118-TYPE TELEGRAPH TRANSMISSION MEASURING SETS

PRINCIPLES

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1. GENERAL

1.01 This section gives the operating, calibrating, and measuring principles for the 118-type telegraph transmission measuring sets.

1.02 This section is reissued to update information on the 118-type sets. Since this issue is a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 Descriptions are included in this issue only insofar as appears necessary to clarify the operating, calibrating, and measuring principles being discussed. Figure 1 is a front view of the modified 118C3 set.

1.04 The 118-type set is arranged to indicate directly, on two meters, the distortion of start-stop teletypewriter signals and can be used to indicate the distortion of telegraph reversals. The BIAS meter indicates the average bias and the TOTAL DIST meter indicates the peak value of all types of distortion combined.

1.05 The 118-type set is arranged to measure distortion at 60-, 75-, and 100-word speeds, i.e., 45.5; 56.9; and 74.2 bauds. Modified 118C3 sets and 118C4 sets are arranged for 3-speed switching by operation of a single key at the set, a testboard extension, or a serviceboard position. Other 118-type sets are limited to 2-speed operation and are normally conditioned for measurement at the two most commonly used speeds. These sets may be used at either of the two normal speeds by operating a key at any appearance of the meter circuit, and may be used at the third speed (normally 100) by changing several of the calibration adjustments to predetermined settings and operating an additional key at the set.

1.06 By operation of the 5-6 CODE key, the set may be used to measure teletypewriter signals in either the 5-unit or the 6-unit selecting codes. The CODE key may be provided at the extensions, if desired.

1.07 Extension circuits are provided to permit locating the distortion indicating meters and controls at telegraph or toll testboard positions, at serviceboards, or at line concentrating units. An extension unit for use at testboards and line concentrating units is shown in Fig. 2. Connection is made to this type extension by means of a patch cord between the TMS IN jack of the set and an appropriate loop jack of the circuit being tested. At a serviceboard the meters are located on the keyshelf, and the set is connected to test cords for measurement purposes by means of keys.

1.08 Busy lamps are provided at each meter circuit appearance to indicate various conditions of the set. The TMS IN jacks have a feature which prevents interference when test connections are made to more than one appearance at a time.

2. INTRODUCTION

2.01 In measuring the quality of signals transmitted over a telegraph circuit, the final criterion is the net distorting effect upon the received signal elements.

