RADIO ENGINEERING

MICROWAVE RADIO

TD-2 FM TERMINALS (J68336)

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1. GENERAL

1.01 TD-2 FM terminals (J68336) accept baseband signals of approximately 30 Hz to 8.0 MHz and produce 70-MHz frequency-modulated IF signals for application to TD-2 radio transmitters, and demodulate the radio receiver IF output to baseband at the receiving end of the radio channel. Six hundred message circuits or one television signal is normally carried on a TD-2 radio channel equipped with these FM terminals. Since TD-2 radio systems are primarily used for long-haul applications, the original design objectives contemplated as many as 16 pairs of FM terminals in tandem on a 4000 mile circuit.

1.02 TD-2 FM terminals are now rated "Manufacture Discontinued". The units are replaced by solid-state 3A (J68383) FM terminals or 4A (J68418B) FM terminal receivers.

1.03 The 70-MHz IF of TD-2 FM transmitters is obtained by mixing the output of a klystron deviation oscillator, operating at a center frequency of 4280 MHz, with the output of a fixed-frequency 4210-MHz klystron beat oscillator. At the receiving terminal, the 70-MHz output of the radio receiver is reduced to baseband by a balanced discriminator circuit.

1.04 The transmitter is aligned to provide an IF peak-to-peak deviation of ± 4 MHz when a sinusoidal test tone input of -12 dBm is applied to the transmitter. The output power of the receiving terminal should then be $+4$ dBm, equal to a channel net gain of 16 dB.

1.05 The J68336A FM terminal transmitter, described in Section 410-200-101, has a 75-ohm unbalanced input circuit but can be modified for 124-ohm balanced input. The J68336K FM terminal transmitter, shown in Fig. 1 and described in Section 410-200-102, accepts signals from a balanced 124-ohm source but can optionally accept an unbalanced 75-ohm input. The J68336G FM terminal receiver (Fig. 2) functions with either transmitting terminal and is described in Section 410-220-101. It has two optional output impedances; 124 ohms balanced or 75 ohms unbalanced.

1.06 Transmission characteristics of TD-2 FM terminals are summarized in Table A. The baseband response, which is not particularly flat across the wide range of frequencies, is within -0.5 and $+0.1$ dB of a reference level at 50 kHz over the 600 message-circuit band of 0.564 to 3.084 MHz (or 0.060 to 2.788 MHz).

2. FUNCTIONAL DESCRIPTION

2.01 A block diagram of the TD-2 FM terminal transmitter is shown in Fig. 3. Baseband signals are applied through either a balanced or unbalanced baseband amplifier to a reflex klystron deviation oscillator. The baseband signal varies

