RADIO IF AMPLITUDE AND EDD RESPONSE TESTS

INTRODUCTION

This procedure describes how to measure the IF-to-IF transmission response of a radio hop which includes the following:

- Amplitude response
- EDD (envelope delay distortion)
- Ripple measurement.

Caution: This testing must be done out-of-service.

This procedure uses only the radio channel from IF IN to IF OUT. Therefore, at each end of the hop, the line terminal frame or the regenerator frame must be disconnected. An order-wire or similar talk circuit is required for communications between stations.

DESCRIPTION

The amplitude response shows the insertion loss across the bandwidth of the channel.

The EDD response is a measurement of the phase distortion present in the radio channel. Phase distortion can greatly affect the signal transmission if it is not properly compensated by equalization.

The ideal amplitude and delay responses are straight horizontal lines which indicate distortionless transmission over the channel. However, these displays usually consist of shapes such as a sloping line, bulges (parabolic), and ripples superimposed on one another. The amplitude and delay responses include the effects of the air path, antennas, waveguide systems, and radio frames. Each of these sources causes different response shapes when added together in a random manner.

Equalization

This radio system uses hop-to-hop rather than end-to-end EDD equalization. This is because the digital signal is regenerated at each station on the radio route.

Equalization requires analyzing the EDD display to identify the major EDD shapes (Fig. 1). Then, selected equalizers are installed to give a specific response.

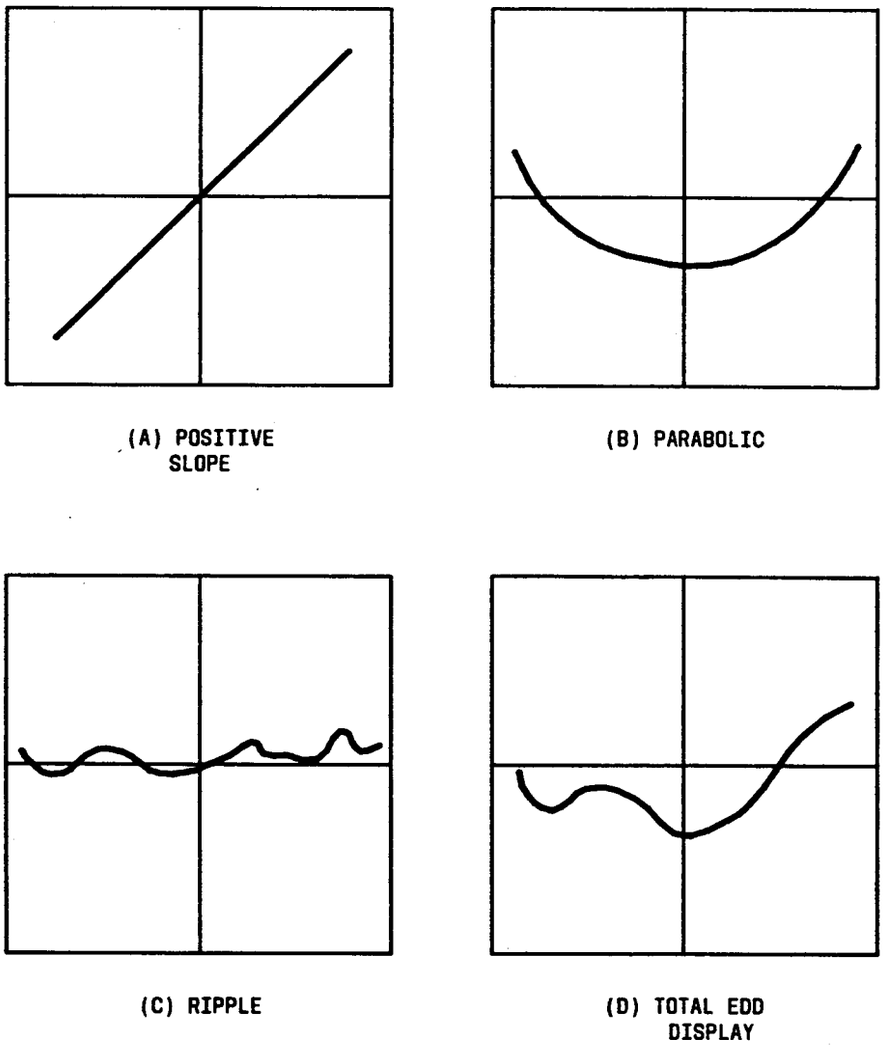


Fig. 1—Major EDD Shapes

Slope

The most important part of the EDD response is the straight line or "slope" component. It is a potential source of intermodulation noise to the digital signal. The slope is corrected by adding the appropriate 2001( ) EQUALIZER in the LINEAR DELAY EQUALIZER unit of the radio frame. Figure 2 shows examples of 2001( ) equalizer slope characteristics. Table A gives detailed specifications of the 2001( ) EQUALIZERS.

