VOICE BANDWIDTH PRIVATE LINE DATA CIRCUITS

MAINTENANCE

CONTENTS PAGE

1. GENERAL

1.01 This section provides the maintenance considerations and testing policy to be used when performing maintenance tasks on voice bandwidth private line data circuits. Voice bandwidth data is defined as data signals occupying a single voice-frequency channel (approximately 300 to 3200 Hz or less with some types of facilities).

1.02 This section is reissued to introduce a new data transmission history form intended for use in recording routine, benchmark, and loopback test results. Change arrows are used to emphasize the more significant changes.

1.03 Descriptive information common to the transmission of data on the Public Switched Network (PSN), private line (PL) services, and Switched Service Networks (SSN) is covered in the following sections:

- Data General—Analog Transmission Parameters—Description (Section 314-010-100)
- Data General—Data Testing Principles (Section 314-010-101)
- Data General—Data Service Support (Section 314-010-102)
- Data General—Interconnection/Interpositioning (Section 314-010-103).

A basic understanding of the Data General sections is recommended prior to the use of this section.

1.04 In order to prevent high level data signals from causing harm to the telephone plant, a program of signal power measurements should be established. Broadband carrier systems should be surveyed for problems caused by high signal power. In addition, signal power measurements are required by the Serving Test Center (STC) or Special Service Center (SSC) every 6 months and are a part of every trouble report involving customer provided equipment (CPE).

2. MAINTENANCE CONSIDERATIONS

2.01 This part provides maintenance and test access information on 2-point and multipoint circuits.

A. 2-Point Circuits

2.02 The 2-point circuits provide data communication between two locations. These circuits may be basic (3002-type) or have C1, C2, C4, or C5 conditioning. The C3 conditioning is restricted to switched services network only. Information on this type of conditioning is given in Section 309-200-301. The C6 conditioning is restricted to protective relaying channels as discussed in Section 310-540-100. The C7 and C8 conditioning are used for trunks in electronic tandem networks (ETN) and tandem tie networks. The C5 conditioning can be ordered only on 2-point circuits.

2.03 An offering called high performance data conditioning (HPDC) or D-type conditioning is available on interstate voice-grade analog data channels. This conditioning provides more stringent control over intermodulation distortion and signal-to-noise ratio than that on previously offered data channels. These parameters are the ones most likely to affect high-speed voiceband modems operating on analog channels.

2.04 The HPDC is available in any one of three offerings. They are listed and defined as follows:

(a) ***Type D1 HPDC*** is designed for a 2-point channel not arranged for switching where there is not more than one station per service point.

(b) ***Type D2 HPDC*** is designed for a 3-point channel equipped with central office (CO) switching and arranged so that only two of the three stations may transmit to each other at any given time.

(c) ***Type D3 HPDC*** is designed for access lines associated with AUTOVON networks, formally called switched circuits automatic network (SCAN). Type D3 HPDC is discussed in Section 309-200-301.

2.05 Network channel terminating equipment (NCTE) are telephone company (TELCO) devices installed on customer premises that provide a standard facility (loop) termination point for TELCO network services. The NCTE-to-NCTE measurements are preferred in all cases and should be performed if service conditions permit. Sectional measurements made with the Collins CLA-type or similar type systems are considered equivalent to NCTE-to-NCTE measurements. The NCTE-to-NCTE measurements are required in all cases where the customer is not satisfied and/or the need for technical escalation is indicated.

2.06 For the purpose of estimating NCTE-to-NCTE performance from non-Collins CLA-type sectional measurements, a basic, C1 or C2, 2-point circuit should be divided into only two sections. One section should normally be from the control SSC or STC to its NCTE, and the other section should be from the same SSC/STC to the distant NCTE. Care should be exercised to ensure that no office equipment or wiring is omitted or measured twice in this sectionalization. The NCTE-to-NCTE performance is estimated from sectional measurements as given in Section 314-010-101.

> ***Note:*** If sectional measurements are to be made and are made partly with the Collins CLA-type equipment and partly with other test equipment, the static measurements should be made using the CLA-type equipment frequencies where possible. Testing with the Collins CLA-type equipment is covered in Section 314-410-104.

