

**OVERALL TD AND TH SYSTEM  
FADE MARGIN TESTS  
COMMON MICROWAVE RADIO**

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**1. GENERAL**

1.01 This section describes the fade margin tests for TD and TH microwave radio systems. This is a troubleshooting section except for the tests in Charts 4 and 11 which are for the initial testing of the radio channels. The fade margin tests and the digital mastergroup fade performance tests are performed on each new channel before being placed in service.

1.02 Whenever this section is reissued, the reason(s) for reissue will be listed in this paragraph.

1.03 Field measurements have shown that many protection switching sections have radio channels that are not switching at their correct fade level. When a radio channel switches to protection at a fade level sooner than it should, it will switch more often and will stay longer on the protection channel. This may deny the other channels in the same section the full use of the protection channel, thus degrading service by reducing the overall reliability of the channels in that section. Switching radio channels carrying high-speed data signals will always cause some data errors; therefore, it is desirable to eliminate as much unnecessary switching as possible. Conversely, when a radio channel switches at a fade deeper than it should, message and data may both be degraded. Except for the 45-Mb/s digital service, the fade depth at which a radio channel should switch to protection normally depends upon the thermal noise

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of the radio channel and the adjustment of the protection switching system's channel initiator. The thermal noise of the radio channel depends upon the received signal power and the "front end" noise of the receiver. Also, for a normal radio hop, it should be possible to fade the channel to the switch point before cochannel tones in the lower end of the baseband can cause errors to data under voice (DUV), or 20 megabits per second (20-Mb/s) service. For 45-Mb/s digital service, the switch to protection is initiated when the bit error rate exceeds a given limit.

**Note:** The measurements in this section should be made when the radio path is in a stable, essentially nonfading condition; that is, when the received carrier power is stable within  $\pm 1$  dB. The received carrier indication on the receiver control panel should be used to verify a stable condition.

**1.04** This section will help locate and isolate the problems which are causing radio channels to switch too soon, too late, or even not at all. Often, incorrect adjustment of the switching system channel initiators is the primary cause. However, even when the switching is properly adjusted and in good working condition, other factors, such as a defective or misadjusted carrier resupply, microwave generator tones, or outside interference can influence the operation of the switching system. For example, adjacent channel interference from either low cross-polarization discrimination (XPD), or low antenna side-to-side coupling loss, might cause the radio channel to switch too soon, or unnecessarily. Also, a defective receiver modulator—IF preamplifier can cause excess 9-MHz noise to be applied to the radio channel from the adjacent channel due to excessive intermodulation in the receiver modulator—IF preamplifier. This excessive 9-MHz noise causes the noise detector to operate sooner than would normally be the case. Cochannel interference, on the other hand, may cause a channel to switch late or not at all. Also, when a radio channel carrying data service is faded, excessive cochannel interference will cause errors to occur before the proper switch point is reached.

**1.05** Prior to performing the tests in this section, it is necessary to define the following terms:

**DUV—Data Under Voice—Digital DATAPHONE\* Service (1A RDS).**

\* Registered trademark of AT&T.

**DMG-1—Digital Mastergroup.**

**20 Mb/s—20-Megabit Digital Radio—A radio channel used exclusively for digital services.**

**45 Mb/s—45-Megabit Digital Radio—A radio channel used exclusively for digital service.**

**Fade Depth at Switch Point—The amount of fade that just causes the protection switching system to switch.**

**DUV Critical Noise Level—That noise level where data errors are expected to occur. The DUV critical noise level at the output of the FM receiver corresponds to a  $-39$  dBm indication on the 6G noise meter; or to a  $-50$  dBm indication on an HP-3400A RMS voltmeter that is calibrated to read power (dBm at 75 ohms) and is terminated in 75 ohms; or when the critical noise lamp lights on the J68448A portable pilot/noise monitor.**

**DUV Critical Fade Depth—The amount of fade necessary to reach the critical noise level.**

**20- and 45-Mb/s Critical Fade Depth—The fade depth point where a given bit error rate (BER) is exceeded.**

**DUV Fade Margin—The DUV fade margin is equal to the critical fade depth minus the fade depth at switch point. If the critical fade is reached before the switch point, the DUV fade margin is negative. If it is reached after the switch point, it is positive.**

**20-Mb/s Fade Margin—The 20-Mb/s fade margin is equal to the critical fade depth minus the fade depth at switch point. If the critical fade is reached before the switch point, the 20-Mb/s fade margin is negative. If it is reached after the switch point, it is positive.**

**45-Mb/s Fade Margin—The 45-Mb/s fade margin is the amount of fade necessary to cause a  $10^{-3}$  BER in a 45-Mb/s service. It is equal to the critical fade depth minus the fade depth at switch point. If the critical fade is reached before the switch point, the 45-Mb/s fade margin is negative. If it is reached after the switch point, it is positive.**

**DMG-1 Fade Margin—The DMG-1 fade margin is the difference between the fade depth at which the BER reaches  $10^{-6}$  and the fade depth at the radio protection switch point.**

**Space Diversity Switching**—Applicable to radio bays normally equipped with a waveguide switch that switches automatically from the main antenna to the diversity antenna when the receiver automatic gain control (AGC) drops to a given level.

**Space Diversity Combining**—Applicable to radio bays equipped with a space diversity radio frequency (RF) combiner which automatically adjusts and adds the phase of the incoming signal (from the diversity antenna) to the signal from the main antenna.

**Note 1:** No fade margin tests or requirements are given for radio hops equipped with space diversity RF combiners because it is impractical to make meaningful fade measurements on such hops. The use of RF combiners substantially reduces the time that a radio channel is switched to protection during fading.

**Note 2:** The protection switching systems will be required to protect the radio channel from equipment failures. To check the switching system, service is switched to the protection channel and the radio channel under test is opened. The fail light associated with that channel shall light.

**1.06** There are three principal parts to the regular and DUV fade margin tests. Each hop of each radio channel in the switching section under test is deliberately faded one at a time from the transmitting end, by attenuating each transmitter's output in turn, down the line. At the receiving end of the switching section, measurements are performed to find the exact switch points resulting from each of the test fades for each radio hop.

- (a) The fade at the switch point for that radio hop is measured and compared to the requirement for a given path length and transmitter output power.
- (b) The noise at 9 MHz is then measured to see if the channel initiator is operating at the desired noise power.
- (c) The channel is then refaded to find the respective fade margin. For a normal radio hop it should be possible to fade the channel to the switch point before any noise or tones in the lower end of the baseband can cause errors to the data service. However, if the cochannel interference or other

sources of noise are severe enough, data errors will occur before the switch point is reached. The purpose of the test is to locate those radio hops which will cause data service errors before the proper switch point is reached. The channel is then refaded to the carrier resupply or squelch trip point to ensure that the carrier resupply or squelch is operating properly.

**1.07** Cochannel interferences are caused when the receiving antenna picks up another radio channel operating on the same frequency. Reflections from nearby terrain, buildings, and other structures are generally the main cause of cochannel interferences. The effect of cochannel interference on DUV signals does not depend on the fact of whether or not the interfering carrier is spread (such as from a TV channel or another DUV channel) or on the frequency offset between the normal carrier and the interfering carrier. This is because the phase deviation applied to the normal channel carrier by the DUV signal causes the interference to be spread across the DUV band. In order to measure the effect of cochannel interference, a similar mechanism is employed. A 64-kHz baseband signal is applied to an FM transmitter at the transmitting end of the switching section under test to deviate the normal channel carrier approximately 800 kHz. At the receiving end of this switching section, a DUV bandpass filter, a 64-kHz narrow-band rejection filter, and a wide-band power meter are employed to measure the effect of this interference.

**Note:** Unless the 64 kHz at the transmitting end of the switching section is exactly tuned to the frequency of maximum loss of the 64-kHz narrow-band rejection filter, the indication may contain more of the 64-kHz signal than of the effect of the cochannel interference. The importance of this fine tuning procedure is expanded on in the DUV fade margin and carrier resupply operation test procedures of this section.

**1.08** The fade margin and carrier resupply operation procedure is the continuation of the frequency diversity switching system and the 9-MHz noise measurement procedure. If the radio hop under test is equipped with space diversity switching, the space diversity switching switch-point procedure must be performed.

**1.09** These tests require personnel at the transmitting end of the switching section, the receiving

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end of the switching section, and at the transmitter being faded. In addition, if a radio hop equipped with space diversity switching is being tested, the receivers of that hop must also be manned.

**1.10** To assure accuracy in the measurement of the 9-MHz noise and the fade margin, a terminated FM transmitter should be placed on the channel under test at the transmit end, except in the case of 20-Mb/s and 45-Mb/s digital radio channels which require normal digital modulation. The 20-Mb/s digital signal contains a small amount of energy at 9 MHz which tends to reduce the actual fade at switch point.

**1.11** Form E-10108, entitled FADE MARGIN TEST FORM, is provided to facilitate standard recordkeeping of information pertaining to the radio hop and switch section to be tested. In those instances where it is normally beyond the resources of local operations personnel to handle abnormal trouble situations, the district or area transmission personnel should be notified and a completed copy of the E-10108 form should be forwarded to those concerned for appropriate action.

**1.12** When frequency diversity is used on radio systems equipped with space diversity switching, the frequency diversity noise threshold is set to a higher noise level than on systems not equipped with space diversity. The space diversity switch must operate 3 dB or more ahead of the frequency diversity switch. This is done to maintain a difference in thresholds between the space diversity switch and the frequency diversity switch and ensures that the space diversity switch operates before the frequency diversity switch. An additional reason is to ensure that the number of switch transitions (both space and frequency) are about the same with or without space diversity switching.

**1.13** It is important to maintain an adequate margin between the frequency diversity switch threshold and the level of the pilot modulation on the carrier resupply signal. This margin is very critical since loss of service occurs if the level of the pilot modulation does not exceed the noise switch threshold of the noise detector.

### **2. DIGITAL MASTER GROUP SYSTEM (DMG-1) FADE PERFORMANCE TESTS**

**2.01** The DMG-1 system allows the transmission of signals in the first level of the digital hierar-

chy (DS1) over various long-haul radio and cable systems. A general description of the system is provided in Section 356-460-100.

**2.02** A computer program called DMG FADE is used to accurately estimate the DMG-1 performance for each radio hop. The program requires entry of data (input hop parameters) for each radio hop to effectively predict the DMG-1 performance. The following input parameters are part of the data required for computing the DMG-1 fade performance using the DMG FADE.

- Fade depth at the frequency diversity switch point
- Carrier interference (C/I) ratio at the frequency diversity switch point
- Signal-to-noise ratio in the DMG-1 receiver at the frequency diversity switch point.

Measurement of these three parameters is highly recommended.

#### **Fade Depth at the Frequency Diversity Switch Point**

**2.03** The procedure for this measurement is described in Charts 1 (for TD radio system) and 6 (TH-3 radio system) of this section. The fade depth at the frequency diversity switch point parameters must be measured first and any problems corrected before proceeding to the other measurements.

#### **C/I Ratio at Frequency Diversity Switch Point**

**2.04** The procedure for performing this measurement is available in Section 422-210-500. This measurement is performed using the Scientific-Atlanta test set. For DMG-1 performance, the following variations to the procedure in Section 422-210-500 should be observed:

- The Scientific-Atlanta test set scan should be operated manually to obtain an accurate indication of the true peak of the interference.
- The C/I ratio selected should correspond to the strongest interference peak.

#### **Signal-to-Noise Ratio in the DMG-1 Receiver at the Frequency Diversity Switch Point**

**2.05** This test is performed to measure the noise in the DMG band at the radio switch point. Mea-

surements are made on each switch section, with test signals inserted at the transmitting end of the route. The procedure for performing this test is described in Chart 11 of this section.

### 3. CHARTS

#### A. Chart 1—TD Frequency Diversity Protection Switching System Switch Point and 9-MHz Noise Measurement

**3.01** In order to find the fade margin requirement, the received carrier power for that hop must be known. If it is posted on the radio bay and is known to be correct, then that received carrier power may be used provided that any deviations in the transmitter output power be used to correct the received carrier power.

**Example:** The posted received carrier power is  $-26$  dBm; the transmitter output power that is transmitting to this receiver is  $+35$  dBm instead of its normal output of  $+37$  dBm; therefore,  $2$  dB is subtracted from the  $-26$  dBm to give a  $-28$  dBm received carrier power.

If the received carrier power is not posted or if the posted number is felt to be incorrect, then the received carrier power should be measured as outlined in Section 410-100-510, 411-100-508, or 415-100-508 (as applicable). Figure 1 can be used as a guide. The data in Fig. 1 is based on the following:

- (a) The radio towers at both ends of the radio hop are 200 feet tall. The total filter/waveguide loss for both the transmitting and receiving ends of the radio hop is 4.8 dB (the channel dropping and combining networks in the radio bays and the system combining and separating networks in the antenna and waveguide systems included). Add or subtract 0.4 dB from the requirements for each 100-foot difference in antenna height.
- (b) The antennas at both ends of the radio hop are assumed to be KS-15676 horns which have a total midband gain of 79.2 dB (39.6 dB each). If other antennas are used, appropriate changes in requirements should be calculated to include their gain.
- (c) The radio path is approximately in a no-fade condition, with the received signal power stable within  $\pm 1$  dB. If the radio path loss is known

to be higher or lower than typical, the requirements should be adjusted accordingly.

(d) If waveguide pads are used at either end of the radio hop, the received carrier power should be reduced by the amount of their loss.

**Note:** When RF waveguide amplifiers are installed, the received carrier power is referred to the input of the waveguide amplifier. The actual measurement is made at the input to the radio receiver and the gain of the waveguide amplifier is subtracted to get the received carrier power at the input to the amplifier.

**3.02** To perform this procedure, the following apparatus is required at the transmitting station of the hop to be faded:

- 1— J68392 or J68428A Test Set or Anritsu\* ME645A or equivalent
- 1— 61B, 5-Watt Waveguide Pad (for TD-2)
- 2— ED-63927-( ) Waveguide Attenuators (for TD-2)
- 2— ED-63900( ) TD-2 Type Transducers
- 1— 10-dB, 10-Watt Coaxial Pad
- 2— 24A Transducers
- 2— Microwave Research Corp. B40-186 Transducers (for TD-3)
- 2— RG-9/U Cord Equipped with Type N Connectors
- 2— ED-51567( ), G1 Type N Female to Waveguide Probe
- 1— 10-dB Loss Cord
- 1— 20-dB Narda Coaxial Pad or equivalent
- 1— 0 to 20-dB Narda 793 FM-SP Adjustable Coaxial Attenuator
- 2— ED-51568( ), G1 Shutters.

\* A registered trademark of the Anritsu Electric Co., Ltd.

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The following apparatus is required at the receiving main station:

- 1— 3A or 4A FM Receiver
- 1— Selective Level Meter (W&G, AT-463, or equivalent).

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STEP	PROCEDURE
1	<b>Caution: The regular service must be switched to the protection channel or the protection channel must be locked out.</b>
	<b>Caution: For message or video channels, a terminated FM transmitter must be placed at the transmitting end of the switched section. For 20-Mb/s digital channels, the normal digital modulation must be maintained on the channels.</b>
2	To calibrate the cords and attenuators to be used, for fade test arrangements, perform Steps 3 through 8. The losses of transducers and adapters are negligible. Measurement is therefore not necessary unless trouble is detected.
3	Turn on the test set RF oscillator and the power meter. Allow warm-up time of approximately ten minutes.
4	Adjust the frequency of the RF oscillator to the frequency of the channel being faded. Set the RF oscillator output power to midrange.
5	Set up the power meter to measure +10 dBm and connect a cable between the RF oscillator output and the power meter input.
6	Adjust the output power for +5.0 dBm. (If necessary, adjust the range of the power meter to +5 dBm, then readjust the output power to +5.0 dBm.)
7	Using the test setup of Fig. 2 (for TD-2 bays) or Fig. 3 (for TD-3, TD-3A, or TD-3D bays), individually measure all attenuators, pads, and coaxial cords, which will be used to fade the output of the transmitters. To determine the equipment to be used, refer to Fig. 4 or Fig. 5.
8	For adjustable attenuators, check the calibrations at 0, 5, 10, 15, and 20 dB. Record the losses of all cords, and note the difference in loss of the pads and attenuators as compared to their labeled values.  <b>Note:</b> -5 dBm should be added to the reading of the power meter, to arrive at the correct value of the loss.
9	<b>DANGER: To prevent high-level radiation, the IF driver amplifier should be temporarily removed before opening any waveguide at the output of the transmitting amplifier.</b>  <b>Warning: Pads and attenuators must be used to reduce high input power levels to below +10 dBm.</b>
	Using the RF power meter, measure the power output of the transmitter to be faded. Have the receiving end of the switching section under test record this value on an E-10108 form as shown in Fig. 6. (Do not use the panel meter indication for the power measurement.)

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<b>STEP</b>	<b>PROCEDURE</b>
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- 10 To obtain the correct received carrier power, subtract the recorded power output from the nominal transmitter output power. Subtract the difference from the posted carrier power.

**Example:**

Nominal Transmitter Power	+37.0 dBm
Measured Transmitter Power	<u>+36.2 dBm</u>
Difference (Nominal – Measured)	0.8 dB
Posted Received Carrier Power	–26.0 dBm
Difference (Nominal – Measured)	<u>0.8 dB</u>
Correct Received Carrier Power	–26.8 dBm

- 11 Record the correct received carrier power on the E-10108 form.
- 12 Obtain the path length of the radio hop from the station license. If this distance is given only in kilometers, convert to miles, using Fig. 7. Record this value on the E-10108 form.
- 13 For a TD-2 radio bay, perform Step 14 and proceed to Step 18. For a TD-3 or TD-3A bay equipped with traveling-wave tube, perform Step 15 and proceed to Step 17. For a TD-3D or TD-3A bay equipped with 660( )-type amplifier, proceed to Step 16.
- 14 Arrange the attenuators to fade the transmitter at the transmitting end of the radio hop to be measured, as shown in Fig. 4. If this is a space diversity hop, have the receiving end force-switch (lock) the switch to the REGULAR antenna and leave the TEST-OPERATE-TRIGGER switch in the TEST position.
- 15 Remove the short piece of flex waveguide above the transmitter and attach the two Microwave Research Corporation B40-186 transducers to the exposed flanges. Attach the fade test arrangement of Fig. 5 to the transducers.
- 16 On the radio transmitter, insert the two probes into the monitor shutter assembly and then insert three shutters into the monitor shutter assembly. Arrange the attenuators to fade the transmitter at the transmitting end of the radio hop to be measured as shown in Fig. 5.
- 17 If this is a space diversity hop, have the receiving end force-switch (lock) the switch to the REGULAR antenna.
- 18 **Caution: When testing the TDAS protection channel, a terminated FMT should be placed on the channel at the transmitting end of the switch section.**

**Caution: Plugging the FMR IF input into the receiving switch bay before the switch point is found will interrupt the IF path to the initiator.**

When ready to fade the channel, notify the receiving end of the switching section to watch for the channel FAIL lamp in the receiving protection switching bay.

## STEP

## PROCEDURE

- 19 Fade the transmitter (add attenuation) until the receiving-end personnel report that the channel FAIL lamp has lighted. Reduce the attenuation 5 dB (FAIL lamp should go out) and slowly fade the transmitter until the point of initiator operation is found. Repeat two or three times until the exact point of initiator operation is found. The total of the cord and attenuator losses equals the amount that the transmitter output has been faded. Record this value on the E-10108 form as ACTUAL FADE AT SWITCH POINT.

**Note:** For TDAS which does not have a channel FAIL lamp, position the meter switch on the initiator to the (A) position. For a regular channel initiator operation the indication will suddenly increase. For the protection channel initiator operation the indication will suddenly decrease.

- 20 With the channel faded to exactly the switch point, immediately measure the average thermal noise at 9 MHz by using the test arrangement as shown in Fig. 8. (Do not use a de-emphasis network with the FMR.)
- 21 Record this value on the 9-MHz NOISE MEASUREMENT line of the E-10108 form for the bandwidth of the selective meter in use. In using a selective meter with other than a 400-Hz or 1.74-kHz bandwidth, determine the correction factor in dB from Fig. 9 and subtract the amount from the selective meter indication. Record the corrected value on the E-10108 form in the space labeled CORRECTED TO 400 Hz BW.

**Requirement:** The channel initiator shall switch to within  $\pm 2$  dB of the requirements given in Table A. If this requirement is not met, the channel initiator BSP routine should be performed. Enter the requirement on the E-10108 form.

- 22 Subtract the corrected 9-MHz noise measurement from the requirement given in Table A to get the 9-MHz noise difference and record it on the E-10108 form (DIFFERENCE line).

**Example:** In Table A under WITHOUT SPACE DIVERSITY, REGULAR CHANNEL 400-Hz BW, 1200 Circuit Loading, the initiator operate requirement is  $-57$  dBm. If the 9-MHz noise corrected to 400-Hz bandwidth is  $-55$  dBm, then the difference is  $(-57 \text{ dBm}) - (-55 \text{ dBm}) = -2$  dB. This number would then be entered as DIFFERENCE on the E-10108 form.

