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TD-3 MICROWAVE RADIO
OVERALL SYSTEM
TESTS
CHANNEL NET GAIN AND BASEBAND RESPONSE

1. GENERAL

1.001 This addendum supplements Section 411-100-503, Issue 1. The attached pages must be inserted in the section in accordance with the filing instructions above.

1.002 This addendum is issued to correct Fig. 3.

Attached:

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TD-3 MICROWAVE RADIO
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CONTENTS PAGE

1. GENERAL

1.01 The TD-3 Microwave Radio System provides approximately 16-dB channel net gain across that portion of the baseband extending from a few hertz to about 6 MHz. Roll-off, or a reduction in the channel net gain, begins above 6 MHz. The amount of roll-off depends primarily on the number of radio hops. This section describes a method of measuring the channel net gain at 50 kHz. Also included are test procedures for measuring the relative baseband response from 200 kHz to 10 MHz on either a point-by-point or a swept-frequency basis.

1.02 Point-by-point baseband response measurements are used to measure accurately the system gain as a function of baseband frequency. The baseband response of each TD-3 radio channel should be as "flat" as possible out to about 6 MHz, the top of the message band. If it is not, service over the channel may be adversely affected. This degradation depends upon the accumulated amount and character of the irregularities and the type of service being carried. For telephone service, for example, peaks and valleys between 500 kHz and 6 MHz affect individual supergroups differently, with the result that an excessive number of adjustments of the supergroup levels may be required. Furthermore, a difference of as little as 0.25 dB between the baseband response of a regular channel and a protection channel may cause a hit to be made on some forms of data signals when a protection switch is made.

1.03 Swept baseband response measurements are useful as a supplement to the more accurate point-by-point measurements. The swept measurement permits making a rapid check of the baseband response of a particular system, and such a check may be especially useful to determine quickly if any gross changes have occurred. The swept measurement also permits a rapid observation of the effect of making changes in the system, such as changes in the system equalization. In general, however, the swept measurement does not provide the accuracy inherent in the point-by-point method and, therefore, should be regarded as a secondary-type measurement.

1.04 Some baseband roll-off is expected in the system, principally because of imperfect amplitude and delay equalization of the radio repeaters and, to a much smaller extent, in the FM terminals. Roll-off above about 6 MHz can be predicted from the nominal transmission characteristic of the radio repeaters. The measurements, on the other hand, may show a markedly different response from that predicted and thus may serve to disclose the presence of abnormal repeater or FM terminal transmission response.

1.05 Excessive roll-off at about 9 MHz may impair the operation of the 100A Automatic Protection Switching System. This system detects the noise power in a 140-kHz slot at 9 MHz and uses this power as a measure of the noise condition

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of the message band below 6 MHz. If within a switching section the expected noise level at 9 MHz is abnormally reduced because of excessive roll-off, the switching system for that section may not request a switch, even though the lower frequencies may be in an unacceptably high noise condition.

2. TEST PROCEDURES

CHART 1

CHANNEL NET GAIN

APPARATUS:

Transmitting Station

1—J64061C (61C) Signal Generator [or a J64061B (61B) Signal Generator With a 75:124 ohm repeat coil]

1—J64070B (70B) Power Meter

2—24H Pads (Part of the J68337J FM terminal test panel and may be used if convenient)

1—35A Pad (Part of the J68337J FM terminal test panel and may be used if convenient)

2—372A Patch Plugs (Part of the J68392A transmitter-receiver test set and may be used if convenient)

3—P3AT cords (6 feet long)

Receiving Station

1—J64037B (37B) Transmission Measuring Set

1—J64070B (70B) Power Meter

1—P3AT Cord (6 feet long)

1—P2BJ Cord (2 feet long) (Part of the J68392A transmitter-receiver test set and may be used if convenient).

STEP	PROCEDURE
1	Warm up the 61C signal generator and the 37B transmission measuring set for at least 1 hour before starting the tests.
2	At the transmitting station, measure and adjust, if required, the rest frequency and deviation sensitivity of the FM terminal transmitter in accordance with Sections 411-200-502 and 411-200-506, respectively.
3	At the receiving station, check the FM receiver in accordance with Section 411-205-503.

