SWITCHED SERVICE NETWORKS
COMMON CONTROL SWITCHING ARRANGEMENT
USING CENTRAL OFFICE SWITCHING MACHINES
TRANSMISSION TESTING AND THROUGH AND TERMINAL BALANCING PROCEDURES
2-WIRE NO. 1 ESS OFFICES

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1. INTRODUCTION

1.01 This section describes the procedures and supplies references necessary for the performance of manual transmission testing and through and terminal balancing (office balancing) at 2-wire No. 1 ESS offices used on Common Control Switching Arrangement (CCSA) Switched Service Networks (SSN). The types of circuits covered in this section are PBX and Centrex-CO access lines, directly-homed station access lines, and intermachine trunks.

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

1.03 The Switched Service Bureau (SSB) associated with a switching machine is normally the Plant Control Office (PCO) for all access lines and part or all of the intermachine trunks terminating on the machine. The PCO will be designated on the Circuit Layout Records (CLR) issued by the circuit design engineer.

1.04 Among the responsibilities of the PCO (see Sections 309-200-000, 309-200-001, 660-005-011, and 660-201-010) are the scheduling and performance of circuit order and routine maintenance testing and trouble clearing. On CCSA/SSN networks, these are generally done using manual testing procedures. Loop around testing procedures may be used when such equipment is available.

1.05 An important part of the circuit order and maintenance testing work is the keeping of appropriate records. These records are maintained to show the tests performed and results of the tests. It is suggested that these records be filed with the CLR, where they will be available for future reference during routine maintenance and trouble clearing procedures. Suggested forms for maintaining these records are contained in Sections 309-200-502, -503, and -506.

1.06 Circuit order (preservice) tests are required before a circuit is initially placed in service and after each circuit order activity affecting the circuit.

1.07 This section should be used in conjunction with other sections in the 309 division covering the specific type of circuit under test and the related test requirements.

1.08 Descriptive and operational information regarding the transmission testing facilities of the 2-wire No. 1 ESS is covered in the 231 division. The sections presently available are:

SECTION	TITLE
231-130-100	Trunk and Line Test Panel, Supplementary Trunk Test Panel, and Auxiliary Test Frame—Description
231-130-101	Trunk Test Capabilities
231-130-301	Trunk and Line Test Panel, Supplementary Trunk Test Panel, and Auxiliary Test Frame—Method of Operation
231-131-501	Trunk Transmission Tests Using Trunk and Line Test Panel and Supplementary Trunk Test Panel

1.09 The operation of the Trunk and Line Test Panel and the Supplementary Trunk Test Panel will not be covered in detail in this section. The sections listed in 1.08 should be referred to as necessary for these operations.

1.10 This section assumes that arrangements for availability of testing personnel and test equipment at the far end of the circuit have already been made when necessary.

2. TEST FACILITIES

2.01 The transmission testing facilities associated with a 2-wire No. 1 ESS office consist of a Trunk and Line Test Panel (TLTP), one or more Supplementary Trunk Test Panels (STTP) and Auxiliary Test Frames (AUT) where provided. In addition to the above, some offices have installed 24A testboards.

2.02 In addition to the TLTP, STTP, and AUT, a circuit patch bay (CPB) may be supplied depending on the size of the office, types of circuits, types of facilities, and other considerations. The CPB is a series of jack appearances physically connected between the switching machine trunk terminations and the facilities to the customer. The CPB provides jack access to the transmission and signaling paths.

2.03 Circuits terminating on the Line Link Network (LLN) frame of the No. 1 ESS machine may be accessed from the TLTP only. Transmission tests from the TLTP on these circuits is possible only with CTX-8 or later generic programs. Circuits which terminate on the Trunk Link Network (TLN) of the No. 1 ESS machine may be accessed from either the TLTP or the STTP.

2.04 The AUT frame, provided with expanded test feature modifications, is located on the right side of a single STTP or between STTPs when two or more STTPs are installed.