- 23 Find the corrected fade at switch point by adding the 9-MHz noise difference to the actual fade at switch point and record it on the E-10108 form (CORRECTED FADE AT SWITCH POINT line).

**Example:** If the actual fade at switch point was 40 dB and the difference was  $-2$  dB, then the corrected fade at switch point would be  $(40) + (-2) = 38$  dB.

- 24 Using the transmitter output power and the received carrier power, find the fade margin requirement in Fig. 10 (1200 circuits), Fig. 11 (1500 circuits), or Fig. 12 (1800 circuits) and enter it on the E-10108 form as REQUIREMENT dB (on the same line as CORRECTED FADE AT SWITCH POINT).

- 25 Compare the corrected fade margin of Step 24 with the calculated fade margin of Step 25.

**Requirement:** Without space diversity switching, the corrected fade margin shall be within  $\pm 2.5$  dB of the calculated fade margin for a regular channel. For a protection channel, the cor-

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STEP	PROCEDURE
	<p>rected fade margin shall be within <math>\pm 2.5</math> dB of the calculated fade margin minus 4 dB. (The protection channel fade margin is 4 dB less than a regular channel.)</p> <p>With space diversity switching, the corrected fade margin shall be within <math>\pm 2.5</math> dB of the calculated fade margin +2 dB for regular channels. For a protection channel, the corrected fade margin shall be within <math>\pm 2.5</math> dB of the calculated fade margin minus 2 dB.</p>
26	<p>If this requirement is not met, check the received signal power (Section 410-100-510 or 411-100-508) at the receiving end of the hop being faded and the XPD (Section 410-410-513, 411-402-513, or 415-410-513) at that station.</p> <p><b>Note 1:</b> The fade margin requirements assume a roll-off at 9 MHz of approximately <math>-0.5</math> dB between the receiving end of the faded hop and the end of the switching section. The requirements may have to be changed somewhat when there is a large number of hops between the faded hop and the receiving main station and where there is considerable baseband roll-up or roll-off at 9 MHz.</p> <p><b>Note 2:</b> When fading the last radio hop (one closest to the receiving main station) and the switch section is equipped with the 100A Protection Switching System using J68381BG or J68381EF initiators, the channel may switch up to 2 dB sooner than given by the requirements and limits. This condition will be corrected when CN-7164 MV is applied to the initiators.</p> <p><b>Note 3:</b> A low fade margin on a 20-Mb/s digital radio channel may be caused by excessive noise at 9 MHz in the digital signal. This condition may be verified by momentarily placing a terminated FM transmitter on the channel at the transmitting end of the switch section and observing the decrease in 9-MHz noise level. Any noise decrease observed may be added to the corrected fade margin in Step 26. A noise decrease greater than 1 dB should be recorded under REMARKS on the E-10108 form.</p>
27	<p>Proceed with Chart 2 if the hop under test is equipped with space diversity. If not so equipped, proceed with Chart 3. In either case, keep the same fade arrangement as set up in this chart.</p>

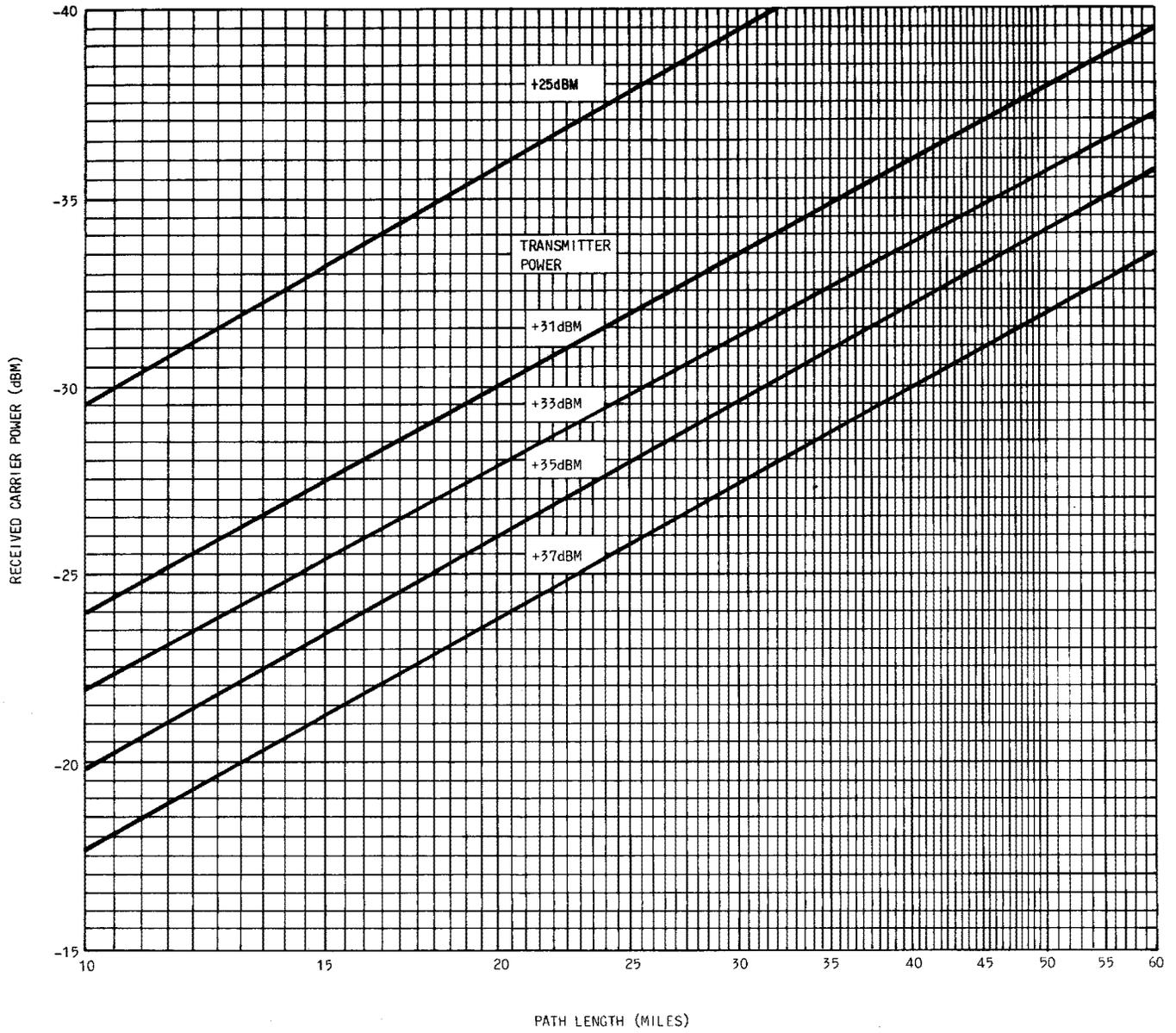
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**TABLE A**  
**CHANNEL INITIATOR OPERATE POINT**  
**FOR TD RADIO SYSTEM**

WITHOUT SPACE DIVERSITY				
MESSAGE CAPACITY OF RADIO CHANNELS*	9-MHz NOISE — dBm			
	REGULAR CHANNEL		PROTECTION CHANNEL	
	400-Hz BW†	1.74-kHz BW	400-Hz BW	1.74-kHz BW
1200 or less Ckt. Loading	-57	-50.5	-61.0	-54.5
1500 Circuit Loading	-63	-56.5	-67.0	-60.5
1800 Circuit Loading	-63	-56.5	-67.0	-60.5
SPACE DIVERSITY ON ONE OR MORE HOPS				
MESSAGE CAPACITY OF RADIO CHANNELS*	9-MHz NOISE — dBm			
	REGULAR CHANNEL		PROTECTION CHANNEL	
	400-Hz BW	1.74-kHz BW	400-Hz BW	1.74-kHz BW
1200 or less Ckt. Loading	-55	-48.5	-59.0	-52.5
1500 Circuit Loading	-61	-54.5	-65.0	-58.5
1800 Circuit Loading	-61	-54.5	-65.0	-58.5

\* For video channels, the sensitivity shall be set to the same point as for 1200 circuit loading. For 20-Mb/s digital channels, the sensitivity shall be set to the same point as for 1500 circuit loading.

† BW is the effective noise bandwidth of the level meter. Figure 9 should be used to calculate the requirement for level meters having different bandwidths.



**Fig. 1—4-GHz Received Carrier Power Versus Path Length and Transmitter Output Power**

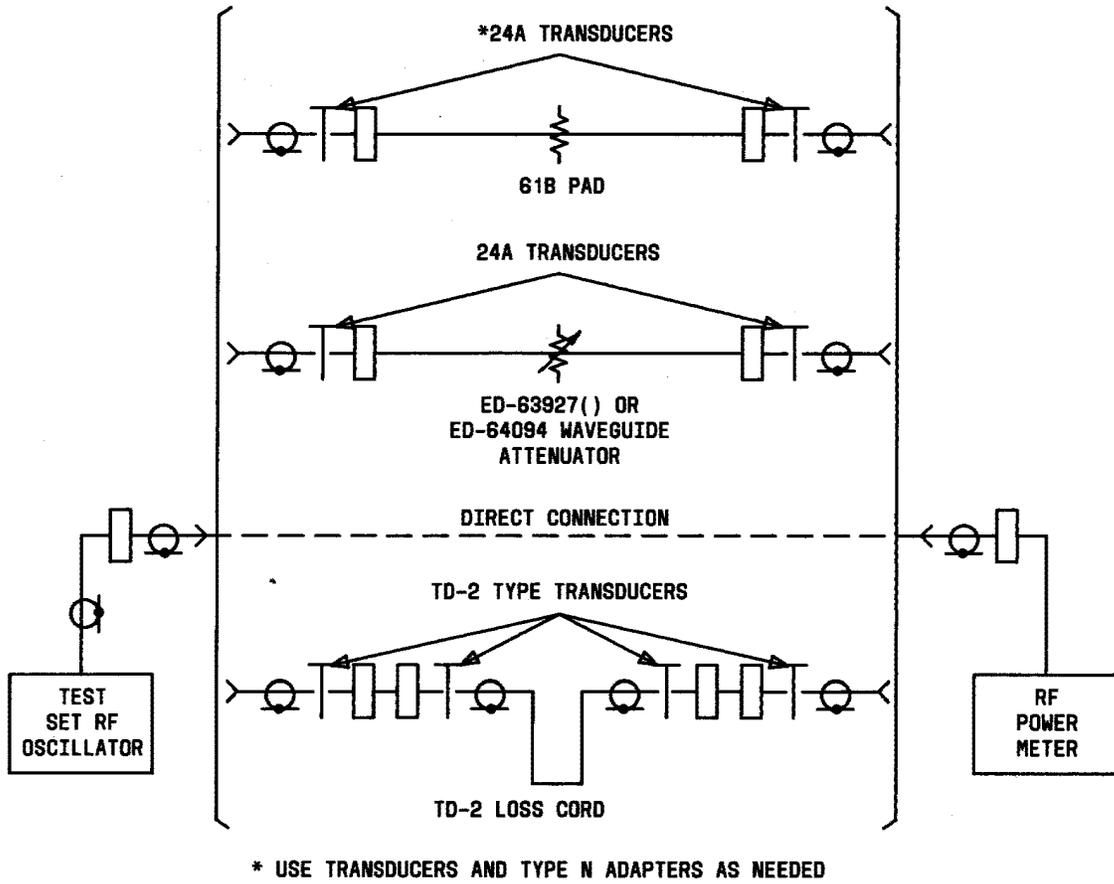


Fig. 2—Calibration of Waveguide Equipment

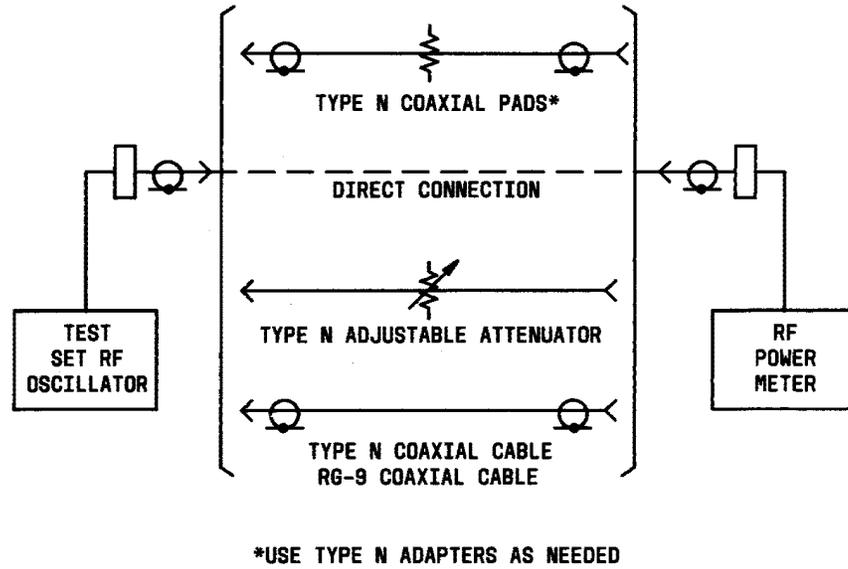


Fig. 3—Calibration of Coaxial Equipment

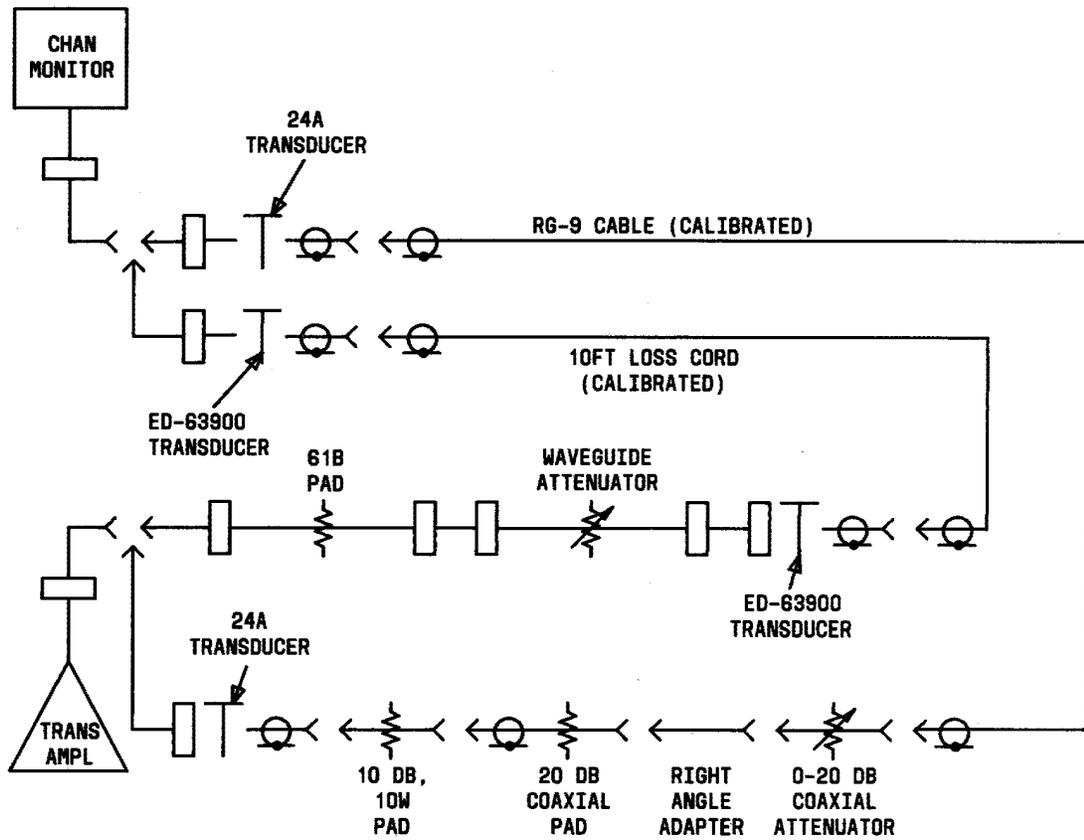


Fig. 4—Fade Test Arrangement—TD-2

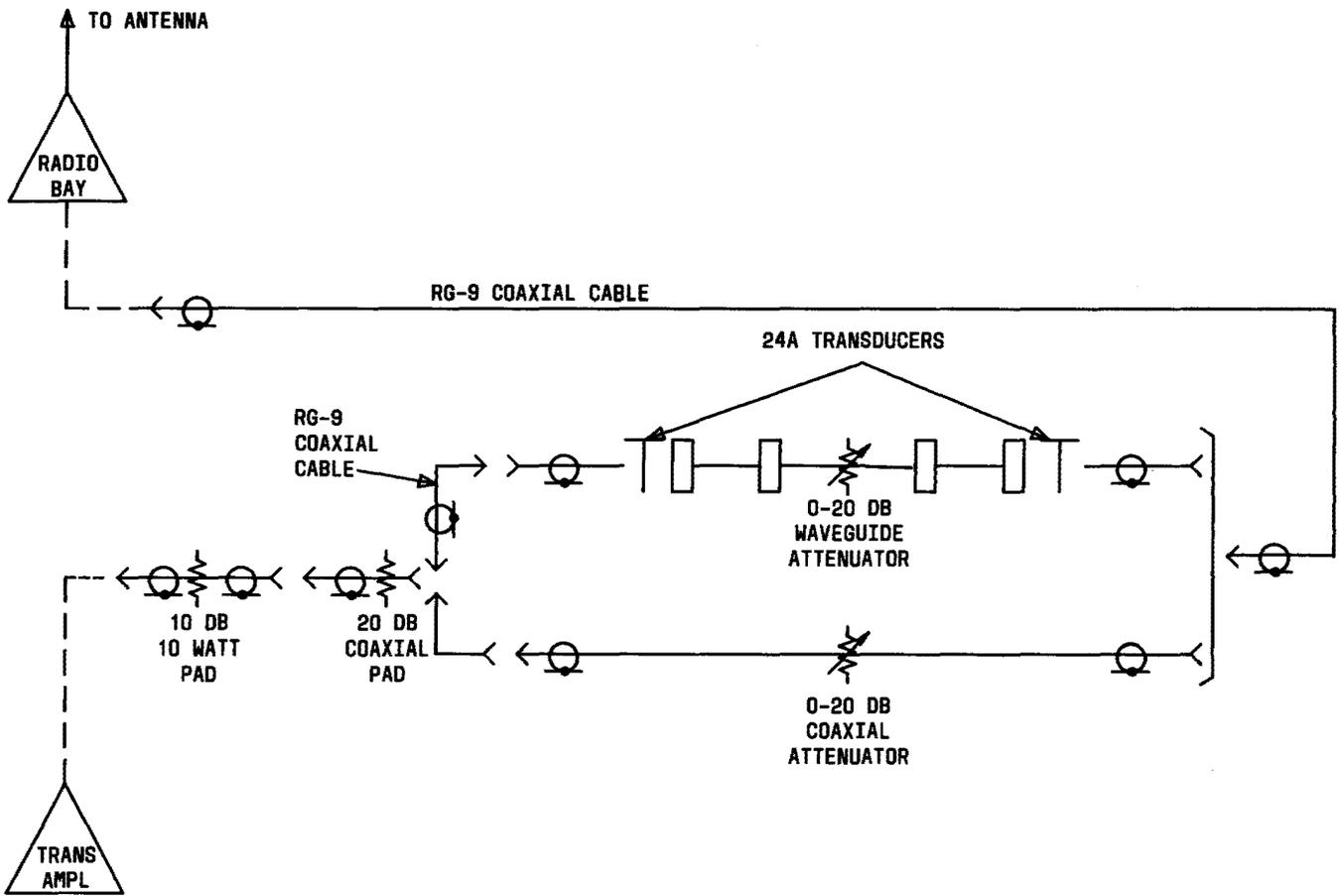


Fig. 5—Fade Test Arrangement—TD-3, TD-3A, TD-3D

## FADE MARGIN TEST FORM

DATE \_\_\_\_\_ MAIN STATION REPORTING \_\_\_\_\_  
 SWITCH SECTION \_\_\_\_\_ TO \_\_\_\_\_  
 RADIO HOP \_\_\_\_\_ TO \_\_\_\_\_  
 RADIO CHANNEL \_\_\_\_\_ HOP LENGTH \_\_\_\_\_ MILES  
 TRANSMITTER POWER \_\_\_\_\_ dBm RECEIVED CARRIER POWER \_\_\_\_\_ dBm  
 ACTUAL FADE AT SWITCH POINT \_\_\_\_\_ dB\*

## 9-MHz NOISE MEASUREMENT

400-Hz BW \_\_\_\_\_ dBm REQUIREMENT \_\_\_\_\_ dB

OR

1.74-kHz BW \_\_\_\_\_ dBm REQUIREMENT \_\_\_\_\_ dB

OR

CORRECTED TO 400-Hz BW \_\_\_\_\_ dBm REQUIREMENT \_\_\_\_\_ dB

DIFFERENCE (REQUIREMENT - MEASURED) \_\_\_\_\_ dB

CORRECTED FADE AT SWITCH POINT \_\_\_\_\_ dB\* REQUIREMENT \_\_\_\_\_ dB\*

CRITICAL FADE DEPTH \_\_\_\_\_ dB\* (45 Mb/s FADE SWITCH)

DUV OR 20 Mb/s FADE MARGIN (CRITICAL FADE DEPTH - ACTUAL  
 FADE AT SWITCH POINT) \_\_\_\_\_ dB

CARRIER RESUPPLY FADE DEPTH \_\_\_\_\_ dB\* REQUIREMENT \_\_\_\_\_ dB\*

REMARKS:

RECORDED BY \_\_\_\_\_

TELEPHONE NUMBER \_\_\_\_\_

\*All fade attenuator entries on this form should have a positive (+) sign.