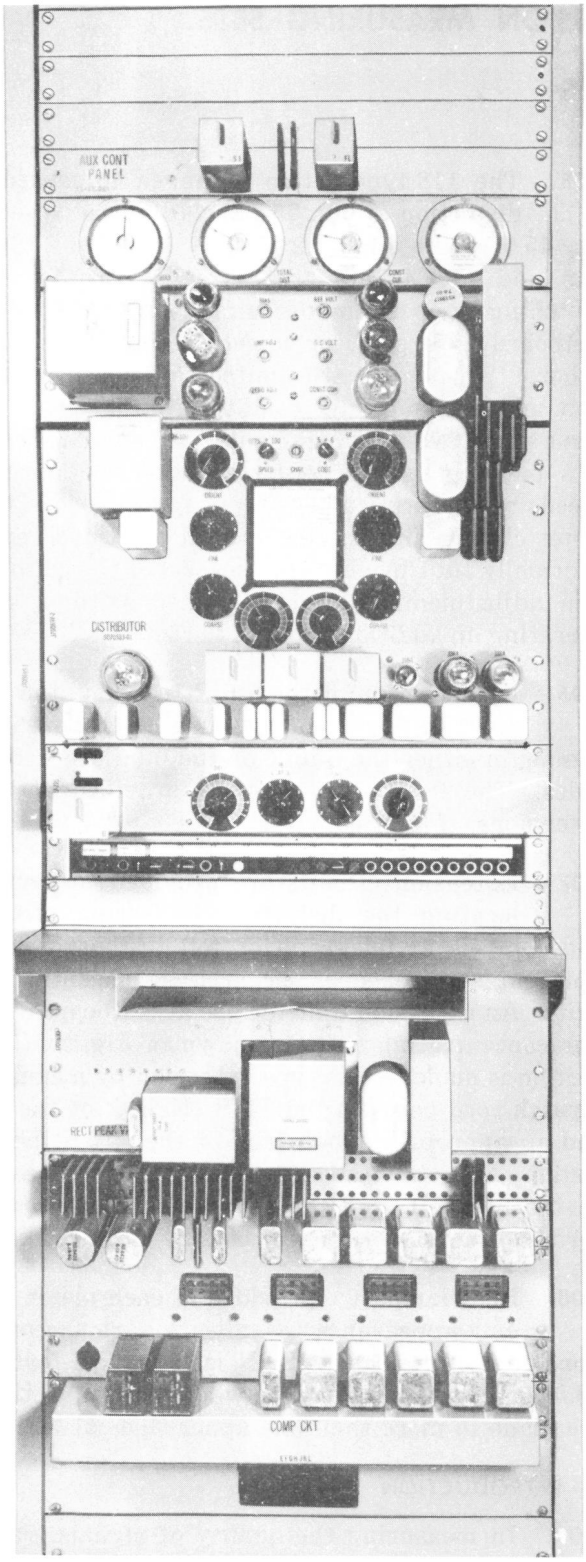


Fig. 1 — 118-Type Set — Front View

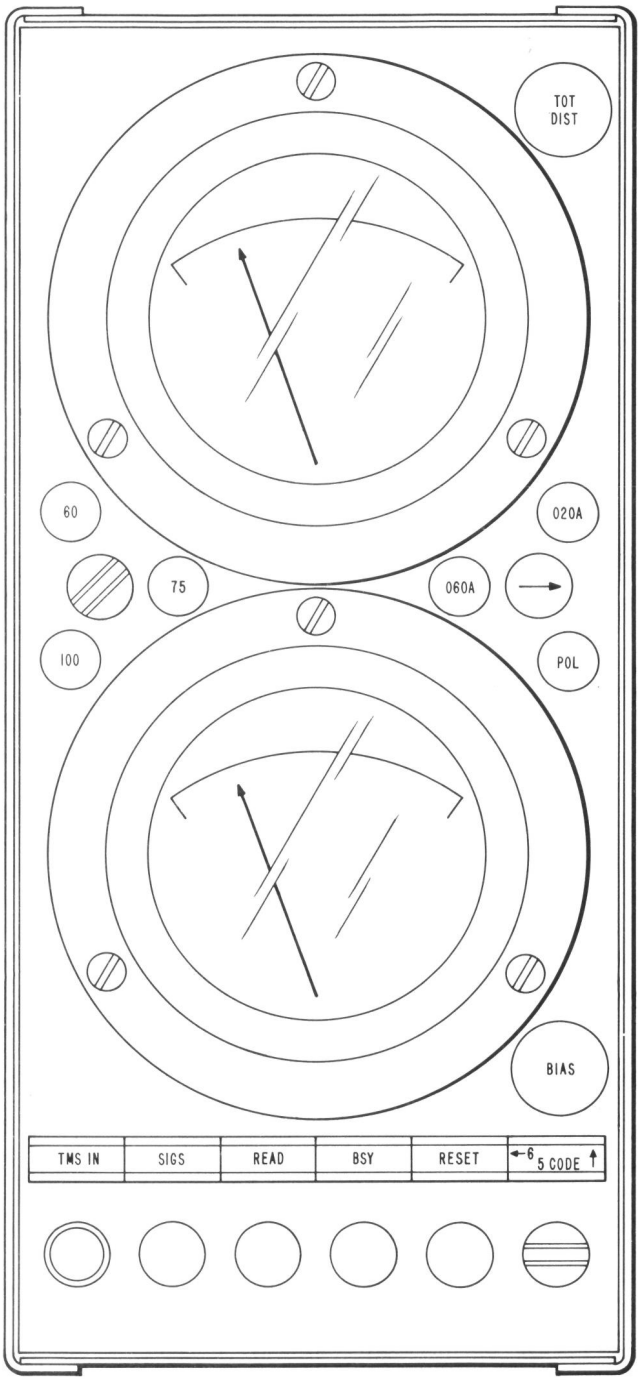


Fig. 2 — Testboard Extension — Jack and Meter Circuit

2.02 When used for telegraph service maintenance, it is desirable that transmission measuring apparatus meet the following requirements:

(a) It should indicate the magnitude of the various components of distortion in the received signals. This is desirable because the service impairment as well as the corrective action to be taken is dependent upon the type and amount of distortion present.

(b) It should not impair service when connected to a working circuit.

(c) It should be suitable for quick measurements making it possible for one set to maintain a large number of services and for qualitative tests to be made on short transmissions.

(d) It should be capable of measuring at different signaling speeds without causing appreciable delay in changing speeds.

(e) It should be arranged for connection to various types of connecting circuits for maximum flexibility.

(f) It should be suitable for measurement of 5-unit teletypewriter, 6-unit teletypesetter code signals and telegraph reversals.

2.03 The 118A1 telegraph transmission measuring set was initially designed to meet some of the foregoing requirements. Later modifications were made (118C1 and 118C2) and the set was subsequently redesigned (118C3) to meet all of these requirements, and many others which developed with progress, growth, and changes in the method of operating telegraph circuits.

2.04 The 118A1 set was quite limited in its application and is somewhat obsolete. The 118B1 set was essentially the same as the 118A1 set except that it was mounted on a portable relay rack. These sets were superseded by the 118C1 set.

2.05 The 118C1 set retained the basic operating principles of the earlier types, but incorporated many improvements, the more important of which are listed below:

(a) Replacement of the mechanical distributor with an electronic distributor.

(b) Elimination of dry batteries for the reference voltage supply by obtaining this supply from improved power equipment.

(c) Provision for measurement at 40-, 60-, and 75-word speeds.

(d) Provision for measurement of 6-unit code signals.

(e) Improved calibration procedure.

(f) Improved bias measuring circuit.

2.06 The 118C2 set was not a new design, but rather included a series of improvements to meet service requirements. All of these improvements were included in the 118C3 set.

2.07 The 118C3 set provided many improvements over the earlier types. Some of the more important improvements in the 118C3 set are listed below:

(a) The BIAS meter scale range was increased from ±25 percent to ±35 percent at extensions (not included on some sets modified from 118C2).

(b) 3-speed switching (when modified).

(c) Improved accuracy of measurement.

(d) Provision for the use of a recording-type meter in the TOTAL DIST meter circuit.

(e) Improved oscillator decrement circuit and a more accurate means of adjustment.

(f) Additional control functions at extensions.

(g) Simplification of the local check procedure.

2.08 The 118C4 set is equivalent to the modified 118C3, but includes 3-speed switching.

3. OPERATING PRINCIPLES

A. General

3.01 The 118-type telegraph transmission measuring set is a time interval measuring set employing the capacitor charge-discharge voltage

comparison principle. The set measures the displacement of signal transitions from their ideal positions, using as a reference the initial mark-to-space transition of the start element. These displacements are converted to voltages stored on measuring capacitors and then compared to a reference voltage which represents the ideal transition points for zero distortion. Any differences between the stored voltages and the reference voltage at the transition points are measured in terms of percentage of a unit interval. Thus, the percent of displacement of signal transitions corresponds to the percent of distortion.

3.02 The graphs in Fig. 3 summarize the various circuit functions with respect to the parts of the signal elements. This information supplements the more detailed circuit descriptions covered in Sections 103-811-102 and 103-811-103.

3.03 In Fig. 3, the transitions occur at the proper time and the voltages attained by the measuring capacitors are equal to the reference voltage at all reference or transition points. Figure 3, therefore, represents measurement of undistorted signals when no currents flow through the measuring circuit and the 118-type set meters indicate zero.

3.04 If, because of distortion, the received signal elements are not of normal length, the voltage attained by the measuring capacitors is increased or decreased with respect to the reference voltage. Distortion, therefore, causes a difference of potential at the two ends of the measuring circuit when the measuring capacitor voltage is compared to the reference voltage at the transition point. This voltage difference causes a surge of current through the measuring circuit on each application. The magnitude of the current is directly proportional to the voltage difference and, consequently, to the distortion. The direction of current flow through the measuring circuit is dependent upon the type, or types, of distortion present. The frequency with which the surges occur through the measuring circuit is dependent upon the speed of signaling, the character code combinations received, and the type of distortion present.

3.05 The TOTAL DIST meter indicates on the occurrence of peaks of rectified voltage in the measuring circuit. It is, therefore, insensitive to the direction of current flow and to the frequency of occurrence. The meter holds the maximum indication for a short period and may be reset to zero by momentarily depressing the RESET key for a new measurement.

