

903-TYPE DATA TEST SETS

DESCRIPTION AND OPERATION

	CONTENTS	PAGE
1.	GENERAL	1
2.	DESCRIPTION	1
3.	OPERATION	4
4.	TESTS	5
5.	MAINTENANCE	8
6.	REFERENCES	8

1. GENERAL

1.01 The 903-type data test sets (DTS) are used in conjunction with the 902-type data test sets for making distortion measurements and error detection measurements on serial data transmission systems such as the 200-type data sets. These data sets are medium-speed sets used primarily in DATA-PHONE® service. Two types of test signals are provided: a 63-bit pseudo-random word, and a dot signal (square wave).

1.02 This section is reissued for the following reasons:

- To show the 903A and 903B DTS rated MD and to show the 903C DTS as the current standard
- To add references to the P43L447 15-pin connector cord.

Because the 903A and 903B 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 903-type DTS (Fig. 1) is designed to operate with the 901- and 902-types DTS. Distortion and error measurements may be made with an arrangement as shown in Fig. 2. Two

903-type DTS (63-bit word generator), one 902-type DTS, and two 901-type DTS are required for this test setup. One 901-type DTS and one 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 sets as shown in Fig. 2.

1.04 A 15-pin connector cord (P-43L447), provided with the 902-type DTS, is used for connecting the 902- and 903-type sets. Power for the 902-type DTS is supplied from the positive 12-volt and negative 12-volt supply in the 903-type DTS.

1.05 The 903C is similar to the 903A and 903B 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 of 903-type DTS should be used at the transmitting and receiving ends to provide compatible bit rates. For example, if a 903C is used at the transmitting end, a 903C DTS should also be used at the receiving end.

2. DESCRIPTION

2.01 The 903-type DTS measures approximately 9 inches wide by 7 inches high by 6 inches deep, and weighs about 8 pounds. It is equipped with a carrying handle and a removable front cover.

2.02 The 903A has an upper limit of 5000 bps; the 903B and 902C sets will operate at speeds up to 50,000 bps with external timing.

Note: A bit is a *binary digit*.

2.03 The 903A and 903B sets may be returned to a distributing house for modification to make them equivalent to the 903C DTS.

