REPLACING PAGE ADDENDUM
Filing Instructions:

1. REMOVE FROM THE SECTION THE PAGES NUMBERED THE SAME AS THOSE ATTACHED TO THIS PINK SHEET.
2. INSERT THE ATTACHED PAGES INTO THE SECTION IN THEIR PLACE.
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TD-3 MICROWAVE RADIO
OVERALL SYSTEM
TESTS
THERMAL NOISE AND SPURIOUS TONES

1. GENERAL

1.001 This addendum supplements Section 411-100-504, 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 revise Fig. 3 and to change the 9-MHz tone level to −18 dBm.

Attached:

Page 7 dated November 1972, revised
Page 8 dated November 1972, reissued

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CONTENTS PAGE

1. GENERAL

1.01 In this practice thermal noise (sometimes called fluctuation noise in other practices) refers to the random-type noise present at the output of an FM terminal receiver when its input 70-MHz carrier is unmodulated. When connected to an idle (unmodulated) radio channel, the thermal noise measured at the output of an FM terminal receiver is the power summation of the random-type noise generated in the FM terminal transmitter (or other source of IF carrier at the head end of the radio channel), the intermediate radio repeaters, and the FM terminal receiver. In the absence of specific noise troubles, the amount of thermal noise depends primarily upon the length and make-up of the radio facilities. Assuming equal received carrier powers at all stations, the thermal noise from the radio repeaters increases 3 dB each time the channel length is doubled. (This assumes that the noise is completely random in character and adds on a power basis.) Also, thermal noise is not evenly distributed across the band at the output of the FM terminal receiver. At the higher baseband frequencies, it increases 6 dB each time the baseband frequency is doubled. The test in this section measures the thermal noise of the channel and serves to check the total effect of noise figures of the individual radio repeaters. Requirements are given in Fig. 1 and 2 in the form of a noise power versus baseband frequency for a channel of the given number of hops. The requirements assume an average received carrier power of –28 dBm at each radio receiver input, and radio repeaters within their noise figure limits.

1.02 The FM terminal transmitter (either 3A or 4A) is the predominant source of thermal noise across most of the baseband for up to about ten hops of the radio channel. Removing the FM transmitter from the system will substantially decrease the noise contribution of the FM terminals and will effectively remove them from the measurements of all but the very short systems. For this reason, it is recommended that the IF carrier resupply in the head-end radio transmitter be used to supply the IF carrier for the channel under test. This is particularly advantageous in searching for spurious tones. The curves of Fig. 1 and 2 assume the use of an IF carrier resupply and take into account the noise contribution of just a 3A or 4A FM terminal receiver.

1.03 The use of a carrier resupply will result in the appearance of either a 63-MHz (protection channel) or a 61-MHz (regular channel) tone in the IF band. The presence of this tone modulation on the 70-MHz carrier will not affect the thermal noise measurements. However, measurements have shown that spurious tones may be generated by intermodulation of the 61- or 63-MHz tone with other tones which may be present in the channel. To eliminate this possibility, the 61- or 63-MHz oscillator in a spare carrier resupply can be disabled. This spare unit can then be substituted for the bay-mounted resupply to "hold up" the channel under test. To disable the 61- or 63-MHz oscillator, it is necessary only to remove the cover from the side nearest the power plug, remove the pin connector in the 61—63-MHz oscillator board, and replace the cover. At the completion of the tests, the modified spare unit should be removed from the bay; the pin connector should be reinstalled; and normal connections should be restored to the original bay-mounted resupply.

1.04 Spurious tones are unwanted signals, or groups of signals, which are present at the output of the FM terminal receiver. These tones may be introduced into the radio system by the FM terminal equipment; or they may originate entirely within the microwave equipment alone. Generally, microwave equipment tones are the more prevalent.

