

A1 DIGITAL TRANSMISSION USING FOUR-PHASE DATA SETS INITIAL TESTING AND LINE-UP PROCEDURE

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1. GENERAL

1.01 This section covers the testing procedures to be followed in the initial testing and line-up of SAGE data circuits, using the four-phase data transmitters and receivers in the A1 Digital Data System. A general description of the system utilizing these data sets is covered in Section 314-500-105. Routine tests to be made on these circuits on a periodic basis are covered in Section 314-500-305. Trouble testing procedures are discussed in Section 314-500-505. This sec-

tion is reissued to include information on SAGE/BUIC Services via the AUTOVON Switched Network. Due to the extent of changes marginal arrows have been omitted.

1.02 Before starting the line-up procedure, an inspection of equipment wiring should be made to check the correctness of any special arrangements of coils, equalizers, or other equipment that have been specified.

1.03 SAGE data circuits are divided into two general categories:

(a) Point-to-Point — These are two-point circuits between a DDT and a DDR. The output of a DDT may be bridged for multipoint operation.

(b) 4-wire Subscriber Lines — The data sets are terminated as a 4-wire subscriber line into an AUTOVON office. The output may be bridged for multipoint operation.

1.04 Both of the above arrangements may route at the local sites via a Dial Restoration Panel (DRP). The DRP is essentially a manual 4-wire patching arrangement which has the capability to establish and restore circuits using the AUTOVON Switched Network. Section 314-561-100 contains additional DRP considerations.

1.05 SAGE locations not having a sufficient quantity of circuits to justify a DRP may be provided with a multiline keypulsing telephone instrument with associated line and transfer circuits. This arrangement has essentially the same features of a DRP; i.e., Dialing, Supervision and Transfer.

1.06 The DRP and the multiline keypulsing equipment have been established as a +1 db receiving and -5 db transmitting level point for all circuits. Pads are adjusted at the line side of the data set and the drop side of the

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carrier equipment to maintain level points shown in Fig. 1.

1.07 Transmission and performance testing of point-to-point data circuits should be made between the DDT and its associated DDR.

1.08 Transmission tests of the 4-wire subscriber lines arranged for data are made in accordance with the 310-200-series of practices between the data sets and the serving AUTOVON office on the regularly assigned facilities and also on any facilities which might be alternately used for data, i.e., AUTOVON PBX access lines. Only one performance or error test should be adequate. This is made between the DDT and the DDR using the regularly assigned subscriber lines.

2. PRELIMINARY TESTING

A. Line Facilities

2.01 This section assumes that all cable pairs assigned to these circuits, both local terminating pairs and interexchange facilities, have been previously tested in accordance with preliminary testing procedures of Section 314-850-500. If any changes in pair assignments or any resplicing of any cable facilities have been made since being tested, the procedures in this section should be repeated before proceeding with the line-up testing.

2.02 If any voice-frequency loaded facilities are assigned to the layout for these circuits, particular attention should be given to the frequency-impedance measurements covered in Section 314-850-500. Any serious irregularity in spacing, missing or improperly connected load coils, poor end sections, or improperly connected ratio repeat coils should be corrected before attempting circuit line-up procedures.

2.03 *Loop Resistance:* On voice-frequency facilities, metallic varley and loop resistance measurements should be made, using no higher than a 6-volt battery. These measurements should not be different by more than 10 per cent from those of other similar pairs or wires in the section. During this measurement, attention should be given to any momentary changes in resistance value which would indicate poor or unreliable connections or splices.

2.04 *Insulation Resistance:* On voice-frequency facilities, insulation resistance between wires and between each wire and ground should be measured with a 100,000-ohm voltmeter and 130- to 150-volt test battery. Cable pairs should measure at least 500 megohm-miles between wires and 250 megohm-miles from either wire to ground. Open-wire sections should measure at least 20 megohm-miles between wires and 10 megohm-miles between each wire and ground when dry. Wet weather measurements on open-wire facilities may be somewhat lower, but the insulation resistance to ground should not differ by more than 10 per cent between wires. In those locations not equipped with 100,000-ohm voltmeters, insulation testing may be done with a Megger. Low-resistance voltmeters should not be used.

