VOICE BANDWIDTH PRIVATE LINE DATA CIRCUITS

MAINTENANCE

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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. At this time, there are several types of data sets used in private line data service, ranging in bit speed from low (below 300 bits per second) to high (up to 9600 bits per second).

1.02 This section is reissued to update and realign information consistent with the Data General Layer (314-010-ZZZ). Information previously covered in this section can be found in the Data General Layer. Since this reissue is a general revision, no revision arrows have been used to denote 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)

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- Data General—Data Testing Principles (Section 314-010-101)
- Data General—Data Service Support (Section 314-010-102)
- DataGeneral—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 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, or have C1, C2, C4, or C5 conditioning. C3 conditioning is restricted to switched services network only. Information on this type of conditioning is given in Section 309-200-301. C6 conditioning is restricted to protective relaying channels as discussed in Section 310-540-100. C7 and C8 conditioning is restricted to electronic tandem networks (ETN) and is contained in Section 309-400-300. C5 conditioning can be ordered only on 2-point circuits.

2.03 End-to-end measurements are preferred in all cases and should be performed if service conditions permit. Sectional measurements made with the Collins CLA-type system are considered equivalent to end-to-end measurements. End-to-end measurements are required in all cases where the customer is not satisfied and/or the need for technical escalation is indicated.

2.04 For the purpose of estimating end-to-end 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 station and the other section should be from the same SSC/STC to the distant station. Care should be exercised to ensure that no office equipment or wiring is omitted or measured twice in this sectionalization. End-to-end 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

2.05 The end link/midlink concept allocates end-to-end 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 redesign 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.

2.06 The end link/midlink allocation rules take advantage of statistics when combining link parameters and thus do not guarantee that the end-to-end 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 end-to-end 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.***

2.07 When acceptable mid-link and end-link tests are completed, end-to-end 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.

2.08 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

2.09 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. End-to-end (customer-to-customer) attenuation distortion and envelope delay distortion measurements are not normally required.

2.10 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

2.11 A customer premises switched arrangement is permissible.

2.12 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.

2.13 The end-to-end facility parameter must be met on each individual channel. However, it is not required to assure that end-to-end 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

2.14 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.

> ***Note:*** The station loss between the jacks and the connection to the data set must be tested before the jack access point is used. The jack access point should ***not*** be used when tests are being performed, in the case of repeated trouble reports, to check that the end-to-end transmission parameters are within limits. Only the point where the data set is connected is used.

2.15 When making transmission measurements at the customer location, DAS 829 type CIU part of the channel facilities and tests are to be made through it.

2.16 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.