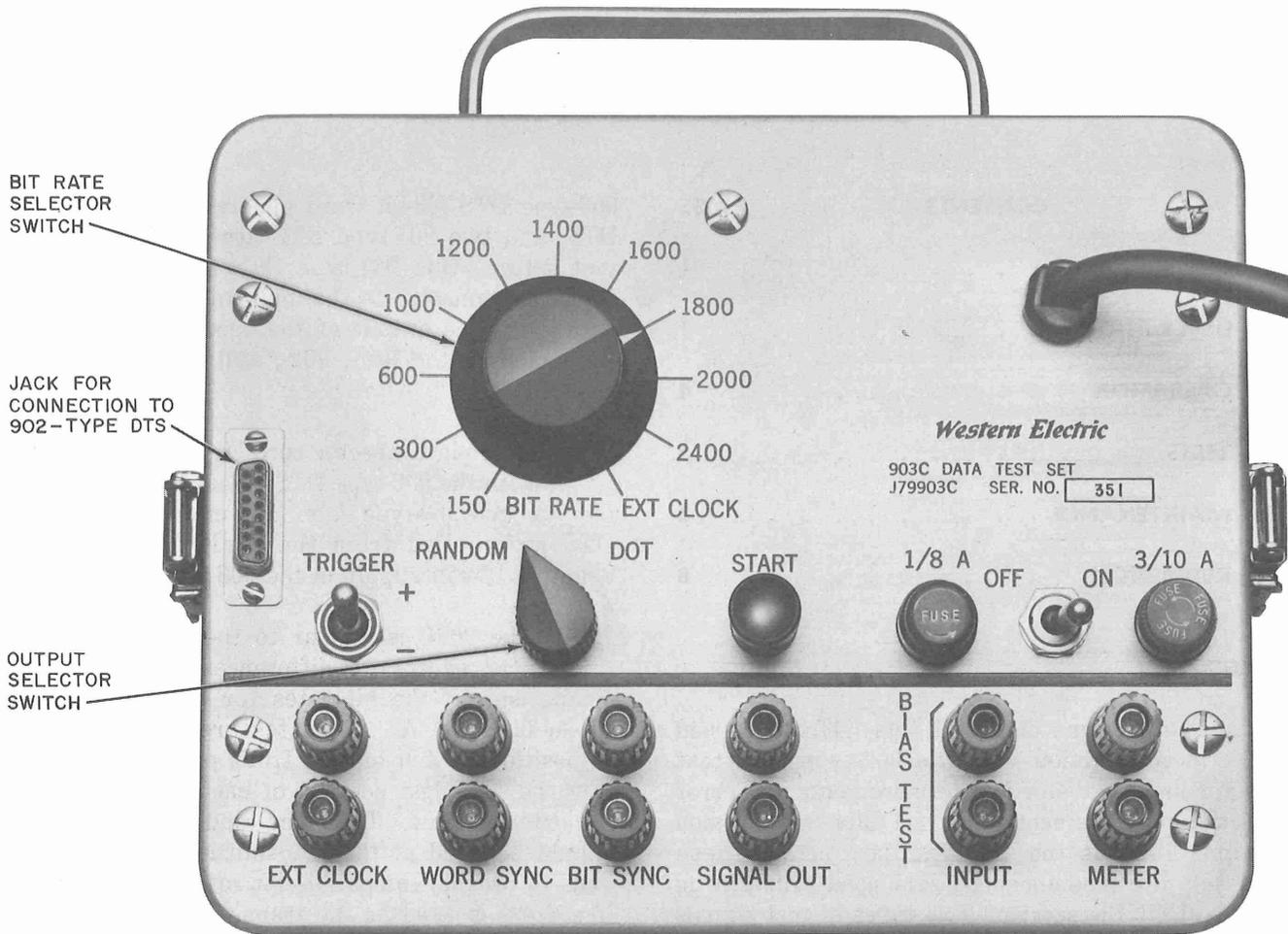


Fig. 1—903-Type Data Test Set

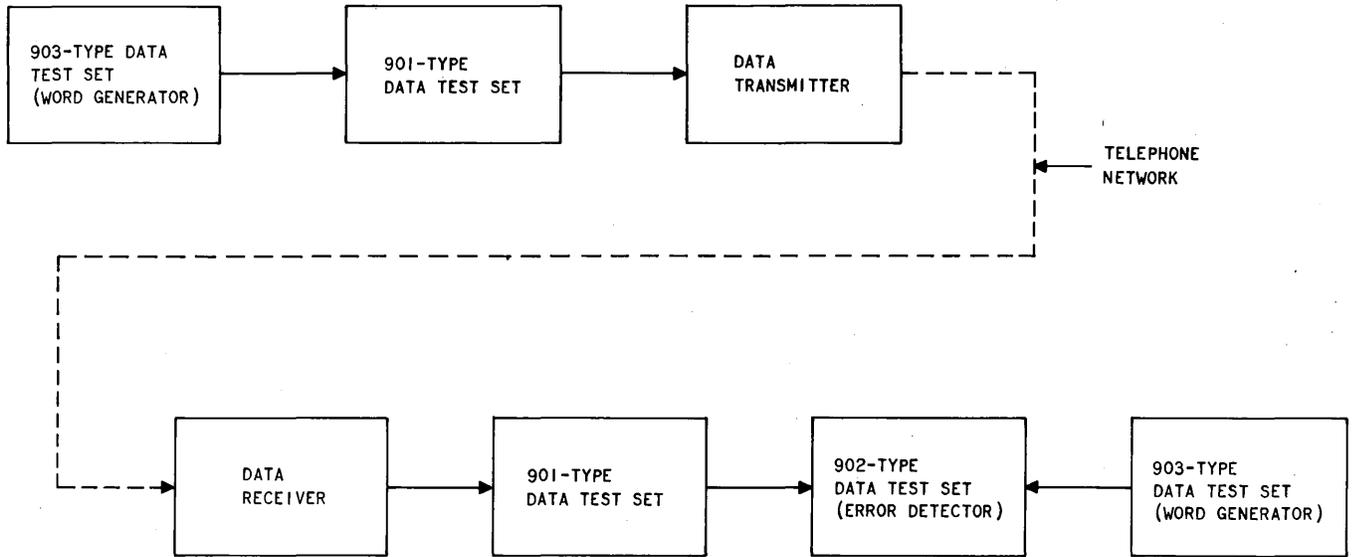
Description of Controls and Jacks

2.04 BIT RATE Switch: This 11-position switch sets the bit synchronization speed of the 903-type DTS to the operating speed of the data set. When an external clock is used, the BIT RATE switch should be set to EXT CLOCK and the external clock (oscillator) should be connected to the EXT CLOCK jacks. With external clock the maximum bit rate is 50,000 bps. Since the external clock signal is used only to trigger the internal clock in the 903-type DTS, either a sine wave or a square wave with positive or negative pulses may be used. The external clock signal amplitude should be at least 6 volts peak-to-peak (Fig. 3).

2.05 RANDOM-DOT Switch: This switch is used to select either the 63-bit pseudo-random

word or the dot signal. The random word simulates various combinations of bits similar to what a customer business machine would transmit. The word is repeated continuously and is exactly the same each time; thus, it is not a true random word. To start the 63-bit word, the RANDOM-DOT switch must be set to RANDOM position, and then the START switch must be depressed momentarily. This word is transmitted over the data line and compared with a word generated locally by another 903-type DTS (Fig. 2). In this application a 902-type DTS is used to make the comparison and register an error for each bit that is not the same as that generated locally. The amount of distortion is also measured by the 902-type DTS.

