transmitter:</p> <p>(a) Set the NOISE pushbutton to the IN position (noise off).</p> <p>(b) Set the POWER LEVEL, dBm attenuator for a total of -49.</p> <p>(c) The UNCALIBRATED light shall be lit.</p>

STEP	PROCEDURE
6	On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)
7	On the IF/baseband analyzer: <ul style="list-style-type: none"><li data-bbox="282 548 878 569">(a) Set the INPUT attenuator for a total of -20.<li data-bbox="282 604 846 625">(b) Set the REF attenuator for a total of -40.<li data-bbox="282 661 776 682">(c) Operate the TONE SEARCH switch.<li data-bbox="282 718 1393 783">(d) Operate the (MODE) MANUAL switch. (Adjust the frequency back to 1 MHz if it has drifted off.)
8	On the X-Y recorder, set the slide switches as follows: <ul style="list-style-type: none"><li data-bbox="282 877 786 898">(a) PEN RECORD/LIFT switch to LIFT.<li data-bbox="282 934 894 955">(b) SERVO ON/STANDBY switch to SERVO ON.<li data-bbox="282 991 1029 1012">(c) CHART HOLD/RELEASE switch to CHART RELEASE.
9	On the X-Y recorder: <ul style="list-style-type: none"><li data-bbox="282 1119 1393 1176">(a) Insert the NPR AND TONE SEARCH form against the left-hand side and bottom paperguides.<li data-bbox="282 1211 1029 1232">(b) Operate the CHART HOLD/RELEASE switch to HOLD.<li data-bbox="282 1268 1393 1325">(c) Observe the digital power meter indication on the IF/baseband analyzer. (This noise value will be used to calibrate the X-Y recorder.)<li data-bbox="282 1360 1393 1446">(d) Using the X-Y ZERO controls, adjust the position of the pen for calibration at 1 MHz and the same $-dBm$ value as indicated on the digital power meter in (c) above. [The far right-hand dBm scale of the graph paper ($-130/-60$) is used for this purpose.]<li data-bbox="282 1482 1393 1570">(e) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)
Thermal Noise and Tone Scan	
10	On the IF/baseband analyzer: <ul style="list-style-type: none"><li data-bbox="282 1722 1393 1778">(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)<li data-bbox="282 1814 1393 1869">(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tone signal.)

STEP	PROCEDURE
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Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.

Requirement: The thermal noise and tone response curve shall resemble the thermal noise and tone curve in Fig. 13. Specific thermal noise and tone requirements are shown in Table N.

TABLE N

THERMAL NOISE AND TONES dBm (1.74-kHz EFFECTIVE NOISE BANDWIDTH)									
FM TERMINALS		BASEBAND FREQUENCY IN MEGAHERTZ							
FMT	FMR	0.5	1	3	6	7	8	9	10
4A	4A	-108	-108	-112	-113	-113	-112	-112	-112
Tone Requirement: No tones greater than -98 dBm from 0.5 to 11 MHz.									

Test Sequence 3 of 4—Noise Load (NPR)

Note: This test should be conducted immediately after the thermal noise and tone search. Test connections are the same as for baseband response and thermal noise and tone search.

- 11 On the baseband noise transmitter:
 - (a) Set the BANDSTOP FILTER, kHz 1248, 5340, and 10,840 pushbuttons to their in-circuit position.
 - (b) Set the NOISE pushbutton to the OUT position (noise on).
 - (c) The UNCALIBRATED light shall be extinguished.
 - (d) Set the 316 and 11,404 FILTERS to their in-circuit position.
 - (e) Set the POWER LEVEL, dBm attenuator to -15.4.

Note: The above attenuator setting establishes the wideband average power input to the FM transmitter of -22.2 dBm.

- 12 On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)

STEP

PROCEDURE

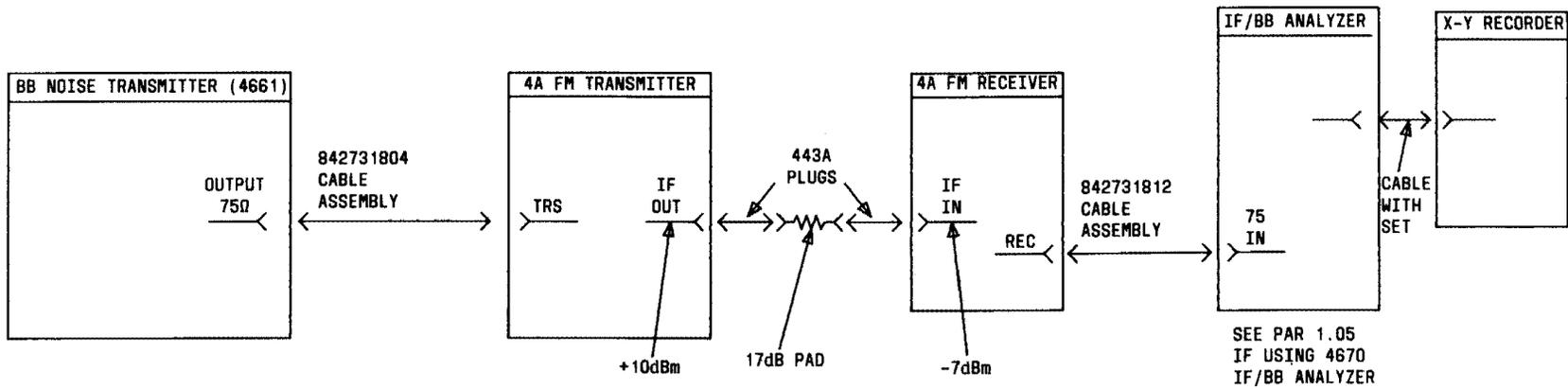
- 13 On the IF/baseband analyzer:
- (a) Operate the NPR switch (see paragraph 1.05).
 - (b) Operate the (MODE) MANUAL switch. (Adjust the frequency if other than 1 MHz.)
 - (c) Set the INPUT attenuator to -15 .
 - (d) Set the REF attenuator to -38 .
 - (e) The digital power meter shall indicate a noise level of -53.0 ± 1 dBm.
 - (f) Under normal conditions, the analog power meter shall indicate 0 dBm on the lower scale (0 through -70 dBm). Readjust the reference attenuator until the analog power meter indicates as closely to 0 dBm as possible.
- 14 On the X-Y recorder, set the slide switches as follows:
- (a) PEN RECORD/LIFT switch to LIFT.
 - (b) SERVO ON/STANDBY switch to SERVO ON.
 - (c) CHART HOLD/RELEASE switch to RELEASE.
 - (d) LINE ON/OFF switch to LINE ON.
- 15 On the X-Y recorder:
- (a) Insert an NPR AND TONE SEARCH test form against the left-hand side and bottom paperguides.
 - (b) Operate the CHART HOLD/RELEASE switch to the HOLD position.
 - (c) Adjust the X and Y ZERO controls until the pen is centered at 1 MHz and 67 dBm (i.e., four divisions below the dot located at 1 MHz and 71 dBm).
 - (d) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y ZERO controls may be necessary to arrive at the desired calibration point.)

Noise Power Ratio (NPR) Scan

- 16 On the IF/baseband analyzer:
- (a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)
 - (b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the NPR signal.)

Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may

STEP	PROCEDURE
	<p>cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>Note 2: The 1248, 5340, and 10,840 slots will appear in the noise spectrum for noise load.</p> <p>Requirement: The noise load curve shall resemble the noise power ratio curves in Fig. 19 (TH 2400).</p> <p>Note 3: Successful use of the dBrnc0 scale depends upon the accurate calibration of the X-Y recorder pen at the 67-dBrnc0 (or 0 NPR) point.</p> <p>Test Sequence 4 of 4—Noise Load With Thermal Noise Plot</p> <p>Note: The thermal noise plot, for best results, must be conducted immediately after the noise load test. The instructions below assume that the thermal noise plot is being conducted immediately after the noise load plot.</p>
17	On the baseband noise transmitter, set the NOISE pushbutton to the IN position (noise off).
18	On the IF/baseband analyzer, operate the (MODE) RECORD switch. The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tones underneath the noise load plot. See Fig. 19 (TH 2400).
	<p>Note: This test sequence (4 of 4) is conducted to determine the noise and tone characteristic in the area of a specific noise load slot.</p>
19	Analysis of the thermal floor area near the noise load slot will reveal: <ul style="list-style-type: none"><li data-bbox="423 1276 1370 1302">(a) If the noise load slot is thermal noise or intermodulation noise controlled<li data-bbox="423 1339 1256 1365">(b) If there is a balance in thermal noise and intermodulation noise<li data-bbox="423 1402 1474 1428">(c) If the noise load slot is influenced by an undesirable tone near the noise load slot.
	<p>Note: See Fig. 19 (TH 2400) for general analysis of test data. For more detailed analysis, see Part 4 of this section.</p>



INITIAL CONTROL POSITIONS					
BB NOISE TRANSMITTER		IF/BB ANALYZER		X-Y RECORDER	
POWER	ON	POWER INPUT REF	ON	POWER RECORD/LIFT SERVO ON/STANDBY CHART HOLD/RELEASE	ON LIFT SERVO ON RELEASE
POWER LEVEL, dBm	-24.4*	BB RESPONSE (MODE) MANUAL TUNING	TOTAL OF 20dB TOTAL OF 29dB OPERATED USE BOTH KNOBS TO ADJUST TO 1-MHZ ANALOG POWER METER SHOULD INDICATE 0-dBm ON THE TOP SCALE. READJUST REF AS NECESSARY UNTIL AS CLOSE TO 0-dBm AS POSSIBLE. THE DIGITAL POWER METER SHOULD INDICATE -50.7dBm†		RETURN TO CHART
NOISE	OUT (ON)				
HPF 316	OUT				
LPF 11404	IN				
BSF:					
1248	OUT				
5340	OUT				
10840	OUT				
UNCALIBRATED	LAMP NOT BURNING. IF BURNING, CLEAR TROUBLE IN NOISE GENERATOR				

* THIS ESTABLISHES A WIDEBAND NOISE POWER LEVEL INTO THE FMT OF -30.5 dBm WHEN FUNCTION SWITCH IS IN BB RESPONSE POSITION.

† IF THIS INDICATION IS NOT OBTAINED, CHECK THE FM TERMINAL TRANSMITTER FOR PROPER DEVIATION. ADJUST THE FM GAIN ONLY AFTER IT IS KNOWN THAT THE FM TRANSMITTER DEVIATION IS PROPERLY SET. TIME SPENT ON THIS IS WELL WORTH THE EFFORT FOR THE FOLLOWING REASON. IF, FOR EXAMPLE, THE FM TRANSMITTER HAD LOW DEVIATION, THE FM RECEIVER GAIN WOULD BE INCREASED TO COMPENSATE FOR THE REDUCED GAIN OF THE FM TRANSMITTER. THIS WOULD CAUSE A CORRESPONDING INCREASE IN THE THERMAL NOISE AND TONES AT THE FM RECEIVER OUTPUT.

Fig. 17—Test Arrangement for Back-to-Back Calibration (TH 2400)—SCIENTIFIC ATLANTA Test Set and FM Terminal Only

RADIO CHANNEL NO. _____ SWITCH SECTION (FROM) _____ (TO) _____
 TYPE RADIO SYSTEM _____ NO. OF HOPS _____ CIRCUIT LOAD _____ DATE _____ TESTER _____

E-10110
 (8-78)
 SHEET 1 OF 2

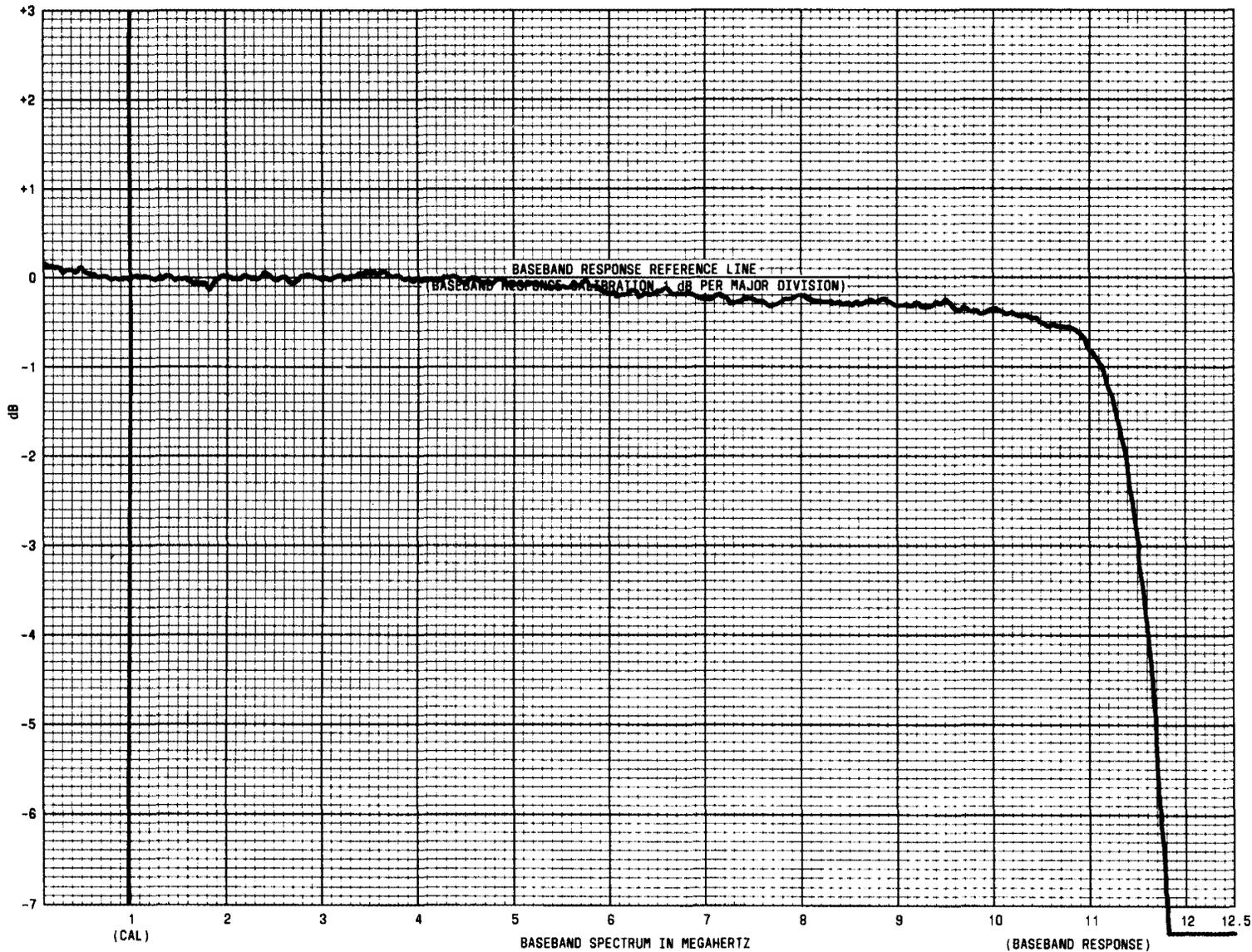


Fig. 18—Baseband Response (TH 2400)—SCIENTIFIC-ATLANTA Test Set and FM Terminal Back to Back

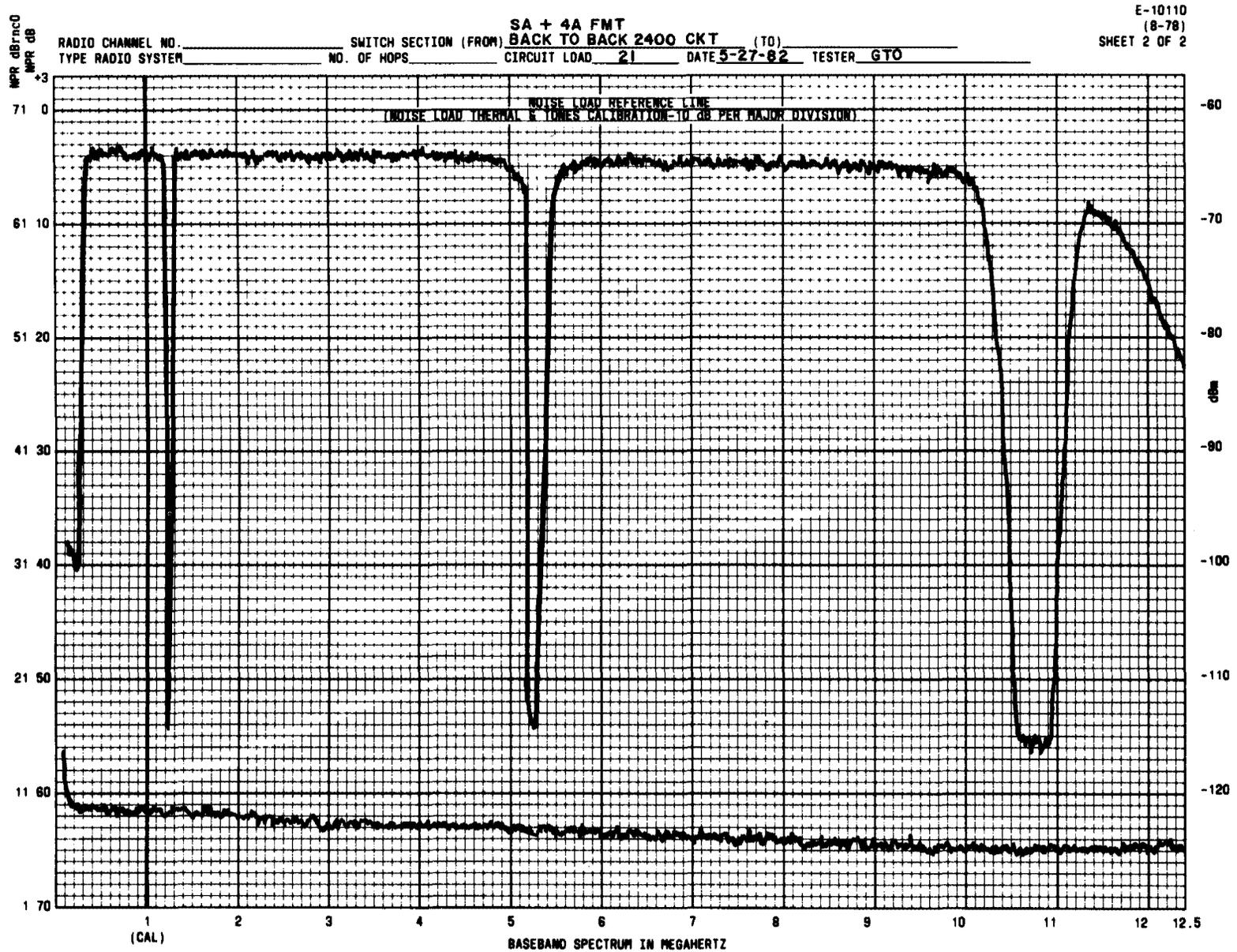


Fig. 19—Noise Load (TH 2400) With Thermal Noise Plot—SCIENTIFIC-ATLANTA Test Set and FM Terminal Back to Back

E. Chart 5—Straight-Away Switch-Section Test Procedures for TD-2, TD-3, TD-3A, TD-3D, TH-1, and TH-3(1800)—(Detailed)

3.09 Before attempting straight-away switch-section tests, the operator should become proficient at making SCIENTIFIC-ATLANTA test set and FM terminal back-to-back tests described earlier in this practice.

3.10 It is recommended that TD protection channels serving mixed services (1200, 1500, and 1800 circuit loading) be noise-load tested at 1200, 1500, and 1800 circuit loading. The multiple noise-load testing of a protection channel will help ensure proper transmission performance during protection channel switching activities.

3.11 This arrangement has the capability of performing baseband response, noise load (NPR), and thermal noise and tone search (baseband related) tests. Field experience shows that technical and time-saving advantages are possible when these tests are conducted in a specific sequence. Therefore, it is recommended that the sequence in Table O be observed whenever possible.

3.12 The following apparatus is required:

1— SCIENTIFIC-ATLANTA Radio Performance Analyzer

Baseband Noise Transmitter (4660)

IF/BB Analyzer (4670)

X-Y Recorder (4673)

1— 3- or 4-Type FM Terminal (A or B, depending upon the type of radio system to be tested)

1— WANDEL-GOLTERMANN* AT462 Oscillator or equivalent (TH-1 Transmit End only)

Cords and Coaxial Pads as indicated.

* Registered trademark of W and G Instruments, Inc.

TABLE O

TEST	SEQUENCE
Baseband Response	1 of 4
Thermal Noise and Tone Search	2 of 4
Noise Load (NPR)	3 of 4
Thermal Noise Plot	4 of 4

STEP

PROCEDURE

Note 1: The 14.8-MHz tone test for TH-1 uses the repeater limiter transfer action and the 14.8-MHz tone to provide an indication as to the tones' effect on service over the switch section under test. An 8-MHz baseband tone is sent from the transmitting main station and the ratio (dB) between the 8-MHz tone and a 6.8-MHz tone, which is generated via limiter transfer action (see paragraph 4.32, TH-1), is measured to determine the effect on service of the 14.8-MHz tone.

Note 2: The COUPLER OUT 1 jack for the channel under test should be terminated at the transmit end of the switch section during tone test to prevent possible random tones.

STEP

PROCEDURE

Note 3: When testing at TD 1800 circuit loading, only the 4A FM terminal may be used.

Note 4: If a J68330Y equalizer-amplifier or a 981E equalizer is used in the main station at the end of the switch section, it should be removed for these tests.

Test Sequence 1 of 4—Baseband Response

- 1 Arrange the test apparatus and follow the Initial Control Positions instruction as given in Fig. 58A, option (X) for TD 1200, TD 1500, and TH-3 1800, or option (Y) for TD 1800; or Fig. 58B for TH-1 1800; or Fig. 58C for TD-2/TD-3D 45-Mb/s channels.

Note 1: Before connecting to the 45A protection modem, lock out both the 45A switching system and the radio switching system.

Note 2: The level for the 400A transmit connection for a common FM/45A radio protection channel is different from the level for an FM-only protection channel. See Fig. 58A and Fig. 58C.

- 2 **Warning: Damage to the pen tip will result if pressure is applied directly to the pen or plastic arm.**

On the X-Y recorder:

- (a) Insert a BASEBAND RESPONSE test form against the left-hand side and the bottom paperguides of the X-Y recorder.
- (b) Operate the CHART HOLD/RELEASE switch to HOLD.
- (c) Verify that a pen of the desired color is in place.
- (d) Adjust the X-Y ZERO controls until the pen is centered over the calibration dot within the small circle located on the 0-dB at the 1-MHz point of the graph paper.
- (e) Use the index finger to apply enough downward pressure to the flat metal bar (located on top of the carriage bar) to cause the pen to make contact with the paper. The pen shall now be against the paper and moving above the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot. (The foregoing is the preferred method. An alternative method is to operate the RECORD switch of the IF/baseband analyzer. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot.)
- (f) Restore the RECORD switch to normal.

Baseband Scan (Baseband Response)

- 3 On the IF/baseband analyzer:
- (a) Operate the (MODE) AUTO switch. (The pen shall rise and travel to the left side of the baseband test form.)

STEP	PROCEDURE
	<p>(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the baseband response signal.)</p> <p>Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>Note 2: See Fig. 20, 21, 22, or 23 (depending on the type of radio), for general analysis of the test data. For detailed analysis, see Part 4 of this section.</p> <p>Requirements: Refer to the transmission performance limits (Fig. 59, 60, 61, 62, or 63) for specific radio system requirements.</p> <p>Test Sequence 2 of 4—Thermal Noise and Tone Search</p> <p>Note 1: This test should be conducted immediately after the baseband response test. Test connections are the same as for the baseband response test.</p> <p>Note 2: The CARR SPRD switch on the FMT must be in the ON position during the tone search test when using the 4A or 4B FMT; otherwise, the CARR SPRD switch must be in the OFF position.</p>
4	<p>On the baseband noise transmitter:</p> <p>(a) Operate the function switch to the TONE SEARCH (noise off) position.</p> <p>(b) Set the attenuator for a total of 49.</p> <p>(c) The UNCALIBRATED light shall be lit.</p>
5	<p>On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)</p>
6	<p>On the IF/baseband analyzer:</p> <p>(a) Set the INPUT attenuator for a total of -20.</p> <p>(b) Set the REF attenuator for a total of -40.</p> <p>(c) Operate the TONE SEARCH switch.</p> <p>(d) Operate the (MODE) MANUAL switch. (Adjust the frequency if other than 1 MHz.)</p> <p>(e) The analog meter shall indicate 0 dB (0- through 70-dB scale); if not, adjust the REF attenuator until the analog power meter indicates as closely to 0 dBm as possible.</p>

STEP	PROCEDURE
7	<p>On the X-Y recorder, set the slide switches as follows:</p> <ul style="list-style-type: none">(a) PEN RECORD/LIFT switch to LIFT.(b) SERVO ON/STANDBY switch to SERVO ON.(c) CHART HOLD/RELEASE switch to RELEASE.
8	<p>On the X-Y recorder:</p> <ul style="list-style-type: none">(a) Insert the NPR AND TONE SEARCH form against the left-hand side and bottom paperguides.(b) Operate the CHART HOLD/RELEASE switch to the HOLD position.(c) Observe the digital power meter indication on the IF/baseband analyzer. (This noise value will be used to calibrate the X-Y recorder.)(d) Using the X-Y ZERO controls, adjust the position of the pen for calibration at 1 MHz and the same -dBm value as indicated on the digital power meter in (c) above. [The far right-hand dBm scale (-130/-60) is used for this purpose.](e) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X and Y controls may be necessary to arrive at the desired calibration point.)
Thermal Noise and Tone Scan	
9	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none">(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tone signal.)
<p>Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p>	
<p>Note 2: See Fig. 24, 25, 26, 27, or 28 for general analysis of the test data. For detailed analysis, refer to Part 4 of this section.</p>	
<p>Note 3: If it is difficult to separate low-level tones from random noise, a second tone search should be made. The two plots should then be compared and any tones not present on both plots should be ignored.</p>	
<p>Requirements: Refer to the transmission performance limits (Fig. 59, 60, 61, 62, or 63) for specific radio system requirements.</p>	

STEP

PROCEDURE

Test Sequence 3 of 4—Noise Load (NPR)

Note: This test should be conducted immediately after the thermal noise load and tone search. Test connections are the same as for baseband response and thermal noise and tone search.

- 10 On the baseband noise transmitter:
- (a) Set the function switch to NPR SLOTS IN.
 - (b) The UNCALIBRATED light shall be extinguished.
 - (c) Set the attenuators as indicated in Table P for the desired noise load:

TABLE P

RADIO	LOAD	CHANNEL SELECTOR	ATTENUATOR SETTING
TD	1200	A	15
TD	1500	B	20
TD	1800	C	22
TH	1800	C	17

- 11 On the X-Y recorder, operate the SERVO ON/STANDBY switch to STANDBY. (This step eliminates unnecessary noise.)
- 12 On the IF/baseband analyzer:
- (a) Operate the NPR switch.
 - (b) Operate the (MODE) MANUAL switch. (Adjust the frequency if other than 1 MHz.)
 - (c) Set the attenuators as indicated in Table Q for various noise levels as selected on the baseband noise transmitter.

STEP

PROCEDURE

TABLE Q

RADIO	LOAD	ATTENUATORS		DIGITAL POWER LEVEL
		INPUT	REFERENCE	
TD	1200	-11	-38	-48.0 ± 1 dBm
TD	1500	-15	-38	-53.5 ± 1 dBm
TD	1800	-20	-38	-58.5 ± 1 dBm
TH	1800	-12	-39	-51.5 ± 1 dBm

(d) The digital power meter shall indicate a noise level as indicated in Table Q.

(e) Under normal conditions, the analog power meter shall indicate 0 dBm on the lower scale (0 through -70 dBm). Readjust the reference attenuator until the analog power meter indicates as closely to 0 dBm as possible.

13 On the X-Y recorder, set the slide switches as follows:

- (a) PEN RECORD/LIFT switch to LIFT.
- (b) SERVO ON/STANDBY switch to SERVO ON.
- (c) CHART HOLD/RELEASE switch to RELEASE.
- (d) LINE ON/OFF switch to LINE ON.

14 On the X-Y recorder:

- (a) Insert an NPR AND TONE SEARCH test form against the left-hand side and bottom paperguides.
- (b) Set the CHART HOLD/RELEASE switch to HOLD.
- (c) Adjust the X and Y ZERO controls until the pen is centered over the applicable vertical calibration point at 1 MHz as specified in Table R.

STEP	PROCEDURE
------	-----------

TABLE R

RADIO	1-MHz CALIBRATION POINT
TD (1200)	
TD (1500)/ (45 Mb/s)	71 dBrnc0 (Dot)
TH (1800)	
TD (1800)	67 dBrnc0 (4 divisions below dot)

(d) Manually lower the pen (using the flat metal bar on the top of the carriage bar) to verify the exact contact point. (Small adjustments of the X and Y ZERO controls may be necessary to arrive at the desired calibration point.)

Noise Power Ratio (NPR) Scan

15 On the IF/baseband analyzer:

- (a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)
- (b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the NPR signal.)

Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.

Note 2: The slots will appear in the noise spectrum for a specific noise load as shown in Table S.

TABLE S

RADIO	LOAD	SLOT FREQUENCIES (kHz)
TD	1200	1248/5340
TD	1500	1248/5340/6900
TD	1800	1248/5340/7600
TH	1800	1248/5340/7600

STEP	PROCEDURE
	<p>Requirements: Refer to the transmission performance limits (Fig. 59, 60, 61, 62, or 63) for specific radio system requirements.</p> <p>Note 3: See Fig. 29, 30, 31, 32, 33, 34, or 35 (depending on the type of radio) for general analysis of the test data. For detailed analysis, refer to Part 4 of this section.</p> <p>Note 4: Successful use of the dBrnc0 scale depends upon accurate calibration of the X-Y recorder pen at the point specified in Table R.</p> <p>Test Sequence 4 of 4—Noise Load With Thermal Noise Plot</p> <p>Note: The thermal noise plot, for best results, must be conducted immediately after the noise load test. The instructions below assume that the thermal noise plot is being conducted immediately after the noise load plot.</p>
16	On the baseband noise transmitter, operate the selector switch to the TONE SEARCH (noise off) position.
17	On the IF/baseband analyzer, operate the (MODE) RECORD switch. The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tones underneath the noise load plot.
	<p>Note: This test sequence (4 of 4) is conducted to determine the noise and tone characteristic in the area of a specific noise load slot.</p>
18	<p>Analysis of the thermal floor area near the noise load slot will reveal:</p> <ul style="list-style-type: none"> (a) If the noise load slot is thermal noise or intermodulation noise controlled (b) If there is a balance in thermal noise and intermodulation noise (c) If the noise load slot is influenced by an undesirable tone near the noise load slot.
	<p>Note: See Fig. 29, 30, 31, 32, 33, 34, or 35 for general analysis of test data. For more detailed analysis, refer to Part 4 of this section.</p>
	<p>TH-1 14.8-MHz Tone Test</p>
19	Perform Steps 20 through 25 for the 14.8-MHz tone test for TH-1 only.
20	Arrange the test apparatus as shown in Fig. 36, option A.

STEP	PROCEDURE
21	Set the oscillator frequency to 8 MHz and adjust its power output to -16 dBm. Requirement: The power meter shall indicate 0 ± 0.5 dBm. If the requirement is met, proceed with Step 22. If the requirement is not met, check the channel net gain and repeat from Step 20.
22	Connect the receiving end as indicated in Fig. 36, option B.
23	On the IF/baseband analyzer: (a) Set the REF attenuator to 0. (b) Operate the (MODE) MANUAL switch. (c) Operate the TONE SEARCH switch. (d) Adjust the COARSE and FINE tuning controls to obtain a maximum INPUT level meter indication corresponding to the 8-MHz input signal. (e) Adjust the REF attenuator to obtain a 0-dB meter indication.
24	On the X-Y recorder, set the slide switches as follows: (a) PEN RECORD/LIFT switch to LIFT. (b) SERVO ON/STANDBY switch to ON. (c) CHART HOLD/RELEASE switch to RELEASE.

STEP	PROCEDURE
25	<p data-bbox="245 407 500 428">On the X-Y recorder:</p> <ul style="list-style-type: none"><li data-bbox="277 470 1390 527">(a) Insert an NPR AND TONE SEARCH form against the left-hand side and bottom paperguides.<li data-bbox="277 558 1175 579">(b) Operate the CHART HOLD/RELEASE switch to the HOLD position.<li data-bbox="277 621 1390 678">(c) Observe the digital power meter indication on the IF/baseband analyzer. (This level will be used to calibrate the X-Y recorder.)<li data-bbox="277 709 1390 766">(d) Using the X and Y ZERO controls, adjust the position of the pen for calibration at 8 MHz and the same -dBm value as indicated on the digital power meter in (c) above.<li data-bbox="277 798 756 819">(e) Operate the (MODE) AUTO switch.<li data-bbox="277 861 683 882">(f) Operate the RECORD switch.<li data-bbox="277 924 1390 980">(g) From the resultant plot, extract the (dB) difference between the 8-MHz tone and the maximum tone appearing at approximately 6.8 MHz.

Requirement: The difference shall exceed 60 dB.

If the requirement is not met, the test indicates an out-of-limits 14.8-MHz tone is present in at least one of the repeater stations comprising the switch section and should be located and eliminated as it is a prime source of intermodulation noise in the top mastergroup.

RADIO CHANNEL NO. R-107 SWITCH SECTION (FROM) SENTINEL (TO) NOBLE
 TYPE RADIO SYSTEM TD-2 NO. OF HOPS _____ CIRCUIT LOAD 8 DATE _____ TESTER 1-26-77

E-10110
 (8-78)
 SHEET 1 OF 2

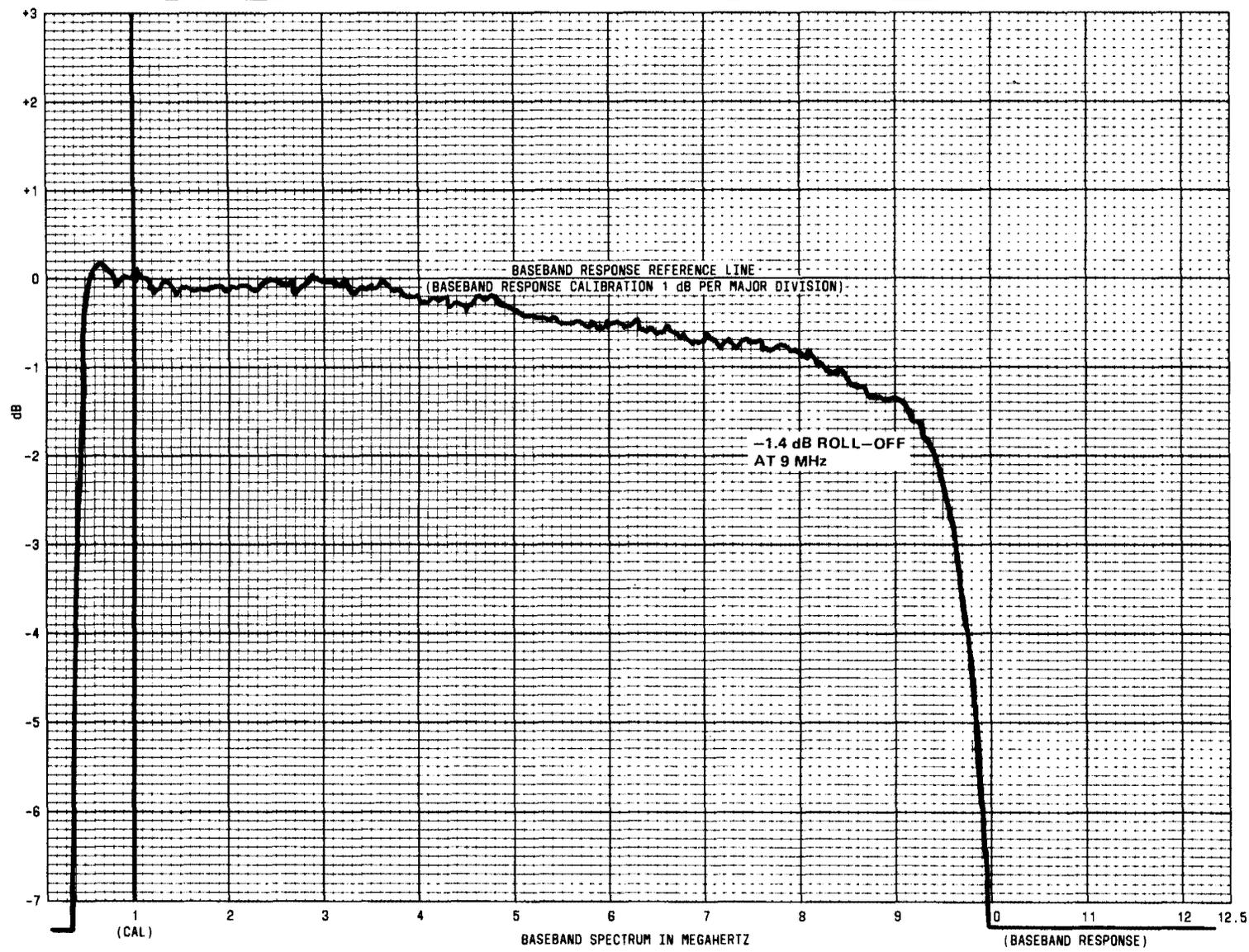


Fig. 20—Baseband Response, 8-Hop TD-2

RADIO CHANNEL NO. R-2211 SWITCH SECTION (FROM) HARTSHORE (TO) NOBLE
TYPE RADIO SYSTEM TD-3 NO. OF HOPS _____ CIRCUIT LOAD _____ DATE _____ TESTER 1-26-77

E-10110
(8-78)
SHEET 1 OF 2

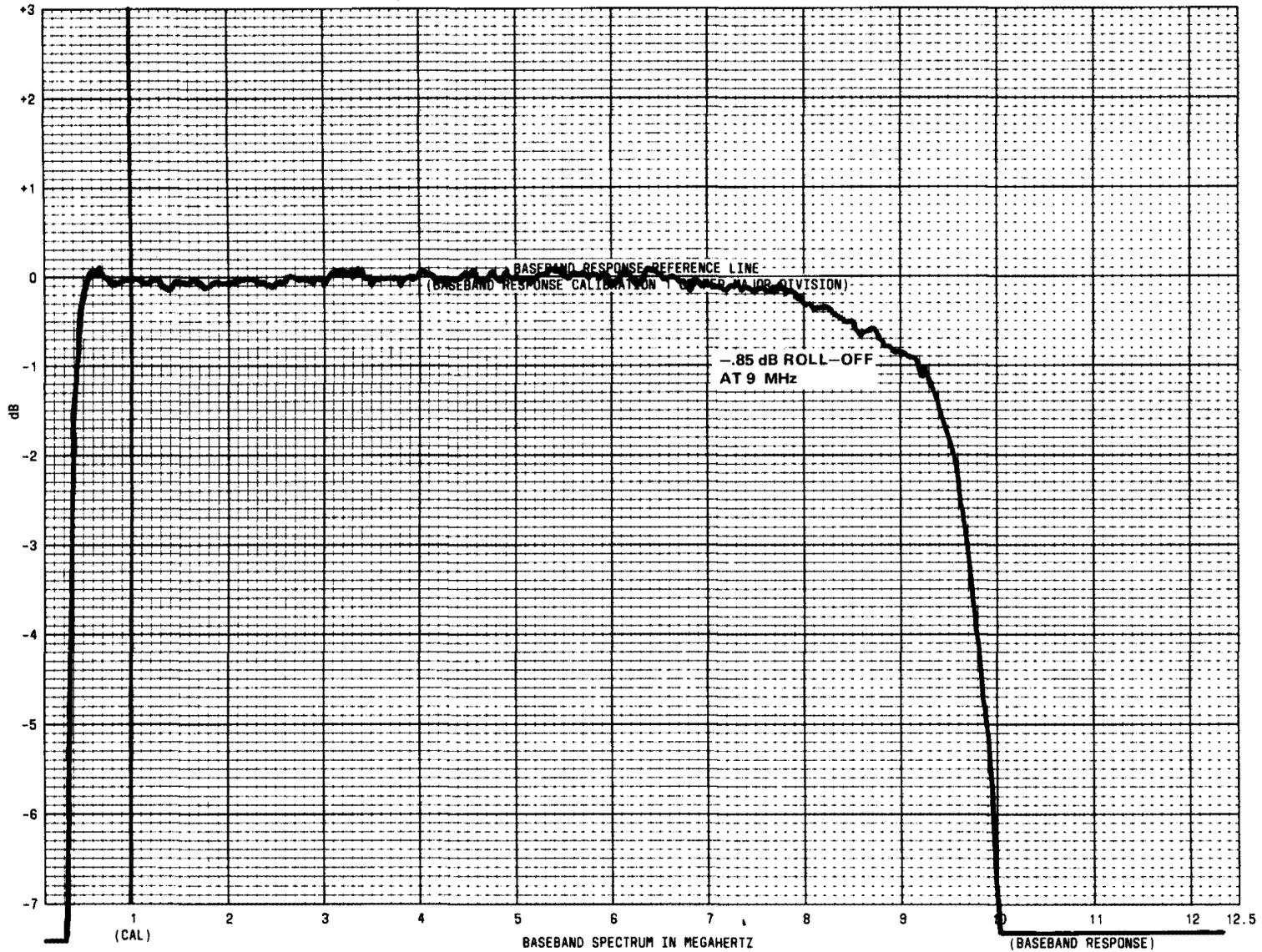


Fig. 21—Baseband Response, 4-Hop TD-3

RADIO CHANNEL NO. R-260 SWITCH SECTION (FROM) AURORA (TO) DODGE CITY JCT.
TYPE RADIO SYSTEM TH-1 NO. OF HOPS 6 CIRCUIT LOAD _____ DATE 1-26-77 TESTER WE