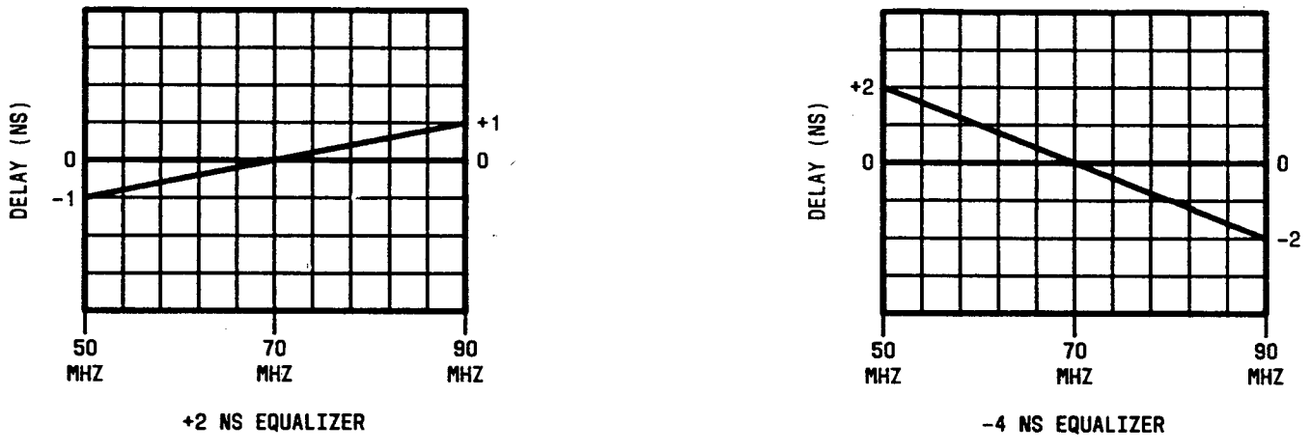


Fig. 2—2001( ) Equalizer Slope Characteristics

TABLE A

2001( ) EQUALIZER CHARACTERISTICS

CODE	TYPICAL LOSS (DB) AT 70 MHZ	DELAY SLOPE (NS) OVER 40 MHZ	DELAY TOLERANCE (NS) 70 ±20 MHZ
2001A	1.1	+2	<±0.4
2001B	1.1	–2	<±0.4
2001C	1.7	+4	<±0.4
2001D	1.2	–4	<±0.4
2001E	1.7	+6	<±0.4
2001F	1.4	–6	<±0.4
2001G	1.4	+8	<±0.4
2001H	0.4	–8	<±0.4
2001J	1.5	+10	<±0.4
2001K	0.5	–10	<±0.4
2001L	1.5	+20	<±0.4
2001M	0.6	–20	<±0.4
2001N	3.2	+30	<±0.4
2001P	0.7	–30	<±0.4

Parabolic Shape

Very little, if any, parabolic shape will be observed since the EDD measurements are made over such a short distance (one hop). The 2002( ) BASIC EQUALIZER in the IF FILTER AND BASIC EQUALIZER unit is used to correct the normal parabolic delay of the RF filters. Table B gives detailed specifications of the IF FILTER AND BASIC EQUALIZER modules.