Fig. 6—Fade Margin Test Form

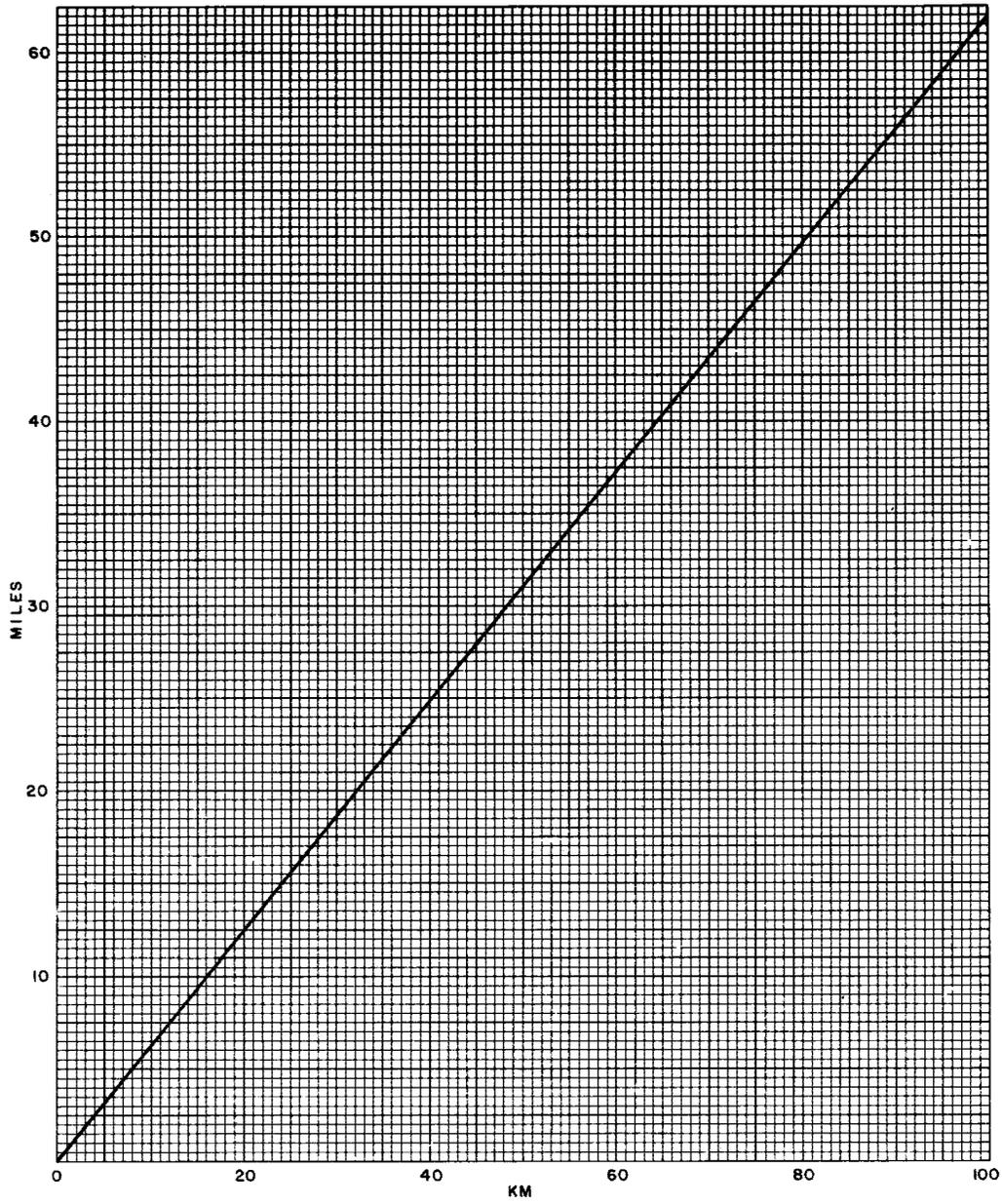


Fig. 7—Kilometers to Statute Miles

RECEIVING MAIN STATION

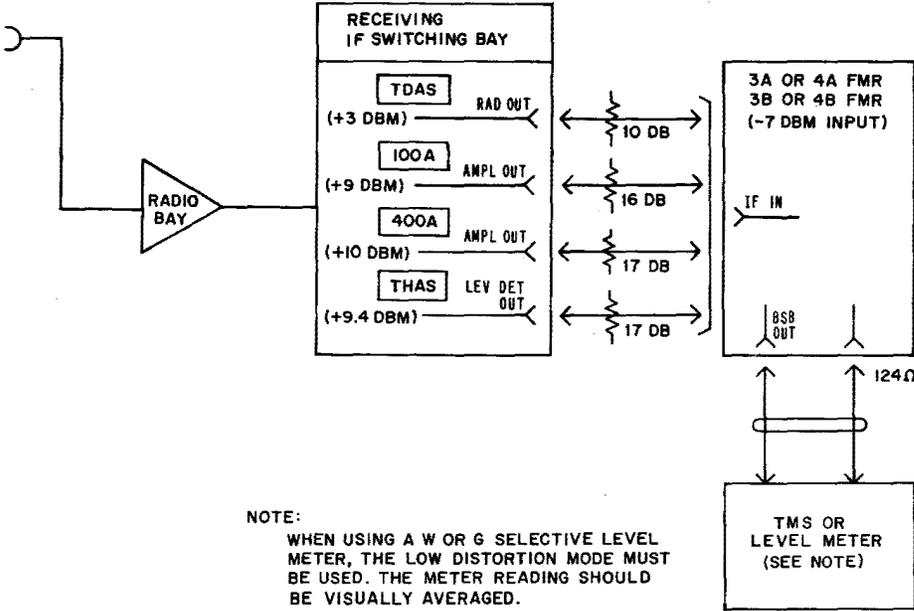


Fig. 8—9-MHz Noise Measurement

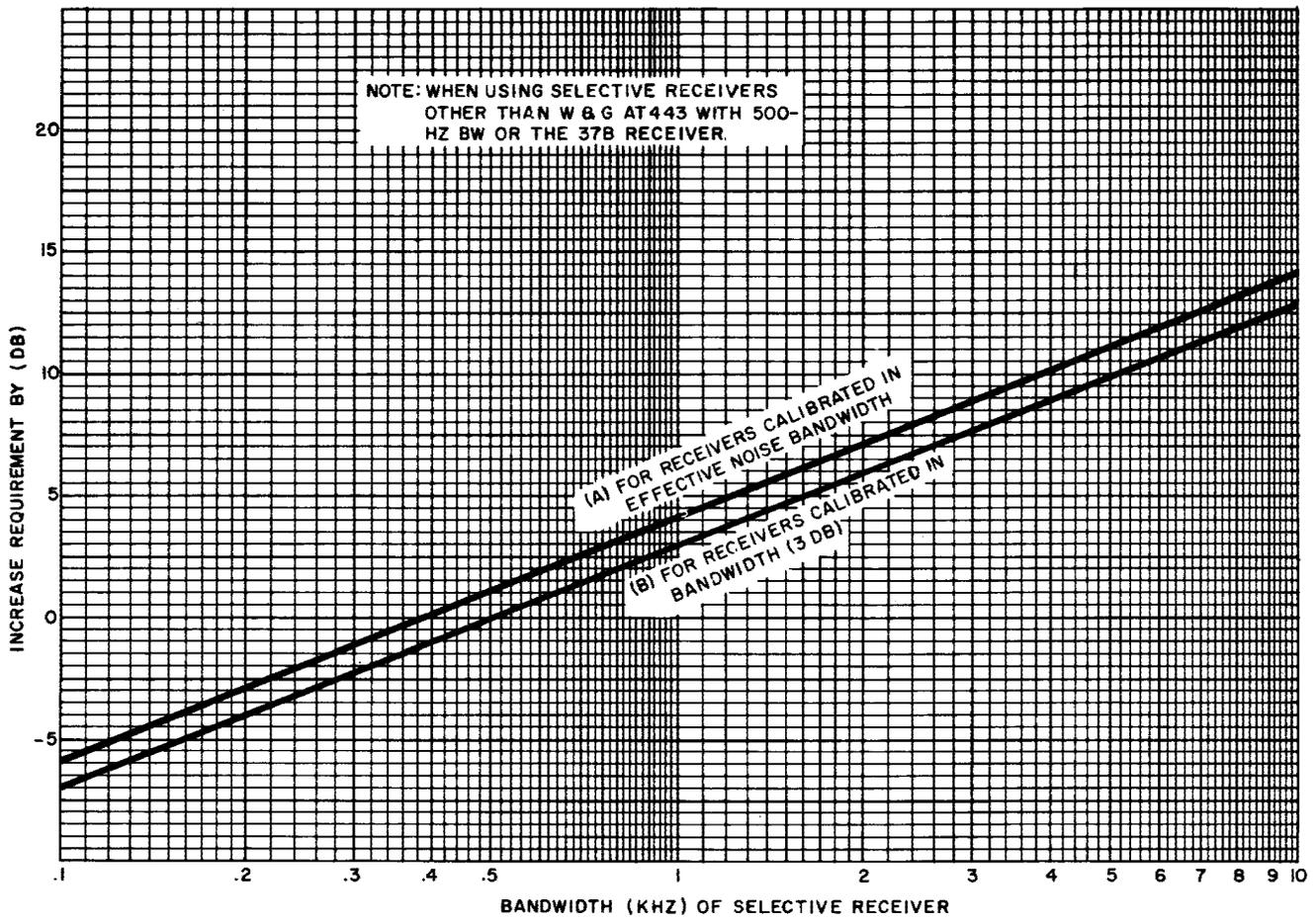
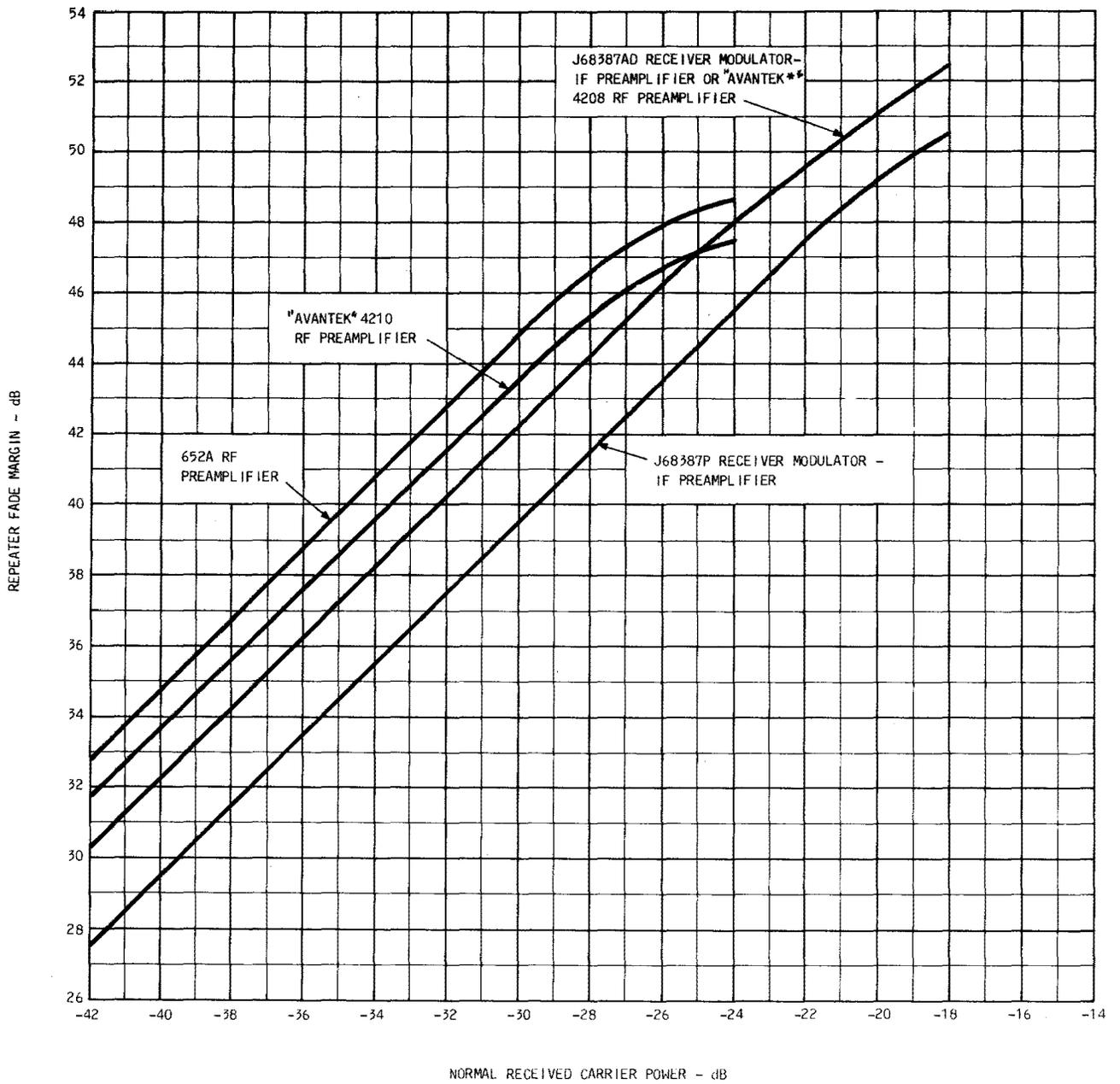


Fig. 9—Correction Factor for Thermal Noise Requirement



\*Registered trademark of Avantek, Inc.

Fig. 10—Fade Margin of TD Repeater—1200 Circuit Loading

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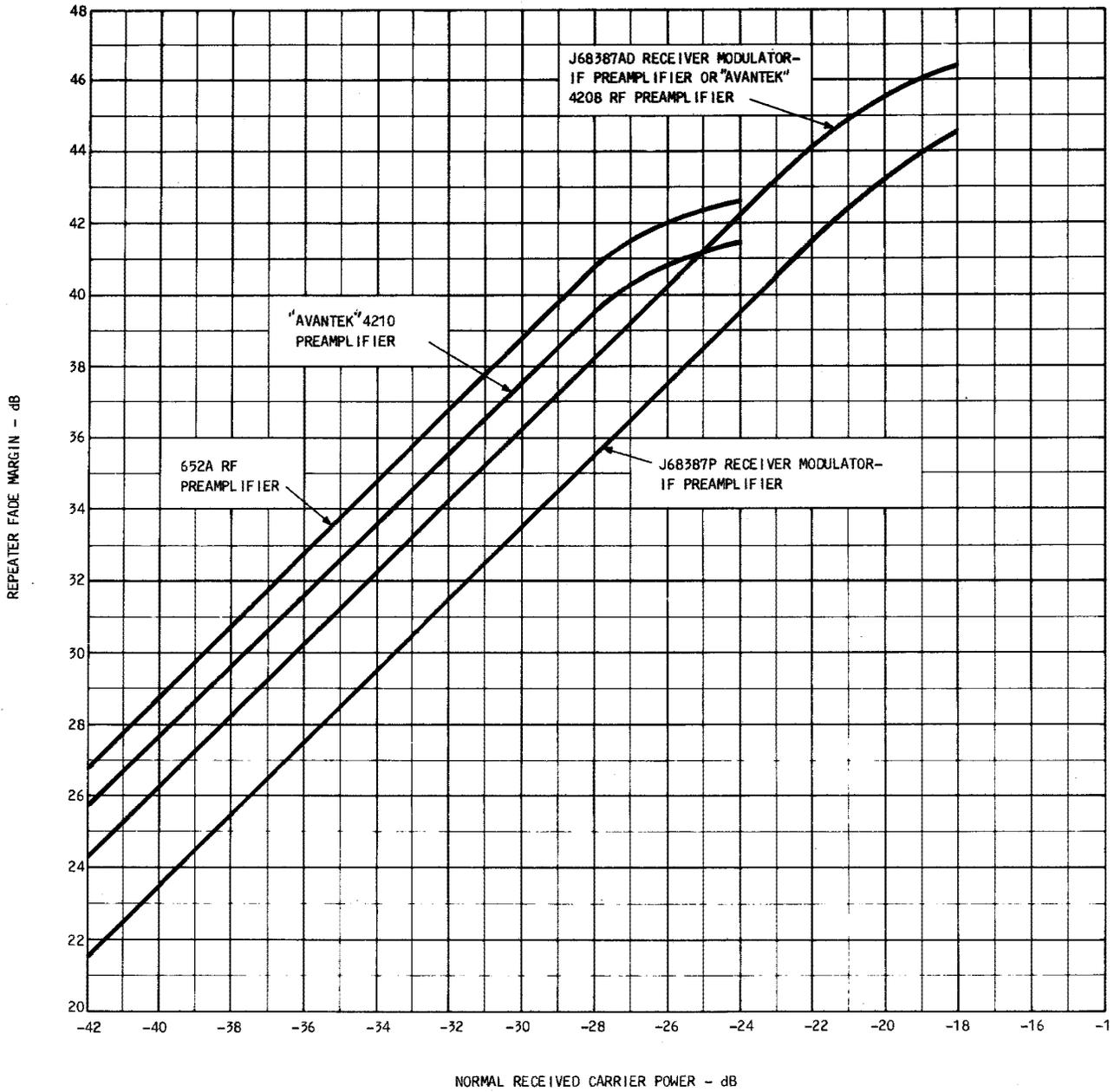


Fig. 11—Fade Margin of TD Repeater—1500 Circuit Loading

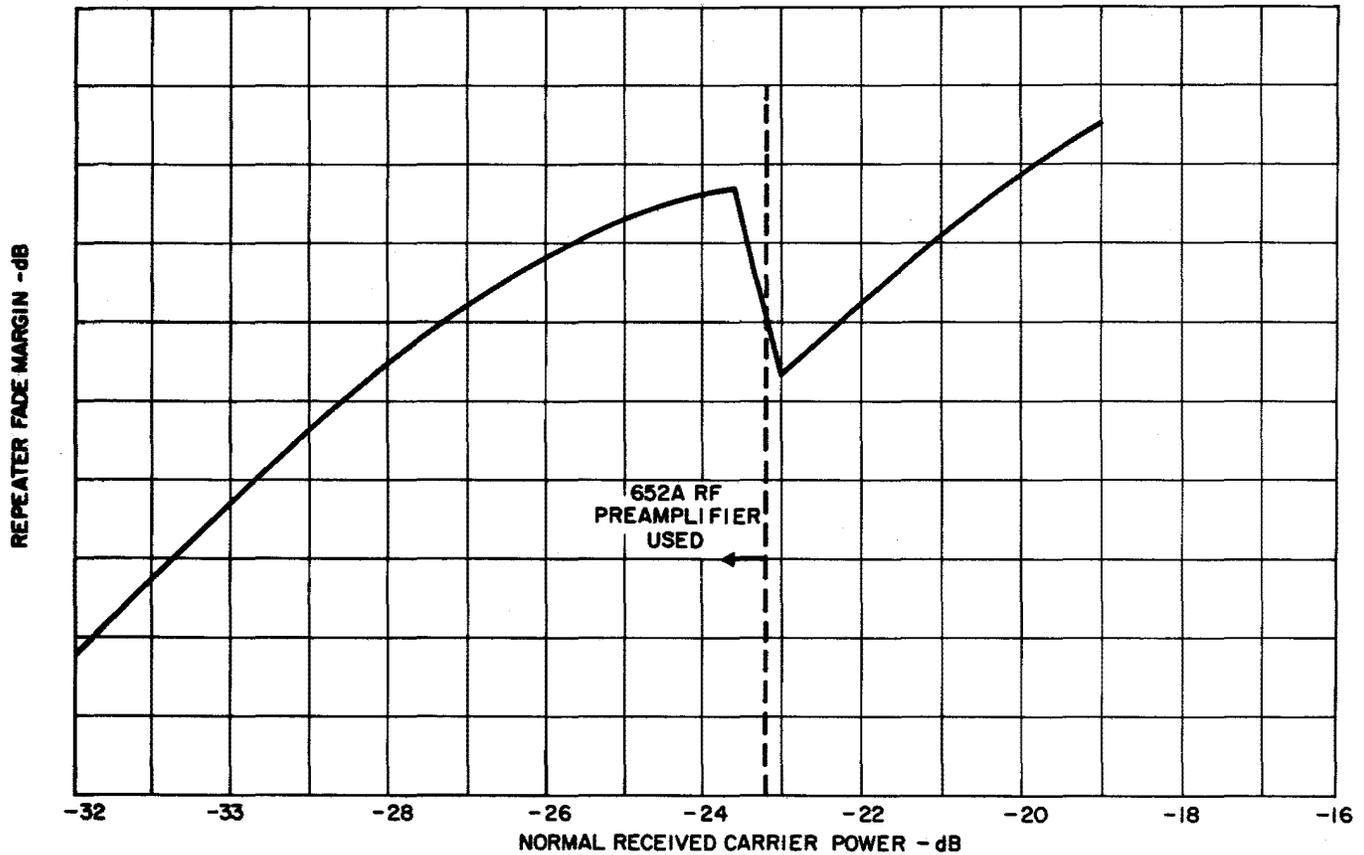


Fig. 12—Fade Margin of TD Repeater—1800 Circuit Loading

**B. Chart 2—TD Space Diversity Switching Switch Point**

**3.03** In addition to the apparatus listed in Chart 1, one KS-14510 voltmeter is required at the receiving end to perform this procedure.