3.06 The BIAS meter indicates in accordance with the magnitude of current, the frequency with which the surges occur, and the direction of the current flow. The response is slowed by a large shunt capacitor. When bias is the only type of distortion present, the surges of current are all in a given direction and the BIAS meter indicates the average bias in the circuit when the signals contain the average number of transitions per second. In many practical applications the BIAS meter receives more or less than the average number of surges per second. The indication should be corrected for the most accurate results. In some instances the BIAS meter receives surges from both the mark-to-space and the space-to-mark measuring capacitors. These surges may be in additive or opposing directions and combine in such a manner as to produce erroneous indications.

B. Input Connections

3.07 One of the things to consider in a study of the measuring set is the method by which the signals to be measured are presented to the measuring set. This is accomplished by means of an input relay circuit which, in effect, is a form of one-way telegraph repeater. The input or receiving relay A of the set is arranged so that, by operation of control keys, it operates in various types of telegraph circuits. Relay A, in turn, repeats the signal elements to the measuring relays and starts and assists in stopping the test set oscillator.

4. MEASUREMENT OF DISTORTION

4.01 The BIAS and TOTAL DIST meters are calibrated in their respective circuits to indicate directly, in percent, the bias and the total distortion of a unit signal element. After calibration, the meter indications usually provide adequate information as to the quality of the received signals.

4.02 The action of the TOTAL DIST and BIAS meters gives indication as to the type and amount of distortion present in the signals being measured. In some cases, however, considerable analysis may be necessary to determine the magnitudes of various components of distortion. In

COMPONENTS OF MEASURING SET	GRAPH	STOPPED OR IDLE CONDITION (MARK)	START ELEMENT (SPACE)	NO. 1 ELEMENT (SPACE)	NO. 2 ELEMENT (MARK)	NO. 3 ELEMENT (MARK)	NO. 4 ELEMENT (SPACE)	NO. 5 ELEMENT (SPACE)	STOP ELEMENT (MARK)
Relays — A,C,D	a	Mark	Space	Space	Mark	Mark	Space	Space	Mark
Relays — B,SC	c	Mark	Space	Space	Space	Space	Space	Space	Mark
Tube B	b	Conducting	Cut off	Cut off	Cut off	Cut off	Cut off	Cut off	Conducting
Oscillator (Left section of tube D) Note 1	d	Stopped by relay B	Oscillates one cycle	Oscillates one cycle	Oscillates one cycle	Oscillates one cycle	Oscillates one cycle	Oscillates one cycle	Stopped by relay B
Detector (Right section of tube D) Note 2	e	Biased to cut off by relay B	Conducts | Cut off	Conducts | Cut off	Conducts | Cut off	Conducts | Cut off	Conducts | Cut off	Conducts | Cut off	Biased to cut off by relay B
Tube E (Grid)	f	−30V from drop across resistor L	Momentarily (+) from detector at (f1)	Momentarily (+) from detector at (f2)	Momentarily (+) from detector at (f3)	Momentarily (+) from detector at (f4)	Momentarily (+) from detector at (f5)	Momentarily (+) from detector at (f6)	−30V from drop across resistor L
Tube E (Ionized by plus voltage swings and cut off when tube F ionizes) Note 3	g	Biased to cut off (−30V)	Ionizes at (g1) cuts off at (g2)	Ionizes at (g3) cuts off at (g4)	Ionizes at (g5) cuts off at (g6)	Ionizes at (g7) cuts off at (g8)	Ionizes at (g9) cuts off at (g10)	Ionizes at (g11) cuts off at (g12)	Biased to cut off (−30V)
Tube F (Grid) (Tube ionizes at zero grid potential)	g	−55V from capacitors F and G	Momentarily zero from capacitor G at (i2)	Momentarily zero from capacitor G at (i3)	Momentarily zero from capacitor F at (h2)	Momentarily zero from capacitor F at (h3)	Momentarily zero from capacitor G at (i6)	Momentarily zero from capacitor G at (i7)	−55V from capacitors F and G
Tube F (Ionizes and cuts off tube E — about 0.002 seconds later cuts itself off)	g	Biased to cut off	Momentarily ionizes and cuts off at (g2)	Momentarily ionizes and cuts off at (g4)	Momentarily ionizes and cuts off at (g6)	Momentarily ionizes and cuts off at (g8)	Momentarily ionizes and cuts off at (g10)	Momentarily ionizes and cuts off at (g12)	Biased to cut off
Voltages on Mark-to-Space Measuring Capacitor F	h	−55V (SC VOLT)	−55V (REF VOLT)	−55V (REF VOLT)	Starts charging from CC at (h1). Discharges to zero at (h2) and continues to charge from CC.	Continues to Charge from CC. Discharges to zero at (h3) and continues to Charge from CC.	Transferred to Meas Ckt and compared with (REF VOLT) at (h4). Remains on −55V (REF VOLT).	−55 V (REF VOLT) Transferred to (SC-VOLT) at (h5).	−55V (SC VOLT) until next M-S Transition.
Voltages on Space-to-Mark Measuring Capacitor G	i	−55 V (REF VOLT)	Starts charging from CC at (i1). Discharges to zero at (i2) and continues to charge from CC.	Continues to charge from CC. Discharges to zero at (i3) and continues to charge from CC.	Transferred to Meas Ckt and compared with (REF VOLT) at (i4). Remains on (REF VOLT) (−55V).	−55V (REF VOLT)	Starts charging from CC at (i5). Discharges to zero at (i6) and continues to charge from CC.	Continues to charge from CC. Discharges to zero at (i7) and continues to charge from CC.	Transferred to Meas Ckt and compared with (REF VOLT) at (i8). Remains on −55V until next M-S Transition.

Note 1: The oscillator frequency is adjusted by varying capacitor C (COARSE and FINE dials).

Note 2: The Detector Bias (graph d) is adjusted by varying the ORIENT control. This adjustment shifts the detector pulses (graph e), the conducting point of tube E (graph f) and the discharge pulse (graph g) with respect to the starting transition.

Note 3: When tubes E and F are ionized (bluish color), the plate-to-cathode impedance is very low. This effectively grounds the measuring capacitors through the 91A coil D. The total time of discharge is about 0.004 seconds.