2.06 The dot signal is produced when the RANDOM-DOT switch is in the DOT position and the START switch is depressed. The dot



TPA 570322

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

TABLE A

COMPARISON OF BIT RATES FOR 903A, 903B, AND 903C DATA TEST SETS

903A, B	903C
75	150
180	300
600	600
800	1000
1000	1200
1200	1400
1600	1600
2000	1800
2400	2000
3000	2400

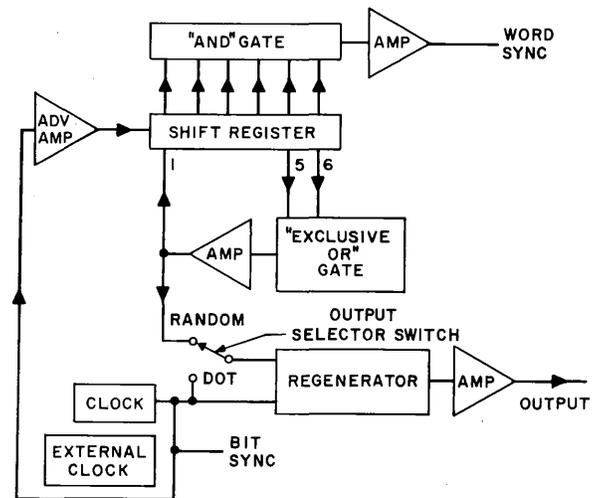


Fig. 3—63-Bit Word Generator—Block Diagram

signal is a bipolar square wave. Each alternation is one bit. The dot signal is used to check the symmetry of signals through the data transmitter and receiver and the interconnecting data line.

An oscilloscope may be used for visual observation of this signal (Fig. 4).

2.07 START Switch: This switch is used to obtain synchronization at the beginning of a test using the 63-bit word.

2.08 TRIGGER + or - Switch: This switch is used to select the polarity of an external clock signal.

2.09 EXT CLOCK Jack: This jack is provided for connecting an external clock input.

2.10 WORD SYNC Jack: This jack provides a synchronizing signal output for an oscilloscope. This signal is provided once for each 63-bit word.