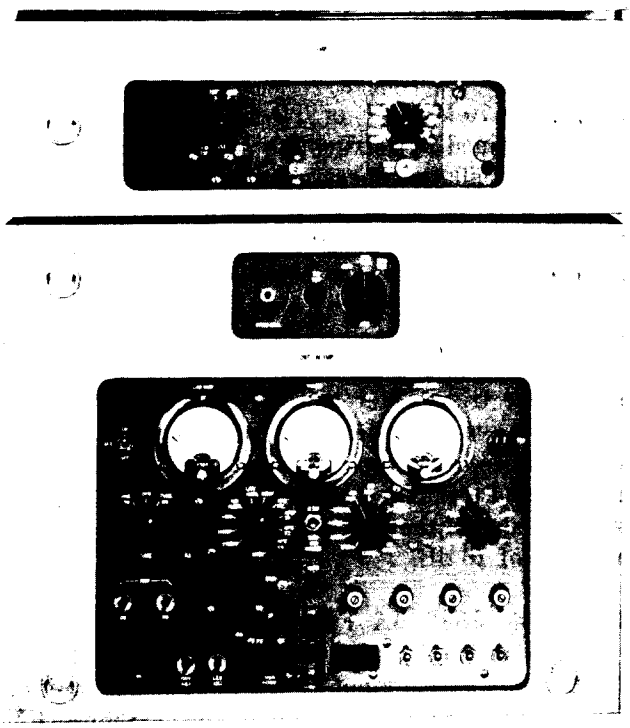

Fig. 1—J68336K FM Terminal Transmitter

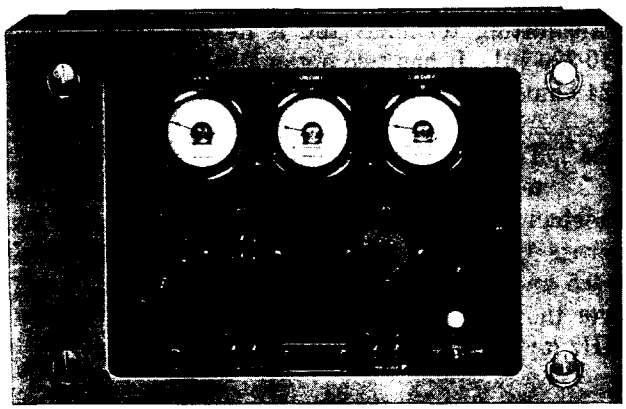

Fig. 2—J68336G FM Terminal Receiver

the repeller voltage of the klystron to form a frequency-modulated signal having a midfrequency of 4280 MHz. This signal is heterodyned in a crystal converter with a 4210-MHz signal from a klystron-type beat oscillator to produce a 70-MHz IF signal. The IF signal is amplified and limited in several stages of the IF limiter-amplifier to reduce amplitude variations and achieve a suitable modulating level. The signal is then applied to the TD-2 transmitter. An automatic frequency control (AFC) circuit provides corrective potentials to the beat oscillator, when required, to maintain the midfrequency of the IF signal at 70 MHz. A single-frequency sine-wave test tone input signal of -12 dBm produces a ± 4 MHz deviation of the IF signal when the transmitter is properly aligned. A positive going voltage on the tip side of the input circuit results in a decrease in IF frequency.

2.02 The FM terminal receiver (Fig. 4) is fed a 70-MHz IF signal from the TD-2 radio receiver. An IF limiter-amplifier limits the signal to suppress amplitude modulation components. It also amplifies the signal before application to the discriminator. Balanced tuned circuits in the discriminator, offset in opposite directions by 15 MHz from the 70-MHz carrier, convert the FM signal back to baseband. A video amplifier then raises the signal level and provides optional output impedances of 124 ohms balanced or 75 ohms unbalanced.

3. TERMINAL PAIR PERFORMANCE

A. Noise Loading

3.01 Figure 5 shows noise-load curves plotted from data obtained when terminal pairs were loaded with the equivalent of 600 message circuits. The 360-kHz and 2.80-MHz curves illustrate the noise generated by a terminal pair near the lowest and highest frequencies of the message band. These curves were made with message pre- and de-emphasis.

3.02 Noise load performance is influenced by pre-emphasis and de-emphasis networks employed at the terminal locations. Pre-emphasis characteristics for both message and television service are shown in Fig. 6. De-emphasis networks have inverse characteristics of the pre-emphasis networks.

B. Baseband Response

3.03 Overall baseband response is shown in Fig. 7. Response begins to fall off rapidly above 5

TABLE A

TD-2 FM TERMINAL TRANSMISSION CHARACTERISTICS

TERMINAL PAIR	
Baseband response	(See Figure 7)
Channel net gain	16 dB
Number of message circuits	600
Number of NTSC television signals	1
Differential gain (±4 MHz deviation)	1 dB maximum
Differential phase (±4 MHz deviation)	3° maximum
Operating temperature range	40 to 140° F
Warmup time	30 minutes
TRANSMITTER	
Baseband input impedance	
J68336A FM terminal transmitter	75Ω unbalanced
J68336K FM terminal transmitter	124Ω balanced
Sine-wave test tone input power for ±4 MHz deviation	−12 dBm
Deviation oscillator frequency	4280 MHz
Beat oscillator frequency	4210 MHz
Carrier frequency	70 MHz
Carrier frequency stability	
AFC on	±0.8 MHz
AFC off	±3.0 MHz
IF output impedance	75Ω unbalanced
Nominal IF output power	+13 dBm
Flatness of IF output (60 to 80 MHz)	0.1 dB
IF output return loss	25 dB
Monitor output impedance	75Ω unbalanced
Monitor output power (±4 MHz deviation)	0 dBm
RECEIVER	
IF input impedance	75Ω unbalanced
IF input return loss (60 to 80 MHz)	30 dB
Nominal IF input power	+3 dBm
Baseband output impedance	124Ω balanced or 75Ω unbalanced
Baseband output power (±4 MHz deviation)	+4 dBm
Baseband output adjustment range	8 dB

MHz but this frequency is beyond the upper baseband limits for both message and video transmission.