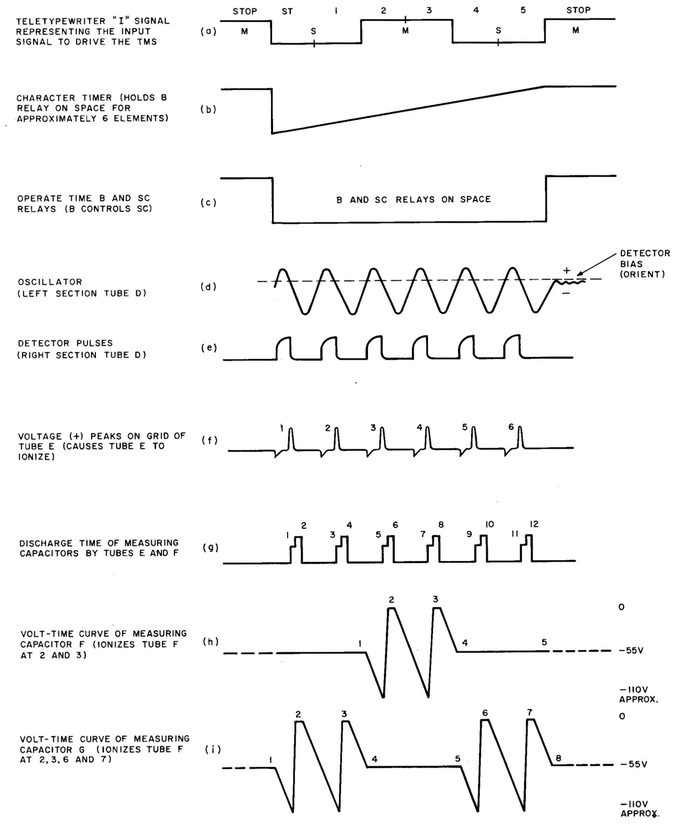


Fig. 3 — Typical Functions of Electronic Distributor and Measuring Capacitors (Teletypewriter "I" Signal)

other cases it may be necessary to perform special tests in order to accurately identify the types of distortion represented in the measurements.

4.03 Generally, any distortion which displaces space-to-mark transitions affects an average of two transitions per character on 5-unit code signals and an average of 2.25 transitions per character on 6-unit code signals. Since all transition displacements are referred to the starting transition, the first mark-to-space transition of each character is not measured. The average measurable mark-to-space transitions per character are, therefore, one less than the average space-to-mark transitions. This accounts for the fact that the BIAS meter indicates only half of the magnitude of end distortion on signals containing the average number of transitions per second. This distribution of transitions also accounts for other actions of the BIAS meter especially in connection with speed irregularities and when more than one type of distortion is involved in the measurement.

4.04 Table A shows the distribution of transitions in the types of signals normally measured on the 118-type set. Table B relates the data

TABLE A — DISTRIBUTION OF TRANSITIONS

TYPE OF SIGNALS	DISTRIBUTION IF TRANSITIONS BY COMBINATIONS				AVERAGE NUMBER OF TRANSITIONS	AVERAGE SPACE-TO-MARK TRANSITIONS	AVERAGE MARK-TO-SPACE TRANSITIONS	AVERAGE MEASURABLE MARK-TO-SPACE TRANSITIONS
	(2T)	(4T)	(6T)	(8T)				
Teletypewriter (32 Combinations)	6	20	6	–	4	2	2	1
Teletypewriter (59 Combinations)	6	32	20	1	4.50	2.25	2.25	1.25
Reversals	–	—	—	–	8	4	4	3

TABLE B — DATA FOR COMPUTING BIAS AND TOTAL DIST METER INDICATIONS

TYPE AND SPEED OF SIGNALS	OPS	SIGNAL ELEMENT LENGTH IN SECONDS	AVERAGE NUMBER OF S-M TRNS/SEC	AVERAGE NUMBER OF M-S** TRNS/SEC	NOMINAL CAPACITANCE OF MEASURING CAPACITORS (F AND G) IN MICROFARADS
Teletypewriter 5-Unit Code					
*60-Speed Misc Signals	6.1	0.022	12.2	6.1	5.40
Repeated 2-Trns Char	6.1	0.022	6.1	0	5.40
Repeated 4-Trns Char	6.1	0.022	12.2	6.1	5.40
Repeated 6-Trns Char	6.1	0.022	18.3	12.2	5.40
*75-Speed Misc Signals	7.6	0.0176	15.2	7.6	4.32
Repeated 2-Trns Char	7.6	0.0176	7.6	0	4.32
Repeated 4-Trns Char	7.6	0.0176	15.2	7.6	4.32
Repeated 6-Trns Char	7.6	0.0176	22.8	15.2	4.32
*100-Speed Misc Signals	10.0	0.0135	20.0	10.0	3.24
Repeated 2-Trns Char	10.0	0.0135	10.0	0	3.24
Repeated 4-Trns Char	10.0	0.0135	20.0	10.0	3.24
Repeated 6-Trns Char	10.0	0.0135	30.0	20.0	3.24
*53-Speed Misc Signals	5.3	0.022	11.9	6.6	5.40
*66-Speed Misc Signals	6.6	0.0176	14.8	8.2	4.32

*Signals assumed to be the equivalent of the standard test sentence.

**The first M-S transition (not counted) in each character compares the SC Volt (—55V) with the REF VOLT (—55V) and is not measured.

in Table A to operating conditions and gives data that might be useful in calculating BIAS and TOTAL DIST meter indications.

A. Measurement of Bias

4.05 In the measurement of bias the TOTAL DIST meter indicates the magnitude of bias immediately and gives the same indication after each momentary operation of the RESET key. The TOTAL DIST meter does not indicate the sign of the bias, and is not dependent upon the speed of signaling. It may not, however, indicate accurately on the transmission of a single character. The BIAS meter indicates the magnitude and sign of the bias when there is no other type of distortion present and when other conditions are satisfied. The other conditions are satisfied when the sending source is operating at full speed and the sent material contains the average number of transitions. The BIAS meter does not indicate the actual bias under the following conditions:

(a) When the sent signals are miscellaneous characters from a keyboard. (Refer to Table D and notes.)

(b) When the speed of the sending distributor or the test set oscillator is incorrect. (Refer to Tables C and D.)

(c) When the signal source contains end distortion. (Refer to 4.06.)

(d) When the signal source is repeated characters not containing the average number of transitions. (Refer to Table B.)

(e) When measuring telegraph reversals. (Divide by two.)