B. Multipoint Circuits

2.07 The end link/midlink concept allocates NCTE-to-NCTE transmission parameter requirements to individual link requirements. This simplifies the design and maintenance of multipoint and switched networks and reduces the need for end-to-end testing. Networks can be altered or expanded with a minimum of redesigning or testing. Sometimes to accommodate planned growth, circuits are engineered with links designated to tighter limits than are immediately required. In these cases they should be maintained on the same basis that they were engineered and shown on the work order and record detail (WORD) document.

2.08 The end link/midlink allocation rules take advantage of statistics when combining link parameters and thus do not guarantee that the NCTE-to-NCTE connection will always meet limits. End links generally contain voice frequency cable plant, and their high-frequency response characteristics tend to be similar and cumulative. The limits on end links have been tightened over previous limits to reflect this condition. Even with the tighter limits,

it is possible for all the end links and midlinks to be within limits and the NCTE-to-NCTE limits to be exceeded. Particularly on end links, it is important that the full capability of any selected equalizers be used; ie, do not add extra equalizers to optimize the parameters, but ***do select the optimum equalizer(s) and optimize any adjustments on lineup.***

2.09 When acceptable midlink and end link tests are completed, NCTE-to-NCTE attenuation distortion and delay distortion tests will not be required on multipoint circuits with conditioning requirements equivalent to C2 or less. End-to-end tests are required on C4 conditioned circuits.

2.10 Where a customer is dissatisfied with performance on a multipoint channel, end-to-end measurements are required between at least one pair of points where service is not satisfactory to the customer before technical escalation on circuits of any grade of conditioning. If the complaint concerns service between one pair of points, the measurements should be between those points. If the complaint concerns service between more than one pair of points but some are worse than others, the worst pair should be chosen for measurement tests. If they are equally bad, choose any convenient pair.

C. Central Office Relay Switched Circuits

2.11 The end link/midlink concept is also used with central office relay switched circuits. The circuit may be unconditioned or have C1 or C2 conditioning between all pairs of stations. The NCTE-to-NCTE attenuation distortion and envelope delay distortion measurements are not normally required.

2.12 Although the transmission parameters are normally measured on an end link/midlink basis, the overall transmission requirements must be met between any pairs of customer stations. These measurements must be made between the two worst-case stations through the switched connection in the event of a trouble report before technical escalation.

D. Customer Premises Switched Circuits

2.13 A customer premises switched arrangement is permissible.

2.14 The overall connection may be arranged to approximate the bandwidth parameter response of a basic channel or a C2 conditioned channel. Only the individual channel should be measured, never the overall connection; and no overall conditioning can be guaranteed.

2.15 The NCTE-to-NCTE facility parameter must be met on each individual channel. However, it is not required to assure that NCTE-to-NCTE facility parameter requirements will be met on the overall connection, since it may include more local and short-haul facilities in tandem than normal.

E. Test Points

2.16 Although there may be a number of points where transmission tests can be made, it is best to limit the choice of test access points to a few locations in order to be certain of measuring at a known impedance and test level. Figure 1 illustrates a typical 4-wire data set circuit design at a customer location using a DAS 829 channel interface unit (CIU). The test access points would be at the point where the data set is connected to the circuit or the jacks provided. These points have been chosen because they are fixed 600-ohm points and terminated measurements can be made (with the data set disconnected from the circuit) which include all the pads and amplifiers at the station.

2.17 When making transmission measurements at the customer location, DAS 829 type CIU is part of the network channel facilities.

2.18 ***The test equipment should not be connected directly to the local cable pairs when transmission components (such as pads, repeat coils, and amplifiers) are used at the customer location, as this will result in the incorrect measurement of attenuation distortion, delay distortion, and other parameters.***

2.19 Figure 2 illustrates a typical long-haul circuit which is 4-wire station-to-station but converts to 2-wire for connection of a 2-wire modem. The test access point is at the point where the data set is connected to the circuit. The 2-wire test access of a DAS 829 type CIU would correspond to the 2-WIRE IN jack of the data mounting. Measurements are made on a 600-ohms terminated basis unless the WORD document specifies some other impedance.

