

902-TYPE DATA TEST SETS DESCRIPTION AND OPERATION

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1. GENERAL

1.01 The 902-type data test sets (DTS) are used in conjunction with the 903-type DTS for making distortion measurements and error detection measurements on serial data transmission systems such as data sets 200-type. These data sets are medium-speed sets used primarily in DATA-PHONE® service.

1.02 This section is reissued for the following reasons:

- To show the 902A and 902B DTS rated MD and to show the 902C DTS as the current standard
- To add reference to P-43L447 15-pin connector cord
- To show the microammeter calibrated to read in percent.

Because 902A and 902B DTS are still in use in the field, information on these sets is retained. Since this reissue constitutes a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 The 902-type DTS (Fig. 1) is designed to operate with the 901- and 903-type DTS, but will not function alone. (It is dependent on the

903-type DTS for its source of dc power). Distortion and error measurements may be made with an arrangement as shown in Fig. 2. One 902-type DTS, two 903-type DTS (63-bit word generator) and two 901-type DTS are required for this test setup. A 901-type and a 903-type DTS are connected to the input of the transmitting data set. The output of the receiving data set is connected to the 901-, 902-, and 903-type DTS as shown in Fig. 2.

1.04 A 15-pin connector cord (P43L447) is provided with the 902-type DTS for connecting to the 903-type DTS. Power for the 902-type DTS is supplied by the positive 12-volt and negative 12-volt supply in the 903-type DTS.

1.05 The 902C DTS is similar to the 902A and 902B sets, except for differences in bit rates. A comparison of the bit rates for the three sets is given in Table A. Bit rates are selected by an 11-position switch on the front panel of each set (Fig. 1). The last position of each switch provides for external sync. The same kind (suffix) of 902/903-type DTS should be used at the transmitting and receiving ends to provide compatible bit rates. For example, if a 903C DTS is used at the transmitting end, a 902C and a 903C DTS should be used at the receiving end.

2. DESCRIPTION

2.01 The 902-type DTS measures approximately 9 inches wide by 7 inches high by 6 inches deep and weighs about 7 pounds. It is equipped with a carrying handle and a removable front cover.

2.02 A CAL potentiometer is located on the front panel of the 902B and 902C sets; this potentiometer is located inside the 902A DTS. The 902A has an upper limit of 5000 bps, while the 902B and 902C sets will operate at speeds up to 42,000 bps with external timing.