C. Envelope Delay and Linearity

3.04 Envelope delay and linearity distortion are shown in Fig. 8 and 9, respectively.

4. SPACE REQUIREMENTS

4.01 J68336A and J68336K FM terminal transmitters are both 31-1/2 inches high (18, 1-3/4 inch mounting plate spaces) and mount in 19-inch duct-type bays. J68336G FM terminal receivers are 14 inches high (8, 1-3/4 inch mounting plate spaces). Typically, two FM terminal pairs are mounted in a single

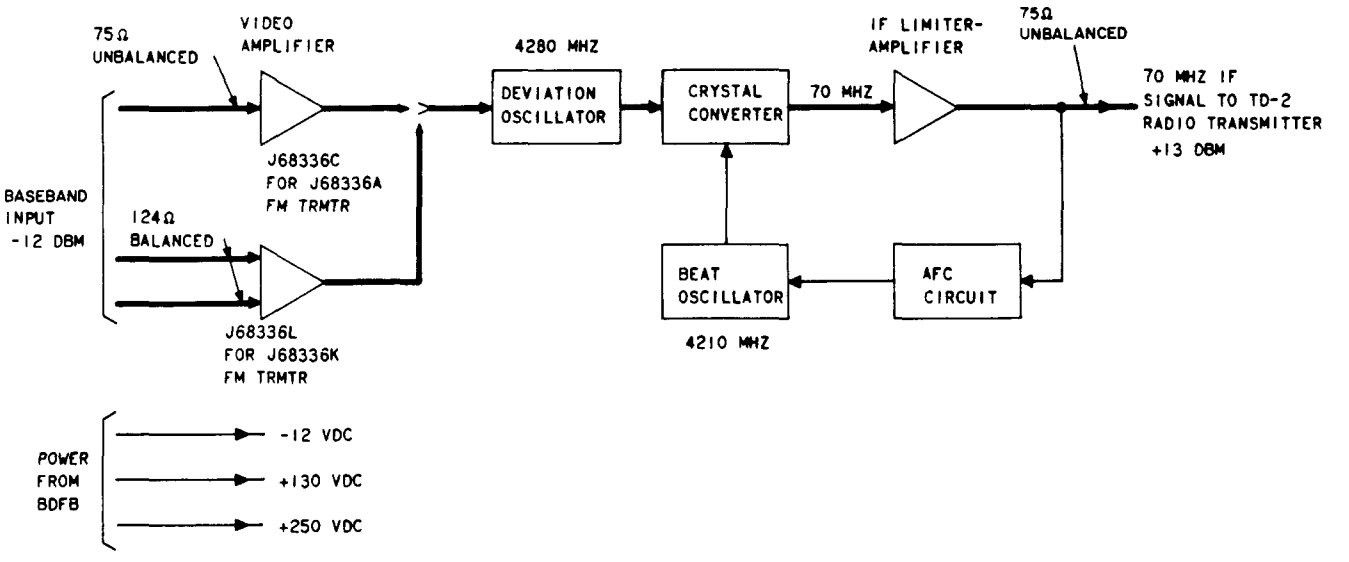

Fig. 3—TD-2 FM Terminal Transmitter

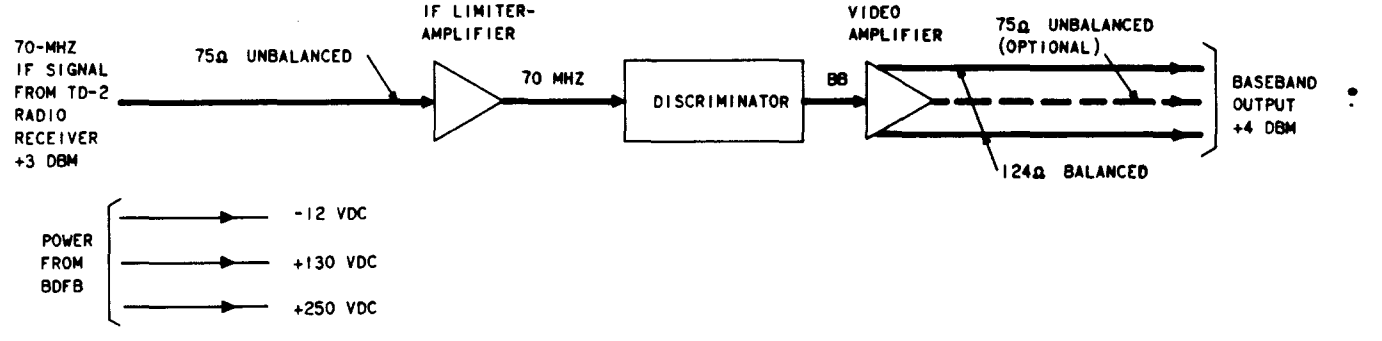

Fig. 4—TD-2 FM Terminal Receiver

9-foot bay. Details of this arrangement are shown on ED-63997-01. The same drawing provides a typical mounting arrangement for FM terminals in an 11-foot 6-inch bay.

5. POWER REQUIREMENTS

5.01 Dc potentials of −12, +130, and +250 volts are required as filament and plate supplies. The current requirements of each supply per terminal are:

SUPPLY VOLTAGE	TRANSMITTER	RECEIVER
−12V	12A	5.85A
+130V	0.17A	0.27A
+250V	0.25A	0.08A

5.02 Separately protected filament and plate leads must be run from the battery distribution fuse bay to each terminal to prevent multiple equipment outage in case of fuse or circuit breaker operation. Alarm contacts must be provided on the fuses and circuit breakers associated with each power lead.

6. TEST EQUIPMENT

6.01 Specialized test equipment is used to align and maintain TD-2 FM terminal equipment. Major functions performed are tests and adjustments of rest frequency, frequency deviation, and linearity.