2.11 BIT SYNC Jack: This jack provides a bit sync pulse output, and is produced for each bit in the word.

2.12 SIGNAL OUT Jack: This jack provides the DTS output for either the 63-bit word or the dot signal.

2.13 BIAS TEST INPUT and METER Jacks: These jacks are provided for making slicing level adjustments in the subscriber data set where it is desired to make the length of the mark and space pulses equal. A polar signal with equal mark and space pulses will produce a zero meter reading on a milliammeter connected to the METER jack.

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 locally by another 903-type DTS at the receiving end (Fig. 2). 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 some 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 by the 902-type DTS 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 the 902-type DTS 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 BIAS TEST INPUT and METER jacks are used to indicate bias distortion in a received dot signal. A DOT test signal is connected to the BIAS TEST INPUT jack and a KS-14510-L1 meter (or equivalent) is connected to the METER jack.

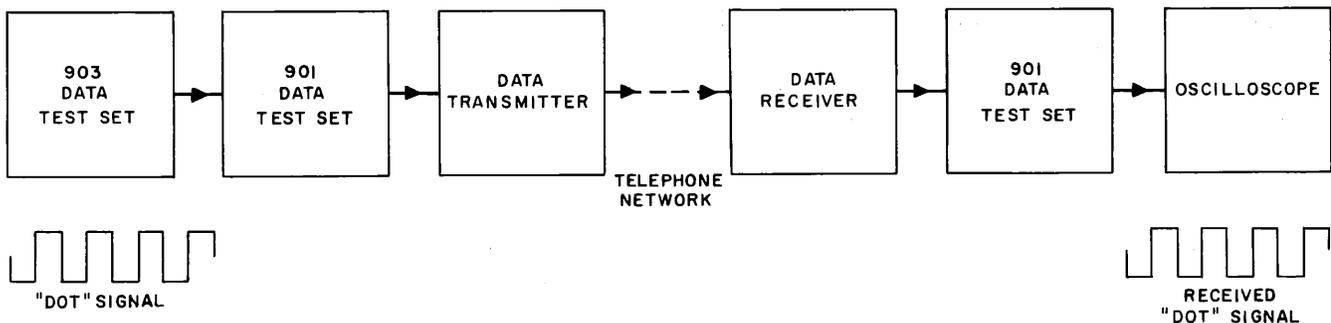


Fig. 4—Test Arrangement Using Oscilloscope

Any meter indication on the 60 μ A scale indicates bias distortion in the circuit under test.

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

4. TESTS

CAUTION: *When the 903-type test set is to be used, to prevent any damage to the transistors in the output circuit, DO NOT connect power to the 903-type set until all other equipment and ALL of their switches have been placed on the proper settings. DO NOT change switch settings of the equipment to any other settings than specified for the particular data set being tested.*

OSCILLOSCOPE TEST

4.01 The 903-type set can be checked by displaying the 63-bit word on an oscilloscope as follows:

- (1) Connect scope to SIGNAL OUT terminals.
Polarity of this connection is not important unless scope is grounded. If it is grounded, care must be taken to connect the ground side of the scope to the ground side of the output (black terminal).
- (2) Set RANDOM-DOT switch to RANDOM.
- (3) Connect 903-type set to a 115-volt ac source.
- (4) Set ON-OFF switch to ON.
- (5) On 903A or 903B DTS, set BIT RATE switch to 3000; on 903C DTS, set BIT RATE switch to 2400.
- (6) Depress the START button momentarily.
- (7) Adjust scope to show entire 63-bit word.
The scope display should agree with Fig. 5 in every detail. The numbers indicate the number of consecutive marks and spaces.

Note: Use a Tektronix 422 oscilloscope (or equivalent) if available. If the scope used is not equipped for external triggering, the pattern in most cases may be held reasonably stationary by adjustment of the horizontal

sweep fine control. If, however, the scope has provisions for external triggering, a WORD SYNC output is provided on the 903-type test set that may be used for synchronizing an oscilloscope display.

