COMMON CHANNEL INTEROFFICE SIGNALING
VOICE FREQUENCY LINK
DESCRIPTION, MAINTENANCE, AND TESTS

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1. GENERAL

1.01 This section provides the maintenance philosophy and test requirements for circuit order and maintenance testing of the voice frequency link (VFL) portion of the common channel interoffice signaling (CCIS) network.

1.02 Whenever this section is reissued, the reason for reissue will be given in this paragraph.

1.03 The testing is performed at 4A Toll Switching Systems having an Electronic Translator System (ETS) and operating as a signal transfer point (STP) or as a switching office (SO) and at No. 4 Electronic Switching System (ESS) offices operating as switching offices.

2. DESCRIPTION OF CCIS SIGNALING NETWORK

2.01 CCIS is a system for exchanging information between processor-equipped switching systems over a network of signaling links. All signaling data, including the supervisory and address signals necessary to control call setup and takedown, as well as network management signals, will be exchanged by these systems over the signaling links instead of being sent over the message trunk voice path as is done using present conventional signaling techniques.

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2.02 As shown in Fig. 1, a signaling link (SLK) consists of two signaling terminals, two modems, and one or two VFLs. The signaling terminals store both outgoing signaling messages awaiting transmission and incoming messages until ready to be processed. Each modem forms a digital-analog interface between the terminal and VFL. The VFL is a conventional 4-wire, message-grade transmission facility, roughly equivalent to a type 3002 private line data channel. The terminal access circuit (TAC) enables the processor to access the various signaling links, provides an interface between processor and terminal, and performs certain maintenance operations.

2.03 Figure 1 is an example of an A- or E-Type SLK between a 4A SO and a SSTP having two VFLs (VFLA and VFLB). As discussed later, the method of test access for the VFL is different for various types of offices and there is only one VFL in a B- or C-type SLK between STPs or in an F-type SLK between SOs.

2.04 With the CCIS system, no signals are passed over the message trunks; therefore, trunk failures can no longer be detected by the loss of supervision as is done with SF/MF signaling. Instead, a number of 1800 Hz continuity check transceivers are provided which are connected to CCIS trunks during call setup to check the continuity of the voice path.

2.05 The simplest and most direct form of CCIS is to provide a direct signaling link between the processors of all CCIS-equipped switching offices having interconnecting trunks. Such a configuration is known as "associated signaling," ie, a redundant pair of signaling links (F links) is associated with a specific trunk group. In most cases, however, CCIS will be provided via a "signaling network" as shown in Fig. 2. For simplicity, no trunks are shown in Fig. 2. The nation will be divided initially into ten signaling regions which have been chosen to correspond to the existing regions of the direct distance dialing (DDD) hierarchy. All CCIS-equipped switching offices within a switching region will concentrate the signaling traffic for all their CCIS trunks on a few well-loaded Access (A) links to a pair of signal message concentrators in the region called signal transfer points (STPs). A links are always provided in fully redundant pairs—one link to each of the two STPs in the region.

2.06 Because the signaling messages for many trunks will be sent over the same signaling link (approximately 3000 trunks per pair of A links), all signaling messages will include a label identifying the trunk for which signaling is being sent. The STPs will use the band portion of this label to determine the outgoing link on which the received signaling message is to be forwarded.

2.07 To provide for signaling backup, all signaling paths and STPs will be duplicated and fully redundant. As shown in Fig. 2, each STP is connected to the "mate" STP in its own region by two or more Cross (C) links. Between regions, two Bridge (B) links will connect both mate STPs in the other region. Together, the four B links between two regions are referred to as a "quad". From each SO, redundancy is achieved by providing A links to both STPs in the home region. A1 and A2 illustrate this redundancy. To achieve even greater reliability, two VFLs (VLFA and VFLB) are assigned to each A link. These VFLs utilize diverse routes if possible. In the event of failure or high error rate on the regular VFL, the reserve is automatically switched into the signaling link under control of the processor.

2.08 A switching office may have E links to a STP in a distant region if warranted by the amount of traffic. Two VFLs are also assigned to each E link. Only one VFL is assigned to B-, C-, and F-type SLKs.

3. SIGNAL LINK OFFICE·CONTROL PLAN

3.01 Each individual signaling link is assigned a control office (Fig. 2). This office is responsible for the overall maintenance and service availability of the link and all facilities which may have an effect on these factors. This office is, in turn, responsible to the network control office of which the link is a part and must operate in support of its activities. Control of VFLs parallels that of the signaling link control. The office having signaling control also has VFL control.

A Links

3.02 The switching office end of A links is designated as control. Since A links operate in mated pairs and are common at the switching office end, this places the switching office in a better position to observe the performance of the complement than either of the regional STPs. Note,

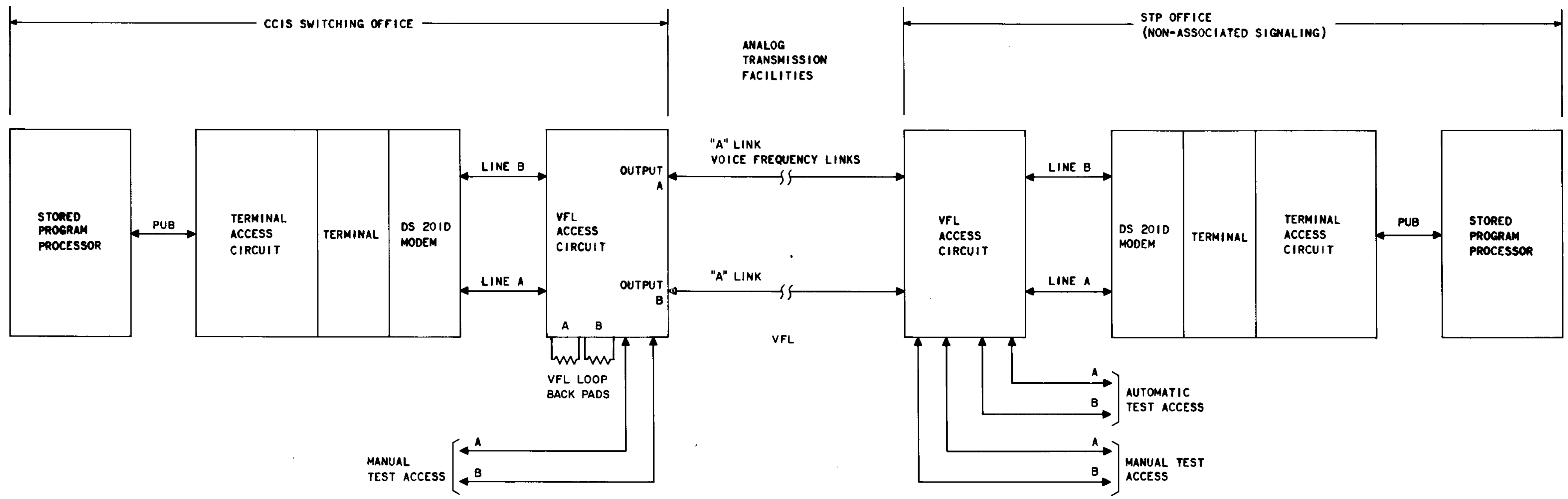


Fig. 1—Basic CCIS System Block Diagram

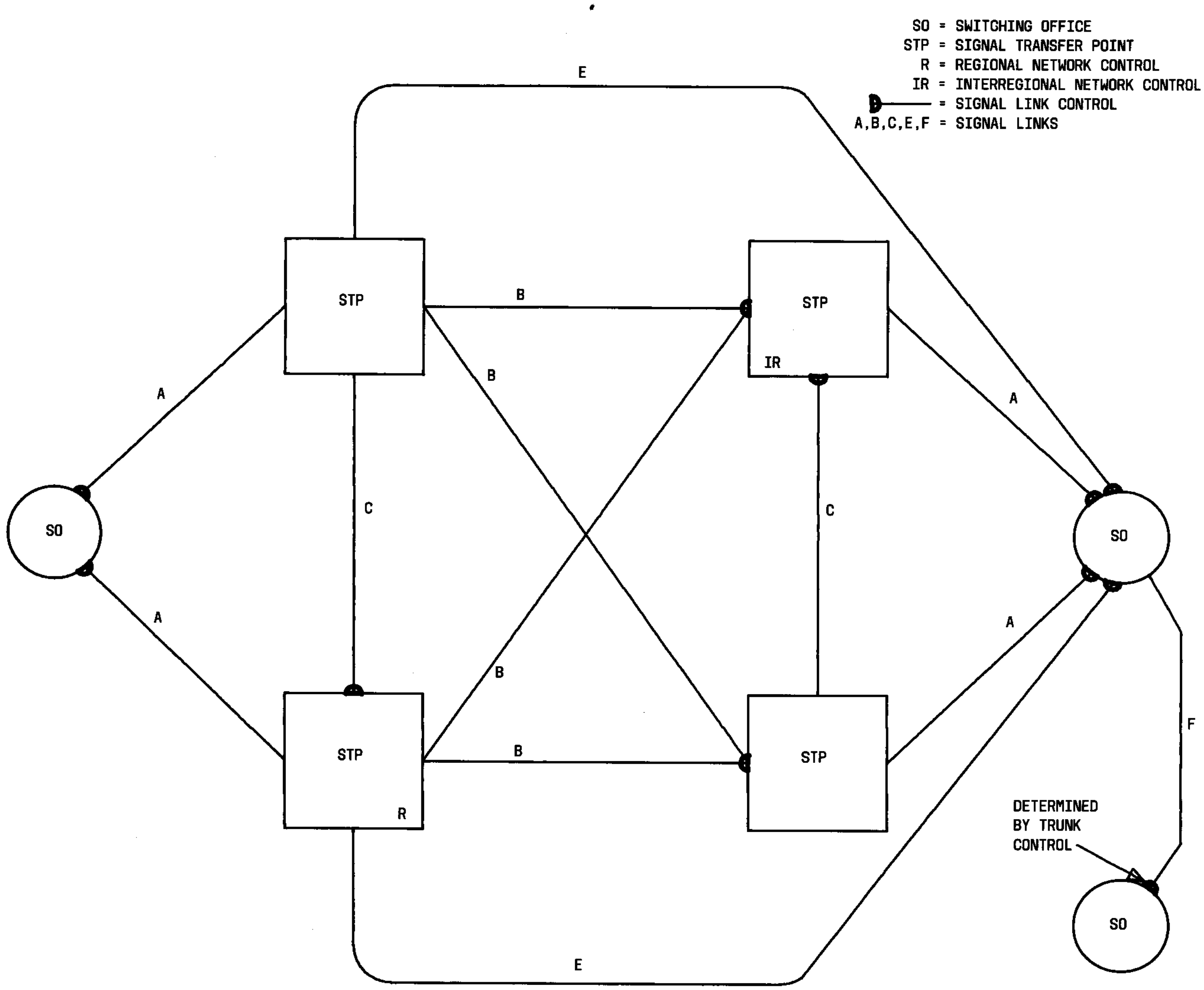


Fig. 2—CCIS Network

however, that an STP has many more VFLs than a SO; thus, the STP has more extensive VFL testing equipment and has more test requirements on VFLs in A-SLKs than the SO.

