# DATA SYSTEMS—"DATA-PHONE"® SERVICE AND DATA ACCESS ARRANGEMENTS ON DIRECT DISTANCE DIALING NETWORK— TEST REQUIREMENTS FOR SUBSCRIBER, FOREIGN EXCHANGE, AND REMOTE EXCHANGE LINES

CONTENTS PAGE



## 1. GENERAL

**1.01** This section describes the transmission test requirements on subscriber, remote exchange, and foreign exchange lines used for data transmission on the switched telecommunication network (DDD). Information in this section applies equally to DATA-PHONE service and data access arrangements (DAA) unless otherwise specified.

**1.02** This section is reissued as follows:

- To revise Fig. 1 to show maximum signal level at serving central office
- To update listing of standard voiceband data sets for DATA-PHONE service in Table B
- To include DAA information throughout the section
- To include reference to the 6H and 6HR impulse counters
- To include reference to the 6F and 6FR voiceband noise measuring sets
- To include information on the 497G weighting network
- To correct BSP references
- To add a reference section.

**1.03** The tests described in this section are made between the serving office (the central office furnishing dial tone) and the data set location unless otherwise specified.


***Test requirements in this section are specified at 1000 Hz and 2800 Hz. However, in actual testing, the signal should be offset by 4 Hz to avoid quantizing problems in T-carrier systems.***

**1.04** Data access arrangements are provided for customers using non-Bell System data modems. When the requirements for DAA differ from those provided for data sets, they will be specified in this section. DAAs are also referred to as data couplers.

**1.05** For the purposes of this section, the term "loop" is used to define the over-all subscriber

line from the data set location to the serving central office. When the first central office is ***not*** the serving office for the line (RX or FX lines), the "loop" will consist of the local loop plus an interoffice facility. The interoffice facility may use metallic pairs or carrier-derived channels (see Fig. 1).

**1.06** The ***local loop*** is the facility from the customer's premises to the main frame of the local serving office. ▶The loops are normally 2-wire instead of 4-wire because the lower cost of 2-wire loops outweighs the improved transmission performance of 4-wire loops.◀

**1.07** Due to serving office or local trunking problems, it will be necessary from time to time to serve a data subscriber from other than his normal office. This type of service is provided by a remote exchange (RX) line. End-to-end error tests (possible only with Bell System modems) should be made prior to taking this action to determine whether an actual service problem exists.

**1.08** The RX line should be served from an office which eliminates part of the normal DDD routing. Each line should be individually designed and the distortion of the bypassed trunk added to the normal loop requirements to determine the parameters of the RX line.

**1.09** Objectives for RX lines include the distortion of a toll connecting trunk. ***If the envelope delay distortion exceeds 300 microseconds between 1000 and 2400 Hz, the RX line must be delay equalized to meet the 300-microsecond objective.*** ▶Information about delay equalizers may be found in Sections 314-820-10Z.◀

**1.10** A foreign exchange (FX) line provides service between the customer's premises and a remote central office in ***another area*** other than the central office which normally would serve that customer's location.

**1.11** FX lines pose a difficult problem from an engineering design and plant maintenance point of view insofar as noise and envelope delay distortion are concerned. It is difficult to design an FX line that may be hundreds of miles long to data transmission loop design criteria. Equalization and noise requirements make this impracticable. However, data service via foreign exchange access should be successful for calls within a 200-mile radius of the serving office if the design criteria are met. ▶If the customer desires, he may order conditioned FX lines (C-conditioning).