CHART (Cont)

STEP	PROCEDURE
4	At each station, set up the test equipment as shown in the appropriate section of Fig. 1 and 3. Use option (X) at the receiving station. Set the IMPEDANCE switch on the 61C signal generator to the 124 OHM BAL position and the OUT 1 switch to the SINE position. ***Caution: To prevent damage to the 70B power meter, set the SINE WAVE OUTPUT LEVEL DBV 10-dB step attenuator switch to the –10 dB position before connecting the power meter to the test circuit.***
5	At the transmitting station, set the 61C signal generator to 50 kHz, using the SINE WAVE FREQUENCY controls.
6	Set the SINE WAVE OUTPUT LEVEL DBV 1-dB step attenuator to –4 dB, and the 10-dB step attenuator to +10 dB. Adjust the LEVEL ZERO ADJ COARSE and FINE controls to obtain an indication of 0 dBm on the power meter.
7	At the receiving station, note the indication on the 70B power meter. ***Requirement:*** The 70B power meter shall indicate 0 dBm ±0.3 dB. This represents a channel net gain of +15.7 to +16.3 dB. If the requirement is not met, recheck the deviation of the FM transmitter and the gain of the FM receiver in accordance with Sections 411-200-506 and 411-205-503, respectively.
8	If the point-by-point baseband response of the system is to be measured, leave the test equipment as last arranged and proceed with Chart 2.

CHART 2

POINT-BY-POINT BASEBAND RESPONSE

APPARATUS:

Same as Chart 1

STEP	PROCEDURE
	Prerequisite: The channel must meet the requirements of envelope delay distortion testing according to Section 411-100-501. ***Note:*** Perform the procedures listed in Chart 1, then continue with Step 1.

CHART (Cont)	
STEP	**PROCEDURE**
1	At the receiving station, change the test connections of Fig. 1 to option (Y) and tune the 37B transmission measuring set for a maximum indication at 50 kHz.
2	Adjust the CAL control on the 37B transmission measuring set so that the meter indicates the same level as in Step 7 of Chart 1. ***Note:*** This calibration procedure is recommended in place of the internal calibration adjustment provided in the 37B transmission measuring set. The above procedure results in a calibration adjustment that compensates for the repeat coil loss at 50 kHz. By compensating for the coil loss at 50 kHz, the error in the measurement introduced by the coil loss at other frequencies is expected to be no greater than about ±0.1 dB over the 10-Hz to 10-MHz range.
3	At the transmitting station, set the 61C signal generator to 200 kHz, using the SINE WAVE FREQUENCY controls.
4	Set the 10-dB step attenuator to +10 dB and adjust the LEVEL ZERO ADJ COARSE and FINE controls to obtain an indication of 0 dBm on the 70B power meter.
5	Switch the SINE WAVE OUTPUT DBV 10-dB step attenuator to the 0-dB position. ***Note:*** This will reduce the drive into the FM transmitter by 10 dB and will give a measuring signal approximately 14 dB below that required for full (±4 MHz) deviation. A low level signal is required for the baseband response measurement. If a high level signal is used (one which approaches that required for full deviation), significant power will be present in the second- and third-order sidebands of the FM signal being transmitted over the radio channel. Because of roll-off in the radio repeaters outside the nominal 64- to 76-MHz IF band, these higher-order sidebands will be significantly attenuated for test tone frequencies above about 4 MHz. As a result, the measurement made with a high level drive into the FM transmitter will show a larger baseband roll-off than is actually present.
6	At the receiving station, tune the 37B transmission measuring set to 200 kHz and measure and record the received tone power. ***Note:*** At each test frequency, tune the ×1 FREQ-KC control to obtain a maximum reading on the meter. An indication of approximately -10 dBm should be obtained in the region of flat baseband response.
7	At the transmitting station, repeat Steps 3 through 5 for each of the frequencies in Table A.
8	At the receiving station, measure and record the output at the listed frequencies. Compute the relative baseband response by comparing each measurement with the value recorded at 200 kHz. Compare this relative baseband response with the limit given in Table A. If the limits are not met, see Part 3.