STEP	PROCEDURE
1	With the channel ready to be faded as set up in Chart 1, have the receiver personnel operate the diversity switch to the REGULAR position and leave the TEST-OPERATE-TRIGGER switch in the OPERATE position.
2	At the receiver, open the IF path between the IF preamplifier output and the main amplifier input.

STEP	PROCEDURE
3	Using clip leads, connect a KS-14510 voltmeter either between terminal 8 (– lead) and terminal 1 (+ lead) of jack J1 (MAIN AMP) in the receiver control panel or to a BNC “T” connector at the AGC IN on the space diversity switch and record the voltage (approximately –8 volts). This is the saturation voltage of the AGC circuit. Leave the meter connected as above and reconnect the IF path between the preamplifier output and the main amplifier input.
4	<p>Slowly fade the transmitter until the receiving end reports that the diversity switch has operated to the DIVERSITY antenna. Since both antennas are experiencing the fade, the switch will operate back and forth between the two antennas. Note the fade depth where this occurs.</p> <p><b>Requirement:</b> The switch must operate either at 0.5 volt before the AGC saturation voltage is reached or at a fade of 3 dB less (earlier) than the ACTUAL FADE AT SWITCH POINT recorded on the E-10108 form as shown in Fig. 6, whichever is the smallest fade. Enter this amount of fade under the REMARKS heading of the E-10108 form. Label it ACTUAL FADE AT SPACE DIVERSITY SWITCH POINT.</p>
5	If this requirement is not met, adjust the trip point as given in Section 410-410-514.
6	<p>Have the receiver personnel force-switch (lock) the switch to the DIVERSITY antenna.</p> <p><b>Note:</b> For TD-2 radio system, the TEST-OPERATE-TRIGGER switch must be left in the TEST position.</p>
7	<p>Fade the transmitter until the switch point of the frequency diversity switching system is reached. Note this value under the REMARKS heading of the E-10108 form for future use in Chart 3 with the diversity antenna. Label it FADE TO FREQUENCY DIVERSITY SWITCH POINT ON DIVERSITY ANTENNA.</p> <p><b>Note:</b> The space diversity switch must switch 3 dB or more before the frequency diversity switching occurs.</p>
8	<p>Force-switch (lock) the switch to the REGULAR antenna and proceed with the tests of Chart 3.</p> <p><b>Note:</b> For TD-2 radio system, the TEST-OPERATE-TRIGGER switch must be left in the TEST position.</p>
9	At the conclusion of all tests, leave the diversity switch in the normal operating position.
<b>C. Chart 3—TD DUV Fade Margin and Carrier Resupply Operation Tests</b>	<p>1— 3A or 4A FM Transmitter</p> <p>1— Baseband Level Generator (W&amp;G, Siemens, or equivalent)</p> <p>1— 26A Splitting Pad</p>
<b>3.04</b> The following apparatus is required at the transmitting main station in addition to the transmitter fade apparatus listed in Chart 1.	

- |  |   |
|--|---|
| <p>1— Frequency Counter</p> <p>P2BJ Cords (unbalanced) or P3AH Cords (balanced) as required</p> <p>Pads as required.</p> <p>The following apparatus is required at the receiving main station to perform this procedure:</p> <p>1— 3A or 4A FM Receiver</p> <p>1— 124:75-ohm Transformer (197B or C) or 840956486 Cable Assembly</p> | <p>1— 1017A 64-kHz Band-Elimination Filter</p> <p>1— 1051F Low-Pass Filter</p> <p>1— J68448A-( ) Portable Pilot/Noise Monitor</p> <p>1— Selective Level Meter (W&amp;G, Siemens, or equivalent)</p> <p>1— 6G Noise Measuring Set or HP-3400A with Option H72, 75-ohm termination, and a 5-dB pad.</p> |
|--|---|

STEP	PROCEDURE
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**Note:** If the hop under test is equipped with space diversity switching, the diversity switch must be switched to REGULAR antenna and the TEST-OPERATE-TRIGGER to TEST.

- 1 Set up the test equipment at the transmitting end of the switching section as shown in Fig. 13. Allow the level generator and frequency counter to warm up.
- 2 Set the frequency of the level generator to 64 kHz  $\pm$ 10 Hz and the power output to 0 dBm (-26 dBm into FMT). Temporarily reduce the fade as much as possible before adjusting the 64 kHz.
- 3 Set up the test equipment at the receiving end of the switching section as shown in Fig. 14, option (X). Adjust the frequency of the selective level meter to peak (maximum) indication of the 64-kHz signal.
- 4 Have the transmitting end slowly and carefully adjust the 64-kHz frequency in order to center the generator frequency at the maximum insertion loss of the 1017A 64-kHz band-elimination filter.
- 5 When the signal is properly centered in the notch of the filter, record the selective level meter power indication. Record the generator frequency at the transmitting end.

**Requirement:** The selective level meter indication should be within the range of -65 to -75 dBm. Refer to Fig. 15 for an explanation of the 1017A filter characteristics.

**Note:** If great difficulty is encountered, the 64-kHz signal should be sent from the receiving end and looped back at the transmitting end of the sections.

**Critical Fade Depth Determination—Preferred Method Using the J68448A-( ) Portable Pilot/Noise Monitor (P/N MON)**

**Note:** The P/N MON must be equipped with the 1017A filter and modified according to CN-6953 MV. Also the baseband gain of the FMR in the P/N MON must be within limits.

STEP	PROCEDURE
6	Connect option (Z), Fig. 14, immediately after centering the 64-kHz signal in the 1017A filter. <b>Note:</b> On some test sets the FLT OUT may be designated BP OUT.
7	Adjust the threshold voltage to the proper level in accordance with Section 103-628-100.
8	Set the NOISE-PLT PH switch to the NOISE position.
9	Fade the far-end transmitter until the counter shows a high rate of counts (15 to 20 NOISE SEC per minute).
10	Decrease the fade 1 dB at a time until the count registers 5 NOISE SEC or less per minute. Record the amount of fade on the E-10108 form as shown in Fig. 6 in the space provided for CRITICAL FADE DEPTH. Proceed to Step 15.  <b>Critical Fade Depth Determination—Alternate Method Using the 6G Noise Measuring Set or HP-3400A Voltmeter</b>
11	If the hops are not equipped with space diversity switching, proceed with Step 12, otherwise, proceed to Step 15.
12	Immediately after centering the 64-kHz signal in the 1017A filter, connect option (Y), Fig. 14.
13	Fade the channel to the switch point found in Step 20 of Chart 1, and check if the critical noise level has been reached.  <b>Note 1:</b> To determine if the critical noise level has been reached with a 6G noise set, the dBrn dial must be set to 20 and to 4. If the average noise reading is greater than 15 on the 6G scale, the amount of fade must be slowly reduced until the reading is averaging 15 on the 6G scale. If the reading is less, the amount of fade must be slowly increased until the reading is averaging around 15 on the 6G scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).  <b>Note 2:</b> To determine if the critical noise level has been reached with the HP-3400A, a 5-dB pad must be connected at the input to the meter and the RANGE switch must be set to -50 dB. If the average noise reading is greater than -5 dB on the HP-3400A scale, the amount of fade must be slowly reduced until the reading is averaging -5 dB. If the reading is less, the amount of fade must be slowly increased until the reading is averaging -5 dB on the scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).
14	Proceed to Step 16.
15	Fade the channel to the switch point found in Step 20 of Chart 1. Reduce the attenuation in the transmitter of the hop under test by 2 dB (when testing a TD-2 or TD-3D radio system) and check if the critical noise level has been reached. For TD-3/TD-3A, simply check if the critical noise level has been reached. Record this amount of fade as the space diversity actual fade at switch point under REMARKS line on the E-10108 form.

STEP	PROCEDURE
	<p><b>Note 1:</b> To determine if the critical noise level has been reached with a 6G noise set, the dBrn dial must be set to 20 and to 4. If the average noise reading is greater than 15 on the 6G scale, the amount of fade must be slowly reduced until the reading is averaging 15 on the 6G scale. If the reading is less, the amount of fade must be slowly increased until the reading is averaging around 15 on the 6G scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).</p> <p><b>Note 2:</b> To determine if the critical noise level has been reached with the HP-3400A, a 5-dB pad must be connected at the input to the meter and the RANGE switch must be set to -50 dB. If the average noise reading is greater than -5 dB on the HP-3400A scale, the amount of fade must be slowly reduced until the reading is averaging -5 dB. If the reading is less, the amount of fade must be slowly increased until the reading is averaging -5 dB on the scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).</p>
16	<p>Calculate the DUV fade margin by subtracting the actual fade at switch point from the critical fade depth. For switch sections with hop(s) equipped with space diversity, calculate the DUV fade margin by subtracting the space diversity actual fade at switch point from the critical fade depth recorded in Step 15.</p> <p><b>Requirement 1:</b> If the DUV fade margin is +2 dB or greater, the DUV fade margin is said to be positive and no further tests or reports are necessary unless DUV trouble reports have been traced to the switch section during the periods of fading.</p> <p><b>Requirement 2:</b> If the DUV fade margin is between +2 dB and -2 dB, the DUV fade margin is said to be marginal and no further tests or reports are necessary unless DUV trouble reports have been traced to the switch section during the periods of fading.</p> <p><b>Requirement 3:</b> If the DUV fade margin is -2 dB or less, the DUV fade margin is said to be negative. A copy of the E-10108 form shall be sent to the transmission or radio engineering group. As it is normally beyond the resources of local operations personnel to correct poor DUV fade margins caused by cochannel interference, the district or area transmission personnel should be notified so they can more fully investigate the sources of cochannel interferences. However, if the problem is caused by the protection switching initiators not being set properly, steps should be taken to readjust them and repeat these tests.</p>
17	<p>If the radio system under test is a TD-2 or TD-3D, perform Steps 18, 19, and 20 and then proceed to Step 28. For a TD-3/TD-3A radio system proceed to Step 21.</p>
18	<p>If the channel is equipped with carrier resupply (CRS), reconnect option (X), Fig. 14 and observe the level meter indication of the 64-kHz signal. Continue fading the channel until the 64-kHz signal disappears. This is the carrier resupply operate point. Record this value on the E-10108 form (CARRIER RESUPPLY FADE DEPTH line).</p> <p><b>Requirement 1:</b> The fade depth at resupply operation shall be within <math>\pm 2</math> dB of the requirement given in Fig. 16.</p> <p><b>Requirement 2:</b> The fade at the CRS trip point shall be 2 dB or more below the fade depth at switch point.</p>

## STEP

## PROCEDURE

- 19 If the requirement is not met, but the requirements of Chart 1 were met, check the CRS trip point adjustment of the IF main amplifier at the receiving end of the radio hop under test. Also, check the gain of the IF preamplifier.

**Note:** Under certain conditions of 1200 circuit loading on the channel, there will be little or no margin between the fade at the carrier resupply operate point and the channel switch point. These conditions are as follows:

- (a) The channel has 1200 circuit loading and is equipped with the J68387P receiver modulator—IF preamplifier and the received carrier power is around  $-22$  dBm.
- (b) The channel has 1200 circuit loading and is equipped with the J68387AD receiver modulator—IF preamplifier and the received carrier power is  $-27$  dBm or greater ( $-25$  dBm).
- (c) The channel has 1200 circuit loading and is equipped with 652A RF preamplifier and the received carrier power is around  $-27$  dBm.

If there is no margin between the CRS operate point and the channel switch point and the above conditions apply, then it will be necessary to readjust the CRS trip point of the IF main amplifier to give a 2-dB margin. (This means the CRS trip point will be adjusted to operate below 0-dB output from the IF main amplifier.) The IF main amplifier shall be tagged with a note stating where the CRS trip point should be set and why.

- 20 If the hop under test has diversity switching, repeat this chart with the receiver force-switched (locked) to the DIVERSITY antenna. When calculating the DUV fade margin, use the switch point of the IF protection switching recorded under the REMARKS heading on the E-10108 form. When this DUV fade margin for the diversity antenna has been measured and calculated, also record this value under the REMARKS heading on the E-10108 form. Label it DUV FADE MARGIN ON DIVERSITY ANTENNA.

- 21 If the channel is equipped with carrier resupply, reconnect option (X), Fig. 14, and observe the level meter indication of the 64-kHz signal. Continue fading the channel until the 64-kHz signal disappears. This is the carrier resupply operate point. Record this value on the E-10108 form (CARRIER RESUPPLY FADE DEPTH line).

**Requirement 1:** The fade at the CRS trip point shall be 2 dB or more below the fade depth at switch point.

**Requirement 2:** With the channel faded, the FAIL lamp should be lighted at the receiving switch bay.

- 22 If Requirement 1 is not met, but the requirements of Chart 1 were met, check the CRS trip point adjustment and IF amplifier gain at the receiving end of the radio hop under test. (Refer to Sections 411-406-501 and 411-404-501 for TD-3 or Sections 411-506-501 and 411-504-501 for TD-3A.)

- 23 Remove the patch to the receiving switch bay from the FMR.

**Requirement:** The FAIL lamp should remain lighted.

STEP	PROCEDURE
24	Reduce the fade by removing approximately 20 dB from the attenuation at the transmitter. <b>Requirement:</b> The FAIL lamp shall extinguish.
25	Slowly increase the attenuation until the FAIL lamp is just lighted. Compare this amount of fade with the amount found in Step 23. <b>Requirement:</b> The fade that calls for a protection switch shall occur 2 dB or more before the fade that causes the carrier resupply to operate.
26	If the requirement is not met, check the frequency and power output of the carrier resupply generator. It should be determined that the sideband frequency is correct for the type of protection used.
27	At the conclusion of all tests, restore the bay to normal and return the channel to service.
28	File all copies of the E-10108 form with the other switching section test results for that particular channel.

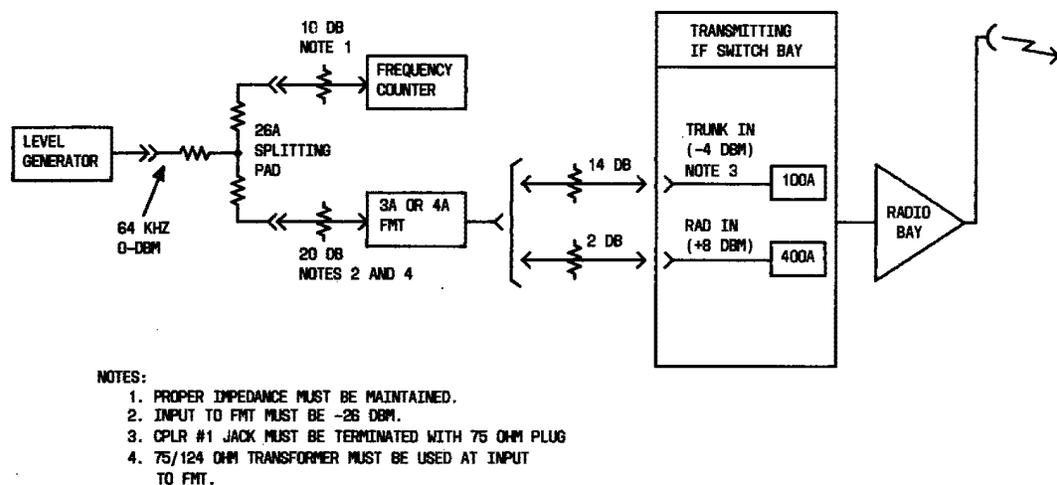


Fig. 13—Transmitting Location—Fade Margin Test Arrangement (TD and TH-3)

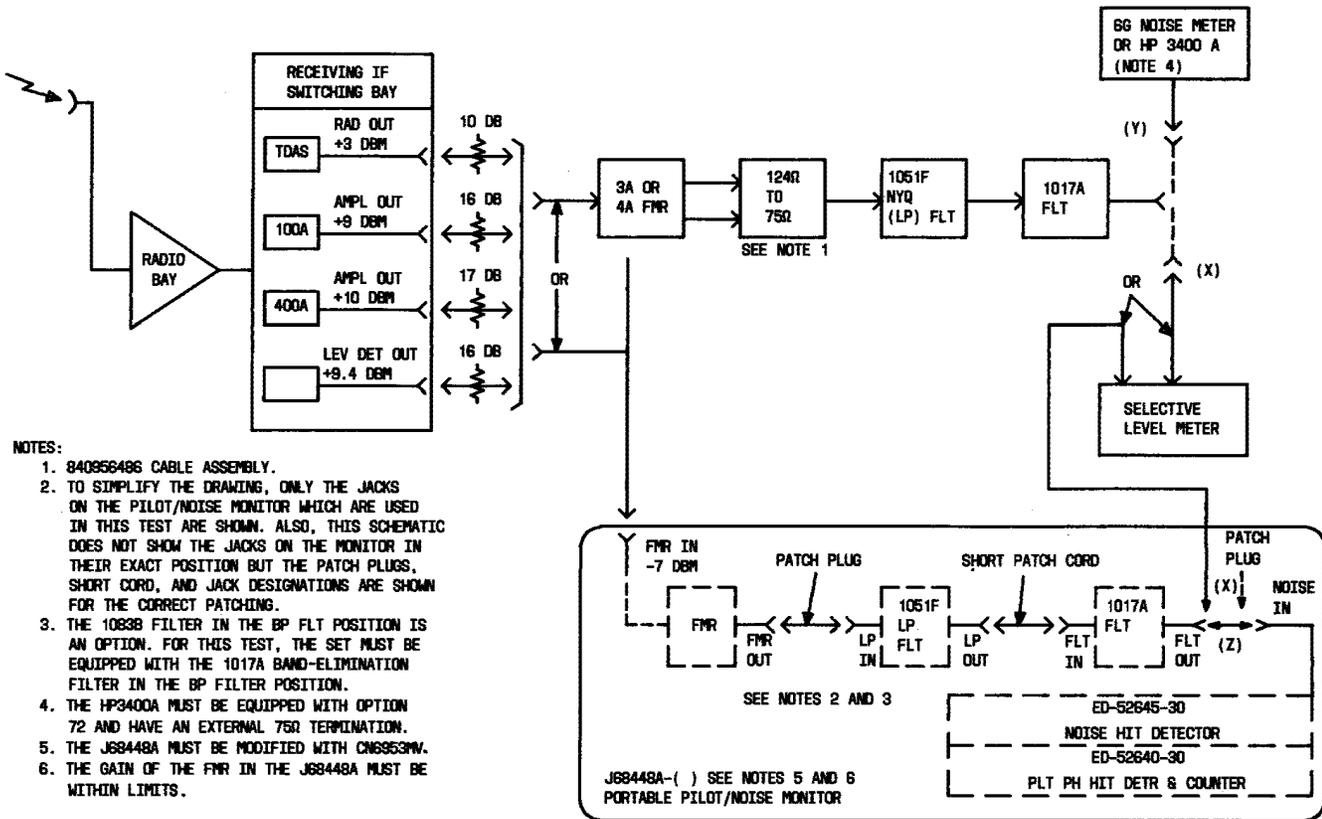
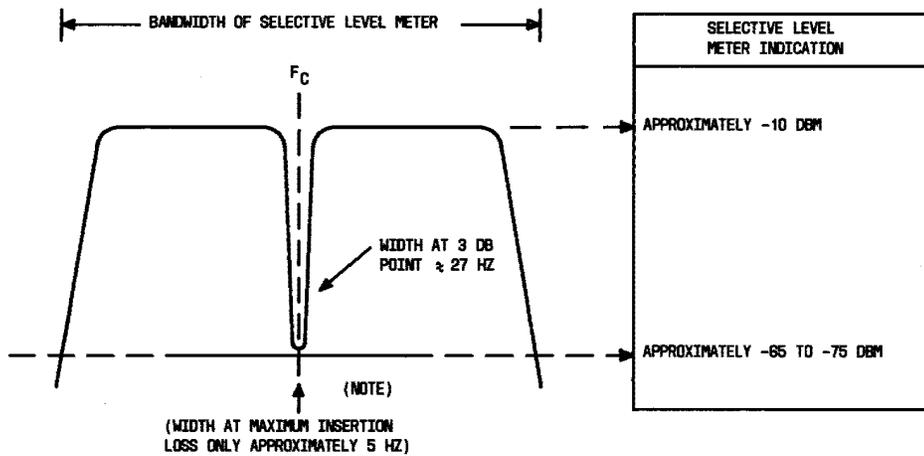
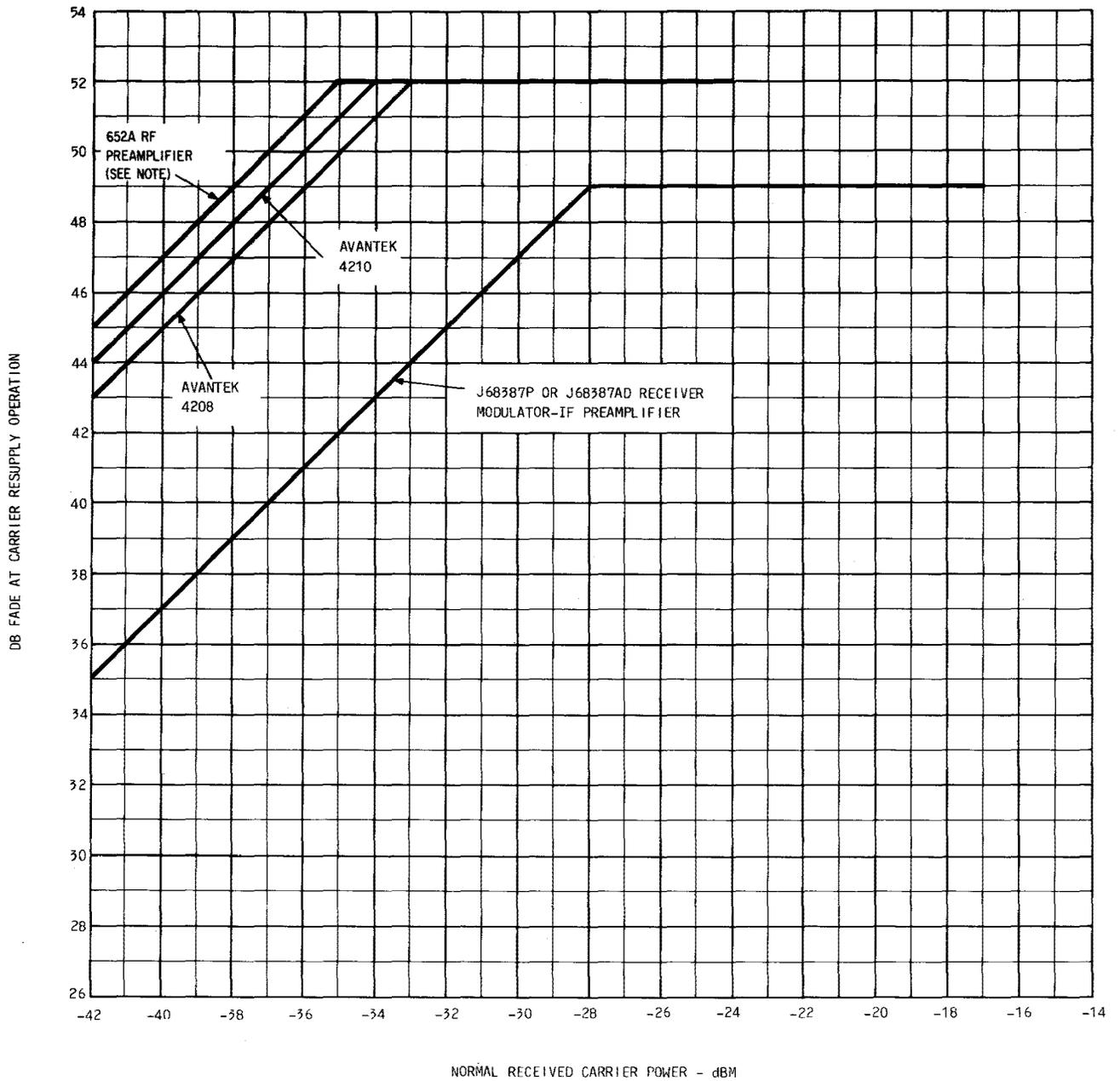