1.05 Requirements are given in Part 3 of this section for the permissible magnitude of spurious tones as a function of baseband frequency. The requirements have been determined on the basis of single frequency tone objectives for telephone message circuits and TV signals, and, in the region around 7 and 9 MHz, by permissible interference into the pilot detectors of the 100A protection switching system initiators.

2. TESTS

CHART 1
THERMAL NOISE AND SPURIOUS TONE MEASUREMENTS

Note 1: The test procedure may be applied to an overall MUR, to an individual IF switching section within an MUR, or to one or more hops within an IF switching section.

Note 2: The FM receiver used in these tests must meet its BSP requirements.

APPARATUS:

Receiving Station

1—J68383B (3A) or J68418B (4A) FM Terminal Receiver

1—J64037B (37B) Transmission Measuring Set, with headphones

1—19A Pad 6 or 16 dB (See Fig. 4.)

1—P3AT Cord (6 feet long)

1—P2BJ Cord (2 feet long) Part of the 92A test set (may be used if convenient)

1—P2BJ Cord (8 feet long) (The P49Q680 cord in the 92A test set may be used if convenient.)

Transmitting Station

None

(See paragraphs 1.02 and 1.03.)

CHART 1 (Cont)	
STEP	**PROCEDURE**
	Caution: ***These tests are performed on an out-of-service basis. Check that the channel is not being used.***
1	At the receiving station, allow the 37B to warm up for at least one hour before starting the tests. Check and adjust, if required, the carrier balance and internal calibration on the 37B before using it in these tests.
2	Connect the test setup of Fig. 4 at the most convenient point.
3	At the transmitting station, install the modified spare IF carrier resupply (see 1.03) if one is to be used. Operate it, or the normal bay-mounted IF carrier resupply, by opening the normal IF connection to the input of the radio transmitter of that channel. A convenient point to open this connection may be at the IF INPUT jack of the IF limiter in the radio bay.
	Note: After approximately 45 seconds, a transmitter alarm indicating carrier resupply operation should occur. Clear the audible alarm by pressing the ACO pushbutton on the common alarm panel.
4	At the receiving station, connect a P3AT patch cord from the repeat coil on the 37B to the BB OUT jack of the FM terminal receiver. Connect a P2BJ cord from the repeat coil to the input on the 37B.
5	Using the frequency controls of the 37B set, search for tones in the baseband by slowly scanning from 20 kHz to 10 MHz. Use of headphones at the MON jacks will help in locating any tones and in maximizing their reading on the 37B set. For each tone observed, record the maximum reading obtained. Typically, this will be a reading of tone plus background noise power. As an aid to determining whether the tone meets system requirements (see 3.04), measure and record the thermal noise power adjacent to any tone (that is, within about 10 to 20 kHz of the tone). Also, measure and record the thermal noise power at each of the following frequencies: 40 kHz, 400 kHz, 4 MHz 70 kHz, 700 kHz, 6 MHz 100 kHz, 1 MHz, 9 MHz 200 kHz, 2 MHz
6	After completion of the test, remove the modified carrier resupply, if installed, and restore the channel to service if no other channel tests are to be performed.

3. REQUIREMENTS

Thermal Noise

3.01 Determine the number of radio "hops" and refer either to Fig. 1 for 8.5-dB noise figure bays, or to Fig. 2 for 12-dB noise figure bays. (The ***repeater*** noise figure limit, for the higher baseband frequencies, is approximately 8.5 dB for bays equipped with the J68387P receiver modulator-IF preamplifier and approximately 12 dB for bays equipped with J68387C receiver modulator-IF preamplifier.) If the radio channel is intermixed with both bays, an overall noise limit can be estimated by averaging the limits given in Fig. 1 and 2 for the total number of hops being measured.