2.05 *Resistance Unbalance:* On voice-frequency facilities, the resistance unbalance on either open wire or cable pairs should not be greater than 3 ohms.

B. Voice-Frequency Repeaters

2.06 Voice-frequency repeaters assigned to data circuits should be tested in the usual manner for message circuit use, except in the following respects.

GRID VOLTAGE

2.07 *V1 or V3 Repeaters:* No grid battery tests required.

2.08 *22-Type Repeaters Modified for 4-Wire Operation (opposite transmission may or may not be made inoperative, as specified):* If the grid voltage is obtained from a common supply, the alarm should be checked in accordance with standard instructions. If individual grid batteries are used, these should measure at least 8.5 volts. Both units should be replaced if below this voltage.

2.09 *22-Type Repeaters Modified for 4-Wire Operation and High Energy Level:* The measured grid voltages should not be less than the following:

- (a) With regulated "A" battery — 21.2 volts.
- (b) With nonregulated "A" battery — 17.0 volts.

2.10 44-Type Repeaters with Individual Grid Batteries: The measured grid battery voltage should not be less than 8.5 volts. Both batteries should be replaced if below this value.

2.11 44-Type Repeaters with Self-Bias: Grid bias should be measured by the voltage drop in the filament circuits and should meet standard message circuit limits.

2.12 44-Type Repeaters Modified for Feedback Operation: The grid bias voltage of each 101F tube, determined as described in standard instructions, should be 8.2 ± 0.5 volts and that of each 102F tube should measure 1.5 ± 0.3 volts.

FILAMENT OR HEATER CURRENT

2.13 No Special Requirements: Measure in accordance with standard instructions for the type repeater involved.

CATHODE ACTIVITY

2.14 Cathode activity tests on V1 and V3 repeaters should be made as specified in standard instructions, using the 1R or 1AC tube test set. The change in cathode current should not exceed 15 per cent.

2.15 Cathode activity tests on 22-type repeaters should be made as specified in standard instructions. When the test is made using transmission measuring equipment, the repeater gain should not change more than 0.3 db. When the test is made on a test set indicating change in plate current, the plate current should not change more than 0.5 mil for the specified change in filament current.

2.16 Cathode activity tests on 44-type repeaters should be made in accordance with standard practices. In the case of repeaters modified for negative feedback, the tubes should be removed and placed in an unmodified repeater for this test.

2.17 Using specified maximum and minimum values of filament current, the repeater gain should not change more than 0.6 db.

2.18 If the repeater gain changes more than 0.6 db in the above test, either the 101F or 102F tube or both should be changed until the repeater gain changes less than 0.6 db.

MAXIMUM GAIN

2.19 The maximum gain of repeaters should meet standard requirements, except that the maximum gain of the 22-type repeater modified for 4-wire operation and high energy level should be $20.9 \text{ db} \pm 2 \text{ db}$.

3. CIRCUIT SECTION TESTS

A. 1000-Cycle Net Loss

3.01 Voice-frequency repeatered cable sections, carrier sections, and repeatered voice-frequency open-wire sections should not deviate from the assigned 1000-cycle net loss by more than $\pm 0.5 \text{ db}$ (except $\pm 1.0 \text{ db}$ for local terminating facilities).

B. Net Loss-Frequency Characteristic

3.02 Voice-frequency repeatered sections should not deviate from the 1000-cycle net loss by more than the following: (+ indicates a loss greater than 1000 cycles).

(a) Cable—V3 Repeaters with External Equalizer.

FREQUENCY	DEVIATION
500	-1.0 to +1.0 db
1000	0
1600	-1.0 to +1.0 db
2000	-1.0 to +1.0 db
2500	-0.7 to +1.3 db

(b) Cable — 22- or 44-Type Repeaters

FREQUENCY	DEVIATION
500	-0.3 to +0.3 db
1000	0
1600	-0.5 to +0.5 db
2000	-0.5 to +0.5 db
2500	-1.0 to +1.0 db

(c) Open Wire with 128A or Higher Cutoff Filter.

