SECTION 411-100-506
Issue 1, February 1969
AT&TCo Standard

TD-3 MICROWAVE RADIO
OVERALL SYSTEM
TESTS
DIFFERENTIAL PHASE AND GAIN

Slight nonlinearities in the TD-3 radio equipment are capable of causing changes in the phase shift and gain of the transmission channel as the instantaneous amplitude of a video signal is varied. As a result, when the chrominance signal is superimposed on a luminance signal near the block level, the phase shift and gain experienced by the chrominance signal may be different from the phase shift and gain experienced when the luminance signal is increased to a value near the white level. Such changes, called differential phase and gain, respectively, are capable of causing variations in the hue and saturation of the color picture as the relative brightness changes. It is necessary, therefore, that these changes or differentials be kept at a minimum. Generally, differential phase and gain are affected by the gain-frequency response, impedance mismatches, and envelope delay distortion.

Differential phase and gain testing is normally made from one television operating center (TOC) to another so that it includes entrance facilities, local cabling and the TOC itself, as well as the radio channel. The differential phase and gain test is included in this series of TD-3 radio system practices to make it readily available when it is necessary to measure the differential phase and gain of the radio channel.

APPARATUS:

Transmitting Terminal

1—J64047B Sending Unit (part of J64047A Transmission Measuring System)

1—372A Plug

1—P3AT Coaxial Patch Cord

Receiving Terminal

1—J64047C Receiving Unit (part of J64047A Transmission Measuring System)

1—372A Plug

1—Dumont 304A Oscilloscope

1—P3AT Coaxial Patch Cord

STEP	PROCEDURE

Prerequisite: The channel must meet the requirements of correct channel net gain according to Section 411-100-503.

Note: This test is meant for channels which transmit color television since it is this type of signal that is primarily affected by differential phase and gain distortion.

1 At the transmitting station, adjust the controls on the 47B sending unit as follows:

	FMT INPUT
	BAL
CONTROL	POSITION
HIGH FREQ	ON
SYNC PULSE	ON
LOW FREQ	ON
LOW FREQ OUT DBV	−12
HIGH FREQ DB BELOW LOW FREQ	8

2 Establish the test arrangement shown in Fig. 1.

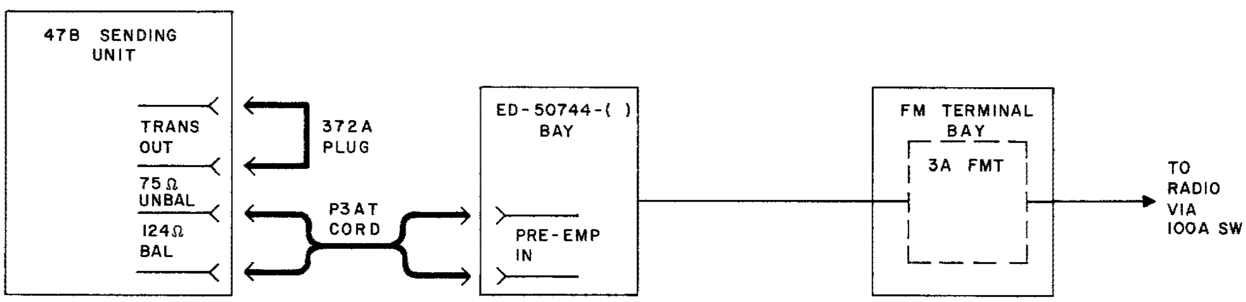

Fig. 1—Test Setup—Transmitting Station

3 At the receiving station, establish the test arrangement shown in Fig. 2.

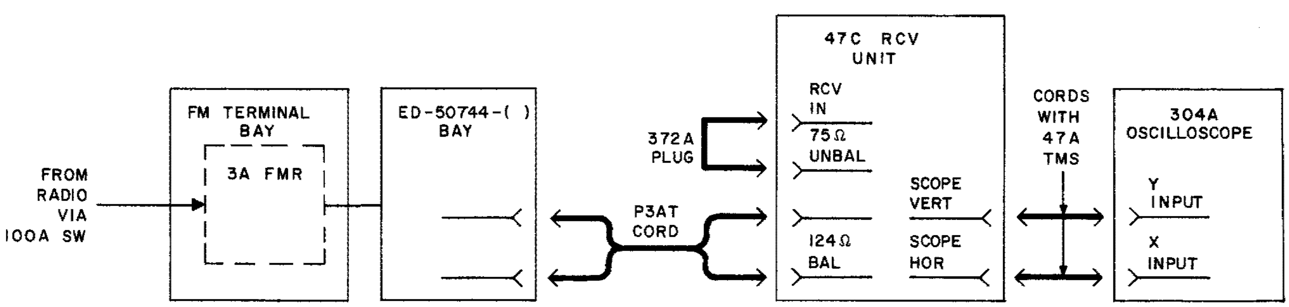

Fig. 2—Test Setup—Receiving Station

STEP	PROCEDURE
4	Calibrate the 47C receiving unit as follows:

SWITCH	SET TO	ADJUST	FOR
SCOPE	MEAS	—	—
CAL-TST	GAIN-CAL 1	COARSE & FINE	20 microamperes
" "	CAL 2	CAL 2	Zero
" "	CAL 3	CAL 3	Zero
" "	CAL 4	CAL 4	Zero
" "	GAIN-CAL 1	—	—
SCOPE	CAL	MULTIPLIER (vertical gain) on 304A scope	1-inch vertical deflection
"	MEAS	SWEEP PHASE	Single line trace

5 Upon completion of the calibration, the oscilloscope display should be similar to the top curve of either photograph in Fig. 3. The sync pulse disturbance should appear on the left-hand end of the trace. If it appears on the right, a turnover exists which should be corrected before proceeding.

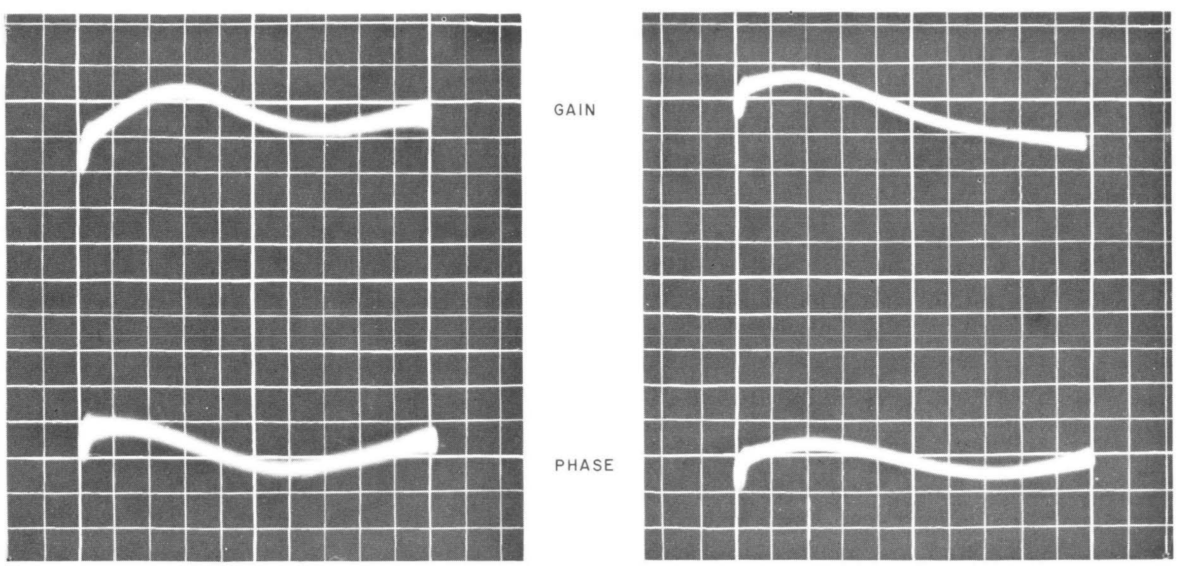

Fig. 3—Typical Waveshapes—30 Hops

6 After calibration, the oscilloscope presentation may be considered a graph with the amplitude of the brightness signal plotted horizontally and the differential phase or gain plotted vertically.

7 The calibration procedure establishes a vertical scale on the oscilloscope of 1 inch equal to either 1.0 dB of differential gain, or 5 degrees of differential phase distortion.