E-10110
(8-78)
SHEET 1 OF 2

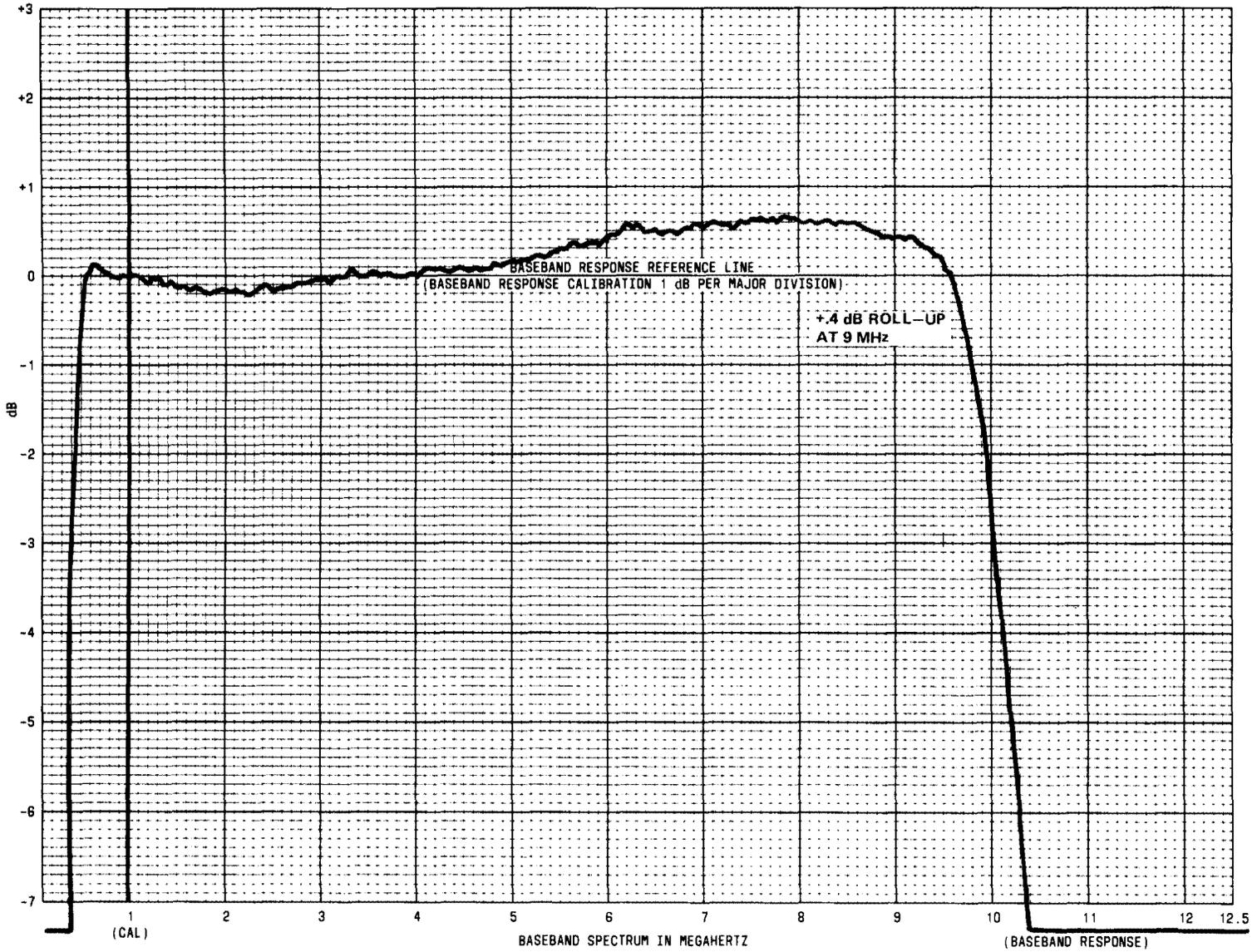


Fig. 22—Baseband Response, 6-Hop TH-1

RADIO CHANNEL NO. R-168 SWITCH SECTION (FROM) SENTINEL (TO) NOBLE
TYPE RADIO SYSTEM TH-3 NO. OF HOPS 8 CIRCUIT LOAD _____ DATE 1-26-77 TESTER WE

E-10110
(8-78)
SHEET 1 OF 2

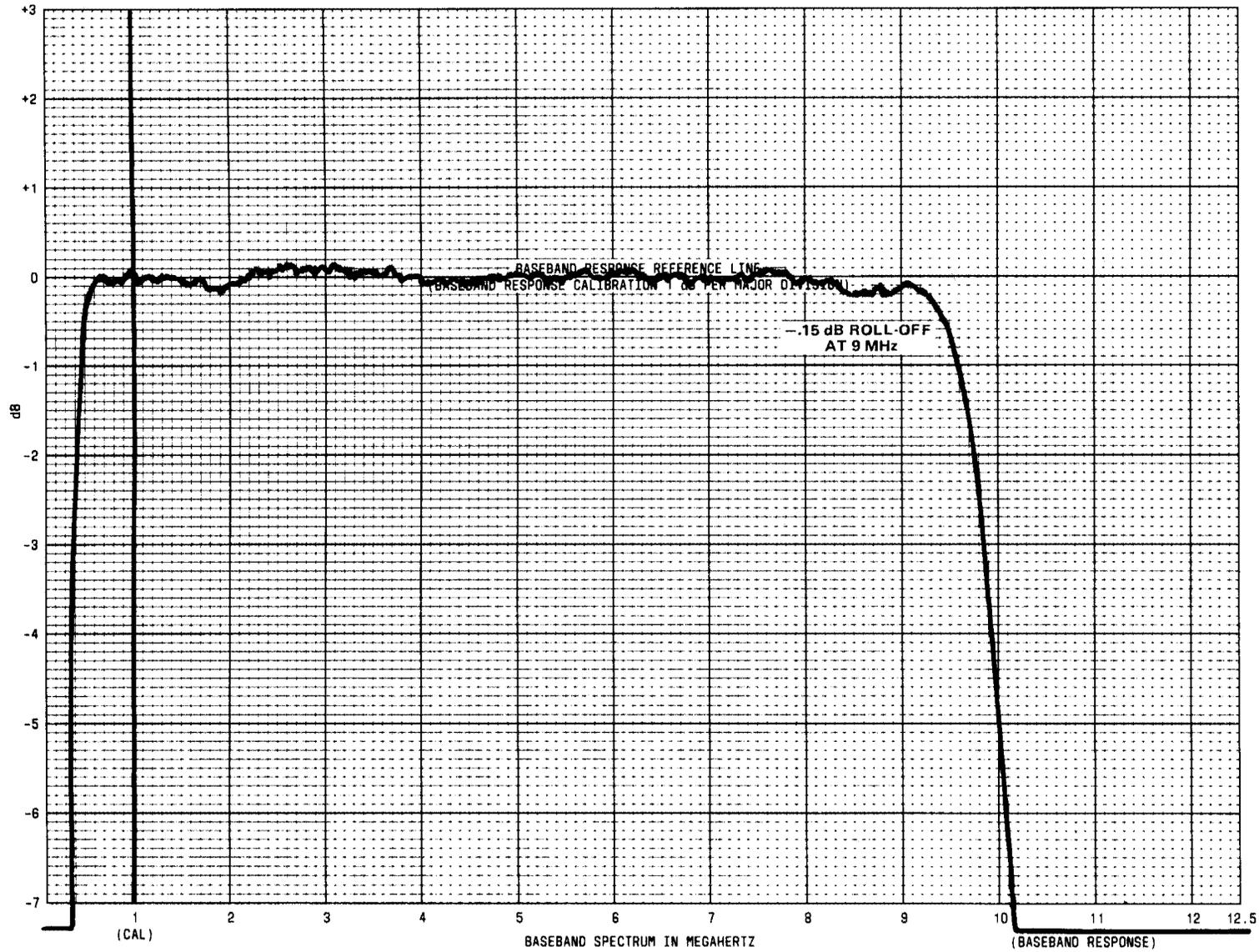


Fig. 23—Baseband Response, 8-Hop TH-3 (1800)

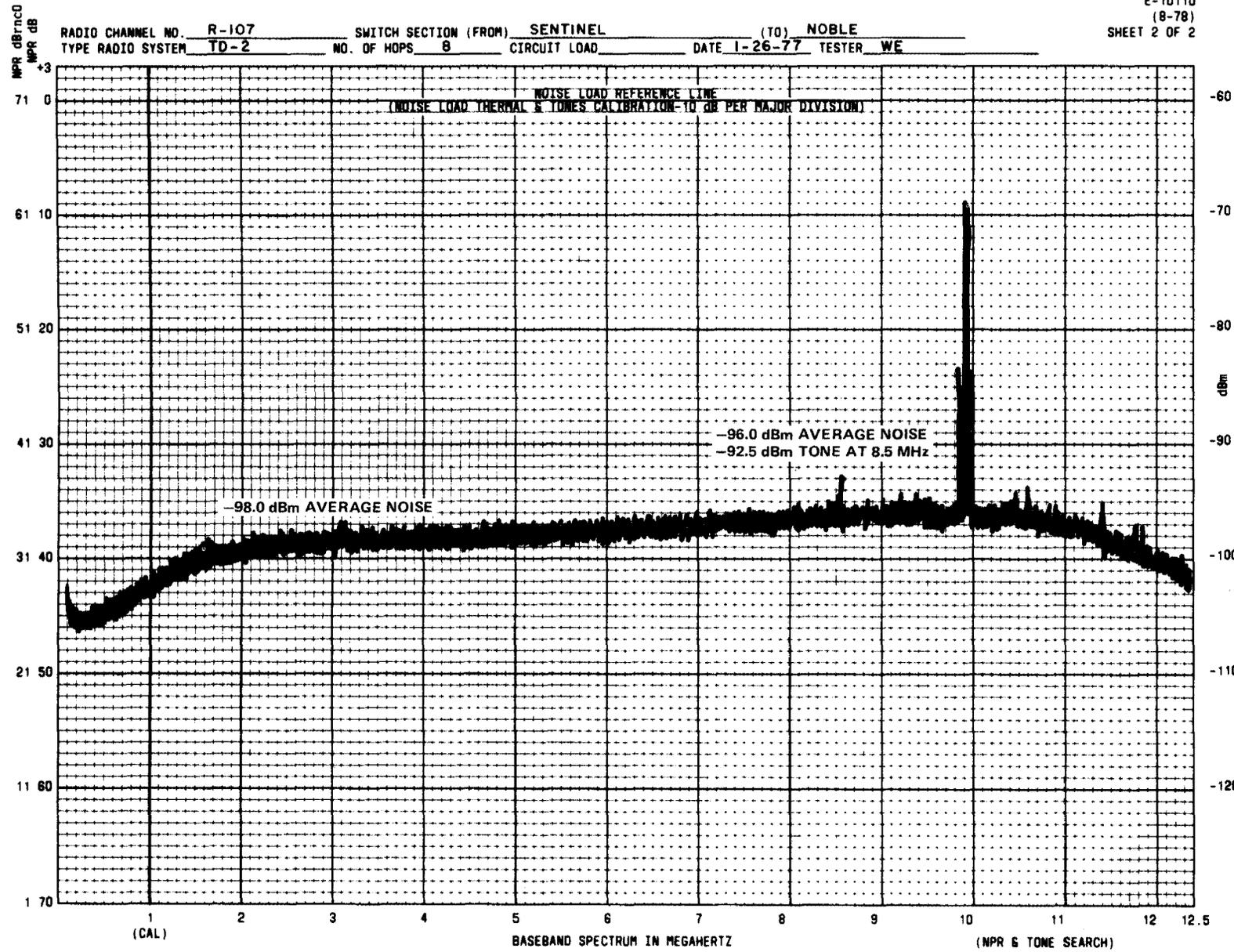


Fig. 24—Thermal Noise and Tones, 8-Hop TD-2

E-10110
(8-78)
SHEET 2 OF 2

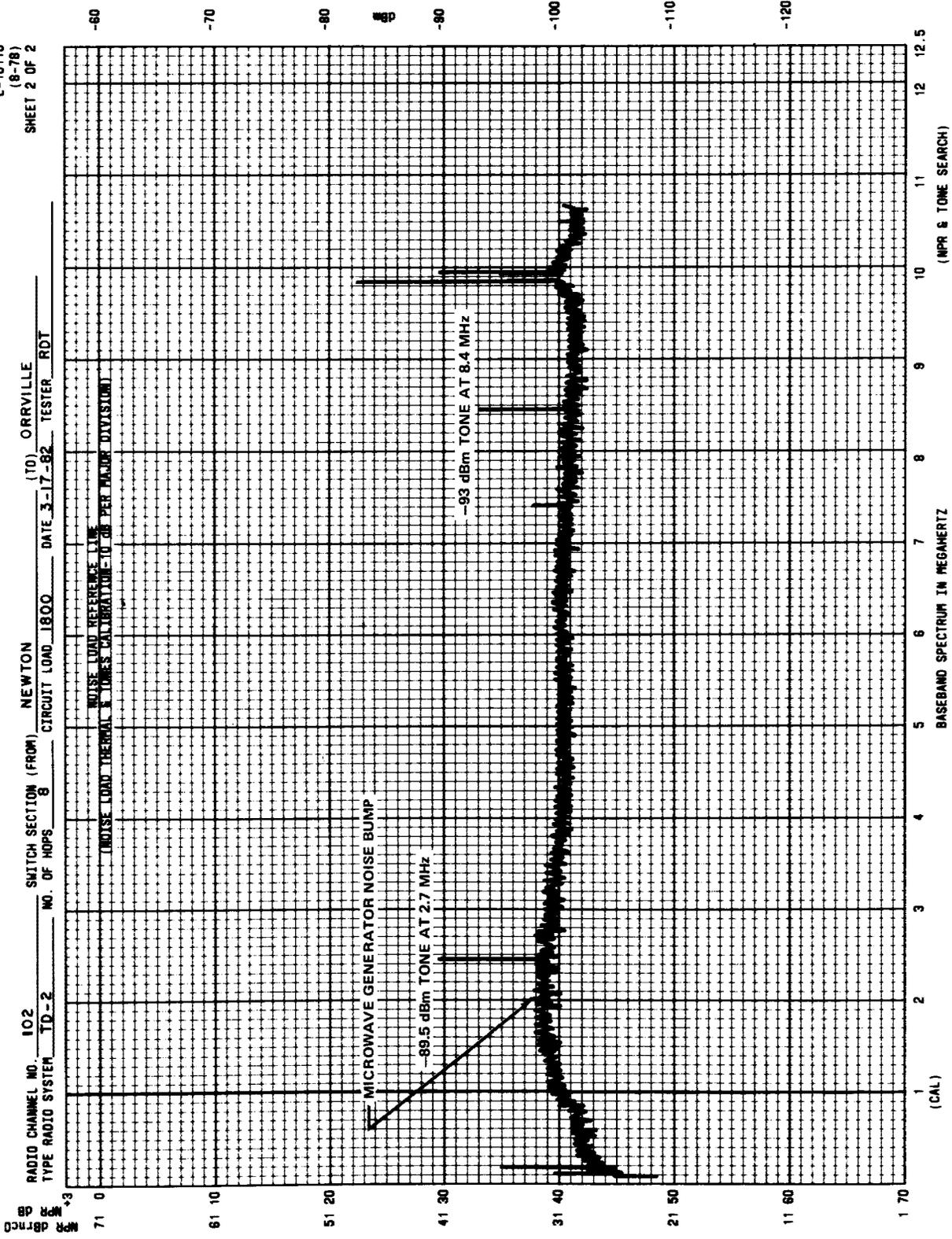


Fig. 25—Thermal Noise and Tones, 8-Hop TD-2 (1800)

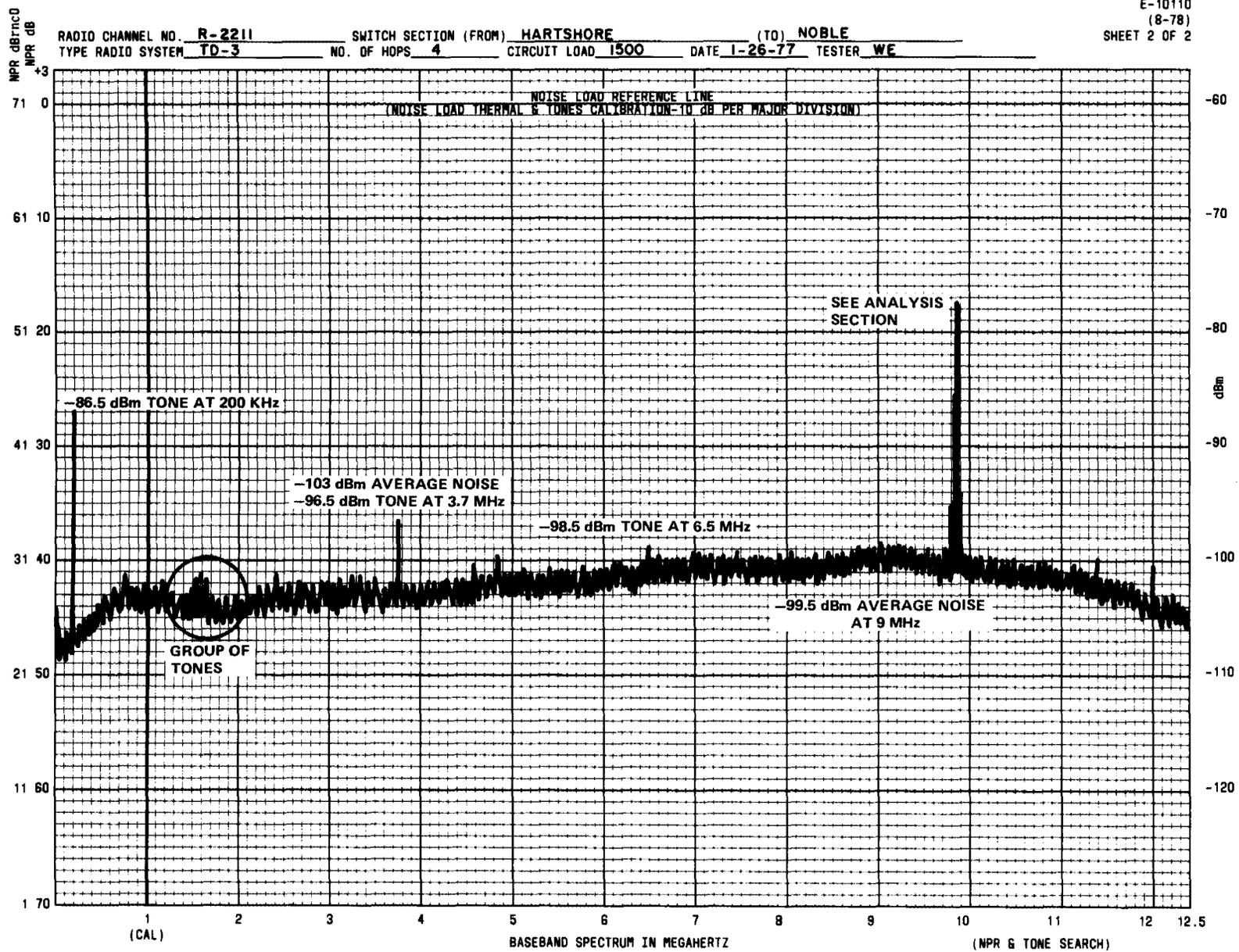


Fig. 26—Thermal Noise and Tones, 4-Hop TD-3

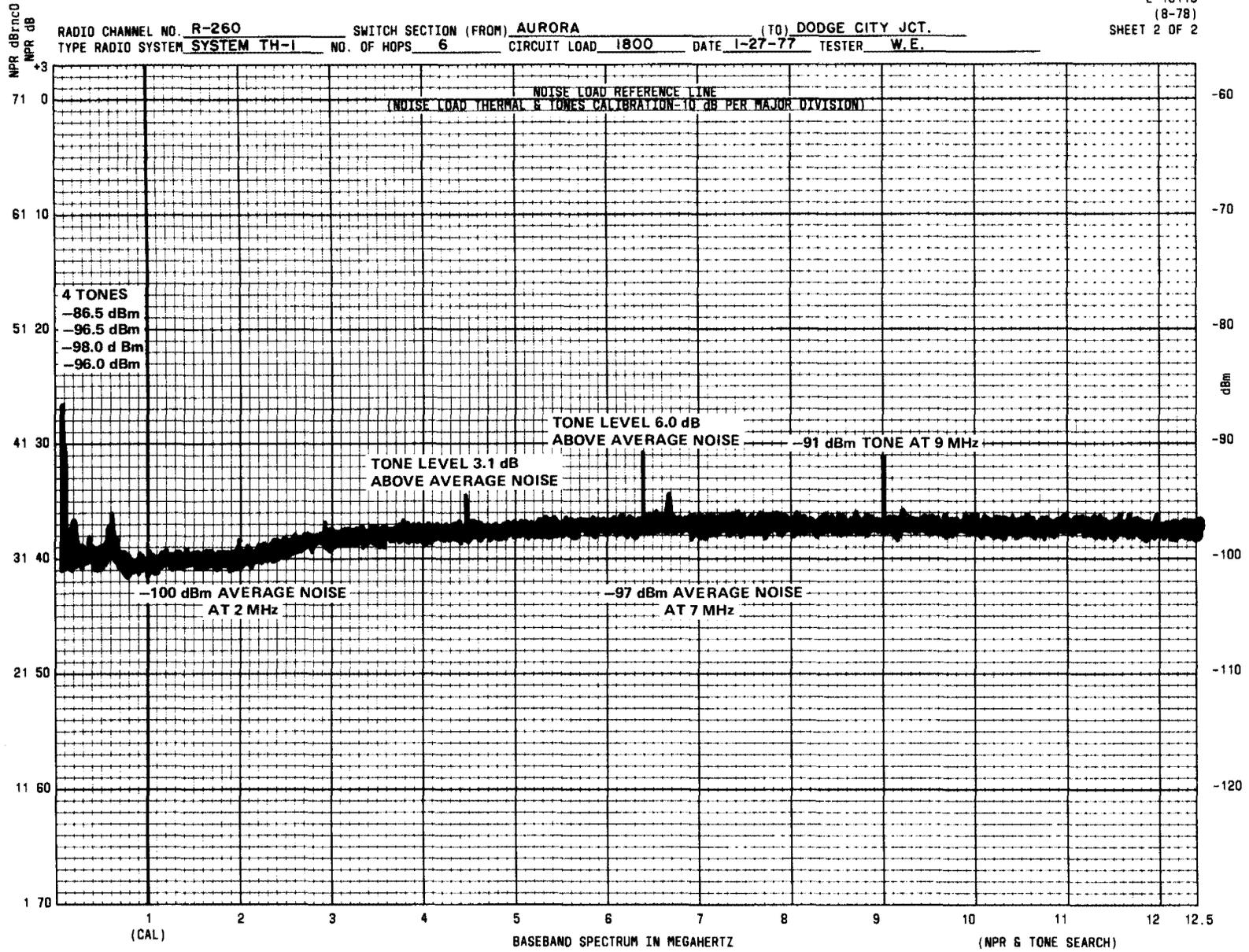


Fig. 27—Thermal Noise and Tones, 6-Hop TH-1

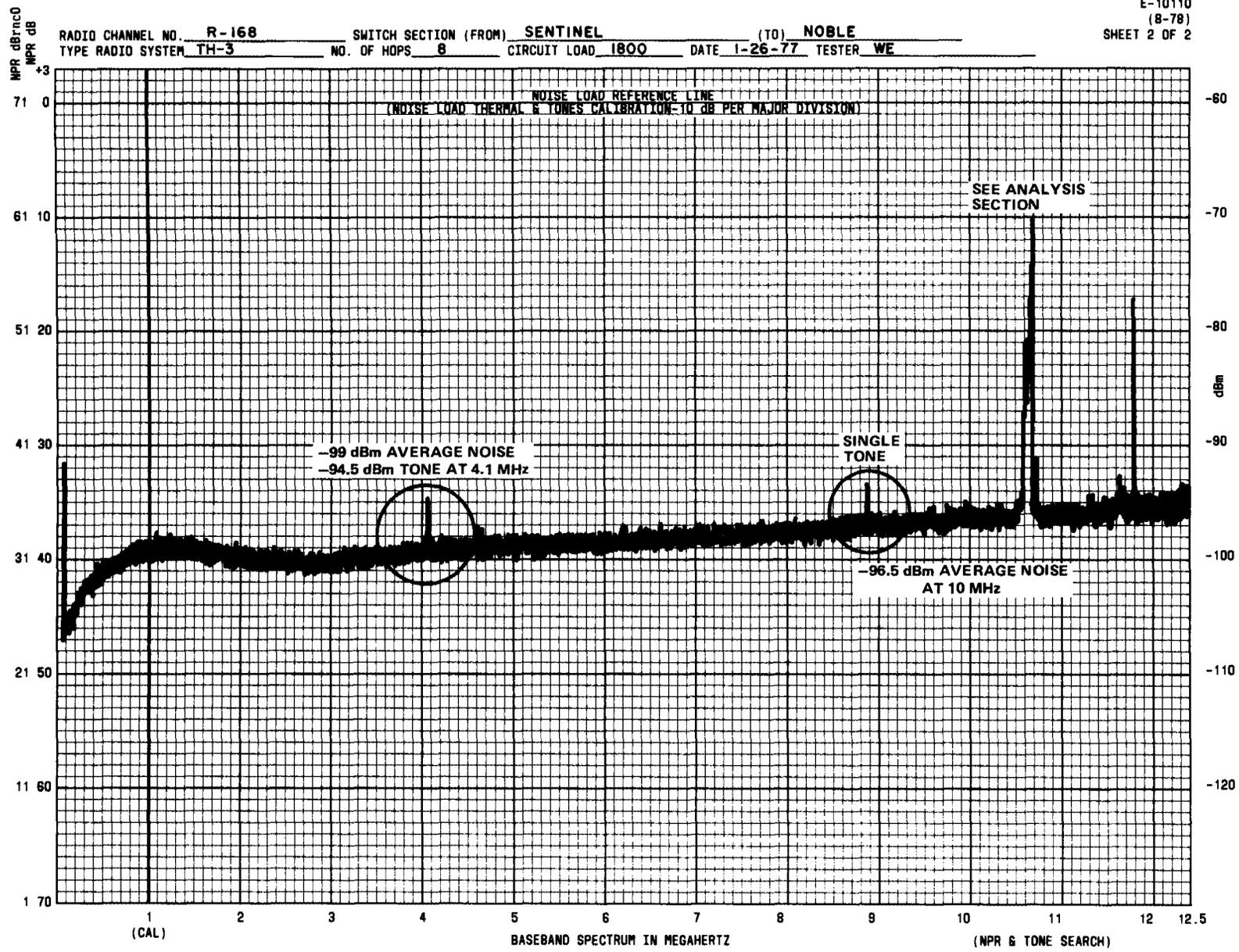


Fig. 28—Thermal Noise and Tones, 8-Hop TH-3 (1800)

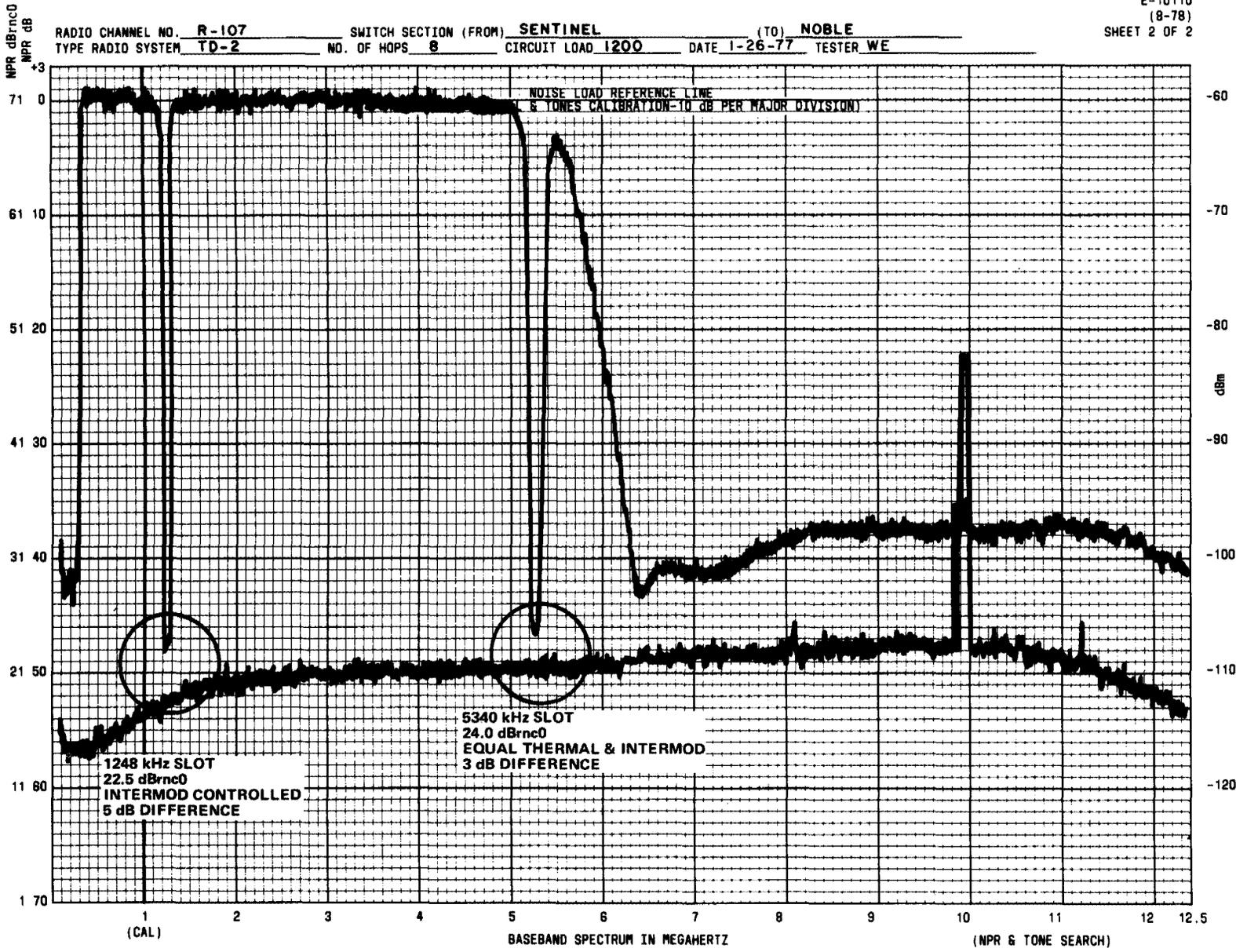


Fig. 29—Noise Load (1200) With Thermal Noise Plot, 8-Hop TD-2

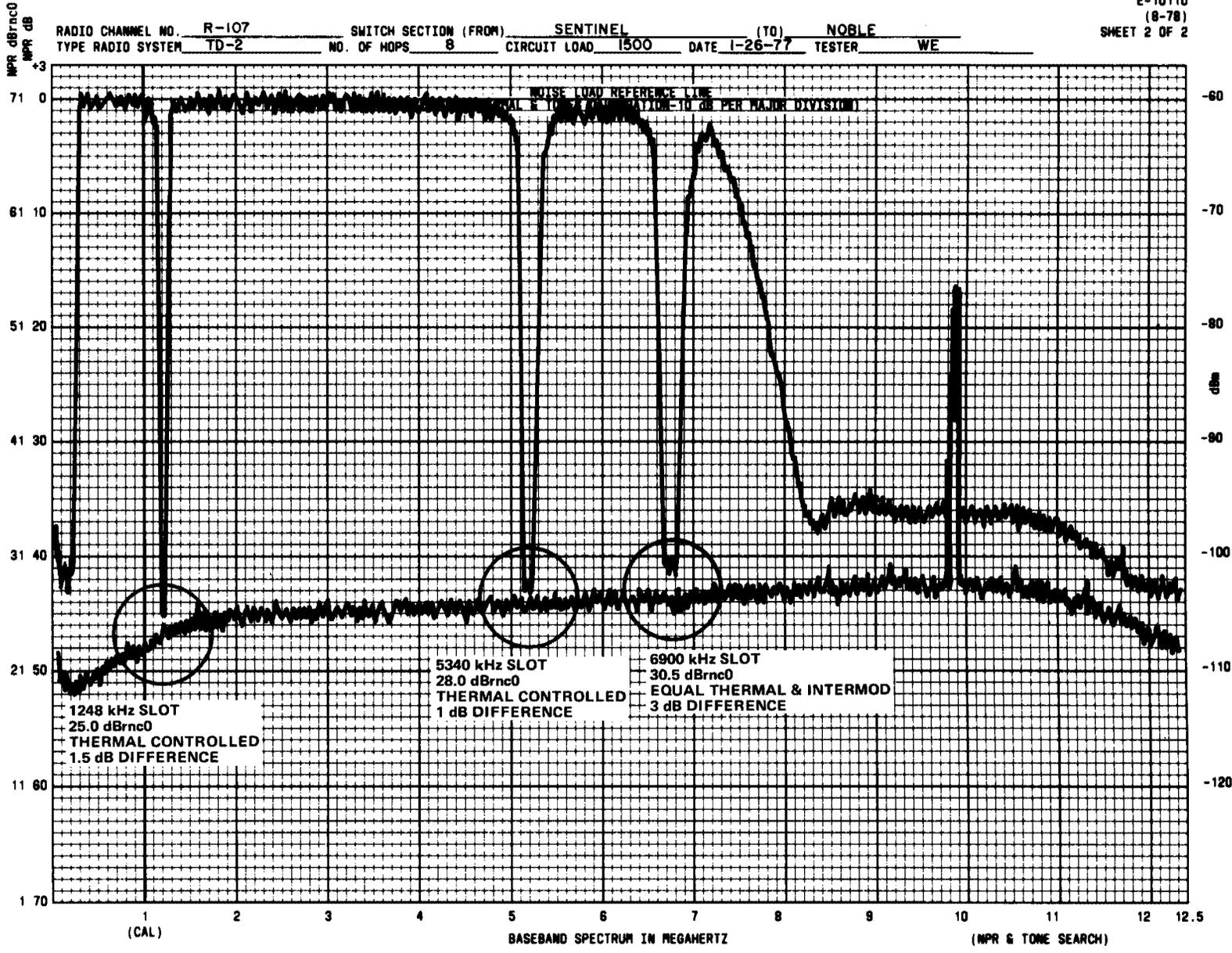


Fig. 30—Noise Load (1500) With Thermal Noise Plot, 8-Hop TD-2

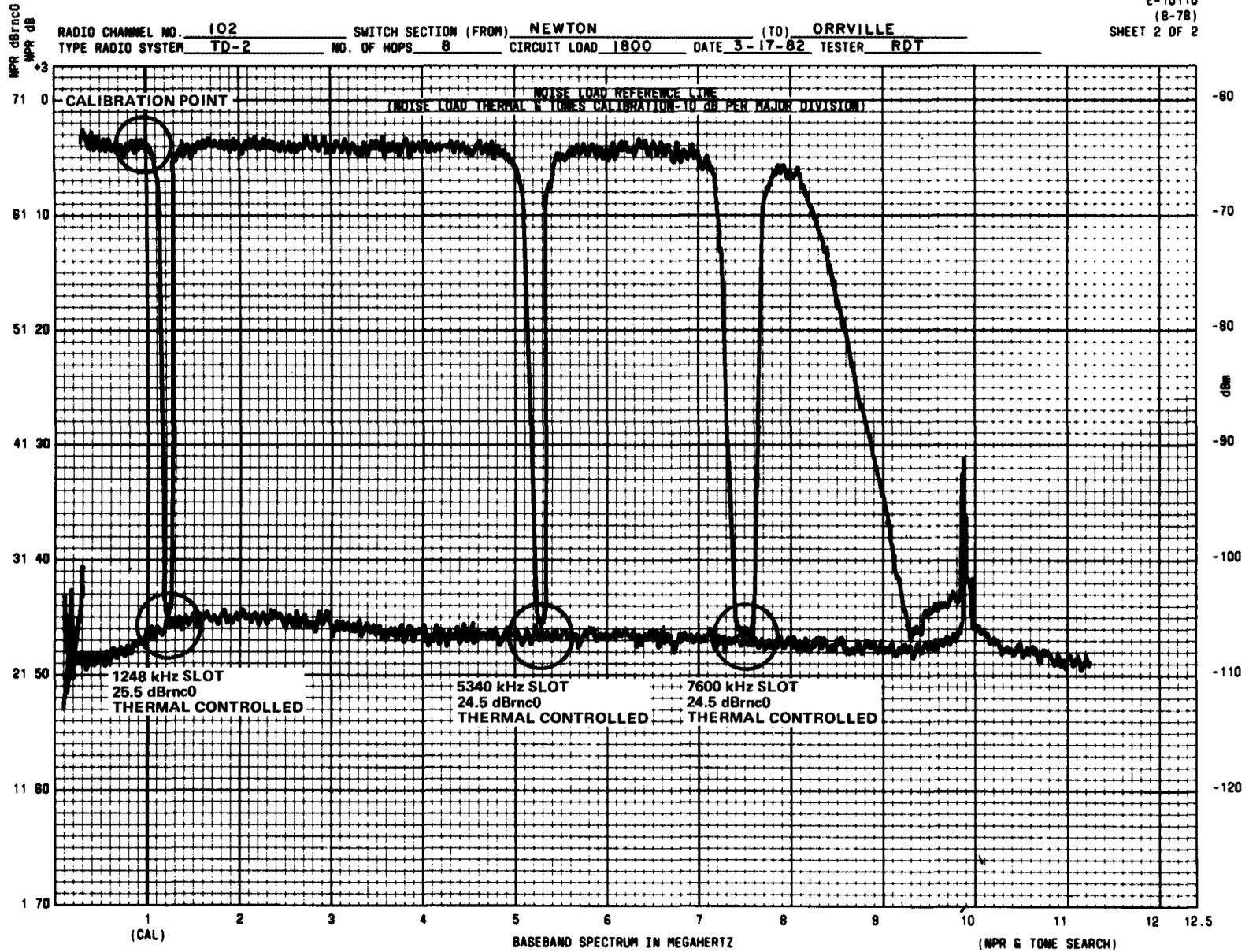


Fig. 31—Noise Load (1800) With Thermal Noise Plot, 8-Hop TD-2

RADIO CHANNEL NO. R-2211 SWITCH SECTION (FROM) HARTSHORE (TO) NOBLE
 TYPE RADIO SYSTEM TD-3 NO. OF HOPS 4 CIRCUIT LOAD 1200 DATE 1-26-77 TESTER WE

