BSm #7788

# SAGE DATA TRANSMISSION SYSTEMS
# INITIAL TESTING AND LINE-UP OF SAGE DATA CIRCUITS

CONTENTS



## 1. GENERAL

**1.01** This section covers the testing procedures to be used in the initial line-up of data transmission circuits of the SAGE type. It is reissued to incorporate information previously given in the addendum and to add over-all data performance tests. Information on impulse noise measurements has been deleted from this section and reference is made to Section 314-500-501 for these measurements.

**1.02** This section assumes that all cable pairs to be used in the circuit both exchange and toll have been previously tested in accordance with the preliminary testing procedures covered in Section 314-850-500. If any changes in plant arrangements, splicing changes or pair assignments have been made since this preliminary testing, the procedures in Section 314-850-500 should be repeated before the line-up testing is started.

**1.03** Before starting the following testing procedure, an inspection of equipment wiring should be made to check the correctness of any special arrangements that have been specified.

**1.04** The tests to be made for the initial line-up of SAGE circuits will depend on the type or types of facilities in the specific circuit layouts. When circuits are made up of combinations of voice-frequency and carrier sections, these sections should be tested separately as outlined below and then the over-all circuit tested for over-all operating requirements.

**1.05** The following outlines the required testing for different types of facilities and parts of the circuit:

(a) ***Voice-frequency Cable Pairs and Repeaters:***

***Line facilities*** should be tested for loop resistance (Paragraph 2.01), insulation resistance (Paragraph 2.02) and resistance unbalance (Paragraph 2.03).

***Voice-frequency repeaters*** if included in the circuit should be tested for grid voltage (Paragraphs 3.02 to 3.07), filament or heater characteristics (Paragraph 3.08), cathode activity (Paragraphs 3.09 to 3.13) and maximum gain (Paragraph 3.14).

(b) ***Voice-frequency Circuit Sections:*** The voice-frequency circuit sections of the circuit should be tested for 1000 cycle net loss (Paragraph 4.01) and for net loss frequency characteristic (Paragraphs 4.02 to 4.05). As indicated in Paragraph 4.05 the local terminating facilities should be tested separately.

(c) *Carrier Circuit Sections:* Carrier channels which are sections of a SAGE circuit should meet the standard tests for message service.

(d) *Over-all Circuit Tests:* After completion of facility and section tests in (a), (b) and (c), the over-all circuit should be tested for deviation of 1000 cycle net loss (Paragraph 5.02), net loss frequency characteristic (Paragraph 5.03), envelope delay (Paragraph 5.04) and noise (Paragraphs 5.05 to 5.11).

(e) *Over-all Data Performance Tests:* After completion of the over-all circuit tests, data terminals, DDT's and DDR's, should be connected to each circuit. Out of service tests for both data line levels and over-all error check, as described in Section 314-500-500 should be made on each data circuit.

## 2. LINE FACILITY TESTS

### (A) Loop Resistance

**2.01** 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.

### (B) Insulation Resistance

**2.02** 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- 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.

### (C) Resistance Unbalance

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

## 3. VOICE-FREQUENCY REPEATER TESTS

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

### (A) Grid Voltage

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

**3.03** *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.

**3.04** *22-Type Repeaters Modified for 4-Wire Operation and High Energy Level:* The measured grid battery voltages should not be less than the following:

(a) With regulated "A" battery — 21.2 volts.

(b) With nonregulated "A" battery — 17.0 volts.

**3.05** *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.

**3.06** *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.

**3.07** *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 $\pm$ 0.5 volts and that of each 102F tube should measure 1.5 $\pm$ 0.3 volts.

**(B) Filament or Heater Current**

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

**(C) Cathode Activity**

**3.09** 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.

**3.10** 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.

**3.11** 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.

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

**3.13** 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.

**(D) Maximum Gain**

**3.14** 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 db ± 2 db.

## 4. CIRCUIT SECTION TESTS

**(A) 1000 Cycle Net Loss**

**4.01** 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 ± 0.5 db.

**(B) Net Loss — Frequency Characteristic**

**4.02** *Voice-frequency repeater cable sections* should not deviate from the 1000 cycle loss more than the following:

(a) V1 or V3 Type Repeaters (with external equalizer).

| FREQUENCY | DEVIATION |
|---|---|
| 500 | −1.0 to +1.0 |
| 1000 | 0 |
| 1600 | −1.0 to +1.0 |
| 2000 | −1.0 to +1.0 |
| 2600 | −1.3 to +0.7 |

(b) 22- or 44-Type Repeaters

| FREQUENCY | DEVIATION |
|---|---|
| 500 | −0.3 to +0.3 |
| 1000 | 0 |
| 1600 | −0.5 to +0.5 |
| 2000 | −0.5 to +0.5 |
| 2600 | −1.0 to +1.0 |

**4.03** *Carrier* section deviations should meet the limits used for normal message circuits.

**4.04** Voice-frequency open wire sections should not deviate from the 1000 cycle loss by more than the following values. This assumes the use of 128A or equivalent filters. ***Lower cut-off filters should not be used.***

| FREQUENCY | DEVIATION |
|---|---|
| 500 | −0.9 to +3.6 |
| 1000 | 0 |
| 1500 | −1.5 to +1.5 |
| 1900 | −1.5 to +1.5 |
| 2500 | −2.0 to +2.0 |