C Links

3.03 The STP having regional network control will be assigned control of the C links. Having direct control of the C links will enhance the STPs' ability to function as regional control.

B Links

3.04 Since these links are viewed on a quad basis, control is assigned to the STPs in the region having interregional network control. Each of the mate STPs in this region will have control of the B link pair terminating at its office.

E Links

3.05 These links are controlled by the switching office end for the same reasons as for A links.

F Links

3.06 These are directly associated signaling links between switching offices and are not part of any network. The control of these links should, in general, parallel that of the assigned trunks using the links. That is, the office having control of the majority of associated trunks should also control the signaling links.

4. VFL TESTING ARRANGEMENTS

4.01 To understand the VFL maintenance plan, it is helpful to first understand how the maintenance for the signaling links will be administered. As shown in Fig. 2, each SO will be the operational control office for its A links. Also, for each signaling region, one of the two mate STPs will be designated as the regional network control office. One of the two regional control offices will also be designated as the interregional network control office for each interregional signaling link quad.

4.02 It is planned that the maintenance control for the VFLs will parallel that for the signaling links. Since the overall maintenance control of the signaling links within the SO will be the responsibility of the Maintenance Operations Center (MOC), the Trunk Operation Center (TOC) will act on a subcontrol basis for the VFL portion of the link.

4.03 Access to the VFLs from the TOC for transmission testing (of standby VFLs) will be on a manually requested basis. Access will always be denied if the VFL is carrying signaling traffic. This is to prevent interruptions due to inadvertent or unauthorized connections. In addition, some diagnosed VFL troubles will clear before actual testing begins and the link will be automatically returned to service. Subsequent attempts to gain test access will therefore be denied and an appropriate report made to maintenance personnel.

4.04 VFL test access implementation in 4A ETS and 4 ESS offices will be different. The 4A ETS offices will employ a dedicated wired path between modems and VFLs via a dedicated per-link test access circuit as indicated in Fig. 1 and 3. The test access circuit in 4A permits testing access to be established to the VFL from the TOC over a dedicated test access path. In the 4 ESS system, however, modems will be connected to VFLs via semipermanent connections through the 4 ESS trunk switching network as indicated in Fig. 4.

VFL Test Position Access at 4A Switching Offices

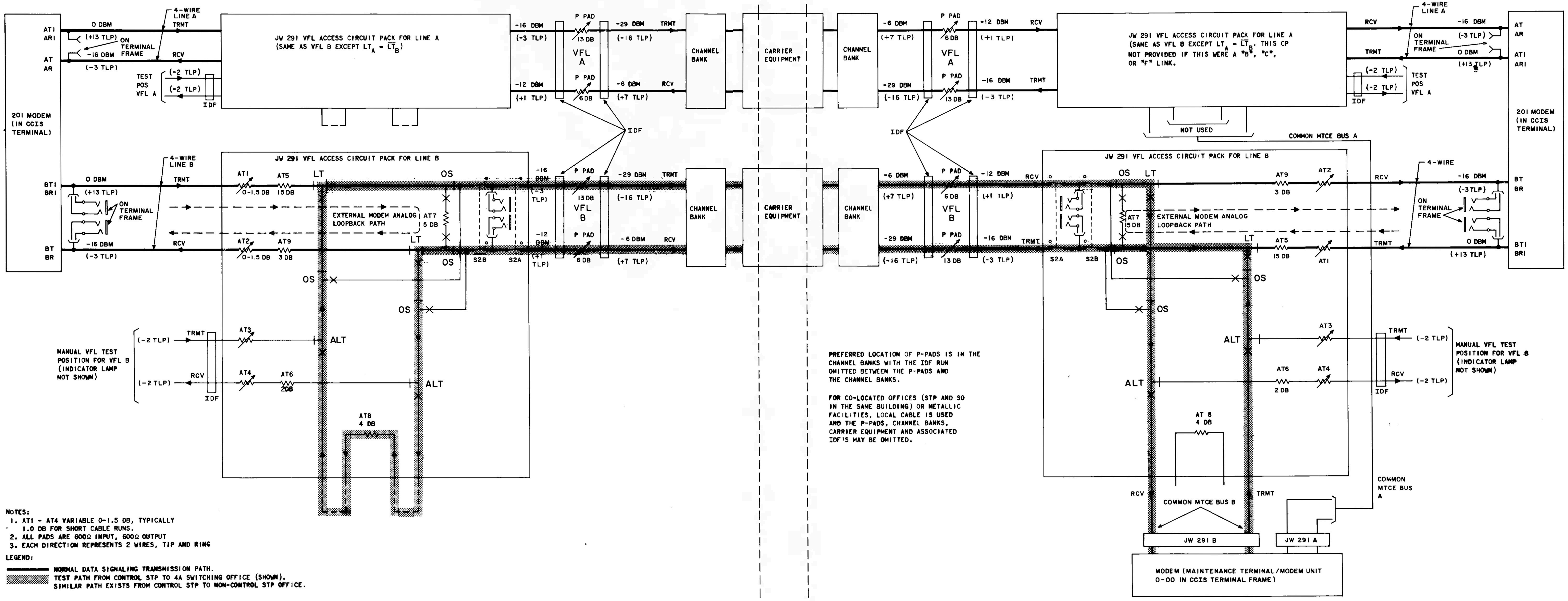
4.05 The VFL test position access at the No. 4A switching offices is shown in the left half of Fig. 3. Each VFL is equipped with a lamp and jack appearance on the trunk test and VFL jack (TTJ) bay. The TTJ bay should be physically located in the CCIS integrated manual test frame (IMTF) test position lineup. Arrangements have been provided for patching from the VFL jack appearance to the IMTF to gain access to the IMTF position test equipment and telephone circuit. Section 212-807-502 provides detailed test frame procedures.

4.06 Normally, the standby VFL is switched to the jacks on the TTJ bay but the lamp associated with the jack will not be lighted. Note, however, in no case can a VFL that is carrying signal load be switched to the TTJ bay. When testing an idle VFL for either trouble isolation or routine transmission tests, the request to switch the VFL to the TTJ bay can be made, via a TTY command, from either the MOC or the IMTF position in the TOC. This will cause the desired idle VFL to be switched to the proper jack, if it was not already in the standby mode, and the associated lamp to be lighted.

4.07 Figure 3 shows that the VFL access circuit provides for connecting the modem and signaling terminal to either VFL. It also provides circuitry for connecting a passive loopback (AT8) in the switching office end of an idle VFL. This allows for an automatic system data transmission test using the maintenance terminal/modem unit at the STP end or for manual loopback measurements from the VFL test frame in the STP end. The passive loopback path is arranged to provide a zero net loss at the looped end.

VFL Test Position Access at 4A STP

4.08 The test position access at a 4A STP is the VFL test frame typically located in the STP area. The test frame is equipped with a Hewlett-Packard 4940A transmission impairment measuring set (TIMS) with option 003 for conducting attenuation distortion, envelope delay, noise, impulse noise and transient phenomena, nonlinear distortion, peak to average ratio (P/AR), and other tests. The frame also contains a telephone set for communications with other personnel involved in the tests. The telephone set, under key control, may also be connected directly to the circuit under test for talking and monitoring purposes. A more detailed discussion of the VFL test frame can be found in Section 212-807-503.



NOTES:
1. AT1 - AT4 VARIABLE 0-1.5 DB, TYPICALLY 1.0 DB FOR SHORT CABLE RUNS.
2. ALL PADS ARE 600Ω INPUT, 600Ω OUTPUT
3. EACH DIRECTION REPRESENTS 2 WIRES, TIP AND RING

LEGEND:

NORMAL DATA SIGNALING TRANSMISSION PATH.

TEST PATH FROM CONTROL STP TO 4A SWITCHING OFFICE (SHOWN). SIMILAR PATH EXISTS FROM CONTROL STP TO NON-CONTROL STP OFFICE.