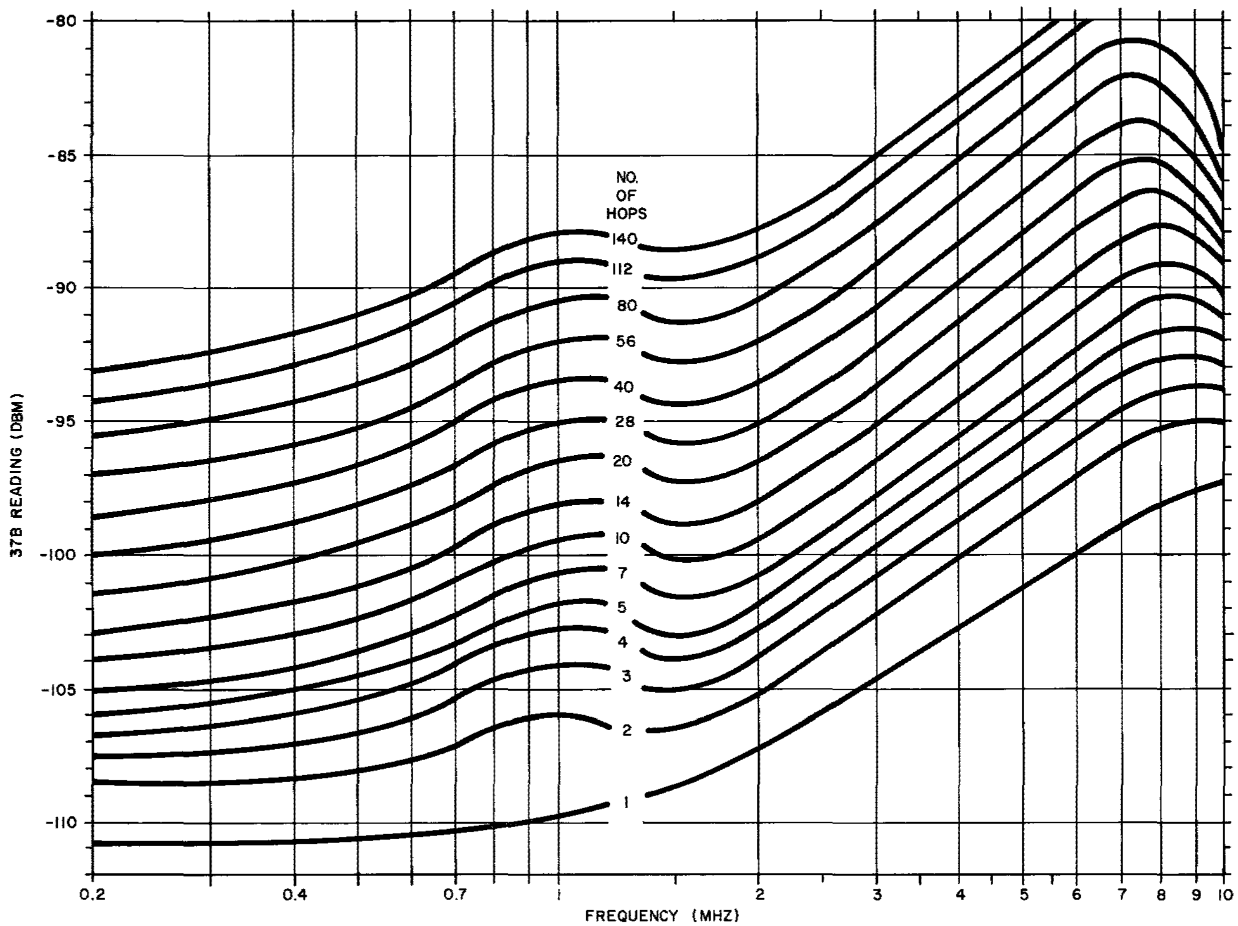


Fig. 1—Thermal Noise Requirement for 8.5-dB Noise Figure Radio Bays (Includes Allowance for One FM Receiver)