CHART 3

SWEPT BASEBAND RESPONSE

APPARATUS:

Transmitting Station

1—J68362A Video Visual Test Set Transmitter

1—P3AT Cord (6 feet long)

Receiving Station

1—J68362B Video Visual Test Set Receiver with patch cords

1—P3AT Cord (6 feet long)

1—Dumont 304A Oscilloscope

STEP	PROCEDURE
1	Calibrate the video visual test set according to Section 103-710-501, using balanced connections.
2	Make the test connections at each station as shown on Fig. 2 and 3.
3	At the transmitting station, set the SYNC switch to OFF. Set the TRS ATT-DB attenuator for a total of 15 dB. ***Note:*** Assuming a 0.6-dB loss in the repeat coil, this setting will give a power of approximately -26 dBm into the FM transmitter.
4	At the receiving station, set the CAL ATT-DB dial to 0 dB and the INPUT switch to NORMAL.
5	Set the REC ATT-DB attenuator for 10 dB. ***Note:*** Including the 0.6-dB loss in the repeat coil, this setting should give a power of -20 dBm into the video visual test set receiver.
6	On the oscilloscope, use ac input and external sweep for the X axis. Use dc input for the Y axis. Adjust the oscilloscope controls for a suitable horizontal display and the desired vertical sensitivity. ***Note:*** The REC SYNC control on the video visual test set receiver may have to be adjusted slightly to maintain horizontal stability of the oscilloscope waveform.
7	Using the CAL ATT-DB control and the MRK OSC control, measure the video response and compare it with the limits given in Table A.

3. TROUBLE LOCATION

3.01 If the baseband response limits are not met, it may be necessary to perform additional tests, depending upon the amount and character of the departure from the limits. Considerable judgment must be used in determining the necessity of further action, and the following can do no more than point out some causes of response impairment and suggest reasonable procedures to follow when the limits are considerably exceeded or when adverse service reactions have been encountered.

3.02 The decision as to whether or not further remedial action is required on channels which do not meet limits may be based, in part, on the following:

(1) ***Comparison with Other Channels:*** Where all but one or two of a number of similar channels in a given section meet the limits, the offending channels might well be checked further, depending upon the degree of response variation, as well as the other factors mentioned here.

(2) ***Past History of Channel:*** A channel which has met limits in the past but which does not now, or one which shows a marked change from its previous condition, should be investigated.

(3) ***Effects on Service:*** Obviously, further action should be taken when adverse service reports have been received which suggest that the baseband response may be the cause. Some of these general effects were mentioned in Part 1 of this section. A specific example of one such effect is failure of the automatic protection switching system to switch to the protection channel before noise on the regular channel becomes unacceptably high. The cause of this "late" switch may be separated between the switching system equipment itself and the effect of baseband response by noting whether the high-frequency roll-off at 9 MHz meets the objective.

3.03 Impaired baseband frequency response may be caused by an abnormal transmission characteristic in one or more repeaters or in the FM terminal equipment. Improper IF levels, particularly if excessively high either in the radio repeaters or in any other portion of the system included in the baseband measurement, may result in an out-of-limit baseband response.

3.04 One approach to determining the source of an abnormal baseband response is to sectionalize the system under test in order to locate the portion that seems to be the major contributor to the problem. In some instances, simultaneous baseband response tests made to intervening main stations may help isolate the trouble to a specific switching section by using either their own FM terminal equipment or portable equipment brought in. This procedure may yield helpful results and, considering the relative ease of making the simultaneous measurements, should be employed. Portable FM terminals also may be used to help isolate trouble to one or more hops within a switching section.

3.05 If the sectionalizing tests isolate the problem to one or more radio hops, the RF and IF amplitude response of the radio repeaters associated with those hops should be checked (and brought within limits), using the 411-4XX-XXX maintenance practices for the TD-3 transmitter-receiver bay. Envelope delay distortion measurements, made according to Section 411-100-501 on one or more of the radio hops in the section in question, may be helpful in identifying the source of trouble. IF levels throughout the portion of the system being investigated should also be checked.

3.06 The effect of the FM terminals may be determined by making a back-to-back baseband response measurement of the terminal equipment. Naturally, on the usual straightaway-type measurement, with the FM terminal transmitter and receiver widely separated by the radio channel, the terminals being used cannot be measured directly. However, response measurements can be made on the terminal equipment at each end, coupled with complementary terminal equipment located at the end stations. Using this method, a suspect unit may be found and should then be routined or replaced before proceeding with further testing.