Fig. 3—VFL Test Access 4A SO/STP

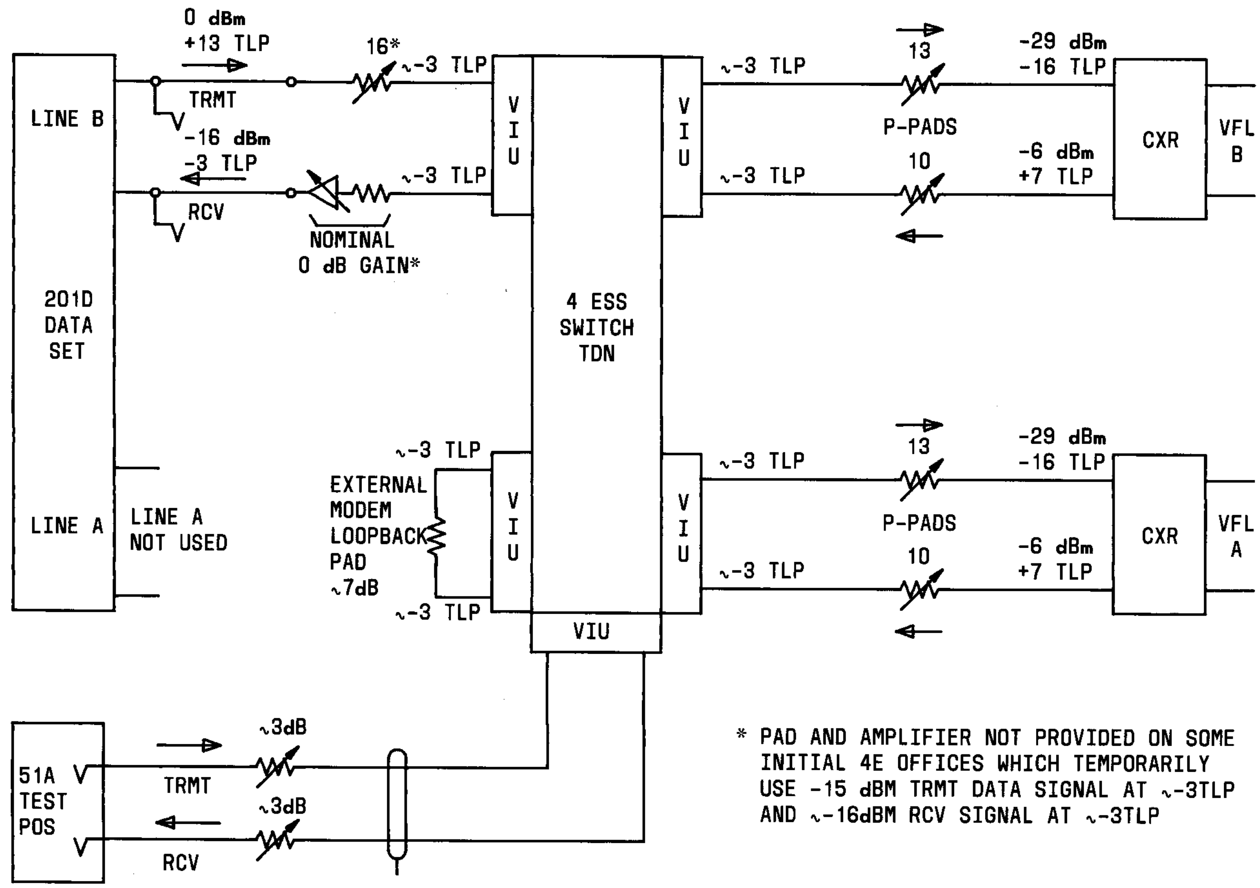


Fig. 4—VFL Test Access 4 ESS CCIS SO

4.09 The VFL test frame will remain if a 4A/ETS STP is converted to a stand alone STP (SPC/STP) which has no trunks and no crossbar switching network.

4.10 Some initial STP offices use the 17C arrangement. In this arrangement the STP VFL access circuit can connect either VFL to the modem/signaling terminal, the 17C jack appearance, or the maintenance terminal modem. Normally, one VFL would be connected to the modem and the other would be in the idle standby state, connected to the 17C jack appearance with the lamp out. For B- and C-type signaling links at the STP, only a single VFL would be provided. However, VFL access circuits can also switch from the modem/signaling terminal to the 17C appearance or the maintenance modem for testing and trouble isolation. An optional stored program control (SPC) TTY channel is also available at the STP VFL test position. It will allow craft at the VFL test position to switch a VFL, not carrying signal traffic, to or from the test position for maintenance reasons.

VFL Test Position Access at 4 ESS

4.11 The VFL testing access for the No. 4 ESS, as shown in Fig. 4, is via a connection through the No. 4 ESS switching network, (see Section 234-150-001). Manual testing, when required, will be provided by switching the VFL, (VFL A or B of Fig. 4) under processor control, to a designated 51A-type position that will also be used for message trunk testing. Jacks are available on this test position to use portable test equipment. As indicated in Fig. 4, a switched connection to a passive loopback termination is not provided. This 0 dB net loss VFL loopback function is provided internally, when required, by the time division switching network (TDN) in the No. 4 ESS. It will also be possible to switch the signaling terminal/modem line B up to the 51-type position for VFL testing and trouble isolation. In all cases, when the maintenance operations are complete, the proper configurations will again be established via the switching network.

4.12 For all three types of VFL test access posiions shown in Fig. 3 and 4, testing access to VFL is not at the actual VFL-modem interface. The tests are performed over an essentially transparent (from a transmission point of view) access path to the test position using designated and preadjusted transmission level points. Jack access has been provided however at the terminal/modem frames for initial lineups and for subsequent testing of possible office wiring troubles should they occur. (Jacks, pads, and amplifiers associated with the data modem have not necessarily been shown.)

> ***Note:*** It is assumed that the tests and adjustments of all portions of the VFL within the individual offices, including the portion between the modem and the test access, have been performed per the applicable BSP sections prior to performing the tests in this section. Certain tests in those applicable BSPs should also be performed again in the event a VFL trouble cannot be cleared.

5. VFL ACCESS FRAME AND ACCESS CIRCUIT

5.01 The VFL access circuit in 4A SOs or STPs permits nonactive VFLs to be connected to the manual VFL test position facilities (integrated manual test frame IMTF/TTJ bay) within SOs. It also provides the facilities for connecting a VFL to the maintenance terminal/modem unit located at the STP for "A" or "E" signaling links. The test positions are referred to as the "manual VFL test position". A new design 7-foot VFL test position frame is available and is located in the SPC area in a STP office.

5.02 The configuration of the VFL access circuit is always controlled by the SPC. Manual test access can be obtained only through system processor approval. The processor gracefully removes signaling traffic from the VFL when manual testing is requested via the SLM-01 TTY input message.

5.03 All ***idle*** VFLs which are not connected to the MTCE terminal/modem unit are connected to the manual VFL test position facilities. A lamp or light emitting diode (LED) associated with a single VFL will be lighted at the manual VFL test position whenever that VFL is connected to the test position and when the associated signal distribute point is operated by the SPC. The connection to the manual VFL test facilties is made or released by use of the SLM-02 TTY input message.

VFL Access Circuit Pack

5.04 The VFL access circuit pack performs the following functions:

(a) Provides access to the 4-wire VFL for testing

(b) Provides line build-out capability to compensate for variable lengths of office wiring

(c) Allows automatic testing of idle VFLs using actual data transmission via loopback tests using pad AT8 in a SO and the maintenance terminal/modem unit in an STP on A- and E-type SLKs

(d) Allows manual loopback transmission measurements to be made by connecting the loopback pad AT8 to the VFL in the SO end in A-, E-, and F-type SLKs and in either STP end of B- or C-type SLKs

(e) Provides an external modem loopback for use in the modem diagnostics program.

5.05 The required tests and adjustments for the level pads in the VFL access circuit (JW291 circuit packs) along with other tests are contained in Section 212-807-701.

5.06 A green LED on the front of the VFL access CP is lighted whenever the terminal unit is disconnected from the VFL. Thus, a lighted LED indicates the VFL is off-line and not carrying CCIS signaling traffic.

5.07 As a fail-safe feature, the VFL is connected to the signaling unit whenever there is no power to the VFL access circuit. (Relays all nonoperated.)

5.08 Both VFLs are simultaneously connected to the manual test position by the SPC in the SO when the signal terminal unit is out of service and the OS lamp is lighted in the terminal unit power control circuit on the terminal frame.

6. VFL TROUBLE ISOLATION (Fig. 5)

6.01 When a nonservice affecting failure on one VFL of an A or E link occurs, the system automatically reroutes the traffic via another path and no report is made at that time. After a suitable delay, the trouble indicated circuitry is automatically retested. If the test passes, no report is made of the initial failure and the VFL is returned to service. If the test fails, the craft is notified by the audible and visual alarms and a TTY output message identifying the problem. The craft person can then take action to connect the VFL unit to the VFL test frame for location and correction of the fault.

6.02 When a nonservice affecting failure occurs on both VFLs of an A-signaling link or a single VFL of a (B) or (C) link, the system automatically reroutes traffic via another path and no report is made. For a period of approximately 3 minutes, the system attempts to automatically restore the faulted VFLs to service. If the attempt is successful, no report is made of the failure. Otherwise, the craft person is notified by the audible and visual alarms and a TTY output message identifying the problem. The craft person can then take action to connect the VFL unit to the VFL test frame for location and correction of the fault.

6.03 Since the results of a processor-initiated diagnostic test at the near end are not automatically printed out at the far end, they must be communicated verbally by personnel in the MOC or ETS maintenance area.

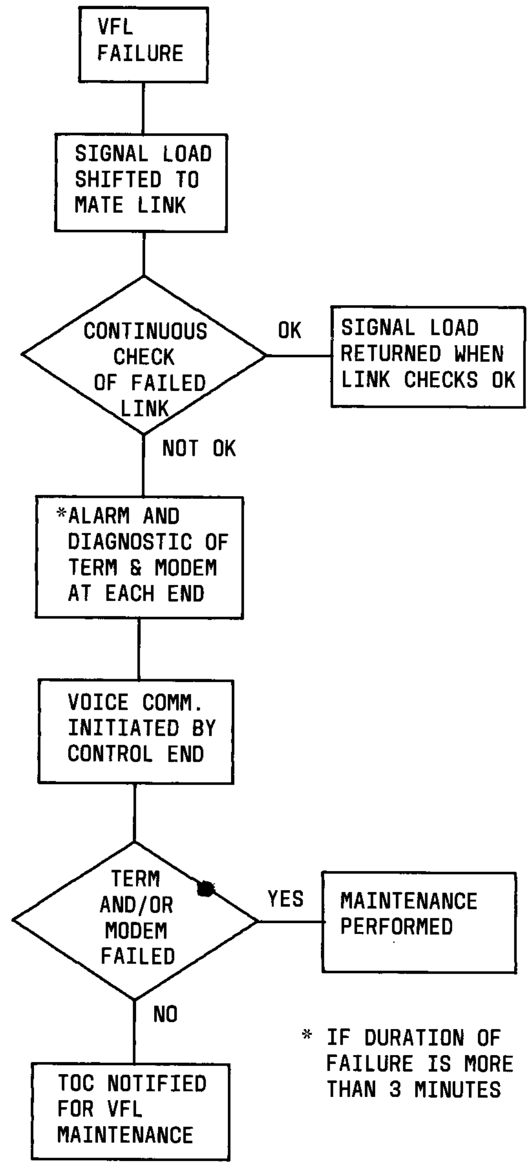


Fig. 5—VFL Failure Flow Chart

7. VFL INTEROFFICE COMMUNICATIONS

7.01 Most interoffice manual communication contacts will be made for the purpose of locating and clearing troubles in the VFL portion of signaling links after automatic tests have done the broad sectionalization to the VFL. A lesser degree of manual communication will be needed for administration and changes and for signaling network translation and other problems that may occur. No. 4A and No. 4 ESS CCIS maintenance areas are reviewed in the following sections.

4A-CCIS Switching Offices

7.02 Manual trunk test positions for CCIS VFL maintenance are the CCIS IMTF test positions. These positions have a testing responsibility for the VFL portion of signaling links. Voice communication for coordinating this work is required with manual test positions at the regional STPs and with other switching offices if fully associated links (F links) exist. In addition, voice contact will be required with intermediate carrier facility junction points when the VFL is made up of several carrier channels in tandem.