2.05 The following optional test equipment may be mounted in the AUT frame:

(a) 3 CR Noise Measuring Set

(b) 6 HR Impulse Noise Counter

(c) KS-20501 Return Loss Measuring Set

(d) 58 ESMS Echo Suppressor Test Set

(e) KS-19260 Voice Frequency Oscillator

(f) PAR Test Set

2.06 Located below the test equipment is a key and control panel for obtaining access to the test equipment. Operation of the appropriate keys connect the selected test set to the Trunk Test Access Trunk (TAT 1 or 2) located in the

STTP. Section 231-130-301 covers the use of the AUT.

2.07 Test point access at the TLTP and the STTP(s) is gained via the No. 1 ESS network. After a circuit has been properly accessed via the Master Test Line (MTL), key operations are performed to transfer the circuit to the Line Test Access Trunk (LAT) or a Trunk Test Access Trunk (TAT) for transmission testing. The TATs allow the use of the Transmission Measuring Set (TMS) and 1 milliwatt supply associated with the TLTP or STTP and also provide jack access for use of portable test equipment. The LAT in the TLTP has the same capabilities except that jack access may not be available in all installations.

2.08 Presently available TLTP and STTP positions may or may not have expanded test features. Figure 1 shows a STTP with expanded test features. TLTPs and STTPs without expanded test features will not have the jacks and keys shown in the shaded areas. The CTX-7 or later generic program must be installed to use the expanded test features.

2.09 When the TLTP and STTP have been modified to provide expanded test features,

(a) Transmission tests on circuits terminated on the LLN may be performed at the LAT jack of the TLTP (CTX-8 and later generic programs).

(b) 2-dB test pads (TP2), under program control, are automatically inserted in the send and receive circuits of the transmission measuring circuit of the TLTP and STTP providing the correct transmission levels for CCSA circuits.

(c) External tone sources such as variable oscillators may be used by adjusting them for a 0-dBm output and patching them to the EXT GEN jack. The 2-dB test pads will lower the send power level to the correct (-2 dBm) level at the network. If it is necessary to use the AT 1 or 2 jacks for transmitting test tones, not recommended method, the test tone power level is adjusted to -2.0 dBm (0 dBm0).

2.10 When the TLTP and STTP have not been modified for the expanded test features,

(a) Transmission testing on circuits terminating on the No. 1 ESS LLN is not possible from the TLTP. In these cases, test access must be supplied by some 2-wire appearance external to the No. 1 ESS machine such as a private line test board, circuit patch bay, etc.

(b) 2-dB test pads are not supplied by the TLTP or STTP transmission test circuit. When transmission tests on CCSA circuits are to be performed at unmodified TLTP and STTP circuits, external 2-dB pads must be connected between the TAT 1 or 2 and the oscillator or transmission measuring set to obtain the transmission levels indicated on the CLRs.

(c) 1004-Hz test tone transmitted by the operation of the SEND key will be 2.0-dB high and should not be used for testing CCSA circuits.

3. TEST EQUIPMENT

3.01 Accurate transmission tests and measurements require good test equipment. All test equipment should be checked routinely to ensure proper operation and calibration. Prescribed warm up times are essential for stable operation of certain test equipment.

3.02 Table A is a partial listing of test equipment that may be used. Some of these test sets or their equivalents may be mounted in the test positions (rack mounted). When portable test equipment is used at the TLTP or STTP, cords necessary for connecting them to the AT or LAT jacks must be available.

3.03 Transmission test equipment for use at the STTP or TLTP should be arranged for 900-ohm impedance. When other test points are used, the impedance of the test point must be determined and the correct impedance test equipment used. If test equipment of the proper impedance is not available, refer to Section 309-200-502 or -503 for correction procedures.

4. SERVICE CONSIDERATIONS

4.01 SSN customers rely heavily on their communications system and place considerable importance on having it available when they need it. It is important that,

(a) Circuits not be removed from service without proper releases.

(b) Release periods be kept as short as possible.