2.17 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

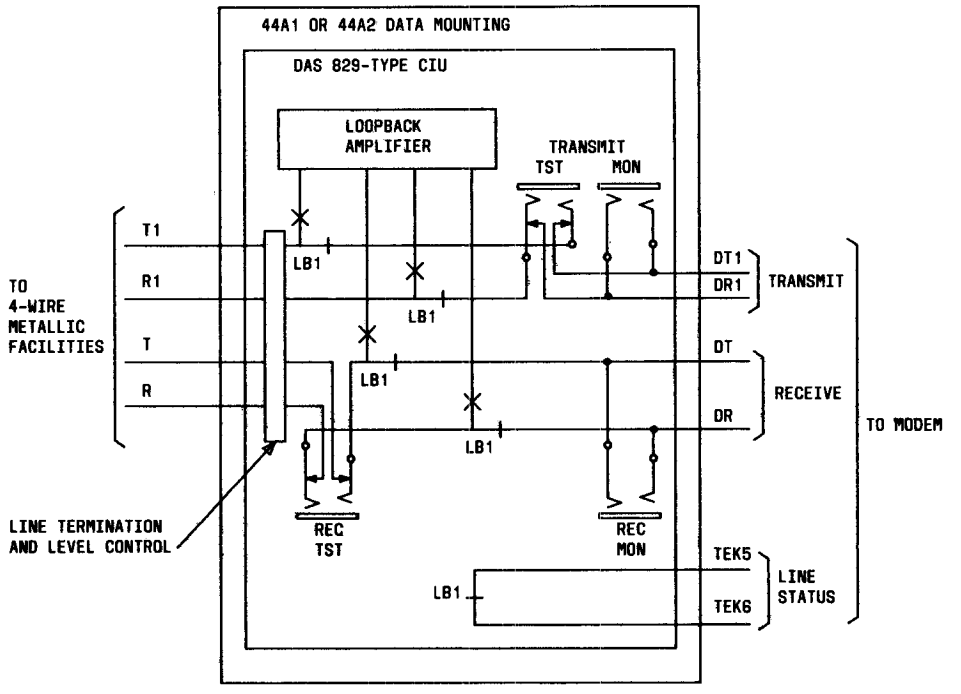

Fig. 1—Standard Circuit Design for Data Only, 4-Wire Data Set

basis unless the WORD document specifies some other impedance.

2.18 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 associated with a 4-wire carrier channel.

2.19 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 that appearance 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 tests required for installation, routine and trouble. While this section deals specifically with maintenance