**1.12** Wide Area Telephone Service (WATS) lines will be designed to the same objectives as RX lines if the local office is not used as a serving office. If the local office is used, the normal loop objectives apply.◀

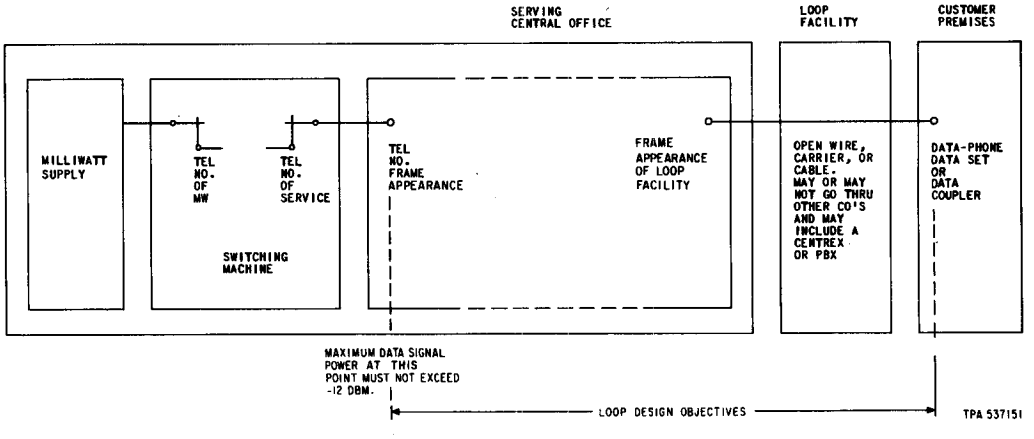


**Fig. 1—▶DATA-PHONE Loop Layout◀**

## 2. PRESERVICE LOOP TESTING

**2.01** Upon receipt of assignment information concerning the installation of a data service, the plant service center should test all subscriber cable conductors involved for opens, short circuits, crosses, leakages, and grounds. These tests should be made on the subscriber cable pair from the central office to the data set location. Measurements of dc conductor resistance, using a battery voltage not exceeding 6 volts, should be made on all subscriber pairs to determine any possible error in plant records, high resistance, or other conductor faults (see AB22.077.2). When these measurements are made, the meter being used should be observed carefully in order to detect any variations. If needle variation occurs, it indicates that a possible trouble condition could exist; therefore, a different cable pair should be assigned. Where interoffice physical plant facilities (RX or FX loops) are involved, cable acceptance tests should be made if this has not been done previously. For information concerning cable acceptance tests, see Sections 330-300-5ZZ.

**2.02** ◗Installation measurements (Table A) to be made are determined by the type of data set (Table B) and the loop (local loop, RX, or FX line) being installed. Tables C and D list the parameters and objectives for local loop, RX, and FX lines.

◗ TABLE A ◖

INSTALLATION MEASUREMENTS

| PARAMETER | DATA SET OR DAA | |
|---|---|---|
| | TYPE I | TYPES II AND III |
| Insertion Loss 1000 Hz | Yes | Yes |
| Attenuation Distortion (Slope) | No | Yes |
| Impulse Noise* | No | Yes |
| Message Circuit Noise | Yes | Yes |
| Envelope Delay Distortion | No | Yes |

*TLP corrections are to be made using the average of the 1000-Hz and 2800-Hz AML readings.

TABLE B

DATA SETS USED WITH DATA-PHONE SERVICE

| TYPE I (BELOW 300 BPS) | TYPE II (300 TO 2400 BPS) | TYPE III (ABOVE 2400 BPS) |
|---|---|---|
| 101 | 201 | 203 |
| 103 | 202 | |
| 113 | 402 | |
| 401 | 602 | |
| 403 | | |
| 603 | | |

TABLE C

LOCAL LOOP OBJECTIVES

| PARAMETER | DATA SET | |
|---|---|---|
| | TYPE I | TYPES II AND III |
| Maximum Insertion Loss in dB | | |
| 1000 Hz | 10.0 dB | 10.0 dB |
| 2800 Hz | Not Critical | 13.0 dB |
| Maximum Slope | Not Critical* | 3.0 dB |
| Impulse Noise — no more than 15 counts in 15 minutes at: | | |
| Noncompandored or compandored facilities with —13 dBm0 holding tone | 59 dBrnc0† | 59 dBrnc0† |
| Message Circuit Noise — Meet voice objectives using 3-Type NMS: | | |
| Noise Metallic | 20 or less dBrn | 20 or less dBrn |
| Envelope Delay Distortion | | |
| 1000 to 2400 Hz | Not Critical | 100 Microseconds |
| Transmitting Level at Serving Central Office in dBm | —12 | —12 |

* While no limit is specified, loop treatment is recommended if the slope exceeds 9 dB.