> *Note:* For reliability, a VFL trunk can be composed of no more than three carrier facilities.

The IMTF positions are equipped for outgoing access to the DDD network in the following ways:

1. Tandem access trunks into the 4A machine
   a. 7- or 10-digit DDD calls
   b. Area code + TTC code + 101 or 598.
2. Selection of a specific outgoing intertoll trunk
   a. 7- or 10-digit DDD calls
   b. Area code + TTC code + 101 or 958
   c. Code 101 call to far-end switching office.
3. Telephone lines to local class five office
   a. 7- or 10-digit DDD calls.

Incoming calls can be received on the local telephone lines or on 101 trunks.

7.03 The 4A MOC can be viewed as being comprised of the 4A machine maintenance area with an adjunct ETS/SPC maintenance area. The location of these with respect to each other could vary between offices from a few feet to possibly another floor. The MOC area has responsibility for the overall signaling link maintenance as well as maintenance relating to the CCIS signaling network as a whole. Those CCIS maintenance functions relating to signaling links and the signaling network are carried out in the ETS/SPC maintenance area. These functions require interoffice voice communications with the regional STPs as well as other SOs.

7.04 The 4A machine maintenance area is provided with tandem access to the toll machine as well as POTS lines. Incoming calls can be received on POTS lines and on the 958 incoming communication trunk. However, these facilities do not appear in the ETS maintenance area. Presently, the ETS areas are only provided with telephone lines to the local class 5 office. The practice in some locations has also been to provide foreign exchange (FX) telephone lines to a class 5 office that homes on another toll machine, thereby providing a bypass around the home office machine. These are provided primarily for communications with a PECC center in case of machine failure. The FX lines would also be available, when provided, for CCIS maintenance.

4A—CCIS Signal Transfer Points

7.05 Present maintenance planning for STP offices was based upon a 4A STP office that provides the CCIS STP function in addition to a conventional trunk switching function but without a CCIS trunk switching function. The description of voice communication capabilities for such an office would be similar to that previously described for the 4A CCIS switching office plus the communications available at the VFL test frame. The MOC typically has VFL maintenance responsibility when the VFL test frame is located in the 4A/ETS area. As far as CCIS VFL maintenance is concerned, conversion of a 4A/ETS to a standalone STP (SPC/STP) with no trunks should require no major changes.

4 ESS—CCIS Switching Office

7.06 Manual trunk test positions (51A test positions) have the testing responsibilities for the VFL portion of the signaling links and have need to communicate with STPs, other switching offices, and intermediate VF facility junction points. The 51A test positions are equipped for voice communication access to the DDD network in the following ways:

(1) Two-way test access trunks for tandem access into the 4 ESS machine or selection of a particular outgoing trunk or receipt of incoming code 101 calls

(2) One-way incoming test access trunks for receipt of code 101 calls

(3) DDD telephone lines on the local class 5 office.

7.07 Voice communications in the 4 ESS MOC are located in the master control console (MCC).

Communication access to the DDD network is provided in the following ways:

(1) Tandem access trunks to the No. 4 ESS machine

(2) DDD telephone lines on the local class 5 office

(3) Code 958 access for incoming calls.

7.08 Present design of the incoming code 958 access provides that the incoming code 958 is translated in the No. 4 ESS machine to a telephone line number on the local class 5 office and the call routed through that office to the MOC on an ordinary telephone line.

8. VFL CIRCUIT ORDER AND TROUBLE TESTING

8.01 Figure 2 shows the layout of the CCIS signaling network and indicates which offices will have maintenance control for the various types of signaling links and their associated VFLs. The general objective of the testing procedures is to minimize the amount of specialized test equipment required at the switching office and of the VFLs.

8.02 The basic circuit order and trouble sectionalization procedures for testing VFLs require that end-to-end testing be done from the designated VFL test positions rather than from the jacks at the data modem locations.

8.03 Using the following tests, it is expected that the craft person at the STP and SO offices will normally be able to turn up the VFLs and/or sectionalize VFL troubles in almost all cases. However, for some difficult data problems (estimated at less than 3 percent of those encountered), the craft person may require outside help, either from normal staff organizations or from specialized DATEC support team. Thus, when either turning up a new VFL or sectionalizing a trouble, if the immediate cause of an out-of-limits or trouble condition cannot be determined, the craft person should make the tests indicated in those procedures and refer the results to the appropriate supervision for help or escalation.

8.04 The tests require that the test positions at the STP offices be equipped with the Hewlett-Packard 4940A TIMS with option 003 or equivalent. They also provide for a series of circuit order loopback measurements at the STP office to serve as benchmarks during trouble isolation on the VFLs. Certain test parameters will be measured only on a loopback basis and will be expected to meet the indicated circuit order requirements in the loopback mode.

> ***Note:*** Unless otherwise noted, any pads (attenuators), amplifiers, or test equipment used should have balanced inputs and outputs and should have 600-ohm input and output impedances. In some tests, the test instrument might use a high impedance (bridging) input instead of the usual 600-ohm input impedance.

8.05 The circuit order and trouble isolation tests are listed in Table A. No routine transmission tests are proposed for the VFLs. Both loopback and end-to-end (E to E) type tests are required between STP and SO offices on A and E links. For B and C links, all the tests indicated in Table A should be performed on an end-to-end (E to E) basis between the two STP offices. Loopback measurements on the B and C links should be made once as benchmarks by the STP having maintenance control responsibility in case the TIMS set at either end is nonoperational. All loopback measurements must be made with an equal-level loopback at the far end as described in paragraph 9.

8.06 The tests in Table A are listed in the recommended order to facilitate trouble isolation. However, the system data transmission test is the simplest in that it requires only one person (at either end of the VFL) and is performed automatically by the system. The net loss test is listed first because it is expected to detect the majority of troubles and be the most useful in isolation and repair. A loopback net loss test is almost a one-person test, requiring only that the craft person at the far end enter the loopback message on the TTY. Use of a form similar to Fig. 6 to record the measurements is recommended.

> ***Note:*** Not all items in Fig. 6 are current required measurements. However, if a TIMS is available, all items take very little time to measure and may be useful as benchmarks or for referring difficult VFL problems to administration or DATE.

8.07 If a VFL is connected to the test position or looped back, it is unavailable to the system

TABLE A

REQUIRED TESTS

TEST TYPE	CIRCUIT ORDER			TROUBLE REPORT		
	END-TO-END A, E LINKS	END-TO-END B, C LINKS	LOOPBACK ALL LINKS	END-TO-END A, E LINKS	END-TO-END B, C LINKS	LOOPBACK ALL LINKS
1. 1004-Hz Loss (1)	Yes	Yes	Yes	Yes	Yes	Yes
2. C-Notched Noise (1)	Yes	Yes	Yes	Yes	Yes	Yes
3. Single Frequency Interference (2)	Yes	Yes	—	Yes	Yes	—
4. P/AR (1)	—	Yes	Yes	—	Yes	Yes
5. Impulse Noise	—	Yes	Yes	—	Yes	Yes
6. Frequency Response (1)	Yes	Yes	Yes	(4)	(4)	(4)
7. Envelope Delay (1)	—	Yes	Yes	—	(4)	(4)
8. Nonlinear Distortion (1)	—	Yes	Yes	—	Yes	Yes
9. 201D Modem Option Settings Data Signal Level (6)	Yes	Yes	—	Yes	Yes	—
10. System Data Transmission Loopback (3)	—	—	Yes	—	—	Yes
End-to-End	Yes	Yes	—	Yes	Yes	—
11. CCIS Terminal/ Modem Diagnostics Program (7)	Yes	Yes	—	Yes	Yes	—
12. CTMS Benchmark (5)	Yes	Yes	—	Yes	Yes	—

Note 1: Whenever a signal is applied to a line for tests, it should be adjusted to −10 dBm0 unless otherwise specified.

Note 2: Listen only test.

Note 3: These tests should be performed on all VFLs of A and E links only.

Note 4: Do only if P/AR differs by more than 4 units from benchmark.

Note 5: Optional — see paragraph 8.14.

Note 6: Measure 201D modem transmit and receive signal levels at each end of line. Always required at circuit order and at trouble isolation if other tests do not indicate trouble.

Note 7: Program run in office at each end of link.

TEST RESULT RECORD FORM FOR CCIS VOICE FREQUENCY LINKS

TEST DATE ____ ____ ____
MONTH DAY YEAR

TEST NO. ________

INITIALS ________

CIRCUIT IDENTIFICATION ________________

TRM GROUP-TRM UNIT-VFL ________________ TYPE OF SLK: A B D E F

COMMENTS ________________

FROM (TRMT) ____________ TO (RCV) ____________

END-TO-END ____________ OR LOOPED BACK AT ____________

MARK OUT OF LIMITS RESULTS WITH "*" AND TESTS NOT APPLICABLE WITH "NA"

1. 1004 HZ LOSS TEST (LEVEL AND FREQUENCY, 60HZ RCV FILTER OUT (NORMAL TEST)

TRMT LEVEL ________ dBm   TRMT TLP ________   TRMT FREQ ________ Hz

RCV LEVEL ________ dBm   RCV TLP ________   RCV FREQ ________ Hz

ACTUAL MEAS. LOSS ________ dB   EXP. MEAS. LOSS ________ dB   FREQ SHIFT ________ Hz

2. C-NOTCHED NOISE AND OTHER NOISE TESTS

	C-MSG	3 kHz FLAT
MSG CKT NOISE	________ dBrn	________ dBrn
1004 Hz RCV LEVEL	________ dBrn	
NOISE-WITH-TONE	________ dBrn	________ dBrn
SIGNAL-TO-NOISE RATIO	________ dB	
NOISE-TO-GROUND	________ dBrn	________ dBrn

1004Hz RCV LEVEL dBrn CONVERSION

REFERENCE -90.0 dBm

RCV LEVEL FROM 1 ________ dBm

RCV LEVEL FROM 2 ________ dBrn

3. SINGLE FREQUENCY INTERFERENCE AND NOISE LISTENING TESTS (NOISE WITH-TONE C-MSG)

ANY SFI TONES HEARD? ________ NO ________ YES

CRACKING OR POPPING? ________ NO ________ YES

OTHER (DESCRIBE) ________________

4. P/AR ________ UNITS

4A. PHASE JITTER ________ DEGREES PEAK-TO-PEAK

TEST RECORD FORM (CONT)

5. IMPULSE NOISE, HITS AND DROPOUTS
(C-MSG, BELL STD, 15 MINUTE COUNT TIME)

IMPULSE NOISE LO THRESHOLD SWITCH SETTING ________ dBrn

(END-TO-END: 71 dBrnCO = 67 dBrn @ -4 TLP, 65 dBrn @ -6 TLP RCV, ETC.
LOOPBACK: 73 dBrnCO = 69 dBrn @ -4 TLP, 67 dBrn @ -6 TLP RCV, ETC.)