B. Measurement of End Distortion

4.06 The TOTAL DIST meter indicates the magnitude of end distortion as though it were bias. The BIAS mefer indicates only half of the end distortion present on average 5-unit code signals. On average 6-unit code signals the BIAS meter indicates slightly more than half of the actual end distortion, although for all practical purposes it may be considered as one half. (Refer to Table B and Fig. 4.)

C. Measurement of Characteristic Distortion

4.07 The TOTAL DIST meter indicates the magnitude of characteristic distortion; however, it may not attain the peak indication until several characters have been transmitted. Usually the TOTAL DIST meter will rise progressively in three or four jumps before attaining the maximum indication. The fact that the TOTAL DIST meter describes the same general patterns after repeated operations of the RESET key gives an indication of the presence of characteristic distortion. The BIAS meter, being highly damped, is unable to follow the rapidly changing signs from character to character. In its attempt to do so, however, it usually vibrates rather unsteadily around an average of near zero. If bias is also present in the received signals, the BIAS meter will be influenced by it. The action of the BIAS meter resulting from characteristic distortion is somewhat the same as that resulting from certain types of switched distortion. These similar conditions can usually be distinguished by knowledge of circuit and test conditions. If the characteristic distortion is of such magnitude that corrective action is indicated, special test procedures as demonstrated in Fig. 5 are recommended.

D. Measurement of Distortion Caused by Speed Irregularities

4.08 The interpretation of 118-type set meter indications resulting from speed irregularities involves special tests and procedures which are demonstrated in Tables C and D.

E. Measurement of Signals Containing Both Bias and End Distortion

4.09 When the received signals contain bias and end distortion, special tests may be required to accurately indicate the circuit condition. In many instances, the performance of these special tests may indicate the proper procedure to correct the fault. In many other instances, failure to perform the special tests may result in an improper adjustment procedure with consequent degradation of the service involved. Figure 4 demonstrates the special tests required in order to evaluate the BIAS meter indications under these conditions.

The purpose of the examples in Fig. 4 is to demonstrate that normal measurements made on the 118-type set may not be indicative of the true condition of a circuit.

Total Distortion Indications

The total distortion indication in all of the examples indicates the maximum ***reduction*** in orientation range. This is an important factor in judging the quality of the received signals; although it is not, in itself, sufficient to indicate which of the various types of distortion is present.

Bias Indications on Signals Affected by Bias

It will be noted by comparison that the BIAS meter indicates the bias in the circuit when there is no other type of distortion present and when the speed of signaling is at the full rate. On keyboard signals, the speed of signaling is never at the full rate and the true bias can only be estimated. For example, if the speed is estimated to be 30 words per minute on a 60-speed circuit, the BIAS meter indication should be multiplied by two.

Bias Indications on Signals Affected by End Distortion

Examples (d) and (e) demonstrate that the BIAS meter indicates the correct sign of end distortion, but indicates only half the magnitude. This is because there is an average of only one measurable mark-to-space transition per character. It is interesting to note that a normal 118-type set measurement of 20M20 in example (b) results in the same teletypewriter range as 20S10 in example (e), and that 20S20 in example (c) results in the same teletypewriter range as 20M10 in example (d). The teletypewriter cannot distinguish between bias and end distortion of opposite sign. The 118-type set cannot completely distinguish between bias and end distortion of the same sign unless special tests are made as outlined below.

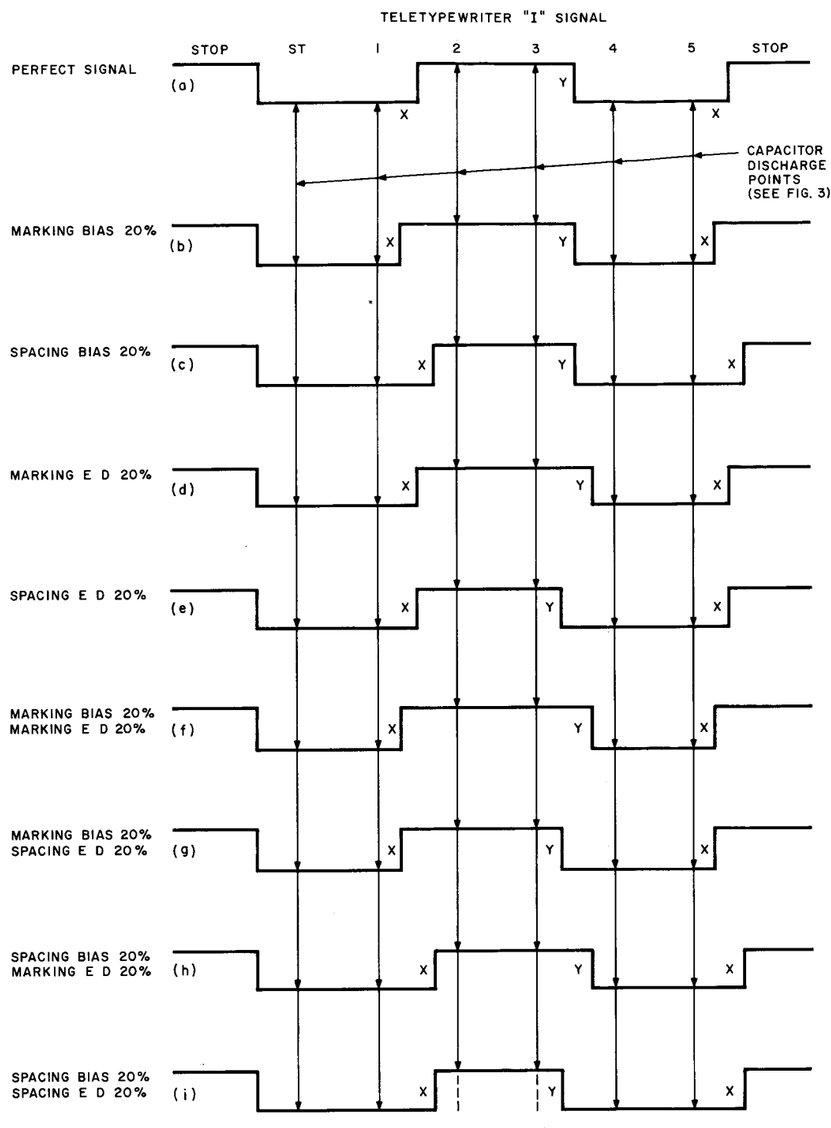
Bias Indications on Signals Affected by Combination of Bias and End Distortion of Like Sign

Examples (f) and (i) demonstrate conditions where the BIAS meter indication is greater than the TOTAL DIST indication. This is because the bias measuring circuit receives an average of three surges per character, one from mark-to-space transition displacements and two from space-to-mark transition displacements. By making individual ***M-S only*** and ***S-M only*** measurements the combining effect is obviated and each type of distortion may be measured. Measurement of repeated 6-transition characters or improper calibration of the 118-type set might also cause the BIAS meter indication to be greater than the TOTAL DIST meter indication.