Fig. 14—Receiving Location—Fade Margin Test Arrangement



NOTE: THE 1017A 64-KHZ BAND-ELIMINATION FILTER HAS A VERY NARROW, STEEP SIDED CHARACTERISTIC. THE OSCILLATOR SHOULD BE TUNED VERY CAREFULLY TO FIND THE CORRECT DEPTH

Fig. 15—1017A 64-kHz Filter Characteristics



NOTE:  
 WHEN AN RF PREAMPLIFIER IS USED, THE OUTPUT OF THE IF PREAMPLIFIER IS SET FOR A +3 DB OUTPUT WHICH WILL GIVE 3 DB MORE FADE MARGIN BEFORE CARRIER RESUPPLY OPERATION.

Fig. 16—Carrier Resupply Fade Depth Versus Normal Received Carrier Power

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D. Chart 4—TD 20-Mb/s Fade Margin and Carrier Resupply Operation Tests

3.05 In addition to the apparatus listed in Chart 1, one DS1 error rate test set (Bowmar 271B or equivalent) and one P3BH cord are required at both

the transmitting and receiving (20-Mb/s terminal) station. At the switch section receive terminal station, one selective level meter (W&G, Siemens, or equivalent) and one 3A or 4A FM receiver are required.

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STEP	PROCEDURE
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**Note:** The following procedure should be used for initial testing of 20-Mb/s systems only.

1 **Caution:** All 12 of the DS1 channels must be placed out of service before testing.

2 At the DSX-1 cross-connect bay of the transmitting 20-Mb/s terminal station, connect the error rate test set (ERTS) DS1 output to the input of any even-numbered DS1 channel of the system.

3 At the DSX-1 cross-connect bay of the receiving 20-Mb/s terminal station, connect the output of the DS1 channel selected in Step 2 to the DS1 input of the ERTS.

4 Set the switches of the ERTS as follows:

MODE to ERROR

ERROR BLOCK to IN

SYNC MODE to AUTO

SELF TEST to NORMAL.

5 Set count interval to  $10^7$  bits.

**Requirement:** The NO DATA and NO SYNC lamps shall extinguish.

6 Depress the RESET/RESYNC switch and observe the display (for one count interval) until the count lamp is extinguished.

**Requirement:** The numerical readout should be zero, indicating error-free operation.

7 If the switch sections are not equipped with space diversity, perform Step 8 and proceed to Step 10; otherwise, proceed to Step 9.

8 Fade the channel to the switch point found in Step 20 of Chart 1, and check if the bit error rate (BER) exceeds  $1 \times 10^{-6}$ . (The count exceeds 10 in  $10^7$  bits.)

**Note:** If the bit error rate is greater than  $1 \times 10^{-6}$  (the count is greater than 10 in  $10^7$  bits). The amount of fade should be slowly reduced until a bit error rate of approximately  $1 \times 10^{-6}$  (a count of 7 to 14 in  $10^7$  bits) is obtained. If the bit error rate is less than  $1 \times 10^{-6}$ , the amount of fade should be slowly increased until a bit error rate of approximately  $1 \times 10^{-6}$  (a count of 7 to 14 in

STEP	PROCEDURE
	<p>10<sup>7</sup> bits) is obtained. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form as shown in Fig. 6 next to CRITICAL FADE DEPTH.</p>
9	<p>Fade the channel to the switch point found in Step 20 of Chart 1. Reduce the attenuation in the transmitter of the hop under test by 2 dB and check if the BER exceeds 1×10<sup>-6</sup>. Record this amount of fade under REMARKS section on the E-10108 form. Label it SPACE DIVERSITY ACTUAL FADE AT SWITCH POINT.</p> <p><b>Note:</b> If the bit error rate is greater than 1×10<sup>-6</sup> (the count is greater than 10 in 10<sup>7</sup> bits). The amount of fade should be slowly reduced until a bit error rate of approximately 1×10<sup>-6</sup> (a count of 7 to 14 in 10<sup>7</sup> bits) is obtained. If the bit error rate is less than 1×10<sup>-6</sup> the amount of fade should be slowly increased until a bit error rate of approximately 1×10<sup>-6</sup> (a count of 7 to 14 in 10<sup>7</sup> bits) is obtained. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form as shown in Fig. 6 next to CRITICAL FADE DEPTH.</p>
10	<p>If the switch section is not equipped with space diversity, perform Step 11 then proceed to Step 13. Otherwise proceed to Step 12.</p>
11	<p>Calculate the 20-Mb/s fade margin by subtracting the actual fade at switch point from the critical fade depth.</p> <p><b>Requirement:</b> If 20-Mb/s fade margin is 0 dB or less (negative), send a copy of the E-10108 form to the transmission or radio engineering group. As it is normally beyond the resources of local operations personnel to correct poor 20-Mb/s fade margins caused by cochannel interference, the district or area transmission personnel should be notified so they can investigate the sources of cochannel interferences. However, if the problem is caused by the protection switching channel initiators not being properly adjusted, steps should be taken to readjust them and repeat these tests.</p>
12	<p>Calculate the 20-Mb/s fade margin by subtracting the space diversity actual fade at switch point from the critical fade depth.</p> <p><b>Requirement:</b> If 20-Mb/s fade margin is 0 dB or less (negative), send a copy of the E-10108 form to the transmission or radio engineering group. As it is normally beyond the resources of local operations personnel to correct poor 20-Mb/s fade margins caused by cochannel interference, the district or area transmission personnel should be notified so they can investigate the sources of cochannel interferences. However, if the problem is caused by the protection switching channel initiators not being properly adjusted, steps should be taken to readjust them and repeat these tests.</p>
13	<p>If the channel is equipped with a carrier resupply, at the receiving main station connect a selective level meter and FMR as shown in Fig. 8.</p>
14	<p>Tune the selective level meter to approximate 1 MHz and note the power level measured. Continue fading the channel until a sharp decrease in the measured level is observed. This is the carrier resupply operate point. Record this value on the E-10108 form (CARRIER RESUPPLY FADE DEPTH line).</p> <p><b>Requirement 1:</b> The fade depth at resupply operation shall be within ±2 dB of the requirement given in Fig. 16.</p>

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STEP	PROCEDURE
	<b>Requirement 2:</b> The fade at the CRS trip point shall be 2 dB or more below the fade depth at switch point.
15	If the requirement is not met, but the requirements of Chart 1 were met, check the CRS trip point adjustment and the IF main amplifier at the receiving end of the radio hop under test. Also, check the gain of the IF preamplifier.
16	If the radio system under test is a TD-2 or TD-3D, perform Step 17 and proceed to Step 21. For a TD-3 or TD-3A, proceed to Step 18.
17	If the hop under test has diversity switching, repeat this chart with the receiver force-switched (locked) to the DIVERSITY antenna. When calculating the 20-Mb/s fade margin, use the switch point of the IF protection switching recorded under the REMARKS heading on the E-10108 form. When this 20-Mb/s fade margin for the diversity antenna has been measured and calculated, record the value under the REMARKS heading on the E-10108 form. Label it 20-Mb/s FADE MARGIN ON DIVERSITY ANTENNA.
18	Remove the selective level meter connection and restore the normal connection to the initiator.
	<b>Requirement:</b> With the channel faded, the lamp will be lighted at the receiving switch bay.
19	Remove the patch to the receiving switch bay.
	<b>Requirement:</b> The FAIL lamp should remain lighted.
20	Reduce the fade by removing approximately 20 dB from the attenuation at the transmitter.
	<b>Requirement:</b> The FAIL lamp shall extinguish.
21	Slowly increase the attenuation until the FAIL lamp is just lighted. Compare this amount of fade with the amount found in Step 14.
	<b>Requirement:</b> The fade that calls for a protection switch shall occur 2 dB or more before the fade that causes the carrier resupply to operate.
22	If this requirement is not met, check the frequency and power output of the carrier resupply generator. It should be determined that the sideband frequency is correct for the type of protection used.
23	At the conclusion of all tests, restore the bay to normal and return the channel to service.
24	File all copies of the E-10108 form with the other switching section test results for that particular channel.

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**E. Chart 5—TD 45-Mb/s Fade Margin Tests**

**3.06** In addition to the pads and attenuator listed in Chart 1, the following apparatus is also required: DS3 error rate transmitter manufactured by Scientific-Atlanta (4651) or equivalent, is required at

the transmitting end of the section and one DS3 error rate receiver manufactured by Scientific-Atlanta (4652) or equivalent, is required at the receiving end of the section.

STEP	PROCEDURE
	<p><b>Note:</b> Unlike the other fade margin tests in this section, the switch of a 45-Mb/s channel to the protection channel is initiated by the 45-Mb/s error rate and not by the noise at 9 MHz. A TD-45A LTS (line terminating system) bay is used at both ends of the switching system with the existing 100A or 400A protection switching bays to provide monitoring and control of the 45-Mb/s digital radio channels, and the protection switching system. There are two requirements in Chart 5. The first is to ensure that the switch to the protection channel occurs at the proper error rate. The second is to measure the 45-Mb/s fade margin to ensure proper performance of the digital radio channel.</p>
1	Switch the digital service on the channel by making a manual switch to the protection channel at the receiver TD-45A LTS bay.
2	Set up the bit error rate transmitter at the transmitting end of the switching system. Refer to Fig. 17. Set the BIT ERROR RATE to CLEAR and the OUTPUT to RANDOM DATA on the transmitter.
3	Set up the bit error rate receiver at the receiving end of the switch section as shown in Fig. 18. Follow instructions on the top of the set for DS3 input. Set the DS3 DISPLAY to BIT ERRORS and MODE to ERROR RATE 10 <sup>8</sup> BITS.
4	Obtain the path length of the radio hop from the station license. If this distance is given in kilometers, convert to miles using Fig. 7. Have this value recorded on an E-10108 form as shown in Fig. 6.
5	Measure the output power of the transmitter to be faded. Record this value on the E-10108 form. <b>Requirement:</b> +25 ±0.2 dBm.
6	Record the received carrier power on the E-10108 form. <b>Note:</b> Because of the lower transmitter power, the received carrier power will be much lower than the FM radio channels.
7	Notify the transmitting end of the switching section to watch the channel fail lamp on the YA71 REG STAT & CONT unit associated with the channel under test (in the receiving TD-45A LTS bay).
8	Fade the output of the transmitter until the transmitting end of the switching section reports that the YA71 REG STAT & CONT unit channel fail lamp has lighted. Reduce the attenuation 5 dB, then slowly refade the transmitter to the exact switch point. Measure the bit error rate.

STEP	PROCEDURE
	<p><b>Requirement:</b> The bit error rate at the switch point shall be between 5 by <math>10^{-5}</math> and 5 by <math>10^{-6}</math>.</p>
9	<p>The total of the cord and attenuator losses equals the amount that the transmitter output has been faded. Record this value on the E-10108 form as ACTUAL FADE AT SWITCH POINT. If this requirement is not met, replace the YA71 REG STAT &amp; CONT unit and repeat test.</p>
10	<p>Continue fading the output at the transmitter until a bit error rate of between 5 by <math>10^{-2}</math> and 5 by <math>10^{-3}</math> is reached. Calculate the amount of fade and record it on the E-10108 form next to CRITICAL FADE DEPTH. Compare this with the requirement shown in Fig. 19.</p> <p><b>Requirement:</b> The 45-Mb/s fade depth shall be within <math>\pm 2</math> dB of that shown in Fig. 19.</p> <p>Record the requirement on the E-10108 form next to REQUIREMENT. If this requirement is not met, check the received carrier power.</p> <p>If the received carrier power is still more than 2 dB lower than the requirement, the channel may have cochannel interference. Notify the district or area transmission group that the channel does not meet the 45-Mb/s performance objective.</p>

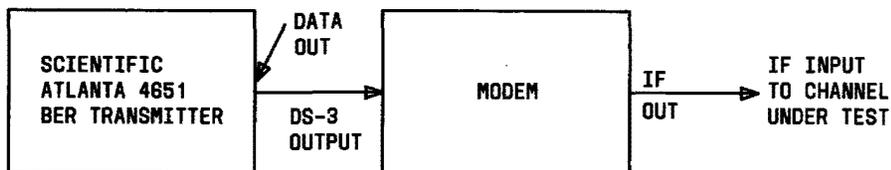


Fig. 17—Transmitting End Fade Test Arrangement for 45-Mb/s—TD

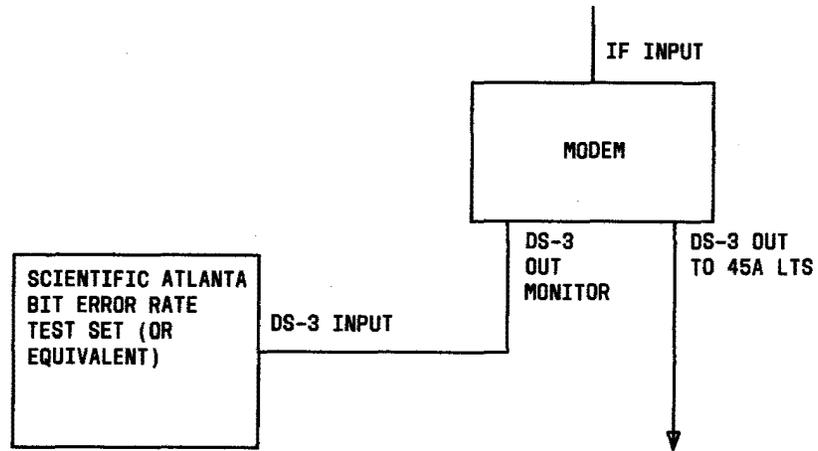


Fig. 18—Receiving End Fade Test Arrangement for 45-Mb/s—TD

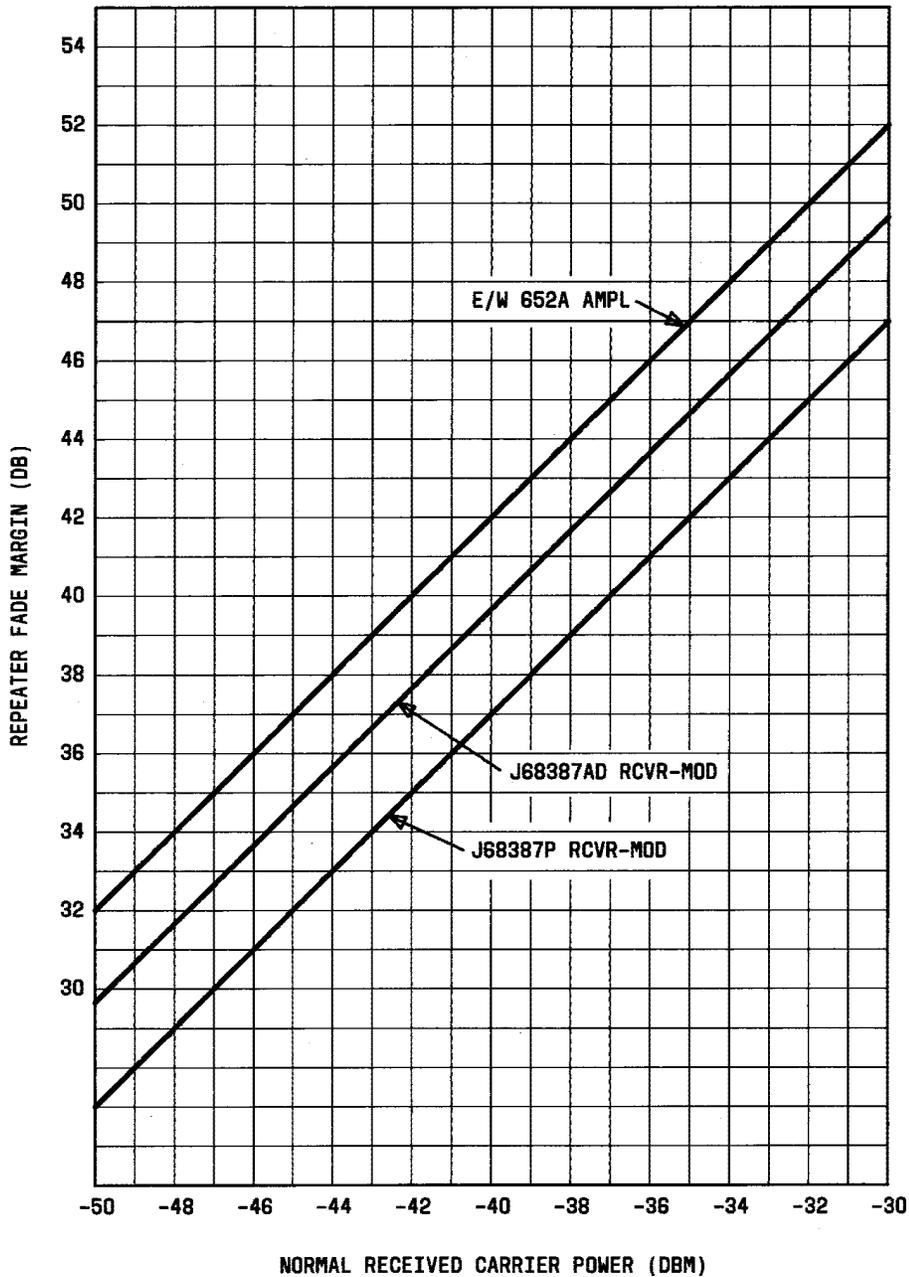


Fig. 19—Requirement for Fade Margin Test—45-Mb/s—TD

**F. Chart 6—TH-3 Frequency Diversity Protection Switching System Switch Point and 9-MHz Noise Measurement**

3.07 The following apparatus is required at the transmitting main station to perform this procedure:

- 1— J68428A Transmitter-Receiver Test Set

- 1— Narda 793 FM or WEC0 20A 20-dB Variable Waveguide Attenuator

- 1— 20-dB Coaxial Pad (KS-20498, L3)

- 1— 10-dB Coaxial Pad, 10 Watts (KS-21100, L1) (see note)

- 2— Waveguide-to-Coaxial Transducers (1B)
- 2— 1B Transducers and KS-19986, L4 Cable Assembly.