PHASE HIT THRESHOLD 20 DEGREES   GAIN HIT THRESHOLD 4 DB

START TIME ______ AM PM   BUSINESS DAY ______ YES ______ NO ______

dBrn COUNTS LO ______   PHASE HITS ______

+4dB COUNTS MID ______   DROPOUTS ______

8 dB COUNTS HI ______   GAIN HITS ______

6. FREQUENCY RESPONSE
(1004Hz REFERENCE)

300	______ dB	2000	______ dB
400	______ dB	2200	______ dB
500	______ dB	2400	______ dB
600	______ dB	2500	______ dB
800	______ dB	2600	______ dB
1000	0 dB	2700	______ dB
1200	______ dB	2800	______ dB
1400	______ dB	3000	______ dB
1600	______ dB	3200	______ dB
1800	______ dB		

7. ENVELOPE DELAY
(USUALLY 1804 Hz REFERENCE)

500	______ µS	2000	______ µS
600	______ µS	2200	______ µS
800	______ µS	2400	______ µS
1000	______ µS	2500	______ µS
1200	______ µS	2600	______ µS
1400	______ µS	2700	______ µS
1600	______ µS	2800	______ µS
1800	0 µS	3000	______ µS

8. NONLINEAR DISTORTION

	2ND ORDER	3RD ORDER
NORMAL TEST SIGNAL	______ dB	______ dB
CHECK SIGNAL	______ dB	______ dB
DIFFERENCE		
NOISE CORRECTION FACTOR (FROM TIMS INSTRUCTIONS)	______ dB	______ dB
NONLINEAR DISTORTION (NORM. TEST SIG. + NOISE CORR. FACTOR)	______ dB	______ dB

9. 201D MODEM OPTION SWITCH SETTINGS
(201D-L1A/AR668B ONLY)

TRMT:	______	0	______	-15 dBm
EQ:	______	IN	______	OUT
LB:	______	16	______	0 dB

10. DATA SIGNAL LEVEL TESTS

BRIDGING AT CCIS TERMINAL FRAME   TRMT ______ dBm   RCV ______ dBm

TERMINATING AT CCIS TERMINAL FRAME   TRMT ______ dBm

TERMINATING AT 51A TEST POSITION (4 ESS 201D MODEM TRMT LEVEL)   TRMT ______ dBm

11. SYSTEM DATA TRANSMISSION TESTS
LOOPBACK USING MTCE TRM IN STP
(VFLs IN A-& E-TYPE SLKs ONLY)

______ PASS ______ FAIL

END-TO-END USING SIG. TRM (ALL VFLs)

______ PASS ______ FAIL

12. TERMINAL/MODEM DIAGNOSTICS PROGRAM   ATP ______ STF ______

13. OTHER TESTS/COMMENTS ________________

Fig. 6—Sample Test Record Form

to be utilized for CCIS signaling. A VFL in such a state is signified by the appropriate lamp lighted at the VFL test position. Since a VFL carries the signaling for a large number of trunks, VFLs should not be left in either of these states unless repair procedures are in progress.

A. 1004-Hz Loss Test

8.08 The allowable 1004-Hz maximum loss deviation for all standard CCIS VFLs is given in Table B for both circuit order and trouble isolation testing. All loss measurements should be made using a -10 dBm0 signal.

8.09 The loopback values for circuit order should be viewed as guides to the expected benchmark values rather than requirements. The actual circuit order measurement for this circuit parameter should be made as an end-to-end measurement.

8.10 The following discussion of expected measured loss (EML) assumes that in 4A SOs or STPs, 0 TLP TRMT and -4 TLP RCV points are used in the tests (2 dB TRMT and RCV pads connected in the test frames). It is also assumed that in 4E SOs, 0 TLP TRMT and -6 TLP RCV points are used in the 51A test position.

8.11 The end-to-end EML from any 4A SO or STP to any other 4A SO or STP is 4 dB (0 TLP TRMT to -4 TLP RCV). The end-to-end EML from a 4A STP to a 4E SO is 6 dB (0 TLP TRMT to -6 TLP RCV). The end-to-end EML from a 4E SO to a 4A STP is 4 dB (0 TLP TRMT to -4 TLP RCV).

8.12 The loopback EML measured in a 4A SO or STP is 4 dB (0 TLP TRMT to -4 TLP RCV). The loopback EML measured in a 4E SO is 6 dB (0 TLP TRMT to -6 TLP RCV). It is assumed

TABLE B

1004-Hz LOSS REQUIREMENTS

STANDARD CCIS VFL		
MAXIMUM DEVIATION FROM EML		
	CIRCUIT ORDER	TROUBLE REPORT
End-to-End	±1.0 dB	±2.0 dB
Loopback	±2.0 dB	±4.0 dB
COLOCATED CCIS VFL		
	CIRCUIT ORDER ALLOWED RANGE OF AML (RECORD SPECIFIC VALUE)	TROUBLE REPORT (MAXIMUM DEVIATION FROM AML RECORDED AT CIRCUIT ORDER)
END-TO-END		
4A STP to 4E SO	5.0 to 8.0 dB	±0.5 dB
4A SO to 4A STP	7.0 to 10.0 dB	±0.5 dB
LOOPBACK		
Measure at 4A STP (Looped at 4E SO)	6.3 to 11.7 dB	±1.0 dB
Measure at 4E SO (Looped at 4A STP)	8.3 to 13.7 dB	±1.0 dB

that equal-level loopbacks are used in the far-end office.

8.13 Various EMLs (eg, 0, 4, or 6 dB) are listed on the circuit layout record card (CLRC). The 0-dB EML is for a nonpreferred arrangement measuring from a -2 TLP TRMT to a -2 TLP RCV point (the 2-dB TRMT and RCV pads not connected in the 4A SO IMTF or 4A STP VFL test frame). The TEST LVL values given on the CLRCs are the TLPs or the expected dBm measurements if a 0-dBm0 test tone were used.

8.14 Tests of the carrier facility may be made with an optionally available Carrier Transmission Maintenance System (CTMS). A Spread Benchmark Display and Update Function (code 632) lists the spread values in dB at the transmit and receive sides of the near-end facility at the time of turnup of the circuit.

8.15 Measurements on circuit with a pulse code modulation (PCM) section (either a T-carrier facility or trunks terminating in a No. 4 ESS office) with a test or holding tone frequency within 1 Hz of 1000 Hz give erratic results because of the 8000-Hz sampling rate in the digital banks. A loss measurement will exhibit a slow variation with time of as much as ±0.25 dB and a noise-with-tone (C-notched) measurement will vary by as much as ±5 dB. As a result, circuits with a PCM link should be tested at a frequency slightly higher than the nominal 1000 Hz. Acceptable test tones of 1010 Hz or 1020 Hz are available from the KS-19260 pushbutton oscillator and 1004 Hz using TIMS.

8.16 The notch filters used for all C-notched measurements are designed to accept holding tones from 995 Hz to 1025 Hz. Therefore, so that confusion will not exist on the subject of the precise holding tone frequency (1000, 1004, 1010, 1020 Hz, etc), loss measurement with any of these tones will be referred to with a Hz offset (ie, 1004) as a reminder. It will be understood that for nominal 1-kHz measurements on PCM circuits, tones within 1 Hz of 1000 Hz should not be used.

Colocated CCIS VFLs

8.17 The 1004-Hz loss test above was for standard CCIS VFLs having P-pads and carrier facilities. In some colocated VLFs between a 4A STP and a 4E SO where the STP and 4E offices are colocated in the same building, P-pads and carrier facilities will not be present and the VFL will consist of purely metallic facilities (in-house cabling).

8.18 For such colocated VFLs, a one-way loss of up to 1 dB is allowed in the in-house cabling in lieu of providing amplifiers or carrier facilities. Also, a ±0.5 dB tolerance for the VIU on the VFL side of the time dimension network must be allowed since no P-pads are provided to compensate for it.

8.19 The requirements for colocated VFLs for the actual measured loss (AML) at circuit order time and for the maximum deviation from the recorded circuit order at trouble isolation time are given in Table B.

B. C-Notched Noise Test

8.20 It is recommended that C-notched rather than C-message noise measurements be made on the VFLs, since this type of test most closely simulates the noise conditions that are encountered in the presence of data signals. C-notched noise is sometimes called noise-with-tone. A -10 dBm0, 1004-Hz holding tone is applied at the TRMT end of the VFL and is notched-out (removed) by the C-notch filter at the RCV end and the remaining noise is measured.

8.21 The overall end-to-end C-notched noise requirement for any CCIS VFL regardless of mileage is that the C-notched noise level must be at least 27 dB below the measured received level of the -10 dBm0 1004-Hz test tone of the net loss test. This is equivalent to saying that the signal-to-C-notched noise ratio must be 27 dB or greater.

8.22 For loopback tests, the requirement is relayed by 3 dB, ie, the overall loopback noise level benchmark should be at least 24 dB below the measured received level of the -10 dBm0 1004-Hz test tone (the signal-to-C-notched noise ratio should be 24 dB or greater).

8.23 The 27- and 24-dB ratios for the -10 dBm0 1004-Hz test tone are equivalent to 24- and 21-dB ratios, respectively, for the -13 dBm0 data signals. For example, assume that the received 1004-Hz test tone level was -14.6 dBm (at the -4 TLP RCV point in a 4A office) in the net loss test. This is equivalent to a 90 -14.6 = 74.5-dBrn test tone signal level. If the measured C-notched noise was 42.2 dBrnC, the signal-to-C-notched noise ratio is 75.4 -42.2 = 33.2 dB which passes both overall end-to-end (27 dB) and overall loopback benchmark (24 dB) requirements.