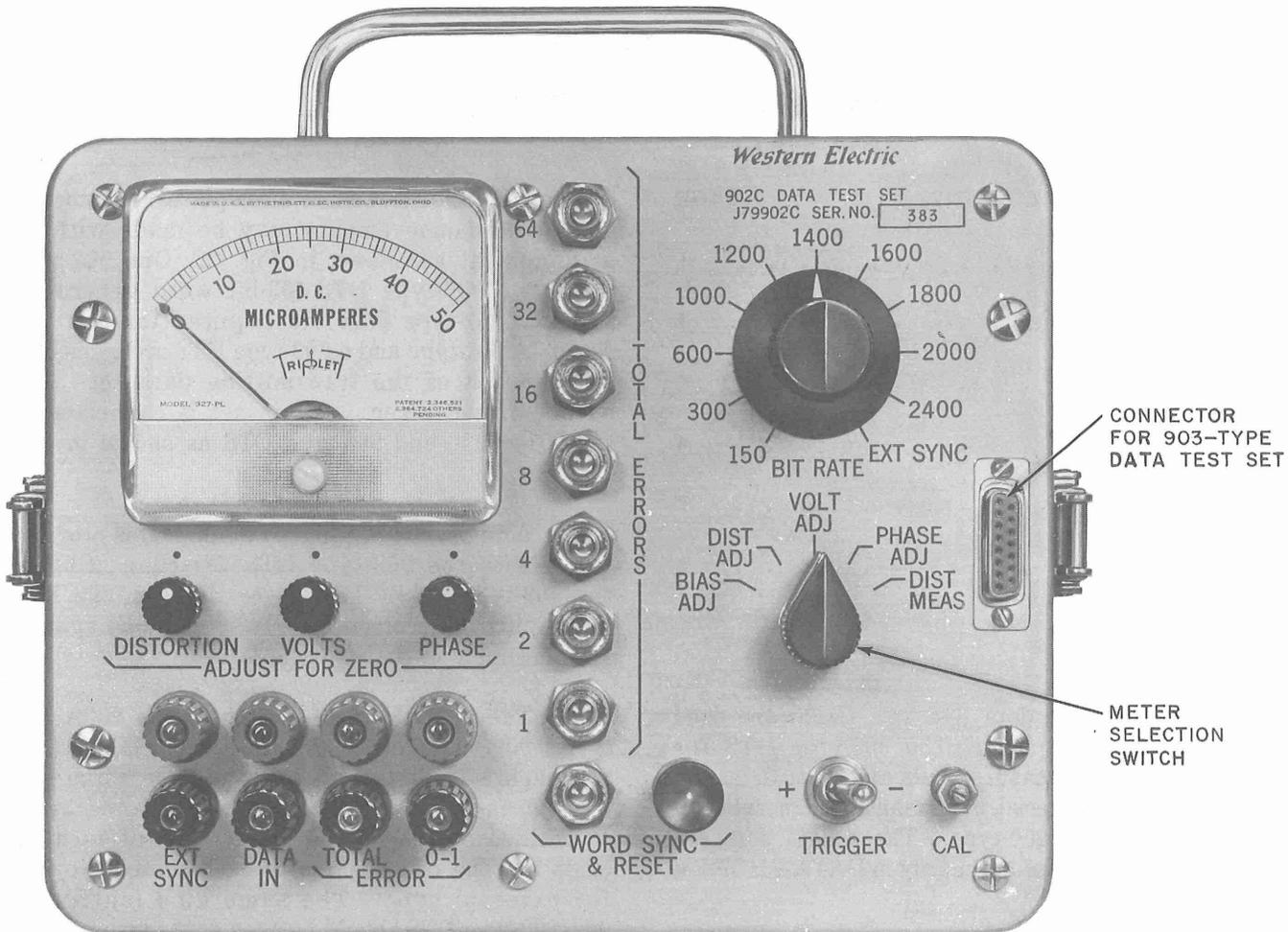


Fig. 1—902C Data Test Set

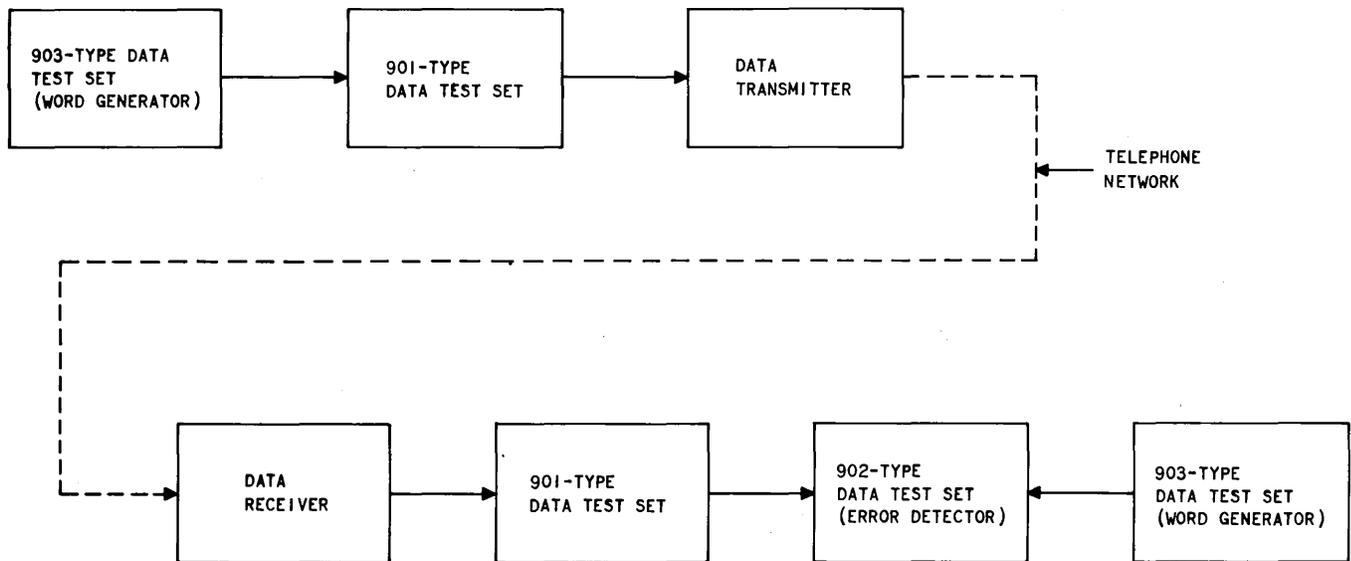
2.03 The 902A and 902B sets may be returned to a distributing house for modification to make them equivalent to a 902C DTS.