† If voiceband weighting is used, increase all objectives by 1 dB.

**2.03** For DAA, the installation measurements (Table A) to be made should be determined by the design engineer from the type of data modem information provided by the customer and specified on the service order. When no information is available on the modem, Type III requirements should be specified. The following guidelines should be used when limited information is available about the customer modem:

(1) For all analog modems, Type III requirements should be specified.

(2) For all other modems, requirements based on the speed of modem (same as for DATA-PHONE service) should be specified.

(3) If the type of modem is known to be similar to a Bell System DATA-PHONE data set, use the requirements for that particular data set.◀

**2.04** During trouble investigation, additional measurements may be needed to verify the transmission parameters given in Tables C and D.

## 3. ▶DATA ACCESS ARRANGEMENTS

**3.01** The DAA may be telephone line powered or require a dc power supply at the customer's premises which is either customer- or telephone company-supplied.

**3.02** Test access points for the loop will be tip and ring on the line side of the DAA.◀

TABLE D

REMOTE EXCHANGE AND FOREIGN EXCHANGE LINE LIMITS

| PARAMETERS | RX, WATS TO CLASS 5 OFFICE FOR DATA SETS* | | RX, WATS TO CLASS 4 OR EQUIVALENT FOR DATA SETS* | | FX FOR DATA SETS | |
|---|---|---|---|---|---|---|
| | TYPE I | TYPES II & III | TYPE I | TYPES II & III | TYPE I | TYPES II & III |
| Attenuation Distortion 1000 to 2800 Hz | 7 dB | 5 dB | 8 dB | 5 dB | 8 dB | 6 dB |
| Envelope Delay Distortion 1000 to 2400 Hz | Not Critical | 300 $\mu$s | Not Critical | 300 $\mu$s | Not Critical | 600 $\mu$s |
| Maximum Insertion Loss 1000 Hz | 10 dB | | | | 8.5 dB | |
| Impulse Noise — No more than 15 counts in 15 minutes at: † | 68 dBrnc0 | | | | | |

* Served from other than the normal local office. Requirements include equivalent distortions of one toll connecting trunk.

† Use a −13 dBm0 holding tone if compandored carrier is used.

## 4. IMPULSE NOISE MEASUREMENTS

**4.01** Impulse noise measurements should be made on loops that are to be used at data transmission speeds above 300 bps. Impulse noise requirements are stated in terms of a maximum of 15 counts in 15 minutes above the specified threshold requirement. Circuits which exceed this number of counts are likely to have degraded error performance.

**4.02** Figure 2 gives the procedure for making impulse noise measurements. Impulse noise measurements on the loop should always be made at the data set location using a 6-type impulse counter (Sections 103-6YY-ZZZ). When a "dial-up" quiet termination is available, it should be used to terminate the central office end of the loop before starting impulse noise measurements. In No. 1 crossbar, step-by-step, and electronic switching system (ESS) offices with joint holding features, the "quiet termination" may go off-hook and on-hook periodically. This is done to release the test line after the calling party hangs up. Impulse hits are usually observed on the 6-type counter due to this action. In this situation, do not use the "dial-up" termination. The impulse noise objectives are one count per minute, and the test line can create as many as 12 counts per minute. The tests should be made by dialing up a test line in the serving central office or by application of a termination to a test shoe which may be connected at the main distribution frame appearance of the subscriber line.

**4.03** ***Where compandored or unknown facilities are involved, the measurements should be made using a −13 dBm0 holding tone at 2800 Hz.*** This stabilizes the compandor action at a level which simulates the working environment (data level). Impulse noise measurements are then referred to the "zero transmission level point" for comparison with the circuit objectives. The test procedure using a −13 dBm0 holding tone is given in Part 9 of this section.