2.20 Figure 3 illustrates a 4-wire circuit at a typical SSC or STC. Measurements should be made at a point where the impedance is known to be 600 ohms

rather than looking directly at the cable pair. ▶An excellent measuring point is the VF jacks or equivalent private line testboard jacks or equivalent SMAS/SARTS access associated with a 4-wire carrier channel.◀

2.21 Figure 4 illustrates a 4-wire multipoint circuit at a central office bridge location. Measurements should be made at the closest test access point to the bridge in order to measure the effect of all equipment used to make up the end link or midlink.

When testing a link off a bridge, it is necessary to first terminate the bridge leg under test in 600 ohms (both transmitting and receiving) in order to avoid unbalancing the bridge and to permit use by the customer of other portions of the circuit without interference from test tones or other trouble conditions.

3. TESTING POLICY

A. Required Channel Transmission Tests

3.01 Table A lists the tests required for trouble investigation. Section 314-010-101 lists the order of tests to be performed for installation, routine, and trouble reports. While this section deals specifically with maintenance of PL data circuits, installation and routine tests must also be considered.

B. Loopback Tests

3.02 The following loopback tests should be performed for purposes of trouble sectionalization on 4-wire facilities from the SSC or STC.

- Net loss
- C-Notched noise
- Impulse noise
- Intermodulation distortion (when the local channel includes short-haul channels, such as N, ON, or T).

The actual loopback is made at the customer station. Before operating the loopback arrangement at the customer station, the transmit leg from the customer location ***must be terminated*** at a point looking toward the other customer stations. At the VF patch bay, a 600-ohm termination placed in the MOD IN jack will be suitable. This is important to prevent the possibility that tests made toward the local customer station might affect service to other stations on multipoint circuits. In the case of some tone-operated loopback arrangements, it will prevent the loopback control tone towards the local station from causing loopback relays at the other customer stations to operate.

3.03 Poor solder connection of cable facilities may cause troubles, such as opens, low levels, or noise, to come clear. In the event of repeated trouble reports of this nature, do not apply direct current to the circuit but isolate the trouble by applying a tone to the circuit and monitoring the circuit at appropriate test points (such as the frame). If a trouble of this nature cannot be isolated and cleared, the use of sealing current is recommended.

C. Interexchange and Midlink Tests

3.04 The initial trouble report tests given in Section 314-011-101 should be performed on the interexchange facilities (in the case of a 2-point private line) or on a suspected midlink, or links in the case of a multipoint circuit.

D. NCTE-to-NCTE Trouble Tests

3.05 The NCTE-to-NCTE trouble tests are required if the customer is not satisfied with the service and the following steps have been taken:

(1) Loopback tests have been made at each end of the circuit and all requirements met.

(2) Interexchange or midlink tests have been made and all requirements met.

(3) The customer has been requested to verify the proper operation of his equipment and has reported that no trouble has been found, but problems are still being encountered overall.

3.06 To make the tests, repair personnel should be dispatched to the appropriate customer locations for purposes of NCTE-to-NCTE trouble tests. In the case of certain multipoint circuits, where the trouble is limited to transmission to a single remote

station, it may only be necessary to make tests of the end link from the bridge to the customer location, and coverage may not be required at any other stations.

3.07 It is not necessary to make all NCTE-to-NCTE transmission tests at the customer location if the tests are primarily intended to verify the proper operation of carrier facilities (such as phase jitter tests). Instead, these tests may be made at the ends of only the carrier portion of the circuit if suitable test equipment is not available at the customer location.

3.08 There will be some circumstances under which special technical support will be needed in order to solve a service problem. Technical support should be sought under the following conditions:

(a) The service meets all Bell System specifications but does not meet customer performance expectations. Telephone company personnel should not attempt to provide better than Bell System specifications without higher management approval.

(b) The service does not meet Bell System specifications and the problem source cannot be identified.

(c) Excessive trouble reports have been received and have been closed out as "Test OK," "Came Clear," "Found OK," or "No Trouble Found." This type of condition should be escalated immediately upon receipt of the third trouble report.