At the receiving main station, one 4A FM receiver and a selective level meter (W&G, Siemens, or equivalent) are required.

**Note:** Earlier versions of the J68428A test set were equipped with the 33A coupler instead of this pad. Arrangements should be made to obtain a KS-21100, L1 pad for this test since the 33A coupler may provide more initial loss than necessary to uncover a potential problem.

STEP	PROCEDURE
1	<p><b>Caution:</b> <i>The regular service must be switched to the protection channel or the protection channel must be locked out.</i></p> <p><b>Caution:</b> <i>For message or video channels, a terminated FM transmitter must be placed at the transmitting end of the switched section. For 20-Mb/s digital channels, the normal digital modulation must be maintained on the channels.</i></p> <p><b>Note:</b> Steps 2 through 7 are performed to calibrate the cords and attenuators to be used in fade test arrangements.</p>
2	Using any available 6-GHz test set, adjust the RF oscillator to a frequency in the middle of the 6-GHz frequency assignments.
3	Plug the power meter (set to the +10 scale) directly into the RF generator. Set the meter to a level of +5 dBm as in option (A), Fig. 20.
4	Check the loss of individual KS-19986, L4 cable assemblies using the arrangement of option (B), Fig. 20. Record the value.
5	Check the loss of individual coaxial pads using the arrangement of option (C), Fig. 20. Record the value.
6	To find the loss of the coaxial pad, subtract the loss recorded in Step 4 from the total loss.
7	Check the loss of the 20A variable attenuator using the arrangement of option (D), Fig. 20. Or check the loss of the 793FM attenuator using the arrangement of option (E), Fig. 20. Record the value.
8	Operate the attenuator to the 5-, 10-, 15-, and 20-dB points to check the loss over its entire range. Record the values.
9	Subtract the loss of both KS-19986, L4 cable assemblies from the loss recorded in Step 8, to find the loss of the variable attenuator.
	<p><b>Note:</b> The losses of the transducers and adapter are negligible and need not be measured unless trouble is suspected.</p>

## STEP

## PROCEDURE

- 10 Measure the power output of the transmitter to be faded. Have the receiving end of the switching section under test record this value on the E-10108 form as shown in Fig. 6.

**Note:** The recorded power output must be subtracted from the nominal transmitter power. The difference must be subtracted from the posted carrier power to obtain the correct received carrier power. The posted received carrier power may be determined using the procedure in Section 413-100-508.

- 11 Obtain the path length of the radio hop from the station license. If this distance is given in kilometers, convert to miles, using Fig. 7. Have this value recorded on the E-10108 form.

- 12 Arrange the attenuators to fade the transmitter at the transmitting end of the radio hop to be measured in option (A), Fig. 21, (20A, 20-dB variable attenuator) or option (B) (793FM variable attenuator).

- 13 When ready to fade the channel, notify the receiving end of the switching section to watch for the channel FAIL lamp in the receiving protection switching bay.

- 14 Slowly fade the transmitter (add attenuation) until the receiving-end channel FAIL lamp has lighted. Reduce the attenuation 3 dB (FAIL lamp should go out) and slowly fade the transmitter until the exact point of initiator operation is found. The sum of the cord and attenuator losses equals the amount that the transmitter output has been faded. Record this value on the E-10108 form as ACTUAL FADE AT SWITCH POINT.

- 15 **Caution: Plugging the FMR IF input into the receiving switch bay before the switch point is found, will interrupt the IF path to the initiator.**

With the channel faded to exactly the switch point, the average thermal noise at 9 MHz should be measured immediately, by using the test arrangement shown in Fig. 8.

- 16 Record this value on the 9-MHz NOISE MEASUREMENT line of the E-10108 form. Record the bandwidth of the selective meter in use. If necessary, convert this value to the 400-Hz or 1.74-kHz bandwidth equivalent, using Fig. 9 and enter it on the E-10108 form.

**Requirement:** The channel initiator shall switch to within  $\pm 2$  dB of the requirements given in Table B. If this requirement is not met, the channel initiator Bell System Practice routine should be performed. Enter the requirement on the E-10108 form.

- 17 Subtract the corrected 9-MHz noise measurement from the requirement given in Table B to get the 9-MHz noise difference and record it on the E-10108 form.

**Example:** The 400-Hz bandwidth, 1800 circuit loading, regular channel initiator operate requirement from Table B is  $-63$  dBm. If the 9-MHz noise corrected to 400-Hz bandwidth is  $-61$  dBm, then the difference is  $(-63 \text{ dBm}) - (-61 \text{ dBm}) = -2$  dB. This number would then be added next to DIFFERENCE on the E-10108 form.

- 18 Find the corrected fade at switch point by adding the 9-MHz noise difference to the actual fade at switch point and record it on the E-10108 form.

---

STEP	PROCEDURE
	<p><b>Example:</b> If the actual fade at switch point was 40 dB and the difference was -2 dB, then the corrected fade at switch point would be <math>(40) + (-2) = 38</math> dB.</p>
19	Using the graph in Fig. 22, find the fade margin requirement and enter it on the E-10108 next to REQUIREMENT dB (on the same line as CORRECTED FADE AT SWITCH POINT).
20	Compare the corrected fade margin of Step 18 with the calculated fade margin of Step 19.
	<p><b>Requirement:</b> The corrected fade margin shall be within <math>\pm 2.5</math> dB of the calculated fade margin.</p>
21	If the requirement is not met, check the received carrier power (Section 413-100-508) at the receiving end of the hop being faded and the XPD (Section 413-400-513) at that station. The fade margin requirements of Fig. 22 are based on the following assumptions:
	<ul style="list-style-type: none"><li data-bbox="418 852 1539 915">(a) An average antenna height of about 200 feet. Add or subtract 0.3 dB from the requirement for each 100-foot difference in antenna height.</li><li data-bbox="418 947 1539 1037">(b) The antennas at both ends of the radio hop are assumed to be KS-15676 horns which have a total midband gain of 86.2 dB (43.1 dB each). If other antennas are used, appropriate changes in requirements should be calculated to include their gain.</li><li data-bbox="418 1068 1539 1159">(c) The radio path is approximately in a no-fade condition, with the received signal power stable within <math>\pm 1</math> dB. If the radio path loss is known to be higher or lower than typical, the requirements should be adjusted accordingly.</li><li data-bbox="418 1190 1539 1262">(d) If waveguide pads are set at either end of the radio hop, the requirements should be reduced by the amount of their loss.</li></ul>
22	Proceed with Chart 7.

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TABLE B

## CHANNEL INITIATOR OPERATE POINT — TH-3

MESSAGE CAPACITY OF RADIO CHANNELS*	9-MHz NOISE — dBm			
	REGULAR CHANNEL		PROTECTION CHANNEL	
	400-Hz BW†	1.74-kHz BW	400-Hz BW	1.74-kHz BW
1800 Circuit Loading	-63.0	-56.5	-67.0	-60.5
2400 Circuit Loading	-59.0	-52.5	-63.0	-57.3

\* For video channels, the sensitivity shall be set to the same point for the message capacity of the channel.

† BW is the effective noise bandwidth of the level meter. Figure 9 should be used to calculate the requirement for level meters having different bandwidths.

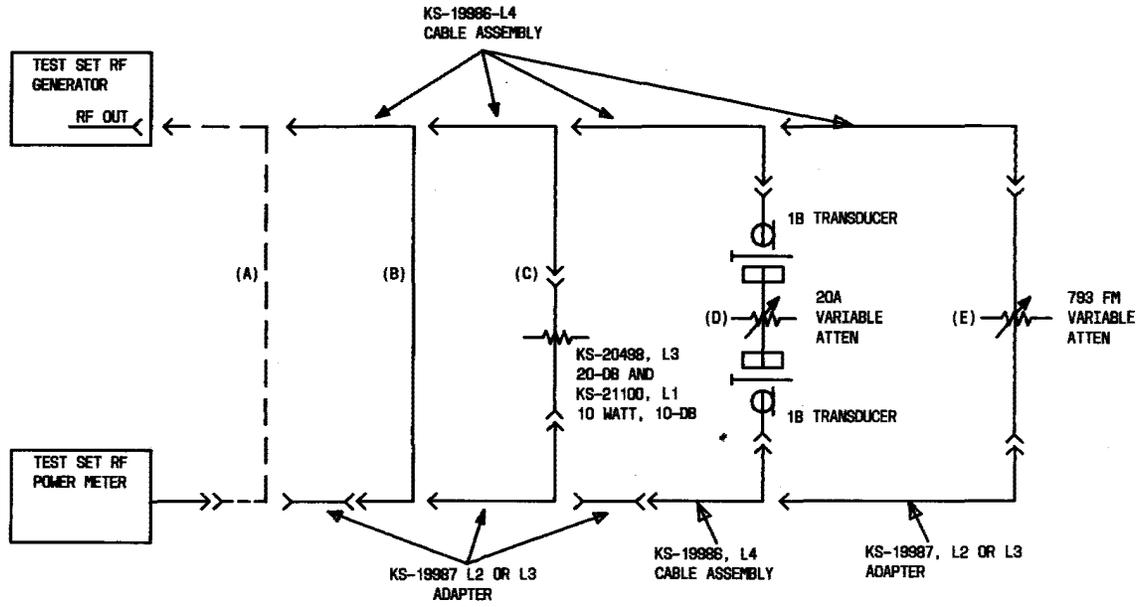
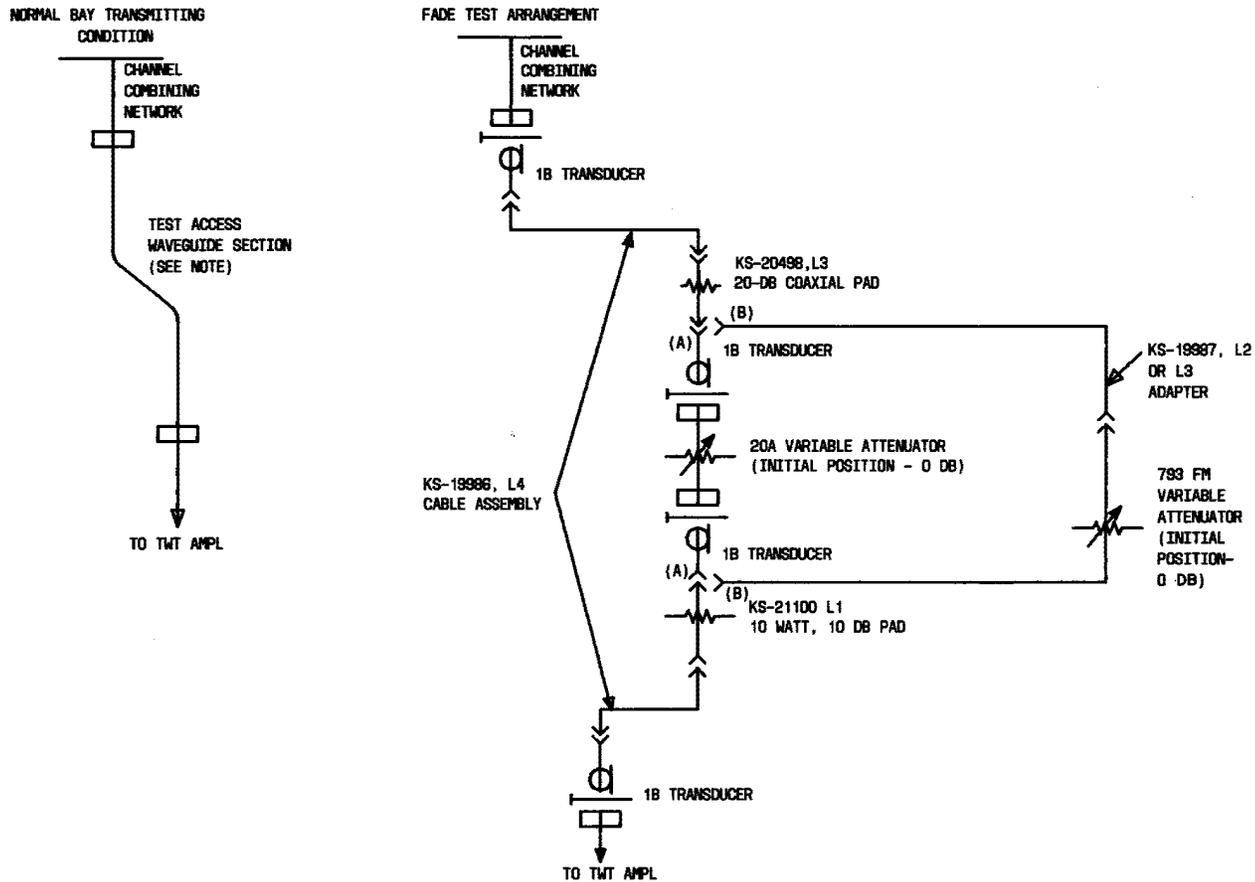


Fig. 20—Calibration of Test Attenuators—TH-3



NOTE: THE FADE TEST ARRANGEMENT ON THE RIGHT MUST BE ATTACHED TO CHANNEL COMBINING NETWORK, UPON REMOVAL OF THE IF DRIVE, AND THE TEST ACCESS WAVEGUIDE SECTION. THE IF DRIVE MUST THEN BE REPLACED.

Fig. 21—Fade Test Arrangement—TH-3

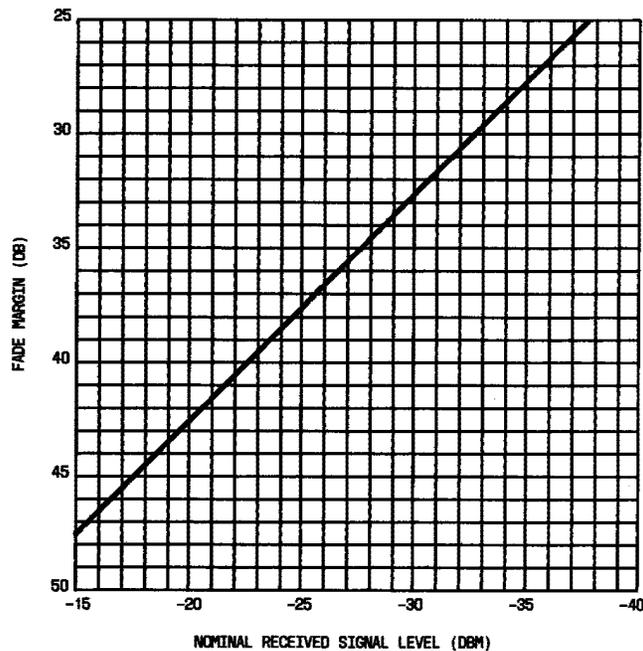


Fig. 22—Requirement for 1800 or 2400 Circuit Loading

**G. Chart 7—TH-3 Cochannel Interference—DUV Fade Margin, RF Squelch, and Carrier Resupply Operation Tests**

**3.08** The following apparatus is required at the transmitting main station to perform this procedure.

- 1— 4A FM Transmitter
- 1— Baseband Level Generator (W&G, Siemens, or equivalent)
- 1— 26A Splitting Pad
- 1— Frequency Counter
- P2BJ Cords (unbalanced) or P3AH Cords (balanced) as required

Pads as required.

The following apparatus is required at the re-

ceiving main station:

- 1— 4A FM Receiver
- 1— 124:75-ohm Transformer (197B, C, or 840956486 Cable Assembly)
- 1— 1017A 64-kHz Band-Elimination Filter
- 1— 1051F Low-Pass Filter
- 1— Selective Level Meter (W&G, Siemens, or equivalent)
- 1— 6G Noise Measuring Set or HP-3400 with Option H72 (with 1051F LP filter)
- or
- 1— J68448A-( ) Portable Pilot/Noise Monitor.

**Note:** Personnel should be stationed at the receiving end if the channel is equipped with RF squelch (J68387S IF main amplifier).

---

STEP	PROCEDURE
1	Set up the test equipment at the transmitting end of the switching section as shown in Fig. 13. Allow the level generator and frequency counter to warm up.
2	Initially, set the frequency of the level generator to 64 kHz $\pm$ 10 Hz and the power output to 0 dB (-26 dBm into FMT). Temporarily reduce the fade as much as possible before adjusting the 64-kHz signal.
3	Set up the test equipment at the receiving end of the switching section as shown in Fig. 14, option (X). Adjust the frequency of the selective level meter to peak (maximum) indication of the 64-kHz signal.
4	Have the transmitting end slowly and carefully adjust the 64-kHz frequency in order to center the generator frequency at the maximum insertion loss of the 1017A 64-kHz band-elimination filter.
5	When the signal is properly centered in the notch of the filter, record the selective level meter power indication and the generator frequency at the transmitting end.  <b>Requirement:</b> The selective level meter indication should be within the range of -65 to -75 dBm. Refer to Fig. 15 for an explanation of the 1017A filter characteristics.  <b>Note:</b> If great difficulty is encountered, the 64-kHz signal should be sent from the receiving end and looped back at the transmitting end of the sections.  <b>Critical Fade Depth Determination—Preferred Method Using the J68448A- ( ) Portable Pilot/Noise Monitor (P/N MON)</b>  <b>Note:</b> The P/N MON must be equipped with the 1017A filter and modified according to CN-6953 MV. Also the baseband gain of the FMR in the P/N MON must be within limits.
6	Connect option (Z), Fig. 14, immediately after centering the 64-kHz signal in the 1017A filter.  <b>Note:</b> On some test sets, the FLT OUT may be designated BP OUT.
7	Adjust the threshold voltage to the proper level in accordance with Section 103-628-100.
8	Set the NOISE-PLT PH switch to the NOISE position.

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STEP	PROCEDURE
9	Fade the far-end transmitter until the counter shows a high rate of count (15 to 20 NOISE SEC per minute).
10	Decrease the fade 1 dB at a time until the count registers 5 NOISE SEC or less per minute. Record the amount of fade on the E-10108 form as shown in Fig. 6 in the space provided for CRITICAL FADE DEPTH. Proceed to Step 13.
	<b>Critical Fade Depth Determination—Alternate Method Using the 6G Noise Measuring Set or HP-3400A Voltmeter</b>
11	Connect option (Y), Fig. 14, immediately after centering the 64-kHz signal in the 1017A filter.
12	Fade the channel to the switch point recorded on the E-10108 form as ACTUAL FADE AT SWITCH POINT and check if the critical noise level has been reached.
	<p><b>Note 1:</b> To determine if the critical noise level has been reached with a 6G noise set, the dBrn dial must be set to 20 and to 4. If the average noise reading is greater than 15 on the 6G scale, the amount of fade must be slowly reduced until the reading is averaging 15 on the 6G scale. If the reading is less, the amount of fade must be slowly increased until the reading is averaging around 15 on the 6G scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).</p>
	<p><b>Note 2:</b> To determine if the critical noise level has been reached with the HP-3400A, a 5-dB pad must be connected at the input to the meter and the RANGE switch must be set to -50 dB. If the average noise reading is greater than -5 dB on the HP-3400A scale, the amount of fade must be slowly reduced until the reading is averaging -5 dB. If the reading is less, the amount of fade must be slowly increased until the reading is averaging -5 dB on the scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).</p>
13	Calculate the DUV fade margin by subtracting the actual fade at the switch point from the critical fade depth.
	<p><b>Requirement 1:</b> If the DUV fade margin is +2 dB or greater, the DUV fade margin is said to be positive and no further tests or reports are necessary unless DUV trouble reports have been traced to the switch section during the periods of fading.</p>
	<p><b>Requirement 2:</b> If the DUV fade margin is between +2 dB and -2 dB, the DUV fade margin is said to be marginal and no further tests or reports are necessary unless DUV trouble reports have been traced to the switch section during the periods of fading.</p>
	<p><b>Requirement 3:</b> If the DUV fade margin is -2 dB or less, the DUV fade margin is said to be negative. A copy of the E-10108 form shall be sent to the transmission or radio engineering group. As it is normally beyond the resources of local operations personnel to correct poor DUV fade margins caused by cochannel interference, the district or area transmission personnel should be notified so they can investigate the sources of cochannel interferences. However, if the problem is caused by the protection switching channel initiators not being set properly, steps should be taken to readjust them and repeat these tests.</p>

STEP	PROCEDURE
14	If the channel is equipped with a carrier resupply (J68387AB IF MAIN AMP), proceed with Step 15. If the channel is equipped with RF squelch (J68387S IF MAIN AMP) proceed to Step 17.
15	Observe the level meter indication of the 64-kHz signal. Continue fading the channel until the 64-kHz signal disappears. This is the carrier resupply operate point. Record this value on the E-10108 form (CARRIER RESUPPLY FADE DEPTH line).  <b>Requirement:</b> The fade depth at carrier resupply or squelch operation shall be $47 \pm 2$ dB.
16	If this requirement is not met, but the requirements of Chart 6 were met, check the carrier resupply trip point as outlined in Section 413-404-500 or the squelch initiator trip point as outlined in Section 413-406-502.
17	Have the receiving end of the hop being faded observe the squelch lamp on the channel being faded. Continue fading the channel until the squelch lamp is lighted. This is the squelch operate point. Record this value on the E-10108 form (CARRIER RESUPPLY FADE DEPTH line). Label it squelch.  <b>Requirement:</b> The fade depth at carrier resupply or squelch operation shall be $47 \pm 2$ dB.
18	If this requirement is not met, but the requirements of Chart 6 were met, check the carrier resupply trip point as outlined in Section 413-404-500 or the squelch initiator trip point as outlined in Section 413-406-502.
19	At the conclusion of all tests, restore the bay to normal and return the channel to service.
20	File all copies of the E-10108 form with the other switching section test results for that particular channel.