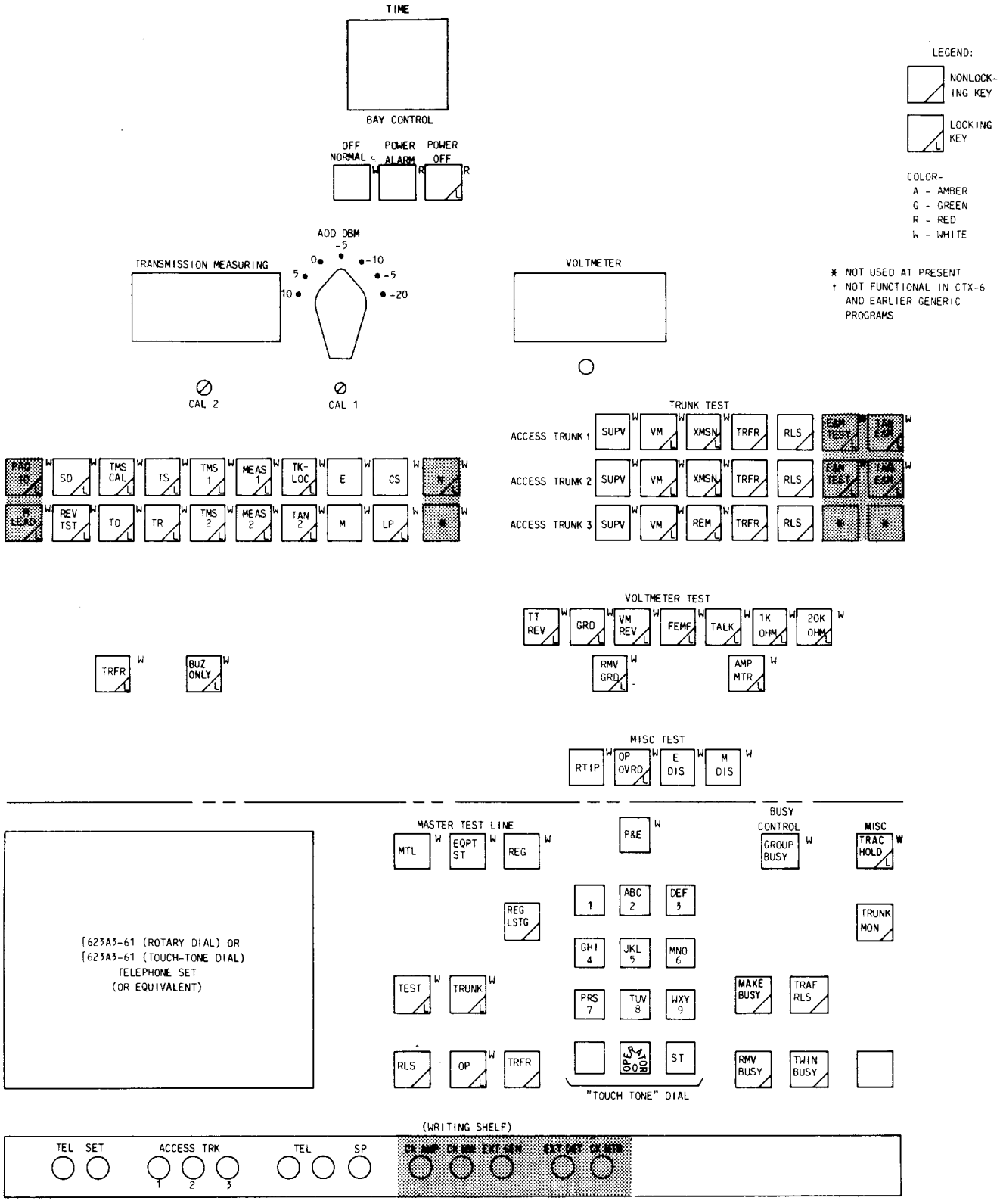


Fig. 1—Supplementary Trunk Test Panel Keys and Lamps (With Expanded Test Features)