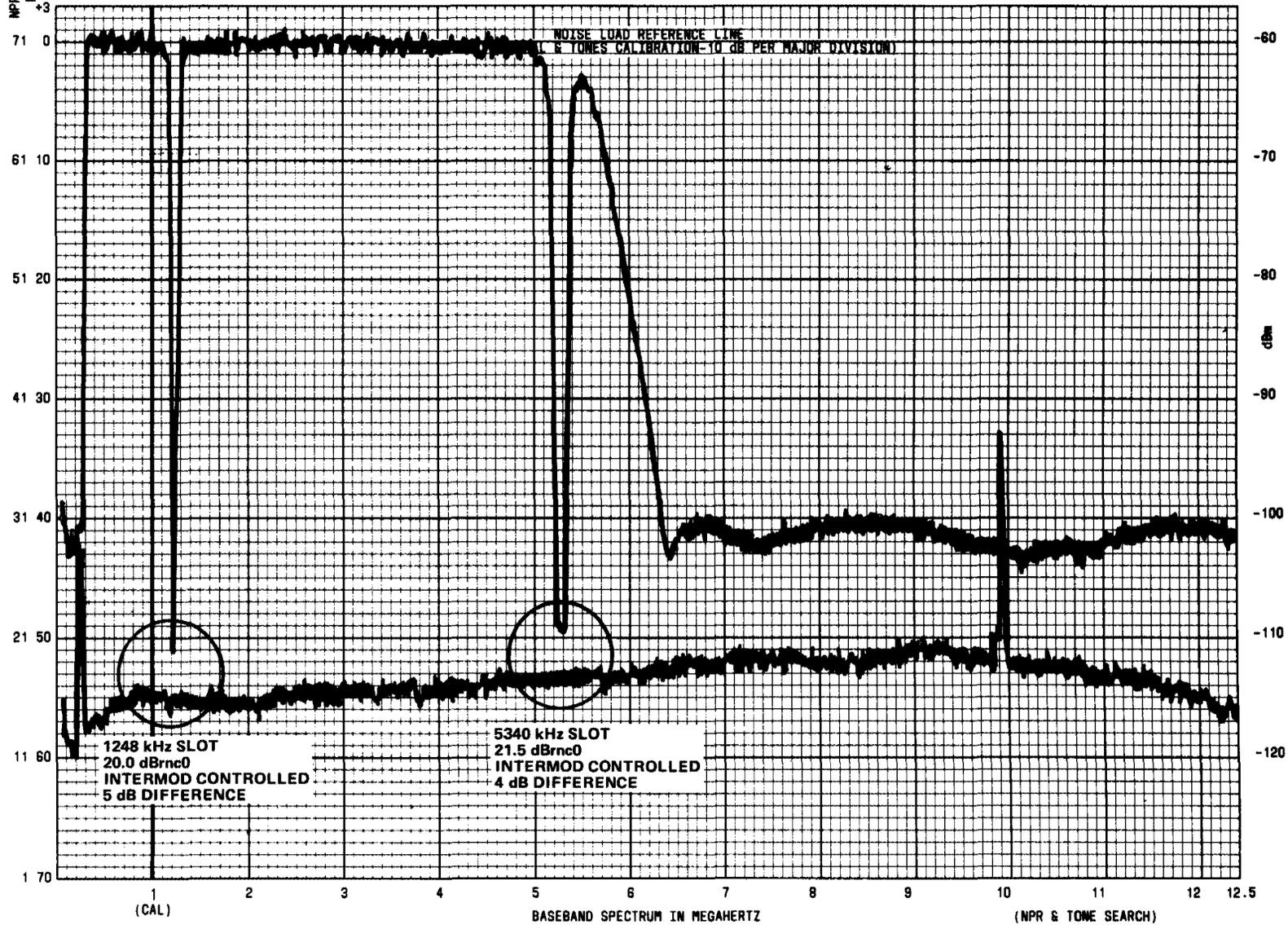


Fig. 32—Noise Load (1200) With Thermal Noise Plot, 4-Hop TD-3

E-10116
(8-78)
SHEET 2 OF 2

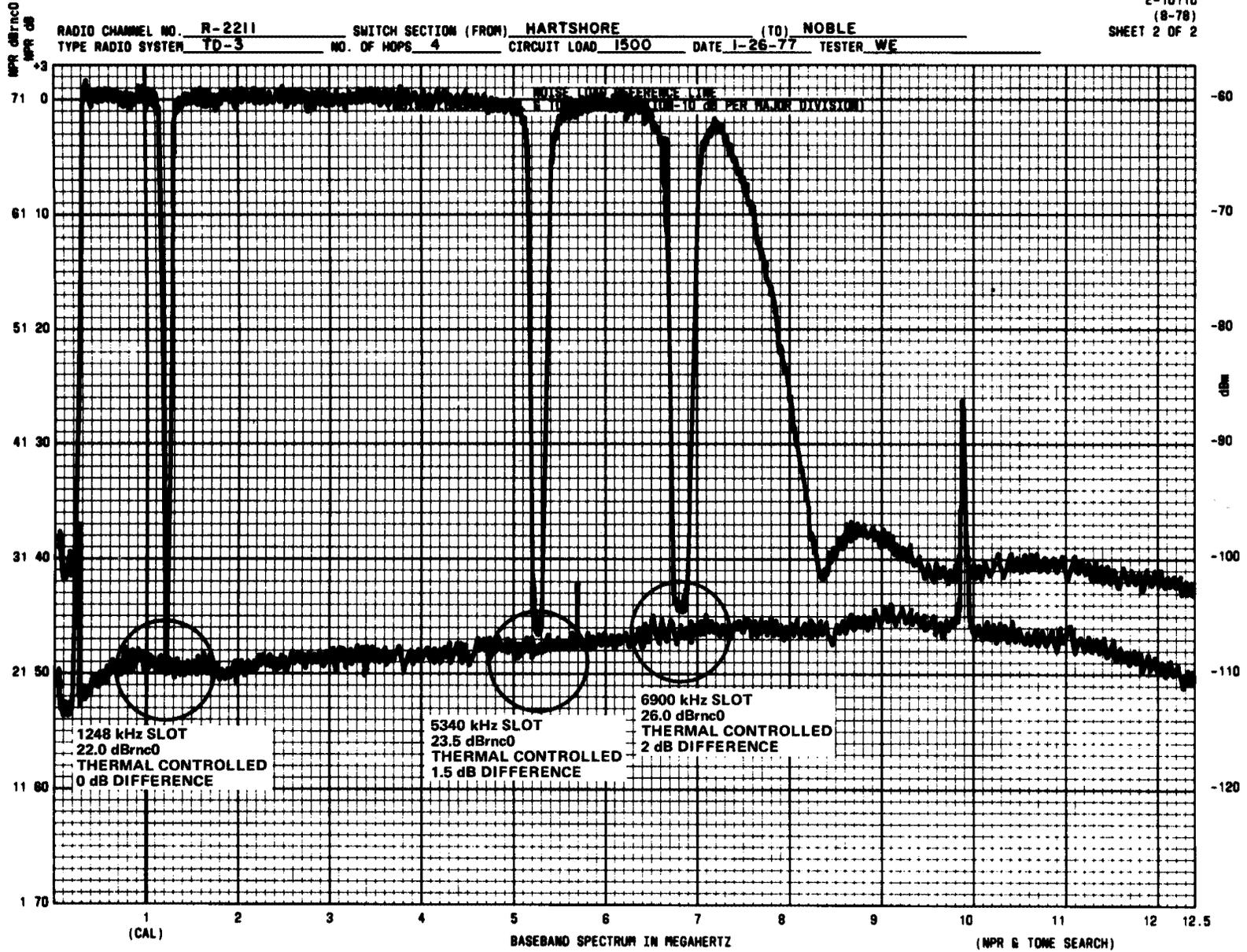


Fig. 33—Noise Load (1500) With Thermal Noise Plot, 4-Hop TD-3

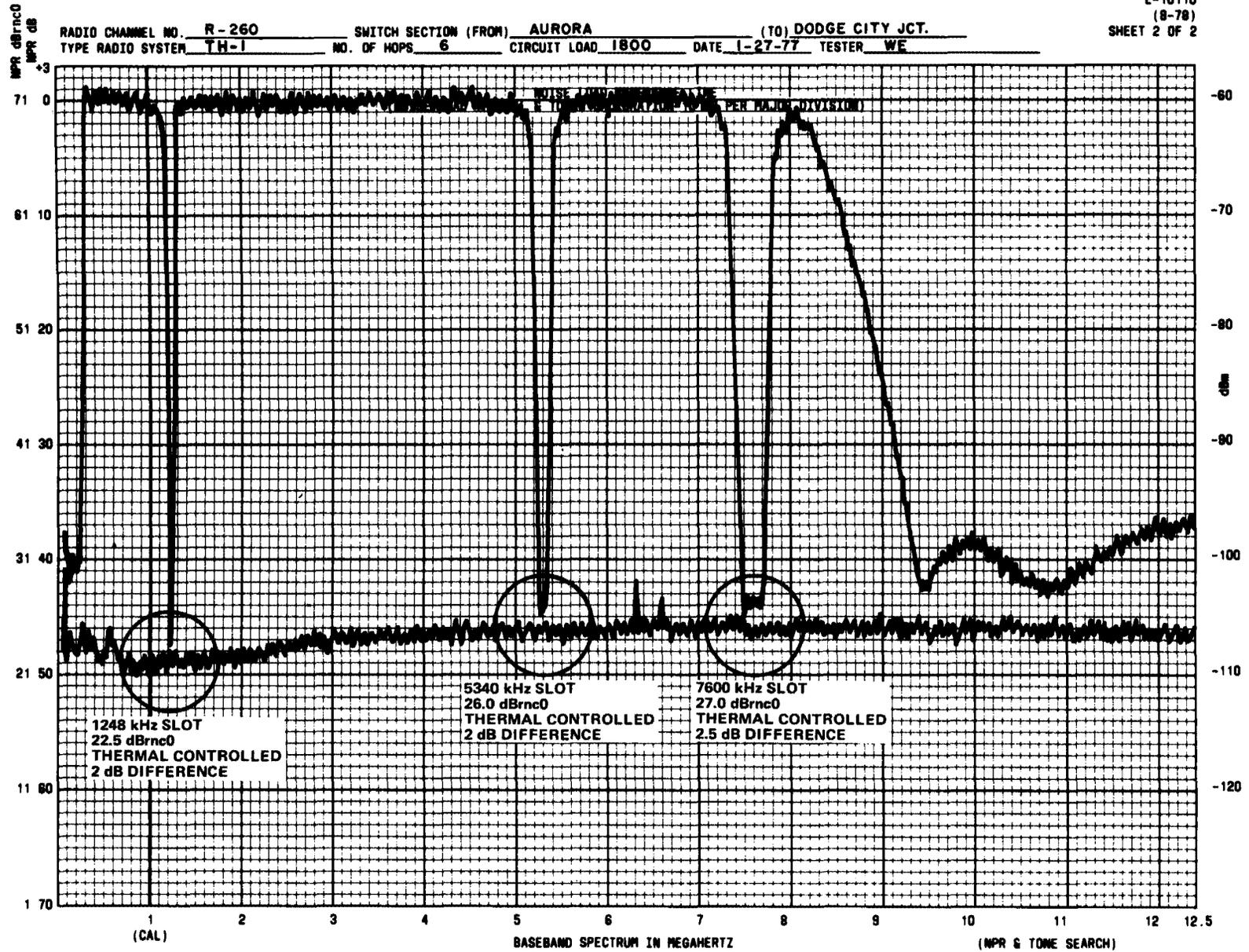


Fig. 34—Noise Load (1800) With Thermal Noise Plot, 6-Hop TH-1

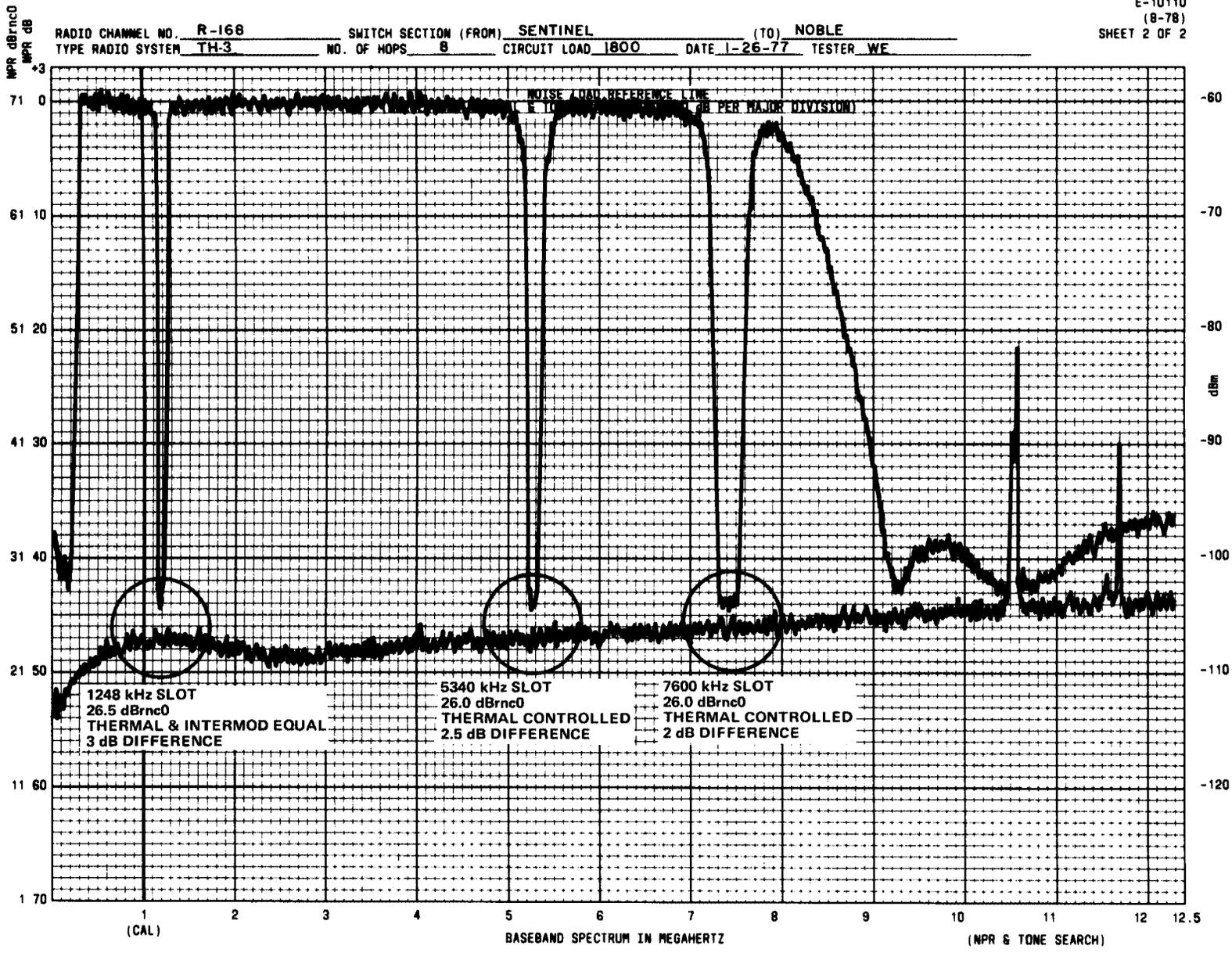


Fig. 35—Noise Load (1800) With Thermal Noise Plot, 8-Hop TH-3

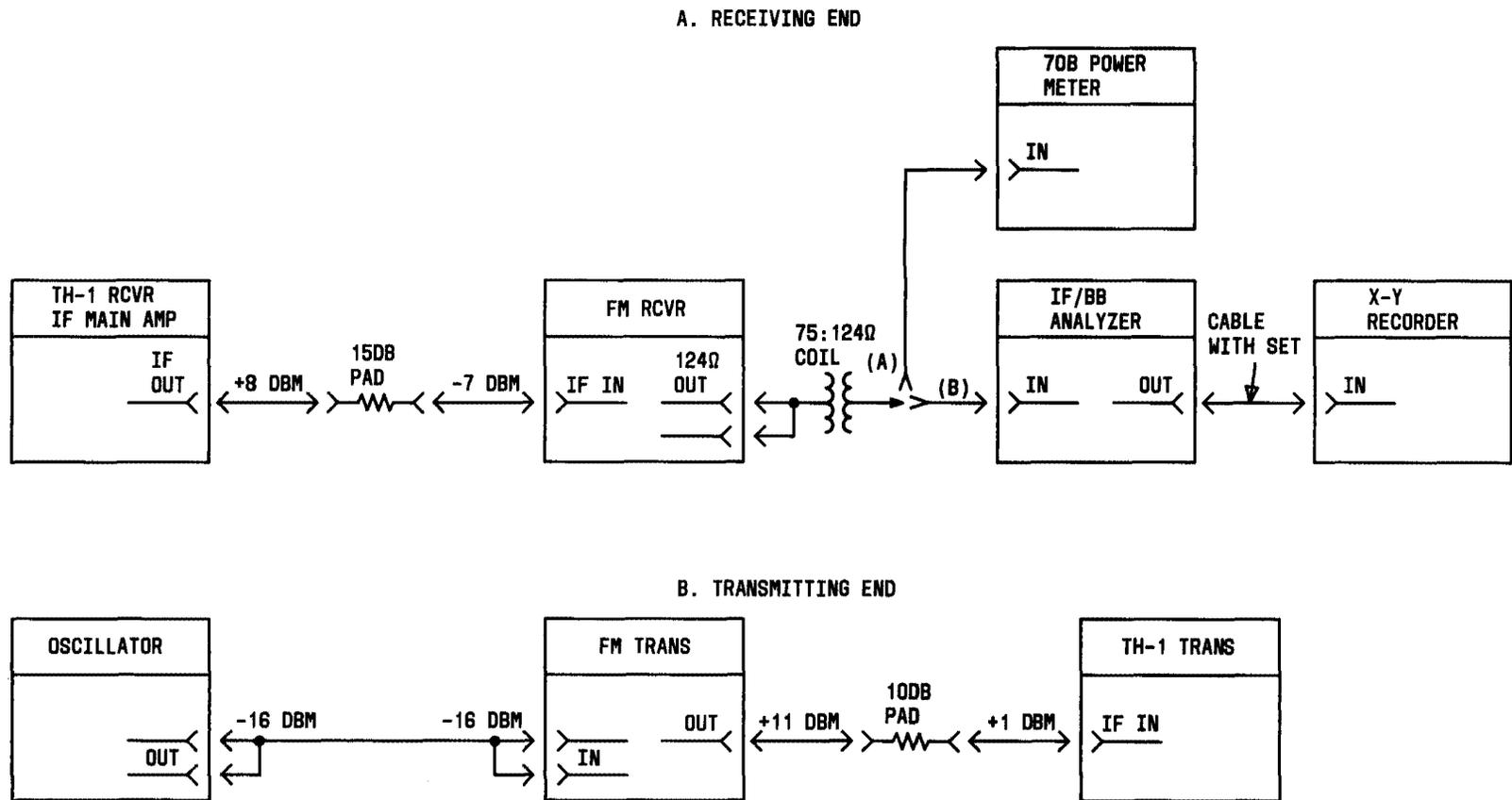


Fig. 36—Setup for 14.8-MHz Tone Test

SECTION 422-210-500

F. Chart 6—Straight-Away Switch-Section Test Procedures for TH-3 (2400) — (Detailed)

3.13 Before attempting straight-away radio switch-section tests, the operator should become proficient at making SCIENTIFIC-ATLANTA test set and FM terminal back-to-back tests described earlier in this practice.

3.14 This arrangement has the capability of performing baseband response, noise load (NPR), and thermal noise and tone search (baseband related) tests. Field experience shows that technical and time-saving advantages are possible when these tests are conducted in a specific sequence. Therefore, it is recommended that the sequence in Table T be observed whenever possible.

TABLE T

TEST	SEQUENCE
Baseband Response	1 of 4
Thermal Noise and Tone Search	2 of 4
Noise Load (NPR)	3 of 4
Thermal Noise Plot	4 of 4

3.15 The following apparatus is required:

1— SCIENTIFIC-ATLANTA Radio Performance Analyzer

Baseband Noise Transmitter (4661)

IF/BB Analyzer (4670 or 4671)

X-Y Recorder (4673)

1— 4A FM Terminal

Cords and Coaxial Pads as indicated.

Note: If a J68330Y equalizer-amplifier is used in the main station at the end of the switch section, it should be removed for this test procedure.

STEP	PROCEDURE
1	Caution: See paragraph 1.05 if using the Model 4670 IF/BB analyzer. Test Sequence 1 of 4—Baseband Response
2	Arrange the test apparatus and follow the Initial Control Positions instructions as given in Fig. 64.
3	Warning: Damage to the pen tip will result if pressure is applied directly to the pen or plastic arm. On the X-Y recorder: (a) Insert a BASEBAND RESPONSE test form against the left-hand side and the bottom paperguides of the X-Y recorder. (b) Operate the CHART HOLD/RELEASE switch to HOLD. (c) Verify that a pen of the desired color is in place.

STEP	PROCEDURE
	<p>(d) Adjust the X and Y ZERO controls until the pen is centered over the calibration dot within the small circle located on the 0-dB at 1-MHz point of the graph paper.</p> <p>(e) Use the index finger to apply enough downward pressure to the flat metal bar (located on top of the carriage bar) to cause the pen to make contact with the paper. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot. (This is the preferred method. An alternative method to accomplish this task is to operate the RECORD switch on the IF/baseband analyzer. The pen shall now be against the paper and moving about the calibration dot. Slight readjustment of the X and Y ZERO controls may be required to center the pen's average activity about the calibration dot.)</p> <p>(f) Restore the RECORD switch to normal.</p>
	<p>Baseband Scan (Baseband Response)</p>
4	<p>On the IF/baseband analyzer:</p> <p>(a) Operate the (MODE) AUTO switch. (The pen shall rise and travel to the left side of the baseband test form.)</p> <p>(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the baseband response signal.)</p> <p>Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>Note 2: For a detailed analysis of the test data, see Part 4 of this section.</p> <p>Requirements: Refer to the transmission performance limits (Fig. 65) for specific radio system requirements.</p> <p>Test Sequence 2 of 4—Thermal Noise and Tone Search</p> <p>Note 1: This test should be conducted immediately after the baseband response test. Test connections are the same as for the baseband response test.</p> <p>Note 2: The CARR SPRD switch on the FMT must be in the ON position during the tone search test when using the 4A FMT; otherwise, the CARR SPRD switch must be in the OFF position.</p>
5	<p>On the baseband noise transmitter:</p> <p>(a) Set the NOISE pushbutton to the IN position (noise off).</p> <p>(b) Set the POWER LEVEL, dBm attenuator for a total of -49.</p>

STEP	PROCEDURE
6	(c) The UNCALIBRATED light shall be lit. On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This step eliminates unnecessary noise.)
7	On the IF/baseband analyzer: (a) Set the INPUT attenuator for a total of -20 . (b) Set the REF attenuator for a total of -40 . (c) Operate the TONE SEARCH switch. (d) Operate the (MODE) MANUAL switch. (Adjust the frequency back to 1 MHz if it has drifted off.) (e) The analog meter shall indicate 0 dB (0- through 70-dB scale); if not, adjust the REF attenuator until the analog power meter indicates as closely to 0 dBm as possible.
8	On the X-Y recorder, set the slide switches as follows: (a) PEN RECORD/LIFT switch to LIFT. (b) SERVO ON/STANDBY switch to SERVO ON. (c) CHART HOLD/RELEASE switch to CHART RELEASE.
9	On the X-Y recorder: (a) Insert the NPR AND TONE SEARCH form against the left-hand side and bottom paperguides. (b) Operate the CHART HOLD/RELEASE switch to the HOLD position. (c) Observe the digital power meter indication on the IF/baseband analyzer. (This noise value will be used to calibrate the X-Y recorder.) (d) Using the X-Y ZERO controls, adjust the position of the pen for calibration at 1 MHz and the same $-dBm$ value as indicated on the digital power meter in (c) above. [The far right-hand dBm scale of the graph paper ($-130/-60$) is used for this purpose.] (e) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)

STEP	PROCEDURE
Thermal Noise and Tone Scan	
10	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none"> (a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.) (b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tone signal.) <p>Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>Note 2: For a detailed analysis of the test data, see Part 4 of this section.</p> <p>Note 3: If it is difficult to separate low-level tones from random noise, a second tone search should be made. The two plots should then be compared and any tones not present on both plots should be ignored.</p> <p>Requirement: Refer to the transmission performance limits (Fig. 65) for specific radio system requirements.</p> <p>Test Sequence 3 of 4—Noise Load (NPR)</p> <p>Note: This test should be conducted immediately after the thermal noise and tone search. Test connections are the same as for baseband response and thermal noise and tone search.</p>
11	<p>On the baseband noise transmitter:</p> <ul style="list-style-type: none"> (a) Set the FILTERS 316, 11,404, 1248, 5340, and 10,840 pushbuttons to their in-circuit position. (b) Set the NOISE pushbutton to the OUT position (noise on). (c) The UNCALIBRATED light shall be extinguished. (d) Set the POWER LEVEL, dBm attenuator to -15.4.
12	<p>On the X-Y recorder, operate the SERVO ON/STANDBY switch to the STANDBY position. (This eliminates unnecessary noise.)</p>
13	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none"> (a) Operate the NPR switch (see paragraph 1.05). (b) Operate the (MODE) MANUAL switch. (Adjust the frequency if other than 1 MHz.) (c) Set the INPUT attenuator to -15. (d) Set the REF attenuator to -38.

STEP

PROCEDURE

- (e) The digital power meter shall indicate a noise level of -58.5 ± 1 dBm.
- (f) Under normal conditions, the analog power meter shall indicate 0 dBm on the lower scale (0 through -70 dBm). Readjust the reference attenuator until the analog power meter indicates as closely to 0 dBm as possible.

14 On the X-Y recorder, set the slide switches as follows:

- (a) PEN RECORD/LIFT switch to LIFT.
- (b) SERVO ON/STANDBY switch to SERVO ON.
- (c) CHART HOLD/RELEASE switch to RELEASE.
- (d) LINE ON/OFF switch to LINE ON.

15 On the X-Y recorder:

- (a) Insert an NPR AND TONE SEARCH test form against the left-hand side and bottom paperguides.
- (b) Operate the CHART HOLD/RELEASE switch to the HOLD position.
- (c) Adjust the X and Y ZERO controls until the pen is centered at 1 MHz and 67 dBm (i.e., four divisions below the dot at 1 MHz and 71 dBm).
- (d) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X and Y ZERO controls may be necessary to arrive at the desired calibration point.)

Noise Power Ratio (NPR) Scan

16 On the IF/baseband analyzer:

- (a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)
- (b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the NPR signal.)

Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF baseband analyzer.

Note 2: The 1248, 5340, and 10,840 slots will appear in the noise spectrum for noise load.

Requirement: Refer to the transmission performance limits (Fig. 35) for specific radio system requirements.

STEP	PROCEDURE
	<p>Note 3: See Part 4 of this section for a detailed analysis of the test data.</p> <p>Note 4: Successful use of the dBrnc0 scale depends upon accurate calibration of the X-Y recorder pen at the 67-dBrnc0 (or 0 NPR) point.</p> <p>Test Sequence 4 of 4—Noise Load With Thermal Noise Plot</p> <p>Note: The thermal noise plot, for best results, must be conducted immediately after the noise load test. The instructions below assume that the thermal noise plot is being conducted immediately after the noise load plot.</p> <p>17 On the baseband noise transmitter, set the NOISE pushbutton to the IN position (noise off).</p> <p>18 On the IF/baseband analyzer, operate the (MODE) RECORD switch. The pen shall be down and the X-Y recorder plotting the characteristic shape of the thermal noise and tones underneath the noise load plot.</p> <p>Note: This test sequence (4 of 4) is conducted to determine the noise and tone characteristic in the area of a specific noise load slot.</p> <p>19 Analysis of the thermal floor area near the noise load slot will reveal:</p> <ul style="list-style-type: none"> (a) If the noise load slot is thermal noise or intermodulation noise controlled (b) If there is a balance in terminal noise and intermodulation noise (c) If the noise load slot is influenced by an undesirable tone near the noise load slot. <p>Note: See Part 4 of this section for a more detailed analysis of test data.</p>
<p>4. ANALYSIS OF SWITCH-SECTION TRANSMISSION PERFORMANCE TEST DATA</p> <p>A. General</p> <p>4.01 The primary objective of every communication system is to convey intelligence from one point to another without objectionable distortion or other transmission related impairments. For this objective to be met, it is necessary to define significant factors which affect transmission performance, to set limits (transmission performance parameters) which must not be exceeded, and to design the overall system to operate within the design limits.</p>	<p>4.02 Significant factors affecting the transmission performance of FM radio systems are:</p> <ul style="list-style-type: none"> (a) Baseband response (b) Noise performance (thermal and inter modulation) (c) Tones (generated within the channel or from undesired coupling sources). <p>4.03 An ideal radio system would exhibit a flat amplitude (baseband) characteristic within an assigned bandwidth, and the noise characteristics (thermal, intermodulation, and tone) would be non-</p>

existent. However, in the real world where design technology (state of the art) and economic worths must reach a balance, there is often a significant departure from these ideal characteristics. Some radio systems will exhibit poorer performance than others, especially when compared with radio systems of later design. A good example of this is the original TD-2 versus the later TD-3 radio system. Until recently, the TD-2 system was a totally vacuum-tube design, with inherently higher noise and poorer baseband response compared to TD-3 which was of solid-state design except for the traveling-wave tube (TWT) amplifier. The main point here is that radio systems are made up of all types of transmission variables that influence the individual repeater performance, therefore, influencing the overall transmission performance of the radio system. Since this practice contains transmission performance requirements for both the TD and TH radio systems, the individual design characteristic (transmission performance) of each radio must be recognized and treated as such.

B. Baseband Response

- 4.04** Baseband response measurements are made on a switch-section basis and are of the straight-away type with one main station transmitting and the next main station in line receiving and making the actual measurement. Therefore, prior coordination between these main stations is required. These measurements are made at the protection switching bays with the service on the channel to be tested switched to the protection channel.
- 4.05** The baseband response of the test equipment and FM terminals can be controlling, particularly on one or two radio hops. Therefore, care must be taken to use FM terminals that are as flat as possible. It will be necessary to measure the FM terminals back to back in order to ensure proper operation and satisfactory transmission performance of the test setup. Failure to meet the back-to-back baseband flatness should be isolated and corrected before continuing.
- 4.06** The baseband response of a radio channel is the baseband gain of the channel versus frequency measured relative to the gain at 1 MHz.
- 4.07** The SCIENTIFIC-ATLANTA test set measures the baseband response characteristic under dynamic load conditions. The transmitted baseband response test signal consists of a pre-emphasized spectrum of band-limited noise with a flat characteristic extending to about 9.5 MHz (for testing TD and TH channels carrying up to 1800 circuits) or to about 10.5 MHz (for TH-3 2400-circuit channel testing). The received baseband test signal is de-emphasized, detected, amplified, and plotted on the baseband test form. The baseband response printout is a graphic presentation of the baseband response characteristic for the radio channel under test.
- 4.08** The baseband response measured on a switch section is the algebraic sum of all the individual factors that contribute to the baseband response characteristic of the radio channel.
- 4.09** The baseband response characteristic of a radio channel is influenced principally by (a) the IF and RF amplitude response characteristics of the passive networks, filters, and any narrow-band active circuits that may be present, and (b) the linear delay slope of the IF and RF networks, filters, and antenna waveguide system acting in combination with compression and/or amplitude modulation (AM) to pulse modulation (PM) conversion in the active circuits. Therefore, maintenance activities associated with the various repeater gain adjustments (i.e., RF and IF level settings), swept response adjustments, and envelope-delay equalization procedures can greatly influence the overall baseband response characteristic of a radio channel.
- 4.10** The baseband response characteristic of a radio channel can be expected to exhibit one of three general shapes: (a) the preferred shape, flat from 1 MHz through 9.5 MHz (10.5 MHz for TH-3 2400-circuit loading), (b) the rolled-up condition, starting at about midband and extending through 9.5 MHz (10.5 MHz for TH-3 2400 loading), and (c) perhaps the least desirable shape, a rolled-off condition, starting at about midband and extending through 9.5 MHz (10.5 MHz for TH-3 2400-circuit loading). In addition to the above, certain TD-2 and TD-3D channels in TD-2 bay lineups that are equipped for space-diversity operation using the RF combiner and which are not equipped with in-bay differential absolute delay equalization (DADE) arrangements have a predictable roll-off caused by the combining operation. This occurs because in TD-2 offices, the main and diversity antenna connections are made at the opposite ends of the bay lineup. With this arrangement, the electrical length of the main and diversity antenna-signal paths can be made the same only at

one point in the bay lineup. That point is normally made to be the center of the lineup and thus results in essentially equal-length paths (within about 2.5 ns) for the signals feeding the center bays (i.e., channels 3 and 4, or 9 and 10). For the other bays in the lineup, the signals arriving at the combiner will have traversed paths having somewhat different electrical lengths. This difference in path length causes the signals to add (combine) increasingly out of phase with increasing baseband frequency, and this produces a roll-off in the baseband response. This effect is greatest in the end channels of the lineup (channels 1 and 6, or 7 and 12) since the difference in electrical length (typically about 14 ns) is greatest for these channels. (For channels 2 and 5, or 8 and 11, the difference is typically about 7.5 ns.) Information for taking this effect into account has been included in the requirements given in Part 3.

4.11 The baseband response of each radio channel should be as flat as possible. If it is not, service over the channel may be adversely affected. This degradation depends upon the accumulated amount and character of the nonflatness.

4.12 In the case of television service, excessive baseband response distortion in the low-frequency region below approximately 500 kHz causes smearing or streaking in the picture. Excessive high-frequency roll-off (1 to 4 MHz) causes loss of picture resolution. Although the receiving television operating center (TOC) has a variable equalizer to provide final adjustment of the high frequencies relative to the low frequencies, this equalizer has a limited range; furthermore, it is not effective below approximately 2 MHz. Therefore, the receiving TOC cannot compensate for excessive color subcarrier level differences nor can it compensate for response impairments below 2 MHz.

4.13 The baseband response characteristic of radio channels carrying television service becomes even more critical for those cases where the audio is duplexed with an audio subcarrier at 5.8 or 6.4 MHz.

4.14 For telephone service, baseband response roll-off below 8.5 MHz (TD and TH-1) or 10.5 MHz (TH-3) affects individual supergroups by different amounts, with the result that an excessive number of adjustments of the supergroup level may be required. From an individual message circuit point of view, any roll-off characteristic of the baseband response affects the signal-to-noise (S/N) ratio of a specific mes-

sage circuit. Decreasing the S/N ratio of individual message circuits in the upper region of the baseband spectrum will result in those circuits exhibiting a higher than normal noise characteristic. Isolation and correction of the decreased S/N ratio characteristic is often difficult to isolate since baseband roll-off and S/N ratio characteristics are cumulative. It is possible for message circuits that are made up of multiradio switch sections to exhibit serious S/N ratio problems between message terminals, and at the same time, each switch section involved to be within limits.

4.15 For the TD and TH-3 radio systems, the baseband response requirements given in Part 3 are those requirements that the radio equipment is expected to meet when the radio equipment is properly adjusted and maintained, and before any baseband amplitude equalization is applied. These equipment requirements are much too lenient for radio channels carrying service for long distances and especially those channels carrying the third (TD) or fourth (TH-3) mastergroup. Deviations in baseband response which may accumulate from switch section to switch section can cause serious signal-to-noise problems at the terminal end of the system. For a solution to this problem, an adjustable IF amplitude equalizer-amplifier (J68330Y) has been designed for use in the TD and TH-3 systems to provide mop-up amplitude equalization on a switch-section basis. This equalizer-amplifier is a zero-loss equalizer which is located in the last main station receiver in a switch section. The equalizer is adjusted to compensate for any roll-off or roll-up of the baseband response as compared with that at 1 MHz. A similar but passive adjustable amplitude equalizer, coded 981E, is provided in the ED-52510-30 amplitude equalizer panel used for baseband response equalization in the TH-1 system.

4.16 The baseband response equalizers are not intended to be used to correct the baseband response of a radio channel that does not meet the requirements in Part 3. The equalization of a radio channel grossly out of limits will result in poor signal-to-noise (noise load) performance.

C. Procedure for Adjusting the J68330Y Amplitude Equalizer-Amplifier and 981E Equalizer

4.17 Measure the baseband response of the radio channel under test with the IF amplitude equalizer removed from the circuit.

Requirement: The baseband response requirement of Part 3 must be met.

If the requirement is met, proceed with paragraph 4.18. If the requirement is not met, the radio channel requires maintenance.

4.18 Reconnect the amplitude equalizer in the radio receiver. Measure and record the response at 1 MHz. Tune to 8 MHz (TD, TH-1, and TH-3 1800) or 10 MHz (TH-3 2400) and adjust the SHAPE control on the left side of the J68330Y equalizer or the control on the front of the 981E equalizer to obtain the same response as at 1 MHz.

4.19 Measure the envelope-delay distortion (EDD) and correct as required.

4.20 Remeasure the baseband response of the radio channel.

Requirement: The 1-MHz and 8-MHz (or 10-MHz) points shall be within ± 0.2 dB of each other.

If this requirement is not met, repeat paragraphs 4.18, 4.19, and 4.20 until it is met.

D. Noise Sources

4.21 There are two basic types of noises within a microwave radio hop; thermal (also called fluctuation) noise, and intermodulation noise. Thermal noise, which is always present, consists of noise generated mainly in the common waveguide preamplifier (if provided), the downconverter, and IF preamplifier stages of the receiver, and to a considerable less extent, the circuits that follow the IF preamplifier. Also, noise from microwave generator sources can add to the thermal noise floor, especially below about 3 MHz in the baseband.

4.22 The thermal noise of a radio channel is the total random noise power of the channel when the carrier is unmodulated (hence the term idle noise). It is the power summation of noise generated by:

- (a) The transmitting equipment at the head end of the radio channel
- (b) The intermediate radio repeaters
- (c) The receiving equipment at the far end of the radio channel.

4.23 In the absence of specific noise problems, the amount of thermal noise depends primarily

upon the length and makeup of the radio facilities. Assuming equally received carrier powers at all stations, the thermal noise contributed by the radio repeaters increases 3 dB each time the channel length is doubled. This noise is completely random in character and adds on a 10-log or power basis.

4.24 Intermodulation noise is introduced into the system through nonlinearities in the equipment, and/or lack of proper amplitude and/or envelope delay equalization. Intermodulation noise does not change linearly with FM deviation as does thermal noise. It is not uncommon for the intermodulation products to change 2 to 3 dB (occasionally more) with a 1-dB change in drive (deviation) level. Whenever a radio system is suspected of out-of-limit intermodulation noise, the cause may be excessive envelope delay distortion which should be measured and corrected. However, a serious nonlinear condition (such as a defective transmitter or common waveguide amplifier) within the radio line may also generate intermodulation products that become burned in, and which are unaffected by envelope-delay equalization.

4.25 In general, when an FM signal is passed through a passive or active circuit having a nonflat amplitude and/or delay characteristic, the resulting distortion of the signal creates intermodulation products, including harmonics, of the baseband signals. Additional intermodulation products may be generated if a circuit having AM to PM conversion follows the nonflat transmission device. Thus, a typical system having imperfectly equalized amplitude and delay characteristics will have in its baseband output harmonics of the applied signals as well as products falling at the sum and difference frequencies of these signals and their harmonics.

4.26 For example, assume that the frequencies of the baseband input signals are called A, B, C, etc.; then the harmonics which appear in the system output will be 2A, 3A, 4A; 2B, 3B, 4B; 2C, 3C, 4C, and so forth. Actually, there are an infinite number of harmonics for each fundamental frequency, but the magnitude of these harmonics diminishes very rapidly with high order so that only the first few harmonics of each frequency have much significance.

4.27 Second-order intermodulation products consist of such frequencies as (A + B), (A - B), (A

+ C), (A - C), (B + C), (B - C), and so forth. Third-order products are of the form:

$$\begin{array}{ll} (A + B + C), & (2A + B) \\ (2A - B), & (A - B - C) \\ (A + B - C), & (B - 2A). \end{array}$$

4.28 The type of intermodulation product that may predominate in a radio channel, and its distribution across the baseband, depend on the mechanism that produces that product. For example, unequalized delay slope causes second-order noise whereas unequalized parabolic delay distortion produces third-order noise. On the other hand, parabolic delay in combination with AM to PM conversion produces second-order noise. For each of these examples, the number of products is greatest, and therefore the intermodulation noise is highest, in the top message circuits.

4.29 The following are some of the other possible contributors to the overall noise performance of an FM radio system:

Channel Loading

Adding more message circuits to a broadband channel results in more intermodulation products and, therefore, more intermodulation noise if the per-circuit frequency deviation is held constant. To decrease this intermodulation noise, the transmission level of each circuit (i.e., the per-circuit deviation) must be reduced. When this occurs, the thermal noise increases accordingly. Therefore, if the thermal noise can be reduced, the number of circuits can be increased without degradation of the transmission. Normal drive levels are established in order to obtain as nearly as possible a balance between thermal and intermodulation noise. Since thermal noise can be predicted, most radio systems' drive level is biased toward the thermal side.

Transmission Line Reflections

Echoes of the IF or RF signals may become an important source of distortion, audible as unintelligible noise. Echoes in IF cabling and RF echoes in the antenna waveguide system are caused by slight impedance mismatches. These mismatches appear typically as amplitude and envelope-delay distortion ripples, superimposed on broader linear, and parabolic characteristics. The delay characteristics of slope and parabolic distortion can be corrected by equalization

while ripple distortion objectives must be met by design.

A principal source of echoes in the antenna waveguide system occurs where the vertical and horizontal waveguide runs are joined through polarization separation networks. Other sources of waveguide echoes are flexible waveguide, bends, and flange joints.

Antenna Misalignment

A misaimed antenna acts as a mode converter and thereby contributes to intermodulation noise in the radio system. If antennas are aimed correctly, not only can moding be reduced, but better cross-polarization discrimination can be achieved.

RF Path Reflections

Echoes in the RF path are produced by reflections off surfaces such as buildings, flat fields, or bodies of water. These echoes cause nonlinear distortion which produces intermodulation noise. Some of these echoes, such as those from water, can be readily located during the map study work; others are located through field checks and path testing. Repeater locations are selected to minimize echoes from these sources.

Repeater Spacing

The maximum length between microwave repeaters is limited by thermal noise in the receiver which manifests itself as noise in the upper message circuits. The thermal noise contributed by the receiver is usually greatest in the top message circuit, but this may vary from system to system depending on the particular pre-emphasis shape used in the system. Path length is a controlling factor for the upper message-circuit noise in an FM system. The longest possible paths consistent with good transmission performance is what a route designer attempts to obtain. Routes have been laid out for many years and the average length is about 25.5 miles per hop. Thermal noise can be calculated very easily once all parameters are known. Some parameters change as a result of technological advances (e.g., receiver noise figures, types of antennas, pre-emphasis, etc.). The equation for thermal noise is complex and will not be given in this practice. For a given noise figure, the thermal noise varies inversely with the RF input to the receiver.

Microwave Generator Noise

Microwave generators can contribute to the thermal noise of the system. In most cases, their contribution

is restricted to the lower half of the baseband because of filtering within the radio bay. A characteristic of microwave generator noise is that it may appear as a broad bump of noise extending from 0.5 MHz to as high as about 2 MHz (e.g., TD-3, TD-3A, TD-3D) or 4 MHz (e.g., TD-2), with its maximum occurring somewhere between 1 and 2 MHz. Such a broad noise bump may be especially noticeable in the thermal noise plots for TD channels that have been conditioned for 1800-circuit loading. This conditioning greatly reduces the thermal noise contribution of the radio receivers. As a result, the generator noise, which is unaffected by this conditioning, may stand out above the reduced receiver noise by as much as several dB in the lower portion of the baseband.