(d) The customer reports a transmission parameter as being out of limits but no mention is made in this section of that parameter. As an example, a report of "percent phase distortion" should be referred for technical support.

3.09 Refer to Section 010-521-100 for guidelines regarding data technical support (DATEC).

E. Routine Tests

3.10 Routine tests, other than total power output, are not necessary except where required by local practices. Total power output should be checked as a part of initial installation tests and all trouble report tests. It should be tested on a routine basis about 6 months after circuit order tests have been completed to verify that changes have not been made in the modem output level. If the total output power is excessive, action should be taken to bring it within limits. Repeated failures to keep the total output power from exceeding TELCO specifications may require the suspension of the customer's service. Ten days after written notice of the tariff violation is delivered to the customer, in those cases where the customer refuses to reduce the total power output, disconnection of the device may be appropriate.

4. USE OF THE DATA TRANSMISSION HISTORY FORM

4.01 The tests to be performed are given in Table A. These measurements should be made and the results recorded on the data transmission history form (Fig. 5). The back of the history form is used for recording routine, benchmark, and loopback measurements. Loopback and straightaway measurements are both provided and should be used at the time of installation for later reference.

> ***Note:*** The circuit mileage is doubled when loopback tests are made for purposes of determining C-notched noise and impulse noise requirements.

4.02 The following is an explanation of entries for the data transmission history form (Fig. 5).

1. ***Circuit Number:*** Enter circuit number.

2. ***Link:*** Enter appropriate link or section of circuit if straightaway measurements are recorded. Also, use this space to indicate loopback test results.

3. ***Test Date:*** Enter date of test.

4. ***EDD/AD:*** Enter results for attenuation distortion (AD) and envelope delay distortion (EDD) measurements made for circuit order or trouble tests. The EDD/AD measurements are required at certain frequencies for each type of data channel. These requirements are listed in Table B.

5. ***1004-Hz Net Loss:*** Enter the 1004-Hz loss measurement.

6. ***C-Notched Noise:*** Enter the C-notched noise test results.

7. ***Impulse Noise:*** Enter the impulse noise measurement.

8. ◗ ***Phase Jitter:*** Enter phase jitter measurements for 20 to 300 Hz (Bell), 4 to 20 Hz (LF), and 4 to 300 Hz (Bell plus LF).

9. ***P/AR:*** Enter the peak-to-average ratio measurement.

10. ***Intermodulation Distortion:*** Enter the second order and third order intermodulation distortion measurements.

11. ***Phase Hits:*** Enter the phase hits measurements as required.

12. ***Gain Hits:*** Enter the gain hits measurements as required.

13. ***Dropouts:*** Enter the dropout measurements as required.

14. ***Return Loss:*** Enter the return loss measurements as required.

15. ***Single Frequency Interference:*** Enter the single frequency interference measurements as required. Also enter the approximate frequency of the tone.

16. ***Frequency Offset:*** Enter the frequency offset measurements as required.

17. ***Composite Power:*** Enter the composite power measurements as required.

18. Enter routine measurements of total power and any others as required by local practices. The total power measurement is a high-impedance level measurement.

19. Enter the benchmark measurements as provided for on the back.

20. Enter the loopback measurements as provided for on the back.

4.03 The data transmission history form, shown in Fig. 5, is not a standard form at this time and should be reproduced for local use.◖

TABLE A

RECOMMENDED ORDER OF TESTS TO BE PERFORMED DUE TO TROUBLE REPORTS

RECOMMENDED ORDER OF TESTS	MANUAL TESTING	SARTS
Continuity	*	Generic 1A
Loss	*	Generic 1A
"C" Notched Noise	*	Generic 1A
Impulse Noise	*	Generic 2
Phase Jitter	†	Generic 2‡
Gain Slope (3-tone)	*	Generic 1A
P/AR	§	Generic 2
Attenuation Distortion	*	Generic 1A
Intermodulation Distortion	*	Generic 2
Hits, Dropouts	*	¶
Return Loss	**	Generic 1A**
Single Frequency Interference	*	¶
Frequency Offset	*	Generic 1A
Envelope Delay Distortion	*	¶

* Test required
† Two of three phase jitter measurements required (4-20, 20-300, or 4-300 Hz).
‡ Available in 4-20 and 20-300 Hz bands only.
§ If P/AR fails, skip immediately to measuring attenuation distortion return loss and envelope delay distortion.
¶ Test is not available
** Required on all data channels with 2-wire sections or 2-wire data terminals.