FREQUENCY	DEVIATION
500	-3.6 to +0.9 db
1000	0
1600	-1.5 to +1.5 db
2000	-1.6 to +1.6 db
2500	-2.0 to +2.0 db

(d) V-4 Type Repeaters.

FREQUENCY	DEVIATION
500	-0.3 to +0.3 db
1000	0
1600	-0.3 to +0.3 db
2000	-0.3 to +0.3 db
2500	-0.3 to +0.3 db

3.03 Carrier section deviations should meet the limits used for normal message service on the particular system.

3.04 Local terminating facilities should not deviate from the 1000-cycle net loss by more than the following:

FREQUENCY	DEVIATION
300	-1.0 to +2.0 db
1000	0
2400	-1.0 to +1.5 db
2700	-1.0 to +2.0 db

C. Noise Measurements

3.05 In the normal case, segregated noise measurements on circuit sections are not required providing overall circuit noise limits, as covered in Part 4 of this section, are met. An exception to this is where some part of the data circuit consists of compandored facilities. If excess noise exists in the compandored facility, the action of the compandor is such as to reduce the operating signal-to-noise ratio on the overall circuit and increase the error rate of the signal without this noise condition being measurable from the circuit terminal.

3.06 Both steady and impulse noise should be measured on the compandored section, using the 3A Noise Measuring Set and the 6A Impulse Counter. Noise should be measured at the carrier terminal nearest the receiving end of the circuit with the compandored section terminated in a quiet termination at the distant carrier terminal.

3.07 *Steady Noise* on the compandored section measured with the 3A NMS, using "C Message" weighting assumes that the SAGE four-phase data circuits are operated at a level of -10 dbm at the 0 TLP and the 3A NMS reading has been corrected accordingly. It need be further corrected only for the operating circuit level at the point of measurement relative to the 0 TLP.

3.08 *Impulse Noise* on the compandored section should be measured with the 6A Impulse Counter, as described in Section 103-620-100 using "Voice-Band" weighting and referred to 0 TLP. It need be further corrected only for the operating circuit level at the point of measurement relative to 0 TLP by changing the REF LEV DBRN switch setting on the counter. In order to obtain reliable measurements on the compandored section, it is necessary that the expander in the carrier receiving terminal be disabled as described in Section 103-620-100. An exception to this method of "disabling" must be used with N2 carrier systems. In these systems, instead of disabling the expander it is necessary to remove the compandor unit and connect the 6A Counter input to the demodulator output (DO-DG) jacks on the face of the modem unit. This point may be assumed to be a -7.5 db TLP and the counter dbrn setting adjusted accordingly.

4. OVERALL CIRCUIT TESTS — GENERAL

4.01 After testing of facilities, repeaters and line sections as covered in Parts 2 and 3, the overall circuit should be tested before the connection of the data sets.

4.02 Part 5 covers overall circuit tests which apply to point-to-point facilities. These tests are performed between the DDT and DDR.

4.03 Part 6 lists overall circuit tests for switched operation. They should be performed on 4-wire subscriber lines arranged for data and any 4-wire access lines which might alternately be used for data. These tests will be made between the data set location and the serving AUTOVON office.

5. CIRCUIT TESTS — POINT-TO-POINT OPERATION**A. 1000-Cycle Net Loss**

5.01 The overall 1000-cycle net loss should not deviate from the assigned loss by more than ± 1.0 db.

B. Net Loss-Frequency Characteristic

5.02 The measured loss over the frequency band should not deviate from the actual measured 1000-cycle loss by more than the following: (Plus sign means greater loss.)

- 300 to 999 Cycle Band -2 to +6 db
- 1000 to 2400 Cycle Band -1 to +3 db
- 2401 to 2700 Cycle Band -2 to +6 db

C. Envelope Delay Distortion

5.03 Maximum envelope delay distortion should not exceed 1000 microseconds in the band between 1000 and 2400 cycles. Measurement should be made using the 25A visual gain and delay measuring set, or equivalent. Operation of this delay set is covered in Section 103-115-100.