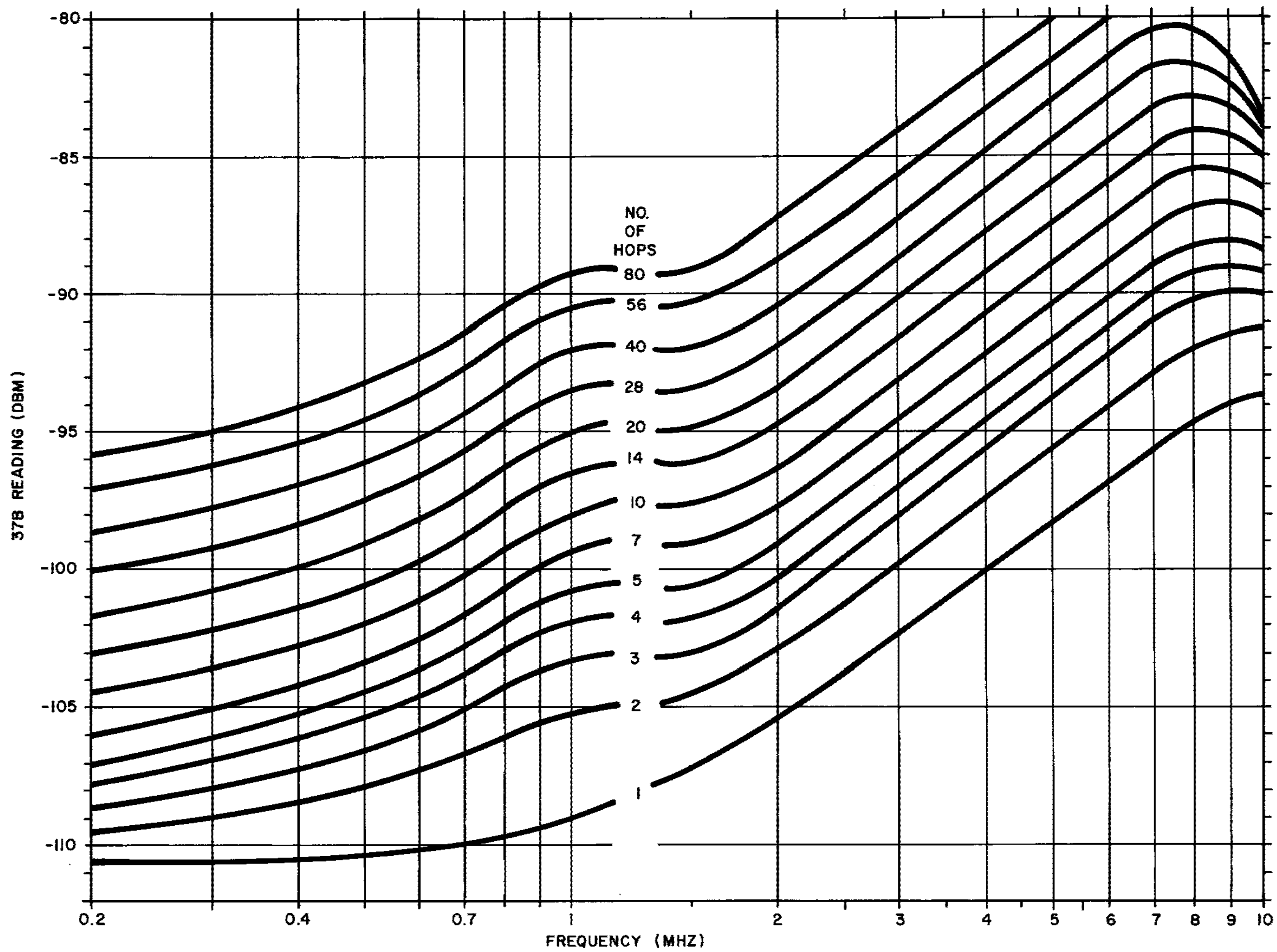


Fig. 2—Thermal Noise Requirement for 12-dB Noise Figure Radio Bays (Includes Allowance for One FM Receiver)

3.02 *Thermal Noise Requirements:*

FREQUENCY	REQUIREMENT
(a) Below 0.2 MHz	The measured noise shall not exceed the value at 0.2 MHz shown on the curve for the appropriate number of hops.
(b) 0.2 to 7.0 MHz	The measured noise shall not exceed the values shown on the curve for the appropriate number of hops.
(c) Above 7.0 MHz	The measured noise above 7.0 MHz depends on baseband roll-off. The measured values should be within ±3 dB of the values shown on the curve for the appropriate number of hops.