**H. Chart 8—TH-1 Frequency Diversity Protection Switching System Switch Point THAS and 400A. (9-MHz Noise Measurement—400A Only)**

**3.09** Apparatus required to perform these tests includes one 20A, 20-dB variable attenuator and one J68405A test set at the transmitting main

station. At the receiving main station, one 3B or 4B FM receiver and one selective level meter (W&G, Siemens, or equivalent) are required. The selective level meter is required for 400A protection switching system only.

STEP	PROCEDURE
1	<p><b>Caution:</b> <i>The regular service must be switched to the protection channel or the protection channel must be locked out.</i></p> <p><b>Caution:</b> <i>For message or video channels, a terminated FM transmitter must be placed at the transmitting end of the switched section.</i></p> <p><b>Note:</b> Steps 2 through 5 of this procedure are performed to calibrate the test apparatus to be used for fade test arrangement.</p>
2	Turn the sweep on the J68405A test set to zero and allow the test set to warm up for 20 minutes.
3	Set the test set RF attenuator for 0-dBm output at the frequency of the channel under test.
4	Connect the 20A variable attenuator and the flexible waveguide as shown in Fig. 23 and measure the loss.
5	Change the 20A attenuator to the 5-dB position and the oscillator output to +5 dB and check the loss.
6	Measure the output power of the transmitter to be faded. Have the receiving end (400A) or transmitting end (THAS) of the switching section record this value on the E-10108 form as shown in Fig. 6. If the hop under test is in a THAS protected station, obtain the normal received signal level of the receiver of the hop for recent bay records or actual measurement (Section 412-100-506) and proceed to Step 9. For 400A section, proceed with Step 7.
7	Obtain the path length of the radio hop from the station license. If this distance is given in kilometers, convert to miles, using Fig. 7. Have this value recorded on the E-10108 form.
8	To obtain the correct received carrier power, subtract the measured transmit power from the nominal transmit power and subtract the difference from the posted received carrier power.
9	Record the correct received carrier power on the E-10108 form.
10	Arrange the test apparatus to fade the transmitter at the transmitting end of the radio hop to be measured as shown in Fig. 24.
11	Notify the personnel at the transmitting end (THAS) or receiving end (400A) of the switching section to watch for the channel FAIL lamp in the receiving protection switching bay.
12	If the radio hop under test is protected by space diversity, have the personnel at the receiving end lock the switch to the REGULAR antenna.
13	If the hop is THAS protected, proceed with Step 14. For a 400A protected hop, proceed to Step 17.
<b>THAS</b>	
14	Slowly fade the transmitter until the transmitting end of the switching section reports that the channel FAIL lamp has lighted. Reduce the attenuation 5 dB, then slowly fade (add attenuation) the transmitter to the exact switching point.

STEP	PROCEDURE
	<p><b>Requirement 1:</b> The channel FAIL lamp shall extinguish when the attenuation is reduced.</p> <p><b>Requirement 2:</b> The total of the normal received signal level plus the amount of the attenuation necessary to cause a switch (monitor port loss, plus flexible waveguide loss, plus attenuator indication) should add up to <math>-60 \text{ dBm} \pm 2 \text{ dBm}</math> for J68402F receiver and <math>-61.5 \text{ dBm} \pm 2 \text{ dBm}</math> for J68402N receiver. Record the total attenuation (monitor port loss, plus flexible waveguide loss, plus attenuator indication) on the line labeled ACTUAL FADE AT SWITCH POINT on the E-10108 form.</p>
15	If the requirement is met, this chart is completed. It is not necessary to fill in any of the spaces on the E-10108 form dealing with 9-MHz noise measurement. Proceed with Chart 9 if the hop is equipped with space diversity. Proceed to Chart 10 if the hop is not equipped with space diversity. In either case, keep the same fade arrangement for use in these charts.
16	If the requirement is not met, check the channel monitor circuit. If the channel monitor is working properly, the trouble may be in the switching equipment. If the switching equipment is working properly, the trouble is in the antenna/waveguide system or the radio path and may require engineering assistance.
	<b>400A</b>
17	Slowly fade the transmitter until the receiving-end personnel reports that the channel FAIL lamp has lit. Reduce the attenuation 5 dB and slowly fade the transmitter until the exact point of initiator operation is found. Record the total attenuation (monitor port loss, plus flexible waveguide, plus attenuator indication) on the E-10108 form as ACTUAL FADE AT SWITCH POINT.
18	<p><b>Caution: Plugging the FMR IF input into the receiving switch bay before the switch point is found will interrupt the IF path to the initiator.</b></p> <p>With the channel faded to exactly the switch point, immediately measure the average thermal noise at 9 MHz, using the test arrangement in Fig. 8 (do not use a de-emphasis network with FMR).</p> <p><b>Note:</b> When fading the last radio hop before the receiving end of a switch section equipped with the J68404A (vacuum tube) IF main amplifier, the amplifier may not have sufficient AGC range (gain) to produce the necessary noise. This can be checked by changing the amount of fade at the transmitter. The noise should follow dB for dB of fade. If the noise level reaches a maximum before the switch point and does not increase with increasing depth of fade, the amplifier has run out of AGC range and must be replaced with one with more range. The amplifier must be routined in accordance with Section 412-430-505 and weak tubes should be replaced with new tubes.</p>
19	Record this value on the 9-MHz NOISE MEASUREMENT line of the E-10108 form and record the bandwidth of the selective meter in use. If necessary, convert this value to the 400-Hz or 1.74-kHz bandwidth equivalent, using Fig. 9 and enter the bandwidth equivalent on the E-10108 form.
	<p><b>Requirement:</b> The channel initiator shall switch to within <math>\pm 2 \text{ dB}</math> of the requirements given in Table C. Enter the requirement on the E-10108 form.</p>

## STEP

## PROCEDURE

- 20 Subtract the corrected 9-MHz noise measurement from the requirement given in Table C to get the 9-MHz noise difference and record on the E-10108 form.

**Example:** The 400-Hz bandwidth, 1800 circuit loading, regular channel initiator operate requirement from Table C is  $-63$  dBm. If the 9-MHz noise corrected to 400-Hz bandwidth is  $-61$  dBm, then the difference is  $(-63 \text{ dBm}) - (-61 \text{ dBm}) = -2$  dB. This number would then be entered next to DIFFERENCE on the E-10108 form.

- 21 Find the corrected fade at switch point by adding the 9-MHz noise difference to the actual fade at switch point and record it on the E-10108 form.

**Example:** If the actual fade at switch point was  $40$  dB and the difference was  $-2$  dB, the correct fade at switch point would be  $(40) + (-2) = 38$  dB.

- 22 Using the transmitter output power and path length, find the fade margin requirement in Fig. 25 (1800 circuit) and enter it on the E-10108 form next to REQUIREMENT dB (on the same line as CORRECTED FADE AT SWITCH POINT).

- 23 Compare the corrected fade margin of Step 21 with the calculated fade margin of Step 22.

**Requirement:** Without space diversity switching, the corrected fade margin shall be within  $\pm 2.5$  dB of the calculated fade margin of a regular channel. For a protection channel, the corrected fade margin shall be within  $\pm 2.5$  dB of the calculated fade margin ( $-4$  dB). With space diversity switching, the corrected fade margin shall be within  $\pm 2.5$  dB of the calculated fade margin ( $+2$  dB) for a regular channel. For a protection channel, the corrected fade margin shall be within  $\pm 2.5$  dB of the calculated fade margin ( $-2$  dB).

- 24 If this requirement is not met, check the received signal level (Section 412-100-506) at the receiving end of the hop being faded and the XPD (Section 412-450-503) at that station.

**Note:** These fade depth requirements are based on the following assumptions:

- (a) The fade margin requirements assume a roll-off at 9 MHz of approximately  $-0.5$  dB between the receiving end of the faded hop and the end of the switching section. The requirements may have to be changed somewhat when there is a large number of hops between the faded hop and the receiving main station and where there is considerable baseband roll-up or roll-off at 9 MHz.
- (b) The radio towers at both ends of the radio hop are 150 feet tall. The total rectangular waveguide loss for both the transmitting and receiving ends of the radio hop is 7.5 dB (the channel dropping and combining networks in the radio bays and the system combining and separating networks in the antenna and waveguide systems included).
- (c) The antennas at both ends of the radio hop are assumed to be KS-15676 horns which have a total midband gain of 86.2 dB (43.1 dB each). If other antennas are used, appropriate changes in requirements should be calculated to include their gain. See Section 412-100-506, Received Signal Level.
- (d) The radio path is approximately in a no-fade condition, with the received signal power stable within  $\pm 1$  dB. If the radio path loss is known to be higher or lower than typical, the requirements should be adjusted accordingly.

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STEP	PROCEDURE
(e)	If waveguide pads are set at either end of the radio hop, the requirements should be reduced by the amount of their loss.
25	Proceed with Chart 9 if the hop under test is equipped with space diversity switching. If not so equipped, proceed to Chart 10. In either case, keep the same fade arrangements as set up in this chart.

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**TABLE C**  
**CHANNEL INITIATOR OPERATE POINT — TH-1**  
**(400A SWITCHING)**

WITHOUT SPACE DIVERSITY				
MESSAGE CAPACITY OF RADIO CHANNELS	9-MHz NOISE — dBm			
	REGULAR CHANNEL		PROTECTION CHANNEL	
	400-Hz BW*	1.74-kHz BW	400-Hz BW	1.74-kHz BW
1800 Circuit Loading	-63.0	-56.5	-67.0	-60.5
WITH SPACE DIVERSITY ON ONE OR MORE HOPS				
MESSAGE CAPACITY OF RADIO CHANNELS	9-MHz NOISE — dBm			
	REGULAR CHANNEL		PROTECTION CHANNEL	
	400-Hz BW	1.74-kHz BW	400-Hz BW	1.74-kHz BW
1800 Circuit Loading	-61.0	-54.5	-65.0	-58.5

\* BW is the effective noise bandwidth of the level meter. Figure 9 should be used to calculate the requirement for level meters having different bandwidths.

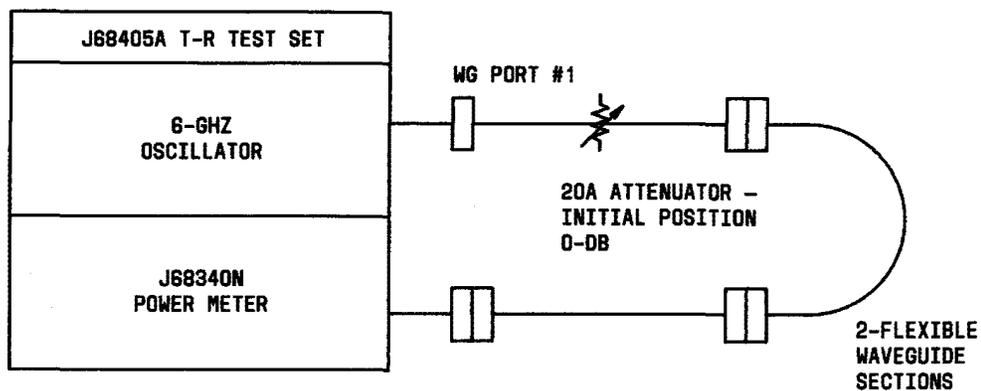
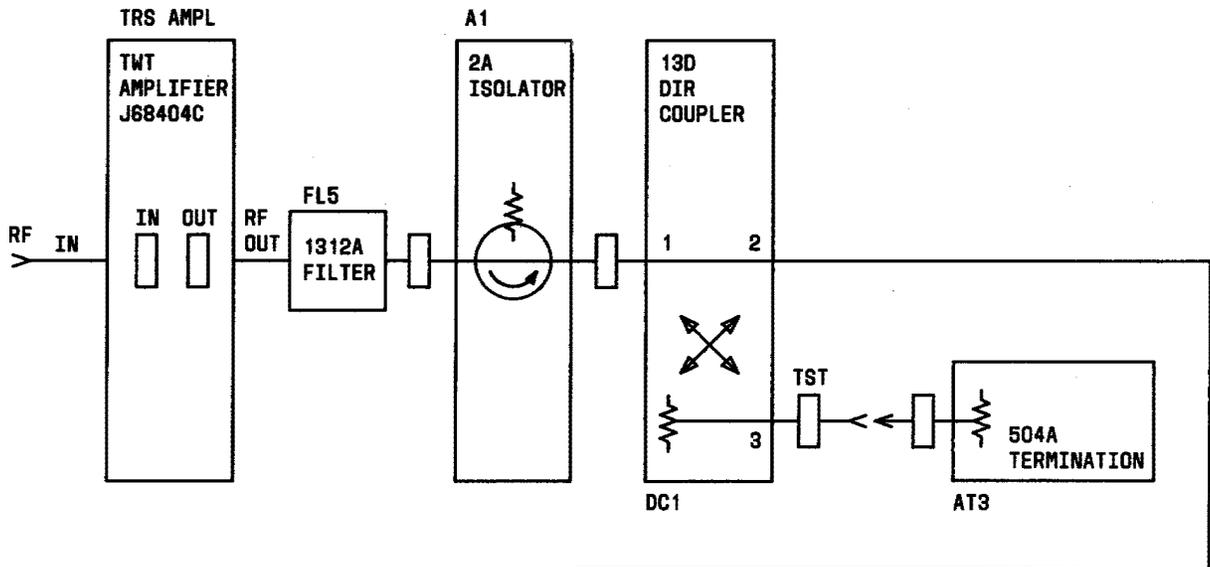


Fig. 23—Calibration of Test Attenuators—TH-1

REPEATER STATION  
BB RADIO TRS



NOTES:  
IN SOME CASES (SHORT HOPS), ADDITIONAL  
FADE MAY BE REQUIRED. IN THESE CASES,  
MOVE THE 20A ATTENUATOR FROM THE MON  
PORT TO THE TST PORT.

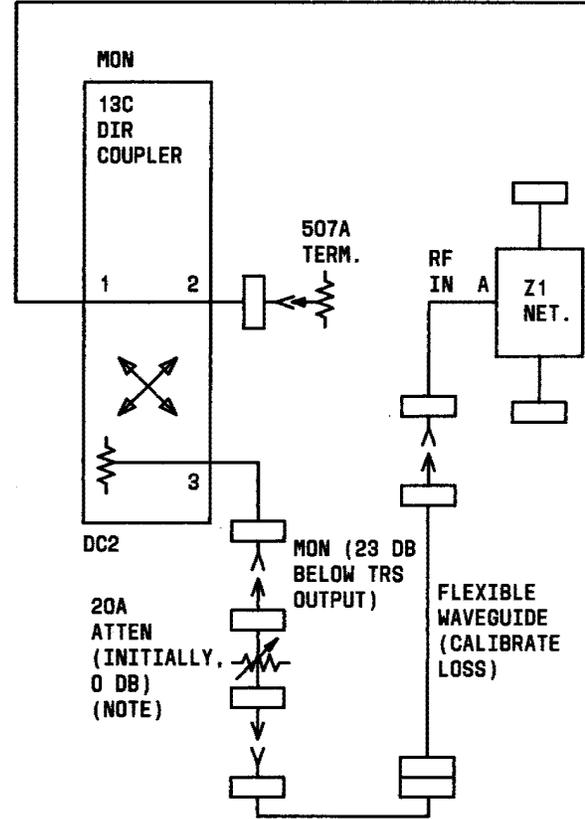


Fig. 24—Fade Test Arrangement—TH-1

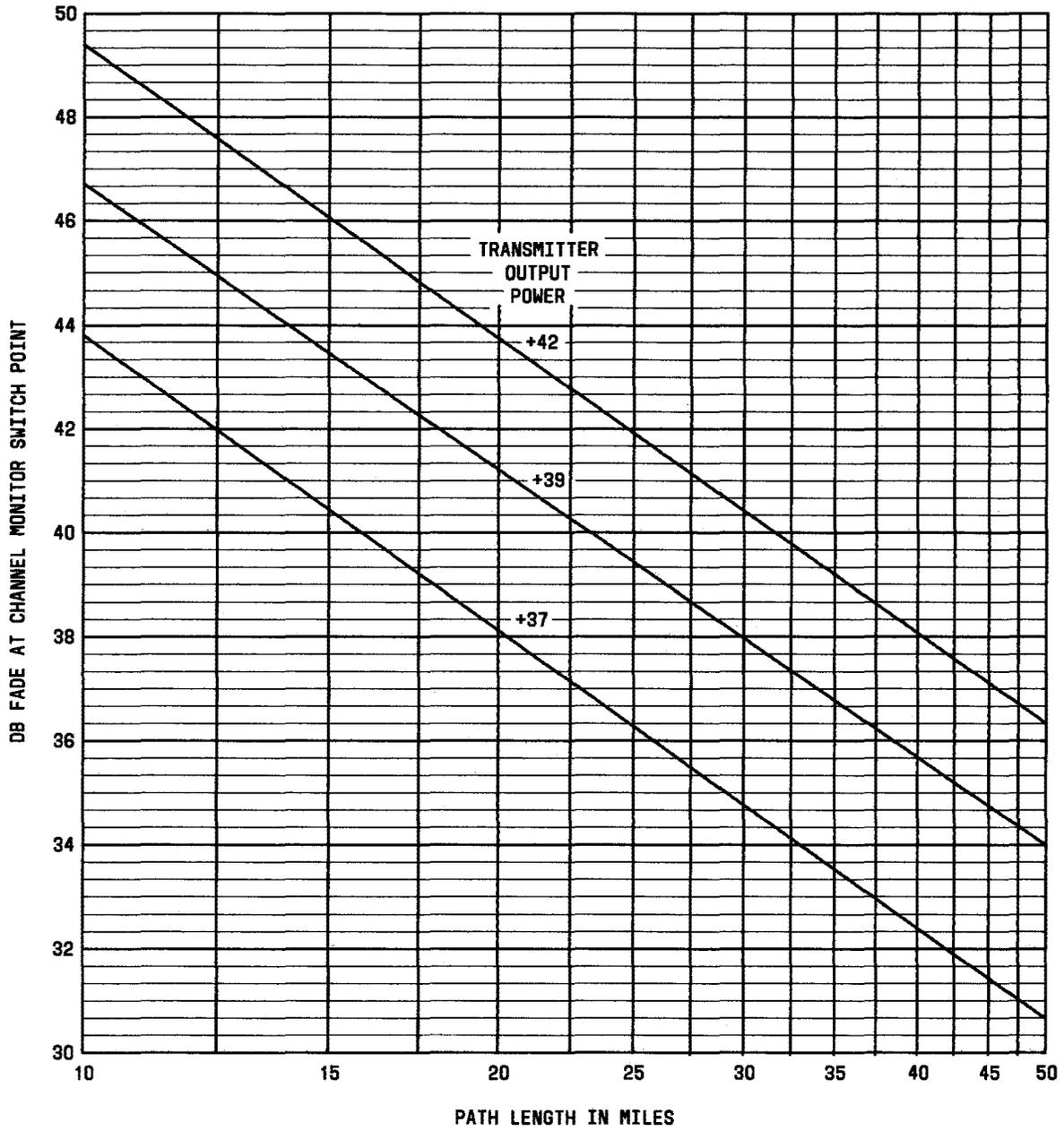


Fig. 25—Requirement for TH-1 Radio

I. Chart 9—TH-1 Space Diversity Switching Switch Point

3.10 This chart is performed with the same apparatus and fade arrangement as in Chart 8.

STEP	PROCEDURE
1	With the channel ready to be faded as set up in Chart 8, have the personnel at the receiving end trigger the diversity switch to the REGULAR antenna and operate the TEST-OPERATE switch to the OPERATE position.
2	Slowly fade the transmitter until the receiving end reports that the diversity switch has operated to the diversity antenna as indicated by the test lamps on the diversity switch.  <i>Note:</i> Since both antennas are experiencing the fade, the switch will operate back and forth between the two antennas at a 10-second rate. The fade depth where this occurs should be noted.  <i>Requirement:</i> The switch must operate at a fade at least 3 dB less (earlier) than the actual fade at switch point recorded (per Chart 8) on the E-10108 form as shown in Fig. 6.
3	If this requirement is not met, adjust the trip point.
4	Enter the amount of fade noted in Step 2, under the REMARKS heading on the E-10108 form. Label it ACTUAL FADE AT SPACE DIVERSITY SWITCH POINT.
5	With the channel ready to be faded as set up in Chart 8, have the personnel at the receiving end trigger the switch to DIVERSITY antenna and set the TEST-OPERATE switch to TEST. Fade the transmitter until the switch point of the frequency diversity switching system is reached.
6	Enter the amount of fade under the REMARKS heading on the E-10108 form. Label it FADE TO FREQUENCY DIVERSITY SWITCH POINT ON DIVERSITY ANTENNA.
7	Trigger the switch to the REGULAR antenna. Leave the TEST-OPERATE switch in the TEST position and proceed with the tests of Chart 10.
8	At the conclusion of all tests, leave the diversity switch operating on the REGULAR antenna with the TEST-OPERATE switch in the OPERATE position.
J. Chart 10—TH-1 DUV Fade Margin and Carrier Resupply Operation Tests	1— Baseband Level Generator (W&G, Siemens, or equivalent)
3.11 The following apparatus is required at the transmitting main station, in addition to the transmitter fade apparatus listed in Chart 1:	1— 26A Splitting Pad 1— Frequency Counter P2BJ Cords (unbalanced) or P3AH Cords (balanced) as required Pads as required.
1— 3A or 4A FM Transmitter	

**SECTION 422-300-512**

At the receiving main station, the following apparatus is required:

1— 3A or 4A FM Receiver

1— 124:75-ohm Transformer (197B or C) or 840956486 Cable Assembly

1— 1017A 64-kHz Band-Elimination Filter

1— 1051F Low-Pass Filter

1— J68448A-( ) Portable Pilot/Noise Monitor

1— Baseband Selective Meter (W&G, Siemens, or equivalent)

1— 6G Noise Measuring Set or HP-3400A with Option H72, 75-ohm termination, and a 5-dB pad.