5.04 There are no requirements for absolute delay measurements on circuits for the normal SAGE data services. Certain special data circuits, such as Time Division Data Links, will have absolute delay requirements specified in the circuit order information.

D. Noise Measurements

5.05 Steady noise measurements should be made at the receiving terminal with a 3A Noise Measuring Set using "C Message" weighting. The far terminal should be terminated during measurement in a quiet termination. Measured noise should not exceed the following:

- Noncompandored Facilities 52 dbrnc0
- Compandored Facilities 32 dbrnc0

The above limits are referred to the 0 TLP and assume the circuit to be operated at -10 dbm at the 0 TLP. The compandored limit should be used only where the entire circuit is made up of compandored facilities. Where a mixture of facilities exists, use the noncompandored limit.

5.06 Impulse noise measurements should be made at the receiving terminal with a 6A Impulse Counter. Terminate the far end of the circuit and set the 6A Counter for "Voice-Band" weighting and the correct dbrn level to compensate for the operating level of the measuring point. For circuits on noncompandored or mixed facilities, the measured noise should not exceed 90 counts in 30 minutes at 70 dbrn0 (referred to 0 TLP). For example, if the measuring point should be the +7 db demodulator output jack of a carrier terminal, the 6A Counter should be set for 76 dbrn. (Use "Add 30" and 45 dbrn.)

5.07 Where the entire circuit is on compandored facilities, it is necessary to disable the expander at the receiving terminal before

measurement. Use the method and limits given for a "section" measurement in paragraphs 3.08 and 3.09. Note the special method and noise limit for N2 carrier facilities. Should the circuit consist of a combination of compandored N2 carrier and other compandored types, use the method and limit for the type adjacent to the receiving terminal.

6. CIRCUIT TESTS — SWITCHED OPERATION

A. 1000-Cycle Net Loss (Unless Otherwise Specified)

- 6.01** Serving AUTOVON office to Dial Restoration Panel = 3 db
- DRP to DDR input = 3 db
- DDT output to DRP = 5 db

Overall Deviation (Data Set to AUTOVON Office) =

- ± 1.0 db (circuits less than 500 mi.)
- ± 1.5 db (circuits more than 500 mi.)

B. Net Loss — Frequency Characteristic

- 6.02** Overall 4-wire subscriber line-loss relative to 1000-cycle, at any frequency in the bands indicated.
- 300-999 cycles -1.0 to +3.5 db
- 1000-2400 cycles -0.5 to +1.5 db
- 2401-2700 cycles -1.0 to +3.5 db

C. Envelope Delay Distortion

- 6.03** 400 Microseconds between 1000 and 2400 cycles

D. Noise Measurements

- 6.04** Steady Noise — 3A NMS — C Message — AT 0 TLP

CIRCUIT LENGTH (Miles)	NOISE MEASUREMENT AT OR BELOW (dbrnc)
0-50	31
51-100	34
101-400	37
401-1000	41
1001-1500	43
1501-2500	45
2501-4000	47

Note: When a circuit is made up of compandored facilities, a combination of compandored facilities or two or more compan-

dored facilities in tandem, the above limits are lowered 5 db. A circuit made up of compandored and noncompandored facilities in tandem shall use the limits above.

6.05 Impulse Noise

Overall circuit — (at 0 TLP)

Noncompandored — 90 counts/30 min. at 59 dbrn0

Compandored — 90 counts/30 min. at 45 dbrn0

(The expander should be disabled in full loss condition.)

7. OVERALL PERFORMANCE TESTS

7.01 After completion of overall circuit tests the circuit should be connected to the four-phase transmitter and receiver. In the case of switched operation, this should be done using the regularly assigned facilities via the AUTOVON Network.

7.02 The data sets should have been previously tested and adjusted in accordance with the appropriate practices. An overall data transmission test should then be made as described below utilizing a Word Generator at the transmitting terminal and a Word Generator and the Matching and Error Counter Circuit at the receiving terminal.

7.03 At the transmitter location, connect the Word Generator (WG1) to the START, DATA and TIMING inputs of the DDT and connect the DDT output (T and R) to the data line.