The noise bump occurs because of the use of a common microwave generator in the repeater station bays. Thermal noise in the generator phase-modulates the generator output signal. This noise modulation reaches the transmitter modulator by two paths. One is the direct path to the local-oscillator input port of the modulator. The other is the path through the shift modulator, receiver modulator, and the receiver IF circuits to the IF input to the transmitter modulator. If the two paths had the same electrical length, the generator noise-modulation would cancel at all baseband frequencies, and there would be no generator noise contribution from the repeater station bays. However, the two paths usually differ substantially in electrical length. As a result, at the transmitter modulator the phase-modulation noise from the generator cancels at some frequencies but adds in phase at others. This produces a scalloping or periodic variation in the generator noise contribution at baseband that starts with a null at 0 MHz and which has a period equal to the reciprocal of the delay difference between the two paths. The delay difference varies between types of radio bays and, for the same type of radio bay, may vary between bays depending, for example, on the number and types of equalizers and other networks in the IF path through the receiver. Therefore, the baseband frequency at which the first noise peak occurs is dependent on the type of radio bay and its configuration. Normally, only the first noise peak is seen on the thermal-noise plots because filtering in the radio bay (e.g., the filter on the shift-modulator output) removes the generator noise at the higher baseband frequencies in at least one of the two paths.

The noise from the separate receiver and transmitter microwave generators used in main station bays is

uncorrelated. Hence the noise from main-station bay generators simply adds on a power basis and, typically, contributes a flat noise spectrum across the lower half of the baseband.

RF Crosstalk

Another source of noise which impairs voice circuits is RF interference from other microwave signals. When designing a route, provision must be made to allow for interference within the main route and into the main route from covering spurs (sidelegs). There are four kinds of main route interference: same section, adjacent section, overreach, and junction. Interference from foreign systems must also be controlled, and this is done through standard frequency coordination.

It must be pointed out that in some cases the calculated or allowed RF interference on a hop may exceed limits. An occasional hop exceeding the average per-hop interference allocation can be tolerated if other paths are sufficiently better to compensate. The objective is to make the noise performance of each switching section equal to or less than its prorated share of the 4000-mile objective.

E. Tones (Specific Tone Characteristics of TD and TH Radio Systems)

4.30 Spurious tones are any unwanted single-frequency signals that can be observed within or above the thermal noise background of the system. Spurious tones generally will appear as narrow vertical spikes, no wider than the pen width of the recorder, rising above the thermal noise display on the X-Y recorder. Some tones (e.g., 10-MHz tones in TD systems) may exhibit a wider width because of modulation sidebands accompanying these spurious signals. Some of the considerations in making and analyzing tone measurements are:

- (a) Low-level tones, within a few dB of the thermal noise, may be difficult to discern from the background noise. If difficulty is experienced in determining whether or not a tone is actually present on a plot, a second tone search should be made. The two plots should then be compared and any tones not present in both plots should be ignored.
- (b) The thermal noise plot typically shows spike-type excursions of up to about ± 1.5 dB with respect to the average noise. These normal excursions

sions often prevent observing and measuring very low-level tones that may be present and, conversely, can be misinterpreted as tones. To avoid these problems, it is acceptable to ignore the tone-like (spike) disturbances that appear at random frequencies in the baseband and which are no greater than 2 dB above the average (as estimated by eye) thermal noise within ± 0.2 MHz of the noise spike in question.

(c) The operation of the carrier-spreading feature in the 4-type FM terminal transmitter, or the transmission of the 1A-RDS digital signal, will cause many tone-like interferences to be spread or smeared in frequency. This reduces the interfering effect of these tones in a 3-kHz message circuit by at least 12 dB. Because of the widespread use of the carrier-spreading feature in normal system operation, as well as the widespread transmission of the 1A-RDS signal, it is permissible to make the channel thermal noise and tone search using a 4-type FM transmitter (FMT) with the carrier spreader turned *ON*. If this is done, it should be so noted on the permanent plot to assure a valid comparison with earlier and/or later measurements.

4.31 Until the development of the SCIENTIFIC-ATLANTA test concept, there was no practical method available to the testroom for the detailed identification of tones in the baseband spectrum. There will be unwanted tones identified using the SCIENTIFIC-ATLANTA test concept that have escaped detection using the manually tuned selective voltmeter method.

4.32 The tone (spurious) information contained in this section is only a portion of the information available in the standard individual radio system switch-section practices. For ease of reference, the TD and TH radio systems will be covered separately.

TD Radio Systems

General

Spurious tones appearing in the baseband of any radio system may be classified as internal and exter-

nal. Internal tones are those associated with a particular radio system, its equipment, or system configuration. These tones may be further classified as follows:

- (a) Microwave generator tones
- (b) 10-MHz tones
- (c) Power supply tones
- (d) Cochannel tones.

Specific Tone Sources

(a) **Microwave Generator Tones (TD-2 only):** There are two types of microwave generator tones that are specific to the TD-2 vacuum tube microwave generator. The first occurs only in main stations and is caused by the two J68330G (vacuum tube) microwave generators coupling to produce 1.11-, 2.22-, 3.33-, 4.44-, and 6.66-MHz tones. If these tones do not meet the requirements, modification to the generators is available and is shown on SD-59409-02. Both generators in the same bay must be modified. The second type of microwave generator tones is produced only in repeater station radio bays equipped with the J68330J 40-MHz shifter-converter and the J68330G microwave generator. Coupling between the 20-MHz oscillator circuits of the 40-MHz shift oscillator and the crystal oscillator stage of the microwave generator can produce a tone at the difference frequency of the two oscillators. Table U shows the radio channel number and the associated tone frequency which can be produced by this mechanism. Modifications are available to the 40-MHz shift oscillator unit to reduce 20-MHz leakage, and they are shown on SD-59410-02. All microwave generators, regardless of the type, may produce tones if coaxial and waveguide connections are not tight and if shields and covers are not securely in place.

TABLE U

RADIO CHANNEL	MWG CRYSTAL	BASEBAND TONE
NUMBER	MHz	MHz
1A and 9A	17.59259	2.40741
1B and 9B	17.77778	2.22222
2A and 10A	17.96296	2.03704
2B and 10B	18.14815	1.85185
3A and 7B	17.68518	2.31482
3B and 8A	17.87037	2.12963
4A and 8B	18.05556	1.94444
4B	18.24074	1.75926
5A	18.42592	1.57408
5B	18.61111	1.38889
6A	18.79630	1.20370
6B	18.98148	1.01852
7A	17.50000	2.50000
11A	18.33333	1.66667
11B	18.51852	1.48148
12A	18.70370	1.29630
12B	18.88889	1.11111

(b) **10-MHz Tone Sources:** Tones of 10-MHz are found in the vicinity of 9.6 through 10.4 MHz. These 10-MHz tones will either directly or through an intermodulation process be accompanied by modulation sidebands (video, message, etc.), the lower sideband of which will fall across the switching system 9-MHz noise slot as well as into the upper mastergroups of the desired baseband signal. The 10-MHz tone requirements have been set to keep the interference from these sidebands at an acceptable level. Three principal sources of these 10-MHz tones are the following:

(1) It is assumed initially, in describing the first and second mechanisms, that the TD-bays are arranged in a standard, nonspace-diversity lineup with the antenna connection at the low frequency channel end of the lineup. In the first mechanism, the receiver local oscillator (LO) frequency is higher than the channel frequency (S). The interfering signal, which is the next received channel of the same polarization (i.e., at S + 80) mixes with the LO frequency (S + 70) in the downconverter to produce a 10-MHz product. This 10-MHz signal then mixes with the 70-MHz carrier in the IF preamplifier to produce 60- and 80-MHz signals. The FM receiver at the end of the message unit radio (MUR) translates these signals to a single 10-

MHz baseband tone. This condition can be found on channels 1, 2, 7, and 8.

(2) In the second mechanism, the LO frequency is lower than the carrier frequency (S). The interfering signal (next higher received channel at S + 80) mixes with the LO frequency (S - 70) in the downconverter to produce a 150-MHz product. This product then mixes in the IF preamplifier with the 70-MHz carrier frequency to produce an 80-MHz product (150 - 70). Again the FM receiver will convert this signal to a 10-MHz baseband tone. This condition will apply to radio channels 3, 4, 5, 9, 10, and 11. Channels 6 and 12 do not normally have 10-MHz tones because there is not a channel 80 MHz above them in frequency.

For standard nonspace-diversity lineups, channels 80 MHz below the desired channel frequency do not produce either the first or second type of interference mechanism because in a standard bay lineup the S - 80-MHz channel is removed by the preceding channel-dropping network. However, when a TD-2 (including a TD-2/TD-3D intermix) lineup is equipped for space-diversity operation, the diversity antenna is connected to the high-frequency channel end of the lineup. In this case, those signals at S - 80 MHz originating from the diversity antenna now become additional sources of 10-MHz tones. From the preceding descriptions it can be seen that in this arrangement, the S - 80-MHz signal from the diversity antenna creates a 10-MHz tone in channels 3, 4, 5, 6, 9, 10, 11, and 12 by means of the first mechanism, and in channels 2 and 8 by means of the second mechanism.

The power of the 10-MHz baseband tones depends on the amount of selectivity the receiver has to the received signal power of the channel 80 MHz above (and below for TD-2 space diversity) the desired channel, and on the presence or absence of a common-waveguide RF amplifier, and on the conversion losses of the receiver modulator and the IF preamplifier to the products formed by this undesired carrier, the LO signal, and the desired carrier.

(3) The third mechanism is the 10-MHz tone that is formed by the mixing of the 40-MHz shift-oscillator frequency with the local oscillator frequency from the microwave generator.

Poor filtering of these products from the local oscillator signals feeding the transmitters and receivers will cause these tones to exceed their requirements. All TD-2 repeater bays should have transmitting band-pass filters (TBF) and receiving band-pass filters (RBF) in these feeds. Loose coaxial or waveguide connections at the microwave generators, 40-MHz shifter-converter, and TBF and RBF filters may cause excessive 10-MHz tones.

(c) **Power Supply Tones:** Power supply tones are caused by the dc-to-dc converters used in the various power plants which generate different voltages to power the radio bays. These converters use switching frequencies from approximately 100 Hz to over 25 kHz. Inadequate filtering or grounding can sometimes generate a wide band of tones which are harmonics of the switching frequency. When present, these tones may appear as a band of closely spaced spikes, often in the 1- to 6-MHz region of the baseband. If these types of tones are suspected and the requirement is not met, consult the appropriate schematic diagrams (SD) and circuit descriptions (CD) for the dc-to-dc converter in question. Determine that the unit is properly installed and if any modifications to reduce tones have been specified and installed in the unit.

(d) **Cochannel Tones:** Cochannel interferences (tones) are caused when the receiving antenna picks up another radio channel operating on the same frequency. Cochannel interferences internal to the system can occur at every repeater and main station because, in general, the same channel frequencies are used in TD for receiving (or transmitting) the opposite direction of transmission. Excessive interference may occur because of poor front-to-back coupling ratios of the repeater station or main station antennas, or because of poor side-to-side coupling between antennas at stations. Reflections from buildings and other structures are generally the main cause of cochannel interferences being out of limits. Adjacent or parallel radio routes are external (to the system) sources of cochannel interferences caused by poor separation of these routes or, again, reflections. Cochannel interferences normally do not cause problems until the interfered with channel fades or fails; then problems with excessive noise and interference to message and data service may occur before a protection switch is initiated. It is normally beyond the resources of local operations

personnel to cure excessive cochannel interferences; therefore, when the interference is above the requirement, Transmission Engineering should be notified so that they can analyze the problem for possible solutions.

(e) **External Tones:** External tones may be caused by radio bay, FM terminal, and/or test equipment pickup of RF radiation from nearby AM, FM, or TV broadcast stations or mobile radio transmitters. Interference from other microwave systems or from high-power radar sets may produce tones or noise in the channel under test. Since this type of interference is usually beyond the control of operating personnel, Transmission Engineering should be notified of the suspected problem.

TH-3 Radio Systems

TH-3 radio channel tones observed most frequently are:

- (a) Low frequency tones (<0.5 MHz).
- (b) Tones close to 4.1 MHz which may be found in channels 16, 17, 18, 20, 21, and 22.
- (c) Tones close to 6.6 MHz which may be found mainly in channels 20, 21, 22, 23, and 24.
- (d) Tones close to 10.7 MHz which can be found in all channels.
- (e) A series of tones with about 24- or 48-kHz spacing which may be caused by a Western Electric manufactured TWT power supply.
- (f) A series of tones with about 20-kHz spacing which may be caused by the -24 to +24 converter in the (300A) switch and (3A) wire-line entrance link bay.
- (g) In addition to the above, cochannel tones and external tones, as described for the TD radio system may also occur in TH-3.

Noise Spikes 8- Through 10-MHz Range

Noise spikes in the 8- through 10-MHz region having a bandwidth of about 100 kHz or less and rising several dB above the noise requirements may be caused by ion oscillations or another phenomenon in a trav-

eling-wave tube amplifier. New tubes, particularly spares which have been unused for long periods, may have ion oscillations when first turned on. Noise spikes due to ion oscillations should disappear after several days of continuous operation. Noise spikes due to another phenomenon may also occur in the 8-through 10-MHz range and are dependent upon the setting of the TWT power supply controls.

4.1- or 6.6-MHz Tones

If a tone is found at 4.1 or 6.6 MHz, the problem is most likely due to RF leakage. Try the following:

- (a) Tighten all waveguide screws. No screws should be missing.
- (b) Examine the 6B isolator locknuts for tightness; if they are not tight, do not attempt to tighten them. Order and install a replacement.
- (c) Verify that the receiver modulator and shift modulator diode holders are tight.
- (d) Examine all flexible waveguide for damage.

If the tone still does not meet the requirements, there may be excessive leakage from a transmitter. The offending transmitter may be determined from Table V.

TABLE V

INTERFERED CHANNEL	INTERFERING CHANNEL FOR TONE FREQUENCY OF	
	4.1 MHz	6.6 MHz
14	—	20
15	—	21
16	20	22
17	21	23
18	22	24
20	16	14
21	17	15
22	18	16
23	—	17
24	—	18

Tighten all transmitter waveguide screws and the locknuts on the tuning controls of the 4() and 5() integrated circuits.

10.7-MHz Tone

If the tone is found at 10.7 MHz, check the tightness of the diode holders in the receiver modulator, shift modulator, and 6-GHz multipliers of the channel approximately 60 MHz (two channel spacings) above and the channel approximately 60 MHz (two channel spacings) below the disturbed channel.

TH-1 Radio Systems

General

For TH-1 radio, the tones observed most frequently are:

- (a) Microwave carrier supply (14.8 MHz) tones
- (b) Cochannel tones
- (c) External tones.

Tone Sources

(a) **Microwave Carrier Supply (14.8 MHz)**

Tones: The TH-1 radio system employs at each station a common, coherent microwave carrier supply (MCS) from which, starting with a 14.8-MHz source, all of the required local oscillator frequencies for all of the radio channels at that station are derived. Baseband (14.8 MHz) tones are generated when RF leakage paths bypass normal local oscillator paths in the transmitter, receiver, and MCS. As in the case of the 10-MHz tones in TD radio, these 14.8-MHz tones typically will acquire modulation sidebands that can overlap and interface with the desired signal. Thus, the 14.8-MHz tone requirement has been set to keep the resulting sideband overlap interference to an acceptable value.

(b) **Cochannel and External Tones:** The origin of cochannel and external interference tones, their effect, and the recommended action to be taken when they are found, are the same for TH-1 as described in paragraphs 4.32(d) and 4.32(e) for the TD radio systems.

F. Noise Load

4.33 Radio systems are designed to meet a specified noise performance requirement. The most ef-

fective way to measure the overall noise performance of a radio channel is to noise-load it. Most noise loading test sets make a signal-to-noise type of measurement which is referred to as a noise power ratio (NRP) measurement. See Fig. 66 for an explanation of this method. The NPR is the difference in dB between the average level of the noise signal near the particular baseband test frequency (i.e., noise slot) and the average noise level in the floor of the noise slot. The SCIENTIFIC-ATLANTA test set uses a modification of this method where the noise measurement of the slots is referred to the noise signal power at 1 MHz. If a radio channel has an excessive amount of roll-up or roll-off at a slot frequency, the measurement will be in error. Therefore, for meaningful noise loading results, the baseband response of the channel should be in limits.

4.34 In the Bell System, the noise performance of a transmission system is usually expressed in dBrnc0. For random noise, 0 dBrnc0 is equal to -88 dBm of C-message weighted noise in a 3-kHz bandwidth at the 0 dB transmission level point (TLP). In the SCIENTIFIC-ATLANTA test set, the NPR in dB is converted to dBrnc0 by subtracting the NPR from an appropriate signal value. That value is 71 dBrnc0 for TD(1200), TD(1500)/(45 Mb/s), and TH(1800); and is 67 dBrnc0 for TD(1800) and TH(2400). The 4-dB difference is necessary to take into account the effects of using 4-dB higher transmission levels on the radio line when carrying 1800- and 2400-message circuits on TD and TH-3, respectively.

Example: If the NPR in a TD(1200) measurement is 41 dB, the noise in dBrnc0 is $71 - 41 = 30$ dBrnc0. If the same NPR is measured on a TD(1800) channel, the noise for that channel is $67 - 41 = 26$ dBrnc0.

When making NPR measurements, the SCIENTIFIC-ATLANTA test set is calibrated to indicate dBrnc0 of noise by setting the noise power to 71 dBrnc0 at 1 MHz (a point denoted by a dot on the NPR and tone search paper), or to 67 dBrnc0 at 1 MHz (i.e., to four divisions below the dot), whichever calibration point is applicable for the noise loading measurement being made.

4.35 For analysis of the noise load, the first run should be a standard noise-load run made at the proper drive level. The depth of each slot is a measure of the total noise on the radio channel; i.e., ther-

mal noise, intermodulation noise, and noise due to cochannel and other interferences. The cochannel and interference noises are generally lumped with the thermal noise in this analysis. A second data run is made with the baseband noise transmitter in the tone search (noise off) position. This measurement will now show only the thermal noise (plus the noise due to interferences).

4.36 Analysis of the noise loading test with the thermal noise plot is simple. Should the thermal noise plot intersect the bottom of a specific noise loading slot, the noise in the slot is totally thermal noise. See Fig. 33. When there is exactly a 3-dB difference between the noise loading slot and thermal noise plot, the noise in the slot represents equal amounts of intermodulation and thermal noise. See Fig. 29, 30, and 35. The greater the separation (more than 3 dB) between the noise loading slot and thermal noise plot, the greater the intermodulation noise. See Fig. 29 and 32.

G. Factors That Influence Thermal and Intermodulation Noise

4.37 The thermal noise of a radio channel is influenced by:

(a) Received signal strength:

Transmitter output power

Path loss (distance between stations)

Antenna gains and waveguide losses

Path reflections or obstructions

Fading.

(b) Repeater noise figure:

Common waveguide amplifier

Receiver modulator

IF amplifier

LO drive level

Noise of LO source

Tube-type transmitters.

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- (c) If all slots show high thermal noise, the probable causes are:

- Defective RF or IF amplifier
- Defective waveguide or antenna system
- Low LO level
- Channel in faded condition
- Defective microwave generator
- Low transmitter output
- Cochannel interference.

An improvement in thermal noise performance of 1 dB will be noted for an increase in transmitter power of 1 dB at each transmitter or a 1-dB reduction of repeater noise figure at each repeater, provided the noise performance of the FM terminals are not controlling in making the measurement.

4.38 Some of the major causes of excessive intermodulation noise are:

- (a) EDD (envelope-delay distortion) out of limits:
 - Defective RF or IF amplifier
 - Defective filter, network, or patch cord
 - RF or IF impedance irregularities

Path echoes, waveguide moding, etc.
Channel in a selective fade condition.

- (b) Improper FM terminal deviation.
- (c) High intermodulation at 1248 kHz: May be caused by nonlinearity in FM terminal transmitter.
- (d) High level tones: May be from microwave generators, shifters, test bays, or from commercial TV (channels 3, 4, and 5), or FM or AM broadcast transmitters.
- (e) Lack of a low-pass filter at the output of the main station IF main amplifier (solid-state amplifiers only).
- (f) Oscillations or singing in active circuits.

5. IF TESTS

A. Chart 7—XPD Measurements (Detailed)

5.01 The following apparatus is required:

- 1— SCIENTIFIC-ATLANTA Radio Performance Analyzer
- 1— FM Terminal Transmitter.

STEP

PROCEDURE

Note: The SCIENTIFIC-ATLANTA IF spectrum test is performed to identify low-level tone characteristics of the individual test set before connecting the test set to the radio line.

- 1 Arrange the test apparatus and set the controls as given in Fig. 37.
- 2 On the IF/baseband analyzer:
 - (a) Operate the ZERO REF switch.

Requirement: 60 dB on the digital power meter. Anything other than the correct indication suggests improper attenuator settings.

- (b) Operate the (MODE) MANUAL switch.
- (c) Operate the (IF 70 MHz) ± 35 MHz switch.

STEP	PROCEDURE
	<p>(d) Adjust the COARSE and FINE frequency controls until 70 MHz (070,000) is indicated on the digital frequency meter.</p> <p>(e) Observe and record the digital power meter indication. This indication will be used to calibrate the X-Y recorder.</p>
3	<p>On the X-Y recorder:</p> <p>(a) Insert an IF TEST FORM and a pen of the desired color.</p> <p>(b) Set CHART RELEASE/HOLD switch to HOLD.</p> <p>(c) Set SERVO ON/STANDBY switch to ON.</p> <p>(d) Adjust the X and Y ZERO controls until the pen is centered over the 70-MHz vertical line and a convenient (selected) vertical calibration point that corresponds to the digital power meter indication recorded in Step 2(e). Mark this power, in dBm, on the right-hand scale. Note that the vertical sensitivity of the recorder is 10 dB per inch and that powers greater than the calibration value will be recorded above this value on the paper.</p> <p>Note: For convenience in reading the plotted recording, the Y ZERO control may be adjusted so as to calibrate the right-hand scale in multiples of 10 dB per major (inch) division (i.e., -80, -90, -100, etc. dBm per inch).</p> <p>(e) Manually lower the pen (using the flat metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)</p>
4	<p>On the IF/baseband analyzer:</p> <p>(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)</p> <p>(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the IF spectrum.)</p> <p>Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p>
	<p>Requirement: The 70 \pm35 MHz spectrum shall have no tones greater than -100 dBm. See Fig. 38.</p>
	<p>Detailed Cross-Polarization Discrimination (XPD) Measurements</p>
	<p>Note 1: Cross-polarization discrimination (XPD) expresses the ratio in dB of the power in the desired polarization to the power of the oppositely polarized signal on the immediately adjacent received radio channel.</p>

STEP

PROCEDURE

Note 2: Due to IF filtering, the XPD can only be measured on an individual radio-hop basis.

Note 3: Instructions contained in this section include the use of a baseband-terminated FM transmitter on the channel under test. However, it is acceptable to use the regular facility feed on the channel under test.

5 **Caution: The XPD measurement is an out-of-service measurement.**

Obtain a release on the radio channel identified as the channel under test.

6 Connect a baseband-terminated FM transmitter to the channel under test. (The FM transmitter may be connected at the head end of the switch section or to the distant radio transmitter associated with the radio receiver of the channel under test.)

Note: The proper IF levels must be observed at all times.

7 On the IF/baseband analyzer:

- (a) Connect the IF/baseband analyzer to the released channel-under-test IF preamplifier OUT jack.
- (b) Set the INPUT attenuator for a total of +10.
- (c) Set the REF attenuator for a total of -10.
- (d) Operate the ZERO REF switch.

Requirement: The digital power meter should indicate 0 dB. Anything other than the correct indication suggests an improper attenuator setting in the previous two steps.

- (e) Operate the (MODE) MANUAL switch.
- (f) Operate the (IF 70) ± 25 MHz switch for TD and TH-3 radio systems or the (IF 70) ± 35 MHz switch for the TH-1 radio system.
- (g) Adjust the COARSE and FINE frequency controls until a frequency indication is obtained as shown in Table W.

STEP	PROCEDURE
------	-----------

TABLE W

RADIO SYSTEMS	ERROR FREQUENCY
TD	70 MHz
TH-3	70 MHz
TH-1	74 MHz

- (h) Slowly adjust the frequency controls until the analog power meter indicates a peak (this peaks the analyzer on the terminated FM transmitter).
- (i) It may be necessary to readjust the reference attenuator during tuning to maintain an on-scale indication during peaking. When the peak is located, adjust the reference attenuator for 0 dBm on the -7 through +3 dBm scale.

Note: Due to the narrow filter used (30 kHz) it will be necessary to check the carrier peak point several times during the calibration setup.

Requirement: The digital power meter shall indicate 0 dBm \pm 6 dB. Failure to meet this requirement indicates possible low transmitter power and/or incorrect receiver IF preamplifier gain.

- 8 On the X-Y recorder, set the slide switches as follows:
- (a) PEN RECORD/LIFT to LIFT.
 - (b) SERVO ON/STANDBY to STANDBY.
 - (c) CHART RELEASE/HOLD to RELEASE.
 - (d) LINE ON/OFF to ON.
- 9 On the X-Y recorder, insert an IF TEST FORM and a pen of the desired color.
- 10 On the X-Y recorder, operate the slide switches as follows:
- (a) CHART RELEASE/HOLD to HOLD.
 - (b) SERVO ON/OFF to ON.
 - (c) Adjust the X and Y ZERO controls until the pen is centered over the 70-MHz (for TD and TH-3) or 74-MHz (for TH-1) and 0-dB relative level calibration point, located 3 dB down from the top of the form.

Note: During this calibration procedure, recheck the carrier peak point on the analog power meter.

STEP

PROCEDURE

(d) Manually lower the pen (using the metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)

Cross-Polarization Discrimination (XPD) Scan

11 On the IF/baseband analyzer:

- (a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)
- (b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the IF spectrum.)

Note 1: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.

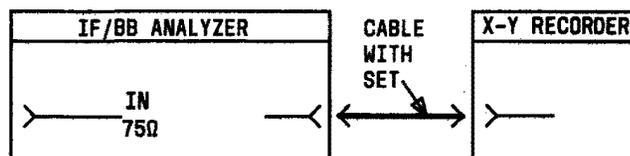
Requirement: The XPD shall be $(30 + L)$ dB or greater for the 4-GHz band and $(25 + L)$ dB or greater for the 6-GHz band where L is the RF selectivity of the receiver at ± 20 MHz (TD) or ± 29.7 MHz (TH) as given in Table X.

TABLE X

RECEIVER	E/W	L, dB
TD-2	1301() FLT	0
	1380() FLT	2
TD-3	1322() FLT	18
	1336() FLT	3
TD-3A		1
TD-3D		2
TH-1		13
TH-3		9

Note 2: Refer to the appropriate adjacent channel XPD frequency chart (Fig. 67 or 68) for proper identification of adjacent channel XPD frequency. See Fig. 39 for TD, Fig. 40 for TH-3, or Fig. 41 for TH-1 XPD plots.

Note 3: When the requirement is not met, the results shall be reported to Transmission Engineering.



INITIAL CONTROL POSITIONS			
IF/BB ANALYZER		X-Y RECORDER	
75Ω INPUT LEVEL -dBm	TERMINATED INPUT -20dB REF -40dB	RECORD/LIFT SEVRO ON/STANDBY CHART HOLD/RELEASE LINE ON/OFF	LIFT STANDBY RELEASE ON RETURN TO CHART

Fig. 37—Test Arrangement for SCIENTIFIC-ATLANTA IF Spectrum Measurements

RADIO CHANNEL NO. S/A TYPE RADIO _____ SWITCH SECTION (From) BACK-TO-BACK (To) _____ E10109
 TYPE TEST IF SPECTRUM SWEEP RANGE 70±35 MHz DATE 1-26-77 TESTER WE

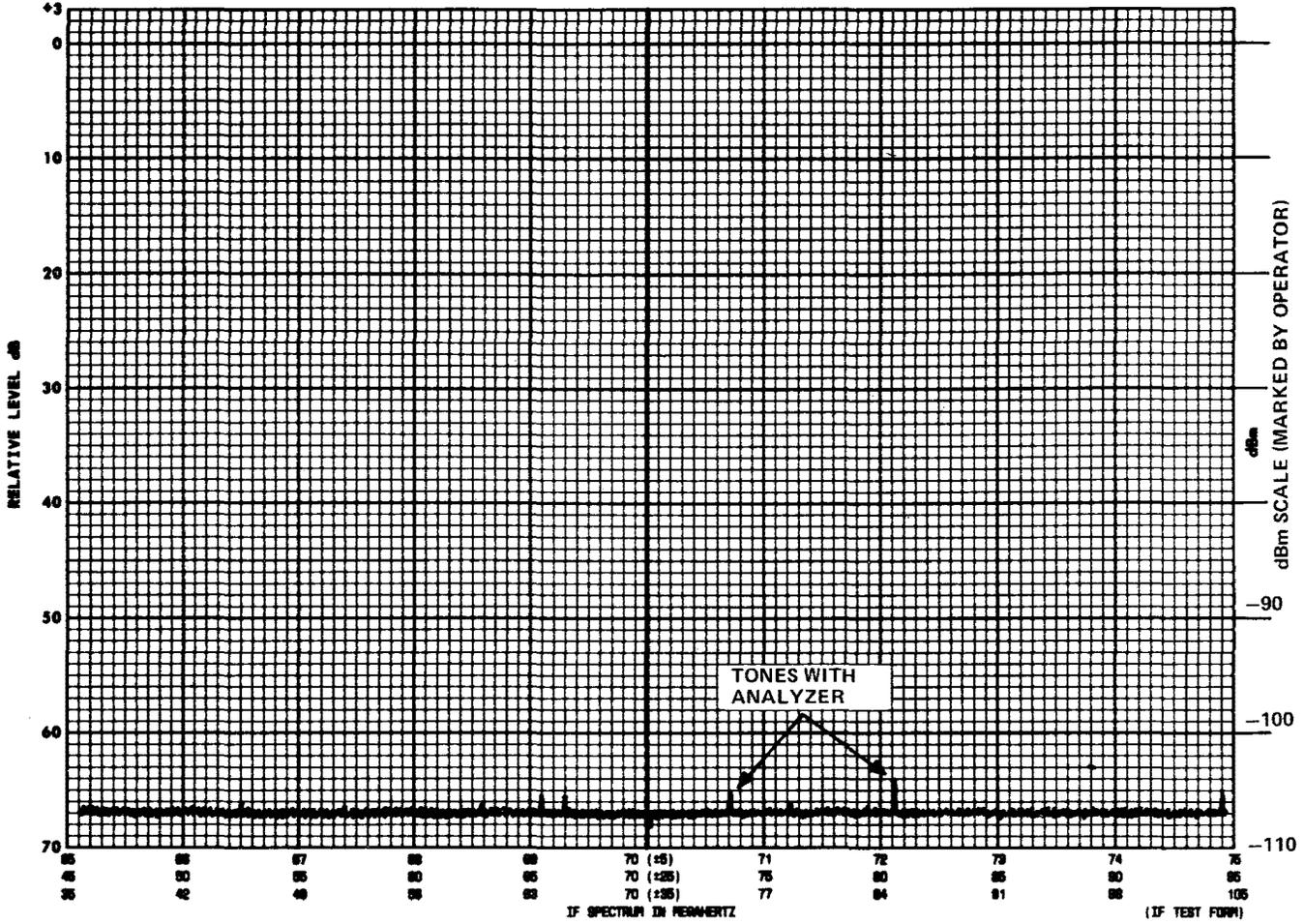


Fig. 38—IF Spectrum Measurement (70 ± 35 MHz)—SCIENTIFIC-ATLANTA Test Set
 Back to Back

RADIO CHANNEL NO. R-207 TYPE RADIO TD SWITCH SECTION (From) OK. CITY (To) NOBLE E10109
 TYPE TEST XPD SWEEP RANGE 70±25 MHz DATE 1-26-77 TESTER WE

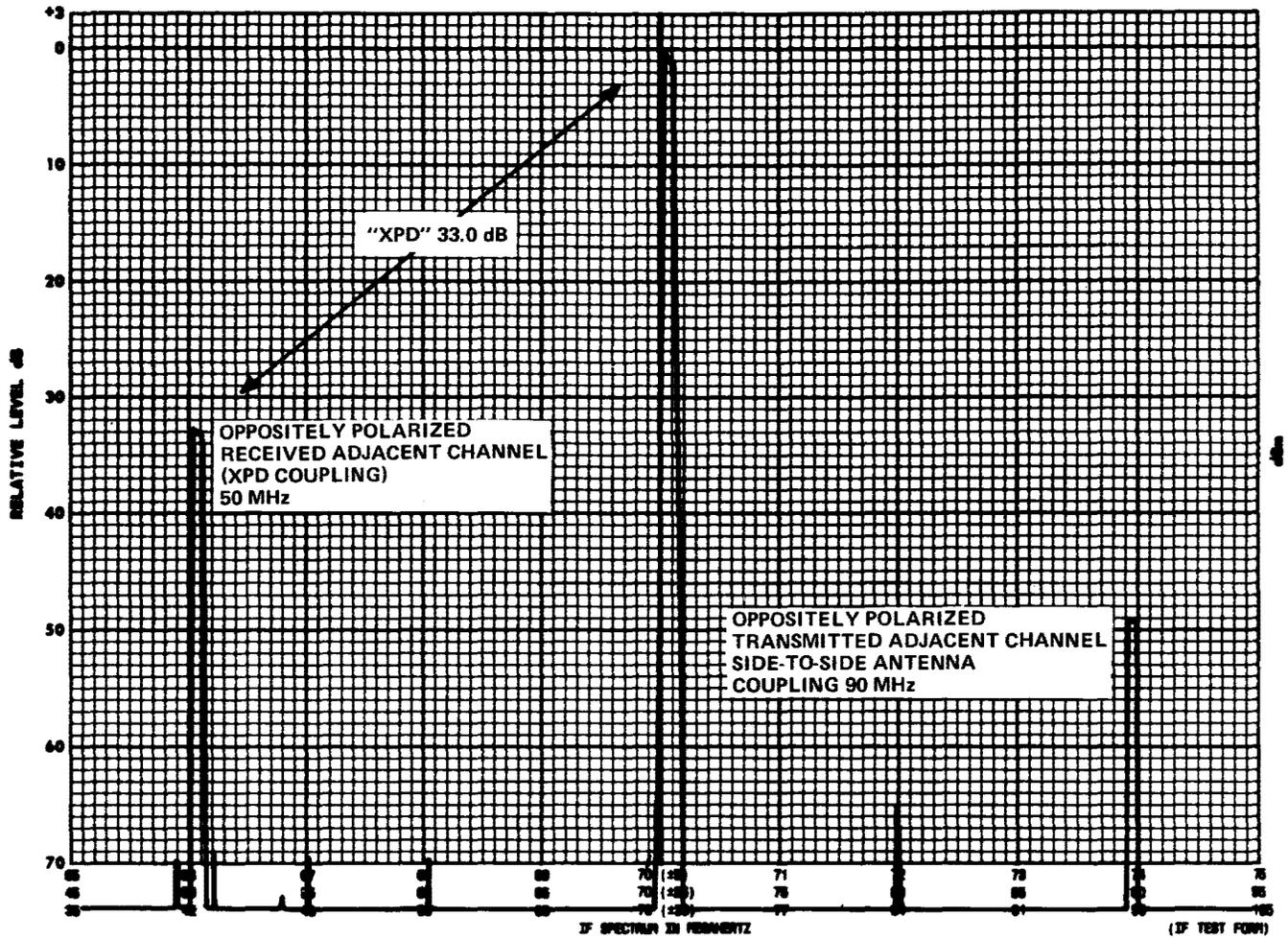


Fig. 39—TD XPD Measurement (70 ±25 MHz)

RADIO CHANNEL NO. R-168 TYPE RADIO TH-3 SWITCH SECTION (From) SENTINEL (To) NOBLE E10109
 TYPE TEST XPD SWEEP RANGE 70±35 MHz DATE 1-26-77 TESTER WE

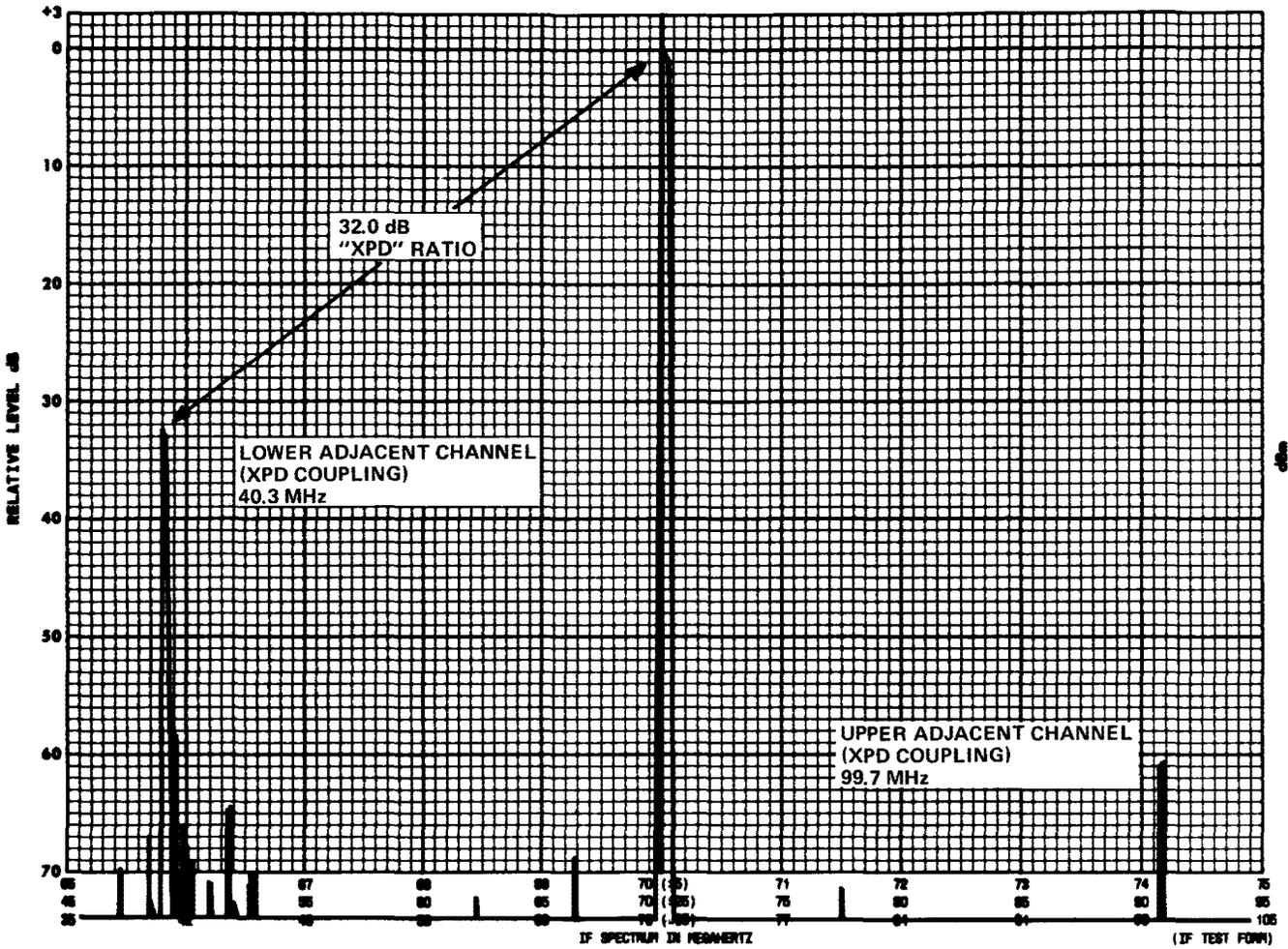


Fig. 40—TH-3 XPD Measurement (70 ±35 MHz)

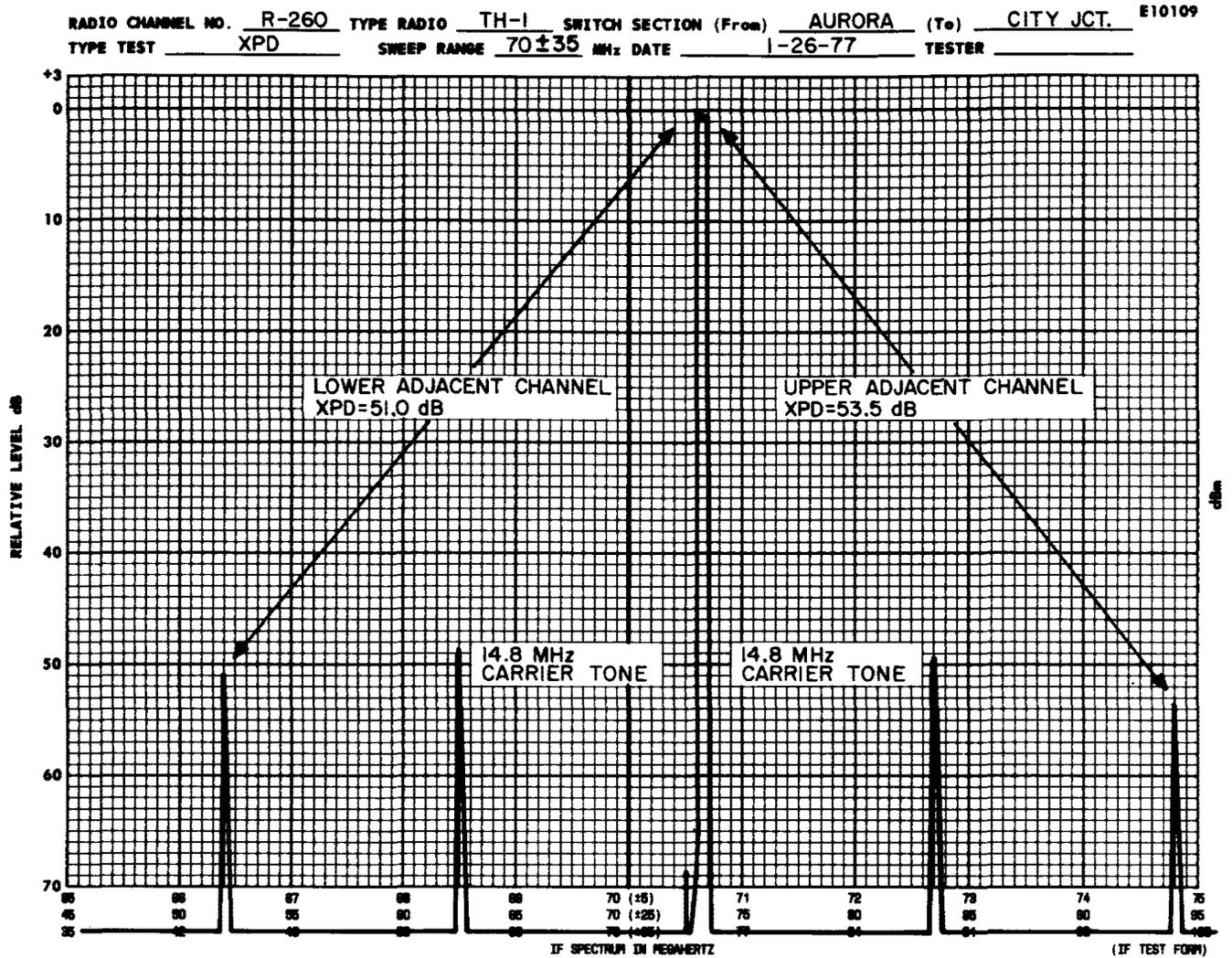


Fig. 41—TH-1 XPD Measurement (70 ± 35 MHz)

B. Chart 8—C/I Measurements (Detailed)

5.02 Carrier-to-interference (C/I) measurements are basic IF spectrum analyzer tests that identify radio frequency interference. In this test, the IF/baseband analyzer is connected to the receiver IF preamplifier output. The C/I measurement also can be made from the protection channel switch bays with equal results. However, for simplicity, since most C/I trouble-isolation activities will occur at auxiliary stations, the one procedure described in this section was selected.