TABLE B
4376( ) IF FILTER AND BASIC EQUALIZER SPECIFICATIONS

MODULE	DELAY (NS) OVER 40 MHZ	DELAY TOLERANCE (NS) 70 ±20 MHZ	TYPICAL LOSS (DB) AT 70 MHZ	AMPLITUDE DEVIATION (DB) 70 ±20 MHZ
2002A	15	< 2	4.9	< 0.2
2002B	20	< 2	4.95	< 0.2
2002E	10	< 1	5.56	< 0.2
2002F	25	< 2	4.6	< ±0.5
1603A	0	< ±0.4	7.0 dB	< ±0.3

Ripple

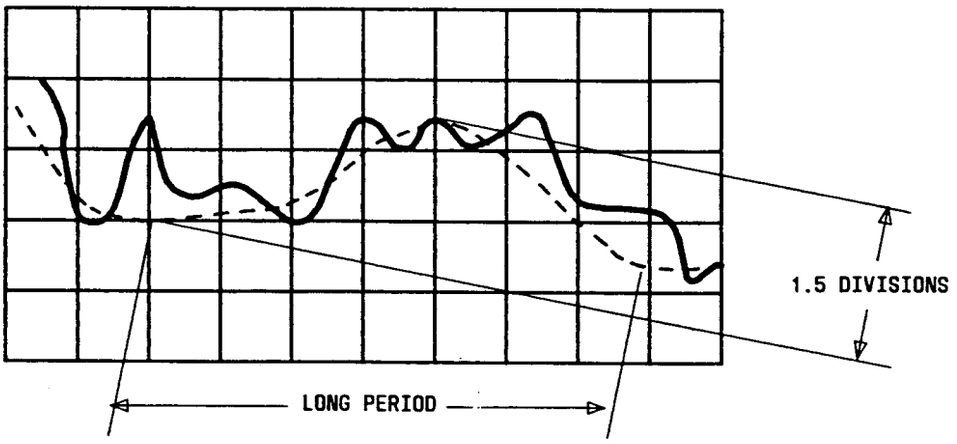
Ripple is measured to verify the performance of the antenna and waveguide system. Ripple is produced by an echo in the IF or RF signal path, and appears in the EDD response as a sinusoidal variation. Since many small echo paths are encountered over the radio channel, the EDD response will be the net effect of all echo paths. The EDD display will show several random spaced ripples of unequal amplitude. A single outstanding sinusoidal ripple would indicate a serious transmission irregularity.

When analyzing ripple, it is useful to separate the ripple into two categories:

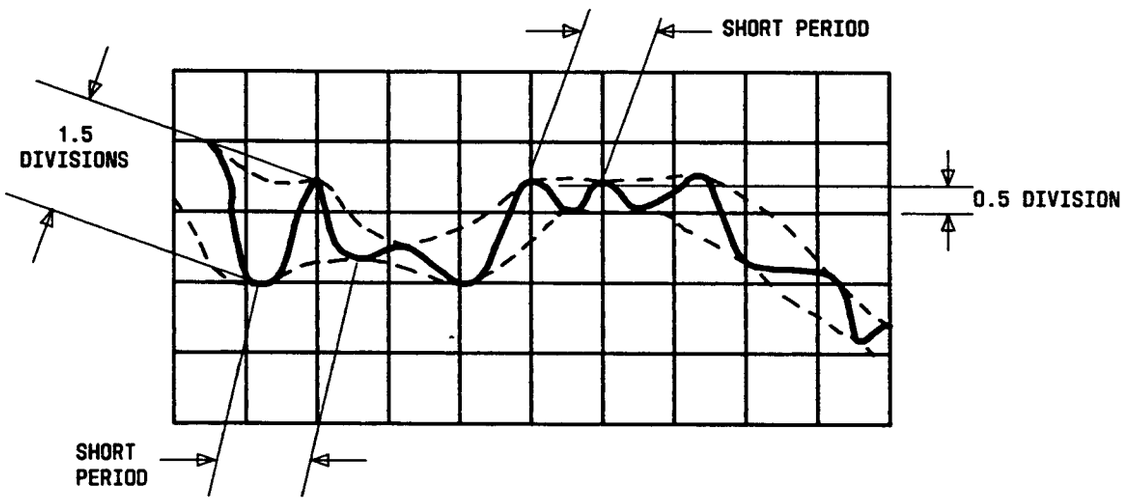
Primary Ripple: is composed of the lower frequency sine waves that peak only a few times on the display. This may be due to IF filters and other radio bay components.

Secondary Ripple: is composed of the higher frequency sine waves with many peaks and valleys of usually small amplitude. This is typically due to the antenna and waveguide systems.

Figure 3 shows examples of primary and secondary ripple.