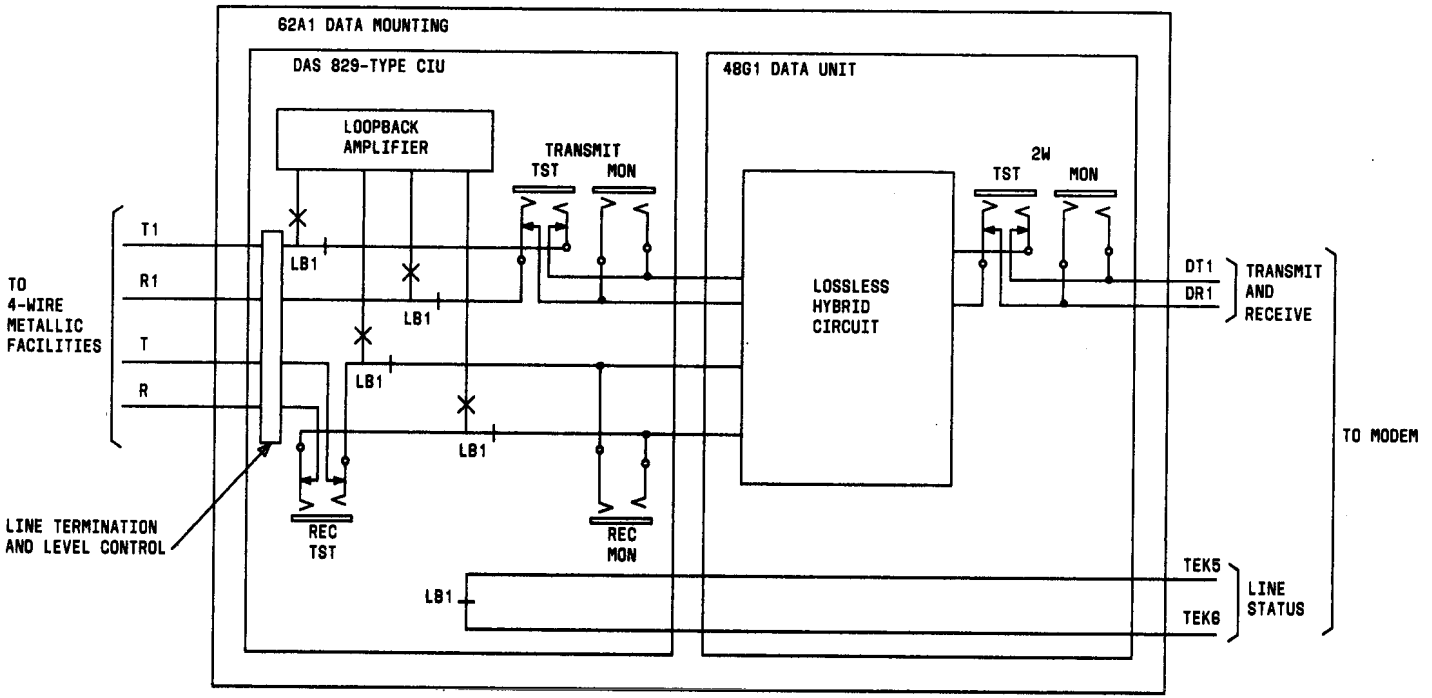

Fig. 2—Standard Circuit Design for Data Only, 2-Wire Data Set

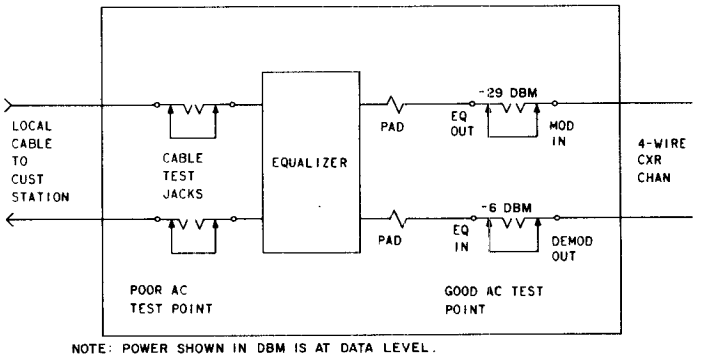

Fig. 3—Test Access Points on 4-Wire Circuit at Typical STC Office

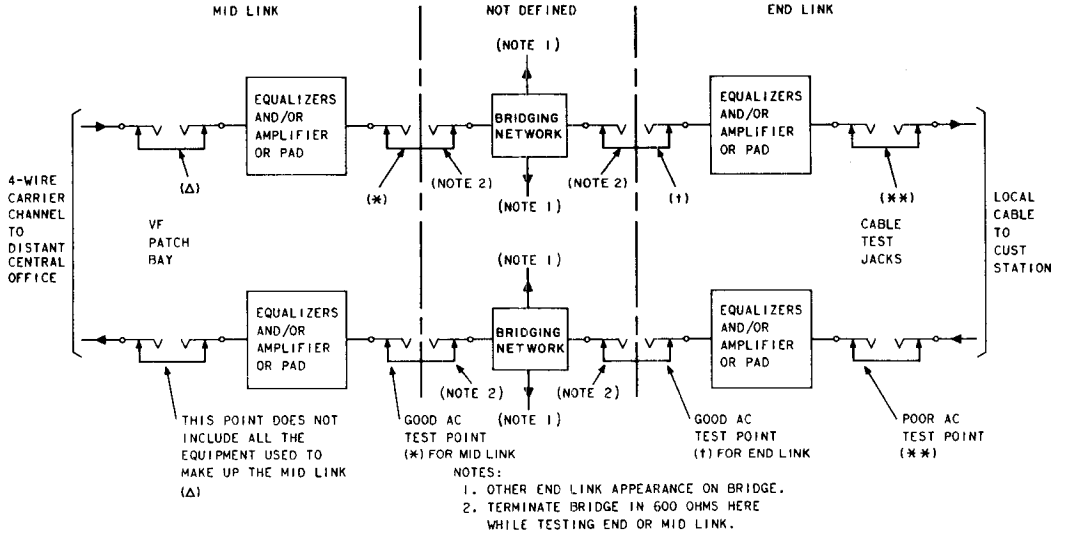

Fig. 4—Test Access Points on 4-Wire Multipoint Circuit at Bridge Location

TABLE A

RECOMMENDED ORDER OF TESTS TO BE PERFORMED DUE TO TROUBLE REPORTS

RECOMMENDED ORDER OF TESTS	MANUAL TESTING	SARTS
Continuity	*	(1)
Loss	*	(1)
"C" Notched Noise	*	(1)
Impulse Noise	*	(2)
Phase Jitter	(3)	(2) (4)
Gain Slope (3-tone)	*	(1)
P/AR	(5)	(2) (5)
Attenuation Distortion	*	(1)
Intermodulation Distortion	*	(2)
Hits, Dropouts	*	—
Return Loss	(6)	(1) (6)
Single Frequency Interference	*	—
Frequency Offset	*	(1)
Envelope Delay Distortion	*	—

Notes:

1. Available on SARTS, generic 1A.
2. Available on SARTS, generic 2.
3. Two of three phase jitter measurements required (4-20, 20-300, or 4-300 Hz).
4. Available in 4-20 and 20-300 Hz bands only.
5. If P/AR fails, skip immediately to measuring attenuation distortion return loss and envelope delay distortion.
6. Required on all data channels with 2-wire sections or 2-wire data terminals.