Description of Controls

2.04 BIT RATE Switch: This 11-position switch sets the bit synchronization speed to the transmitted bit rate. When no timing signal is received from the data receiver, the BIT RATE switch should be set to the transmitted bit rate. When a timing signal is received, the BIT RATE switch should be set to EXT SYNC position and the received timing signal should be connected to the EXT SYNC terminals. The incoming data signal from the data receiver is connected to the DATA IN terminals.

2.05 Meter Selection Switch: This 5-position switch is directly below the BIT RATE switch; and performs the following functions.

- (1) The BIAS ADJ position connects the data signal to the bias measuring circuit for adjusting bias, if required.
- (2) The DIST ADJ position connects the distortion measuring circuit to the meter for zero adjustment of distortion, if required. The distortion adjustment is made by means of the DISTORTION—ADJUST FOR ZERO knob.
- (3) The VOLT ADJ position permits adjusting of the internal transistor amplifier to zero output with zero signal input. The meter is



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Fig. 2—Typical Test Arrangement Using 901-, 902-, and 903-Type Data Test Sets

TABLE A

COMPARISON OF BIT RATES FOR 902A, 902B, AND 902C, DATA TEST SETS

902A, B	902C
75	150
180	300
600	600
800	1000
1000	1200
1200	1400
1600	1600
2000	1800
2400	2000
3000	2400

adjusted to zero by means of the VOLTS—ADJUST FOR ZERO knob.

(4) The PHASE ADJ position permits the elimination of phase error between the internal oscillator and the incoming data. The meter is adjusted to zero by means of the PHASE—ADJUST FOR ZERO knob.

(5) The DIST MEAS position permits reading the percent peak distortion of the received

signal on the meter. (The meter is calibrated so that 1 μ A = 1-percent distortion; see 2.07).

2.06 TRIGGER Switch: The position of this switch (+ or -) determines whether the sampling interval for error detection is taken on the positive-going or negative-going transition of the timing signal.

2.07 CAL Potentiometer: This adjustment is used to calibrate the meter to make each microampere of current equal to 1 percent distortion. On the 902B and 902C sets the CAL potentiometer is located on the lower right corner of the front panel. However, on the 902A DTS, this potentiometer is mounted inside the set on circuit board 3. On the 902A DTS it is necessary to remove the cover in order to make this calibration.

2.08 WORD SYNC & RESET Switch: When momentarily operated, this pushbutton switch resets the counter circuit to zero (all lights extinguished), and synchronizes the two word generators so that the two 63-bit words (pulse sequences) are started at the same instant. The lamp associated with this switch lights when the capacity of the error counter has been exceeded (127 errors).

2.09 TOTAL and 0-1 ERROR Terminals: The TOTAL ERROR terminals may be used to

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operate an external counter with a capacity greater than 127 when required. The 0-1 ERROR terminals may be used with an external counter to determine the relative number of errors occurring in the 0-to-1 transition and the 1-to-0 transition.

2.10 TOTAL ERRORS Lamps: These lamps total the capacity of the counter (127 errors). When the 128th error occurs, the lamp associated with the WORD SYNC & RESET pushbutton will light, indicating that the counter capacity has been exceeded and that any further count shown is invalid.

3. OPERATION

3.01 In operation, a 903-type DTS at the transmitting end feeds a 63-bit pseudo-random word through the data set and over the data line to the receiver. At the receiving end, a 902-type DTS is used to compare the word received over the data line from the distant 903-type DTS with the word produced by another 903-type DTS at the receiving end (Fig. 3). Differences in the two signals are recorded as errors.

Note: The pseudo-random word is of a more or less random nature, but is repeated exactly the same each time. Also, each 903-type DTS produces exactly the same word.

3.02 At the receiver a transition detector and a phase-locked oscillator system are used to recover the bit synchronization from the received signal. In synchronous data receivers the sync recovery function is a part of the data receiver.