(A) PRIMARY RIPPLE



(B) SECONDARY RIPPLE

Fig. 3—Examples of Delay Ripple

TEST PROCEDURES

An IF transmitter/receiver test set is used to sweep the bandwidth of a radio channel from the transmitter IF IN jack to the receiver IF OUT jack. This is done to verify that the gain-frequency response meets transmission requirements.

Note: Two test sets are required to perform these tests.

The IF transmitter test set is used to generate an IF test signal that is transmitted from one station to another. The IF receiver test set at the receiving station recovers the test signal, and displays the transmission response.

The transmitter/receiver test set is commonly called a microwave link analyzer or a microwave system analyzer. The recommended test set, for use with the DR 6/11-40-140 radio system, is the Model 453C Microwave System Analyzer, manufactured by Anritsu Electric Company.

Test Set Controls

The test set transmitter controls should be set to the following positions:

- Center Frequency = 70 MHz
- Sweep Width (Δ F) = $\pm$17 MHz (Note 1)
- Modulation Frequency (f_{mod}) = 250 kHz
- Output Level = -28 dBm (Note 2)

Note 1: The sweep width is set to +34 MHz bandwidth of the channel to ensure that the test signal does not sweep into the adjacent channels.

Note 2: The output level from the test set transmitter is set 20 dB lower than the normal IF signal into the transmitter. This is done to ensure that the signal into the down-converter at the receiving station will be out of the AGC range.

The test set receiver must be set to the corresponding positions to receive the transmitted signal.

The test set receiver should also be set to display the amplitude and delay responses.

Radio Frame Controls

1. At the transmitter:
   - The ALC switch on the POWER AMPLIFIER must be set to the *OFF* position.
2. At the receiver:
   - The MAN/AUTO pushbutton on the IF AGC AMPL unit must be set to the *MAN* position.

     Note: If this is a space diversity receiver, the IF COMBINER must be set to the MAN condition, which will disable the AGC in that unit. Also, the regular and diversity paths must be separately tested. To do this, disconnect the REG IF IN or DIV IF IN cable to the combiner input while the alternate input is being tested.
   - Adjust the MAIN GAIN control on the IF AGC AMPL unit for -7.0 dBm $\pm$1.0 dB at the IF OUT jack at the top of the frame.

- The MAN/AUTO pushbutton on the ADAPTIVE SLOPE EQL unit must be set to the *MAN* position.

Test Equipment Setup

Figure 4 shows the equipment configuration for performing these tests.