VOLTMETER TEST

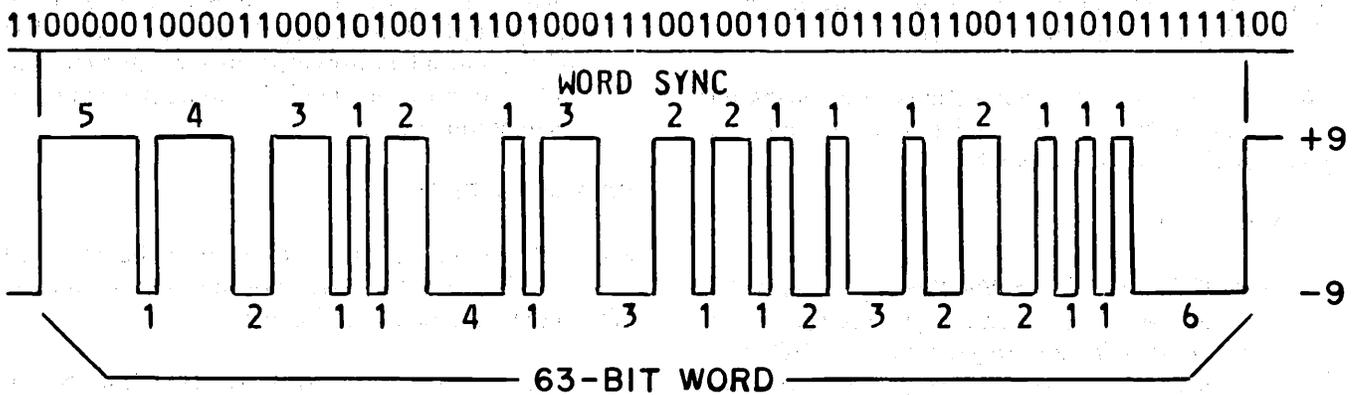
4.02 The 63-bit random word may be checked with a KS-14510-L1 volt-ohm-milliammeter (VOM) (or equivalent) as follows:

- (1) Place meter on 60-volt range. Connect + lead of meter to red SIGNAL OUT terminal; connect - lead of meter to black SIGNAL OUT terminal of 903-type DTS.
- (2) Connect the 903-type DTS to a 115-volt ac source.
- (3) Set ON-OFF switch to ON position.
- (4) Set BIT RATE switch to EXT CLOCK.
- (5) Set the RANDOM-DOT switch to RANDOM.
- (6) Place a short across the EXT CLOCK terminals; this makes flip-flop operation more reliable.
- (7) Operate the TRIGGER switch for six operations (one operation equaling + to - to +) while holding the START button depressed. This loads the register stages.
- (8) Operate the TRIGGER switch and count the operations between voltage changes. Use the number of marks or spaces indicated in Fig. 5 as the number of switch operations to determine where the voltage changes will occur. For example, the first five operations indicate a positive reading on the meter; the next operation, a negative.

Note: This test will be complete only if followed for the entire 63-bit word.

COMPARISON TEST

4.03 Local checks of 902- and 903-type data test sets should be made periodically to determine their reliability before taking them out on customer premises. The following procedure will provide a



NUMBERS INDICATE THE NUMBER OF CONSECUTIVE MARKS AND SPACES

Fig. 5—63-Bit Word Output

check when at least two 903- and 902-type test sets are available.

- (1) Connect the receiving 903 to the 902 using the P43L447 connector cord provided with the 902-type test set.
- (2) Connect the SIGNAL OUT terminals of the transmitting 903 to the DATA IN terminals of the 902-type DTS.
- (3) Plug in ac power cord, and turn ON-OFF switch of both 903-type sets to ON. Set the controls on the transmitting 903-type DTS as follows:
 - BIT RATE speed at desired bit rate for test.
 - RANDOM-DOT switch to RANDOM.
 - TRIGGER not required.
- (4) Set the controls on the receiving 903-type follows:
 - BIT RATE switch to EXT CLOCK.
 - RANDOM-DOT switch to RANDOM.
 - TRIGGER switch to +.
- (5) After both 903-type sets are connected and switch settings adjusted, momentarily depress

the START button on the transmitting 903-type DTS.