8.24 The C-notched noise requirements for end-to-end measurements on VFLs assigned to various facility types are given in Table C below. For loopback, the values given should be increased by 3 dB. The values given in Table C are expected values for troubleshooting on various facility sections that make up the VFL if the overall C-notched noise requirements are not met. The C-notched requirements are given in Table C for VFLs employing both compandored and noncompandored facilities. For VFLs employing any compandored sections, the requirements are listed for -10, -13, and -16 dBm0 holding tones. For example, the C-notched requirements for a VFL having a mixture of analog and N carrier facilities 500 miles long using a -16 dBm0 holding tone would be 50 dBrnc0.

C. Single Frequency Interference

8.25 A listening test for single frequency interference (also called single tone interference) should be made during the C-notched noise measurements. Note that the C-notched weighting network must be used when making this test to eliminate out-of-band tones.

8.26 If message noise can be heard but noticeable tones are not heard, the circuit is probably good. If tones are heard, perform a C-notched noise measurement. If the noise measurement meets the limits listed in Table D, the single frequency tone is within limits. Table D can also be used to isolate trouble to a particular facility. If the limits of Table D are not met, measurements may be required using a frequency selective voltmeter as outlined in Section 314-410-500 or the trouble should be referred to administration or DATEC.

D. P/AR Measurements

8.27 On B and C links, the P/AR measurements should be made during circuit order on an end-to-end basis between the TIMS, or equivalent, at the STPs. The basic requirement is that the measured P/AR in each direction be greater than 60. On A and E links (also on B and C links at the control STP), the P/AR measurements should be made and recorded at the STP as a loopback benchmark test during circuit order. There is no minimum requirement for this loopback benchmark test, since measurements of tandem facility sections are not predictable. However, if during trouble isolation the P/AR measurement is not within ±4 units of the benchmark value, the following parameters should be checked in the order listed:

(1) 1004-Hz loss

(2) C-notched noise

(3) Envelope delay distortion

(4) Frequency response.

Typical minimum end-to-end P/AR readings as a function of facility are given in Table E.

E. Impulse Noise

8.28 End-to-end impulse noise measurements should be made on all B or C links while loopback measurements should be made on all A and E links. In the event a VFL of a A- or E-type SLK is not suitable for signaling, it may be desirable to make end-to-end impulse noise measurements on the VFL using a TIMS or a 6F impulse counter, or equivalent, at the SO end.

8.29 The threshold for impulse noise masurements on VFLs should be set at 71 dBrnc0 for end-to-end impulse noise measurements. For loopback measurements, the threshold should be 73 dBrnc0. The 71-dBrnc0 end-to-end threshold is equivalent to a 67-dBrnc threshold at a -4 TLP RCV point in a 4A office or a 65-dBrnc threshold at a -6 TLP RCV point in a 4E office. The 73-dBrnc0 loopback threshold is equivalent to a 69-dBrnc threshold in a 4A or a 67-dBrnc threshold in a 4E office. When compandored facilities (N, ON, or T carrier) are employed on the VFLs, a -10 dBm0 1004-Hz holding tone should be used with the above limits. (TIMS provides a holding tone on impulse measurements.) The allowable number of counts for the given threshold are a maximum of 15 counts in 15 minutes.

> ***Note:*** A C-notch filter and a Bell System Standard counting rate device should be used at the RCV end for all impulse noise measurements.

TABLE C

END-TO-END C-NOTCHED NOISE (NOISE WITH TONE)
LIMITS IF OVERALL LIMIT IS NOT MET

COMPANDORED AND NONCOMPANDORED FACILITY MIX	END-TO-END CIRCUIT MILES							
	0 TO 50	51 TO 100	101 TO 400	401 TO 1000	1001 TO 1500	1501 TO 2500	2501 TO 4000	HOLD TONE dBm0
Noncompandored (only)	32*	34	37	41	43	45	47	None
Analog and	43	45	48	47	47	48	49	−10
N Carrier	42	44	47	46	47	47	49	−13
(N1, N2, N3, ON)	40	42	45	44	45	47	48	−16
Analog and	54	54	54	54	54	55	55	−10
T Carrier	51	51	51	52	52	52	53	−13
(D1A, D1B)	48	48	48	49	49	50	51	−16
Analog and	47	47	48	48	49	49	50	−10
T Carrier	44	45	45	46	47	48	49	−13
(D1D, D2, D3)	41	42	43	44	45	47	48	−16

Note 1: Values given are in maximum allowable dBrnC0. To obtain the maximum allowed dBrnc TIMS readings, subtract the value of the TLP from the value given.

Note 2: For mixed compandored/noncompandored VFL facilities greater than 200 miles, the compandored section was assumed to be 50 to 100 miles in length.

Note 3: For loopback testing the values given should be increased by 3 dB.

* Use 30 dBrnC0 for voice frequency cables.

8.30 While making the impulse noise reading with the TIMS, the phase hit threshold should be set for 20 degrees and the gain hit threshold for 3 dB with a requirement of less than 8 hits in 15 minutes. Out of limit results should be referred to the appropriate supervision for help or escalation.

8.31 In those cases where the impulse noise counts are exceeded, the values in Table F below represent expected thresholds for various facilities types. These may be used to isolate a high impulse noise condition to a particular facility section.

8.32 The T and N carrier entries in the table apply to either all T or N carrier for the shorter mileages or to mixtures of other noncompandored analog carriers with T or N carrier sections in the longer mileage ranges.

F. Frequency Response Tests

Note: These tests are also referred to as frequency runs or as attenuator distortion/frequency tests.

8.33 At switching offices the VFLs are expected to be maintained from trunk test positions. Therefore, the SO measurement frequencies given in Table G for the end-to-end and loopback frequency response measurements for VFLs in A- or E-type SLKs are those normally available at the trunk test positions.

8.34 For VFLs in B- and C-type SLKs, the measurement frequencies in Table H should be used for both end-to-end and loopback frequency response tests. For VFLs in A- and E-type SLKs, the measurement frequencies in Table H should

TABLE D

SINGLE FREQUENCY INTERFERENCE REQUIREMENTS IF LISTENING TEST INDICATES SFI

CIRCUIT LENGTH MILES	LEVEL OF MEASURED TONE		
	dBrnC0	dBrnC	
		@ 4 TLP	@ 6 TLP
0-50	28	24	22
51-100	31	27	25
101-400	34	30	28
401-1000	38	34	32
1001-1500	40	36	34
1501-2500	42	38	36
2501-4000	44	40	38
4001-8000	47	43	41
8001-16,000	50	46	44
Satellite Channel	41	37	35

TABLE E

TYPICAL MINIMUM EXPECTED P/AR (END-TO-END)

TYPE OF CARRIER FACILITY	MIN P/AR
T	92
N1, N3, ON	86
N2	90
L or Radio	85

Note: These values apply only to a single facility. Values for the loopback measurements are not predictable.

be used for measurements at the STP with the VFL looped back at the SO end. The end-to-end requirement is a loss (relative to 1004 Hz) within a -2 dB to +8 dB range over the 500- to 2500-Hz band and a loss (relative to 1004 Hz) within a -3 dB to +12 dB range over the 300- to 3000-Hz band.

8.35 Table H includes the corner frequencies for attenuation and delay measurements of type 3002-basic and 3002-C2 private line channels for convenience in possible comparison during trouble shooting.

8.36 In the event a VFL in a A- or E-type SLK is not suitable for signaling, it may be desirable to perform end-to-end frequency response tests on the VFL using the frequencies in Table H.

8.37 There are no requirements for the loopback frequency response measurement. However, it should be measured in SOs at the Table G frequencies and in STPs at Table H frequencies during circuit order as a benchmark for trouble isolation measurements. If the end-to-end limits in Table G are exceeded during either circuit order or trouble isolation or if the loopback benchmark varies by more than ±2 dB from the loopback value recorded at circuit order time, then a more detailed end-to-end frequency run should be made using the frequencies given in Table H on A- and E-type SLKs as well. This table should also be used for the envelope delay measurement frequencies in the next section.

8.38 The frequency response of a circuit may be measured (and adjusted if equalizers are added to the VFL) at the same time that the 1000-Hz loss measurements are made. The distortion is stated in terms of the loss at a particular frequency referenced to the loss at 1000 Hz. The conversion used is + for more loss and - for less loss. The attenuation distortion should be brought within limits before envelope delay distortion is measured, since adjustment of the attenuation distortion equalizers may have considerable effect on the envelope delay distortion. It is expected that equalizers will rarely be required in the CCIS VFLs. These equalizers are not the compromise equalizer in data set 201D.

8.39 If frequency response requirements cannot be met and the problem cannot be isolated, engineering assistance should be requested. A record of measurements made should be kept to aid engineering in arriving at a solution.

8.40 The TIMS provides a direct reading of loss (in dB) with respect to the loss at 1004 Hz by simply using 1004 Hz as the reference frequency.

G. Envelope Delay

8.41 Measurement of end-to-end envelope delay should be made on B and C links. The

TABLE F

END-TO-END IMPULSE NOISE THRESHOLDS

COMPANDORED AND NONCOMPANDORED FACILITY MIX	END-TO-END CIRCUIT MILES				
	0 TO 125	126 TO 1000	1001 TO 2000	OVER 2000	HOLD TONE dBm0
Noncompandored (only)	56	57	59	62	None
Analog and N Carrier	65 64 63	65 64 63	65 65 65	66 65 66	−10 −13 −16
Analog and T Carrier	67 65 62	67 65 62	67 65 62	68 65 62	−10 −13 −16

Note 1: Threshold values given in dBrnC0.

Note 2: To obtain threshold in dBrnC, subtract the TLP value from the given value.

Note 3: Maximum allowed number of counts is 15 in 15 minutes.

Note 4: For loopback measurements, the values should be increased by 2 dB while continuing to use the end-to-end circuit mileage.

TABLE G

SO FREQUENCY RESPONSE REQUIREMENTS FOR VFL IN A OR E TYPE SLKS

MEASUREMENTS	CIRCUIT ORDER AND TROUBLE ISOLATION	
End-to-End	404 and 2804 Hz	−3.0 to +12 dB*
Loopback	404 and 2804 Hz	(Benchmark)

* Gain (−) or loss (+) relative to 1004 Hz value.

requirement for these measurements is less than 1750 microseconds in the 800- to 2600-Hz band. The measurement frequencies are given in Table H.

8.42 A benchmark loopback test should be performed and recorded at the STP on the A and E links at the frequencies in Table H. A maximum requirement for this loopback measurement is less than 3500 microseconds in the 800- to 2600-Hz band. Readings less than this do not specifically imply that each direction of an end-to-end measurement would meet the requirements given above for the B and C links. These loopback readings will, however, serve as a benchmark during trouble sectionalization.