TABLE A

BASEBAND RESPONSE LIMITS IN DB

FREQUENCY	1 HOP	2 HOPS	3 HOPS	4 HOPS	5 HOPS	6 HOPS	7 HOPS	8 HOPS	9 HOPS	10 HOPS	11 HOPS	12 HOPS	n HOPS	
													MEAN	DEVIATION
200 kHz	REF.	REF.	REF.	REF.	REF.	REF.	REF.	REF.	REF.	REF.	REF.	REF.		
400														
700														
1 MHz	+.1 to −.1	+.1 to −.1	+.2 to −.2	+.2 to −.2	+.2 to −.2	+.2 to −.2	+.3 to −.3	+.3 to −.3	+.3 to −.3	+.3 to −.3	+.3 to −.3	+.3 to −.3	0	$\pm.10\sqrt{n}$
2														
3														
4	+.2 to −.2	+.2 to −.2	+.2 to −.2	+.3 to −.2	+.3 to −.3	+.3 to −.3	+.4 to −.3	+.4 to −.3	+.4 to −.4	+.4 to −.3	+.5 to −.4	+.5 to −.4	.003n	$\pm.12\sqrt{n}$
5	+.2 to −.2	+.2 to −.2	+.3 to −.3	+.3 to −.3	+.4 to −.3	+.4 to −.3	+.5 to −.4	+.5 to −.4	+.5 to −.4	+.6 to −.4	+.6 to −.4	+.6 to −.4	.007n	$\pm.154\sqrt{n}$
6	+.2 to −.2	+.3 to −.3	+.4 to −.3	+.4 to −.4	+.5 to −.4	+.5 to −.4	+.5 to −.5	+.6 to −.5	+.6 to −.5	+.7 to −.6	+.7 to −.6	+.7 to −.6	.005n	$\pm.190\sqrt{n}$
7	+.2 to −.3	+.3 to −.3	+.4 to −.4	+.4 to −.5	+.5 to −.5	+.5 to −.6	+.6 to −.6	+.6 to −.7	+.6 to −.7	+.6 to −.8	+.7 to −.8	+.7 to −.9	−.007n	$\pm.224\sqrt{n}$
8	+.3 to −.4	+.3 to −.5	+.3 to −.7	+.4 to −.8	+.4 to −1.0	+.4 to −1.1	+.4 to −1.2	+.4 to −1.3	+.4 to −1.4	+.3 to −1.5	+.3 to −1.6	+.3 to −1.7	−.059n	$\pm.296\sqrt{n}$
9	+.2 to −.6	+.1 to −.9	+.1 to −1.2	0 to −1.5	−.1 to −1.8	−.3 to −2.1	−.4 to −2.4	−.5 to −2.6	−.6 to −2.9	−.8 to −3.1	−.9 to −3.4	−1.0 to −3.7	−.196n	$\pm.376\sqrt{n}$
10	−.2 to −1.1	−.6 to −1.9	−1.1 to −2.7	−1.6 to −3.4	−2.1 to −4.2	−2.6 to −4.9	−3.2 to −5.6	−3.7 to −6.3	−4.2 to −7.0	−4.8 to −7.7	−5.3 to −8.4	−5.9 to −9.1	−.625n	$\pm.460\sqrt{n}$

n	$\sqrt{n}$	n	$\sqrt{n}$
13	3.6	55	7.4
15	3.9	60	7.7
18	4.2	65	8.1
20	4.5	70	8.4
25	5.0	75	8.7
30	5.5	80	8.9
35	5.9	85	9.2
40	6.3	90	9.5
45	6.7	95	9.7
50	7.1	100	10.0

Examples of using the formula under the n hops column, where n equals the number of hops.