TABLE A

RECOMMENDED TEST EQUIPMENT

MEASUREMENT/TEST	TEST EQUIPMENT	REFERENCE
1000-Hz Loss and Frequency Response	Halycon 515A Data Line Test Set Hewlett Packard 4940A Transmission Impairment Measuring Set (TIMS) Northeast Electronics TTS4BNH Northeast Electronics TTS4BNH-N Northeast Electronics TTS15B Northeast Electronics TTS35B TTI 1110A Transmission Noise Test Set WECo 23-Type Transmission Measuring Set (detector only) Collins CLA 101 25—Type Gain and Delay Measuring Set	Mfr. Manual Mfr. Manual Mfr. Manual Mfr. Manual Mfr. Manual Mfr. Manual Mfr. Manual 103-223-100, -101 Mfr. Manual 103-115-100, -101
Message Noise	Hewlett Packard 4940A TIMS Northeast Electronics TTS4BNH-N TTI 1105 Level/Noise Digital Test Set WECo 3-Type Noise Measuring Set	Mfr. Manual Mfr. Manual Mfr. Manual 103-611-100, -101, -102
DC Voltage and Ringing Voltage	KS-14510 VOM	100-520-101
Signaling	Northeast Electronics TTS26B Signaling Test Set WECo 1A, 2B,or 4A Signaling Test Set	Mfr. Manual 100-262-101 100-263-501 100-267-101
Return Loss (Echo and Singing)	KS-20501 Return Loss Measuring Set WECo 2D or 2E Singing Point Test Set WECo 54C Return Loss Measuring Set Wiltron Model 9031 Return Loss Measuring Set	103-106-115 103-106-105 103-106-110 Mfr. Manual
Impedance Matching, Holding, and DC Blocking	WECo J94002AB (2AB) Auxiliary Transmission Test Set	103-202-100
Envelope Delay	25A or 25B Gain and Delay Measuring Set Hewlett Packard 4940A TIMS Collins CLA 101	103-115-100 Mfr. Manual Mfr. Manual
Impulse Noise	Hewlett Packard 4940A TIMS WECo 6F Noise Measuring Set WECo 6H Impulse Counter	Mfr. Manual 103-620-100 103-620-101
Nonlinear Distortion	Hewlett Packard 4940A TIMS Hekimian Model 65 or 65LN Test Set	Mfr. Manual Mfr. Manual

(continued)

TABLE A (Cont)

RECOMMENDED TEST EQUIPMENT

MEASUREMENT/TEST	TEST EQUIPMENT	REFERENCE
Phase Jitter	Hewlett Packard 4940A TIMS Hekimian Model 48 Test Set	Mfr. Manual Mfr. Manual
Frequency Measurements	WECo 72A Frequency Meter Wilcom T-132 Spectrum Analyzer and Noise Measuring Set Hewlett Packard 4940A TIMS	103-425-100 Mfr. Manual Mfr. Manual

(c) The customer be kept informed of the status of circuits.

(d) Test requirements be met.

(e) All communications with the customer be handled in a courteous and businesslike manner.

5. TRANSMISSION TEST TONES

5.01 Test tone power levels for 1004-Hz loss deviation and attenuation distortion measurements on voice only circuits correspond to the TLP values shown on the CLRs. These levels are referred to as 0 dBm0.

5.02 Test tone power levels for testing circuits that will be used for data transmission should be 13 dB below the TLP shown on the CLR. These levels are referred to as -13 dBm0.

5.03 Test tone power levels should never be allowed to exceed the TLP values as higher level tones may cause interference, noise, or failure of circuits using other channels in the same transmission system or facility.

5.04 All test frequencies should be offset 4 Hz from multiples of 100 Hz. This is necessary to prevent possible measurement errors when D-type channel bank equipment is encountered.

5.05 When the central office milliwatt supply is used as the test tone source, a verification should be performed to determine that the supply has been modified for 1004 Hz. Unless the supply is arranged for 1004 Hz, it should not be used for measurements on circuits using D-type channel bank equipment.