5.03 Cochannel interference (tones) is caused when the receiving antenna picks up another radio

channel operating on the same frequency. Intrasystem cochannel interference can occur on every hop of a radio route because of poor front-to-back ratios of transmitting or receiving antennas. Intersystem interference can be caused by poor side-to-side coupling between antennas at main stations having more than two directions of transmission and therefore, having more than one 2-way receiving radio channel operating on the same frequency.

5.04 Reflections from buildings and other structures are generally the main cause of cochannel interference being out of limits. Adjacent or parallel radio routes also can cause cochannel interferences due to poor separation of these routes, or

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again, reflections. Cochannel interferences normally do not cause problems until the regular channel fades or fails; then problems with proper operation of the protection channel switching system or with excessive noise and interference to message service may occur.

5.05 The C/I measurements described in this section are normally made at the receiving end of the switch section. However, they can be performed on individual radio hops if desired.

5.06 The following apparatus is required:

- 1— SCIENTIFIC-ATLANTA Radio Performance Analyzer
- 1— FM Terminal Transmitter (carrier spreader, if provided, set to OFF)
- or
- 1— SCIENTIFIC-ATLANTA 4682 IF/Baseband Test Oscillator.

STEP	PROCEDURE
1	Caution: The C/I measurement is an out-of-service measurement.
	Note: To avoid the possibility of cochannel interference, channels having the same number in opposite directions should not be tested at the same time.
2	Obtain a release on the radio channel identified as the channel under test.
3	If using a 4682 IF/baseband oscillator, proceed to Step 5.
4	Using a frequency counter, adjust the frequency control on the test FM terminal until the FM transmitter output frequency is 70.300 MHz for 70-MHz radio systems (TD and TH-3), or 74.430 MHz for 74-MHz radio systems (TH-1). Proceed to Step 7.
5	On the Model 4682 IF/baseband test oscillator: <ul style="list-style-type: none">(a) Set the LEVEL control as required to match the input of the channel under test.(b) Set the FREQ MHz control +0.3 MHz above channel center frequency (70.3 MHz for TD or TH-3 or 74.43 MHz for TH-1).
6	Caution: Make certain the terminated FM transmitter or the 4682 oscillator is removed before restoring protection switching to normal. Failure to do so will result in a service interruption.
	Connect the test equipment to the channel under test as given in Fig. 69, option A for the 4682 oscillator, or option B for the terminated FMT.
7	Connect the IF/baseband analyzer to the channel under test and set the controls as given in Fig. 69.
8	On the IF baseband analyzer: <ul style="list-style-type: none">(a) Operate the ZERO REF switch. (The digital power meter should indicate 0 dB. Anything other than the correct indication suggests an improper attenuator setting.)

STEP

PROCEDURE

- (b) Operate the (MODE) MANUAL switch.
- (c) Operate the (IF 70) ± 5 MHz switch.
- (d) Adjust the COARSE and FINE frequency controls until a frequency indication is obtained as shown in Table Y.

TABLE Y

RADIO SYSTEMS	ADJUSTED CARRIER FREQUENCY
TD	70.300 MHz ± 25 kHz
TH-3	70.300 MHz ± 25 kHz
TH-1	74.430 MHz ± 25 kHz

- (e) Slowly adjust the frequency controls until the analog power meter indicates a peak. (This peaks the analyzer on the adjusted carrier frequency.)
- (f) It may be necessary to readjust the reference attenuator during tuning to maintain an on-scale indication during peaking. When the peak is located, adjust the reference attenuator for 0 dBm on the +3 through -7 dBm scale.

Requirement: The digital power meter shall indicate 0 dBm ± 6 dB.

Failure to meet this requirement indicates possible low transmitter power and/or incorrect receiver preamplifier gain.

Note: Due to the narrow filter used (30 kHz), it will be necessary for the operator to check the carrier peak point several times during calibration setup.

- 9 On the X-Y recorder, insert an IF TEST FORM and a pen of the desired color.
- 10 Operate the X-Y recorder slide switches as follows:
 - (a) CHART RELEASE/HOLD to HOLD.
 - (b) SERVO ON/STANDBY to ON.
- 11 On the X-Y recorder:
 - (a) Adjust the X and Y ZERO controls until the pen is centered over the 70.300 MHz or 74.430 MHz and 0-dB relative level calibration point.

Note: During this calibration procedure, recheck the carrier peak point on the analog power meter.

STEP	PROCEDURE
	<p>(b) Manually lower the pen (using the metal bar on top of the carriage bar) to verify the exact contact point. (Small adjustments of the X-Y controls may be necessary to arrive at the desired calibration point.)</p>
	<p>Carrier-to-Interference (C/I) Scan</p>
12	<p>On the IF/baseband analyzer:</p> <p>(a) Operate the (MODE) AUTO switch. (The pen shall travel to the left-hand side of the test form.)</p> <p>(b) Operate the (MODE) RECORD switch. (The pen shall be down and the X-Y recorder plotting the characteristic shape of the IF spectrum. With current frequency tolerances, interference will appear as a tone or tones offset by 0-500 kHz from the 70.3 or 74.43 carrier.)</p> <p>Note: The pen will automatically return to the far left position when the scan is completed. Keep hands off the recorder until the auto scan cycle is completed. However, the operator may cancel the auto scan cycle at any point by operating the RECORD switch on the IF/baseband analyzer.</p> <p>(c) Operate the (MODE) MANUAL switch and manually tune to the highest level interference tone (between 0-500 kHz offset from carrier).</p> <p>(d) Operate the (MODE) RECORD switch and record the peak level of this tone for a period of 5 minutes. The C/I ratio for this channel is the difference in level between the peak value of the carrier and the peak value of the highest level interference tones as recorded during a 5-minute period.</p> <p>(e) See Fig. 42 for TD, Fig. 43 for TH-3, and Fig. 44 for TH-1.</p> <p>Requirement 1: Channels with a C/I ratio of 62 dB or larger are satisfactory.</p> <p>Requirement 2: Channels with a C/I ratio of 59 to 61 dB should be noted and a record should be kept with the switch-section test results for those channels.</p> <p>Requirement 3: Channels with a C/I ratio of less than 59 dB (i.e., 58, 57, etc.), should be tested further to determine the effect of the interference as follows:</p> <p>(1) Arrangements should be made to fade the channel, with the low C/I, on the first hop and the last hop in the switch section under test. This fade may be accomplished using the procedures in the fade margin practice, Section 422-300-512.</p> <p>(2) Each of these two hops should be faded, one hop at a time, until the switch point is reached. At this point, the 9-MHz noise should be measured to ensure that the initiator is set at the proper level as outlined in the fade margin practices. With the channel faded to the switch point, the C/I test should be rerun.</p> <p>(3) If the hop which is faded is the hop suffering interference, the C/I ratio faded will be much less than the C/I ratio unfaded. If both the first and last hops in the section have</p>

STEP

PROCEDURE

been faded without a resulting decrease in C/I ratio, Transmission Engineering should be consulted to determine additional tests to be conducted.

Requirement 4: With the channel faded to the switch point, the C/I ratio should be no less than the limits shown in Table Z.

TABLE Z

LOADING ON CHANNEL UNDER TEST	FADED C/I LIMIT
TD 1200 Circuits or less	14 dB
TD 1200 Circuits or less + DUV	18 dB
TD 1500 Circuits	16 dB
TD 1500 Circuits + DUV	18 dB
TD 1800 Circuits	18 dB
TD 1800 Circuits + DUV	18 dB
TH 1800 Circuits	16 dB
TH 1800 Circuits + DUV	18 dB
TH-3 2400 Circuits	14 dB
TH-3 2400 Circuits + DUV	18 dB

Each channel failing to meet the above requirements has interference exposures which could affect service during fading conditions. These channels should be reported to the Transmission Engineer including:

- (1) All of the original SCIENTIFIC-ATLANTA plots made while sectionalizing the trouble
- (2) The results of any tests made after consulting with the Transmission Engineer
- (3) A narrative of the steps taken to sectionalize the trouble.

- 13 When C/I tests are completed, readjust the FM transmitter at the transmit end for proper output frequency.
- 14 Restore the channel under test to normal.
- 15 Make certain the terminated FM transmitter or the 4682 oscillator is removed and restore the protection switching to normal.

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RADIO CHANNEL NO. R-207 TYPE RADIO TD SWITCH SECTION (From) OK. CITY (To) NOBLE E10109
 TYPE TEST C/I SWEEP RANGE 70 ± 5 MHz DATE 1-26-77 TESTER WE

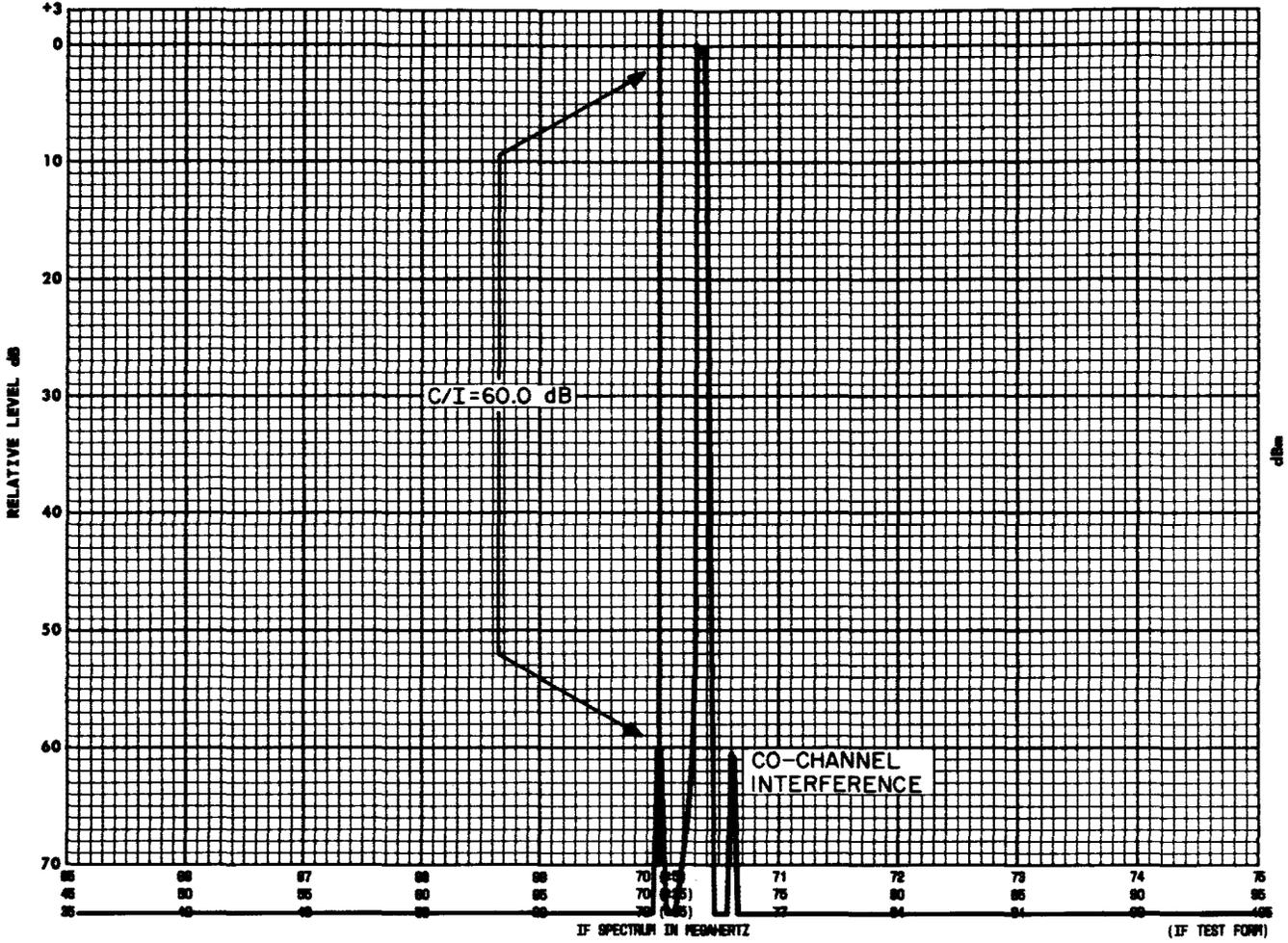


Fig. 42—TD C/I Measurement (70 ± 5 MHz)

RADIO CHANNEL NO. R-168 TYPE RADIO TH-3 SWITCH SECTION (From) SENTINEL (To) NOBLE E10109
 TYPE TEST C/I SWEEP RANGE 70±5 MHz DATE 1-26-77 TESTER WE

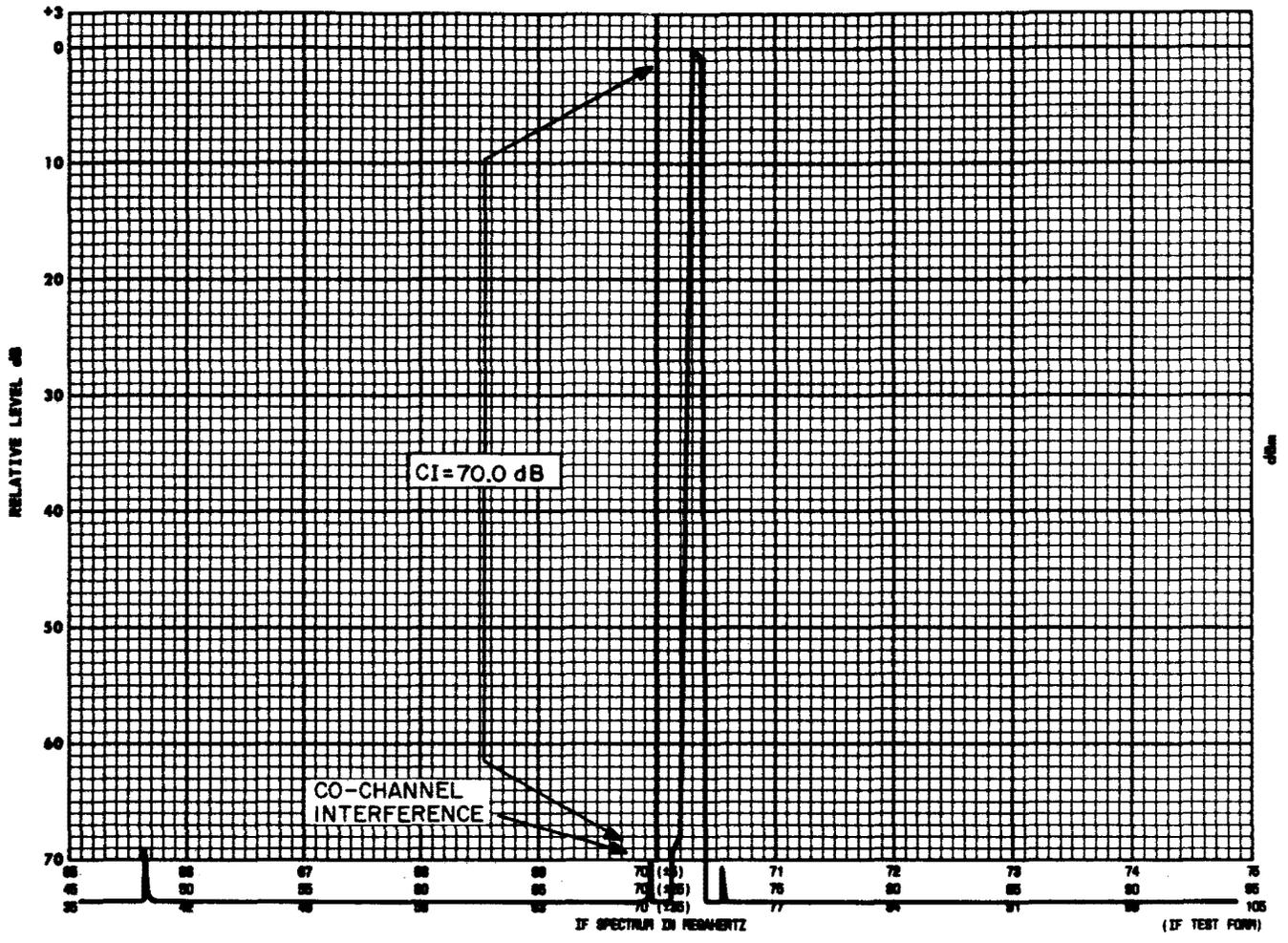
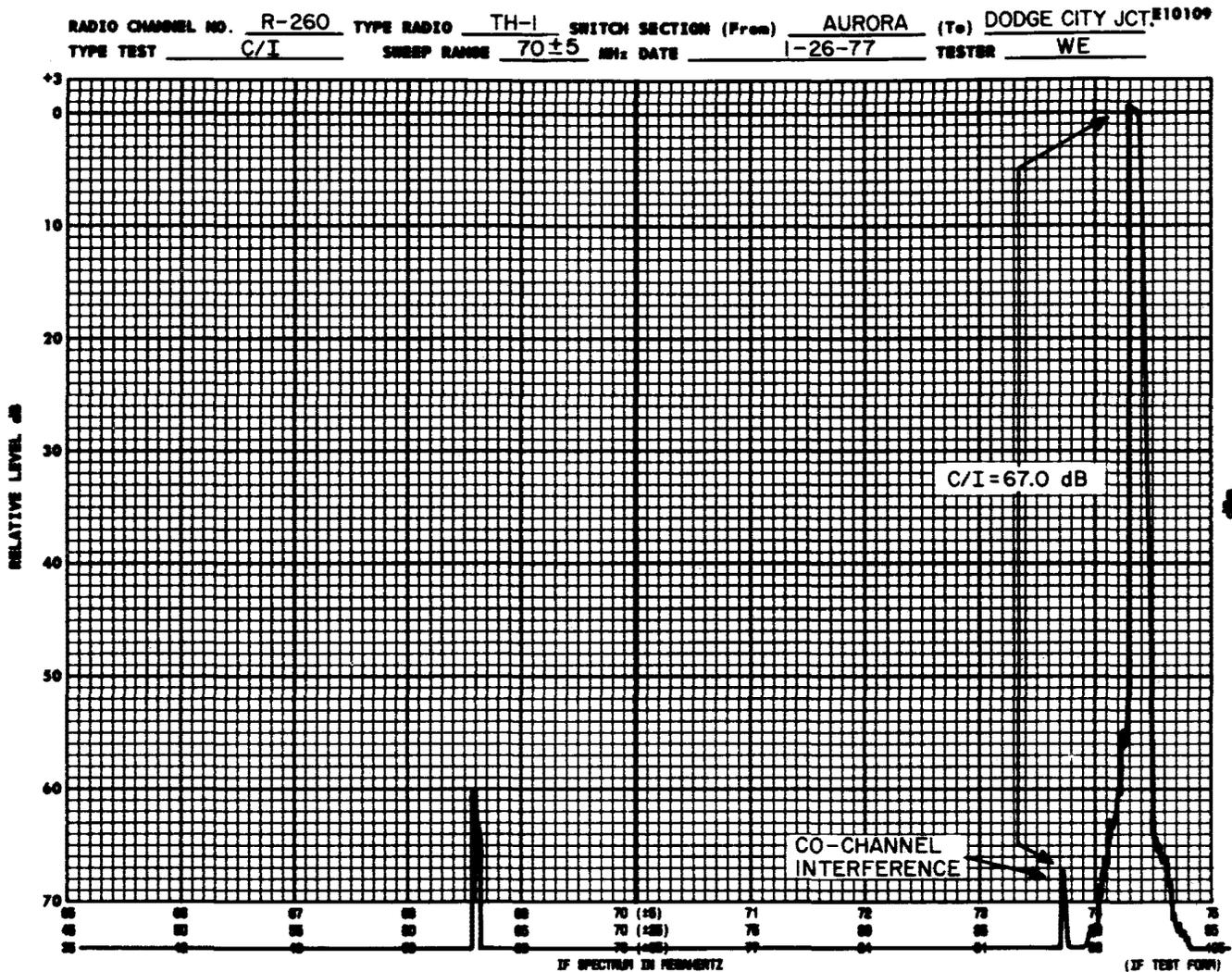


Fig. 43—TH-3 C/I Measurement (70 ± 5 MHz)

Fig. 44—TH-1 C/I Measurement (70 ± 5 MHz)

C. Chart 9—TH-1 Second-Order Sideband Asymmetry Measurements

5.07 A measurement of the relative amplitude of the TH-1 radio second-order sideband is necessary to observe the effects of equalization adjustments which are made to reduce system intermodulation noise. This noise results from certain delay distortions in combination with AM/PM conversions which occur principally in the radio transmitter. The noise caused by these effects is reduced by adding various combinations of IF cubic-amplitude equalization in the form of 981A, B, C, D, or F plug-in equalizers in the ED-52510 amplitude equalizer panel located in the TH-1 mop-up bay. A

predictable effect of this distortion is a shift in the relative amplitude of the FM second-order sidebands. This is measured at IF by observing the relative amplitude of the ± 10 MHz second-order sidebands of a 5-MHz baseband tone. The normal unequalized difference between these sidebands varies between 0 and ± 2 dB. The equalization required is determined by measuring the sideband asymmetry of the FM terminal transmitter alone, the sideband asymmetry of the combined FM terminal transmitter and radio system, and then subtracting the distortion of the FM transmitter to obtain the asymmetry of just the radio channel. Equalization is accomplished when the difference between the second-order sidebands, due to just the radio system, has been reduced to less

than 0.5 dB. This corresponds to minimum system intermodulation noise from this source.

5.08 The following apparatus is required:

1— 4B or 3B FM Terminal Transmitter

1— WANDEL-GOLTERMANN AT-462 Oscillator or equivalent 5-MHz signal source

Transmitting End

1— SCIENTIFIC-ATLANTA Radio Performance Analyzer

Receiving End

1— SCIENTIFIC-ATLANTA Radio Performance Analyzer.

STEP	PROCEDURE
Transmitting End	
1	Arrange the test apparatus and set the controls as shown in Fig. 45A, option A.
2	Adjust the oscillator to 5 MHz at an output of -16 dBm.
3	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none"> <li data-bbox="423 995 824 1020">(a) Set the REF attenuator to 0. <li data-bbox="423 1054 954 1079">(b) Operate the (MODE) MANUAL switch. <li data-bbox="423 1113 987 1138">(c) Operate the (IF 70 MHz) ± 25 MHz switch. <li data-bbox="423 1171 1539 1234">(d) Adjust the COARSE and FINE frequency controls until 74.1 MHz (074.100) is indicated on the digital frequency meter.
4	<p>On the X-Y recorder:</p> <ul style="list-style-type: none"> <li data-bbox="423 1325 1170 1350">(a) Insert an IF TEST FORM and a pen of the desired color. <li data-bbox="423 1383 1117 1409">(b) Set the CHART RELEASE/HOLD switch to HOLD. <li data-bbox="423 1442 1029 1467">(c) Set the SERVO ON/STANDBY switch to ON.
5	<p>On the IF/baseband analyzer:</p> <ul style="list-style-type: none"> <li data-bbox="423 1562 1539 1654">(a) Set the INPUT attenuator and the COARSE and FINE frequency controls to obtain a peak frequency indication of 0 dB at 74.1 MHz. (An adjustment of the recorder X-Y ZERO controls may be necessary.) <li data-bbox="423 1688 911 1713">(b) Operate the (MODE) AUTO switch. <li data-bbox="423 1747 834 1772">(c) Operate the RECORD switch.
6	The resultant is an IF spectrum plot of the 74.1-MHz IF carrier and its first- (74.1 ± 5 MHz) and second- (74.1 ± 10 MHz) order sidebands.

STEP	PROCEDURE
7	From the plot, extract the difference (dB) between the two (74 ±10 MHz) second-order sidebands to the nearest 0.5 dB. If the amplitude of the lower (74.1 -10 MHz) sideband is greater, assign a negative (-) sign to the quantity. If the amplitude of the upper (74.1 +10 MHz) sideband is greater, assign a positive (+) sign to the quantity. Record the number and pass it along to the receiving end so that it can be subtracted from the overall route measurement.
8	Connect the oscillator and terminal transmitter, depending on the test access point being used, as shown in Fig. 45A, option B.
	Receiving End
9	Arrange the test apparatus, depending on the test access point and set the controls as shown in Fig. 45B.
10	On the IF/baseband analyzer: <ul style="list-style-type: none"><li data-bbox="293 890 691 911">(a) Set the REF attenuator to 0.<li data-bbox="293 949 821 970">(b) Operate the (MODE) MANUAL switch.<li data-bbox="293 1008 854 1029">(c) Operate the (IF 70 MHz) ±25 MHz switch.<li data-bbox="293 1066 1406 1129">(d) Adjust the COARSE and FINE frequency controls until 74.1 MHz (074.100) is indicated on the digital frequency meter.
11	On the X-Y recorder: <ul style="list-style-type: none"><li data-bbox="293 1226 1032 1247">(a) Insert an IF TEST FORM and a pen of the desired color.<li data-bbox="293 1285 984 1306">(b) Set the CHART RELEASE/HOLD switch to HOLD.<li data-bbox="293 1344 894 1365">(c) Set the SERVO ON/STANDBY switch to ON.
12	On the IF/baseband analyzer: <ul style="list-style-type: none"><li data-bbox="293 1474 1406 1562">(a) Set the INPUT attenuator and the COARSE and FINE frequency controls to obtain a peak frequency indication of 0 dB at 74.1 MHz. (An adjustment of the recorder X-Y ZERO controls may be necessary.)<li data-bbox="293 1600 773 1621">(b) Operate the (MODE) AUTO switch.<li data-bbox="293 1659 699 1680">(c) Operate the RECORD switch.
13	The resultant is an IF spectrum plot of the 74.1MHz IF carrier and its first- (74.1 ±5 MHz) and second- (74.1 ±10 MHz) order sidebands.
14	From the plot, extract the difference (dB) between the two (74.1 ±10 MHz) second-order sidebands to the nearest 0.5 dB. If the amplitude of the lower (74.1 -10 MHz) sideband is greater,

STEP

PROCEDURE

assign a negative (-) sign to the quantity. If the amplitude of the upper (74.1 +10 MHz) sideband is greater, assign a positive (+) sign to the quantity. Record the number and algebraically subtract from it the number received from the transmitting station.

Example:

	RADIO LINE NO.			
	#1	#2	#3	#4
Overall Meas.	+1	0	-1	-2
Trans. End Meas.	+0.5	+0.5	+0.5	+0.5
Computed Radio Line	+0.5	-0.5	-1.5	-2.5

Note: Assumes same FMT is used for all tests.

Requirement: The computed radio line second-order sideband difference shall not exceed ± 0.5 dB.

If the requirement is met, this test is completed. If the requirement is not met and the sign of the computed radio line sideband asymmetry is:

- (a) Positive and out of limits, add combinations of 981C, D, and F.
- (b) Negative and out of limits, add combinations of 981A, B, and F equalizers.

Note 1: In either case, the 981-type equalizers are installed in combinations in positions 4 and 6 of the associated ED-52510 amplitude equalizer panel until the computed difference between the ± 10 MHz sidebands is less than 0.5 dB.

Note 2: The 981A and B equalizers have a +1.0 and +0.5 dB equalization shape. The 981C and D equalizers have a -0.5 and -1.0 dB shape. Do not intermix 981-type equalizers having + and - shapes. Always use equalizers with the same sign or mix with the 981F equalizer, which is a 10-dB pad without shape, and is used to maintain proper level in the equalizer panel when only one equalizer is required.

Note 3: If the switch section is to be noise-loaded at this time, and the transmit end (FM terminal transmitter) exhibits ± 0.5 dB or greater difference between its second-order sidebands, it may then be desirable to temporarily change the 981-type equalizers to reduce the overall (FM terminal transmitter plus radio channel) measurement to ± 0.5 dB in order to reduce the intermodulation noise for this measurement. After the noise-load measurement is complete, the 981-type equalization should be changed back to that which was determined to be needed for the radio line alone.

SECTION 422-210-500

6. ABBREVIATED TEST PROCEDURES

6.01 Figures 70 through 77 are the abbreviated forms of Charts 1 through 8.

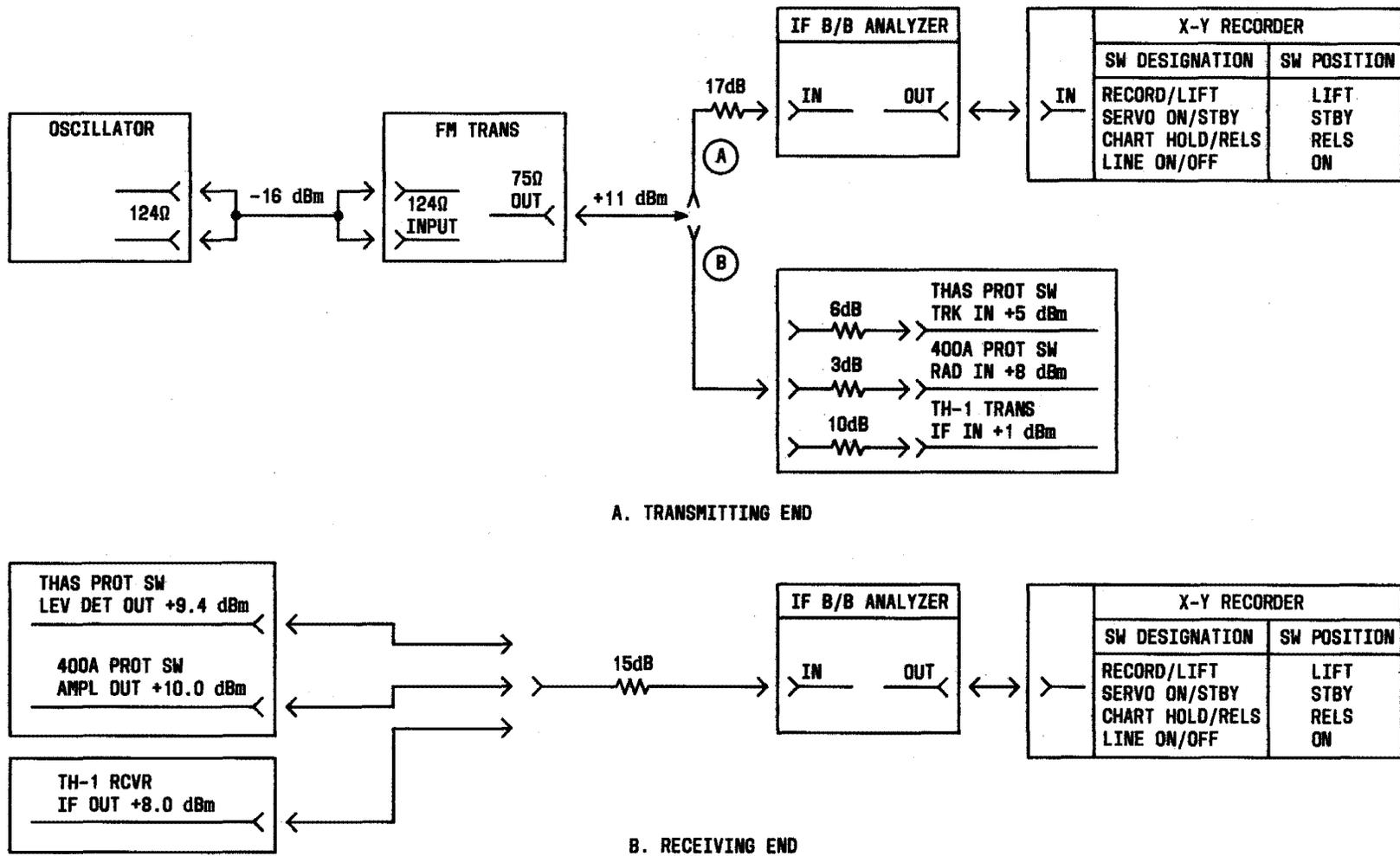


Fig. 45—Test Arrangement for Second-Order Sideband Asymmetry

WORK SHEET — SWITCH SECTION NOISE REQUIREMENTS

NUMBER OF STATIONS	RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
		dBm	10^{-15} WATTS	dBrc0	pWc0
1st HOP	-26	-101.5	71	18.5	71
2nd HOP	-28	-102.0	63	18.5	71
3rd HOP	-24	-100.5	89	18.0	63
4th HOP					
5th HOP					
6th HOP					
7th HOP					
8th HOP					
9th HOP					
FM TERMINALS	4A	-108.0	16	18.0	63
MISC					
TOTAL			239		268
REQUIREMENT		-96.2*		24.2†	

Fig. 46—Work Sheet—Switch-Section Noise Requirements—Example—TD(1200) With 652A and 4A FM Terminal

WORK SHEET - SWITCH SECTION NOISE REQUIREMENTS

NUMBER OF STATIONS	RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
		dBm	10^{-15} WATTS	dBrc0	pWc0
1st HOP					
2nd HOP					
3rd HOP					
4th HOP					
5th HOP					
6th HOP					
7th HOP					
8th HOP					
9th HOP					
FM TERMINALS					
MISC					
TOTAL					
REQUIREMENT					

Fig. 47—Work Sheet—Switch-Section Noise Requirements

**OVERALL SWITCH-SECTION TESTS
FM TERMINALS — NOISE CONTRIBUTION**

RADIO SYSTEM — LOADING TYPE OF FM TERMINAL	THERMAL NOISE		NOISE LOAD	
	dBm	10^{-15} WATTS	dBmnc0	pWc0
TD-1200 3A 4A	-102.0 -108.0	63 16	21.0 18.0	126 63
TD-1500 3A 4A	-102.0 -108.0	63 16	19.0 18.0	79 63
TD-1800 4A	-108.0	16	16.0	40
TH-1800 4A 4B	-108.0 -108.0	16 16	19.0 19.0	79 79
TH-2400 4A	-108.0	16	21.0	126

Fig. 48—FM Terminals—Noise Contribution Table

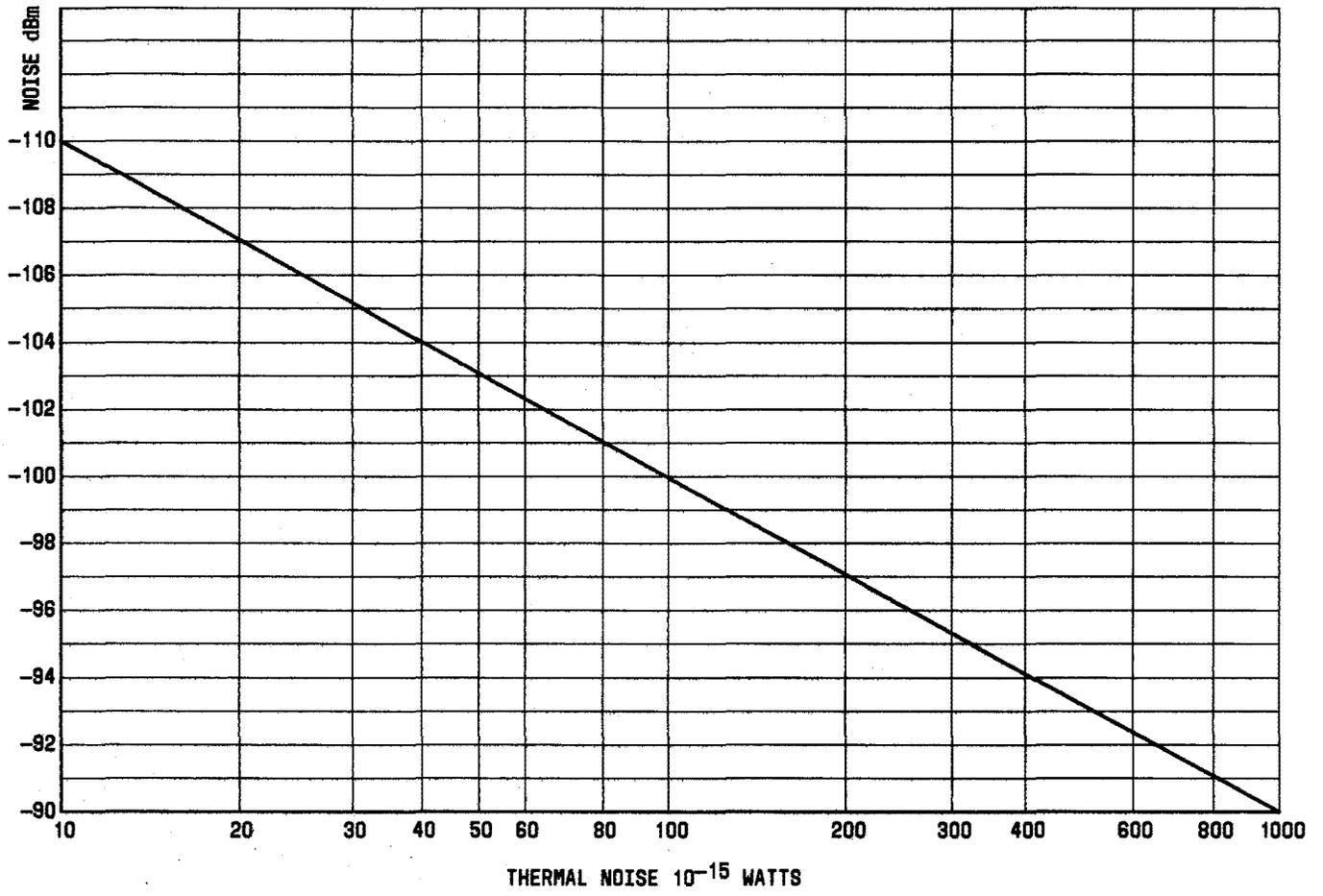


Fig. 49—Thermal Noise Conversion Chart

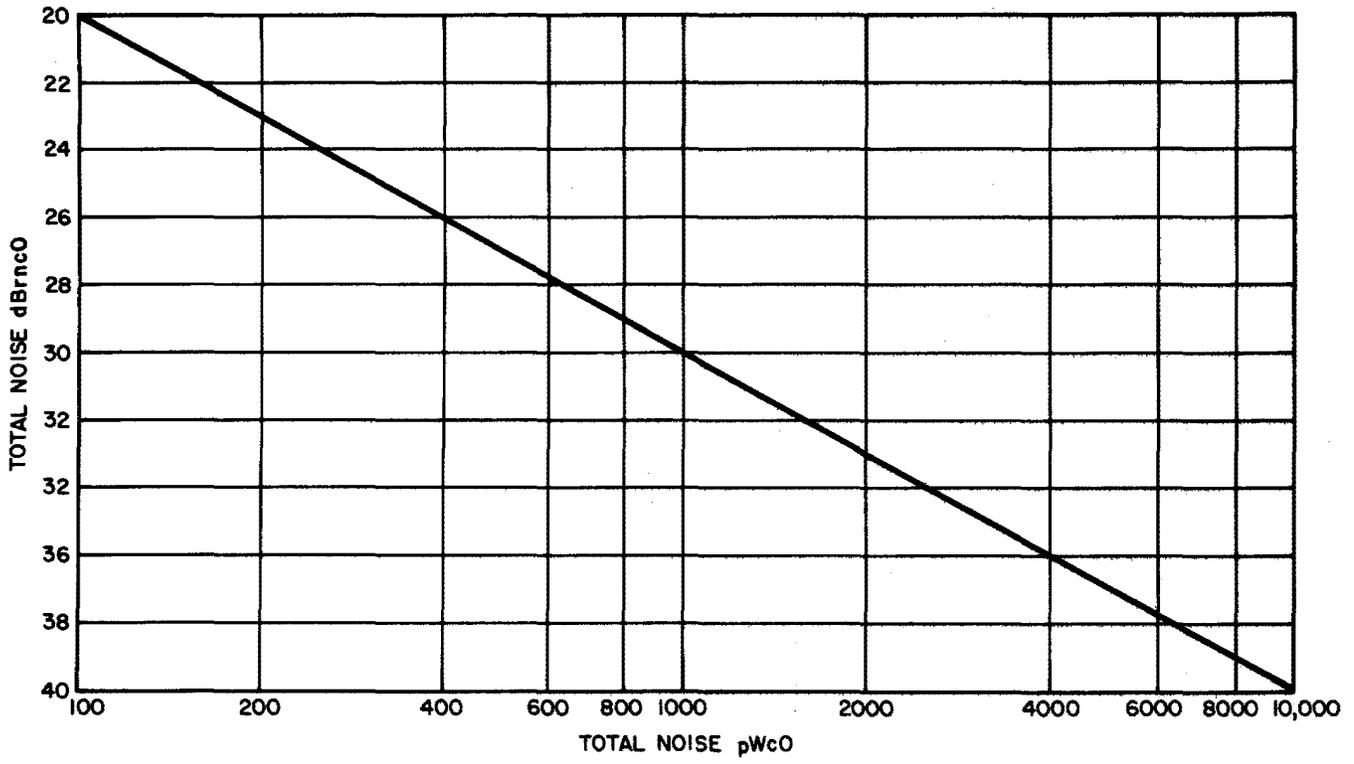


Fig. 50—Noise Load Conversion Chart

WORK SHEET — SWITCH SECTION NOISE REQUIREMENTS

NUMBER OF STATIONS	RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
		dBm	10^{-15} WATTS	dB _{rnc0}	pW _{c0}
1st HOP	-27	-105.0	32	20.5	112
2nd HOP	-28	-105.0	32	20.5	112
3rd HOP	-25	-105.0	32	19.5	89
4th HOP					
5th HOP					
6th HOP					
7th HOP					
8th HOP					
9th HOP					
FM TERMINALS	3A	-102.0	63	19.0	79
MISC					
TOTAL			159		392
REQUIREMENT		-98.0*		25.9†	

