DATA SET MODELS 3 AND 3A

TRANSMITTER-RECEIVER

INSTALLATION TESTS AND ADJUSTMENTS

1. INTRODUCTION

1.01 Information in this section was formerly in Section 592-010-200, Issue 1.

1.02 The data set should be adjusted and tested after installation before turning over to the customer for service.

2. ADJUSTMENT PROCEDURE

2.01 ***Equipment Required:***

- 72A frequency meter or equivalent (see 2.07)
- KS-14510 Volt-Ohm-Milliammeter
- 903-Type Data Test Set
- 902-Type Data Test Set
- Adjustable Attenuator, 600-ohm impedance, 0 to −40 db range
- Oscilloscope or zero centered voltmeter (required only if CLAMP or DEM SENS adjustment is necessary)

2.02 After modification, if required, and specified wiring options are completed, connect the data set to a 117-volt ac power source.

2.03 Two switches for line-up adjustment are located on the front of the data set, Fig. 1.

- ***Switch S1.*** TRANS position is the normal position. The TEST position is used only during line-up and certain operational tests. This disconnects the modulator input from the external sending equipment and allows (a) continuous MARK, or (b) continuous SPACE, or (c) application of a test signal source to the modulator.

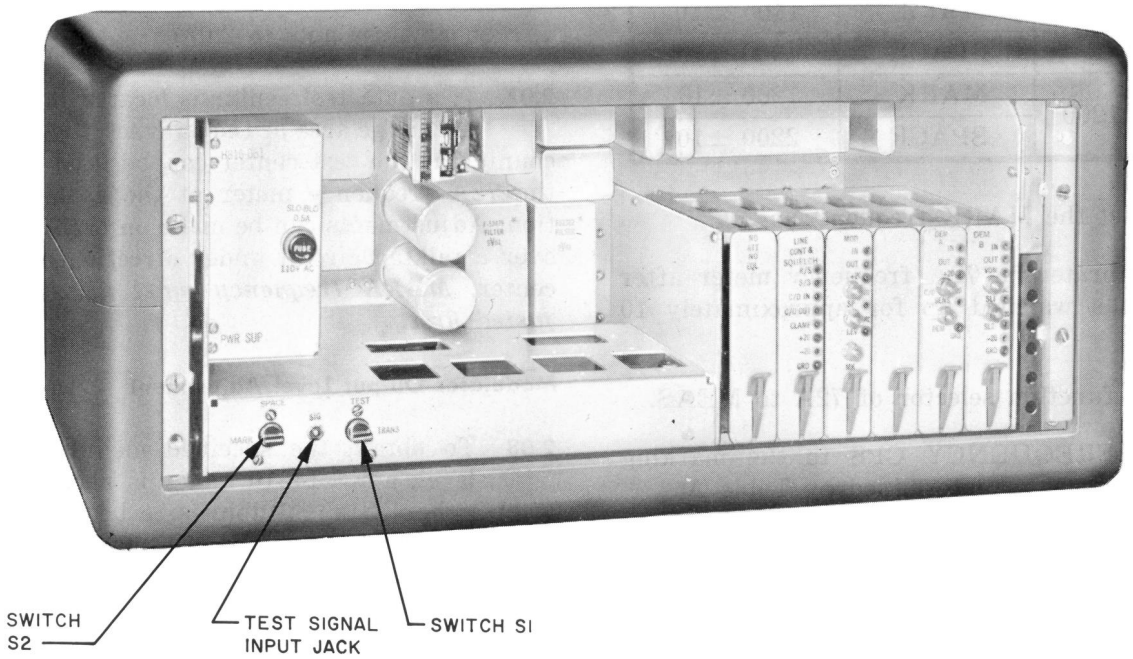

Fig. 1 — Data Set Model 3, Interior View

- *Switch S2.* MARK position is used to cause the modulator to send steady MARK signal, if nothing is connected to the test signal jack, Fig. 1. The MARK position is also used when a signal is applied to the test signal jack. The SPACE position is used to cause the modulator to send steady SPACE signal.