5.06 Test tone frequencies should be verified with a 72A frequency meter or equivalent when oscillators other than the KS-19260 type are used. The frequencies should be within ±5 Hz of the specified frequency except when D-type channel equipment is involved in which case the limits are -1 to +6 Hz.

5.07 When adjusting oscillator (OSC) output levels, a TMS of the same impedance as the OSC should be used to verify the test tone level before connecting to the circuit.

6. VERIFICATION TESTS AND CHECKS

6.01 To perform accurate and meaningful tests on a line or trunk, the testing personnel must know the composition of the circuit. The only record of this information available to the CCSA testboard personnel is the CLR. Any field substitutions for engineered equipment on the circuit must be corrected by an equipment change or CLR correction. Where discrepancies are found in circuit layouts that cannot be corrected due to lack of equipment, incompatability, etc, they should be referred to the circuit designer responsible for the overall circuit. The circuit designer must resolve the problem, with other groups if necessary, and determine the action to be taken.

6.02 The following verification tests and checks are made as part of the circuit order tests:

(a) A physical check of the equipment and facilities used to make up the circuit to verify that they are exactly as called for by

the CLR. This is done after the installation phase of the circuit order work and before the initial circuit order transmission and operational tests.

(b) Verification that amplifier gains have been adjusted to the values specified by the CLR and that screw switch settings and strapping options are correct.

(c) Verify that the COMP NET screw switches on the terminating sets are closed and that the correct pads are installed.

(d) Verify that plug-in equipment has been bench tested as required by appropriate sections.

(e) Verify that carrier facilities where used have been lined up before starting any section or overall circuit transmission testing.

(f) Check with any intermediate offices to determine that cross connections are completed and that they have performed the above in their respective offices.

7. TRANSMISSION TESTING

A. General

7.01 The following transmission tests may be performed from the TLTP, STTP, or other 2-wire test point available (see 2.10a).

(a) 1004-Hz Loss Deviation

(b) Attenuation Distortion (see 7.02a)

(c) Message Circuit Noise

(d) Impulse Noise

(e) C-Notched Noise

(f) Single Frequency Interference.

7.02 The following transmission tests are performed at 4-wire test points such as circuit patch bays, VF patch bays, and repeater test jacks.

(a) Envelope Delay

Note: Attenuation distortion and envelope delay tests may be performed simultaneously with the use of the 25-type delay and gain test set.

(b) Phase Jitter

(c) Nonlinear Distortion

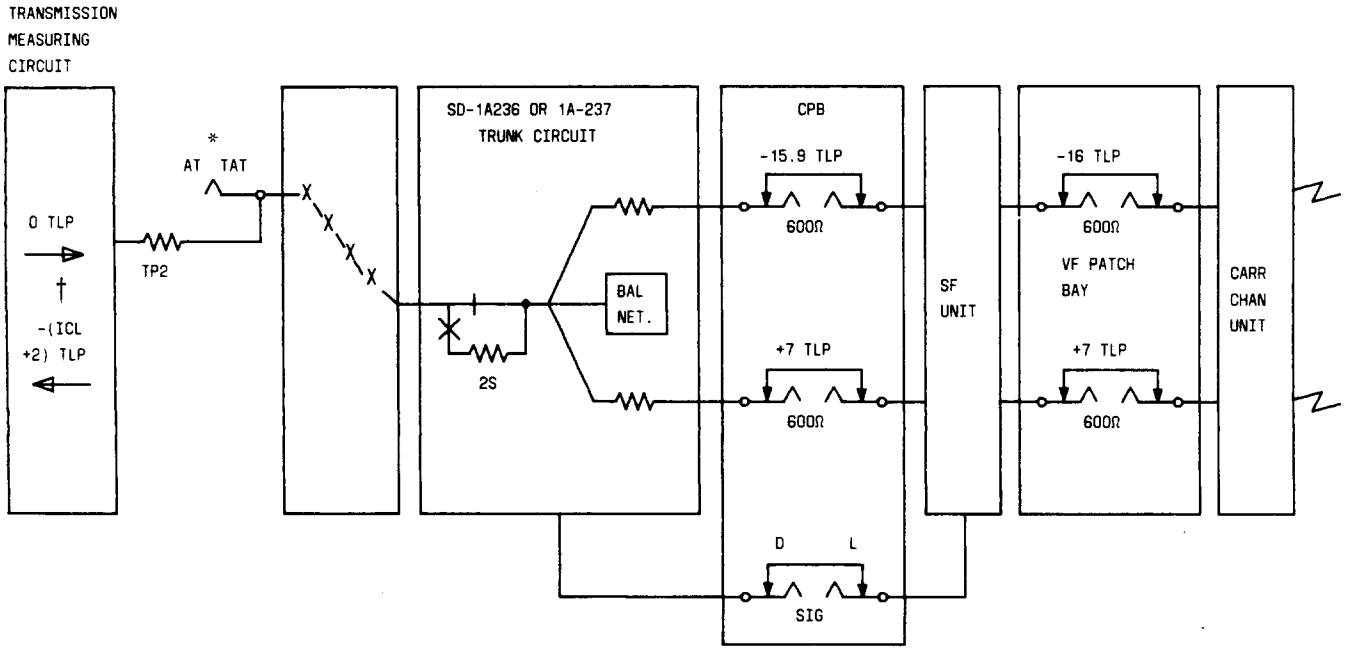
(d) Frequency Shift.