Fig. 51—Work Sheet—Switch-Section Noise Requirements—Example—TD(1500)/(45 Mb/s) With 652A and 3A FM Terminal

WORK SHEET - SWITCH SECTION NOISE REQUIREMENTS

NUMBER OF STATIONS	RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
		dBm	10^{-15} WATTS	dB _{rnc0}	pW _{c0}
1st HOP	-26	-107.0	20	20.0	100
2nd HOP	-28	-106.0	25	20.5	112
3rd HOP	-24	-107.0	20	19.5	89
4th HOP					
5th HOP					
6th HOP					
7th HOP					
8th HOP					
9th HOP					
FM TERMINALS	4A	-108.0	16	16.0	40
MISC					
TOTAL			81		341
REQUIREMENT		-101.0		25.4	

Fig. 52—Work Sheet—Switch-Section Noise Requirements—Example—TD(1800) With 4A FM Terminal

WORK SHEET — SWITCH SECTION NOISE REQUIREMENTS

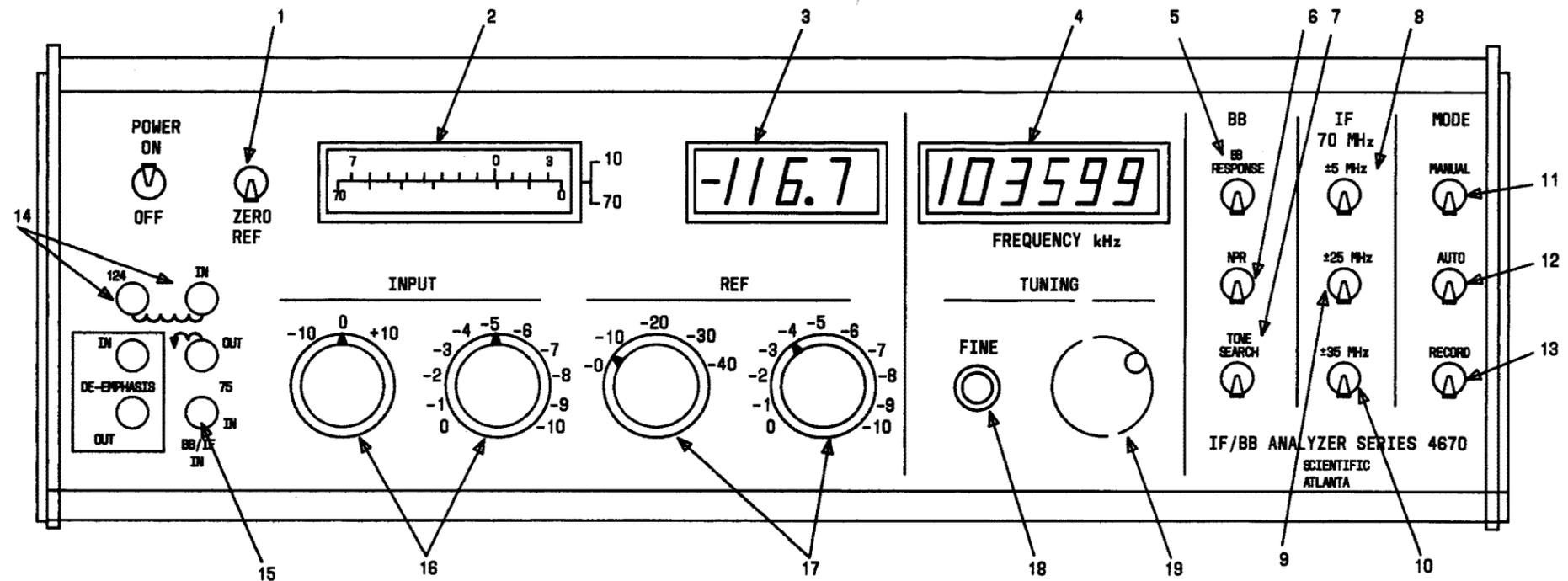
NUMBER OF STATIONS	RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
		dBm	10^{-15} WATTS	dBrc0	pWc0
1st HOP	-22	-104.5	36	19.5	89
2nd HOP	-23	-104.0	40	20.0	100
3rd HOP	-25	-102.5	56	21.0	126
4th HOP					
5th HOP					
6th HOP					
7th HOP					
8th HOP					
9th HOP					
FM TERMINALS	4B	-108.0	16	19.0	79
MISC					
TOTAL			148		394
REQUIREMENT		-98.4		25.9	

Fig. 53—Work Sheet—Switch-Section Noise Requirements—Example—TH-1(1800)

WORK SHEET — SWITCH SECTION NOISE REQUIREMENTS

NUMBER OF STATIONS	RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
		dBm	10^{-15} WATTS	dBrc0	pWc0
1st HOP	-24	-103.0	50	19.5	89
2nd HOP	-26	-101.5	71	21.0	126
3rd HOP	-28	-99.5	112	22.0	159
4th HOP					
5th HOP					
6th HOP					
7th HOP					
8th HOP					
9th HOP					
FM TERMINALS	4A	-108.0	16	21.0	126
MISC					
TOTAL			249		500
REQUIREMENT		-96.1		27.0	

Fig. 54—Work Sheet—Switch-Section Noise Requirements—Example—TH-3(1800) and (2400)



1. ZERO REF - CONTROLS THE DIGITAL DISPLAY LEVEL METER.
2. LEVEL - dB_m - THE ANALOG READOUT OF INPUT LEVEL. +3 TO -7 dB_m IN BB RESPONSE, 0 TO -70 dB_m ALL OTHER OPERATIONS.
3. LEVEL - dB_m - THE DIGITAL DISPLAY SHOWS THE SUM OF THE INPUT AND REF ATTENUATOR INDICATIONS IN ONE POSITION (ZERO REF SWITCH DEPRESSED MOMENTARILY) AND THE SUM OF THE ANALOG METER AND THE ATTENUATOR INDICATIONS IN THE NORMAL SWITCH CONDITION. FLASHING DECIMALS NOTE "SYSTEM OVERLOAD".
4. FREQUENCY - kHz - THE DIGITAL DISPLAY METER INDICATES FREQUENCY FOR BOTH BB AND IF MODES. FLASHING DECIMALS NOTE "OUT OF RANGE".
5. BB RESPONSE - MOMENTARY OPERATION FOR THE BB RESPONSE TEST
6. NPR - MOMENTARY OPERATION FOR THE NPR TEST
7. TONE SEARCH - MOMENTARY OPERATION FOR THE THERMAL NOISE AND SPURIOUS TONE TEST
8. ±5 MHz - SELECTS AN IF SCAN RANGE OF FROM 65 TO 75 MHz
9. ±25 MHz - SELECTS AN IF SCAN RANGE OF FROM 45 TO 95 MHz
10. ±35 MHz - SELECTS AN IF SCAN RANGE OF FROM 35 TO 105 MHz
11. MANUAL - MOMENTARY OPERATION FOR THE MANUAL FREQUENCY SCAN
12. AUTO - MOMENTARY OPERATION FOR THE AUTOMATIC FREQUENCY SCAN
13. RECORD - PROVIDES 1. PEN DOWN, PEN UP, CONDITION
2. START SIGNAL FOR AUTO SCAN CONDITION
14. 124Ω IN - 124 ohm BALANCED INPUT. NEED ONE SHORTING PLUG WITHOUT DE-EMPHASIS NETWORK, 2 SHORTING PLUGS WITH DE-EMPHASIS NETWORK
15. 75Ω IN - IF/BB ANALYZER 75 ohm UNBALANCED INPUT
16. INPUT - INPUT ATTENUATORS FOR ANALYZER CONNECTION, +10 dB TO -20 dB INPUT LEVEL
17. REF - ATTENUATOR FOR POSITIONING THE ANALOG METER AND RECORDER FOR 0 dB (FULL SCALE). TOTAL RANGE = 50 dB
18. FINE - A FINE TUNING FREQUENCY ADJUSTMENT
19. TUNING - COARSE TUNING FOR FREQUENCY CHANGE IN THE MANUAL MODE

Fig. 55—IF/Baseband Analyzer—Series 4670—Front Panel Controls

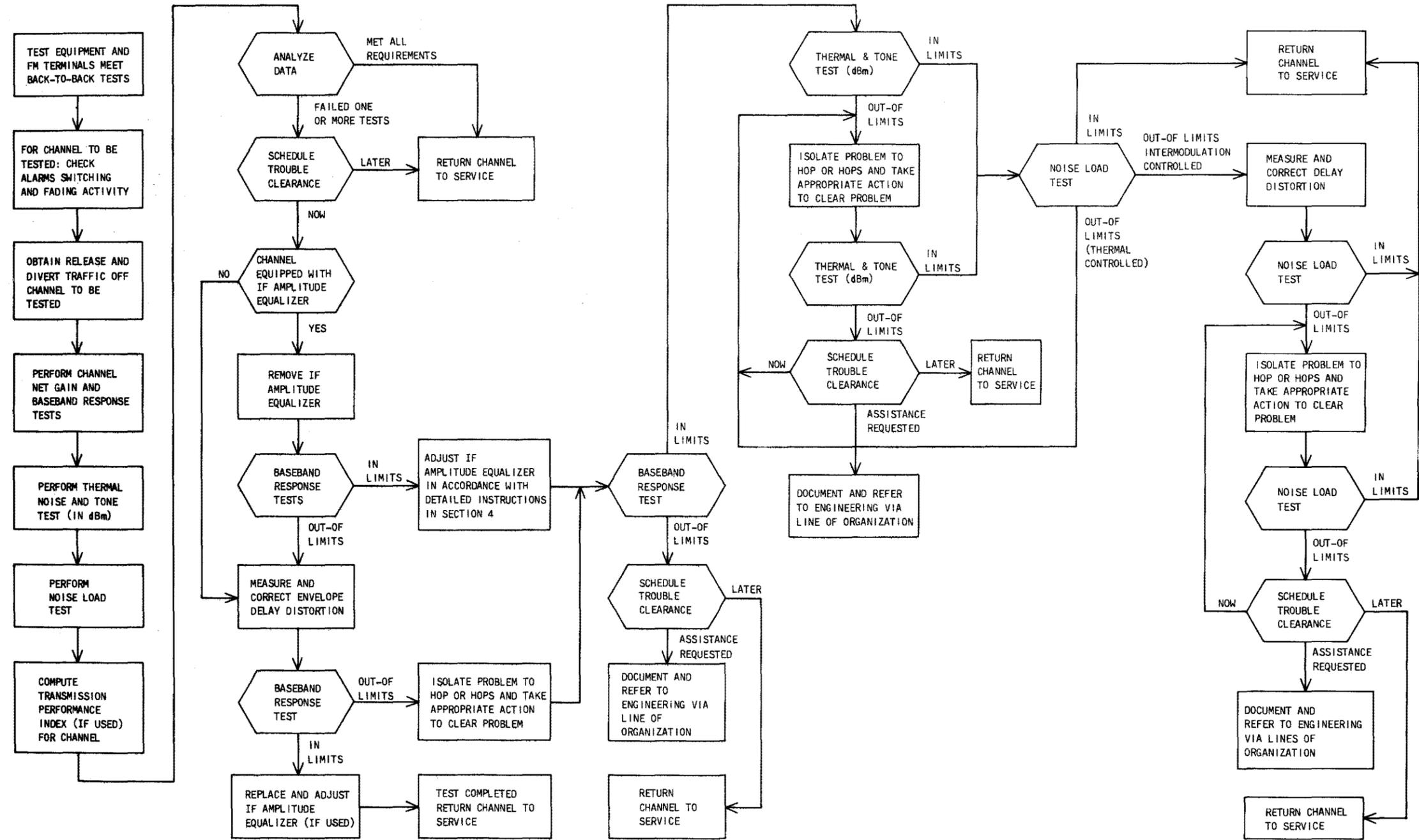
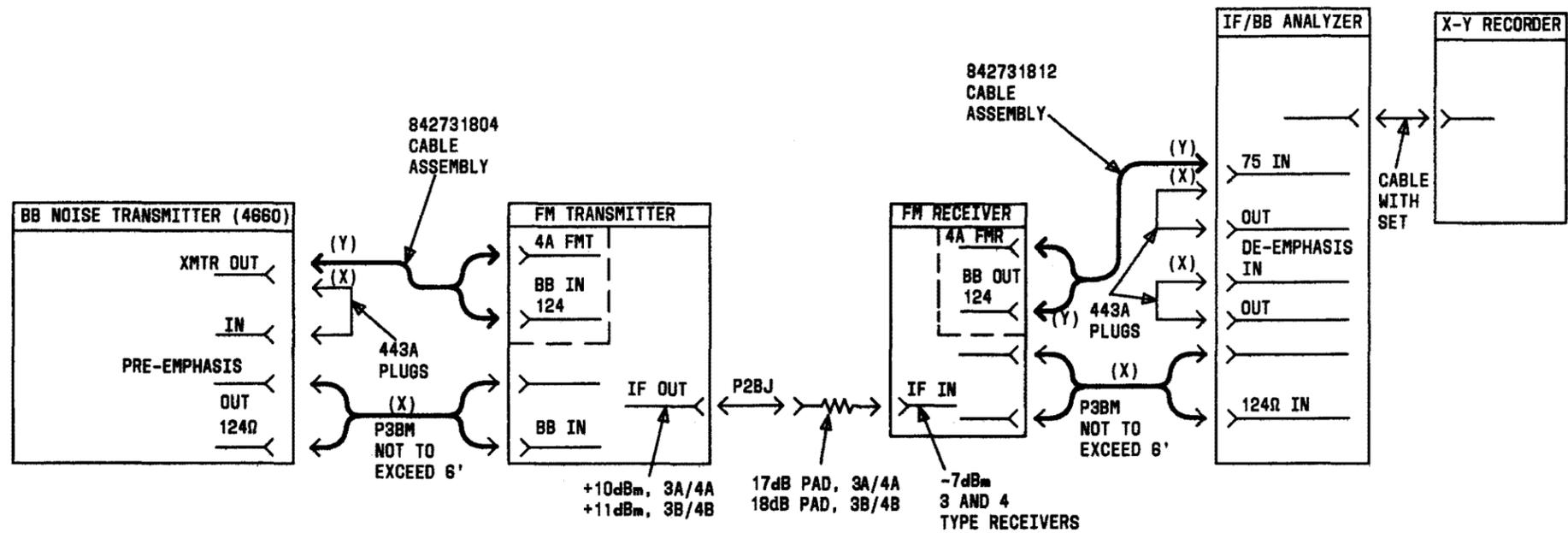


Fig. 56—Transmission Performance and Testing Trouble-Clearance Flowchart

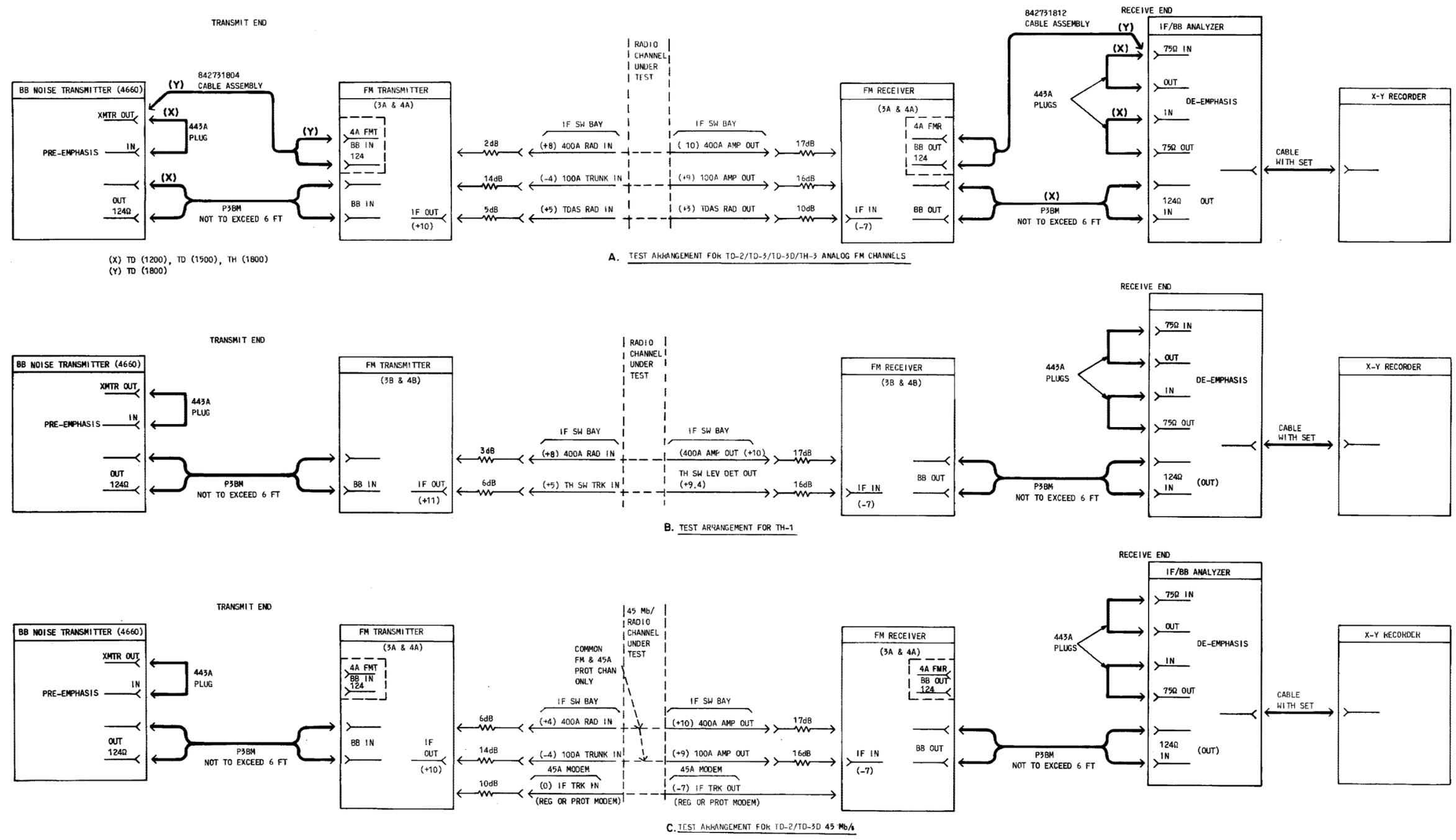


INITIAL CONTROL POSITIONS					
BB NOISE TRANSMITTER		IF/BB ANALYZER		X-Y RECORDER	
POWER ATTENUATION FUNCTION SWITCH UNCALIBRATED	ON TOTAL OF -25 dB*	POWER INPUT REF	ON TOTAL OF 20dB TOTAL OF 29dB	POWER RECORD/LIFT SERVO ON/STANDBY CHART HOLD/RELEASE	ON LIFT SERVO ON RELEASE
	BB RESPONSE LAMP NOT BURNING. IF BURNING, CLEAR TROUBLE IN NOISE GENERATOR	BB RESPONSE (MODE) MANUAL TUNING	OPERATED OPERATED USE BOTH KNOBS TO ADJUST TO 1-MHz ANALOG POWER METER SHOULD INDICATE 0-dBm ON THE TOP SCALE. READJUST REF AS NECESSARY UNTIL AS CLOSE TO 0-dBm AS POSSIBLE. THE DIGITAL POWER METER SHOULD INDICATE -49±1dBm†		RETURN TO CHART

* THIS ESTABLISHES A WIDE-BAND NOISE POWER LEVEL INTO THE FMT OF -30.5 dBm WHEN FUNCTION SWITCH IS IN BB RESPONSE POSITION.

† IF THIS INDICATION IS NOT OBTAINED, CHECK THE FM TERMINAL TRANSMITTER FOR PROPER DEVIATION. ADJUST THE FMR GAIN ONLY AFTER IT IS KNOWN THAT THE FM TRANSMITTER DEVIATION IS PROPERLY SET. TIME SPENT ON THIS IS WELL WORTH THE EFFORT FOR THE FOLLOWING REASON. IF, FOR EXAMPLE, THE FM TRANSMITTER HAD LOW DEVIATION, THE FM RECEIVER GAIN MIGHT BE INCREASED TO COMPENSATE FOR THE REDUCED GAIN OF THE FM TRANSMITTER. THIS WOULD CAUSE A CORRESPONDING INCREASE IN THE THERMAL NOISE AND TONES AT THE FM RECEIVER OUTPUT.

Fig. 57—Test Arrangement for Back-to-Back Calibration—TD(1200), TD(1500)/(45 Mb/s), TD(1800) and TH(1800)—(SCIENTIFIC-ATLANTA Test Set and FM Terminal Only)



INITIAL CONTROL POSITIONS					
BB NOISE TRANSMITTER		IF/BB ANALYZER		X-Y RECORDER	
POWER	ON	POWER	ON	POWER	ON
ATTENUATOR	TOTAL OF 25*	INPUT	TOTAL OF 20	RECORD/LIFT	LIFT
FUNCTION SWITCH	BB RESPONSE	REF	TOTAL OF 29	SERVO ON/STANDBY	SERVO ON
UNCALIBRATED	LAMP NOT LIT	BB RESPONSE	OPERATED	HOLD/RELEASE	RELEASE
	IF LIT, CLEAR TROUBLE IN NOISE GENERATOR	(MODE) MANUAL	OPERATED		RETURN TO CHART
		TUNING	USE BOTH KNOBS TO ADJUST FOR 1 MHZ		
			ANALOG POWER METER SHOULD INDICATE 0dBm ON THE TOP SCALE; READJUST REF AS NECESSARY UNTIL AS CLOSE TO 0dBm AS POSSIBLE. DIGITAL POWER METER SHOULD INDICATE -49 ± 1 dBm†		

* THIS ESTABLISHES A WIDE-BAND NOISE POWER LEVEL INTO THE FMT OF -30.5 dBm WHEN THE FUNCTION SWITCH IN BB RESPONSE POSITION.
 † IF THIS INDICATION IS NOT OBTAINED, CHECK THE FM TERMINAL TRANSMITTER FOR PROPER DEVIATION. ADJUST THE FMR GAIN ONLY AFTER IT IS KNOWN THAT THE FM TRANSMITTER DEVIATION IS PROPERLY SET. TIME SPENT ON THIS IS WELL WORTH THE EFFORT FOR THE FOLLOWING REASON: IF, FOR EXAMPLE, THE FM TRANSMITTER HAD LOW DEVIATION, THE FM RECEIVER GAIN MIGHT BE INCREASED TO COMPENSATE FOR THE REDUCED GAIN OF THE FM TRANSMITTER. THIS WOULD CAUSE A CORRESPONDING INCREASE IN THE THERMAL NOISE AND TONES AT THE RECEIVER OUTPUT.

Fig. 58—Test Arrangement for Straight-Away Switch Section Test—TD(1200), TD(1500)/(45 Mb/s) TD(1800) and TH(1800)

Example of computation of switch-section thermal-noise and noise-load requirements:

- Determine the received carrier power of each hop in the switch section. (If received carrier powers are not available, refer to Section 410-100-510, 411-100-508 or 415-100-508.) For this example, the powers are -26 dBm for the first hop, -28 dBm for the second hop, and -24 dBm for the third hop.
- Select the table (either with or without the 652A RF waveguide amplifier) that is applicable to each hop. For this example, each hop is assumed to be w/652A.
- Transfer data from appropriate table (in this example for -26 dBm, -28 dBm, and -24 dBm) to worksheet as shown in Fig. 46. (A copy of the worksheet is provided in Fig. 47.)
- Transfer data from FM Terminals - Noise Contribution table in Fig. 48 to worksheet as shown in Fig. 46.
- Total the THERMAL NOISE 10^{-15} WATTS and NOISE LOAD pWc0 columns as shown in Fig. 46.

Note: These columns give the numeric conversions from dBm and dBrnc0 and are necessary since dB units cannot be added directly.

- Enter into Fig. 49 the total THERMAL NOISE 10^{-15} WATTS to obtain the thermal-noise requirement in dBm. For example, locate 239 on the horizontal axis of the chart in Fig. 49. Proceed vertically until the 239 line intersects with the diagonal line and read the thermal-noise requirement directly from the left-hand axis as -96.2 dBm. Enter the requirement on the worksheet.
- Likewise, enter into Fig. 50 the total NOISE LOAD pWc0 to obtain the noise-load requirement in dBrnc0. For example, locate 268 on the horizontal axis of the chart in Fig. 50. Proceed vertically until the 268 line intersects with the diagonal line and read the noise-load requirement directly from the left-hand axis as 24.2 dBrnc0. Enter the requirement on the worksheet.

Note: Channels conditioned for 1800-circuit loading may show a broad thermal-noise bump that peaks between approximately 1.0 and 1.5 MHz in TD-3, TD-3A and TD-3D channels, and between about 1.5 and 2.0 MHz in TD-2 channels. The peak of the noise bump may be as much as 3 dB above the thermal noise at 8 MHz. This condition is normal and is caused by microwave generator noise. This broad noise bump is not expected to cause the thermal noise or total noise in the 1 to 3 MHz region to exceed the requirements that are calculated in Steps 6 and 7 for 1200 circuit loading.

BASEBAND RESPONSE LIMITS

BASEBAND FREQUENCY	BASEBAND RESPONSE LIMITS - SEE ALSO NOTES A & B -NUMBER OF RADIO HOPS-												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1 MHZ	CALIBRATION FREQUENCY (REFERENCE POINT)												
3 MHZ	+0.4	+0.4	+0.4	+0.4	+0.4	+0.4	+0.5	+0.5	+0.5	+0.5	+0.5	+0.5	+0.5
6 MHZ	+0.8	+0.8	+0.8	+0.8	+0.8	+0.8	+0.9	+0.9	+0.9	+0.9	+1.0	+1.0	+1.1
7 MHZ	+0.8	+0.8	+0.8	+0.9	+0.9	+0.9	+1.0	+1.0	+1.0	+1.1	+1.1	+1.1	+1.2
8 MHZ	+0.8	+0.9	+0.9	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0
9 MHZ	+0.8	+0.8	+0.8	+0.7	+0.7	+0.7	+0.7	+0.6	+0.6	+0.6	+0.6	+0.6	+0.6

NOTE A: ADDITIONAL ROLL-OFF FOR EACH HOP EQUIPPED WITH A 713() RF COMBINER WITHOUT IN-BAY DADE - TD-2 OFFICES ONLY

CHANNEL	BASEBAND FREQUENCY - MHz			
	3	6	8	9
1, 6, 7, 12	-0.08	-0.31	-0.55	-0.70
2, 5, 8, 11	-0.02	-0.09	-0.16	-0.20
3, 4, 9, 10	-0.00	-0.01	-0.02	-0.02

- This additional roll-off is applicable only to TD-2 TR bay line-ups, i.e., line-ups in which the main and diversity antenna connections are made to opposite ends of the line-up. Radio bays in these line-ups may be TD-2 and/or TD-3D.
- Multiply the above per-hop roll-offs by the number of hops in the switch section that are equipped with 713() combiners but which do not have in-bay DADE to obtain the total additional roll-off expected for each channel. Add this result to the applicable Baseband Response Limits to obtain the total limits for each channel in the switching section.

NOTE B: The limits given in this table pertain to channels on which the EDD has been equalized per Section 422-300-500 and on which no IF amplitude equalization has been applied. See Part 4C for instructions on adjusting the J68330Y IF adjustable amplitude equalizer-amplifier to flatten the baseband response.

TD 1200-CIRCUIT LOADING NOISE REQUIREMENT PER HOP W/652A

NORMAL RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
	dBm	10^{-15} WATTS	dBrnc0	pWc0
-40	-96.0	251	24.0	251
-39	-96.5	224	23.0	200
-38	-97.5	178	22.5	178
-37	-98.0	158	21.5	141
-36	-99.0	126	21.0	126
-35	-99.5	112	20.5	112
-34	-100.0	100	20.0	100
-33	-100.5	89	20.0	100
-32	-101.0	79	19.5	89
-31	-101.5	71	19.0	79
-30	-101.5	71	19.0	79
-29	-102.0	63	19.0	79
-28	-102.0	63	18.5	71
-27	-102.0	63	18.5	71
-26	-101.5	71	18.5	71
-25	-101.5	71	18.5	71
-24	-101.5	89	18.0	63
-23	-100.0	100	18.0	63

TD 1200-CIRCUIT LOADING NOISE REQUIREMENT PER HOP W/O 652A

NORMAL RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
	dBm	10^{-15} WATTS	dBrnc0	pWc0
-40	-91.5	708	27.5	562
-39	-92.5	562	27.0	501
-38	-93.5	447	26.0	398
-37	-94.5	355	25.0	316
-36	-95.0	316	24.5	282
-35	-96.0	251	23.5	224
-34	-96.5	224	23.0	200
-33	-97.5	178	22.0	159
-32	-98.0	158	21.5	141
-31	-99.0	126	21.0	126
-30	-99.5	112	20.5	112
-29	-100.0	100	20.0	100
-28	-100.5	89	19.5	89
-27	-101.0	79	19.5	89
-26	-101.5	71	19.0	79
-25	-101.5	71	19.0	79
-24	-102.0	63	18.5	71
-23	-102.5	56	18.5	71
-22	-102.5	56	18.5	71
-21	-101.5	56	18.5	71
-20	-101.5	56	18.0	63
-19	-103.0	50	18.0	63
-18	-103.0	50	18.0	63

1200 CIRCUIT TONE REQUIREMENT

FREQUENCY (MHz)	SHALL NOT EXCEED
0.5 to 5.8	-85 dBm
5.8 to 8.8	-72 dBm
8.8 to 9.1	-95 dBm*
9.1 to 10.5	-62 dBm

* Tones shall not exceed the thermal noise background in cases where the thermal noise requirement is higher than the tone requirement. See paragraph 4.30 for additional information concerning the measurement and analysis of low-level tones.

Example: -98 is the tone requirement and -96 is the thermal noise background. The tones shall not exceed -96 dBm.

Fig. 59—TD (1200) Radio Systems—Switch-Section Baseband-Related Transmission Performance Limits

Example of computation of switch-section thermal-noise and noise-load requirements:

- Determine the received carrier power of each hop in the switch section. (If received carrier powers are not available, refer to Section 410-100-510, 411-100-508 or 415-100-508.) For this example, the powers are -26 dBm for the first hop, -28 dBm for the second hop, and -24 dBm for the third hop.
- Select the table (either with or without the 652A RF waveguide amplifier) that is applicable to each hop. For this example, each hop is assumed to be w/652A.
- Transfer data from appropriate table (in this example for -26 dBm, -28 dBm, and -24 dBm) to worksheet as shown in Fig. 51. (A copy of the worksheet is provided in Fig. 47.)
- Transfer data from FM Terminals - Noise Contribution table in Fig. 48 to worksheet as shown in Fig. 51.
- Total the THERMAL NOISE 10⁻¹⁵ WATTS and NOISE LOAD pWc0 columns as shown in Fig. 51.

Note: These columns give the numeric conversions from dBm and dBrcn0 and are necessary since dB units cannot be added directly.

- Enter into Fig. 49 the total THERMAL NOISE 10⁻¹⁵ WATTS to obtain the thermal noise requirement in dBm. For example, locate 159 on the horizontal axis of the chart in Fig. 49. Proceed vertically until the 159 line intersects with the diagonal line and read the thermal-noise requirement directly from the left-hand axis as -98.0 dBm. Enter the requirement on the worksheet.
- Likewise, enter into Fig. 50 the total NOISE LOAD pWc0 to obtain the noise-load requirement in dBrcn0. For example, locate 392 on the horizontal axis of the chart in Fig. 50. Proceed vertically until the 392 line intersects with the diagonal line and read the noise-load requirement directly from the left-hand axis as 25.9 dBrcn0. Enter the requirement on the worksheet.

Note: Channels conditioned for 1800-circuit loading may show a broad thermal-noise bump that peaks between approximately 1.0 and 1.5 MHz in TD-3, TD-3A and TD-3D channels, and between about 1.5 and 2.0 MHz in TD-2 channels. The peak of the noise bump may be as much as 3 dB above the thermal noise at 8 MHz. This condition is normal and is caused by microwave generator noise. This broad noise bump is not expected to cause the thermal noise or total noise in the 1 to 3 MHz region to exceed the requirements that are calculated in Steps 6 and 7 for 1500 circuit loading.

BASEBAND FREQUENCY	BASEBAND RESPONSE LIMITS - SEE ALSO NOTES A & B -NUMBER OF RADIO HOPS-												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	CALIBRATION FREQUENCY (REFERENCE POINT)												
1 MHZ													
3 MHZ	+0.4	+0.4	+0.4	+0.4	+0.4	+0.4	+0.5	+0.5	+0.5	+0.5	+0.5	+0.5	+0.5
	-0.5	-0.5	-0.5	-0.5	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.7	-0.7	-0.7
6 MHZ	+0.8	+0.8	+0.8	+0.8	+0.8	+0.8	+0.9	+0.9	+0.9	+0.9	+1.0	+1.0	+1.1
	-1.0	-1.1	-1.1	-1.2	-1.3	-1.3	-1.4	-1.5	-1.5	-1.6	-1.7	-1.8	-1.8
7 MHZ	+0.8	+0.8	+0.8	+0.9	+0.9	+0.9	+1.0	+1.0	+1.0	+1.1	+1.1	+1.1	+1.2
	-1.1	-1.2	-1.4	-1.4	-1.5	-1.6	-1.7	-1.8	-1.9	-2.0	-2.1	-2.2	-2.3
8 MHZ	+0.8	+0.9	+0.9	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0
	-1.3	-1.4	-1.6	-1.7	-1.8	-1.9	-2.0	-2.2	-2.4	-2.4	-2.6	-2.7	-2.9
9 MHZ	+0.8	+0.8	+0.8	+0.7	+0.7	+0.7	+0.7	+0.6	+0.6	+0.6	+0.6	+0.6	+0.6
	-1.4	-1.6	-1.8	-1.9	-2.1	-2.3	-2.5	-2.6	-2.9	-3.0	-3.2	-3.3	-3.6

NOTE A: ADDITIONAL ROLL-OFF FOR EACH HOP EQUIPPED WITH A 713() RF COMBINER WITHOUT IN-BAY DADE - TD-2 OFFICES ONLY

CHANNEL	BASEBAND FREQUENCY - MHz			
	3	6	8	9
1, 6, 7, 12	-0.08	-0.31	-0.55	-0.70
2, 5, 8, 11	-0.02	-0.09	-0.16	-0.20
3, 4, 9, 10	-0.00	-0.01	-0.02	-0.02

- This additional roll-off is applicable only to TD-2 TR bay line-ups, i.e., line-ups in which the main and diversity antenna connections are made to opposite ends of the line-up. Radio bays in these line-ups may be TD-2 and/or TD-3D.
- Multiply the above per-hop roll-offs by the number of hops in the switch section that are equipped with 713() combiners but which do not have in-bay DADE to obtain the total additional roll-off expected for each channel. Add this result to the applicable Baseband Response Limits to obtain the total limits for each channel in the switching section.

NOTE B: The limits given in this table pertain to channels on which the EDD has been equalized per Section 422-300-500 and on which no IF amplitude equalization has been applied. See Part 4C for instructions on adjusting the J68330Y IF adjustable amplitude equalizer-amplifier to flatten the baseband response.

TD 1500-CIRCUIT LOADING NOISE REQUIREMENT PER HOP W/652A

NORMAL RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
	dBm	10 ⁻¹⁵ WATTS	dBrcn0	pWc0
-40*	-95.5	282	29.0	794
-39	-96.5	224	28.0	631
-38	-97.5	178	27.0	501
-37	-98.5	141	26.5	447
-36	-99.5	112	25.5	355
-35	-100.5	89	24.5	282
-34	-101.0	79	24.0	251
-33	-102.0	63	23.0	200
-32	-102.5	56	22.5	178
-31	-103.5	45	22.0	159
-30	-104.0	39	21.5	141
-29	-104.5	35	21.0	126
-28	-105.0	32	20.5	112
-27	-105.0	32	20.5	112
-26	-105.5	28	20.0	100
-25	-105.0	32	19.5	89
-24	-104.5	35	19.5	89
-23	-104.0	40	19.5	89
-22				
-21				
-20				
-19				
-18				

* Add 1 dB to the noise requirement for each dB that the received carrier power is less than -40 dBm.

TD 1500-CIRCUIT LOADING NOISE REQUIREMENT PER HOP W/O 652A

NORMAL RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
	dBm	10 ⁻¹⁵ WATTS	dBrcn0	pWc0
-30*	-100.0	100	24.5	282
-29	-101.0	79	24.0	251
-28	-101.5	71	23.0	200
-27	-102.5	56	22.5	178
-26	-103.0	50	22.0	159
-25	-104.0	40	21.5	141
-24	-104.5	35	21.0	126
-23	-105.0	32	20.5	112
-22	-105.5	28	20.0	100
-21	-105.5	28	20.0	100
-20	-106.0	25	19.5	89
-19	-106.0	25	19.5	89
-18	-106.5	22	19.5	89

* Add 1 dB to the noise requirement for each dB that the received carrier power is less than -30 dBm.

1500 CIRCUIT

FREQUENCY (MHz)	SHALL NOT EXCEED
0.5 to 7.3	-98 dBm**
7.3 to 8.8	-72 dBm
8.8 to 9.1	-98 dBm**
9.1 to 10.5	-62 dBm

** Tones shall not exceed the thermal noise background in cases where the thermal noise requirement is higher than the tone requirement. See paragraph 4.30 for additional information concerning the measurement and analysis of low-level tones.

Example: -98 is the tone requirement and -96 is the thermal noise background. The tones shall not exceed -96 dBm.

Fig. 60—TD(1500)/(45 Mb/s) Radio Systems—Switch-Section Baseband-Related Transmission Performance Limits

Example of computation of switch-section thermal-noise and noise-load requirements:

1. Determine the received carrier power of each hop in the switch section. (If received carrier powers are not available, refer to Section 410-100-510, 411-100-508 or 415-100-508.) For this example, the powers are -26 dBm for the first hop, -28 dBm for the second hop, and -24 dBm for the third hop.
2. Transfer data from the table (in this example for -26 dBm, -28 dBm, and -24 dBm) to worksheet as shown in Fig. 52. (A copy of the worksheet is provided in Fig. 47.)
3. Transfer data from FM Terminals - Noise Contribution table in Fig. 48 to worksheet as shown in Fig. 52.
4. Total the THERMAL NOISE 10⁻¹⁵ WATTS and NOISE LOAD pWc0 columns as shown in Fig. 52.

Note: These columns give the numeric conversions from dBm and dBrnc0 and are necessary since dB units cannot be added directly.

5. Enter into Fig. 49 the total THERMAL NOISE 10⁻¹⁵ WATTS to obtain the thermal-noise requirement in dBm. For example, locate 81 on the horizontal axis of the chart in Fig. 49. Proceed vertically until the 81 line intersects with the diagonal line and read the thermal-noise requirement directly from the left-hand axis as -101.0 dBm. Enter the requirement on the worksheet.
6. Likewise, enter into Fig. 50 the total NOISE LOAD pWc0 to obtain the noise-load requirement in dBrnc0. For example, locate 341 on the horizontal axis of the chart in Fig. 50. Proceed vertically until the 341 line intersects with the diagonal line and read the noise-load requirement directly from the left-hand axis as 25.4 dBrnc0. Enter the requirement on the worksheet.

Note: Channels conditioned for 1800-circuit loading may show a broad thermal-noise bump that peaks between approximately 1.0 and 1.5 MHz in TD-3, TD-3A and TD-3D channels, and between about 1.5 and 2.0 MHz in TD-2 channels. The peak of the noise bump may be as much as 3 dB above the thermal noise at 8 MHz. This condition is normal and is caused by microwave generator noise. For this reason, on channels that exhibit this broad noise bump, the thermal noise and total noise in the 1 to 3 MHz region are permitted to be up to 3 dB greater than the noise requirements that are calculated in Steps 5 and 6 for 1800-circuit loading.