3.03 If the measured thermal noise fails to meet the requirements in any of the above frequency regions, the following factors should be considered when attempting to localize the trouble:

(a) Below about 2 MHz, noise from the microwave generator tends to mask the noise from all other sources in a normal transmitter-receiver bay. (It is the noise of the common microwave generator in the repeater station bays that causes the expected noise "hump" at around 1 MHz shown in Fig. 1 and 2.) Hence, a region of excess noise below about 2 MHz may be caused by a defective microwave generator in one or more stations. At this time there is no noise figure test procedure available which will check the generator noise contribution. To correct the problem, it may be necessary to follow a sectionalizing procedure to locate the hop contributing the excess noise, and then to substitute a spare microwave generator for the suspect unit.

(b) Above about 2 MHz, the noise of the radio receiver (principally the receiver modulator-IF preamplifier) should predominate over all other sources of thermal noise in a normal transmitter-receiver bay. Therefore, excess noise appearing over all or most of the band above about 2 MHz may be caused by a poor noise figure in one or more radio receivers. The receiver noise figure can be checked using the procedures given in Section 411-404-501. As noted in 1.01, the requirements given in Fig. 1 and 2 assume a normal received carrier power of –28 dBm. The noise contribution of the radio receiver depends on the received carrier power, increasing approximately dB for dB as the carrier power decreases, and vice versa. Hence, the noise above about 2 MHz depends on the received carrier power and, in particular, may exceed, in some cases, the requirements given in Fig. 1 and 2 only because of one or more abnormally long hops in the section being tested.

(c) Noise spikes having a bandwidth of about 100 kHz or less and rising several dB above the noise requirements given in Fig. 1 and 2 may be caused by ion oscillations in a traveling-wave tube amplifier. New tubes, particularly spares which have sat unused for very long periods, may have ion oscillations when first turned on. Generally, these oscillations and, therefore, the noise spikes, disappear after a day or so of continuous operation.

Spurious Tones

3.04 *Spurious Tone Requirement:* From 20 kHz to 10 MHZ, any spurious tone shall be below the tone requirement curve of Fig. 3.

At frequencies above 312 kHz, the thermal noise of the radio system may nearly equal the level of the tone requirement. The 37B will measure the power sum of the tone plus the thermal noise. Supplemental curves, plotted in Fig. 3, give the power addition of the tone requirement curve and various levels of system thermal noise over the message band. A prerequisite for use of the curves is the measurement of the termal noise directly adjacent to a suspect tone. Then, by entering Fig. 3 on the proper contour, the requirement for the tone plus thermal noise at the tone frequency can be determined. It will generally be necessary to interpolate between two contours. Because the thermal noise changes with frequency, any one contour does not apply across the entire message band. The thermal noise has to be measured at each tone frequency, and then the proper contour has to be used. It is easy to see that the higher the thermal noise the more difficult it is to "see" the tone.