Bias Indications on Signals Affected by Combination of Bias and End Distortion of Unlike Sign

Examples (g) and (h) demonstrate conditions in which the BIAS meter indication is reduced by the cancelling effect of types of distortion having unlike signs. Compare the teletypewriter range in (g) with that in (d), and the range in (h) with that in (e).

Note: A teletypewriter "I" signal is used to demonstrate the average condition. "X" represents bias and "Y" represents end distortion.



* INDICATIONS REPRESENT EXPECTED RESULTS ON MISCELLANEOUS SIGNALS. THE TTY IS ASSUMED TO BE IN GOOD ADJUSTMENT.

Fig. 4 — Miscellaneous 118-Type TMS Indications

Table C has been prepared to demonstrate several characteristics of the 118-type telegraph transmission measuring set.

(1) It demonstrates that the TOTAL DIST and BIAS meter indications are not indicative of teletypewriter orientation range limits.

(2) It demonstrates that speed irregularities in the sending source displaces both mark-to-space and space-to-mark transitions.

(3) It demonstrates that mark-to-space and space-to-mark transition displacements may combine in different ways to cause erroneous meter indications.

(4) It demonstrates that the effects of bias may be obviated in the measurement by measuring mark-to-space transitions only, and that the effects of end distortion may be obviated by measuring space-to-mark transitions only.

Three individual measurements are made when bias or end distortion combines with the speed irregularity and masks the meter indications caused by the irregularity. The suggested procedure is to apply an equivalency check, given below, to the measurements and apply the measurement which meets the equivalency check requirement to determine the speed irregularity. If the normal measurement meets the equivalency check requirement, the other tests are not necessary to determine the speed irregularity.

	USE 5- OR 6-UNIT COLUMN AS APPLICABLE				SPEED VARIATION IN PERCENTAGE		SENDING SOURCE FAST OR SLOW	
	5-UNIT		6-UNIT		5-UNIT	6-UNIT	BIAS SIGN	TRANS
Check 1								
Use Normal Measurement When:	$\frac{TD}{6} = \frac{BIAS}{1.75}$		$\frac{TD}{7} = \frac{BIAS}{1.75}$		$\frac{TD}{6}$	$\frac{TD}{7}$	Marking Spacing	Fast Slow
Check 2								
Use M-S Only Measurement When:	$\frac{TD}{5} = \frac{BIAS}{1.75}$		$\frac{TD}{6} = \frac{BIAS}{3.5}$		$\frac{TD}{5}$	$\frac{TD}{6}$	Marking Spacing	Slow Fast
Check 3								
Use S-M Only Measurement When:	$\frac{TD}{6} = \frac{BIAS}{3.5}$		$\frac{TD}{7} = \frac{BIAS}{4}$		$\frac{TD}{6}$	$\frac{TD}{7}$	Marking Spacing	Fast Slow

TD is TOTAL DIST (First figure in the first column of Table C)

Check 1 is applicable when the indications of speed irregularity are not complicated by the presence of bias or end distortion. ***Check 2*** is applicable when the indications of speed irregularity are complicated by the presence of bias. ***Check 3*** is applicable when the indications of speed irregularity are complicated by the presence of end distortion.

EXAMPLES OF 118-TYPE TMS MEASUREMENTS IN CONNECTION WITH SPEED IRREGULARITIES

MISCELLANEOUS SIGNALS

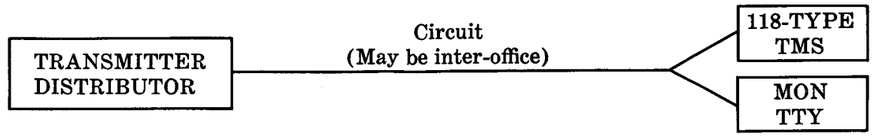


TABLE C

CONDITION OF TRANSMITTER DISTRIBUTOR	BIAS IN CKT	118-TYPE TMS MEASUREMENT				COMPARABLE SHIFT IN ORIENTATION RANGE ON MISCELLANEOUS SIGNALS	
		CODE	NORMAL	M-S ONLY	S-M ONLY	LOWER LIMIT	UPPER LIMIT
(1) Good	None	5-Unit 6-Unit	ONB ONB	ONB ONB	ONB ONB	0 0	0 0
(2) 4% Slow	None	5-Unit 6-Unit	24S7 28S7	20M7 24M9	24S14 28S16	Up 20 Up 24	Up 8 Up 8
(3) 4% Slow	Mkg 7 %	5-Unit 6-Unit	20NB 24NB	20M7 24M9	17S7 21S9	Up 20 Up 24	Up 1 Up 1
(4) 4% Slow and 14% Marking and Distortion	None	5-Unit 6-Unit	34NB 38NB	34M14 38M16	24S14 28S16	Up 34 Up 38	Up 8 Up 8
(5) 4% Slow	Spg 7 %	5-Unit 6-Unit	31S14 35S14	20M7 24M9	31S21 35S23	Up 27 Up 31	Up 8 Up 8
(6) 4% Slow and 14% Spacing End Distortion	None	5-Unit 6-Unit	24S14 28S15	6NB 10M1	24S14 28S16	Up 20 Up 24	Down 6 Down 6
(7) 4% Fast	None	5-Unit 6-Unit	24M7 28M7	20S7 24S9	24M14 28M16	Down 4 Down 4	Down 24 Down 28
(8) 4% Fast	Mkg 7 %	5-Unit 6-Unit	31M14 35M14	20S7 24S9	31M21 35M23	Down 8 Down 8	Down 31 Down 35
(9) 4% Fast and 14% Marking and Distortion	None	5-Unit 6-Unit	24M14 28M15	6NB 10S1	24M14 28M16	Up 6 Up 6	Down 24 Down 28
(10) 4% Fast	Spg 7 %	5-Unit 6-Unit	20NB 24NB	20S7 24S9	17M7 21M9	Up 3 Up 3	Down 20 Down 24
(11) 4% Fast and 14% Spacing End Distortion	None	5-Unit 6-Unit	34NB 38NB	34S14 38S16	24M14 28M16	Down 4 Down 4	Down 34 Down 38

To check speed irregularities from keyboard signals, refer to Table D.