7.03 In the following procedures, ***Trunk*** refers to circuits terminated on TLNs and ***Line*** refers to circuits terminated on LLNs. Figure 2 shows a typical CCSA circuit termination at a No. 1 ESS machine.

7.04 Loop around testing procedures may be used for routine and trouble testing. They are applicable only to 1004-Hz loss and message circuit noise tests.

7.05 Loop around test results are valid only if loop around tests have been performed in connection with straightaway tests and the results accurately recorded.

Note: Differences between straightaway and loop around measurements should be recorded on test records.



* TRANSMIT TLP = -2.0
RECEIVE TLP = -(ICL)DB (TYPICALLY -5.0 TLP)

† TRANSMIT TLP = 0.0 DB
RECEIVE TLP = -(ICL +2.0) DB

NOTE: WHEN MAKING TRANSMISSION TESTS AT THE (AT) JACKS, AN EXTERNAL 2.0-DB PAD SHOULD BE USED TO OBTAIN REF LEVELS SHOWN ON CLR

Fig. 2—Typical CCSA Circuit Termination at a No. 1 ESS Machine

B. 1004-Hz Loss Deviation Tests

7.06 The 1004-Hz loss deviation tests should be performed and requirements met before any other transmission tests are performed.

7.07 The 1004-Hz lineups on circuits employing aerial cable should be avoided, if possible, at times when the outside temperature is unusually high because cable loss increases with increased temperature. Circuits lined up under high temperature conditions may become unstable when the cable temperature decreases.

7.08 The 1004-Hz Expected Measured Loss (EML) limits at various temperatures are given on some CLRs. When this information is given on the CLR, the limits specified are applicable. When these limits are not specified by the CLRs, those in Section 309-200-300 should be used.

7.09 Facility lineups between the CCSA and the serving central office or between CCSAs, in the case of intermachine trunks, should be completed before overall 1004-Hz loss deviation tests are started.

7.10 The following procedure describes straightaway 1004-Hz loss deviation tests on trunks. When questions arise regarding operation of the TLTP/STTP, test personnel should refer to Sections 231-130-301 and 231-131-501.