STEP	PROCEDURE
8	***Differential Gain:*** Observe the oscilloscope pattern. Establish an imaginary line beginning at the point where the sync pulse meets the remainder of the trace (see REFERENCE POINT, Fig. 4) and extending horizontally across the face of the oscilloscope tube. Measure and record the amount and sign of the differential gain distortion (the equipment is arranged for this measurement as a result of the calibration procedure in Step 4). The measurement is obtained by first measuring the greatest deviation above and below the imaginary horizontal line and then adding the magnitude of these deviations, disregarding the signs of the deviations. ***Example:*** If the trace on the oscilloscope approximates the curve of Fig. 4A or 4B and if the oscilloscope had been adjusted as indicated in Step 4 for a 1-inch vertical deflection representing 1.0 dB of differential gain, then the curve of Fig. 4A (+4 divisions) would be read as 0.4 dB and the curve of Fig. 4B (+1, -3 divisions) would be read as 0.4 (+0.1, -0.3) dB of differential gain. The inclusion of the deviations, in parentheses, gives an indication of the type of variation of gain with level.
9	***Differential Phase:*** Operate the CAL-TST switch to the PHASE position. Observe the oscilloscope trace. Establish an imaginary horizontal line across the face of the oscilloscope tube as described in Step 8. Measure and record the amount and sign of the differential phase distortion. The measurement is obtained by determining the maximum departures on the trace, both plus and minus, from the imaginary horizontal line. Beginning at the reference point, the curve should be followed across the face of the tube and the maximum deviations (both plus and minus) read as they occur in time. ***Example:*** If the trace on the oscilloscope approximates the curve of Fig. 4A or 4B and if the oscilloscope had been adjusted as indicated in Step 4 for a 1-inch vertical deflection representing 5 degrees of phase, then the curve of Fig. 4A (+4 divisions) would be read as +2 degrees and the curve of Fig. 4B (+1, -3 divisions) would be read as +0.5 degree, -1.5 degrees.
10	No requirements for differential phase or gain distortion are given here. As discussed in the introductory paragraphs of this section, differential phase and gain measurements are normally made between TOCs and include other facilities besides the radio channel. Any remedial action required to correct high differential distortion is usually controlled by the TOC. Limits for the radio channel portion of a TV facility have not been established. However, as a guide, experience has shown that 1000 miles of TD-3 radio system can be maintained to within about ±1 degree of differential phase and about ±0.5 dB of differential gain. Random addition of each type of distortion is expected in the radio channel. Therefore, the performance that may be expected for some other length of radio channel can be estimated as follows: $\text{Estimated distortion for } n \text{ miles of radio channel} = \text{1000 mile distortion} \times \sqrt{\frac{n}{1000}}$

STEP	PROCEDURE
	For example, for a 500-mile radio channel, $$\text{Estimated differential phase} = \pm 1\sqrt{\frac{500}{1000}} = \pm 0.71 \text{ degrees}$$ $$\text{Estimated differential gain} = \pm 0.5\sqrt{\frac{500}{1000}} = \pm 0.35 \text{ dB}$$
11	A record of any differential phase and gain distortion measurements made should be kept for a comparison between parallel channels and the same channel at successive dates.
12	Increasing or abnormally high differential distortion may indicate inadequate envelope delay equalization of the radio channel. Where the distortion has increased above a previously recorded value, it may indicate a need for re-equalization. See Section 411-100-501 on envelope delay test.

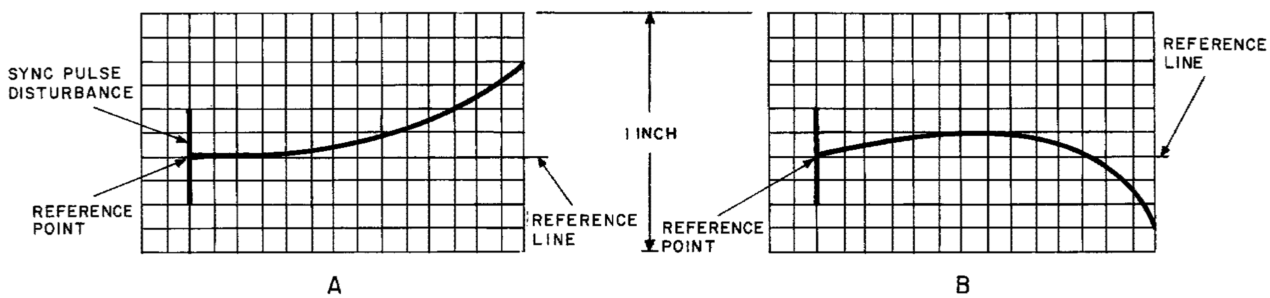

Fig. 4—Differential Phase and Gain Measurements