- (6) Set the controls of the 902-type set as follows:
 - BIT RATE to the same speed setting as the transmitting 903-type DTS.
 - DISTORTION, Zero adjust—Set to approximate center of rotation.
 - VOLTS, Zero adjust—Set to approximate center of rotation.
 - PHASE, Zero adjust—Set to approximate center of rotation.
 - TRIGGER—not required.
- (7) Set meter selection switch to DIST ADJ. Zero the meter with the DISTORTION knob.
- (8) Set meter selection switch to VOLT ADJ, and zero the meter by means of the VOLTS adjustment knob.
- (9) Set the meter selection switch to PHASE ADJ, and zero the meter by the PHASE adjustment knob (See 4.07).
- (10) Set the meter selection switch to DIST MEAS. Momentarily depress the WORD SYNC & RESET button. All the lamps should

go out and the meter should not read more than 3 percent distortion. (Meter is calibrated to read in percent.)

4.04 With all three sets connected in this manner, the outputs of the two 903-type test sets are being compared bit for bit.

4.05 If there is more than 3 percent distortion reading on the meter, it will not be caused by the receiving 903-type DTS. Reversing the roles of the transmitting and receiving 903-type sets should determine whether the trouble is in the 902-type or the transmitting 903-type DTS. If after the set reversal the reading is normal, the 903-type DTS that is now the receiving 903 is in trouble.

4.06 To further check that the 902-type DTS is working properly, momentarily depress the START button of either 903-type DTS. This will throw the two words out of synchronization, and the lights on the 902-type set should start to flash. Repeating Steps 7, 8, 9, and 10 of 4.03 should cause the lights to extinguish.

4.07 If the 902-type set and the transmitting 903 are off frequency from each other, there will be difficulty adjusting the PHASE ADJ knob to zero. A frequency counter must be used to locate the set in trouble. A 72A test set or a frequency counter, such as the Hewlett-Packard 5321B, can be used and connected as follows:

To check 903-type sets:

- (1) Set RANDOM-DOT switch to DOT.
- (2) Connect frequency counter to SIGNAL OUT.
- (3) Rotate the BIT RATE switch to each position and note that the readings fall within the limits given in Table B.

To check the 902-type set:

- (1) Connect a 903 to the 902 using the P43L447 connector cord provided with 902-type test set.
- (2) Connect the frequency counter to EXT CLOCK terminals of the receiving 903-type DTS.

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

- (3) Set BIT RATE of 903-type DTS to EXT CLOCK.
- (4) Follow Steps 7, 8, and 9 described in 4.03. Turn the PHASE control knob to the center of its rotation (white dot pointing up).
- (5) Rotate the BIT RATE switch of 902-type test set to each position and observe the readings. The frequency counter readings should fall within the limits given 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 to its most counterclockwise position and check the bit rates at each of the positions (except EXT SYNC)

SECTION 107-200-100

of the BIT RATE switch of the test set. All readings should be less than the limits given in Table D.

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

(7) Turn the PHASE control to its most clockwise position and again check the bit rates. Each of the readings should be greater than the limits given in Table E.

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

4.08 If the lights on the 902-type DTS do not go out when the WORD SYNC & RESET button is depressed and held depressed, there is trouble in either the reset or counter circuit of the set.

4.09 Should the lights on the 902-type DTS keep blinking irregularly, it is possible that the 903-type test sets are not in synchronization and that one or both of them are making word errors. The 903-type DTS can be checked by the tests in 4.01 and 4.02.

5. MAINTENANCE

5.01 No field maintenance is to be performed on the 903-type DTS except replacement of defective fuses. If a set is otherwise defective, it should be replaced and returned for repairs in accordance with local instructions.

6. REFERENCES

6.01 The following documents contain additional information on the 903-type DTS and related test sets.

SECTION	TITLE
107-100-100	901A and 901B Data Test Sets—Identification and Operation
107-300-100	902-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