Modulator Carrier Frequency Adjustment

2.04 The setting of the MARK and SPACE frequencies delivered by the modulator will depend on the bit rate at which the customer wishes to operate, see Table A. Note that the frequency tolerances are ±10 cps. The MARK and SPACE frequency adjustments are made by adjusting the MK and SP potentiometers on the modulator board. ***Always adjust the MARK frequency first since the MK potentiometer affects the SPACE frequency adjustment.*** A 72A frequency meter is recommended as a convenient and accurate self-calibrating reference source.

TABLE A

BIT RATE AND DATA FREQUENCIES

Bit Rate bps	Signal	Frequency cps
Up to 600	MARK	1400 ±10
	SPACE	1900 ±10
601 to 1200	MARK	1200 ±10
	SPACE	2200 ±10

2.05 To set the MARK frequency:

(1) Calibrate the 72A frequency meter after it has warmed up for approximately 10 minutes.

(2) Set function selector of 72A to MEAS.

(3) Set FREQUENCY CPS to the marking frequency as determined by Table A.

(4) Connect terminals 3 and 4 of TB2 of the data set to the 600-ohm IN terminals of the 72A (telephone line disconnected).

(5) Operate switch S1 of the data set to TEST and switch S2 to MARK.

(6) Adjust the MK potentiometer until a circular or elliptical stationary pattern is obtained on the cathode ray tube of the frequency meter. The data set is now delivering the correct MARK frequency.

Note: If the circular or elliptical pattern on the cathode ray tube is rotating slowly, the marking frequency will be within specified limits. Each 360-degree rotation of the pattern during 1 second is one cycle off from the reference. Therefore, the acceptable adjustment requires less than ten 360-degree rotations per second.

2.06 To set the SPACE frequency:

(1) Be sure the 72A is still properly calibrated.

(2) Set function selector of 72A to MEAS.

(3) Set FREQUENCY CPS to the spacing frequency as determined by Table A.

(4) Operate switch S1 of the data set to TEST and switch S2 to SPACE.

(5) Adjust the SP potentiometer until a circular or elliptical pattern is obtained on the cathode ray tube of the frequency meter. The data set is now delivering the correct SPACE frequency, see note in 2.05(6).

2.07 If a data test center is located in the same exchange area as the data set, the frequency counter at the test center can be used in lieu of the 72A frequency meter at the customer location. Adjustments can be made on each frequency over a talking circuit under direction of the test center. ***MARK frequency must always be adjusted first.***

Modulator Output Level Adjustment

2.08 To obtain the specified modulator output level, a KS-14510 meter is necessary. If a level higher than −6 dbm is to be obtained, the modulator board must be modified by soldering an insulated wire between holes D55 and E55. This shorts out a resistor in series with the LEV potentiometer and makes a 0-dbm output adjustment possible. Care must be exercised during the soldering, since excessive heat can peel the print-

ed wiring from the circuit board. A small soldering tip on a 25-watt soldering iron is recommended. Use rosin core solder only.

(1) Operate switch S1 to TEST.

(2) Make sure data set is in the talk mode.

(3) Connect KS-14510 meter across terminals 3 and 4 of TB2 of the data set. Set meter to 3-volt ac scale.

(4) Disconnect line wires.

(5) Adjust modulator LEV potentiometer according to Table B with switch S2 operated to the position causing the highest output level.

TABLE B

Desired Output Level	KS-14510 Meter Reading
dbm	volts
−6	0.8
−4	1.0
−2	1.2
0	1.55

(6) After level adjustment has been made and locked, check to be certain level has not been changed by the locking procedure.

(7) Operate switch S1 to TRANS.

Demodulator Slicing Level No. 1 Adjustment

2.09 ***Procedure***

(1) If the demodulator contains equalization, it is necessary to replace the attenuation equalizer board (ED-1D048-30) with a shorting frame board (ED-1D054-30). If a shorting frame is not available, strap terminal 9 to 12, 3 to 7, and 2 to 16 of jack 1 on the data set. ***Failure to remove the attenuation equalization can result in serious adjustment error.***

(2) Adjustments described are assumed to be made from modulator and demodulator in the same set, with the telephone line disconnected and the data set in the talk mode.

(3) Connect *V* option. If *U* option is wired in, swing the strap from 4 to 6 on TB1 of the data set (other end of strap connected to 5).

(4) Set C/D potentiometer on DEMOD A board to its extreme counterclockwise position.