BASEBAND RESPONSE LIMITS

BASEBAND FREQUENCY	BASEBAND RESPONSE LIMITS - SEE ALSO NOTES A & B -NUMBER OF RADIO HOPS-												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1 MHZ	CALIBRATION FREQUENCY (REFERENCE POINT)												
3 MHZ	+0.4 -0.5	+0.4 -0.5	+0.4 -0.5	+0.4 -0.5	+0.4 -0.6	+0.4 -0.6	+0.5 -0.6	+0.5 -0.6	+0.5 -0.6	+0.5 -0.6	+0.5 -0.7	+0.5 -0.7	+0.5 -0.7
6 MHZ	+0.8 -1.0	+0.8 -1.1	+0.8 -1.1	+0.8 -1.2	+0.8 -1.3	+0.8 -1.3	+0.9 -1.4	+0.9 -1.5	+0.9 -1.5	+0.9 -1.6	+1.0 -1.7	+1.0 -1.8	+1.1 -1.8
7 MHZ	+0.8 -1.1	+0.8 -1.2	+0.8 -1.4	+0.9 -1.4	+0.9 -1.5	+0.9 -1.6	+1.0 -1.7	+1.0 -1.8	+1.0 -1.9	+1.1 -2.0	+1.1 -2.1	+1.1 -2.2	+1.2 -2.3
8 MHZ	+0.8 -1.3	+0.9 -1.4	+0.9 -1.6	+1.0 -1.7	+1.0 -1.8	+1.0 -1.9	+1.0 -2.0	+1.0 -2.2	+1.0 -2.4	+1.0 -2.4	+1.0 -2.6	+1.0 -2.7	+1.0 -2.9
9 MHZ	+0.8 -1.4	+0.8 -1.6	+0.8 -1.8	+0.7 -1.9	+0.7 -2.1	+0.7 -2.3	+0.7 -2.5	+0.6 -2.6	+0.6 -2.9	+0.6 -3.0	+0.6 -3.2	+0.6 -3.3	+0.6 -3.6

NOTE A: ADDITIONAL ROLL-OFF FOR EACH HOP EQUIPPED WITH A 713() RF COMBINER WITHOUT IN-BAY DADE- TD-2 OFFICES ONLY

CHANNEL	BASEBAND FREQUENCY - MHZ			
	3	6	8	9
1, 6, 7, 12	-0.08	-0.31	-0.55	-0.70
2, 5, 8, 11	-0.02	-0.09	-0.16	-0.20
3, 4, 9, 10	-0.00	-0.01	-0.02	-0.02

- a) This additional roll-off is applicable only to TD-2 TR bay line-ups, i.e., line-ups in which the main and diversity antenna connections are made to opposite ends of the line-up. Radio bays in these line-ups may be TD-2 and/or TD-3D.
- b) Multiply the above per-hop roll-offs by the number of hops in the switch section that are equipped with 713() combiners but which do not have in-bay DADE to obtain the total additional roll-off expected for each channel. Add this result to the applicable Baseband Response Limits to obtain the total limits for each channel in the switching section.

NOTE B: The limits given in this table pertain to channels on which the EDD has been equalized per Section 422-300-500 and on which no IF amplitude equalization has been applied. See Part 4C for instructions on adjusting the J68330Y IF adjustable amplitude equalizer-amplifier to flatten the baseband response.

TD-1800 CIRCUIT LOADING NOISE REQUIREMENT PER HOP

NORMAL RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
	dBm	10 ⁻¹⁵ WATTS	dBrnc0	pWc0
-40	-96.0	251	30.0	1000
-39	-97.0	200	29.0	794
-38	-98.0	158	28.0	631
-37	-99.0	126	27.5	562
-36	-100.0	100	26.5	447
-35	-101.0	79	25.5	355
-34	-101.5	71	24.5	282
-33	-102.5	56	24.0	251
-32	-104.0	40	23.0	200
-31	-104.0	40	22.5	178
-30	-104.5	35	21.5	141
-29	-105.5	28	21.0	126
-28	-106.0	25	20.5	112
-27	-106.5	22	20.5	112
-26	-107.0	20	20.0	100
-25	-107.0	20	19.5	89
-24	-107.0	20	19.5	89
-23	-106.0	25	20.5	112
-22	-106.5	22	20.0	100
-21	-107.0	20	20.0	100
-20	-107.5	18	19.5	89
-19	-107.5	18	19.0	79
-18	-108.0	16	19.0	79

1800 CIRCUIT TONE REQUIREMENT

FREQUENCY (MHz)	SHALL NOT EXCEED
0.5 to 8.6	-103 dBm
8.6 to 8.8	-72 dBm
8.8 to 9.1	-103 dBm*
9.1 to 10.5	-62 dBm

* Tones shall not exceed the thermal noise background in cases where the thermal noise requirement is higher than the tone requirement. See paragraph 4.30 for additional information concerning the measurement and analysis of low-level tones.

Example: -98 is the tone requirement and -96 is the thermal noise background. The tones shall not exceed -96 dBm.

Fig. 61—TD(1800) Radio Systems—Switch-Section Baseband-Related Transmission Performance Limits

AVERAGE HOP SPACING MI- (KM)	TH-1 RADIO THERMAL NOISE REQUIREMENTS (dBm)									
	A = 3B FM TERM TRANS					B = 4B FM TERM TRANS				
	RADIO HOPS									
	1	2	3	4	5	6	7	8	9	10
A 10(16.1)	-100.5	-99.5								
B 10(16.1)	-106.0	-104.5								
A 12(22.5)	-100.5	-99.5	-99.0							
B 12(22.5)	-106.0	-104.0	-102.5							
A 14(25.7)	-100.0	-99.5	-99.0	-98.5	-98.0	-97.5				
B 14(25.7)	-106.0	-103.5	-102.6	-101.0	-100.5	-99.5				
A 16(26.0)	-100.0	-99.5	-99.0	-98.0	-98.0	-97.5	-97.0			
B 16(26.0)	-105.5	-103.5	-102.0	-101.0	-100.0	-99.5	-98.5			
A 18(29.0)	-100.0	-99.5	-98.5	-98.0	-97.5	-97.0	-96.5	-96.0	-96.0	-95.5
B 18(29.0)	-105.5	-103.0	-101.5	-100.5	-99.5	-99.0	-98.0	-98.0	-97.5	-96.5
A 20(32.2)	-100.0	-99.0	-98.5	-98.0	-97.5	-96.5	-96.5	-96.0	-95.5	-95.5
B 20(32.2)	-105.0	-102.5	-101.0	-100.0	-99.0	-98.5	-98.0	-97.5	-97.0	-96.5
A 22(35.4)	-100.0	-99.0	-98.0	-97.5	-97.0	-96.5	-96.0	-95.5	-95.5	-95.0
B 22(35.4)	-104.5	-102.0	-101.0	-99.5	-98.5	-98.0	-97.5	-97.0	-96.5	-96.0
A 24(38.6)	-99.5	-98.5	-97.5	-97.0	-96.5	-96.0	-95.5	-94.0	-94.5	-94.5
B 24(38.6)	-104.0	-101.5	-100.0	-99.0	-98.0	-97.5	-97.0	-95.5	-95.5	-95.0
A 26(41.8)	-99.0	-98.5	-97.0	-96.5	-96.0	-95.5	-95.0	-94.0	-94.0	-93.5
B 26(41.8)	-103.5	-101.0	-99.0	-99.0	-97.5	-96.5	-96.0	-95.5	-95.0	-94.0
A 28(45.0)	-99.5	-97.5	-96.5	-96.5	-95.0	-94.5	-93.5	-93.5	-93.0	-92.5
B 28(45.0)	-102.5	-100.5	-99.0	-98.0	-96.0	-95.5	-94.5	-94.0	-93.5	-93.0
A 30(48.2)	-99.0	-97.0	-96.0	-95.0	-94.0	-93.5	-93.0	-92.5	-92.0	-91.5
B 30(48.2)	-101.5	-100.0	-98.5	-97.0	-95.0	-94.0	-93.5	-93.0	-92.5	-92.0
A 35(56.3)	-98.0	-96.0	-94.5	-93.5	-93.0	-92.0	-91.5	-91.0	-90.5	-90.5
B 35(56.3)	-100.0	-98.5	-97.0	-95.5	-93.5	-93.0	-92.5	-92.0	-91.5	-91.0
A 40(64.4)	-97.5	-95.0	-93.5	-92.5	-92.0	-91.0				
B 40(64.4)	-99.0	-97.0	-95.5	-94.0	-92.5	-92.0				
A 45(72.4)	-96.5	-94.5	-93.0							
B 45(72.4)	-98.0	-95.5	-94.5							
A 50(80.5)	-96.0	-94.0								
B 50(80.5)	-97.5	-94.5								

AVERAGE HOP SPACING MI- (KM)	TH-1 RADIO NOISE LOADING REQUIREMENTS (dbrrnCO)									
	A = 3B FM TERM TRANS					B = 4B FM TERM TRANS				
	RADIO HOPS									
	1	2	3	4	5	6	7	8	9	10
A 10(16.1)	26.0	27.0								
B 10(16.1)	23.0	25.0								
A 12(22.5)	26.0	27.0	28.0							
B 12(22.5)	23.0	25.5	26.5							
A 14(25.7)	26.0	27.0	28.0	29.0	29.5	30.0				
B 14(25.7)	23.0	25.0	27.0	28.0	28.5	29.5				
A 16(26.0)	26.0	27.0	28.0	29.0	29.5	30.0	31.0			
B 16(26.0)	23.5	25.5	27.0	28.0	29.0	29.5	30.0			
A 18(29.0)	26.0	27.5	28.5	29.0	30.0	30.5	31.0	31.5	31.5	32.0
B 18(29.0)	23.5	25.5	27.0	28.0	29.0	29.5	30.0	30.5	31.5	32.0
A 20(32.2)	26.0	27.5	28.5	29.0	30.0	30.5	31.0	31.5	32.0	32.0
B 20(32.2)	23.5	25.5	27.0	28.0	29.0	29.5	30.5	31.0	31.5	32.0
A 22(35.4)	26.0	27.5	28.5	29.5	30.0	30.5	31.0	31.5	32.0	32.5
B 22(35.4)	23.5	25.5	27.0	28.5	29.0	30.0	30.5	31.0	31.5	32.0
A 24(38.6)	26.0	27.5	28.5	29.5	30.0	30.5	31.5	31.5	32.0	32.5
B 24(38.6)	24.0	26.0	27.5	28.5	29.5	30.0	30.5	31.0	31.5	32.0
A 26(41.8)	26.0	27.5	28.5	29.5	30.5	30.5	32.0	32.0	32.5	33.0
B 26(41.8)	24.0	26.0	27.5	28.5	29.5	30.5	31.0	31.5	32.0	32.5
A 28(45.0)	26.5	28.0	29.0	30.0	30.5	31.5	32.0	32.5	33.0	33.5
B 28(45.0)	24.0	26.5	28.0	29.0	30.0	31.0	31.5	32.0	32.5	33.0
A 30(48.2)	26.5	28.0	29.5	30.5	31.0	32.0	32.0	33.0	33.5	34.0
B 30(48.2)	24.5	27.0	28.5	29.5	30.5	31.0	31.5	32.5	33.0	33.5
A 35(56.3)	27.0	28.5	30.0	31.0	31.5	32.5	33.0	33.5	34.0	34.5
B 35(56.3)	25.0	27.5	29.0	30.5	31.0	32.0	32.5	33.0	33.5	34.5
A 40(64.4)	27.0	29.0	30.5	31.5	32.0	33.0				
B 40(64.4)	25.5	28.0	29.5	31.0	31.5	32.5				
A 45(72.4)	27.5	29.5	31.0							
B 45(72.4)	26.0	28.5	30.5							
A 50(80.5)	28.0	30.0								
B 50(80.5)	26.5	29.5								

1	2	3
-85.0	-82.0	-80.0

0 to 300-kHz tone shall not be greater than the limit for the number of 14.8-MHz tones (T). See Paragraph 4.3 for measurement and a

BASEBAND FREQUENCY	REQUIREMENT	
	1	2
1 MHz		
3 MHz	±0.4	±0.4
6 MHz	±0.4	±0.4
7 MHz	±0.4	±0.4
8 MHz	±0.4	±0.4
9 MHz	±0.4	±0.4

Note 1: Requirement have to be developed.
 Note 2: Requirement have to be developed.
 Note 3: The baseband channel on which the measurement is equalized per the Part 4C of this B

Example of computation of switch-section thermal noise and noise load requirements:

1. Determine the received carrier power of each hop in the switch-section. (If received carrier powers are not available, refer to Section 412-100-506.) For this example, the powers are -22 dBm for the first hop, -23 dBm for the second hop, and -25 dBm for the third hop.
2. Transfer data from table (in this example for -22 dBm, -23 dBm, and -25 dBm) to worksheet as shown in Fig. 53. (A copy of the worksheet is provided in Fig. 47.)
3. Transfer data from FM Terminals-Noise Contribution table in Fig. 48 to worksheet as shown in Fig 53.
4. Total the THERMAL NOISE 10^{-15} WATTS and NOISE LOAD pWc0 columns as shown in Fig. 53.

Note: These columns give the numeric conversions from dBm and dBrnc0 and are necessary since dB units cannot be added directly.

5. Enter into Fig. 49 the total thermal noise 10^{-15} watts to obtain the thermal noise requirement in dBm. For example, locate 148 on the horizontal axis of the chart in Fig. 49. Proceed vertically until the 148 line intersects with the diagonal line and read the thermal noise requirement directly from the left hand axis as -98.4 dBm. Enter the requirement on the worksheet.

Note: This step converts the numeric value back into dBm.

6. Likewise, enter into Fig. 50 the total noise load pWc0 to obtain the noise load requirement in dBrnc0. For example, locate 394 on the horizontal axis of the chart in Fig. 50. Proceed vertically until the 394 line intersects with the diagonal line and read the actual noise load requirement directly from the left hand axis as 25.9 dBrnc0. Enter the requirement on the worksheet.

Note: This step converts the numeric value back into dBrnc0.

BASEBAND FREQUENCY	BASEBAND RESPONSE LIMITS - SEE NOTE A NUMBER OF RADIO HOPS												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1 MHZ	CALIBRATION FREQUENCY (REFERENCE POINT)												
3 MHZ	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4
6 MHZ	±0.4	±0.4	±0.4	+0.3 -0.5	+0.3 -0.6	+0.3 -0.6	+0.3 -0.6	+0.2 -0.6	+0.2 -0.6	+0.2 -0.8	+0.2 -0.8	+0.2 -0.8	+0.2 -0.8
7 MHZ	+0.4 -0.5	+0.4 -0.5	+0.4 -0.5	+0.3 -0.6	+0.3 -0.7	+0.3 -0.7	+0.2 -0.8	+0.2 -0.8	+0.2 -0.8	+0.2 -1.0	+0.2 -1.0	+0.2 -1.1	+0.2 -1.2
8 MHZ	+0.4 -0.6	+0.4 -0.6	+0.4 -0.7	+0.3 -0.8	+0.3 -0.8	+0.3 -0.9	+0.2 -1.0	+0.2 -1.1	+0.2 -1.1	+0.2 -1.2	+0.2 -1.2	+0.2 -1.3	+0.2 -1.3
9 MHZ	+0.3 -0.7	+0.3 -0.7	+0.3 -0.8	+0.3 -0.9	+0.3 -1.0	+0.3 -1.1	+0.2 -1.2	+0.2 -1.3	+0.2 -1.4	+0.2 -1.5	+0.2 -1.6	+0.2 -1.7	+0.2 -1.8

TH-3 1800 CIRCUIT LOADING NOISE REQUIREMENT PER HOP

NORMAL RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
	dBm	10^{-15} WATTS	dBrnc0	pWc0
-30	- 98.0	158	24.5	280
-29	- 99.0	125	23.5	224
-28	-100.0	100	25.5	356
-27	-101.0	79	22.0	159
-26	-102.0	63	21.5	141
-25	-102.5	56	21.0	126
-24	-103.5	44	20.5	112
-23	-104.0	40	20.0	100
-22	-104.5	36	19.5	89
-21	-105.0	32	19.0	79
-20	-105.5	28	18.5	71
-19	-106.0	25	18.5	71
-18	-106.0	25	18.0	63

NOTE A: The limits given in this table pertain to channels on which the EDD has been equalized per section 413-100-501, and on which NO IF amplitude equalization has been applied. See part 4C for instructions on adjusting the J68330Y IF adjustable amplitude equalizer-amplifier to flatten the baseband response.

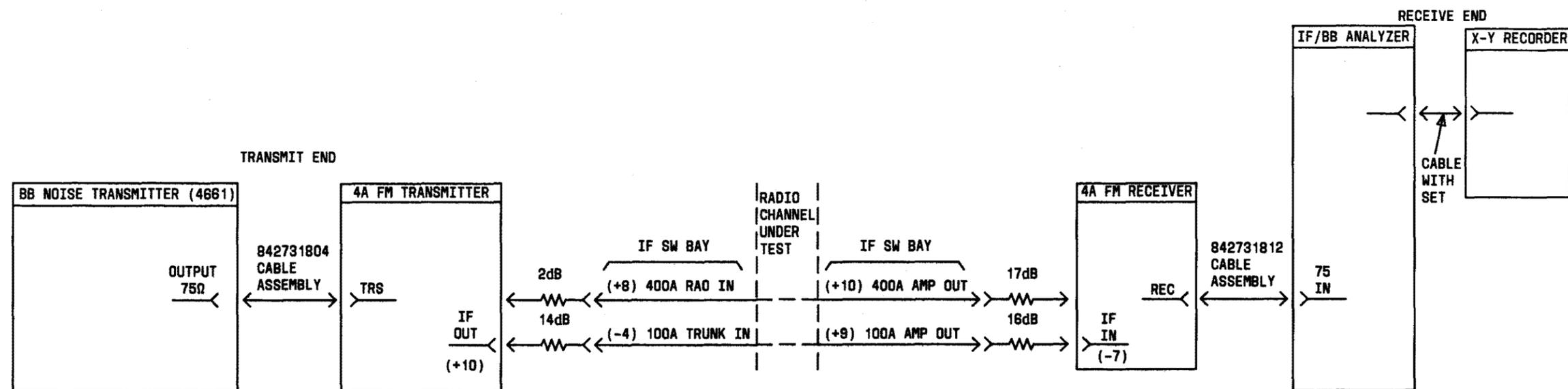
TONE REQUIREMENT	SHALL NOT EXCEED
0.5 to 8.5 MHz	-98 dBm
8.5 to 8.9 MHz	-72 dBm
8.9 to 9.1 MHz	-98 dBm
9.1 to 11.4 MHz	-72 dBm
11.1 to 11.7 MHz†	-98 dBm

* Tones shall not exceed the thermal noise background in cases where the thermal noise requirement is higher than the tone requirement. See paragraph 4.30 for additional information concerning the measurement and analysis of low level tones.

Example: -98 is the tone requirement; -96 is the thermal noise background. The tones shall not exceed -96 dBm.

† For those channels carrying frequency dplexed aux channel.

Fig. 63—TH-3(1800) Radio Systems—Switch-Section Baseband-Related Transmission Performance Limits



TEST ARRANGEMENT FOR TH-3

SEE PAR. 1.05
IF USING MODEL
4670 IF/BB
ANALYZER

INITIAL CONTROL POSITIONS					
BB NOISE TRANSMITTER		IF/BB ANALYZER		X-Y RECORDER	
POWER	ON	POWER INPUT REF	ON	POWER RECORD/LIFT	ON
POWER LEVEL, dBm	-24.4*	BB RESPONSE (MODE) MANUAL TUNING	TOTAL OF 20dB	SERVO ON/STANDBY	LIFT
NOISE	OUT (ON)		TOTAL OF 29dB	CHART HOLD/RELEASE	SERVO ON
HPF 316	OUT		OPERATED		RELEASE
LPF 11404	IN		OPERATED		
BSF:			USE BOTH KNOBS TO ADJUST TO		RETURN TO CHART
1248	OUT		1-MHZ		
5340	OUT		ANALOG		
10840	OUT		POWER METER SHOULD INDICATE		
UNCALIBRATED	LAMP NOT BURNING. IF BURNING, CLEAR TROUBLE IN NOISE GENERATOR		0-dBm ON THE TOP SCALE. READJUST REF AS NECESSARY UNTIL AS CLOSE TO 0-dBm AS POSSIBLE. THE DIGITAL POWER METER SHOULD INDICATE		
			-50.7dBm†		

* THIS ESTABLISHES A WIDE-BAND NOISE POWER LEVEL INTO THE FMT OF -30.5 dBm WHEN FUNCTION SWITCH IS IN BB RESPONSE POSITION.

† IF THIS INDICATION IS NOT OBTAINED, CHECK THE FM TERMINAL TRANSMITTER FOR PROPER DEVIATION. ADJUST THE FMR GAIN ONLY AFTER IT IS KNOWN THAT THE FM TRANSMITTER DEVIATION IS PROPERLY SET. TIME SPENT ON THIS IS WELL WORTH THE EFFORT FOR THE FOLLOWING REASON. IF, FOR EXAMPLE, THE FM TRANSMITTER HAD LOW DEVIATION, THE FM RECEIVER GAIN MIGHT BE INCREASED TO COMPENSATE FOR THE REDUCED GAIN OF THE FM TRANSMITTER. THIS WOULD CAUSE A CORRESPONDING INCREASE IN THE THERMAL NOISE AND TONES AT THE FM RECEIVER OUTPUT.

Fig. 64—Test Arrangement for Straight-Away Switch-Section Test TH-3(2400)

Example of computation of switch-section thermal noise and noise load requirement:

1. Determine the received carrier power of each hop in the switch-section. (If received carrier powers are not available, refer to Section 413-100-508.) For this example, the powers are -24 dBm for the first hop, -26 dBm for the second hop, and -28 dBm for the third hop for 2400 circuit loading.
2. Transfer data from table (in this example for -24 dBm, -26 dBm, and -28 dBm) to worksheets as shown in Fig. 54. (A copy of the worksheet is provided in Fig. 47.)
3. Transfer data from FM Terminals-Noise Contribution table in Fig. 48 to worksheet as shown in Fig 54.
4. Total the THERMAL NOISE 10⁻¹⁵ WATTS and NOISE LOAD pWc0 columns as shown in Fig. 54.

Note: These columns are numeric conversions from dBm and dBrnc0 and are necessary since dB units cannot be added directly.

5. Enter into Fig. 49 the total thermal noise 10⁻¹⁵ watts to obtain the thermal noise requirement in dBm. For example, locate 249 on the horizontal axis of the chart in Fig. 49. Proceed vertically until the 249 line intersects with the diagonal line and read the thermal noise requirement directly from the left hand axis as -96.1 dBm. Enter the requirement on the worksheet.

Note: This step converts the numeric value back into dBm.

6. Likewise, enter into Fig. 50 the total noise load pWc0 to obtain the noise load requirement in dBrnc0. For example, locate 500 on the horizontal axis of the chart in Fig. 50. Proceed vertically until the 500 line intersects with the diagonal line and read the actual noise load requirement directly from the left hand axis as 27.0 dBrnc0. Enter the requirement on the worksheet.

Note: This step converts the numeric value back into dBrnc0.

BASEBAND FREQUENCY	BASEBAND RESPONSE LIMITS - SEE NOTE A NUMBER OF RADIO HOPS												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1 MHZ	CALIBRATION FREQUENCY (REFERENCE POINT)												
3 MHZ	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4	±0.4
6 MHZ	±0.4	±0.4	±0.4	+0.3 -0.5	+0.3 -0.6	+0.3 -0.6	+0.3 -0.6	+0.2 -0.6	+0.2 -0.6	+0.2 -0.8	+0.2 -0.8	+0.2 -0.8	+0.2 -0.8
7 MHZ	+0.4 -0.5	+0.4 -0.5	+0.4 -0.5	+0.3 -0.6	+0.3 -0.7	+0.3 -0.7	+0.2 -0.8	+0.2 -0.8	+0.2 -0.8	+0.2 -1.0	+0.2 -1.0	+0.2 -1.1	+0.2 -1.2
8 MHZ	+0.4 -0.6	+0.4 -0.6	+0.4 -0.7	+0.3 -0.8	+0.3 -0.8	+0.3 -0.9	+0.2 -1.0	+0.2 -1.1	+0.2 -1.1	+0.2 -1.2	+0.2 -1.2	+0.2 -1.3	+0.2 -1.3
9 MHZ	+0.3 -0.7	+0.3 -0.7	+0.3 -0.8	+0.3 -0.9	+0.3 -1.0	+0.3 -1.1	+0.2 -1.2	+0.2 -1.3	+0.2 -1.4	+0.2 -1.5	+0.2 -1.6	+0.2 -1.7	+0.2 -1.8
10 MHZ	+0.3 -0.9	+0.3 -0.9	+0.3 -1.1	+0.3 -1.2	+0.3 -1.4	+0.3 -1.5	+0.3 -1.7	+0.3 -1.8	+0.3 -2.0	+0.3 -2.2	+0.3 -2.4	+0.3 -2.6	+0.3 -2.8

TONE REQUIREMENT	SHALL NOT EXCEED
0.5 to 8.5 MHz	-98 dBm
8.5 to 8.9 MHz	-98 dBm
8.9 to 9.1 MHz	-98 dBm
9.1 to 11.4 MHz	-98 dBm
11.1 to 11.7 MHz†	-98 dBm

* Tones shall not exceed the thermal noise background in cases where the thermal noise requirement is higher than the tone requirement. See paragraph 4.30 for additional information concerning the measurement and analysis of low level tones.

Example: -98 is the tone requirement; -96 is the thermal noise background. The tones shall not exceed -96 dBm.

† For those channels carrying frequency diplexed aux channel.

TH-3 2400 CIRCUIT LOADING NOISE REQUIREMENT PER HOP

NORMAL RCVD CARR POWER dBm	THERMAL NOISE		NOISE LOAD	
	dBm	10 ⁻¹⁵ WATTS	dBrnc0	pWc0
-30	- 97.5	178	24.0	251
-29	- 98.5	141	23.0	200
-28	- 99.5	112	22.0	159
-27	-100.5	89	21.5	141
-26	-101.5	71	21.0	126
-25	-102.0	63	20.0	100
-24	-103.0	50	19.5	89
-23	-103.5	45	19.0	79
-22	-104.0	40	18.5	71
-21	-104.5	35	18.0	63
-20	-105.0	32	18.0	63
-19	-105.5	28	17.5	56
-18	-105.5	28	17.5	56

NOTE A: The limits given in this table pertain to channels on which the EDD has been equalized per section 413-100-501 and on which NO IF amplitude equalization has been applied. See part 4C for instructions on adjusting the J68330Y IF adjustable amplitude equalizer-amplifier to flatten the baseband response.

Fig. 65—TH-3(2400) Radio Systems—Switch-Section Baseband-Related Transmission Performance Limits

Description of Noise Power Ratio (NPR) Measuring Principle

The most effective method of evaluating radio system performance for a given multiplex load or determining the load carrying capacity of a radio system, is White Noise Loading. White Noise characteristics are very similar to those of Voice Multiplex so that noise may be legitimately used to simulate the multiplex load. When simulating a multiplex load with White Noise, there are three transmission parameters that must be satisfied before a true comparison between White Noise Load and multiplex carrying capacity of a radio system can be made:

1. The bandwidth of the White Noise must duplicate the bandwidth of the multiplex load.
2. The drive level of the White Noise signal must be the same as the normal drive level of the multiplex.
3. The White Noise signal spectrum must be flat within the band of interest.

The Baseband Noise Transmitter (White Noise Generator) generates a broad band of White Noise ^① that is suitable as a test signal for Baseband Response and Noise Load Measurements. The noise transmitter contains band limiting filters to restrict the noise generator output ^② to the frequency range for simulation of Baseband Response or various channel carrying capacity multiplex loads. The noise load transmitter also contains notch filters to block the noise transmitted in a small segment of the band ^③. The output power is variable and a step attenuator is provided in the output in order to obtain proper level for signal insertion at any transmission level point in the system.

Because of the triangular shape of the baseband noise characteristic, the signal-to-noise ratio will be greater for the lower frequencies than for the higher frequencies in the baseband. In order to equalize the S/N across the baseband, the signal is passed through a pre-emphasis network ^④, prior to being applied to the FM transmitter. The effect of the pre-emphasis network is to produce the same FM deviation ratio for all frequencies in the baseband, thus giving each slot approximately the same noise performance. The lower frequencies experience more noise than without pre-emphasis, but there is significant noise improvement at the higher frequencies.

The noise load signal at the output of the FM receiver ^⑤ will be similar to the noise shape at the FM transmitter input with two possible exceptions: 1) the noise shape at higher frequencies may reflect a Baseband Response roll-off or gross roll-up condition and 2) noise will appear in the notches, representing the noise characteristic of the system under test.

The de-emphasis network has the reverse shape characteristic of pre-emphasis to restore the flat shape of the baseband signal ^⑥. The noise load signal is analyzed to determine the thermal and intermodulation noise characteristics of the radio system under test. During Noise Power Ratio (NPR) measurements, it is not necessary to use a de-emphasis network, since the NPR ratio value is arrived from the difference between the signal level and noise in a specific notch. However, since the same test-up is used for other transmission tests requiring the use of a de-emphasis network, it is left in for simplicity reasons.

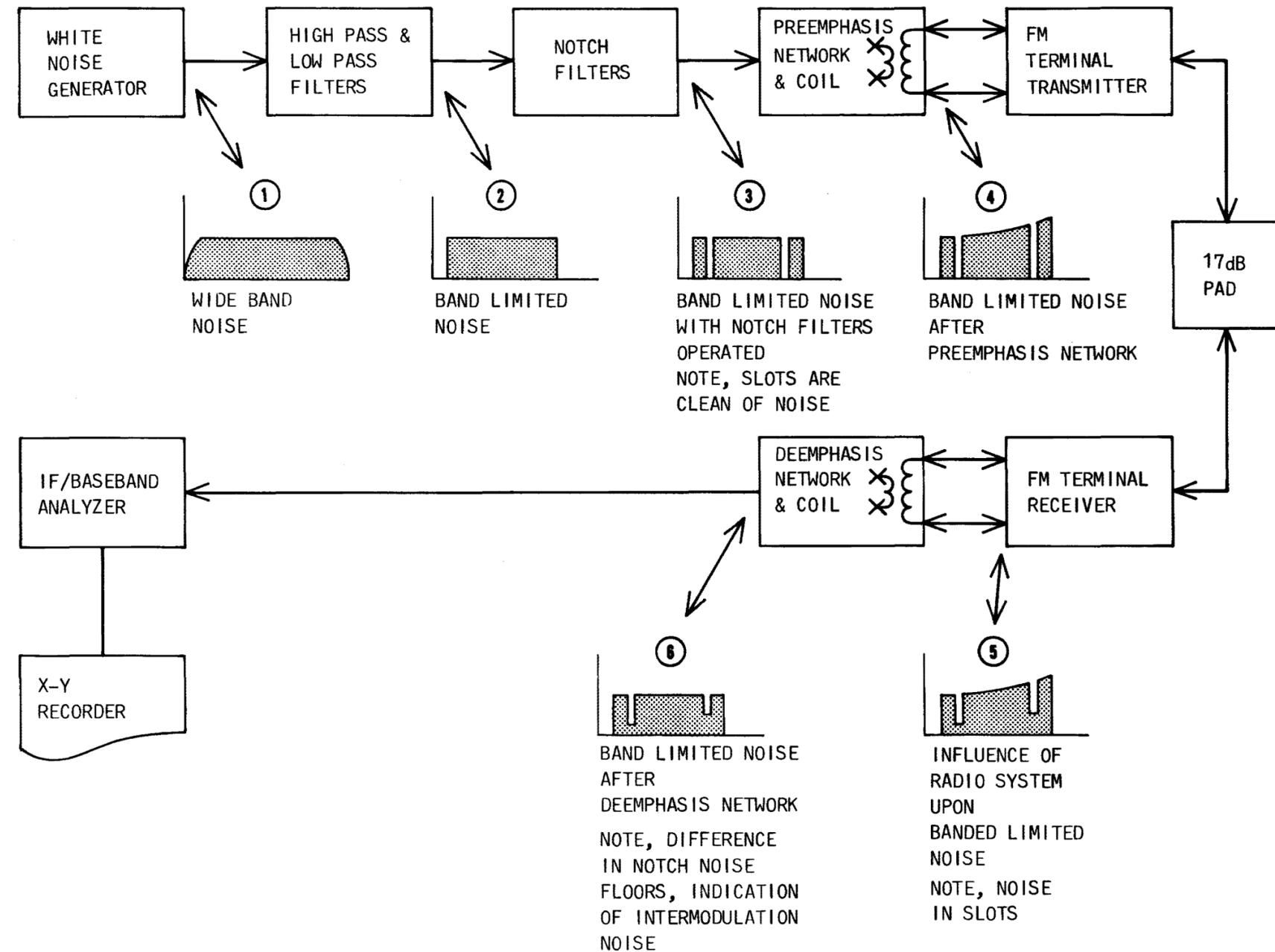


Fig. 66—Noise Power Ratio (NPR) Measuring Principle

TD-2, TD-3, TD3A, & *TD-3
 ADJACENT CHANNEL XPD FREQUENCY CHART
 (AT IF PREAMPLIFIER OUT)

CHANNEL UNDER TEST	ADJACENT CHANNEL																								
	7 3710	7 3750	8 3790	8 3830	9 3870	9 3910	10 3950	10 3990	11 4030	11 4070	12 4110	12 4150	1 3730	1 3770	2 3810	2 3850	3 3890	3 3930	4 3970	4 4010	5 4050	5 4090	6 4130	6 4170	
1	3730	90																							
1	3770		90																						
2	3810			90																					
2	3850				90																				
3	3890					50																			
3	3930						50																		
4	3970							50																	
4	4010								50																
5	4050									50															
5	4090										50														
6	4130											50													
6	4170												50												
7	3710													50											
7	3750														50										
8	3790															50									
8	3830																50								
9	3870																	90							
9	3910																		90						
10	3950																			90					
10	3990																				90				
11	4030																					90			
11	4070																						90		
12	4110																							90	
12	4150																								90

* The TD-3 XPD frequency point (50 or 90 MHz) is the same as TD-2 with the following exceptions:

- Early production bays equipped with the J68387D 40-MHz shifter oscillator and shift modulator units, (channels 3A, 3B, 9A, and 9B) may be different. In order to verify the exact frequency in the 70 ±25 MHz spectrum in which the adjacent channel will appear, the following format may be used:

Adjacent channel (XPD) frequency = difference between adjacent channel receive frequency + LO frequency of channel under test.

Fig. 67—TD Adjacent Channel XPD Frequency Chart

TH-3 & TH-1
 NT CHANNEL XPD FREQUENCY CHART
 (AT IF PREAMPLIFIER OUT)
 H-3 REGULAR FREQUENCY PLAN
 ADJACENT CHANNEL

63.5	6123.1	6152.8	6197.2	6226.9	6256.5	6286.2	6315.9	6345.5	6375.2	6404.8
6	17	18	21	22	23	24	25	26	27	28
9.7										
—	99.6									
0.4	—	99.7								
	40.3	—								
			—	99.7						
			40.3	—	99.6					
				40.4	—	99.7				
					40.3	—	99.7			
						40.3	—	99.6		
							40.4	—	99.7	
								40.3	—	99.6
									40.4	—

appear in the spectrum due to normal channel separation.

TH-1 REGULAR FREQUENCY PLAN

11	5945.2	—	44.53																
12	5974.8	103.78	—	44.88															
13	6004.5		103.83	—	44.43														
14	6034.2			103.78	—	44.48													
15	6063.8				44.55	—	103.85												
16	6093.5					44.47	—	103.77											
17	6123.1						44.52	—	103.82										
18	6152.8							44.47	—										
21	6197.2								—	44.47									
22	6226.9										103.82	—	44.52						
23	6256.5											103.77	—	44.47					
24	6286.2												103.82	—	44.42				
25	6315.9													44.48	—	103.78			
26	6345.5														44.53	—	103.83		
27	6375.2															44.48	—	103.78	
28	6404.8																44.53	—	

The 14.8-MHz frequency will cause a presentation at $14.8 + 74.13 = 88.93$ and $74.13 - 14.8 = 59.33$

Fig. 68—TH-3 and TH-1 Adjacent Channel XPD Frequency Chart

TH-3 & TH-1
 ADJACENT CHANNEL XPD FREQUENCY CHART
 (AT IF PREAMPLIFIER OUT)
 TH-3 REGULAR FREQUENCY PLAN
 ADJACENT CHANNEL

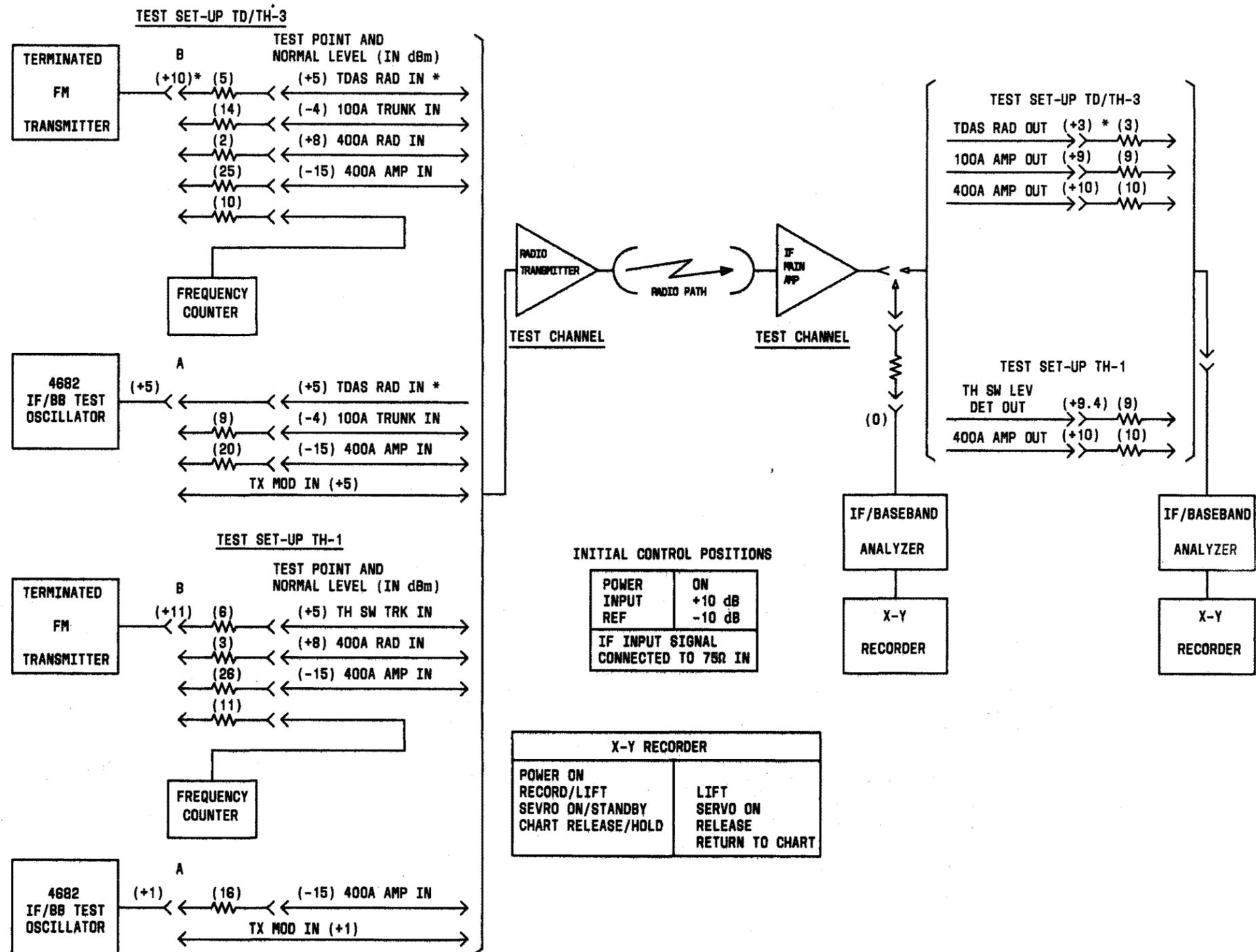
CHANNEL UNDER TEST		5945.2	5974.8	6004.5	6034.2	6063.8	6093.5	6123.1	6152.8	6197.2	6226.9	6256.5	6286.2	6315.9	6345.5	6375.2	6404.8
CH.	FREQ.	11	12	13	14	15	16	17	18	21	22	23	24	25	26	27	28
11	5945.2	—	99.6														
12	5974.8	40.4	—	99.7													
13	6004.5		40.3	—	99.7												
14	6034.2			40.3	—	99.6											
15	6063.8				40.4	—	99.7										
16	6093.5					40.3	—	99.6									
17	6123.1						40.4	—	99.7								
18	6152.8							40.3	—								
21	6197.2									—	99.7						
22	6226.9									40.3	—	99.6					
23	6256.5										40.4	—	99.7				
24	6286.2											40.3	—	99.7			
25	6315.9												40.3	—	99.6		
26	6345.5													40.4	—	99.7	
27	6375.2														40.3	—	99.6
28	6404.8															40.4	—

Frequency of 59.3 MHz will appear in the spectrum due to normal channel separation.