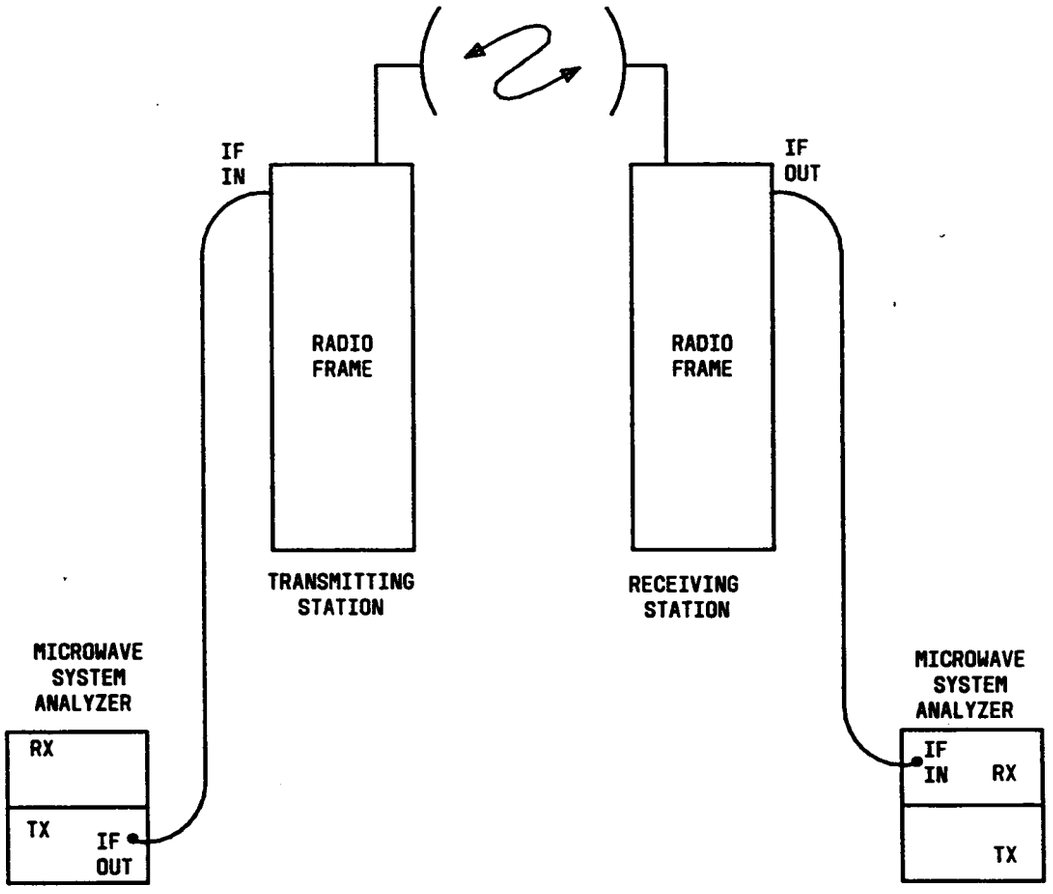


Fig. 4—Test Connections for Transmission Response Tests

REQUIREMENTS

The transmission response requirements are given for both the amplitude response and the delay response. In each case, separate requirements are given for the slope, parabolic and ripple components of the response.

Note: These requirements are not the same as those in the installation handbook. This is because the channel is not being swept over the full 40-MHz bandwidth.

Amplitude Response

The amplitude response is required to meet the following limits:

- Slope $\leq \pm 2.0$ dB
- Parabolic $\leq \pm 1.3$ dB
- Ripple ≤ 0.6 dB peak-to-peak

Note: The response should be smooth with no discontinuities.

Amplitude Response Out-of-Limits

There are no adjustments or equalizers to compensate for amplitude variations. If the amplitude response requirements are not met, the problem could possibly be a defective BASIC EQUALIZER in the IF FILTER AND BASIC EQUALIZER module. If not, the problem could be anywhere in the transmission path including the transmitter, antennas and waveguide, and receiver.

In an orderly process, replace the receiver units one at a time; then, replace units one at a time in the transmitter. The operation and maintenance manuals should be referred to as necessary to replace units and perform any related tests or adjustments.

Figure 5 can be used to help identify components in the transmission path. Block diagrams of the radio receiver and transmitter are provided in the "Alarm Matrix" tab. Other sections of this manual that might provide assistance in locating the problem include the "Equipment Description" and the "Controls, Jacks, and Indicators" tabs.