3.03 The 903-type DTS at the receiving end is driven at the recovered bit sync rate and a bit-by-bit comparison is made between the received data word and the locally generated word to determine errors. Means are provided to obtain proper phasing between the two 903-type sets, which is referred to as word synchronization.

3.04 Distortion is found by measuring the time displacement of a transition from the average period. A holding circuit records the maximum time displacement, and a meter indicates this value as percent distortion.

3.05 Switch settings, connections, and operating instructions are specified in the section covering the data set under test.

4. TESTS

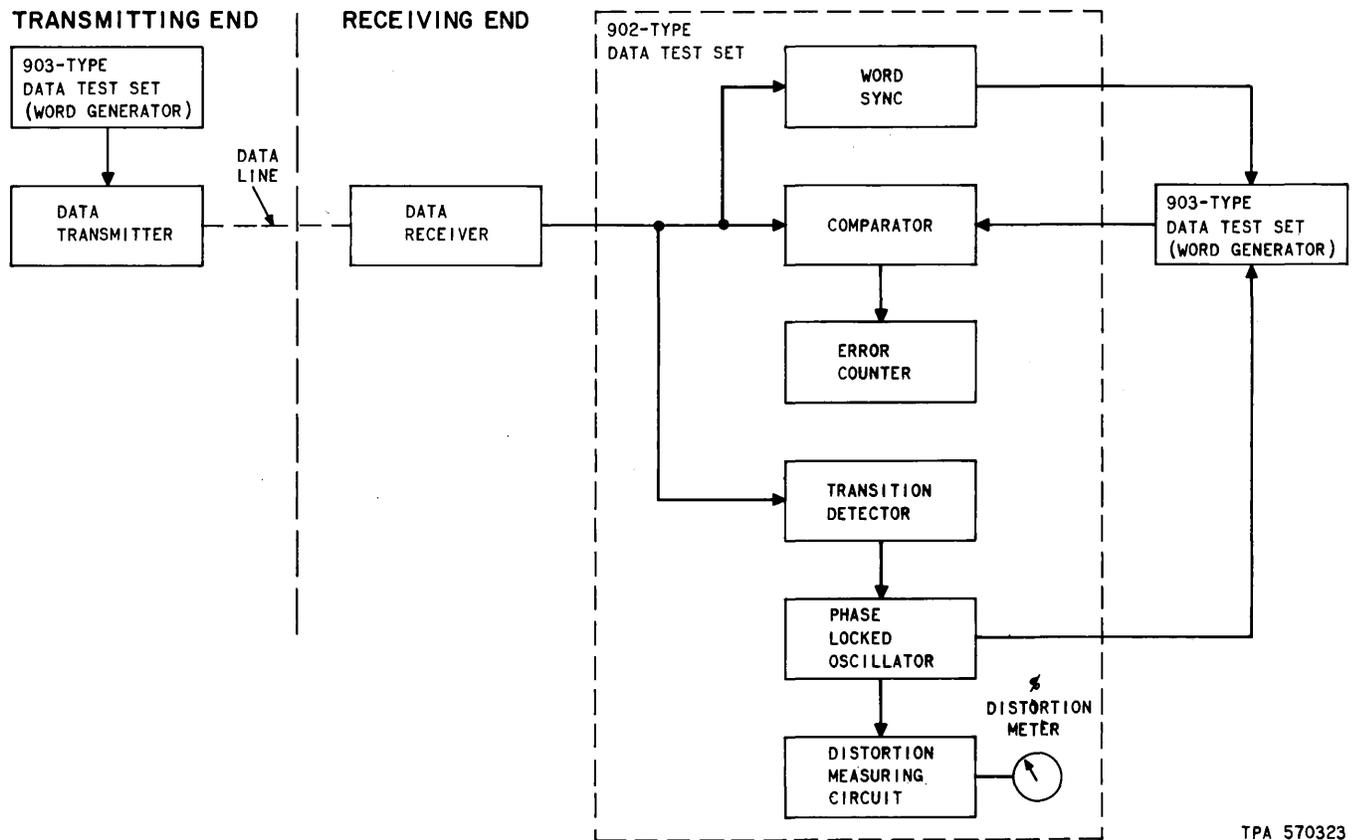
4.01 Tests should be made locally on a periodic basis or when the set is suspected of being defective to determine that the 902-type DTS is in proper operating condition.