STEP	PROCEDURE
1	Initiate a test call on the Trunk Under Test (TUT) to the far-end 101 test line, TLTP/STTP, or PBX test number.
2	When far-end test personnel have been contacted, request them to transmit 1004-Hz test tone at 0 dBm0 (TLP level) [-13 dBm0 (13 dB below TLP) for data carrying access lines] for a predetermined length of time, and return to the circuit.
3	At the TLTP/STTP, measure the received test tone level with trunk in tandem state (2-dB switch pads out). ***Notes:*** (a) With expanded test features: A 2-dB test pad is inserted automatically in the transmission measuring circuit and the panel meter will indicate the engineered loss ± deviation. (b) Without expanded test features: The 2-dB test pad is not available. In these cases, the TMS will read 2-dB higher than the engineered level.
4	Record the far-to-near 1004-Hz loss deviation on the test records. ***Note:*** The 1004-Hz loss deviation is the difference between the AML and the EML indicated by the CLR. Excess loss is assigned a (+) sign and excess gain is assigned a (-) sign.
5	Refer to Section 309-200-300 for 1004-Hz loss deviation limits.
6	Test the 2-dB switch pad in the trunk circuit by putting the trunk in the local mode (TK-LOC key) and observing the TMS. The loss in the local state should increase 2.0 to 2.8 dB. Restore trunk to tandem state.
7	Return to talk state and wait for far end to return to TUT.

STEP	PROCEDURE
8	Request far end to measure 1004-Hz test tone and return to trunk after measurement.
9	Transmit 1004-Hz test tone on the TUT at 0 dBm0 (-13 dBm0 for conditioned circuits). ***Notes:*** (a) With expanded test features: This may be done using the SEND key of the TMS circuit. (b) Without expanded test features: An external OSC adjusted for 900-ohm impedance, 1004 Hz, and -2.0 dBm output is used in conjunction with the TAT jack.
10	When sufficient time has elapsed for far end to obtain a reading, return to the talk state.
11	When far end returns to TUT, obtain the near-to-far AML.
12.	Record the near-to-far 1004-Hz loss deviation (see Step 4), and verify that specified limits are met.
13	Proceed with other tests if required or restore TUT to service.

7.11 The following procedure describes loop around 1004-Hz loss deviation tests on trunks. When questions arise regarding operation of the TLTP/STTP, test personnel should refer to Sections 231-130-301 and 231-131-501. The test arrangement is shown in Fig. 3.

STEP	PROCEDURE
1	On the first trunk in a trunk group to be tested, initiate a test call to the far-end 102-type test line.
2	At the TLTP/STTP, measure the received test tone level in the tandem state (2-dB switch pads out). ***Notes:*** (a) With expanded test features: A 2-dB test pad is inserted automatically in the transmission measuring circuit and the panel meter will indicate the engineered loss ± deviation. (b) Without expanded test features: The 2-dB test pad is not available and the TMS meter will read 2-dB higher than the engineered level.
3	Record the far-to-near 1004-Hz loss deviation on the test records.
4	Test the 2-dB switch pad in the trunk circuit by putting the trunk in the local mode (TK-LOC key) and observing the TMS. The loss in the local state should increase 2.0 to 2.8 dB. Restore the trunk to the tandem state.
5	Repeat Steps 1 through 4 on all remaining trunks in the group.
6	Select one trunk in the group as a reference trunk. This trunk should normally be the one with the least 1004-Hz loss deviation in the far-to-near direction.
	First Reference Trunk Seizure
7	Using the reference trunk, initiate a test call to the first appearance of the far-end loop around test line.
8	Transfer the reference trunk to TAT 2.
9	Measure the far-end to near-end 1004-Hz test tone level. Record the level measured (AML) for future reference. ***Note:*** This measurement will be used to determine the near-end to far-end 1004-Hz loss deviation of the rest of the trunks to be tested.
	Seizure and Measurement of Trunk Under Test (TUT)
10	Using a trunk to be tested in the near-end to far-end direction, initiate a test call to the second appearance of the far-end loop around test line.
11	Transfer the TUT to TAT 1.