— Test is not available

* Test required

of PL data circuits, installation and routine tests must also be considered.

B. Loop-Back Tests

3.02 The following loop-back 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 loop is made at the customer station. Before operating the loop-back 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 loop-back arrangements, it

will prevent the loop-back control tone towards the local station from causing loop-back relays at the other customer stations to operate.

3.03 The application of direct current to the 4-wire simplex path for purposes of operating the loop-back relay at the customer station may cause troubles, such as opens or noise, to come clear. This is generally caused by a poor solder connection. 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, 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. End-to-End Trouble Tests

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

(1) Loop-back tests have been made at each end of the circuit and all limits met.

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

(3) The customer has been requested to verify the proper operation of his equipment and has reported back 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 end-to-end 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 end-to-end 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 When the modem is CPE, the initial trouble report tests specified in Section 314-010-101 should be made and any troubles found cleared.

3.09 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 the customer's 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.

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

E. Routine Tests

3.11 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 FORM E-5596

4.01 The tests to be performed are given in Table A. These measurements should be made and the results recorded on Form E-5596. The back of Form E-5596 is used for recording benchmark measurements. Loop-back and straightaway measurements are both provided and should be used at the time of installation for later reference. Note that the circuit mileage is doubled when loop-back tests are made for purposes of determining C-notched noise and impulse noise requirements.

4.02 The following is an explanation of entries for Form E-5596 (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 loop-back test results.

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

4. ***CKT Order No.:*** Enter circuit order number.

5. ***ED/AD:*** Enter results for attenuation distortion and envelope delay distortion (EDD) measurements made for circuit order or trouble tests.

6. ***1004-Hz Net Loss:*** Enter the 1004-Hz loss measurement.

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

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

9. ***Phase Jitter:*** Enter phase jitter measurements as required.

10. ***Gain Slope:*** Enter the three tone measurements.

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

12. ***Intermodulation Distortion:*** Enter the intermodulation distortion measurements as required.

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

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

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

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

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

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

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

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

4.03 Form E-5596 is available only in package units of 25 forms. Orders should be placed in multiples of 25 forms and worded as follows:

(Quantity), Form E-5596

4.04 This form will not be stocked automatically at the Western Electric Company Service Center. Each company must authorize its local service center to stock new forms. In case of revised forms, disposition must be given of the old forms before the revised forms can be stocked.

314-410-500 E-5596

CIRCUIT NUMBER (1) DATA TRANSMISSION HISTORY CARD LINK (2) PRINTED IN U.S.A.

TEST DATE	(3)		(3)		(3)		(3)		(3)		(3)	
CKT. ORDER NO. (4)	(5) TR (INITIAL)		(5) REC (INITIAL)		(5) TR		(5) REC		(5) TR		(5) REC	
	DELAY	GAIN FREQ	DELAY	GAIN FREQ	DELAY	GAIN FREQ	DELAY	GAIN FREQ	DELAY	GAIN FREQ	DELAY	GAIN FREQ
300	X		X		X		X		X		X	
500												
600												
800												
1000												
1200												
1400												
1600												
1800												
2000												
2200												
2400												
2500												
2600												
2700												
2800												
3000												
3200	X		X		X		X		X		X	
(6) FREQ. SHIFT HZ												
(7) PHASE JITTER DEGREES												
(8) SINGLE-FREQ INT. DBRNCO												
(9) HARMONIC DIST. (2ND/3RD) DB												
(10) C-NOTCHED NOISE DBRNCO												
(11) RETURN LOSS - SP DB												
(12) DC LOOP RESISTANCE OHMS												

A - Form E-5596 (Front)

ROUTINE MEASUREMENTS

CIRCUIT NUMBER (1) LINK (2)

TEST DATE	Total Power DBMO		1000 HZ Loss DEVIATION		Noise DBRNCO		Impulse Noise COUNTS/15 Min.		P/AR	
	TR	REC	TR	REC	TR	REC	TR	REC	TR	REC
INITIAL MSMNTS	(13)	(13)	(14)	(14)	(15)	(15)	(16)	(16)	(17)	(17)
(3)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)	(18)
(3)										

B - Form E-5596 (Back)

Fig. 5—Form E-5596—Data Transmission History Card