4.02 Calibration of the 902-type DTS requires the use of a 903-type DTS also. Calibration is accomplished as follows:

- (1) Connect the 902- and 903-type sets together using the P43L447 cord.
- (2) Connect the SIGNAL OUT terminals of the 903-type set to the DATA IN terminals of the 902-type set.
- (3) Connect the 903-type set ac power cord to a source of 115-volt 60 Hz power and operate ON-OFF switch to ON.
- (4) Set the RANDOM—DOT switch on the 903-type set to DOT. (This provides an alternate mark-space output from the 903-type DTS).
- (5) Set the BIT RATE switches on the 902- and 903-type sets to provide a 2 to 1 bit-rate ratio. For example, set the 903 to 2000 and the 902 to 1000.
- (6) Set each of the three ADJUST FOR ZERO controls on the 902-type DTS to the center of rotation (white dot up).
- (7) Set the meter selection switch to DIST ADJ. After the meter becomes stable, adjust the meter to zero using the DISTORTION—ADJUST FOR ZERO knob.
- (8) Set the meter selection switch to VOLT ADJ. Adjust the meter to zero using the VOLTS—ADJUST FOR ZERO knob.
- (9) Set the meter selection switch to PHASE ADJ. Adjust the meter to zero using the PHASE—ADJUST FOR ZERO knob. (If meter will not zero, see 4.07.)



If adjustment of the PHASE—ADJUST FOR ZERO knob has little or no effect on the meter reading, this could be an indication that the START switch



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Fig. 3—Error Detection Using 902- and 903-Type Data Test Sets

on the 903-type DTS has not been depressed or that the 903 signals are not being properly applied to the 902-type DTS.

- (10) Set the meter selection switch to DIST MEAS.
- (11) The meter should indicate 25 ± 3 percent. (Remember that $1 \mu\text{A} = 1\%$).
- (12) If the 902B or 902C DTS is out of limits, adjust the CAL potentiometer on the front panel to give an indication of 25 percent.
- (13) If the 902A is out of limits, gain access to CAL potentiometer R302 by loosening the four large outside screws and removing the cover. Exercise care when removing cover not to damage the circuit cards. R302 is located on circuit board 3 (the short board) directly under the carrying handle. Adjust R302 to give an indication of 25 percent on the meter.

4.03 The following test may be used to isolate a 902-type test set suspected of being defective. This test requires the use of two 903-type sets in addition to the suspect 902-type DTS. (All three sets should bear the same letter suffix). Perform this test as follows:

- (1) Connect one 903-type set to the 902-type set using the P-43L447 connector cord. This 903-type set will serve as the receiver.
- (2) Connect the SIG OUT terminals of the other 903-type set to the DATA IN terminals of the 902-type DTS. This 903-type DTS will serve as the transmitter.
- (3) Connect the ac power cords of both 903-type sets to a source of 115-volt 60-Hz power and operate ON-OFF switch on each set to ON. Set the controls of the 903-type set serving as the transmitter as follows:
 - BIT RATE switch to position desired for test

- RANDOM-DOT switch to RANDOM
 - TRIGGER switch—Not required.
- (4) Set the controls of the 903-type set serving as the receiver as follows:
- BIT RATE switch to EXT CLOCK
 - RANDOM-DOT switch to RANDOM
 - TRIGGER switch to +.
- (5) Momentarily depress the START switch of the transmitting 903-type DTS.
- (6) Set the BIT RATE switch on the 902-type DTS to the same value as the transmitting 903-type DTS. Set each of the three ADJUST FOR ZERO controls to the approximate center of rotation (dot up).
- (7) Set the meter selection switch to DIST ADJ. After the meter becomes stable, adjust the meter to zero using the DISTORTION—ADJUST FOR ZERO knob.
- (8) Set the meter selection switch to VOLT ADJ. Adjust the meter to zero using the VOLTS—ADJUST FOR ZERO knob.
- (9) Set the meter selection switch to PHASE ADJ. Adjust the meter to zero using the PHASE—ADJUST FOR ZERO knob. If the meter will not zero, refer to 4.02 (9) and 4.07.
- (10) Set the meter selection switch to DIST MEAS. Momentarily depress the WORD SYNC & RESET switch. All lamps should extinguish and the meter should not read more than 3 percent distortion. (Remember that 1 μ A = 1%).

4.04 With the three test sets properly connected and adjusted as described, the outputs of the two 903-type sets are being compared by the 902-type DTS.