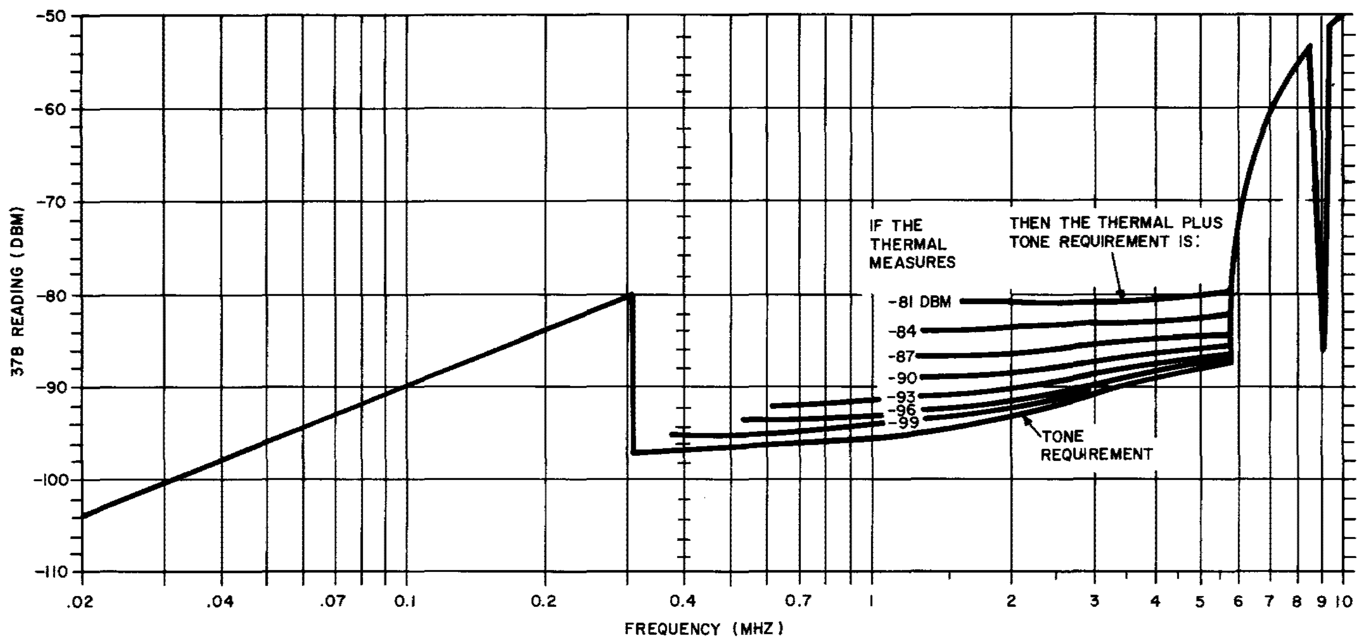


Fig. 3—♦Tone Requirement at the FMR Output♦

Example: A tone at 4 MHz measures −88 dBm, and the nearby thermal noise measures −93 dBm. Since the tone requirement (Fig. 3) at 4 MHz is about −89 dBm, it would appear that the measured tone does not meet the requirements. However, the background thermal noise has elevated the level of the tone above its true value. The supplemental curves on Fig. 3 show how much the tone requirement curve should be increased to account for the thermal noise addition. In this case, the nearby thermal noise measures −93 dBm and the −93 dBm contour shows the requirement of tone-plus-thermal noise to be −87 dBm at 4 MHz. Therefore, the −88 dBm tone measurement is below the −87 dBm requirement and can be disregarded.

3.05 The tone requirement at 9 MHz is −87.5 dBm, which generally will be below the 9-MHz thermal noise. Since the requirement at 5.5 MHz is also −87.5 dBm, the contours at that frequency can be used to evaluate a 9-MHz measurement. If a suspect tone is detected at 9 MHz, the thermal noise at 9 MHz should be measured. Then the contours at 5.5 MHz should be used for the tone-plus-noise requirement.