(5) Set DEM SENS potentiometer on DEMOD A board to its extreme clockwise position.

(6) Set switch S1 to TEST.

(7) Set switch S2 to SPACE.

(8) Set KS-14510 meter to 3-volt dc scale. Connect − probe to DEMOD B board VOM jack. Connect + probe to DEMOD B board +20 jack.

(9) Adjust SL1 potentiometer on DEMOD B board for meter indication of 1.5 volts. Lock potentiometer SL1 and recheck measurement.

(10) Proceed to adjustment of slicing level No. 2 leaving *V* option connected.

Demodulator Slicing Level No. 2 Adjustment

2.10 ***Procedure***

(1) Set switch S1 to TEST.

(2) Set switch S2 to MARK.

(3) Set 903 data test set controls as follows:

RANDOM/DOT — to DOT
BITS/SEC — maximum bit speed of customer equipment
TRIGGER — + or − (not required)

(4) Connect 903 to a 117-volt ac source and set OFF-ON switch to ON. Connect red SIGNAL OUT terminal to the test signal input jack on the data set. Connect the black SIGNAL OUT terminal to GRD on the data set. Depress 903 START switch momentarily.

(5) Set 902 data test set controls as follows:

BITS/SEC — Transmitted bit speed (same as 903)

Meter Selection Switch — BIAS ADJ
Distortion Zero Adjust — (not required)
Trigger — + or − (not required)
Volts Zero Adjust — center of rotation (white dot pointing up)
Phase Zero Adjust — center of rotation (white dot pointing up)

(6) Connect red DATA IN terminal to demodulator board B OUT terminal. Connect black DATA IN terminal to demodulator board B GRD terminal.

(7) The microammeter on 902 set will now indicate bias distortion. Adjust SL2 on demodulator board B for a zero meter reading. ***Make sure that this is not a false zero indication, caused by malfunction of the test equipment, by changing the adjustment of the SL2 potentiometer in each direction.*** This should cause the meter to deflect on each side of zero.

3. TEST PROCEDURES

Back-to-Back Test

3.01 After completing the foregoing adjustments, it is necessary to send test data locally through the modulator and demodulator using 903 and 902 data test sets.

(1) Arrange the data set for 4-wire operation (*U* option).

(2) Connect an adjustable attenuator as shown in Fig. 2 if no telephone set or remote control of data and talk modes is used in the

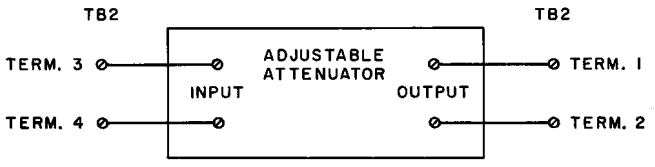

Fig. 2 — Attenuator Connection, No Relay Operation

installation. Where the relay is to be operated, which will be the case in which a telephone set or remote control of the data and talk modes is used, connect the attenuator as shown in Fig. 3.

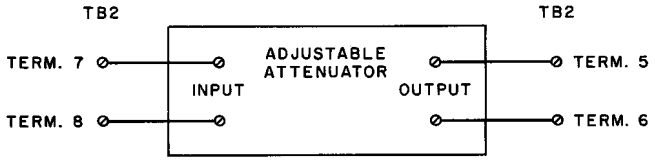

Fig. 3 — Attenuator Connection with Relay Operation

(3) The delay and attenuation equalizer board should be in the data set if the installation requires it.

(4) Telephone line remains disconnected.

(5) Set switch S1 to TEST.

(6) Set switch S2 to MARK.

(7) Operate data key on telephone set with handset off hook if attenuator is connected as in Fig. 3.

(8) Set 903 data test controls as follows:

RANDOM/DOT — RANDOM
BITS/SEC — Maximum bit speed of customer's equipment
TRIGGER — + or − (not required)

(9) Connect red SIGNAL OUT terminal of 903 to the test signal input jack on the data set.

(10) Connect black SIGNAL OUT terminal of 903 to GRD on the data set.

(11) Connect 903 power cord to a 117-volt ac outlet; set OFF-ON switch to ON.

(12) Depress START switch momentarily.