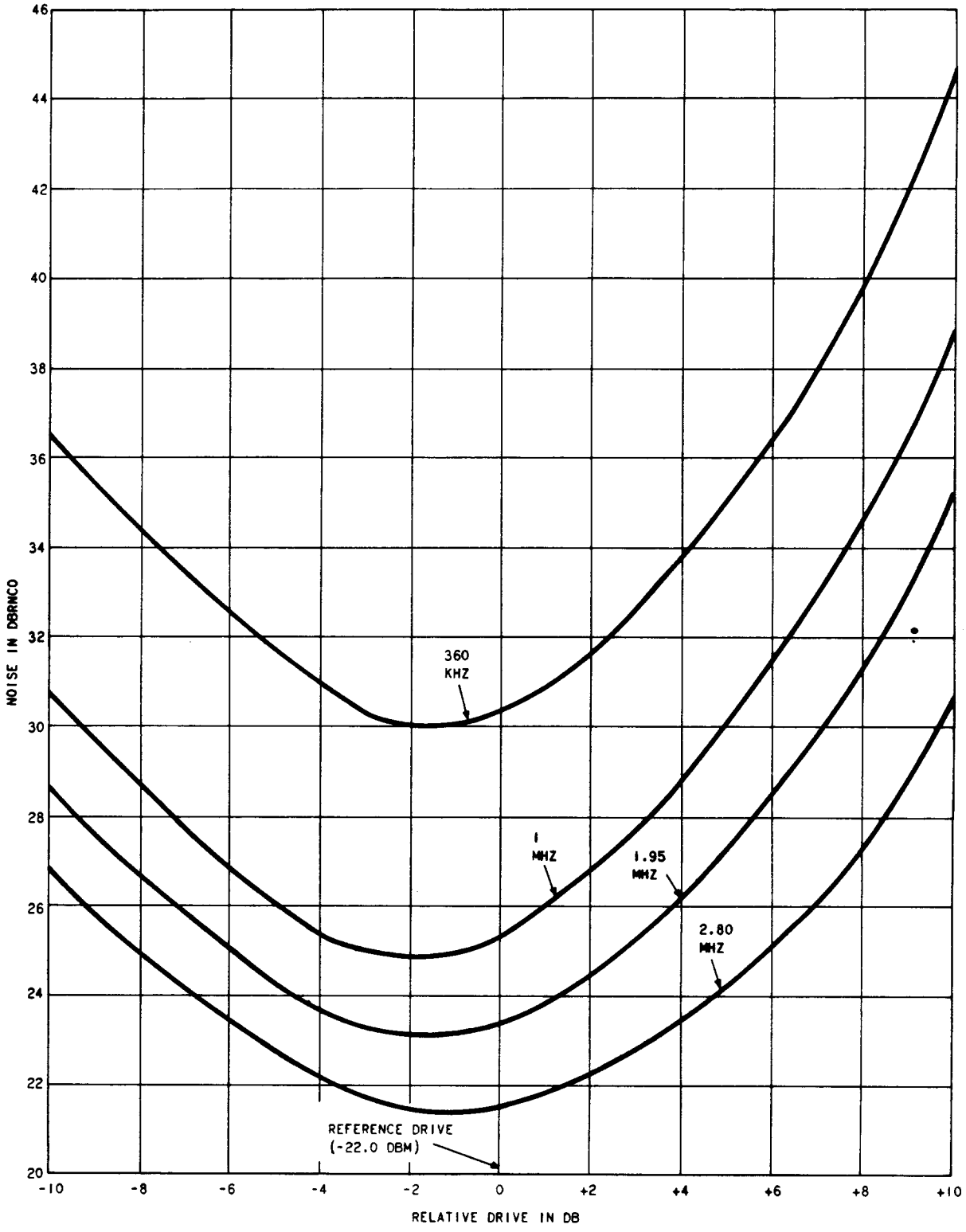

Fig. 5—TD-2 FM Terminal Pair 600-Circuit Noise Load Curves (Pre-Emphasized)