3.06 The radio channel tones observed most frequently are:

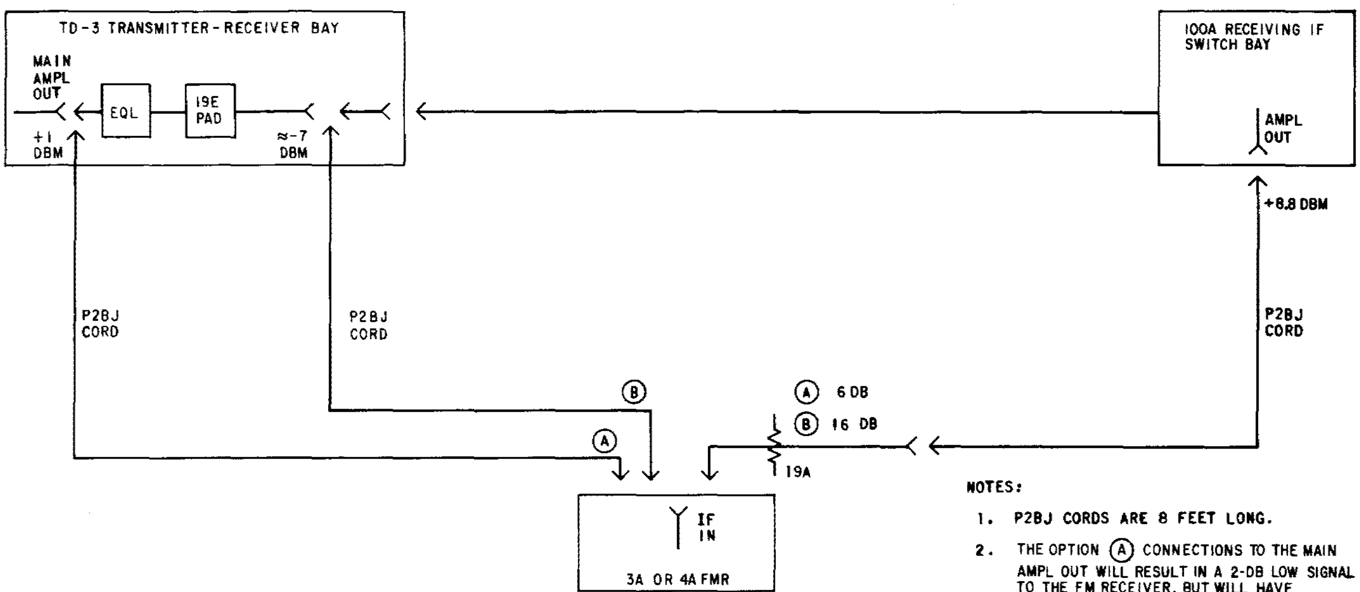
(a) Low-frequency tones caused by co-channel interference

(b) 6-MHz tones due to the second harmonic of an adjacent protection channel pilot (7-MHz) tone

(c) 7-MHz tones due to pilot tone leakage from the IF carrier resupplies on a protection channel. If on a protection channel the standard bay-mounted IF carrier resupply is used at the head end to supply the carrier, a 7-MHz tone at approximately −13 dBm should appear at the output of the FM receiver.

(d) 9-MHz tones due to pilot tone leakage from the IF carrier resupplies on a regular channel. If the standard bay-mounted IF carrier resupply at the head end is used to supply the carrier on a regular channel, a 9-MHz tone at approximately ♦−18♦ dBm should appear at the output of the FM receiver.

(e) 10-MHz tones caused by microwave generators.



NOTES:

1. P2BJ CORDS ARE 8 FEET LONG.
2. THE OPTION (A) CONNECTIONS TO THE MAIN AMPL OUT WILL RESULT IN A 2-DB LOW SIGNAL TO THE FM RECEIVER, BUT WILL HAVE NEGLIGIBLE EFFECT ON THE TEST.

OPTIONS:

(A) USE IF THE 3A FM RECEIVER IS EQUIPPED WITH A J68383H LIMITER-AMPLIFIER.

(B) USE WITH THE 4A FM RECEIVER OR IF THE 3A FM RECEIVER IS EQUIPPED WITH A J68383L LIMITER-AMPLIFIER.

Fig. 4—Connections at the Receiving Station