(13) Set 902 data set controls as follows:

BITS/SEC — transmitted bit speed (same as 903)
TRIGGER — + or − (not required)
Meter Selection Switch — DIST ADJ

(14) Connect the 902 to the 903 with the cord supplied. Connect the red DATA IN terminal of the 902 to the demodulator board B OUT jack. Connect the black DATA IN terminal to demodulator board B GRD jack.

(15) Zero the meter by means of the DISTORTION adjustment control of the 902. (Wait several seconds before adjusting).

(16) Move meter selection switch to VOLT ADJ and zero the meter by the volts adjustment control.

(17) Move meter selection switch to PHASE ADJ and zero the meter by the PHASE adjustment control.

(18) Adjust the attenuator connected to the modulator and demodulator to 0 db.

(19) Move meter selection switch to DIST MEAS. The meter on the 902 is now reading peak distortion. 1 microamp is equal to 1 per cent distortion. (Ignore the error lamps on the 902 for this test.) Note the meter reading. The distortion should be considerably less than 10 per cent without delay equalizers, and less than 20 per cent with delay equalizers. (If reading is zero, there is probably some malfunction in the test setup.)

Note: Power line disturbance can cause some early models of the 902 test set to fall out out of synchronization and erroneously indicate steady 50 per cent distortion. If this occurs, readjust the 902.

3.02 Using a KS-14510 meter, measure the clear-to-send interface voltage between the S/S jack on the line and control board and GRD. While switch S1 is in TEST position, meter should read approximately +8 volts. Change switch S1 to TRANS. Meter should read approximately −8 volts with *S* option. With *R* option, meter should stay at +8 volts.

3.03 Using a KS-14510 meter, measure the carrier detector interface voltage between the C/D OUT jack on the line and control board and GRD. With switch S1 in the TEST position, meter should read approximately +8 volts. Change switch S1 to TRANS. Meter should read approximately −8 volts with *S* option. With *R* option, meter should stay at +8 volts.

3.04 Disconnect 902 and 903 data test sets. Verify that the modulator MARK and SPACE frequencies are still within tolerances without readjusting (see 2.05, 2.06, and 2.07).

3.05 If settings of the C/D and DEM SENS potentiometers other than maximum are specified, adjust as outlined in 3.06 and 3.07. ***Do not*** make C/D and DEM SENS adjustments until all tests covered in 2.01 through 2.10 and 3.01 through 3.04 are completed.

Clamp Adjustment (if required)

3.06 The C/D potentiometer on demodulator board A sets the carrier detector gain and thereby controls the level at which the CLAMP on the demodulator operates. When the CLAMP is set for maximum sensitivity, the demodulator is capable of receiving signal levels in the range of −35 to −40 dbm. Below this range, the CLAMP comes on, locking the demodulator output to a constant marking signal. When the CLAMP circuit (C/D potentiometer) is used, the DEM SENS potentiometer should be set at maximum sensitivity, see 2.09 (5).

(1) Make sure the data set is trapped for 4-wire operation (*U* option).

(2) Make sure the adjustable attenuator is connected as shown in Fig. 2.

(3) Insert sufficient attenuation to reduce the modulator signal to the lowest signal level to be received, including normal circuit variations. For example, if the modulator is set at −6, and −30 dbm is the specified level, then 24 db of attenuation is necessary.

(4) Operate switch S1 to TEST.

(5) Operate switch S2 to SPACE.

(6) Observe the output of demodulator board B between OUT and GRD using an oscilloscope set for dc input or a zero centered voltmeter. Adjust the C/D potentiometer to the point where the output just swings from −8 volts to +8 volts. Check this adjustment by inserting 1-db additional loss, which should cause the observed signal to swing from +8 volts back to −8 volts. Lock the C/D potentiometer and recheck the reading to make sure adjustment was not changed by the locking procedure.

(7) Return switch S1 to TRANS and switch S2 to MARK.

Demodulator Sensitivity Adjustment

3.07 Normally the DEM SENS potentiometer is adjusted for maximum sensitivity (maximum clockwise). There is a very special case where adjustment of the DEM sensitivity to a value other than maximum may be necessary. If the data set is installed on a private line circuit over which data carrier is being continuously transmitted to minimize the effect of momentary loss of carrier, the customer may request that the CLAMP on the demodulator be removed. The CLAMP is removed by disconnecting the strap between terminal 16 to J2 and terminal 16 to J6. Removal of the CLAMP should make the demodulator sensitive to noise at about −50 dbm. If such excessive noise is present, it will cause the output of the demodulator to jump around when no carrier is being received. In this circumstance, it is necessary to adjust the DEM SENS potentiometer to decrease the demodulator sensitivity to a point where this noise is no longer troublesome.

