
**TL-1 MICROWAVE RADIO
SYSTEM TESTS
ENVELOPE DELAY AND LINEARITY TESTS**

This section describes methods for measuring the envelope delay and linearity of a TL-1 radio hop. Both the application and the analysis of these tests are covered in Section 940-320-102.

These tests require the interruption of the radio system baseband continuity; therefore, refer to Section 409-306-500 for procedures for removing and restoring service on diversity and nondiversity systems.

These tests are intended for use in fault locating in message systems where noise-loading tests indicate delay kinks or ripples. They may also be used for diagnosis in television systems where delay distortion interferes with differential phase performance.

APPARATUS:

At the Transmitting End:

- 1—J99262AA TL Test Set
- 1—Collins Radio Model 70E1 MW Delay and Linearity Test Signal Generator or equivalent
- 1—P2BJ Cord
- 1—P2BC Cord
- 1—372A Plug

At the Receiving End:

- 1—J68345J, List 2 IF Meter
- 1—Collins Radio Model 70E2 MW Delay and Linearity Test Signal Analyzer or equivalent
- 1—Hewlett-Packard Model 120B Oscilloscope or equivalent
- 1—P2BC Cord

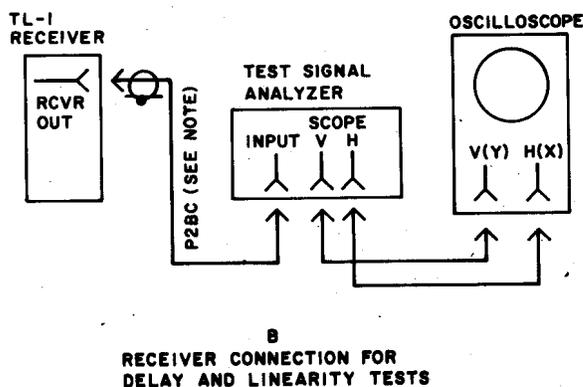
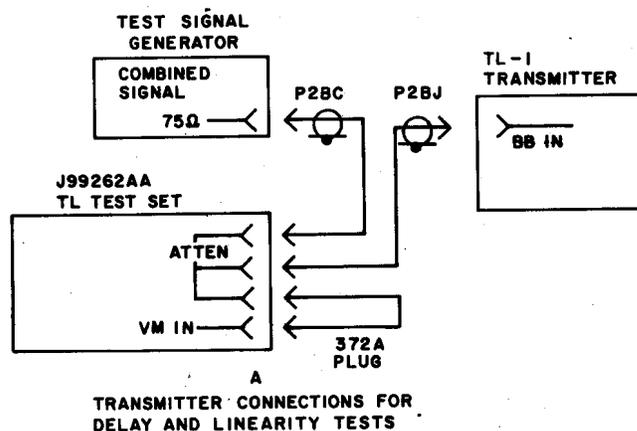
STEP

PROCEDURE

It is preferable that the radio hop be first aligned for correct transmitter frequency, antenna orientation, transmitter deviation sensitivity and linearity, receiver IF center frequency, and baseband amplifier gain. Failure to do so may lead to wrong conclusions on the part of the tester.

Envelope Delay

- 1 Remove the hop from service, if not done previously. Connect the test equipment as shown in Fig. 1A and 1B. Set the ATTENUATOR in the TL test set to 10 dB.



NOTE:
USE CABLE P39M432 WITH J99351E-1 IF AMPLIFIER UNIT.

Fig. 1—Delay and Linearity Tests—Test Setup Diagrams

- 2 Connect the ATT OUT jack to VM IN on the TL test set. Calibrate the SWEEP SIGNAL output level of the delay and linearity test signal generator by switching on only the SWEEP SIGNAL and adjusting the SWEEP SIGNAL control for a indication of -12 DBM

STEP

PROCEDURE

- on the VOLTMETER of the TL test set. (Note that the actual output of the generator is -2 dBm and that the 10 dB of attenuation in the TL test set is used to center the control ranges of the generator.)
- 3 Calibrate the MEASURING SIGNAL output level by switching on only the MEASURING SIGNAL and adjusting the MEASURING SIGNAL control for a VOLTMETER indication of -32 DBM. (Note that this level is not critical and may be reduced later to improve resolution at the expense of noise or jitter on the trace.)
 - 4 Switch on both the SWEEP and MEASURE SIGNALS and apply them to the BB IN jack of the radio transmitter through the 10-dB attenuator as shown in Fig. 1A.
 - 5 At the receiving end of the hop, connect the test equipment as shown in Fig. 1B. Set the controls on the signal analyzer as follows:

INPUT ATTENUATION to 20 DB
MODE, DELAY NANoseconds to 10
 - 6 Adjust the HORIZONTAL PHASE control on the analyzer and the horizontal and vertical gain settings on the oscilloscope to obtain a pattern similar to that in Fig. 2.