8.43 In the event a VFL in an A- or E-type SLK is not suitable for signaling, a TIMS or 25B in the SO end can be used to make end-to-end envelope delay distortion measurements per the

TABLE H

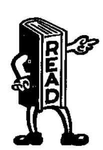
DETAILED MEASUREMENT FREQUENCIES

FREQUENCY (Hz)	FREQUENCY RESPONSE	ENVELOPE DELAY
304	X	
404	X	
504	X	X
604	X	X
804	X	X
1004	X	X
1404	X	X
1804	X	X
2204	X	X
2504	X	X
2604	X	X
2804	X	X
3004	X	
CORNER FREQ (Hz)	**ATTEN (dB)**	**DELAY (μsec)**
3002 Basic		
500-2500	−2 to +8	
300-3000	−3 to +12	
800-2600		1750
3002 C2		
500-2800	−1 to +3	
300-3000	−2 to +6	
1000-2600		500
600-2600		1500
500-2800		3000

frequencies in Table H. The end-to-end maximum is 1750 μs over the 800- to 2600-Hz band.

8.44 The delay distortion of a circuit should be measured only after the attenuation distortion of the circuit has been brought within limits. In the event that delay distortion requirements cannot be met using the equalizers specified (equalizers are not always specified), refer the problem to circuit engineering. Engineering personnel should be able to specify the required equalizers which will bring the circuit within limits.

8.45 The TIMS provides direct readings of the envelope delay distortion (in μs) by simply using the "fastest" frequency (the frequency with the most negative delay in the 800- to 2600-Hz band) as the reference frequency (often 1804 Hz).



The 25A and 25B voiceband gain and delay measuring sets may produce erroneous delay measurements when used to measure the short local circuits consisting of only nonloaded cable or measuring equipment within an office. Certain harmonic products generated in the transmitting modulator stage may enter the receiver producing erroneous measurements results in the form of ripple. For more information, refer to Sections 103-115-100 and 103-115-101.

Example of Test: A 25B voiceband gain and delay set is connected in place at the near end and set for an output level of 0 dBm at a +13

TLP. Another 25B set is connected in place at the far end at a level of -3 TLP. Both received level and envelope delay in this direction are measured and recorded as shown in Table I. The measurements are recorded on Form E-5596.

H. Nonlinear Distortion (Intermodulation) Test

8.46 The B and C link VFLs should have end-to-end nonlinear distortion so that:

(1) The ratio of the fundamental to the second-order products is greater than 27 dB

(2) The ratio of the fundamental to the third-order products is greater than 32 dB.

8.47 These requirements assume the 4-tone method of measurement employed in the TIMS set. Loopback benchmark measurements of the nonlinear distortion should also be made and recorded at the STP on the A and E links.

8.48 In the event a VFL in an A- or E-type SLK is not suitable for signaling, it may be desirable to use a TIMS or compatible 4-tone instrument in the SO end to make end-to-end nonlinear distortion measurements.

8.49 To measure nonlinear (intermodulation) distortion, four equal-level tones are transmitted over the facility to be measured. Two of these tones are closely spaced around a center frequency "A" (860 Hz) and the other two tones are centered around a center frequency "B" (1380 Hz). Each pair of narrowly spaced tones is used to simulate a narrowband of noise at each center frequency. The second order distortion is determined

TABLE I

SAMPLE MEASUREMENT RESULTS USING A 25B

VOICEBAND GAIN AND DELAY SET

MEASURED FREQUENCY	ENVELOPE DELAY	RECEIVED LEVEL	LOSS WITH RESPECT 1004 HZ
804	180	—15.7	—0.1
1004	150	—15.8	0
1204	85	—15.4	—0.4
1404	25	—15.6	—0.2
1604	10	—15.7	—0.1
1804	0	—15.8	0
2004	—15	—15.8	0
2204	—35	—15.9	+0.1
2404	—10	—16.0	+0.2
2604	15	—16.2	+0.4

Note 1: To calculate the envelope delay distortion between 804 Hz and 2604 Hz, determine the maximum envelope delay (180 μs) and the minimum envelope delay (—35 μs) between those frequencies. The envelope delay distortion is the difference between those values 180 — (—35) = 215 μs. The envelope delay distortion between 1004 Hz and 2004 Hz is 150 — (—15) = 165 μs.

Note 2: To calculate the attenuation distortion, reference all loss measurements with respect to 1004 Hz. The attenuation distortion between 804 Hz and 2604 Hz would be the minimum loss (—) and maximum loss (+) between those frequencies (—0.4 to +1.1 dB).

by measuring the energy through narrowband filters centered at B - A (520 Hz) and B + A (2240 Hz). Third order distortion is measured through a narrowband filter centered at 2B - A (1900 Hz). Most present and planned nonlinear distortion test sets will read out the distortion (and noise factor) as a ratio in dB with respect to the measured power of the fundamental signal.

I. 201D Modem Option Switch Settings

8.50 The standard -13 dBm0 data signal level will be used on the VFL in all offices. Unless otherwise noted, the option switches on the 201D modem on the front of the AR668 circuit pack (201D-L1) or the AR668B circuit pack (201D-L1A) should be set as follows:

- TRMT set to 0
- EQ set to IN
- LB (201D-L1A only) set to 16.

8.51 With these settings, the 201D modem transmits a 0-dBm level, has the compromise equalizer in the channel, and has a facility test VFL loopback gain of 16 dB.

8.52 The EQ IN setting is preferred because it is expected to provide an improved error rate performance on most VFLs. In unusual cases it may be desirable to set the EQ option switch to OUT (instead of IN) in order to improve the error rate performance of the link or to make the terminal/modem diagnostic program go ATP (all tests pass).

8.53 Attenuator pads and amplifiers will be provided on the CCIS terminal frame in 4E offices between the 201D modem and its voiceband interface unit port.

> ***Note:*** On some early 4E CCIS SOs which use a -15 dBm0 level and do not have attenuator pads and amplifiers, the following settings should be used initially until the pad and amplifier circuit is added:

- TRMT set to -15
- EQ set to IN
- LB (201D-L1A only) set to 0.

J. Data Signal Level Tests

8.54 These tests check the power level of the 201D modem TRMT and RCV data signals.

Bridging TRMT and RCV Data Signal Level

8.55 This test may be performed whether the SLK is in or out of service. It is always required at circuit order time and during trouble isolation if other tests do not indicate the trouble.

8.56 Using the level meter of an accurate portable transmission measuring set (TMS) in the bridging (high impedance) mode, measure the level at the TRMT jack in the CCIS terminal frame associated with the VFL under test.

> ***Caution: Make sure the TMS meter is in a bridging mode. Do not connect the TMS oscillator to any jacks on the terminal frame.***

8.57 The TRMT and RCV jacks on the CCIS terminal frame are labeled A or B (for line A or B of the 201D modem which, for a 4A SO or STP, corresponds to VFL A or VFL B of a SLK while B- and C-type SLKs use VFL B only) and a 2-digit subscript representing the terminal unit number on the frame. A SLK number a_1 a_2 $-b_1b_2$ consists of the terminal frame group number a_1a_2 (00-15) and the terminal/modem unit number b_1b_2 (00-15) within that frame group. For example, in a 4A SO or STP, the TRMT A13 jack on terminal group frame 01 is used when measuring the modem TRMT data signal level of VFL A of SLK 01-13 (the TRMT B13 jack is used when tsting VFL B).

8.58 In a 4A SO or STP, the modem (SLK) must be operating on line A (B) if VFLA(B) is under test. In a 4E office, line B of the modem (and the B jack) is always used regardless of which VFL (A or B) is in use by the SLK.

8.59 The TRMT level shall be 0 dBm ±1.3 dB for all VFLs at all times when the modem is transmitting on the VFL and the VFL is cut through so it properly terminates the modem. This is the data signal level of the transmitter output in the 201D modem in the office in which the measurement is made. (In some initial 4E SOs which do not have the pad and amplifier circuit on the CCIS terminal frame, the TRMT level shall be -15 dBm ±1.3 dB).

8.60 Using the level meter of the TMS in a bridging (high impedance) mode, measure the RCV data signal level at the RCV jack in the CCIS terminal frame associated with the VFL under test.

> ***Caution: Make sure the TMS meter is in a bridging mode. Do not connect the TMS oscillator to any jacks on the terminal frame.***

8.61 For standard CCIS VFLs, the RCV level shall be -16 dBm ±2.5 dB at circuit order time or -16 dBm ±3.5 dB during subsequent trouble isolation. For colocated VFLs between a 4A STP and 4E SO in the same building with no transmission facilities and no P-pads used, the RCV level shall be between -23.7 dBm and -17.3 dBm at the 4A STP and or between -18.7 dBm and -13.3 dBm at the 4E SO end.

8.62 The RCV level measured above is the 201D modem transmitter data signal from the far end office. The RCV level test requires that the VFL be cut through modem-to-modem. This test may be postponed if for some reason (eg, the SLK will not sync on the VFL under test) the VFL cannot be cut through long enough to make the test. However, the RCV level must always be measured at circuit order time and must be measured during trouble isolation if other tests do not indicate the trouble.

Terminating TRMT Modem Signal Level Tests

8.63 This test is required on all SLKs. It is more accurate than the bridging test above but can only be made if the SSLK can be taken out of service. This requires that the signaling load be transferred to another SLK. This test may be postponed for this reason or, for example, on an A- or E-type SLK when VFLB is under test but VFL A is in service and the signaling load cannot be transferred.

8.64 In a 4A SO or STP, turn the power off of the JW291 VFL access circuit pack associated with the VFL under test and remove the pack.

> ***Caution: Make sure the correct pack is removed.***

Place the level meter in the 600-ohm terminating mode and connect it to the TRMT jack in the CCIS terminal frame associated with the VFL under test.

8.65 The TRMT level shall be 0 dBm ±1 dB. Disconnect the meter from the jack, reinsert JW291 circuit pack and restore power to the pack after completing test.

8.66 In a 4E SO, switch the signal terminal/modem associated with the VFL under test to the 51A test position. The 51A receive level (which is the data signal level of the TRMT output of the 201D modem in the 4E SO) shall be -19 dBm ±1.3 dB. Remove the signal terminal/modem connection to the 51A after completing this test.