**4.04** General tests of loops used in connection with data transmission indicate that switching machines can introduce impulse noise on these circuits. Where impulse noise measurements exceed the requirements shown in Table C for the station loop, the noise may be on the outside plant facilities or in the serving office. For a minimum of central office impulse noise, an electronic switching system

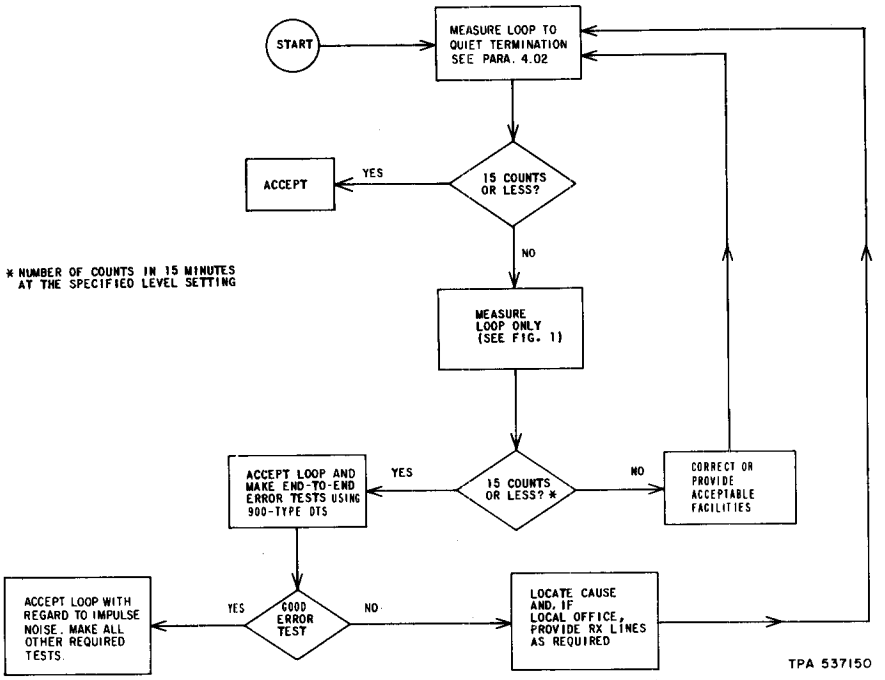


**Fig. 2—Procedure for Impulse Noise Objectives**

or a No. 5 crossbar office is the most desirable type of office to use as a serving office.◀ The next best would be a "known-quiet" step-by-step office. ▶Step-by-step offices equipped with rotary-out-trunk switches may produce impulse noise at an unacceptable level. These offices should be tested as specified in EL 1379—PL 2510.◀ The use of a panel office as a serving office for data services should be avoided, with the exception of low-speed data systems which are relatively insensitive to impulse noise. If impulse noise measurements exceed the objectives, this information should be forwarded to the Engineering Department responsible for the installation.

## 5. MESSAGE CIRCUIT NOISE REQUIREMENTS

**5.01** Message circuit noise requirements for data service are the same as those for voice communication. ▶Requirements and detailed procedures for making measurements are covered in Section 311-100-501 for station loops, Section 311-100-500 for central office PBX trunks and tie trunks, and Section 314-410-500 for C-type conditioned FX lines. Sections 103-611-1ZZ cover the use of 3-type noise measuring sets.◀

## 6. INSERTION LOSS

**6.01** ▶The loop should meet its 1000-Hz expected measured loss (EML) requirements as specified on the Service Order or Detail Work Sheet with a variation of no more than $\pm 1$ dB. If the EML does not appear on the circuit layout card, consult the engineering group responsible when analyzing trouble on the circuits. The maximum allowable insertion loss (loss between serving central office and data set or DAA) for data services is 10 dB at 1000 Hz. This does not include the insertion loss of the DAA. The maximum insertion loss including the DAA (measured to the data set side of the DAA) is 12 dB at 1000 Hz. See Table D for RX and FX line requirements.