Table D has been prepared to demonstrate the same characteristics of the 118-type set as demonstrated in Table C, except that a repeated "I" signal is measured in this case. This additional table is provided because of the impracticability of operating a keyboard at full speed on miscellaneous signal transmissions. This procedure is also applicable for tests from tape transmitter distributors when suitable test tape is not readily available.

The 118-type set test information is applicable for the "I" signal repeated continuously at full speed. The information is not correct for any other character.

As in the tests with miscellaneous signals, three individual measurements are made when bias or end distortion combines with the speed irregularity and masks the meter indications caused by the irregularity. The suggested procedure is to apply an equivalency check, given below, to the measurements and apply the measurement which meets the equivalency check requirement to determine the speed irregularity. If the normal measurement meets the equivalency check requirement, the other tests are not necessary to determine the speed irregularity.

	USE 5- OR 6-UNIT COLUMN AS APPLICABLE				SPEED VARIATION IN PERCENTAGE		SENDING SOURCE FAST OR SLOW	
	5-UNIT		6-UNIT		5-UNIT	6-UNIT	BIAS SIGN	TRANS
Check 1								
Use Normal Measurement When:	$\frac{TD}{6} = \frac{BIAS}{2}$		$\frac{TD}{7} = \frac{BIAS}{2.25}$		$\frac{TD}{6}$	$\frac{TD}{7}$	Marking Spacing	Fast Slow
Check 2								
Use M-S Only Measurement When:	$\frac{TD}{4} = \frac{BIAS}{2}$		$\frac{TD}{5} = \frac{BIAS}{2.75}$		$\frac{TD}{4}$	$\frac{TD}{5}$	Marking Spacing	Slow Fast
Check 3								
Use S-M Only Measurement When:	$\frac{TD}{6} = \frac{BIAS}{4}$		$\frac{TD}{7} = \frac{BIAS}{5}$		$\frac{TD}{6}$	$\frac{TD}{7}$	Marking Spacing	Fast Slow

TD is TOTAL DIST (First figure in the columns of Table D)

Check 1 is applicable when the indications of speed irregularity are not complicated by the presence of bias or end distortion. ***Check 2*** is applicable when the indications of speed irregularity are complicated by the presence of bias. ***Check 3*** is applicable when the indications of speed irregularity are complicated by the presence of end distortion.

EXAMPLES OF 118-TYPE TMS MEASUREMENTS IN CONNECTION WITH SPEED IRREGULARITIES

REPEATED "I" SIGNALS

KEYBOARD OR TRANSMITTER DISTRIBUTOR "I" SIGNALS — Circuit (May be inter-office) — 118-Type TMS

TABLE D

TRANSMITTER-DISTRIBUTOR CONDITION	BIAS IN CKT	118-TYPE TMS MEASUREMENT				COMPARABLE SHIFT IN ORIENTATION RANGE ON MISCELLANEOUS SIGNALS	
		CODE	NORMAL	M-S ONLY	S-M ONLY	LOWER LIMIT	UPPER LIMIT
(1) Good	None	5-Unit 6-Unit	ONB ONB	ONB ONB	ONB ONB	0 0	0 0
(2) 4% Slow	None	5-Unit 6-Unit	24S8 28S9	16M8 20M11	24S16 28S20	Up 20 Up 24	Up 8 Up 8
(3) 4% Slow	Mkg 7 %	5-Unit 6-Unit	17S1 21S2	16M8 20M11	17S9 21S13	Up 20 Up 24	Up 1 Up 1
(4) 4% Slow and 14% Marking End Distortion	None	5-Unit 6-Unit	30S1 34S2	30M15 34M18	24S16 28S20	Up 34 Up 38	Up 8 Up 8
(5) 4% Slow	Spg 7 %	5-Unit 6-Unit	31S15 35S16	16M8 20M11	31S23 35S27	Up 27 Up 31	Up 8 Up 8
(6) 4% Slow and 14% Spacing End Distortion	None	5-Unit 6-Unit	24S15 28S16	2M1 6M4	24S16 28S20	Up 20 Up 24	Down 6 Down 6
(7) 4% Fast	None	5-Unit 6-Unit	24M8 28M9	16S8 20S10	24M16 28M20	Down 4 Down 4	Down 24 Down 28
(8) 4% Fast	Mkg 7 %	5-Unit 6-Unit	31M15 35M16	16S8 20S11	31M23 35M27	Down 8 Down 8	Down 31 Down 35
(9) 4% Fast and 14% Marking End Distortion	None	5-Unit 6-Unit	24M15 28M16	2S1 6S4	24M16 28M20	Up 6 Up 6	Down 24 Down 28
(10) 4% Fast	Spg 7 %	5-Unit 6-Unit	17M1 21M2	16S8 20S11	17M9 21M13	Up 3 Up 3	Down 20 Down 24
(11) 4% Fast and 14% Spacing End Distortion	None	5-Unit 6-Unit	30M1 34M2	30S15 34S18	24M16 28M20	Down 4 Down 4	Down 34 Down 38

Characteristic distortion is indicated on the 118-type set meters during the transmission of miscellaneous signals as discussed in Part 4. When the characteristic distortion is of such magnitude that equalization is indicated, special tests may be performed to simplify the procedure. Figure 5 represents typical measurements employing the special test procedure.