TABLE B

ATTENUATION DISTORTION AND ENVELOPE DELAY DISTORTION REQUIREMENTS (NOTE)

HERTZ	CONDITIONING											
	BASIC		C1		C2 & C5		C4		C7		C8	
	ATT DIST	ENV DEL	ATT DIST	ENV DEL	ATT DIST	ENV DEL	ATT DIST	ENV DEL	ATT DIST	ENV DEL	ATT DIST	ENV DEL
304	X		X		X		X					
404									X		X	
504	X		X		X	X	X	X	X		X	
604	X		X		X	X	X	X	X		X	
804	X	X	X	X	X	X	X	X	X		X	
1004	X	X	X	X	X	X	X	X	X	X	X	X
1204	X	X	X	X	X	X	X	X	X	X	X	X
1404	X	X	X	X	X	X	X	X	X	X	X	X
1604	X	X	X	X	X	X	X	X	X	X	X	X
1804	X	X	X	X	X	X	X	X	X	X	X	X
2004	X	X	X	X	X	X	X	X	X	X	X	X
2204	X	X	X	X	X	X	X	X	X	X	X	X
2404	X	X	X	X	X	X	X	X	X	X	X	X
2504	X	X	X	X	X	X	X	X	X	X	X	X
2604*	X	X	X	X	X	X	X	X	X	X	X	X
2704†	X		X		X	X	X	X	X		X	
2804	X		X		X	X	X	X				
3004	X		X		X		X					
3204							X					

Note: Make frequency response and/or envelope delay distortion runs at the frequencies indicated for each type of data channel. The limits are found under each configuration.

* Do not measure at this frequency if 2600-Hz signaling units are used in the layout. Instead interpolate from the values measured at 2504 and 2704 Hz.

† Tone-operated loopback devices (such as the 44A1 data unit) must be disabled.