(1) Make sure the adjustable attenuator is connected as shown in Fig. 2.

(2) Make sure the data set is strapped for 4-wire operation (*U* option).

(3) Insert sufficient attenuation to reduce the signal to about 5 db below the minimum signal level that will be received, ie, if −25 is the minimum signal level to be received and the modulator output is at −6 dbm, the DEM SENS potentiometer should be set for −30 DBM, and 24 db of attenuation is necessary.

(4) Operate switch S1 to TEST.

(5) Operate switch S2 to SPACE.

(6) Observe the output of demodulator board B between OUT and GRD using an oscilloscope set for dc input or a zero centered voltmeter. Adjust the DEM SENS potentiometer until the demodulator just swings from a nominal −8 volts to a nominal +8 volts.

(7) Lock the potentiometer and recheck the measurement to be certain the setting was not changed by the locking procedure.

(8) Return switch S1 to TRANS.

3.08 Remove the attenuator and connect proper wiring options.

3.09 Connect line wiring.

3.10 At the conclusion of the previous adjustments, "on-line" operating tests should be made to ensure over-all performance before the set is turned over to the customer. These tests can be divided into two parts: a test with the data test center, and a test between customer station locations. The test center will measure and record data set transmit level and receiver sensitivity for future reference in analyzing trouble reports. Plant Project Control should coordinate station-to-station tests. On station-to-station tests, both data sets must be adjusted, as previously described, before testing. The station-to-station tests consist of two long calls and ten short calls. 15-minute data error checks should be made on the long calls and 1-minute checks on the short calls. Peak distortion readings should be made for each direction on short calls. Fig. 4 is a work sheet which can be used as a sample for recording the performance of each test call.

3.11 The test equipment and connections are arranged for transmitting or receiving as described in the following:

Transmitting End

(1) 903 Data Test Set

Trigger — + or − (not required)
RANDOM/DOT — RANDOM
BITS/SEC — Maximum bit speed of customer equipment

(2) 902 Data Test Set — not used

(3) Data Set

Switch S1 to TEST
Switch S2 to MARK

(4) Connect:

903 red SIGNAL OUT terminal to data set test signal input jack.
903 black SIGNAL OUT terminal to GRD on data set.
903 power cord to 117-volt ac outlet, OFF-ON switch to ON.

DATA SET PRE-SERVICE PERFORMANCE TEST RECORD

Date: _____

Data Test Calls Placed Between:

	LOCATION	TEL. # OF TEST LINE OR STATION
(A)	_____	_____
(B)	_____	_____

Contemplated Customer S.O. Number's _____

Under Control of Data Test Center at _____

LONG DURATION TEST CALLS					BIT ERROR COUNT — MINUTE NUMBER														
ORIGINATED #	AT	TIME	PEAK DISTORTION AT	%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

SHORT DURATION TEST CALLS			SHORT CALL — NUMBER (READINGS AT _____)						(READINGS AT _____)					
ORIGINATED AT	TIME		1	2	3	4	5		1	2	3	4	5	
		Peak Dist. Reading (%)												
		One Minute Error Count (Bits in Error)												
		Peak Dist. Reading (%)												
		One Minute Error Count (Bits in Error)												

Billing Adjustment (if required) referred to: _____

Parties involved in Tests: _____

Coordinated with tests to other locations at: _____

Comments and Notes:

Fig. 4 — Work Sheet

Receiving End

(1) 903 Data Test Set

Trigger to +
RANDOM/DOT to RANDOM
BITS/SEC to EXT CLOCK

(2) 902 Data Test Set

Trigger — + or − (not required)
BITS/SEC — Bit speed of distant 903 set
Meter Selection Switch — DIST ADJ

(3) Data Set

Switch S1 to TRANS
Switch S2 to MARK

(4) Connect:
15-conductor cable between 902 and 903 test sets.
902 red DATA IN terminal to demodulator board B OUT terminal on data set.
902 black DATA IN terminal to demodulator board B GRD terminal.
903 power cord to 117-volt ac outlet, OFF-ON switch to ON.