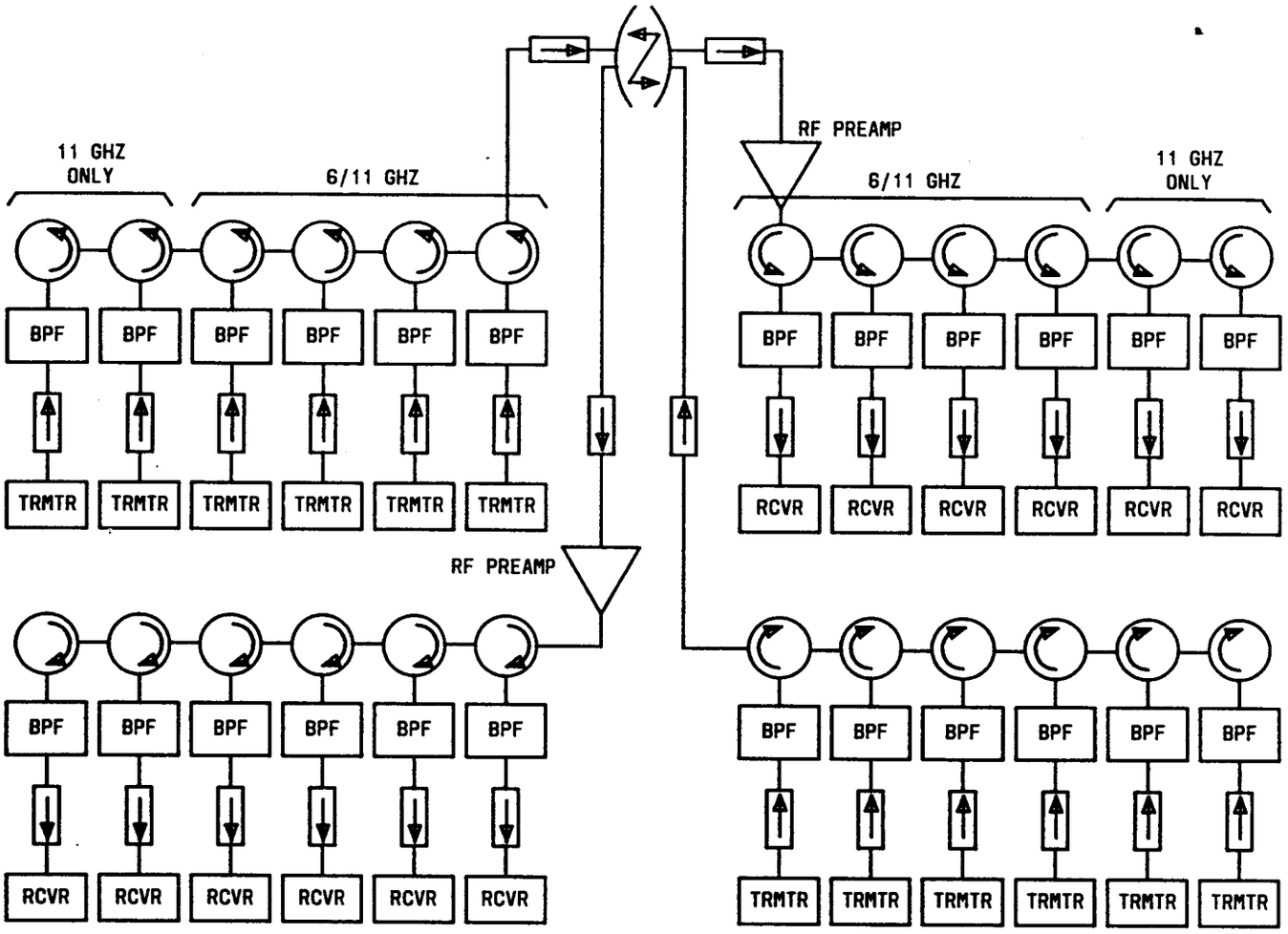


Fig. 5—Radio System Block Diagram

Delay Response

The delay response is required to meet the following limits:

- Slope = ±1 ns
- Parabolic = ±4 ns
- Ripple = $(\tau_{p\text{-}p})$ x (F) ≤12.6 where τ is in nanoseconds and F is in Megahertz (Fig. 6).
- For frequencies above 8.5 MHz, the delay ripple should not exceed 1.5 nanoseconds peak-to-peak.

Note 1: The equation that describes the ripple requirement is plotted in Fig. 7. The ripple requirement is met as long as the coordinates of the delay and frequency intersect within the shaded area of the curve.

Note 2: The response should be smooth with no discontinuities.