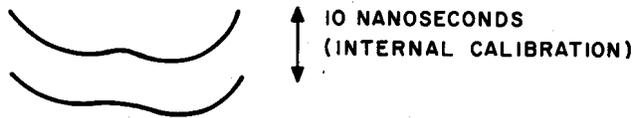


Fig. 2—Delay Pattern—Normal Hop

- Note:** This test should first be performed on a hop with known good noise-loading results to obtain familiarity with the equipment and a normal display.
- 7 The Fig. 2 pattern is typical of a radio hop without delay ripples. In cases where the top message channel noise loading curves are "flat bottomed", the delay characteristic will probably look like one of the patterns in Fig. 3. These shapes are analyzed in detail in Section 940-320-102. The action to be taken at this point will depend upon the shape found. If the ripples in Fig. 3A are found, Steps 8 through 10 should be used to characterize the curve. If patterns similar to Fig. 3B or 3C are found, refer to Section 940-320-102 for further information and analysis.
 - 8 **Determination of Ripple Rate:** If a ripple of the type shown in Fig. 3A is found, it will be useful in fault locating to measure the ripple spacing in megahertz and its peak-to-peak amplitude in nanoseconds. Measure the ripple spacing in one of the following ways.
 - (a) **Method I** (preferred): Insert a J68345J, List 2 IF meter or equivalent, in the cable path connecting the preamplifier and IF and baseband amplifier unit of the receiver

STEP

PROCEDURE

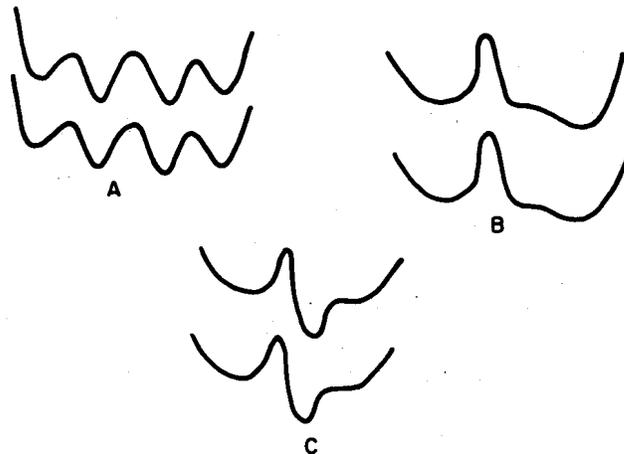


Fig. 3—Delay Patterns with Distortion

under test. Use the frequency meter and the resulting dip on the delay display to determine the ripple spacing in megahertz.

Note: It may be necessary to reduce the MEASURE SIGNAL level to improve resolution for this step. If possible, measure over several ripples at once and divide by the number of cycles of ripple to obtain the average spacing. (See Fig. 4.)



Fig. 4—Delay Pattern with Ripples

(b) **Method 2:** Adjust the amplitude of the SWEEP SIGNAL until a convenient number of cycles (3, 4, or 5) just fills the display as shown in Fig. 5. If necessary, adjust the transmitter repeller voltage slightly to shift the ripples in phase to obtain the proper display. Measure the amplitude of the SWEEP SIGNAL applied to the transmitter input in dBm by using the TL test set. Refer to Fig. 6 to determine the peak-to-peak deviation. Divide the deviation by the number of ripples to obtain the average spacing.

Note: Method 2 depends upon the accuracy of the setting of the transmitter deviation sensitivity and on the TL test set VOLTMETER calibration. It is, therefore, less accurate than method 1.

STEP	PROCEDURE
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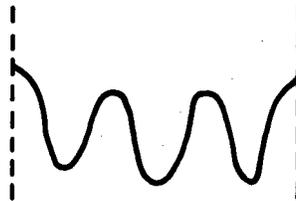