STEP	PROCEDURE
1	Set up the equipment at the transmitting end of the switching section as shown in Fig. 13. Allow the level generator and frequency counter to warm up.
2	Initially, set the frequency of the level generator to 64 kHz and the power output of 0 dBm (-26 dBm into FMT). Temporarily reduce the fade as much as possible before adjusting the 64-kHz signal.
3	If the hop under test is equipped with space diversity switching, trigger the receiver for REGULAR antenna operation and leave the TEST-OPERATE switch in the TEST position.
4	Set up the test equipment at the receiving end of the switching section as shown in Fig. 14, option (X). Adjust the frequency of the selective level meter to peak (maximum) indication of the 64-kHz signal.
5	Have the transmitting end slowly and carefully adjust the 64-kHz frequency in order to center the generator frequency at the maximum insertion loss of the 1017A 64-kHz band-elimination filter.
6	When the signal is properly centered in the notch of the filter, record the selective level meter power indication. Record the generator frequency at the transmitting end.
	<b>Requirement:</b> The selective level meter indication should be within the range of -65 to -75 dBm. Refer to Fig. 15 for an explanation of the 1017A filter characteristics.
	<b>Note:</b> If great difficulty is encountered, the 64-kHz signal should be sent from the receiving end and looped back at the transmitting end of the sections.
	<b>Critical Fade Depth Determination—Preferred Method Using the J68448A-( ) Portable Pilot/Noise Monitor (P/N MON)</b>
	<b>Note:</b> The P/N MON must be equipped with the 1017A filter and modified according to CN-6953 MV. The baseband gain of the FMR in the P/N MON must be within limits.
7	Connect option (Z), Fig. 14, immediately after centering the 64-kHz signal in the 1017A filter.
	<b>Note:</b> On some test sets the FLT OUT may be designated BP OUT.
8	Adjust the threshold voltage to the proper level in accordance with Section 103-628-100.
9	Set the NOISE-PLT PH switch to the NOISE position.

STEP	PROCEDURE
10	Fade the far-end transmitter until the counter shows a high rate of count (15 to 20 NOISE SEC per minute).
11	Decrease the fade 1 dB at a time until the count registers 5 NOISE SEC or less per minute. Record the amount of fade on the E-10108 form as shown in Fig. 6 in the space provided for CRITICAL FADE DEPTH. Proceed to Step 16.
	<b>Critical Fade Depth Determination—Alternate Method Using the 6G Noise Measuring Set or HP-3400A Voltmeter</b>
12	Connect option (Y), Fig. 14, immediately after centering the 64-kHz signal in the 1017A filter.
13	If the switch sections are not equipped with space diversity switching, perform Step 14 and proceed to Step 16; otherwise, proceed to Step 15.
14	Fade the channel to the switch point found in Step 14 or 17 of Chart 8, and check if the critical noise level has been reached.
	<b>Note 1:</b> To determine if the critical noise level has been reached with a 6G noise set, the dBrn dial should be set to 20 and to 4. If the average noise reading is greater than 15 on the 6G scale, the amount of fade should be slowly reduced until the reading is averaging 15 on the 6G scale. If the reading is less, the amount of fade should be slowly increased until the reading is averaging around 15 on the 6G scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).
	<b>Note 2:</b> To determine if the critical noise level has been reached with the HP-3400A, a 5-dB pad should be connected at the input to the meter and the RANGE switch should be set to -50 dB. If the average noise reading is greater than -5 dB on the HP-3400A scale, the amount of fade should be slowly reduced until the reading is averaging -5 dB. If the reading is less, the amount of fade should be slowly increased until the reading is averaging -5 dB on the scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).
15	Fade the channel to the switch point found in Step 14 or 17 of Chart 8, reduce the attenuation in the transmitter of the hop under test by 2 dB, and check if the critical noise level has been reached. Record the amount of fade (space diversity actual fade at switch point) under the REMARKS heading on the E-10108 form.
	<b>Note 1:</b> To determine if the critical noise level has been reached with a 6G noise set, the dBrn dial should be set to 20 and to 4. If the average noise reading is greater than 15 on the 6G scale, the amount of fade should be slowly reduced until the reading is averaging 15 on the 6G scale. If the reading is less, the amount of fade should be slowly increased until the reading is averaging around 15 on the 6G scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).
	<b>Note 2:</b> To determine if the critical noise level has been reached with the HP-3400A, a 5-dB pad should be connected at the input to the meter and the RANGE switch should be set to -50

## STEP

## PROCEDURE

dB. If the average noise reading is greater than  $-5$  dB on the HP-3400A scale, the amount of fade should be slowly reduced until the reading is averaging  $-5$  dB. If the reading is less, the amount of fade should be slowly increased until the reading is averaging  $-5$  dB on the scale. When the correct fade point is found, the amount of fade should be recorded on the E-10108 form (CRITICAL FADE DEPTH line).

- 16 Calculate the DUV fade depth by subtracting the frequency diversity actual fade at switch point found in Step 14 or 17 of Chart 8 or space diversity actual fade at switch point determined in Step 15 of this chart from the critical fade depth.

**Requirement 1:** If the DUV fade margin is  $+2$  dB or greater, the DUV fade margin is said to be positive and no further tests or reports are necessary unless DUV trouble reports have been traced to the switch section during the periods of fading.

**Requirement 2:** If the DUV fade margin is between  $+2$  dB and  $-2$  dB, the DUV fade margin is said to be marginal and no further tests or reports are necessary unless DUV trouble reports have been traced to the switch section during the periods of fading.

**Requirement 3:** If the DUV fade margin is  $-2$  dB or less, the DUV fade margin is said to be negative. A copy of the E-10108 form shall be sent to the transmission or radio engineering group. As it is normally beyond the resources of local operations personnel to correct poor DUV fade margins caused by cochannel interference, the district or area transmission personnel should be notified so they can investigate the sources of cochannel interferences. However, if the problem is caused by the protection switching channel initiators not being set properly, steps should be taken to readjust them and repeat these tests.

**Note:** Radio routes which are equipped with 400A and space diversity protection switching are adjusted for critical noise switch points relating to the space diversity switch point. In these cases, the 400A protection switching is adjusted to switch 2 dB later and the requirement is applied to the fade depth where the space diversity switch occurs.

- 17 If the channel is equipped with carrier resupply, reconnect option (X) and observe the level meter indication of the 64-kHz signal. Continue fading the channel until the 64-kHz signal disappears. This is the carrier resupply operate point. Record this value on the E-10108 form (CARRIER RESUPPLY FADE DEPTH line).

**Requirement:** The fade depth at resupply operation shall be within  $\pm 2$  dB of the requirement given in Fig. 26. The fade at the CRS trip point shall be 5 dB or more below the fade depth at switch point.

- 18 If the requirement is not met, but the requirements of Chart 8 were met, check the CRS trip point adjustment of the IF main amplifier at the receiving end of the radio hop under test. Also check the gain of the IF preamplifier. The output of the IF preamplifier should not be greater than 0 dBm.

- 19 If the hop under test has space diversity switching, repeat this chart with the receiver force-switched to the DIVERSITY antenna. When calculating the DUV fade margin, use the switch

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STEP	PROCEDURE
	<p>point of the IF protection switching recorded under the REMARKS heading on the E-10108 form, labeled FADE TO FREQUENCY DIVERSITY SWITCH POINT ON DIVERSITY ANTENNA. When this DUV fade margin for the diversity antenna has been measured and calculated, record the value under the REMARKS heading of the E-10108 form.</p>
	<p><b>Note:</b> The DIVERSITY antenna may normally have a lower received signal level so the critical fade depth need not be the same as the REGULAR antenna operation.</p>
20	At the conclusion of all tests, restore the bay to normal and return the channel to service.
21	File all copies of the E-10108 form with the other switching test results for that particular channel.

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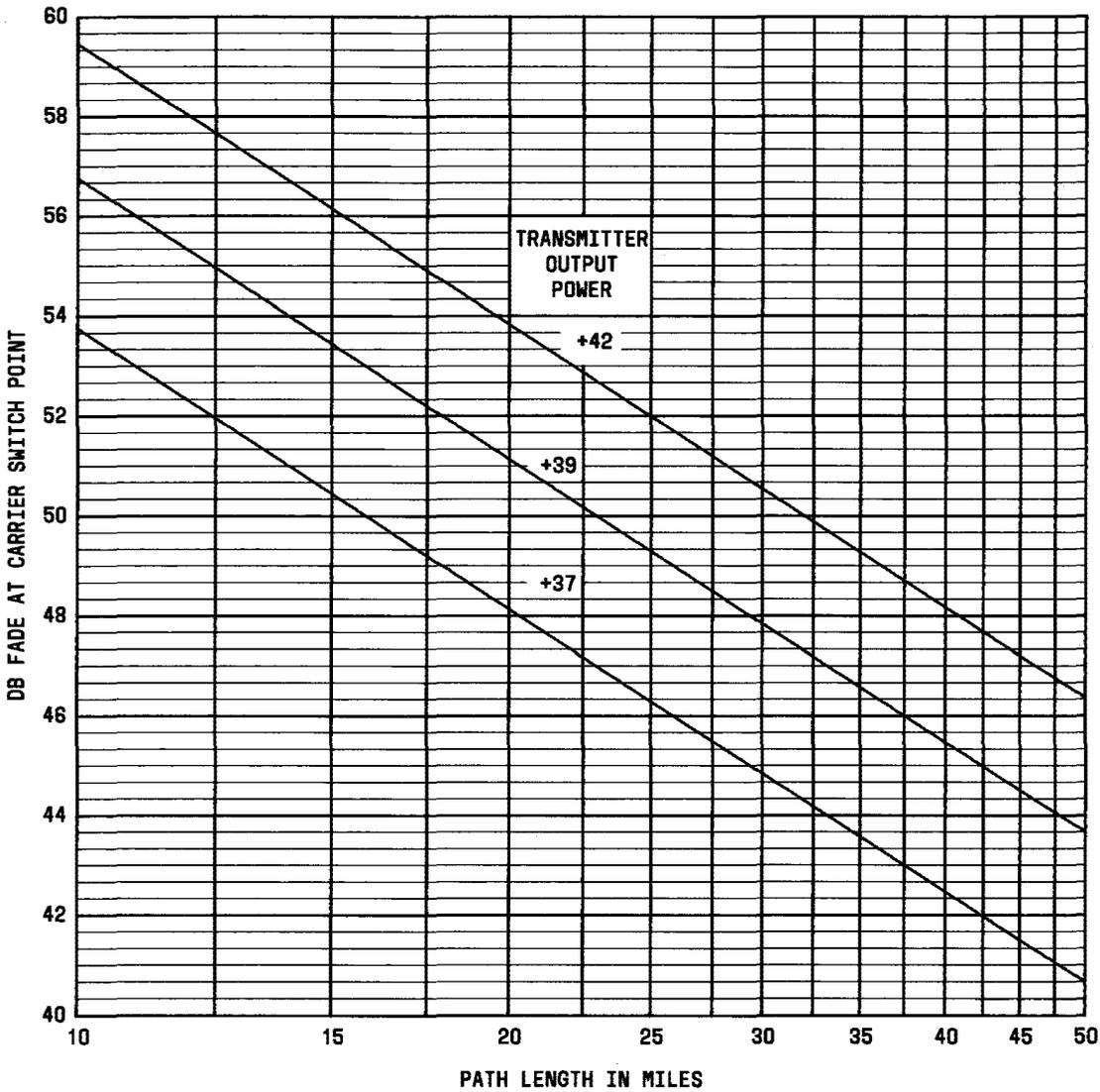


Fig. 26—Carrier Resupply Fade Depth Versus Path Length—TH-1

**K. Chart 11—DMG-1 Receiver Signal-to-Noise Ratio at the Frequency Diversity Switch Point**

- 1 — J62609F Power and Line Interface (Optional)
- P/O ED 54817 ( ) DMG Test Set

or

**3.12** One test signal generator (W&G, Siemens, or equivalent) is required at the transmitting end to perform this procedure. In addition, the following apparatus is required at the receiving end:

- 1 — 3A or 4A FM Receiver
- 1 — 124:75-ohm Transformer in the Portable 4A FM Terminal or a Transformer suitable for passing Mastergroup 1 Frequencies
- 1 — 1122B Band-Pass Filter
- 1 — 457E or 457G De-emphasis Network (as required).

- 1 — Baseband Selective Meter (W&G, Siemens, or equivalent)
- 1 — HP-3400A with Option H72, 75-ohm termination, and a 5-dB pad

## STEP

## PROCEDURE

**Note:** The measurement described in Chart 1 or 6 must be made before proceeding with this test.

- 1 **Caution: This is an out-of-service test. Any service on the DMG-1 mastergroup must be removed.**

At the transmitting terminal, connect a test signal generator to the input of the mastergroup distribution frame (MGDF). Insert a  $-18$  dBm test tone at a frequency of 1.824 MHz in the mastergroup slot.

**Note:** The  $-18$  dBm test tone is at 0 dBm0 and is used as a reference level for measuring the signal-to-noise ratio.

- 2 Switch the frequency diversity switch section containing the hop to be measured to the protection channel.

- 3 At the receiving end, connect the test equipment to measure the signal-to-noise ratio as shown in Fig. 27. Measure the level of the test signal at the output of the 1122B or 1121AB band-pass filter (BPF) with a W&G selective level receiver.

**Note:** The level of the tone is the transmission level point (TLP) at the point of measurement.

- 4 Record the TLP.

- 5 Connect the appropriate de-emphasis network.

**Note:** A 457E de-emphasis network is to be used for all loadings except TD-1800 and TH-2400. The latter two loadings use the 457G de-emphasis network.

- 6 Remove the test signal generator at the transmitting end.

- 7 Fade the transmitter of the hop that is being tested to the corrected fade at the protection switch point determined in Chart 1 or 6.

- 8 Measure the noise power ( $P_n$ ) at the output of the de-emphasis network with the HP-3400A RMS voltmeter equipped with a 75-ohm termination. Record the value in dBm.

- 9 Determine the signal-to-noise ratio for the DMG-1 by using the following formula:

For the 457G de-emphasis:

$$\text{DMG-1 drive level} = +7.8 \text{ dBm0}$$

$$\text{SNR} = \text{TLP} + 5.8 - P_n$$

$$\text{DMG-1 drive level} = +11.8 \text{ dBm0}$$

$$\text{SNR} = \text{TLP} + 9.8 - P_n$$

STEP

PROCEDURE

For the 457E de-emphasis:

$$SNR = TLP + 8.1 - P_n$$

**Note:**  $P_n$  is always a negative number.

- 10 Repeat this test for all hops to be measured.
- 11 Restore all connections to normal at the conclusion of the test.

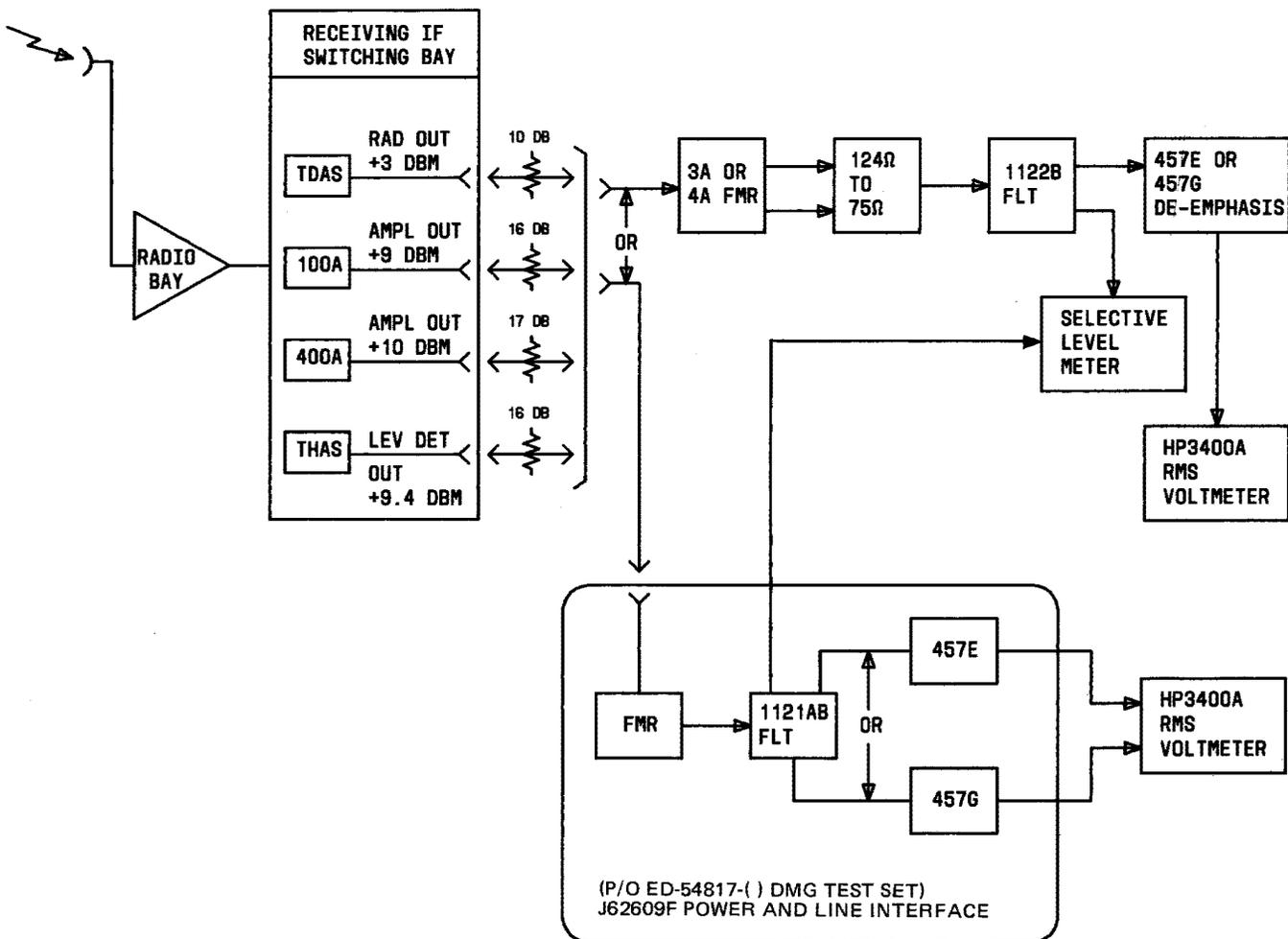


Fig. 27—Receiving Location DMG-1 Signal-to-Noise Ratio Measurement Test Arrangement