3.12 ***Procedure***

(1) Establish voice communication in the manner normally used by the customer when placing data calls, ie,

- DDD
- Attendant or operator assisted

Take proper steps to ensure customer is not billed for toll calls on test.

Alternately place calls from each station, except where one customer location will always be receiving or transmitting and always originating the call. These test calls should be placed during busy hours and, as the circuit will be used by the customer, this will give reasonable assurance that all test calls do not use same first choice trunks and routes.

(2) With voice communication established, a brief aural continuity check should be made. At the transmitting end, momentarily depress the DATA key and then the START switch of the 903. The receiving end should hear random data audio tones. After 5 or 10 seconds the transmitting end returns to the talk mode and obtains verification of data reception.

(3) Transmitting end shifts from TALK to DATA and momentarily depresses 903 START switch. The transmitting station has no further duties until the end of the test period.

(4) Receiving end shifts to DATA and performs the following steps:

(a) Allow the 902 meter selection switch to remain in the DIST ADJ position for several seconds. Then zero the meter by means of the DIST ADJ knob.

(b) Move selection switch to VOLTS ADJ and zero the meter by means of the VOLTS ADJ knob.

(c) Move selection switch to PHASE ADJ and zero the meter with the PHASE ADJ knob.

(d) Move selection switch to DIST MEAS and depress the WORD SYNC & RESET switch momentarily. The microammeter should now settle down to some relatively stable value that indicates peak distortion. The error lamps on the test set should indicate the number of bit errors from the time the RESET switch was released. 1 microamp is equal to 1 per cent distortion.

(5) As a check for possible loose connections or "microphonics" in the data set, both sets should be rapped with the hand, and any errors noted on the lamps of the 902 set.

(6) At the end of 1 minute, both stations return to the TALK mode.

3.13 If the preceding 1-minute checkout verifies that the test setup is functioning properly, the test procedure should be repeated for about 16 minutes. The receiving station should make a minute-by-minute count of errors for a period of

15 minutes. The WORD SYNC & RESET switch should be depressed momentarily at the end of each minute after the total errors have been noted (see Fig. 4).

3.14 Repeat the test procedures in the opposite direction, with the transmitting station becoming the receiver and the receiving station becoming the transmitter, unless data is to be transmitted in one direction at all times. ***Make sure*** all necessary changes have been completed.

3.15 With the completion of the long calls in each direction, the procedures should be repeated for a series of short calls of about 1 minute each.

3.16 ***Test Results***

Long Calls, Each Direction

(a) During 20 of the 30 minutes, no more than 2 bit errors per minute.

(b) During 6 of the 30 minutes, no more than 10 bit errors per minute.

(c) Any 4 of the 30 minutes may be disregarded to allow for occasional hits or noise bursts.

(d) Maximum allowable average distortion must not exceed 20 per cent. An occasional peak over 20 per cent is permissible, as long as the 20 per cent average is not exceeded.

Short Calls, Each Direction

(a) During 8 of 10 calls, no more than 10 bit errors in the 1 minute.

(b) Average distortion of 20 per cent must not be exceeded in 9 of the 10 calls.

Note: The above limits are in ***no way*** to be construed as guaranteed error rates that the customer will experience. For one thing, the majority of his calls should do better. However, the occasional catastrophic call could be much worse. This has the effect of making any short-term test objective useless for either long-term average error purposes or for setting any upper limit on what an occasional call will encounter.

3.17 If required, measure the impulse noise between the data set ground and the business machine ground using a 6A impulse counter (see Section 592-010-200).

(1) Connect business machine ground to J1 of 6A.

(2) Connect data set ground to J4 of 6A.

Do not ground 6A for this test.

(3) Set switch S1 to voice band.

(4) Set switches S2 and S3 to total 90 dbrn.

(5) Set timer for 15 minutes.

(6) Reset counter to 0.

If any counts are noted in a 15-minute period, grounding arrangements must be improved.

Note: General description, calibration, and operating procedure for the 6A impulse counter are contained in Section E40.467.

3.18 If the preceeding test requirements are met, the data set may be considered satisfactory for turn-over to the customer for service.