1. Find the 5 MHz requirement for 8 hops

$$\text{Mean} = .007\ (8) = .056$$

$$\text{Deviation} = \pm.154\ (\sqrt{8}) = \pm.436$$

$$\text{Limits} = \left.\begin{array}{l} .056 + .436 = +.492 \\ .056 - .436 = -.380 \end{array}\right\} +.5 \text{ to } -.4$$

2. Find the 8 MHz requirement for 15 hops.

$$\text{Mean} = -.059\ (15) = -.885$$

$$\text{Deviation} = \pm.296\ (\sqrt{15}) = \pm1.154$$

$$\text{Limits} = \left.\begin{array}{l} -.885 + 1.154 = +.269 \\ -.885 - 1.154 = -2.039 \end{array}\right\} = +.3 \text{ to } -2.0$$

Note: For less than 8 hops, the values obtained from the formula may not agree with the values given in the table because of an allowance which has been included for FM terminals. The FM terminal contribution is negligible for 8 or more hops.

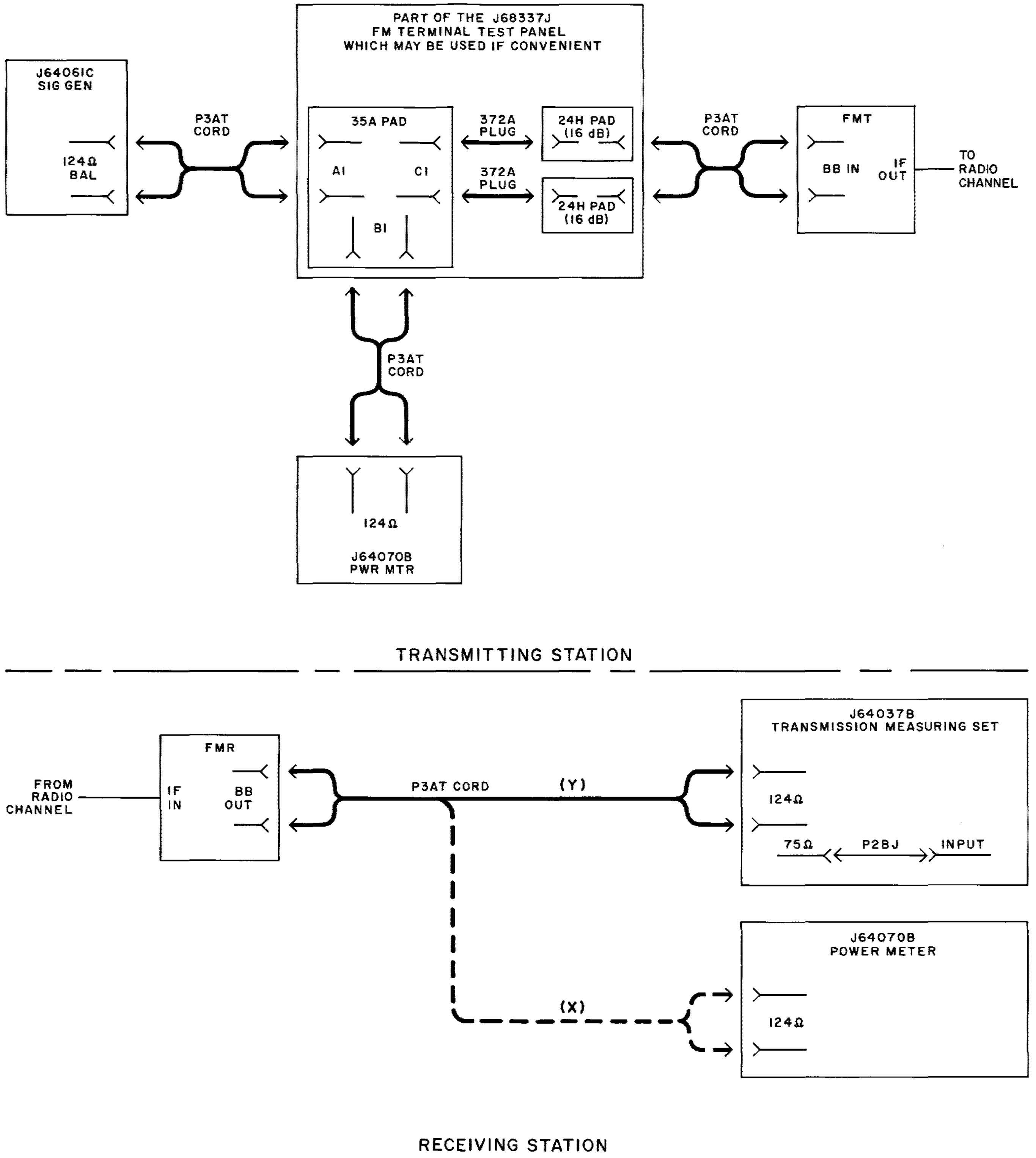

Fig. 1—Baseband Response Test—Point-By-Point Method

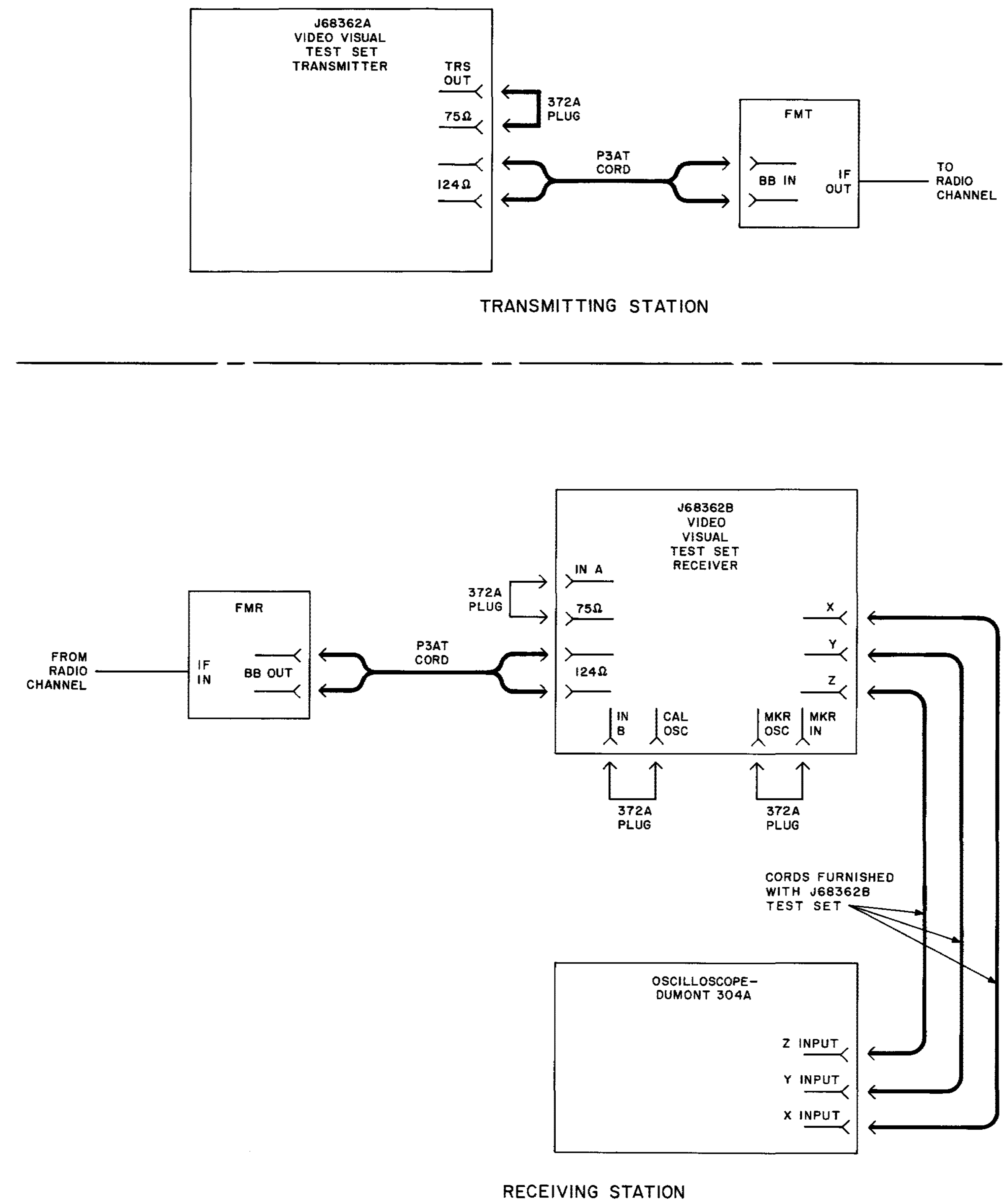

Fig. 2—Baseband Response Test—Visual Sweeper Method

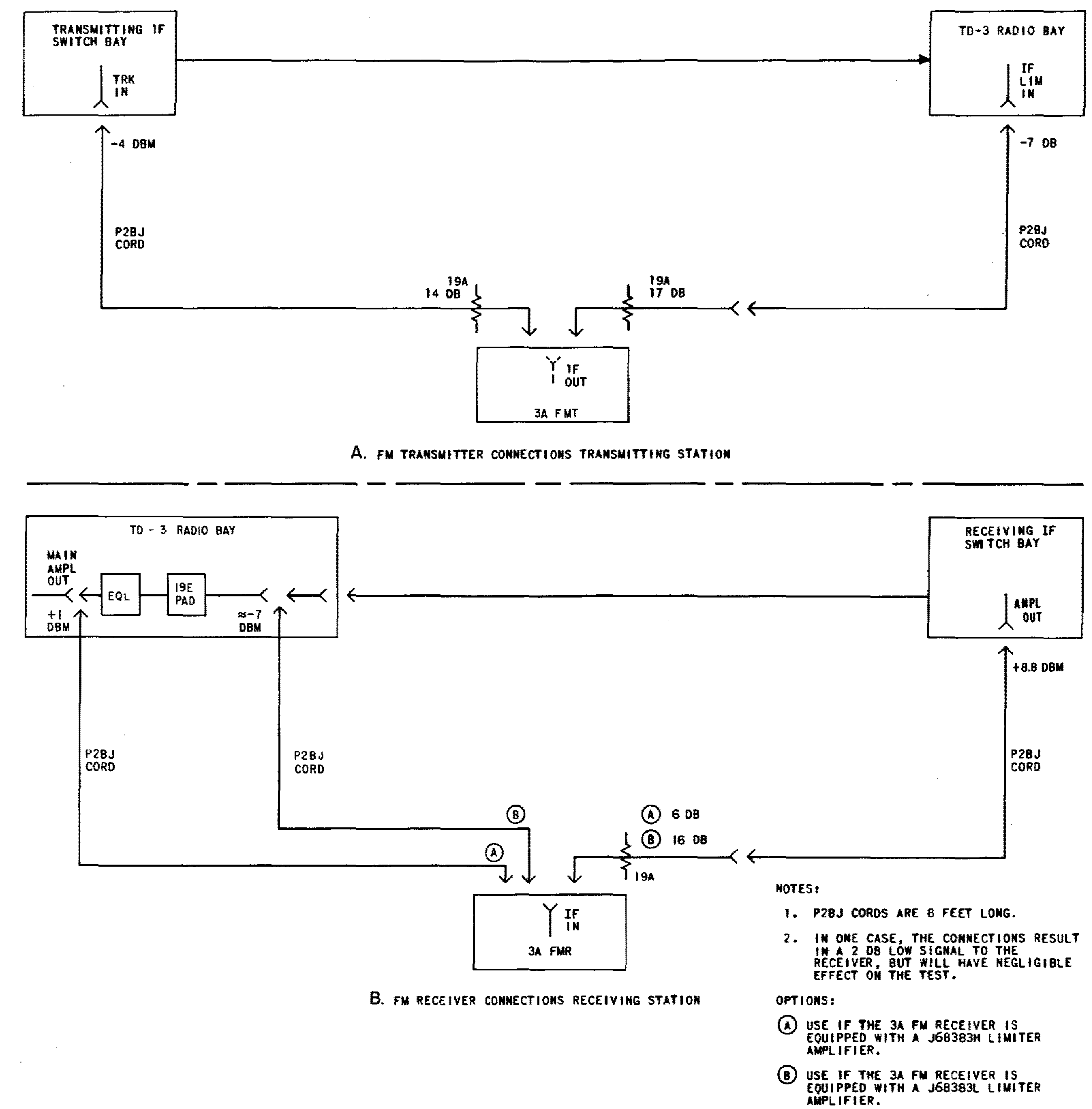

Fig. 3—FM Terminal Connections