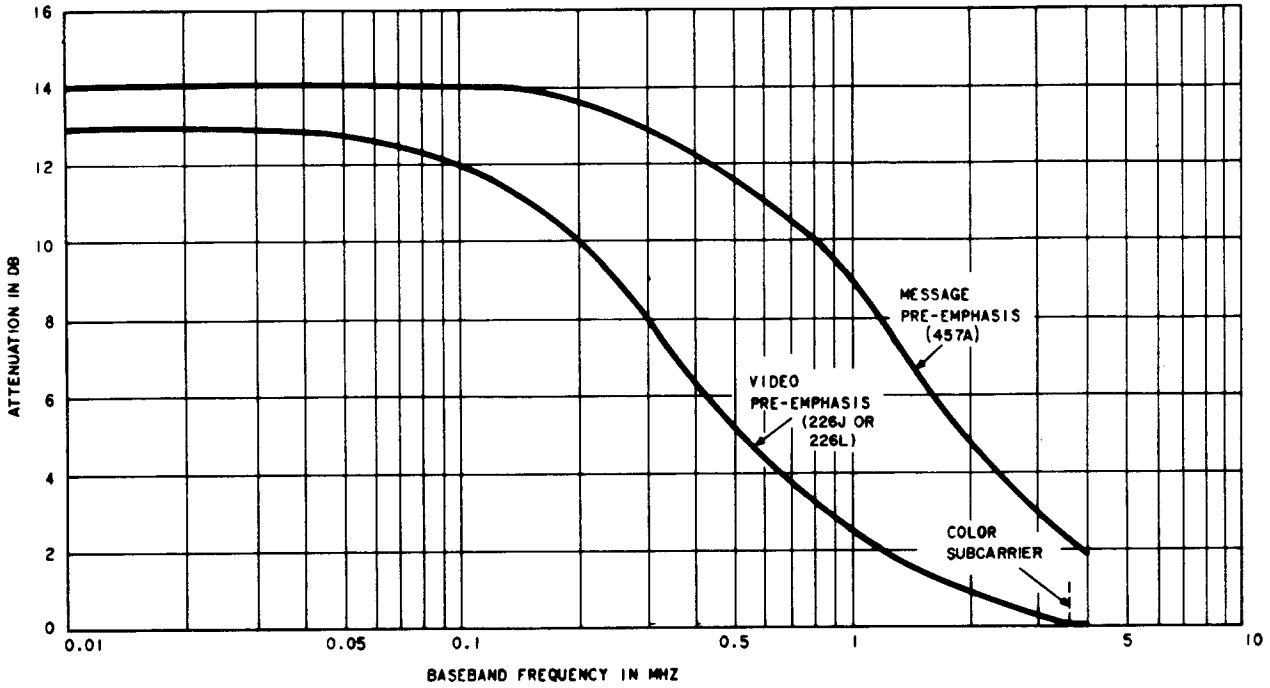

Fig. 6—TD-2 Pre-Emphasis Characteristics

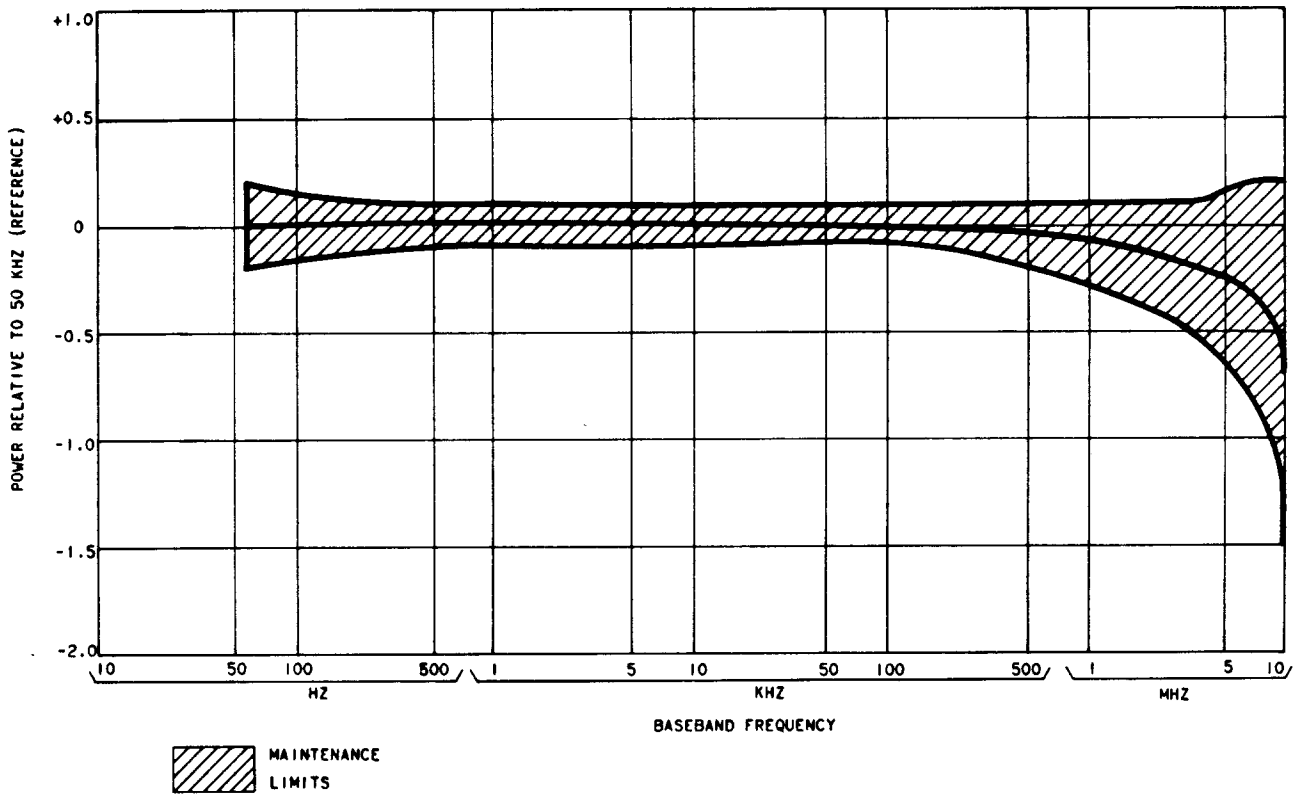

Fig. 7—TD-2 FM Terminal Pair Frequency Response

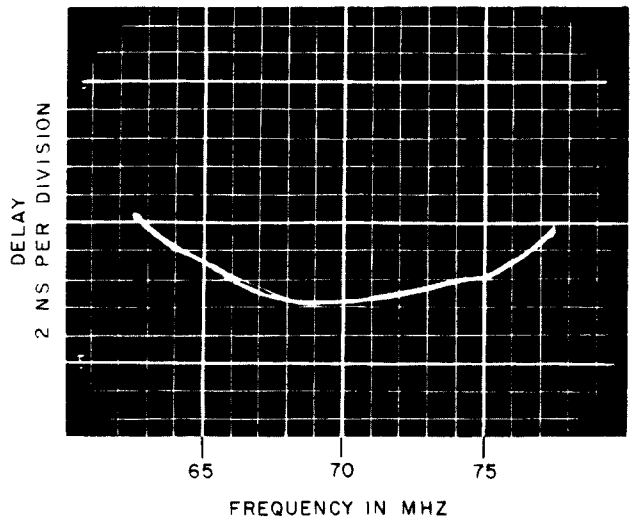

Fig. 8—TD-2 FM Terminal Pair Envelope Delay Distortion

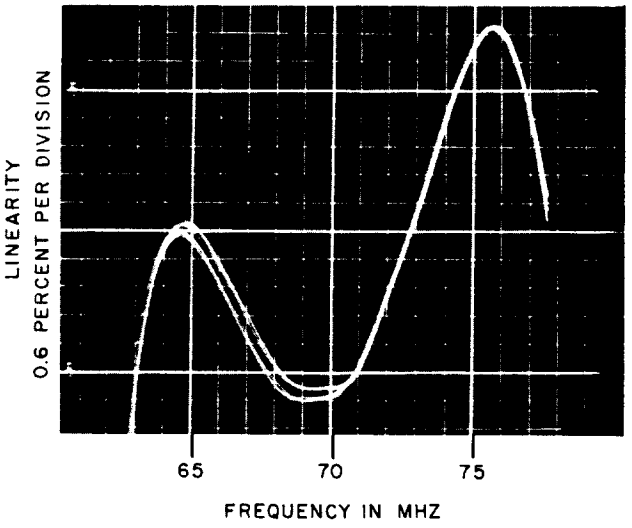

Fig. 9—TD-2 FM Terminal Pair Linearity

6.02 Units required for testing the terminals are a J68337F FM test set, a J68337G linearity test set, and a KS-15512 oscilloscope. These units are normally mounted in a mobile cabinet assembly which is then called the J68337H FM terminal test set. The individual units may also be mounted in carrying cases for portable use.

7. REFERENCES

7.01 The following references provide detailed information on TD-2 FM terminals and associated equipment.

SECTION	TITLE
AA266.031	Type TD-2 Radio System, General Requirements (J68339)
AA266.032	TD Radio, FM Terminal Equipment (J68336)
AA266.033	TD Radio, FM Terminal Test Set (J68337)
104-303-100	Radio Test Equipment, FM Terminal Test Sets, J68337H FM Terminal Test Set, Description
410-200-101	TD-2 Microwave Radio, FM Terminals, J68336A FM Terminal Transmitter, Description
410-200-102	TD-2 Microwave Radio, FM Terminals, Description, J68336K FM Transmitter
410-220-101	TD-2 Microwave Radio, FM Terminals, J68336G FM Receiver, Description
940-390-100	Radio Engineering, Microwave Radio, FM Terminals, General

DRAWING	TITLE
SD-59361-01	TD Radio, FM Terminal Transmitter, Application Schematic (J68336A)
SD-59361-02	TD Radio, FM Terminal Transmitter, Application Schematic (J68336K)
SD-59365-01	TD Radio, FM Terminal Receiver, Application Schematic (J68336G)