**4.05** *Local terminating facilities* should not deviate from the 1000 cycle loss by more than the following: (− indicates a loss greater than 1000 cycles).

| FREQUENCY | DEVIATION |
|---|---|
| 500 | −2.0 to +1.0 |
| 1000 | 0 |
| 1600 | −0.5 to +0.5 |
| 1800 | −0.5 to +0.5 |
| 2000 | −0.6 to +0.6 |
| 2400 | −0.7 to +0.7 |
| 2600 | −1.0 to +1.0 |

## 5. OVER-ALL CIRCUIT TESTS

**5.01** After testing of facilities, repeaters and line sections as covered in Parts 2, 3, and 4 the over-all circuit should be tested for (a) 1000 Cycle Loss, (b) Net Loss — Frequency, (c) Envelope Delay and (d) Noise. When the circuit consists of only one section, these over-all tests should be made in addition to those section tests in Part 4.

### (A) 1000 Cycle Net Loss

**5.02** The over-all 1000 cycle net loss should not deviate from the assigned loss by more than ± 0.5 db.

### (B) Net Loss — Frequency Characteristic

**5.03** The over-all circuit should have not more than ±2 db variation from the 1000 cycle net loss between 1000 and 2600 cycles nor more than ±3 db variation from the 1000 cycle net loss between 500 and 1000 cycles. The loss in the 300 to 500 range should preferably be greater than the 500 cycle loss. Similarly, the loss in the 2600 to 3000 range should preferably be greater than the 2600 cycle loss. However, in specific instances gains may be permissible in the range 300 to 500 cycles and 2600 to 3000 cycles referred to 500 cycles and 2600 cycles respectively, but in no cases should these gains exceed 2 db.

### (C) Envelope Delay

**5.04** Envelope delay measurement should be made on the over-all circuit. The variation in measured delay should not exceed 500 microseconds over the band from 1000 to 2500 cycles for the over-all circuit between customer terminals.

### (D) Noise

**5.05** There are two general types of noise that have important effects on data circuits, the usual "steady tone" noise, generally constant in amplitude and pitch and the sharp "crackle" and "pop" of short duration impulse noise such as that from atmosphere static and electrical contact noises. The first or "steady" noise can be measured by the usual methods on the 2 type noise measuring sets except that for data circuits an allowance should be made in the permissible limits for fluctuations in line level that may reduce the usable signal-to-noise ratio. The impulse noise however, is of such short duration and the noise meters response so slow that this noise must be measured on a fast responding instrument such as an oscilloscope. The following testing procedure is arranged to check both of these noise types.

**5.06** The weighted noise level of the over-all circuit measured on a type 2 noise meter using F1A weighting should not exceed 48 dba at zero transmission level. When measurements are made at other than zero level points on the circuit this limit must be adjusted for the actual signal level. This limit may, in the case of carrier facilities be further modified for circuit stability as covered in Paragraph 5.08.

**5.07** The noise limit in Paragraph 5.06 assumes a circuit of stable transmission loss. On all circuits other than those made up exclusively of voice-frequency facilities a check of the stability of the transmission loss should be made. A 1000-cycle test signal should be transmitted from the far end and the received signal observed on a calibrated oscilloscope. If the oscilloscope used is not equipped for interval calibration in db, it may be calibrated with a vacuum tube voltmeter having a db scale.

**5.08** As indicated in Paragraph 5.06 circuit instability reduces the signal-to-noise ratio. Slow variations in the transmission loss at a rate of about one in four seconds or longer will be cared for by automatic regulation in the terminal equipment and may be ignored in this test. Variations in loss occurring at a faster rate should be observed on the oscilloscope for a period of about five minutes and the maximum variation noted.

For variations up to ± 0.3 db — no degradation.

For variations up to ± 0.5 db — 3 db degradation, i.e., noise limitation becomes 45 dba at zero circuit level.

For variations up to ± 0.85 db — 5 db degradation, i.e., noise limitation becomes 43 dba at zero circuit level.

For variations of more than ± 1.0 db — circuit is not usable for SAGE service.

**5.09** The noise measurement above applies to the normal or "steady state" noise identified when audible by a more or less steady hiss. Impulse noise is characterized by the sharp "crackle" and "pop" of static bursts rather than the steady hiss. On all circuits containing N or ON carrier facilities and on any other cable circuits where previous testing indicates the presence of this impulse noise, values should be made as outlined in Section 314-500-501. Impulse noise measurements should not normally be made on open wire circuits due to the difficulty of getting a true sample of atmospheric noise. On open wire circuits, the probability of this impulse noise should be considered in the design of the circuit rather than depend on a single measurement.

**5.10** To guard against false readings of high frequency noise from the voice-frequency wiring and voice-frequency cable section, this wiring should be removed when using the oscilloscope method at carrier terminals. On N and ON carrier sections this may be done conveniently by placing the channel unit in the test stand when making noise measurements.

**5.11** For impulse noise measurements refer to Section 314-500-501. ←