K. System Data Transmission Test

8.67 These tests should be performed after all the other circuit order tests have been passed and as a final test during trouble isolation and repair, or in an emergency when a VFL must be returned to service quickly. The maintenance terminal/modems unit in the STP office terminal group-terminal unit (00-00) for loopback tests and the normal signaling terminal/modem units at each end of the VFL under test must pass the terminal/modem diagnostics program for these tests to have meaning.

8.68 The automatic VFL loopback test using the STP maintenance terminal/modem unit under control of the STP office processor should be performed on all VFLs in signaling links having duplex VFL (A- or E-type SLKs).

8.69 Since the VFL loopback test is used as part of the VFL automatic diagnostic tests, the circuit order tests are required to determine if the test will pass with the equivalent of two VFLs in tandem (with double the impairments).

> ***Note:*** It is possible that some of the VFLs may fail this VFL loopback test while meeting all the other circuit order requirements. Thus, it is necessary that this be determined during circuit order so it can be handled administratively.

8.70 It is important that the VFL under test is the idle VFL of the duplex VFL A/B pair in the A- or E-type SLK. A loopback test is done on the idle VFL using the maintenance terminal/modem unit whereas an end-to-end test is done on the active VFL using the normal signaling terminal/modem units.

8.71 The automatic VFL end-to-end test should also be performed on all VFLs of all type SLKs. It is important that the VFL under test be active if it is one of the VFLs in a A/B pair in an A- or E-type SLK. The normal signaling terminal/modem units are used in this end-to-end test.

L. CCIS Terminal/Modem Diagnostics

8.72 The terminal/modem diagnostics program must go ATP for all SLKs. This program is typically run automatically by the system before a SLK is placed in service. It can also be run on demand via TTY input message. An occasional STF from phases 14 or 15 of this program may indicate a marginal 201D modem.

9. REREFERENCES

9.01 The following list of documents shall support and supplement the instructions within this section.

SECTION	TITLE
212-570-701	Adjustment and Compensation for Loss in Integrated Manual Test Frame
212-807-101	CCIS Terminal Group and VFL Access Circuit Description—4A Toll Switching System
212-807-502	Voice Frequency Link and Access Circuit Tests in a 4A Toll Switching System Using the Integrated Manual Test Frame
212-807-503	VFL Tests at a Signal Transfer Point Office Using VFL Test Frame SD-68769-01 in a 4A Toll Switching System containing Common Channel Interoffice Signaling
212-807-701	CCIS Voice Frequency Links Access Circuit SD-68758-01 Testing and Adjustment Procedures—4A Toll Switching System
212-826-302	System Evaluation Procedures in a 4A CCIS Switching Office
212-826-303	System Evaluation Procedures in a 4A CCIS Signal Transfer Point Office
234-110-070	Common Channel Interoffice Signaling Terminal Group Description, No. 4 ESS
234-110-071	Common Channel Interoffice Signaling Terminal Group Theory, No. 4 ESS
234-150-001	CCIS VFL Testing Positions in a No. 4 ESS Switching Office
312-811-100	Data Set 201D-Type—Description
660-450-507	CCIS Voice Frequency Link—Description, Maintenance, and Tests
682-300-961	Circuit Layouts, Circuit Order and Layout Record (COLR) for Common Channel Interoffice Signaling Links, Appendix 2

9.02 The following publications are for information only and contain no direct requirements for CIS VFLs.

010-521-100	Data Technical (DATEC) Support

SECTION	TITLE
314-410-500	Voice Bandwidth Private Line Data Circuits—Tests and Requirements
PUB41004	AT&T Technical Reference, Data Communications Using Voiceband Private Line Channels

10. GLOSARY OF ABBREVIATIONS AND DEFINITIONS OF UNIQUE TERMS

10.01 The following paragraphs list abbreviations used in common channel interoffice signaling and define unique terminology.

Abbreviations

10.02 The listing of common abbreviations follows:

SECTION	TITLE
A&D	Alarm and Display
AML	Actual Measured Loss
ATP	All Tests Pass
CCIS	Common Channel Interoffice Signaling
CLRC	Circuit Layout Record Card
CTMS	Carrier Transmission Measuring System
DATEC	Data Technical Support
dB	Decibels, relative difference between two dBm levels or two dBrn values
dBm	Decibels relating to 1 milliwatt into 600 ohms. A 0 dBm signal has a power of 1 mW into 600 ohms.
dBm0	dBm relative to the 0 TLP. (See 8.0.)
dBrn	Decibels relative to -90 dBm. A 40 dBrn signal has a power of -50 dBm.
dBrnC	dBrn as measured through a C-message filter
DDD	Direct Distance Dialing
DS	Data Set (MODEM)
EML	Expected Measured Loss
IMTF	Integrated Manual Test Frame
MCC	Master Control Console
MODEM	Modulator-Demodulator (DS)
MOC	Maintenance Operation Center
MTCE	Maintenance
P/AR	Peak to Average Ratio
PECC	Product Engineering Control Center
POTS	Plain Old Telephone Services
SLK	Signal Link
SMAS	Switched Maintenance Access System
SO	Switching Office
SPC	Stored Program Control Processor
STF	Some Tests Fail
STP	Signal Transfer Point
TAC	Terminal Access Circuit
TEC	Terminal Equipment Center
TIMS	Transmission Impairment Measuring Set (See 8.0.)
TLP	Transmission Level Point
TOC	Trunk Operation Center
TRM	CCIS Terminal (or terminal/modem unit)

SECTION	TITLE
TTJ	Trunk Test and VFL Jack
TTY	Teletypewriter
VFL	Voice Frequency Link

Definitions

10.03 ***Benchmark Measurement:*** These are measurements made on a looped-back or one-way basis when the VFL is known to meet all requirements. They are performed immediately following the completion of installation and circuit order tests and the results recorded for later reference purposes.

10.04 ***Equal-Level Loopback:*** A circuit arrangement interconnecting the receive and transmit paths and correcting for any differences in TLP at the point of connection. The simplest way to accomplish this is to interconnect two identical TLPs, for example, at -3 and -3. To interconnect a -3 TLP receive point with a +13 TLP transmit point, an amplifier with 16 dB of gain would be required in the loopback path. To interconnect a +7 TLP receive point with a -16 TLP transmit point, a pad with a loss of 23 dB is required. This ensures that signals on the line are maintained at standard data level during loopback tests when a test signal at data level is applied toward the customer station. In a 4E office, the equal-level loopback internal to the time division network is available via a system TTY message for software generics 4E2 and later. An equal-level loopback can be obtained at the 51A test position by connecting an amplifier of 6-dB gain between the -6 TLP RCV and 0 TLP TRMT jacks. In a 4A SO or STP, a convienient method for the equal-level loopback is a simple patchcord between the -2 TLP RCV and -2 TLP TRMT manual VFL test position jacks indicated for each VFL. Another method for 4A offices is to use the system TTY VFL loopback message (SLM-02-LPB) which is valid for all ends of VFLs in 4As except for the STP end of VFLs in A- or E-type SLKs which use the MTCE bus instead of AT8. (See Fig. 3.)

10.05 ***Transmission Level Point (TLP):*** An understanding of TLP is necessary before making measurements on VFLs.

(a) In discussing a channel, it is necessary to describe the power (of the signal, noise, or test tones) present at a particular point in the channel and compare this power to the power present at other points in the channel. The power present at a particular point in a channel is dependent upon the power at the source, where the source is applied, and the loss or gain in the channel between the points in question. Since this information is not always available, it is convenient to describe the power present in a channel by comparing it to some standard reference point in the channel.

(b) Describing this power is similar to the problem of trying to describe the height of a mountain. In order to measure the height of a mountain, it is necessary to pick a reference height from which to measure. If the reference height is standardized, then comparison of two mountains can be made even though they are thousands of miles apart. The widely accepted standard reference height for measuring mountains is sea level.

(c) The standard reference point for measuring power in Bell System channels is called the zero transmission level point, or 0 TLP. This reference point makes it possible to compare the signal power at two points in the channel even though the points are many miles apart.

(d) With the establishment of the 0 TLP concept, the power present in a channel is described by stating what this power would be if it were accurately measured at the 0 TLP. The standard notation used to describe the power in this case is dBm0. For example, the term -13 dBm0 means that the power at the 0 TLP is -13 dBm; if a -13 dBm0 signal were measured at the 0 TLP, the meter would indicate -13 dBm.

(e) After the power at the 0 TLP is described, the power (from the same source) at any other point in the channel can be determined. For example, if the signal is -13 dBm when measured at the 0 TLP, it will be 13 dB below the numeric value of any TLP on the channel when measured at that TLP. If the signal is -13 dBm at the 0 TLP, then the power at the +5 TLP would be +5 -13 = -8 dBm. If this -13 dBm0 signal were measured with a transmission measuring set (TMS) at the +5 TLP, the meter would indicate -8 dBm. Similarly, if a -13 dBm0 signal were measured at the -3 TLP, the meter would indicate -16 dBm [(-13) + (-3) = (-16)].

> *Note:* The numeric value of the TLP does not describe the power present at that point any more than the elevation of a mountaintop above sea level describes how high the mountain rises above the plains which surround it. In order to know how high the mountain rises above the plains, it is necessary to know the elevation of the plains above sea level as well as the elevation of the mountain itself. In order to know the power present at a given TLP, it is necessary to know the power present at some other TLP in the channel. As mentioned previously, the standard way to describe the signal is in terms of its power at the 0 TLP (with the notation dBm0). The signal can be described in dBm0 if the power is known at any TLP. For example, if a -29 dBm signal is supplied to the channel at the -16 TLP, the signal at the 0 TLP is -29 + 16 = -13 or a -13 dBm0 signal. The power at the -16 TLP is 16 dB lower than the power at the 0 TLP. Therefore, to find the power at the 0 TLP, 16 dB must be added to the power at the -16 TLP.

(f) Use of the 0 TLP reference also permits transmission objectives and measured results to be stated independently of any specific TLP. For example, the end-to-end impulse noise threshold objective is 71 dBrnc0. Knowing this, the appropriate value at any other TLP can be determined. For measurements at the -4 TLP receive terminal, 4 dB should be subtracted from the objective to determine the absolute threshold which is 67 dBrnc. For measurements at the +7 TLP DEMOD OUT jack, 7 dB should be added to the objective to determine the absolute threshold which is 78 dBrnc. Similarly, if a channel was designed for 16-dB net loss and 0-dBm transmit power and -13 dBm0 design, the receiver is a -3 TLP, and 3 dB should be subtracted from the relative objective to obtain the absolute setting, which is 68 dBrnc (71 -3 = 68).