7.04 Set the word length switch on WG1 to position 16 (switch S1 on SD-1G097 or switch S14 on SD-1G005). Set switches S2, S4, S7, S8, S9, and S11 to the ON or 1 position. Set all other data switches to the OFF or 0 position. Set the DDR-DDT switch to DDT and the 1600-1300 switch to 1300.

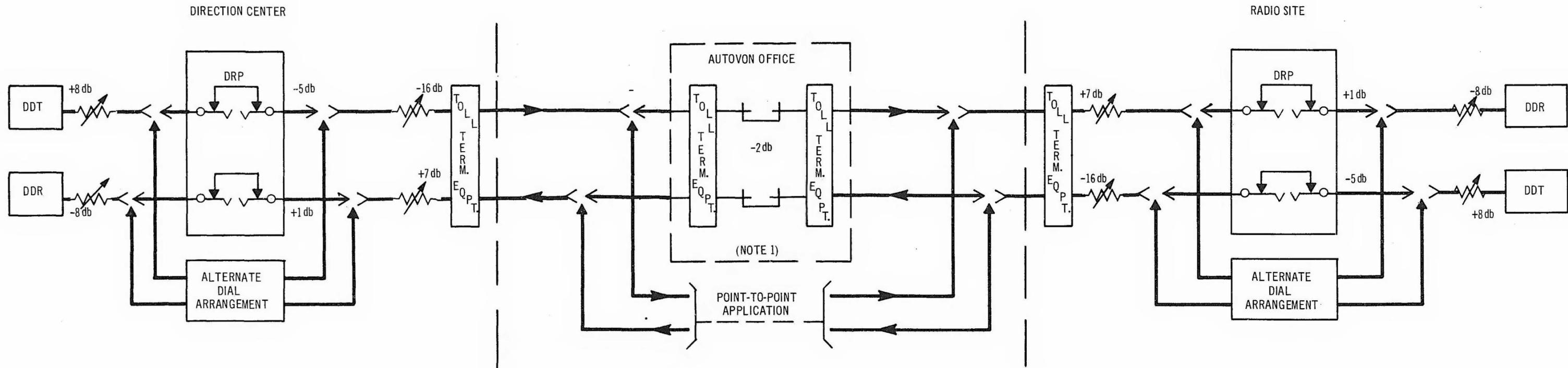
7.05 At the receiving location, connect the data line to the four-phase receiver input and the DDR outputs to the Word Generator (WG2) and Matching and Error Counting Circuit. The DDR OUT S jack is patched to the Word Generator No. 2 S jack and DDR OUT D and T jacks patched to the Matching and Error Counter D and T jacks.

7.06 Connect WG2 for proper operation with the Matching and Error Counter. Set the data switches on WG2 the same as those on WG1 (Par. 5.03). Set the DDR-DDT switch to DDR.

7.07 Unless otherwise specified in circuit order information, adjust operating levels so that 0.7 volt peak-to-peak dipulses are fed from WG1 to the DDT and adjust the DDT output to be -10 db relative to the 0 TLP of the data line input. The DDR output should be adjusted to 0 dbm (2.2 volts peak-to-peak).

7.08 Operation of the test setup may be checked by temporarily reversing one of the data switches (S2, S4, etc.) on the receiving Word Generator (WG2). Errors should be recorded at a rapid rate. Restoring the switch to normal should stop the rapid error count.

7.09 For satisfactory operation, the circuit should produce less than one error per minute. The test should be continued for a minimum of 30 minutes.



NOTES:

(1) FOR SIMPLICITY PURPOSES, A SWITCHED CONNECTION HAS BEEN DEPICTED AS ORIGINATING AND COMPLETING WITHIN THE SAME AUTOVON OFFICE. A CALL VIA THE AUTOVON NETWORK COULD ENCOUNTER A MAXIMUM OF FOUR ZERO LOSS INTEROFFICE TRUNKS IN TANDEM.

Fig. 1 - Transmission Level Points - Sage Data Circuits with Access to the AUTOVON Switched Network.