In the special test procedure the indicated bias is measured for each of the 2-transition characters, after which the circuit bias and characteristic distortion components are determined by analysis. The bias component of the measurements represented in Fig. 5 (A) may be determined in one of three ways:

1 — Average the indicated bias for the "O" and "M" characters $\left(\frac{+3+7}{2} = 5\%\ \text{Marking}\right)$

2 — Average the indicated bias for all characters $\left(\frac{-8+40}{6} = 5.3\%\ \text{Marking}\right)$

3 — Measure the bias of telegraph reversals $\left(\frac{\text{Indicated Bias}}{2}\right)$

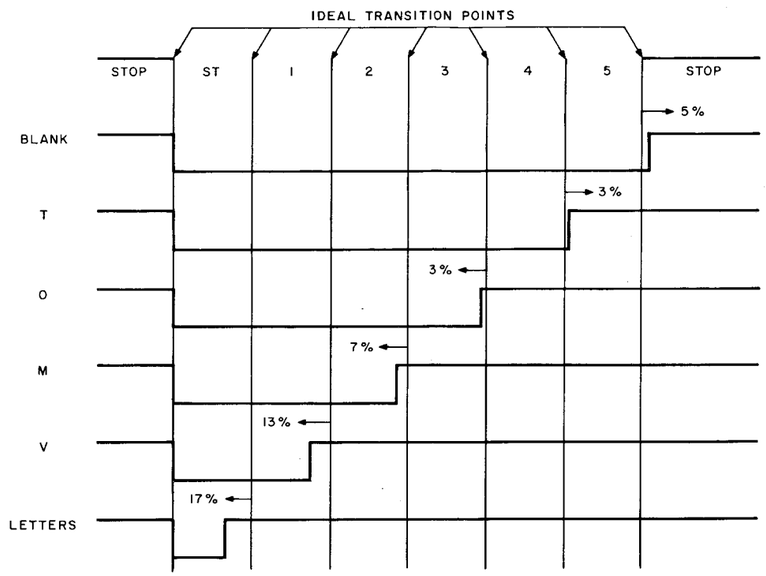
After the bias component has been determined, the characteristic distortion may be determined by correcting the indicated bias measurements as follows:

	BLANK	T	O	M	V	LETTERS
Indicated bias	−5	−3	+3	+7	+13	+17
Bias	+5	+5	+5	+5	+5	+5
Characteristic Distortion	−10	−8	−2	+2	+8	+12

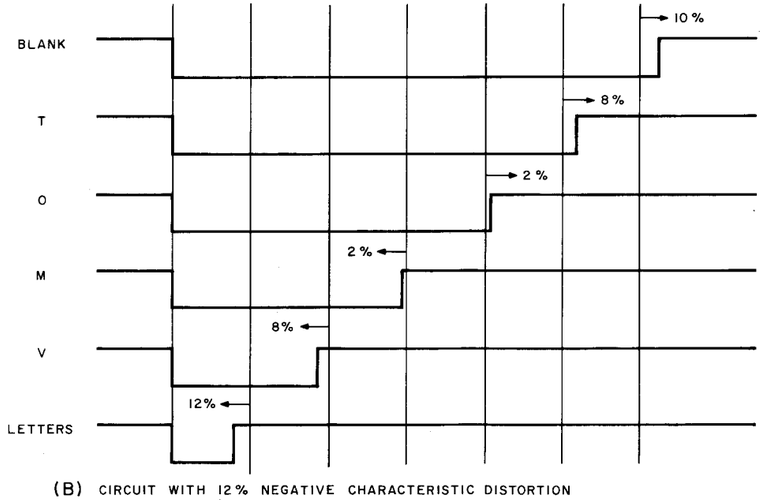
The characteristic distortion is now clearly defined and may be removed by equalization. Ideal equalization for Fig. 5 (A) is achieved when all characters measure 5 percent indicated marking bias. Ideal equalization of Fig. 5 (B) is achieved when all characters measure zero indicated bias. The choice being whether to remove the 5 percent bias before or after equalization.

Factors to Consider

1 — The bias measurements made by this method are not generally as accurate as those made with a 161-type set or a type of cathode-ray measuring set.
2 — End distortion is not indicated on the TOTAL DIST or BIAS meters during this test, and additional tests are required to indicate it.
3 — The type of characteristic distortion present is determined by this procedure, whereas it would not be known on miscellaneous signal measurements. Shortening of the short signal elements indicates negative-type characteristic distortion as represented in Fig. 5. Lengthening of short signal elements would indicate positive characteristic distortion.
4 — Knowing the type of characteristic distortion present gives definite indications as to the proper procedure for adjustment. For example, if distortion is of the negative type, it is known that the dc components are predominant in the received signals. This fact established, a procedure that will bypass some of the dc components and bring them in equalization with the higher frequency ac components can be employed.



(A) CIRCUIT WITH 12% NEGATIVE CHARACTERISTIC DISTORTION AND 5% MARKING BIAS



(B) CIRCUIT WITH 12% NEGATIVE CHARACTERISTIC DISTORTION

* BIAS METER INDICATES HALF OF THE BIAS ON 2-TRANS CHARACTERS.

Fig. 5 — Characteristic Distortion Indications

F. Measurement of Fortuitous Distortion

4.10 Fortuitous distortion reacts in the 118-type set measurement somewhat like characteristic distortion, except that the BIAS meter usually averages more nearly zero. It may usually be identified, however, by its nonsystematic nature. The distortion indication may occur frequently or infrequently. It may produce a maximum TOTAL DIST indication of 10 or less on one occurrence and 25 or more on the next. Usually it can be identified by its nature after watching the action of the TOTAL DIST meter for a few seconds and frequently depressing the RESET key. In some cases it may require several minutes or longer to measure the maximum peak. On infrequent occurrences of large peaks of distortion, the TOTAL DIST meter indicates only about 70 percent of the actual distortion present. As an example of this characteristic of the set, if the average TOTAL DIST peak indication is 5 and a sudden fortuitous peak of 8 is indicated, no correction is required. On the other hand, if the average TOTAL DIST peak indication is 5 and a sudden fortuitous peak of 25 is indicated, the actual distortion is approximately 25/0.70 or about 35 percent. This correction factor may be useful in determining the peak distortion present as the result of switching lines or amplifiers in the transmission path.

G. Other Special Tests

4.11 In some instances it is desirable to be able to identify the type of signals sent from a bias producing or signal distorting set. With the older types of equipment, such as the 119A1 set, this is no problem because it produces only one type of switched distortion. With the 119C1 signal distorting set, however, three types of switched distortion may be generated. Since these three types of switched distortion give somewhat the same indications on the 118-type set meters, special test procedures as outlined below may be helpful:

(a) Note the TOTAL DIST meter indication.

(b) Depress the S-M ONLY key momentarily and note the TOTAL DIST meter indication.

(c) Depress the M-S ONLY key momentarily and note the TOTAL DIST meter indication.

Analysis of Results

Switched bias is indicated if tests (a) and (b) give approximately the same TOTAL DIST indication and test (c) indicates near zero.

Switched end distortion is indicated if tests (a) and (c) give approximately the same TOTAL DIST indication and test (b) indicates near zero.

Switched combination distortion is indicated if tests (a), (b), and (c) give approximately the same TOTAL DIST indication.