## 7. ATTENUATION FREQUENCY DISTORTION REQUIREMENTS

**7.01** The attenuation frequency distortion of the loop may be determined by measuring the loss of the loop at 2800 Hz and calculating the loss deviation from the measured 1000-Hz loss. There is no attenuation frequency distortion requirement for Type I data sets on local loops. For Types II and III data sets, the 2800-Hz loss deviation should not vary more than $\pm 3$ dB from the 1000-Hz loss or more than $\pm 2$ dB from the 2800-Hz loss shown on the circuit layout card. The maximum allowable 2800-Hz insertion loss for Type II and III data sets on local loops is 13 dB. A loop checker should not be used as erroneous readings may result. The loop checker looks at a much broader response than the 3-dB limit from 1000 Hz to 2800 Hz.

## 8. ENVELOPE DELAY DISTORTION

**8.01** The maximum envelope delay distortion for Types II and III data sets (above 300 bps) is 100 microseconds for the 1000- to 2400-Hz band. There is no requirement for Type I data sets (below 300 bps). See Table D for RX and FX lines.

## 9. HOLDING TONE FOR IMPULSE NOISE MEASUREMENTS

**9.01** This procedure involves the use of a "holding tone" of $-13$ dBm0 applied at the far end (central office) of a circuit and a tone-rejecting filter at the input to the 6-type impulse noise measuring set at the near end (customer) of the circuit. The holding tone establishes the loss of the compandor at a level which simulates the working environment.

**9.02** Since the attenuator in the 6A impulse noise counters cannot always be adjusted to the desired attenuation, allowance for this limitation is made in the following tests by providing both the desired level settings and the suggested attenuator settings if the actual setting cannot be used. In addition, when making impulse noise measurements, the level settings must be adjusted up by 1 dB if voiceband weighting is used as opposed to C-message weighting. The C-message filter attenuates impulse noise 1 dB more than the voiceband filter.