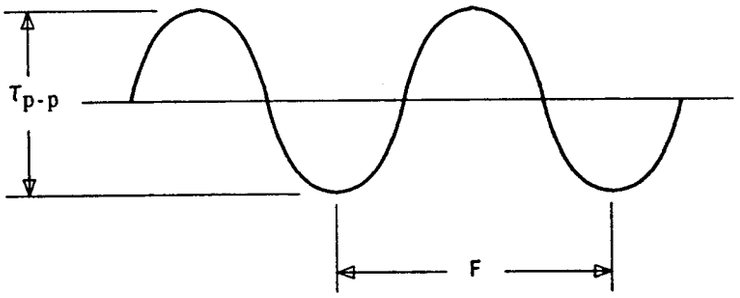


Fig. 6—Ripple Measurement

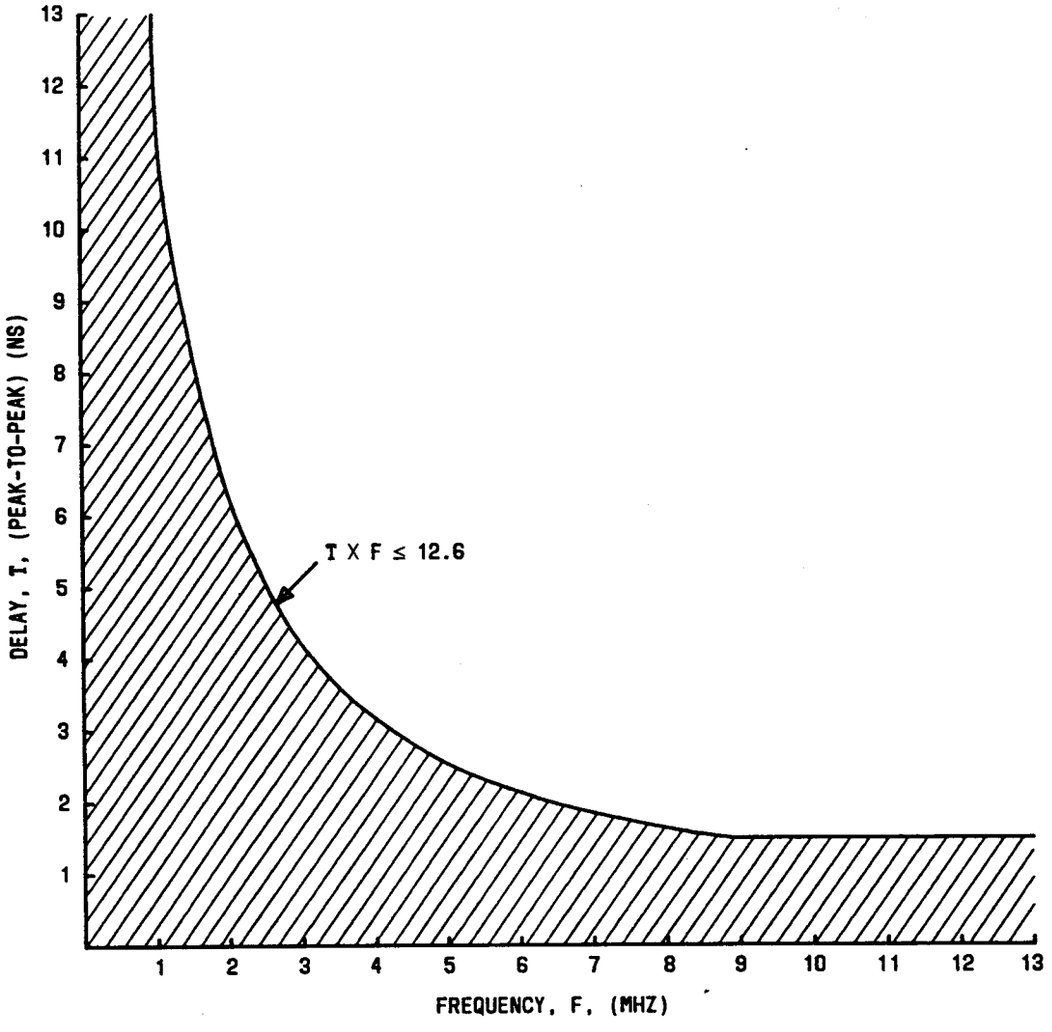


Fig. 7—Graphical Representation of Delay Ripple Requirement

Delay Slope Out-of-Limits

If the delay slope is ≤5 ns, select a new EQUALIZER to install in the LINEAR DELAY EQUALIZER unit. Refer to Table A in the "Description" section of this procedure.

If the delay slope is >5 ns, the problem may be a defective EQUALIZER. If not, the problem could be anywhere in the transmission path including the transmitter, antennas and waveguide, and receiver.

In an orderly process, replace the receiver units one at a time; then, replace units one at a time in the transmitter. The operation and maintenance manuals should be referred to as necessary to replace units and perform any related tests or adjustments.

Figure 5 can be used to help identify components in the transmission path. Block diagrams of the radio receiver and transmitter are provided in the "Alarm Matrix" tab. Other sections of this manual that might provide assistance in locating the problem include the "Equipment Description" and the "Controls, Jacks, and Indicators" tabs.

Parabolic Delay Out-of-Limits

If the parabolic delay requirement is not met, replace the BASIC EQUALIZER in the IF FILTER AND BASIC EQUALIZER with another equalizer of the same unit code. If a replacement is not available, replace the receiver units and then the transmitter units as previously described in "Delay Slope Out-of-Limits".

Delay Ripple Out-of-Limits

If the delay ripple requirement is not met, check the antenna and waveguide systems. There may be return loss or discontinuity problems. Replace filters, isolators, and other waveguide units where possible.