TH-1 REGULAR FREQUENCY PLAN

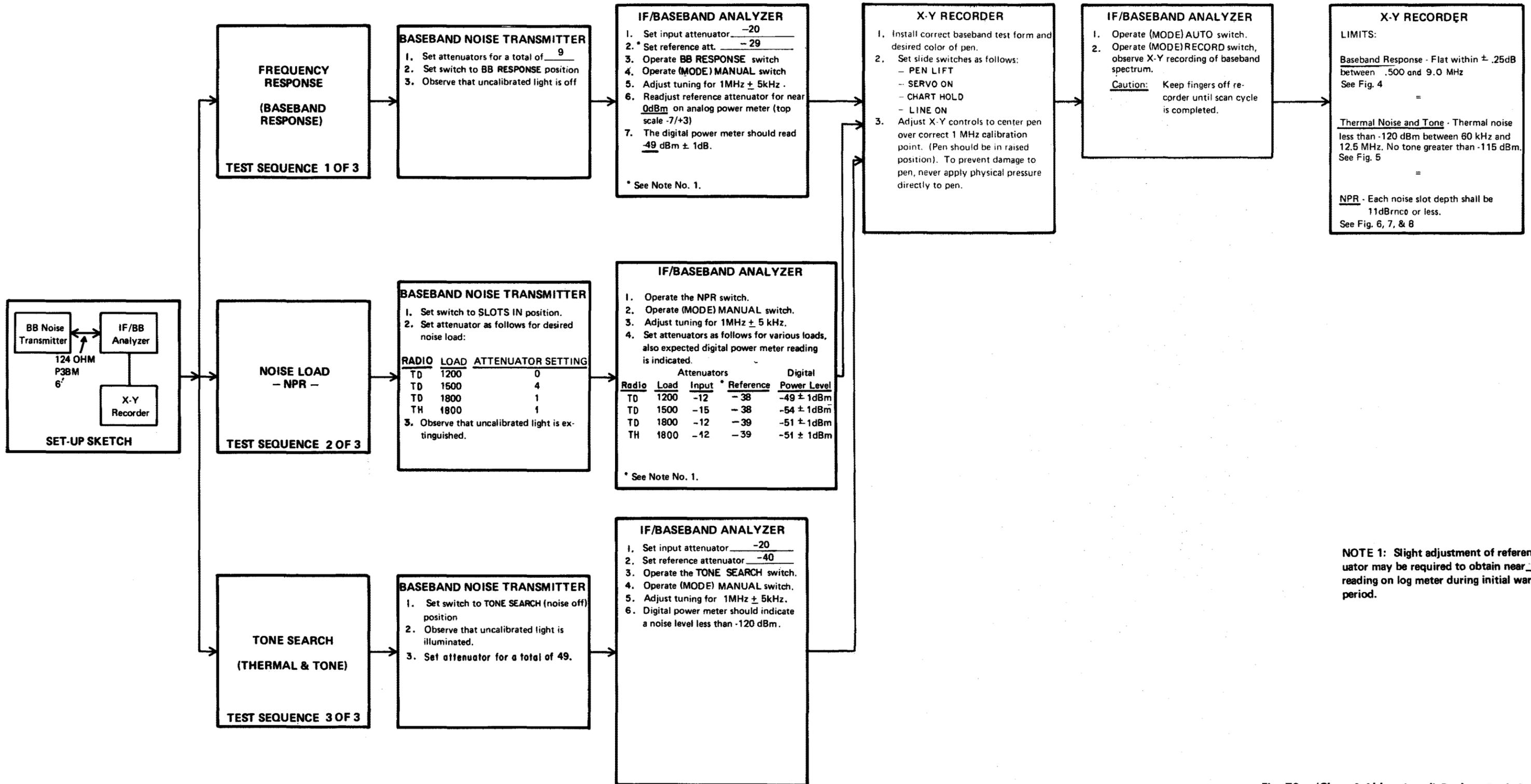
11	5945.2	—	44.53														
12	5974.8	103.78	—	44.88													
13	6004.5		103.83	—	44.43												
14	6034.2			103.78	—	44.48											
15	6063.8				44.55	—	103.85										
16	6093.5					44.47	—	103.77									
17	6123.1						44.52	—	103.82								
18	6152.8								44.47	—							
21	6197.2																
22	6226.9																1
23	6256.5																
24	6286.2																
25	6315.9																
26	6345.5																
27	6375.2																
28	6404.8																

The 14.8-MHz frequency will cause a presentation at $14.8 + 74.13 = 88.93$ and 74.13



* THIS IS NOT A CONTROLLED LEVEL POINT. PADS SHOULD BE SELECTED TO INSURE:
 1. CORRECT IF POWER AT TRMTR MOD IN
 2. 0 dBm AT IF/BASEBAND ANALYZER IN.

Fig. 69—Test Arrangement for C/I Measurements



NOTE 1: Slight adjustment of reference attenuator may be required to obtain near "0" dBm reading on log meter during initial warm up period.

Fig. 70— (Chart 1 Abbreviated) Back-to-Back Calibration Test Procedures for TD(1200), TD(1500)/(45 Mb/s), TD(1800), and TH(1800) SCIENTIFIC-ATLANTA Test Set Only

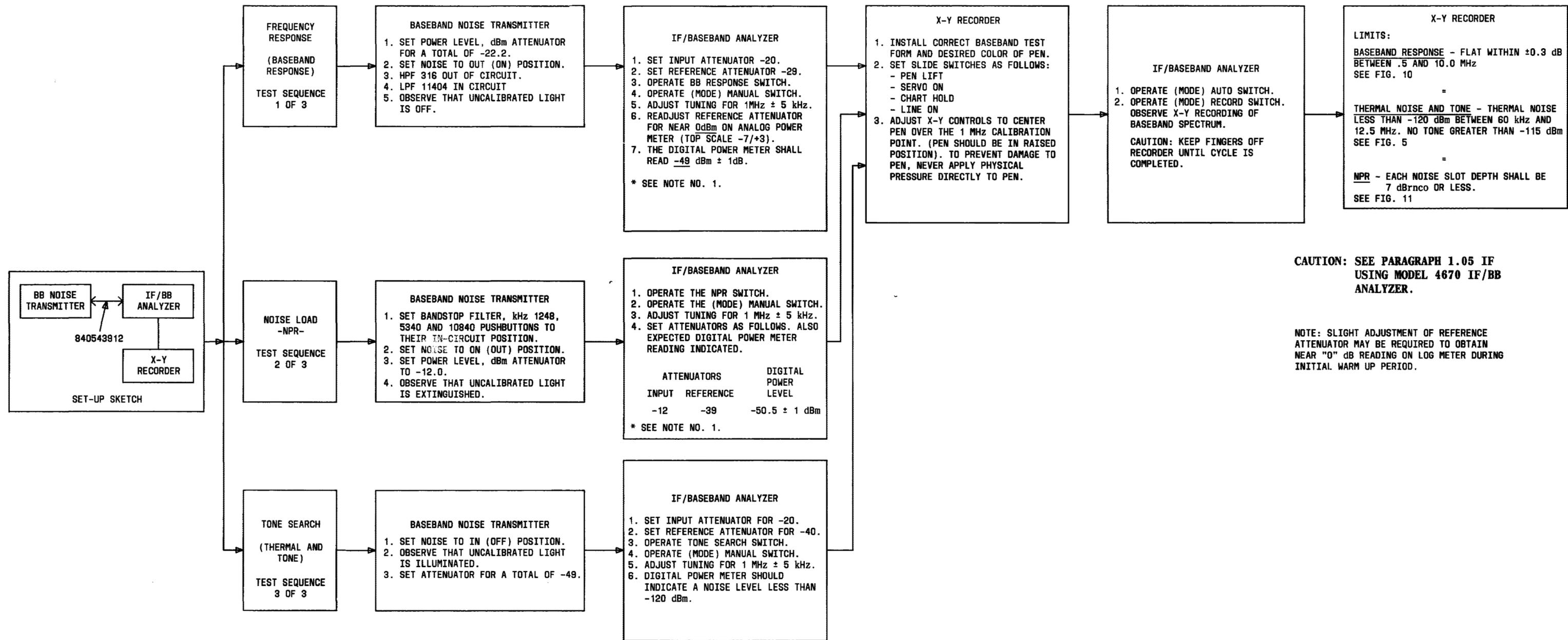
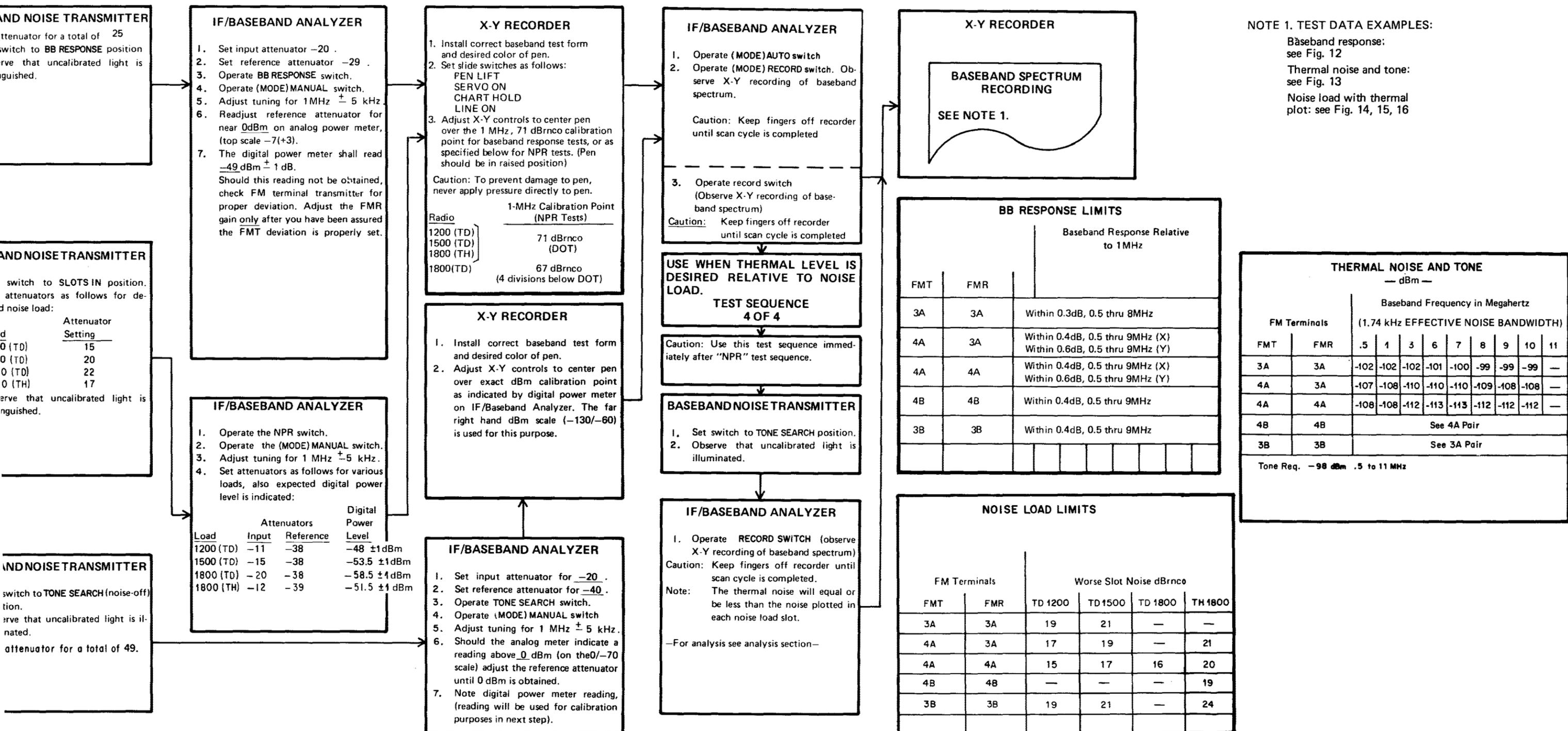


Fig. 71—(Chart 2 Abbreviated) Back-to-Back Calibration Test Procedures for TH(2400)—SCIENTIFIC-ATLANTA Test Set Only



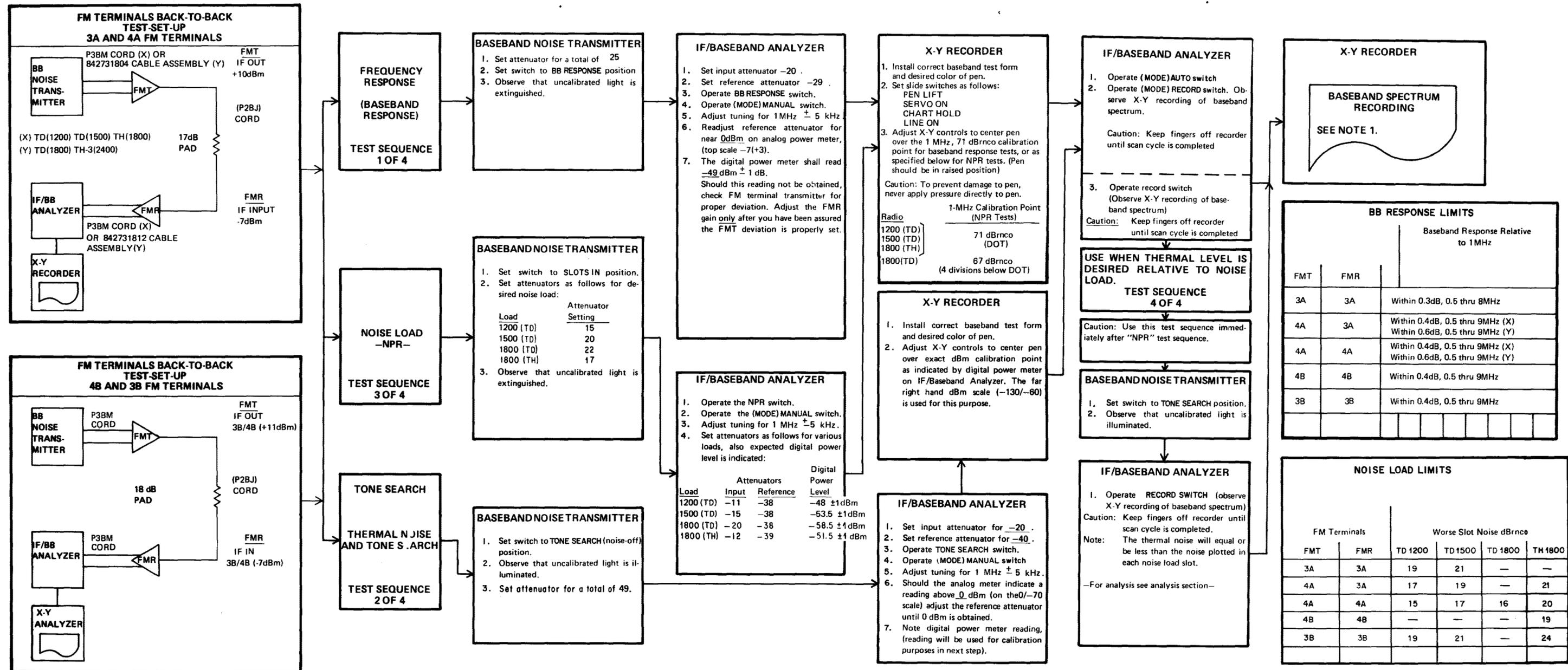
NOTE 1. TEST DATA EXAMPLES:

Baseband response:
see Fig. 12

Thermal noise and tone:
see Fig. 13

Noise load with thermal
plot: see Fig. 14, 15, 16

Fig. 72—(Chart 3 Abbreviated) Back-to-Back Calibration
Test Procedures for TD(1200), TD(1500)/
(45Mb/s), TD(1800), and TH(1800)—SCIEN-
TIFIC-ATLANTA Test Set and FM Terminals Only



NOTE 1. TEST DATA EXAMPLES:
 Baseband response:
 see Fig. 12
 Thermal noise and tone:
 see Fig. 13
 Noise load with thermal
 plot: see Fig. 14, 15, 16

BB RESPONSE LIMITS		
Baseband Response Relative to 1MHz		
FMT	FMR	
3A	3A	Within 0.3dB, 0.5 thru 8MHz
4A	3A	Within 0.4dB, 0.5 thru 9MHz (X) Within 0.6dB, 0.5 thru 9MHz (Y)
4A	4A	Within 0.4dB, 0.5 thru 9MHz (X) Within 0.6dB, 0.5 thru 9MHz (Y)
4B	4B	Within 0.4dB, 0.5 thru 9MHz
3B	3B	Within 0.4dB, 0.5 thru 9MHz

THERMAL NOISE AND TONE											
- dBm -											
FM Terminals		Baseband Frequency in Megahertz (1.74 kHz EFFECTIVE NOISE BANDWIDTH)									
FMT	FMR	.5	1	3	6	7	8	9	10	11	
3A	3A	-102	-102	-102	-101	-100	-99	-99	-99	-	-
4A	3A	-107	-108	-110	-110	-110	-109	-108	-108	-	-
4A	4A	-108	-108	-112	-113	-113	-112	-112	-112	-	-
4B	4B	See 4A Pair									
3B	3B	See 3A Pair									

Tone Req. -98 dBm .5 to 11 MHz

NOISE LOAD LIMITS						
FM Terminals		Worse Slot Noise dBm				
FMT	FMR	TD 1200	TD 1500	TD 1800	TH 1800	
3A	3A	19	21	-	-	
4A	3A	17	19	-	21	
4A	4A	15	17	16	20	
4B	4B	-	-	-	19	
3B	3B	19	21	-	24	

Fig. 72—(Chart 3 Abbreviated) Back-to-Back Calibration Test Procedures for TD(1200), TD(1500)/(45Mb/s), TD(1800), and TH(1800)—SCIENTIFIC-ATLANTA Test Set and FM Terminals Only

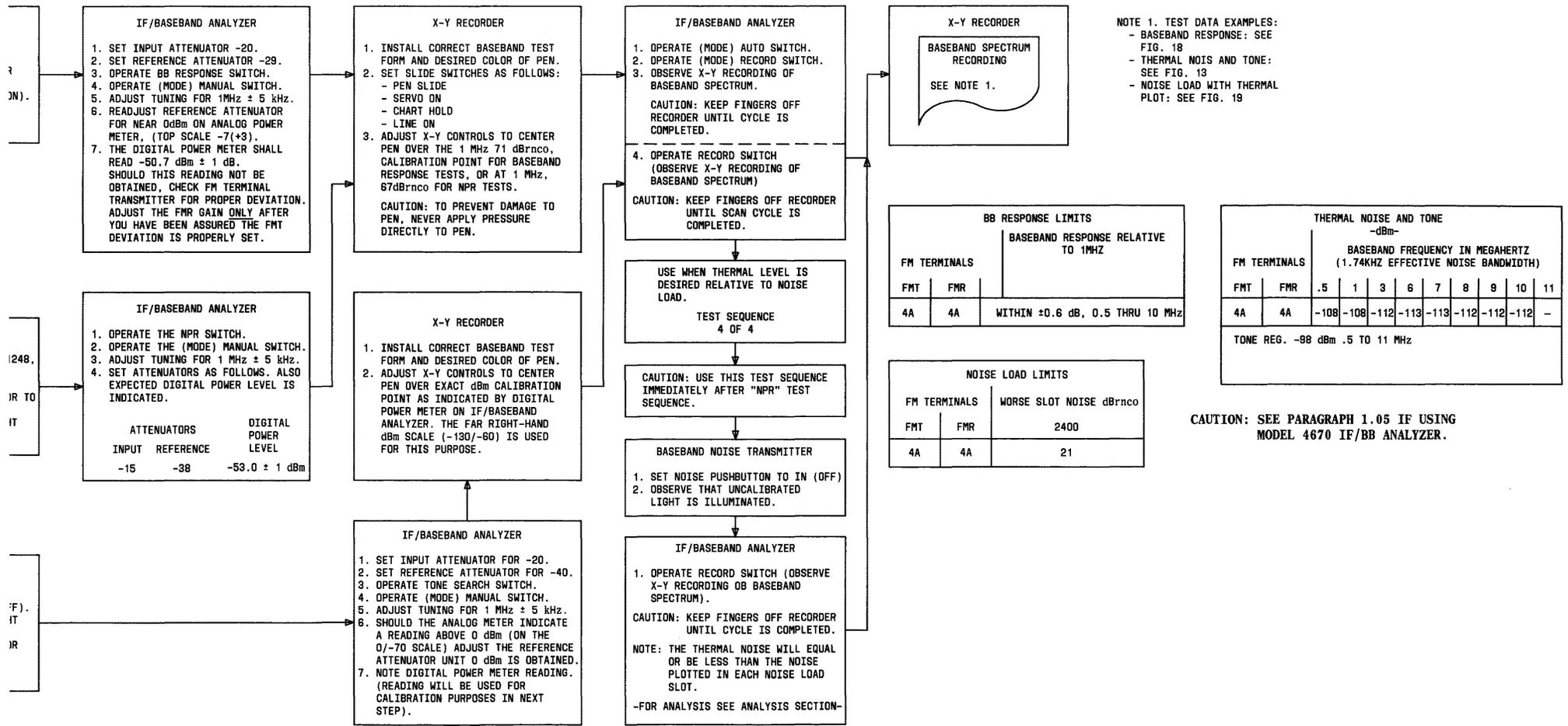
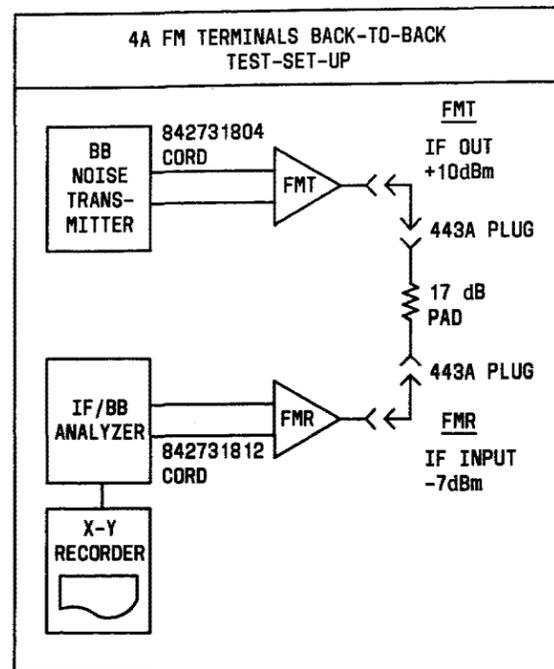


Fig. 73—(Chart 4 Abbreviated) Back-to-Back Calibration Test Procedures for TH(2400)—SCIENTIFIC-ATLANTA Test Set and FM Terminals Only



FREQUENCY RESPONSE (BASEBAND RESPONSE)
TEST SEQUENCE 1 OF 4

BASEBAND NOISE TRANSMITTER

1. SET POWER LEVEL dBm ATTENUATOR FOR -24.4.
2. SET NOISE PUSHBUTTON TO OUT (ON).
3. OBSERVE THAT UNCALIBRATED LIGHT IS EXTINGUISHED.

IF/BASEBAND ANALYZER

1. SET INPUT ATTENUATOR -20.
2. SET REFERENCE ATTENUATOR -29.
3. OPERATE BB RESPONSE SWITCH.
4. OPERATE (MODE) MANUAL SWITCH.
5. ADJUST TUNING FOR 1MHz \pm 5 kHz.
6. READJUST REFERENCE ATTENUATOR FOR NEAR 0dBm ON ANALOG POWER METER, (TOP SCALE -7(+3)).
7. THE DIGITAL POWER METER SHALL READ -50.7 dBm \pm 1 dB. SHOULD THIS READING NOT BE OBTAINED, CHECK FM TERMINAL TRANSMITTER FOR PROPER DEVIATION. ADJUST THE FMR GAIN ONLY AFTER YOU HAVE BEEN ASSURED THE FMT DEVIATION IS PROPERLY SET.

X-Y RECORDER

1. INSTALL CORRECT BASEBAND TEST FORM AND DESIRED COLOR OF PEN.
2. SET SLIDE SWITCHES AS FOLLOWS:
- PEN SLIDE
- SERVO ON
- CHART HOLD
- LINE ON
3. ADJUST X-Y CONTROLS TO CENTER PEN OVER THE 1 MHz 71 dBm_{nc}, CALIBRATION POINT FOR BASEBAND RESPONSE TESTS, OR AT 1 MHz, 67dBm_{nc} FOR NPR TESTS.

CAUTION: TO PREVENT DAMAGE TO PEN, NEVER APPLY PRESSURE DIRECTLY TO PEN.

IF/BASEBAND ANALYZER

1. OPERATE (MODE) AUTO SWITCH.
2. OPERATE (MODE) RECORD SWITCH.
3. OBSERVE X-Y RECORDING OF BASEBAND SPECTRUM.

CAUTION: KEEP FINGERS OFF RECORDER UNTIL CYCLE IS COMPLETED.

NOISE LOAD -NPR-
TEST SEQUENCE 3 OF 4

BASEBAND NOISE TRANSMITTER

1. SET THE BANDSTOP FILTER, KHz 1248, 5340 AND 10840 PUSHBUTTONS TO THEIR IN-CIRCUIT POSITION.
2. SET POWER LEVEL, dBm ATTENUATOR TO -15.4.
3. OBSERVE THAT UNCALIBRATED LIGHT IS EXTINGUISHED.

IF/BASEBAND ANALYZER

1. OPERATE THE NPR SWITCH.
2. OPERATE THE (MODE) MANUAL SWITCH.
3. ADJUST TUNING FOR 1 MHz \pm 5 kHz.
4. SET ATTENUATORS AS FOLLOWS. ALSO EXPECTED DIGITAL POWER LEVEL IS INDICATED.

ATTENUATORS		DIGITAL POWER LEVEL
INPUT	REFERENCE	LEVEL
-15	-38	-53.0 \pm 1 dBm

X-Y RECORDER

1. INSTALL CORRECT BASEBAND TEST FORM AND DESIRED COLOR OF PEN.
2. ADJUST X-Y CONTROLS TO CENTER PEN OVER EXACT dBm CALIBRATION POINT AS INDICATED BY DIGITAL POWER METER ON IF/BASEBAND ANALYZER. THE FAR RIGHT-HAND dBm SCALE (-130/-60) IS USED FOR THIS PURPOSE.

USE WHEN THERMAL LEVEL IS DESIRED RELATIVE TO NOISE LOAD.
TEST SEQUENCE 4 OF 4

CAUTION: USE THIS TEST SEQUENCE IMMEDIATELY AFTER "NPR" TEST SEQUENCE.

BASEBAND NOISE TRANSMITTER

1. SET NOISE PUSHBUTTON TO IN (OFF)
2. OBSERVE THAT UNCALIBRATED LIGHT IS ILLUMINATED.

TONE SEARCH THERMAL NOISE AND TONE SEARCH
TEST SEQUENCE 2 OF 4

BASEBAND NOISE TRANSMITTER

1. SET NOISE PUSHBUTTON TO IN (OFF).
2. OBSERVE THAT UNCALIBRATED LIGHT IS ILLUMINATED.
3. SET POWER LEVEL, dBm ATTENUATOR FOR A TOTAL OF -50.7.

IF/BASEBAND ANALYZER

1. SET INPUT ATTENUATOR FOR -20.
2. SET REFERENCE ATTENUATOR FOR -40.
3. OPERATE TONE SEARCH SWITCH.
4. OPERATE (MODE) MANUAL SWITCH.
5. ADJUST TUNING FOR 1 MHz \pm 5 kHz.
6. SHOULD THE ANALOG METER INDICATE A READING ABOVE 0 dBm (ON THE 0/-70 SCALE) ADJUST THE REFERENCE ATTENUATOR UNIT 0 dBm IS OBTAINED.
7. NOTE DIGITAL POWER METER READING. (READING WILL BE USED FOR CALIBRATION PURPOSES IN NEXT STEP).

IF/BASEBAND ANALYZER

1. OPERATE RECORD SWITCH (OBSERVE X-Y RECORDING OF BASEBAND SPECTRUM).

CAUTION: KEEP FINGERS OFF RECORDER UNTIL CYCLE IS COMPLETED.

NOTE: THE THERMAL NOISE WILL EQUAL OR BE LESS THAN THE NOISE PLOTTED IN EACH NOISE LOAD SLOT.

-FOR ANALYSIS SEE ANALYSIS SECTION

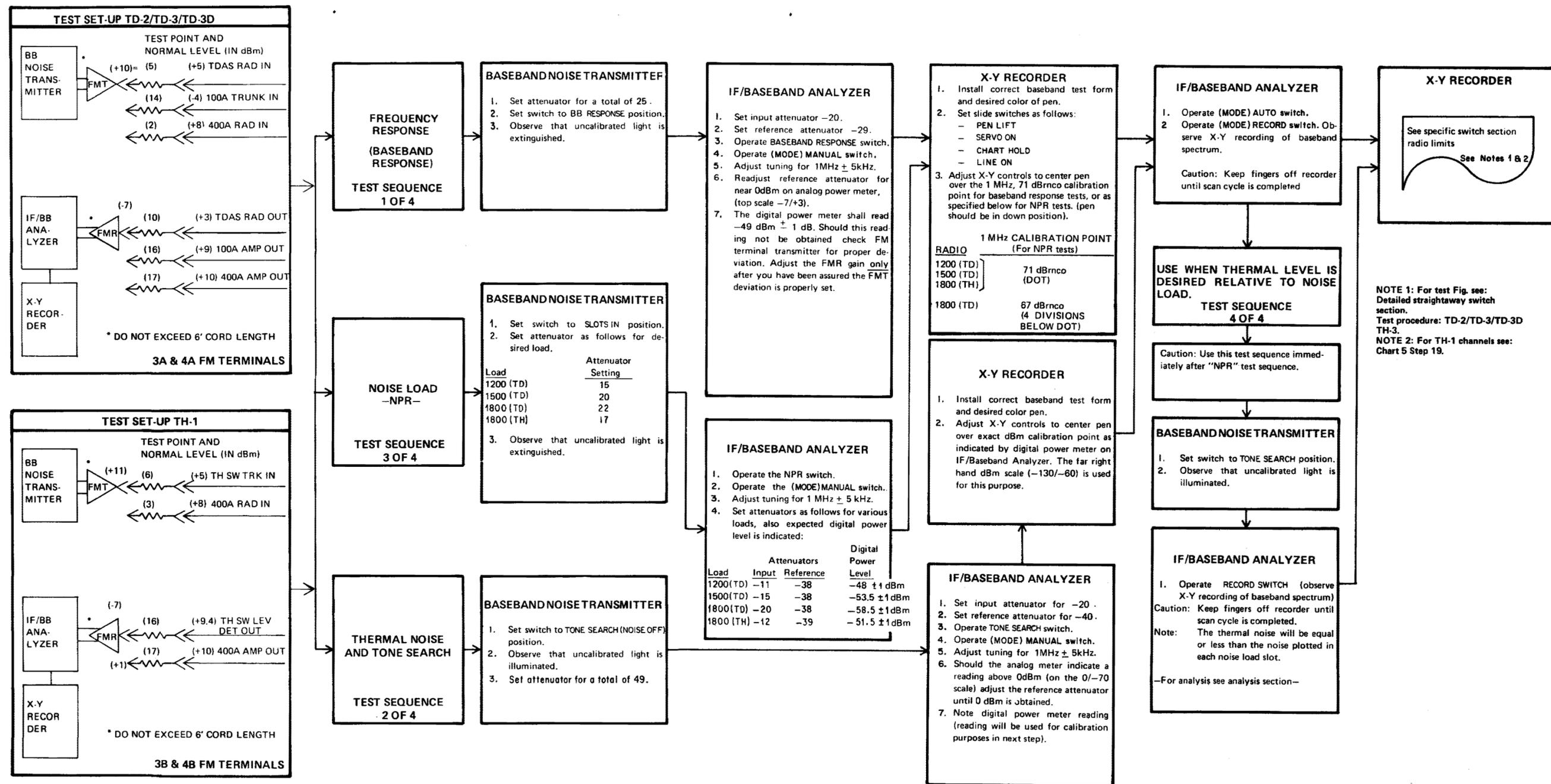


Fig. 74—(Chart 5 Abbreviated) Straight-Away Switch-Section Test Procedure for TD-2, TD-3, TD-3A, TD-3D, TH-1, and TH-3(1800)

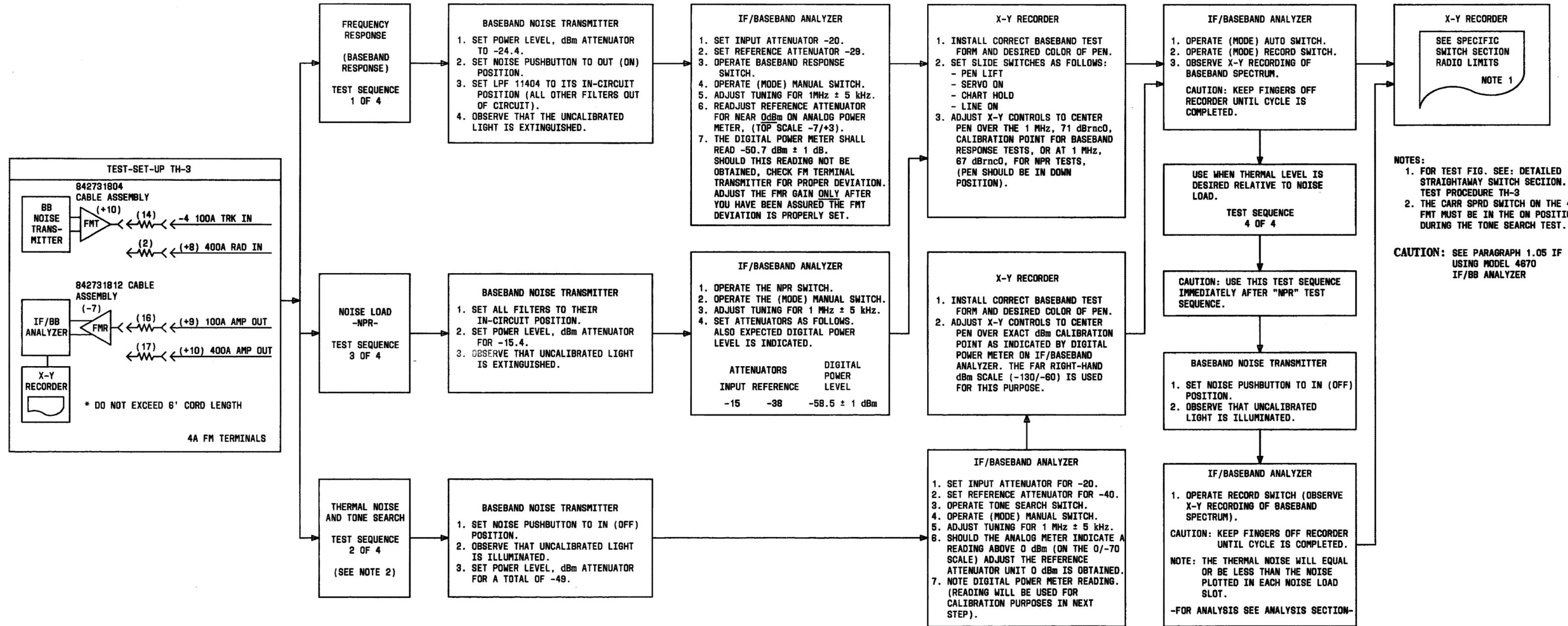


Fig. 75—(Chart 6 Abbreviated) Straight-Away Switch Section Test Procedure for TH-3(2400)

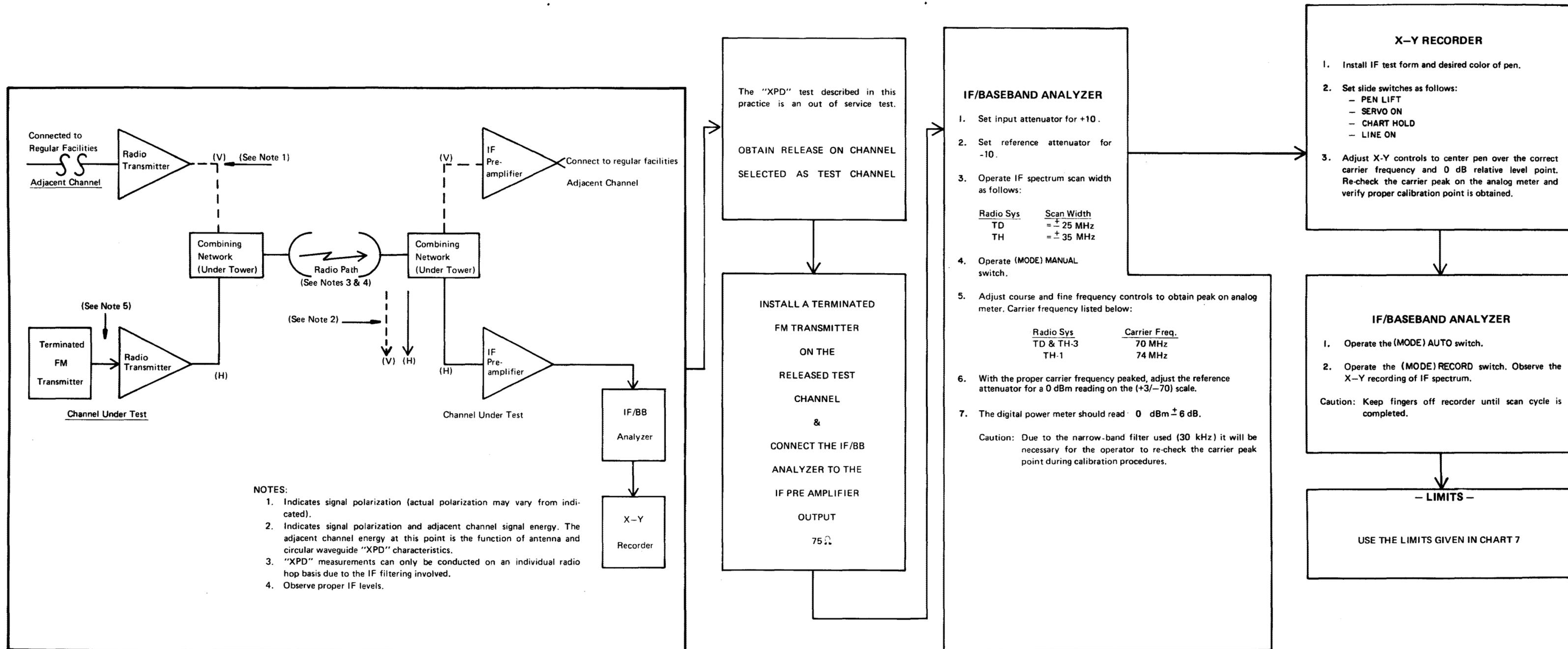


Fig. 76— (Chart 7 Abbreviated) XPD Measurement

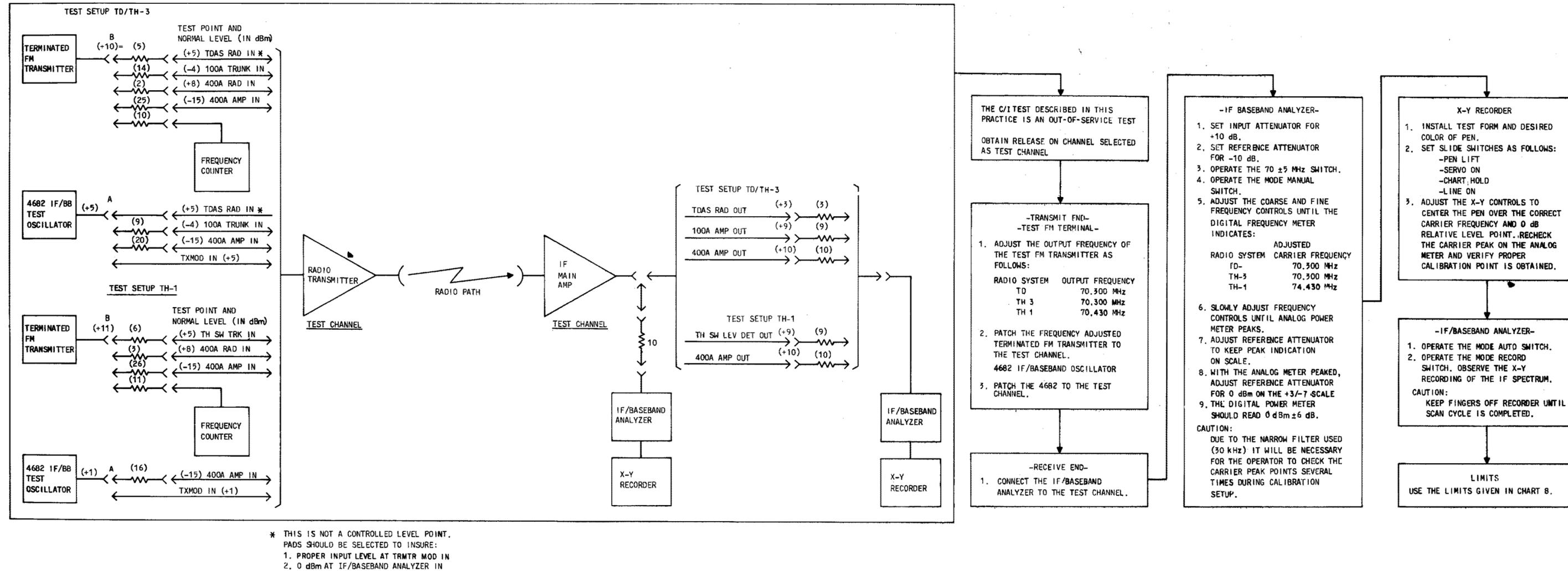


Fig. 77—(Chart 8 Abbreviated) C/I Measurement