Fig. 5—Adjusted Delay Pattern

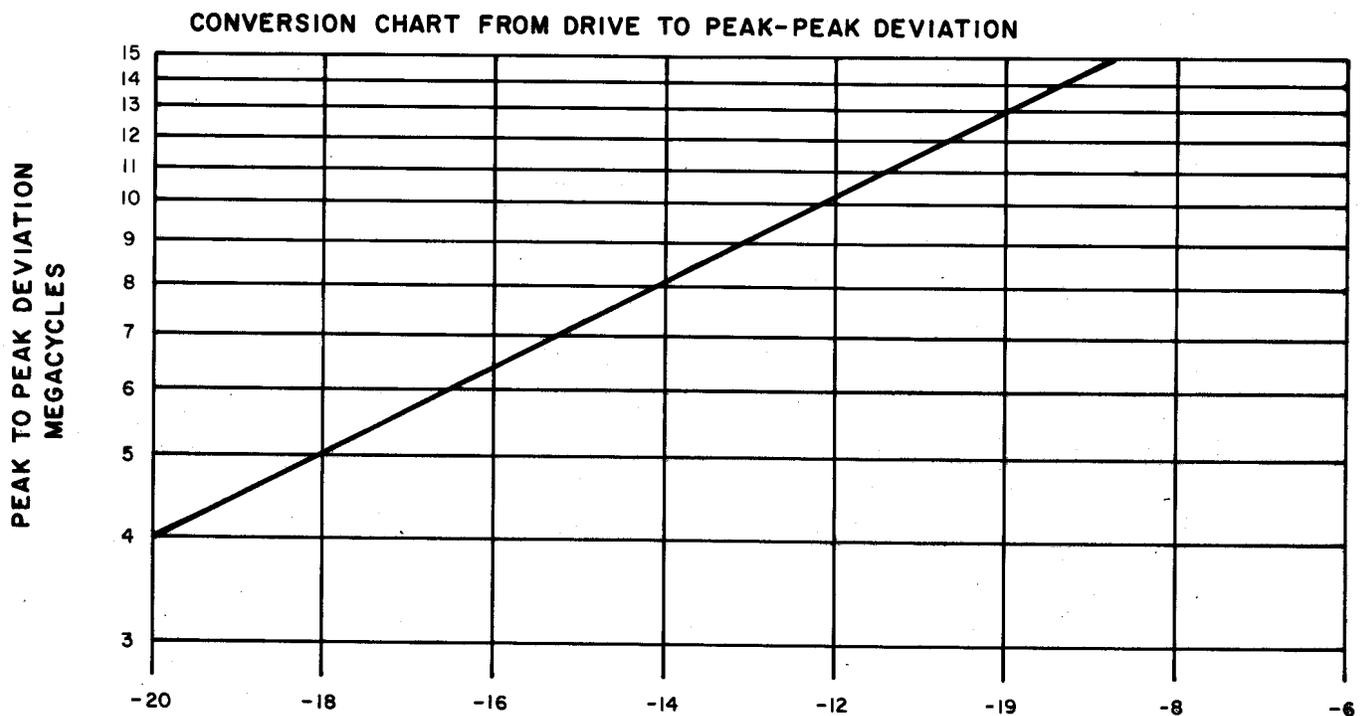


Fig. 6—Sine-Wave Drive Level (dBm) at Transmitter BB IN Jack—Graph

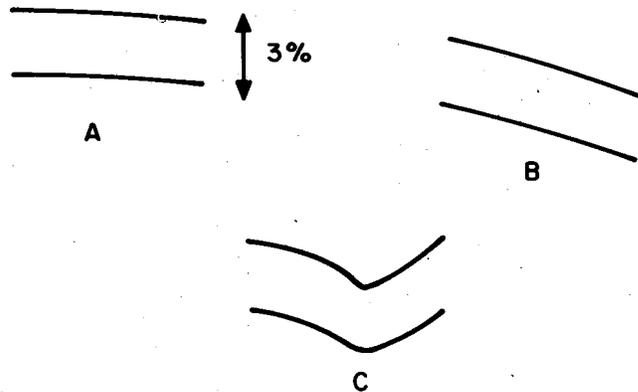
- 9 Calibrate the vertical sensitivity of the oscilloscope so that the peak-to-peak ripple amplitude can be measured in nanoseconds. This is done by separating the two traces by 5 or 10 oscilloscope divisions which then will represent 10 nanoseconds.
- 10 Measure the amplitude of the ripple in nanoseconds peak-to-peak and refer to Section 940-320-102 for interpretation of the results and further tests to be made.

STEP

PROCEDURE

Linearity

- 11 If a hop linearity display is desired, calibrate the generator in accordance with Steps 1, 2, and 3 with the analyzer MODE switch in the LINEARITY 3% position and observe the resulting pattern on the oscilloscope. A properly adjusted hop will appear as in Fig. 7A. A sloping pattern suggests that the transmitting klystron linearity is improperly set (Fig. 7B). A kinked pattern indicates misalignment of the receiver discriminator or nonlinearity of one of the baseband amplifiers (Fig. 7C).

**Fig. 7—Linearity Patterns**

- 12 Refer to the appropriate maintenance method sections to restore the transmitter and receiver adjustments if they were disturbed in Step 8.