**9.03** The following is a step-by-step procedure for making impulse noise measurements. Figure 3 shows the test setup.

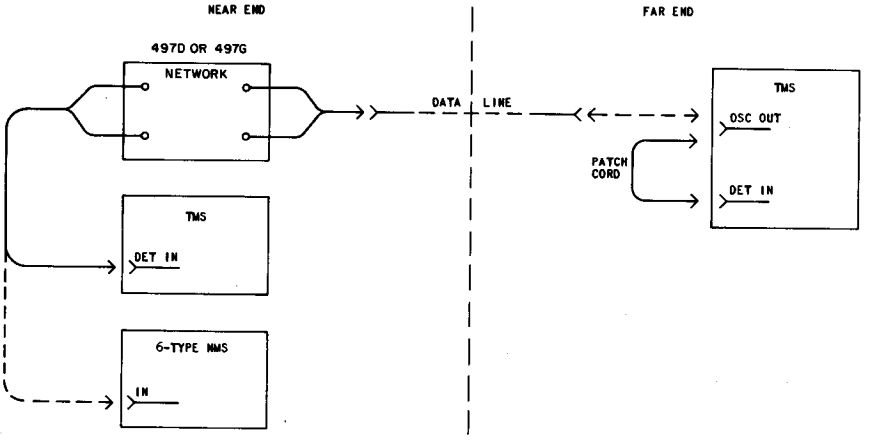


**Fig. 3—Typical Arrangement for Providing Holding Tone**

| STEP | PROCEDURE |
|---|---|
| | **Far End** |
| 1a | If compandored facilities are not involved, connect a termination to the circuit at the central office and proceed with Step 4. |
| 1b | If compandored facilities are to be measured, connect the oscillator output on the transmission measuring set (TMS) to the detector input of the TMS and adjust the oscillator frequency to approximately 2800 Hz, if the 497G network is used, or approximately 2750 Hz if the 497D network is used. |
| 2b | Adjust the oscillator output level to −13 dBm. |
| 3b | Connect the oscillator output to the data line, thus terminating the data line for impulse noise measurements. |
| | **Near End** |
| 4 | Connect the 6F or 6H impulse noise test set to the line at the same test access point used for 1000-Hz loss measurement. |
| 5 | Determine the threshold setting in dBrnc0 from Table C or D. |
| 6 | Add the average of the measured 1000-Hz and 2800-Hz loss from the threshold setting in dBrnc0 to obtain the corrected threshold setting in dBrnc0 for the test point. |
| 7 | Adjust the impulse noise counter threshold setting to the corrected threshold setting and record the counts over a 15-minute period. |
| 8 | For more information on impulse noise test sets, refer to Sections 103-6YY-ZZZ. |
| | ***Example:*** The impulse noise is to be measured on a local loop. The threshold requirement from Table C is 59 dBrnc0. The 1000-Hz test tone from the central office measures −7.3 dBm and the 2800-Hz test tone measures −8.5 dBm. The average of these losses is (−7.3) + (−8.5)/2 = −7.9 dB. The corrected impulse noise threshold is 59 + (−7.9) = 51.1 dBrnc. If the 6F is used, set the FUNCTION switch to TERM 600—900 Ω and the DBRN switches to 21 dBrn (an additional 30-dB attenuation is provided in the first counter circuit to provide a threshold setting of 51 dBrnc). |

## 10. REFERENCES

**10.01** Bell System Practices covering the various equipment associated with data service are as follows:

| SECTION | TITLE |
|---|---|
| AB22.077.2 | Transmission Design Objectives for DATA-PHONE® Service and Data Access Arrangements Provided Over Station Loops, Remote Exchange Lines, Foreign Exchange Lines, and Wide Area Telephone Service Lines |
| 103-611-100 | J94003A and B Noise Measuring Set |
| 103-611-101 | J94003C Noise Measuring Set |
| 103-611-102 | J94003CR Noise Measuring Set |
| 103-620-100 | J94006A (6A) Impulse Counter, Description, Operation, and Maintenance |
| 103-620-101 | 6H and 6HR Impulse Counters (J94006H and J94006HR) Description, Operation, and Maintenance |
| 103-626-100 | 6F and 6FR Voiceband Noise Measuring Sets (J94006F and J94006FR) Description, Operation, and Maintenance |
| 311-100-500 | Circuit Order and Trunk Order Transmission Tests—PBX Central Office Trunks, Off-Premises Station Lines and Tie Trunks Having Access to the Direct Distance Dialing Network |
| 311-100-501 | 1000 Hz and Noise Measurements—PBX Central Office Trunks, Off-Premises Station Lines and Tie Trunks Having Access to the Direct Distance Dialing Network |
| 314-205-500 | Data Systems—DATA-PHONE® Service and Data Access Arrangements on Direct Distance Dialing Network, Overall Data Transmission Test Requirements |
| 314-410-500 | Voice Bandwidth Private Line Data Circuits, Tests and Requirements |
| 314-820-100 | Envelope Delay Characteristics of 200-Type Delay Equalizers |
| 314-820-103 | Envelope Delay Characteristics of 366- and 367-Type Equalizers |
| 314-820-104 | Envelope Delay Characteristics of 384- and 385-Type Equalizers |
| 330-300-500 | Completion Tests of Exchange-Area Cables Introduction |
| 330-300-501 | Completion Tests of Exchange-Area Cables Apparatus, Records, and Forms |
| 330-300-502 | Completion Tests of Exchange-Area Cables Preparation |
| 330-300-503 | Completion Tests of Exchange-Area Cables Testing |
| 330-300-504 | Completion Tests of Exchange-Area Cables Analysis and Reports |
| 590-010-300 | Data Systems—DATA-PHONE® Service on Direct Distance Dialing Network—Overall Field Force Maintenance Procedures |
| 668-010-300 | Data Systems—DATA-PHONE® Service on Direct Distance Dialing Network, Data Test Center, Trouble Analysis Procedure |
| 590-103-1ZZ | Data Couplers |
| 598-080-ZZZ | Data Auxiliary Set 828C. |

## NOTES