4.05 If more than 3-percent distortion is indicated on the meter, it is not caused by the receiving 903-type DTS. Reversing the transmitting and receiving 903-type sets should determine which set is operating incorrectly. If after reversing the 903-type sets the reading is normal (less than 3

percent distortion), the 903-type set now serving as the receiver is defective.

4.06 As an additional check that the 902-type DTS is operating properly, momentarily depress the START switch of either 903-type DTS. This will cause loss of synchronization, and the counter lamps on the 902-type DTS should flash. Repeat (7) through (10) of 4.03 to reestablish sync.

4.07 If the 902-type DTS and the transmitting 903-type DTS are operating at other than a 2-to-1 frequency difference, difficulty will be experienced in adjusting the meter to zero with the PHASE—ADJUST FOR ZERO knob. A frequency counter may be used to determine which of the two sets is in difficulty. A WE 72A test set or a HP5321B or similar counter can be used for this determination as follows:

(a) To check the 903-type DTS:

- (1) Set RANDOM-DOT switch to DOT.
- (2) Connect frequency counter to SIG OUT.
- (3) Rotate BIT RATE switch in turn to each of the bit rate settings and observe that the counter indicates within the limits specified in Table B.

TABLE B

903-TYPE DATA TEST SET BIT RATE LIMITS

BIT RATE	COUNTER READING	
	MIN	MAX
150	71.2	78.8
300	142	158
600	285	315
1000	475	525
1200	570	630
1400	665	735
1600	760	840
1800	855	945
2000	950	1050
2400	1140	1260

(b) To check the 902-type DTS:

- (1) Connect the 902- and 903-type sets together using the P-43L447 cord.

- (2) Connect frequency counter to EXT CLOCK terminals of the 903-type DTS.
- (3) Set BIT RATE switch on 903-type DTS to EXT CLOCK.
- (4) Perform (7) and (8) of 4.03. Turn the PHASE control knob to the center of its rotation (dot up).
- (5) Rotate the BIT RATE switch to each position and observe reading on the frequency counter. All counter readings should fall within the values specified in Table C.

TABLE C

902-TYPE DATA TEST SET BIT RATE LIMITS

BIT RATE	COUNTER READING	
	MIN	MAX
150	140	160
300	280	320
600	560	640
1000	930	1070
1200	1120	1280
1400	1310	1490
1600	1500	1700
1800	1680	1920
2000	1860	2140
2400	2240	2560

- (6) Turn the PHASE control knob fully counterclockwise. Rotate the BIT RATE switch to each position and observe the reading on the frequency counter. All counter readings should be less than the values specified in Table D.
- (7) Turn the PHASE control knob fully clockwise. Rotate the BIT RATE switch to each position and observe the reading on the frequency counter. All counter readings should be greater than the values specified in Table E.

4.08 If the lamps on the 902-type DTS fail to extinguish when the WORD SYNC & RESET switch is depressed, the test set is defective and should be replaced.

TABLE D

902-TYPE DATA TEST SET BIT RATE LIMITS
PHASE CONTROL FULLY CCW

BIT RATE	COUNTER READING MAX
150	140
300	275
600	550
1000	925
1200	1110
1400	1295
1600	1480
1800	1665
2000	1850
2400	2220

TABLE E

902-TYPE DATA TEST SET BIT RATE LIMITS
PHASE CONTROL FULLY CW

BIT RATE	COUNTER READING MIN
150	160
300	325
600	650
1000	1075
1200	1290
1400	1505
1600	1720
1800	1935
2000	2150
2400	2580

4.09 If the lamps on the 902-type DTS blink irregularly, the 903-type sets are probably not in synchronization and one or both sets are making word errors. Refer to section 107-200-100 for information on the 903-type DTS.

5. MAINTENANCE

5.01 No field maintenance is to be performed on the 902-type DTS. If a set is defective, it should be replaced. The defective set should be returned for repair in accordance with local instructions.

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6. REFERENCES

6.01 The following documents contain additional information on the 902-type DTS and related test sets.

SECTION	TITLE
107-200-100	903-Type Data Test Sets— Description and Operation
SD-&CD-73000-01	902 Series Data Test Sets— Distortion Measuring and Error Checking Set
SD-&CD-73001-01	903 Series Data Test Sets—63-Bit Serial Generator

SECTION	TITLE
107-100-100	901A and 901B Data Test Sets—Identification and Operation