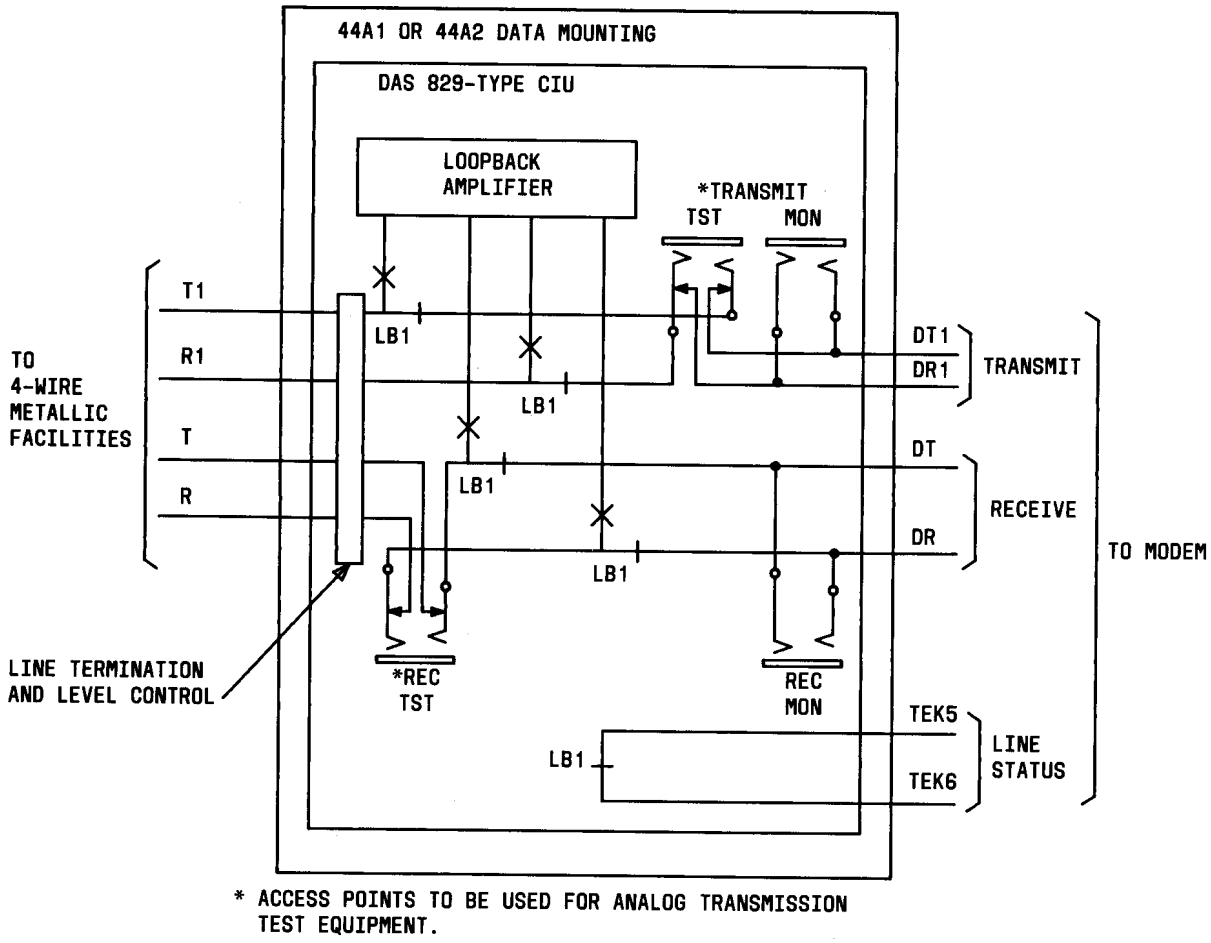

Fig. 1—Standard Circuit Design for Data Only, 4-Wire Data Set

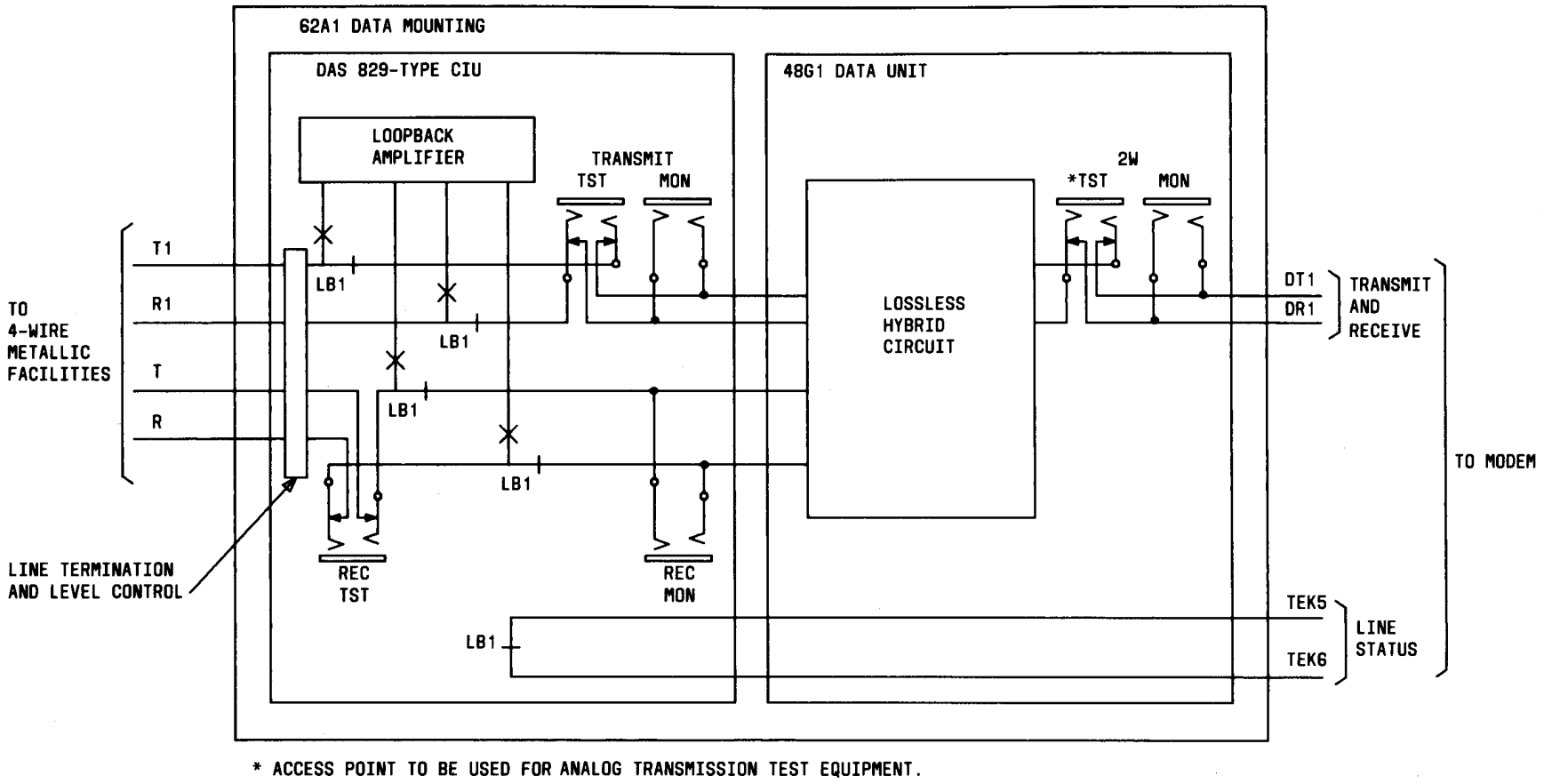

Fig. 2—Standard Circuit Design for Data Only, 2-Wire Data Set

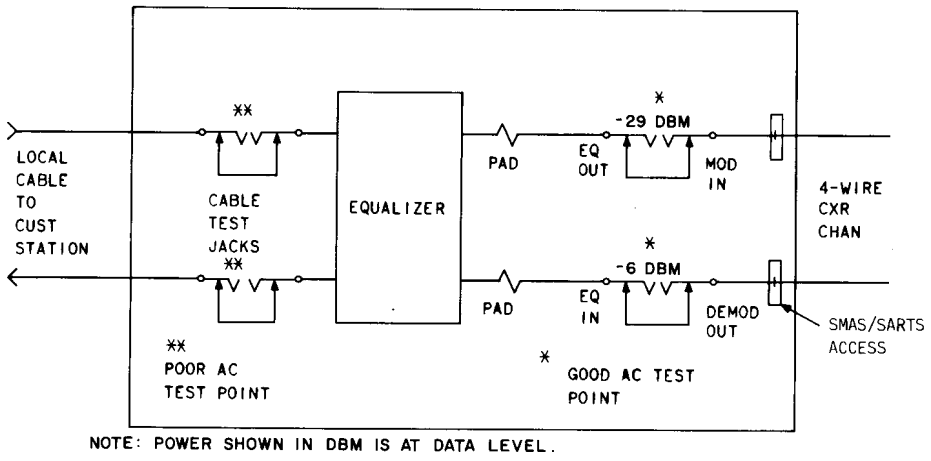

Fig. 3—Test Access Points on 4-Wire Circuit at Typical STC Office

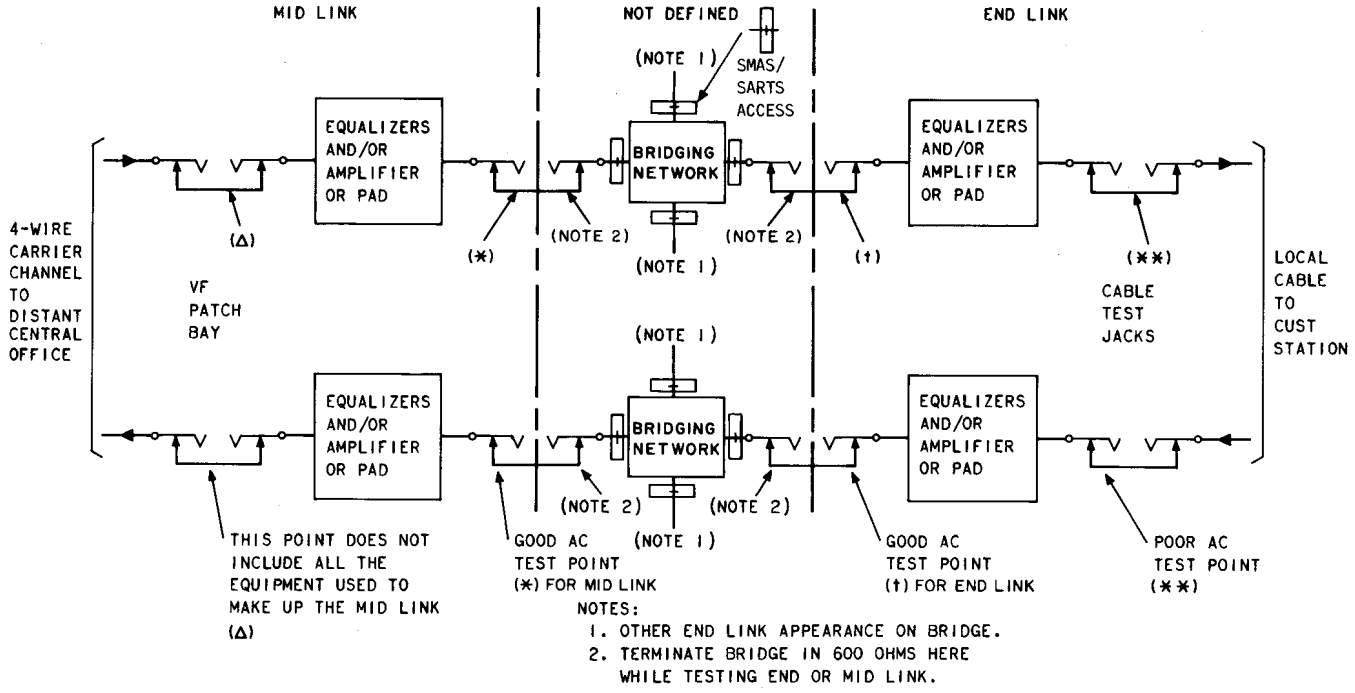

Fig. 4—Test Access Points on 4-Wire Multipoint Circuit at Bridge Location

DATA TRANSMISSION HISTORY FORM

CIRCUIT NUMBER (1) LINK (2)

TEST DATE	(3) TRANS		(3) REC		(3) TRANS		(3) REC	
	EDD (4)	AD (4)	EDD (4)	AD (4)	EDD (4)	AD (4)	EDD (4)	AD (4)
304								
404								
504								
604								
804								
1004								
1204								
1404								
1604								
1804								
2004								
2204								
2404								
2504								
2604								
2704								
2804								
3004								
3204	X		X		X		X	
(5) 1004 HZ NET LOSS								
(6) C-NOTCHED NOISE								
(7) IMPULSE NOISE								
(8) PHASE JITTER - BELL								
LF								
BELL + LF								
(9) PEAK-TO-AVE RATIO (P/AR)								
(10) INTERMOD DISTORTION - 2ND ORDER								
3RD ORDER								
(11) PHASE HITS								
(12) GAIN HITS								
(13) DROP OUTS								
(14) RETURN LOSS								
(15) SINGLE FREQ INTERFERENCE								
(16) FREQUENCY OFFSET								
(17) COMPOSITE POWER								

Fig. 5—Data Transmission History Form (Sheet 1 of 2)

ROUTINE MEASUREMENT (18)								
TOTAL POWER	TRANS	REC	TRANS	REC	TRANS	REC	TRANS	REC
BENCHMARK MEASUREMENTS (19)								
END-TO-END								
1004 HZ								
P/AR								
C-NOTCHED NOISE								
COMPOSITE POWER								
LOOPBACK MEASUREMENTS (20)								
1004 HZ								
P/AR								
C-NOTCHED NOISE								
COMPOSITE POWER								

B-FORM E-5596 (BACK)

Fig. 5—Data Transmission History Form (Sheet 2 of 2)