STEP	PROCEDURE
12	Transmit 1004-Hz test tone on the TUT at 0 dBm0. ***Notes:*** (a) With expanded test features: The SEND portion of the transmission measuring circuit may be used. (b) Without expanded test features: An external OSC adjusted for 900-ohm impedance, 1004-Hz, and -2.0 dBm output is patched into the AT 1 jack.
13	Measure and record the 1004-Hz test tone on the first reference circuit (TAT 2).
14	Calculate the near-end to far-end AML of the TUT as follows: Near-end to far-end AML of TUT = AML of loop (-) AML of reference trunk. ***Example:*** The AML measured on the reference trunk (Step 9) = 5.6 dB. The AML measured on the loop (Step 13) = 10.2 dB. AML of TUT = 10.2 - 5.6 = 4.6 dB.
15	Calculate and record the near-end to far-end 1004-Hz loss deviation of the TUT.
16	Restore the TUT to service or other as required.
17	Repeat Steps 10 through 16 on each of the remaining trunks to be tested. ***Note:*** To measure the near-end to far-end AML of the first reference trunk, select another trunk as the reference trunk and perform Steps 10 through 16 on the first reference trunk.

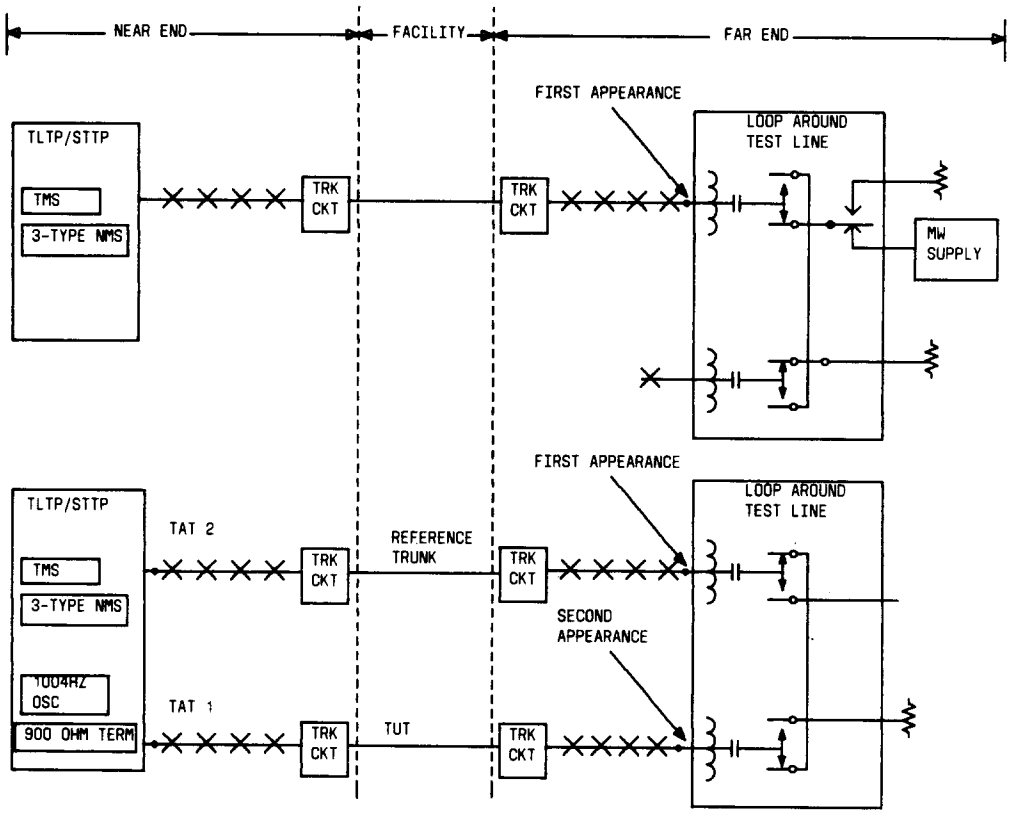


Fig. 3—Loop Around Test Arrangement for Performing 1004 Hz Loss and Message Circuit Noise Measurements

7.12 The following procedure describes 1004-Hz loss deviation tests on lines. Reference to Section 309-200-503 may be helpful.

STEP	PROCEDURE
1	From the TLTP, initiate a test call on the Line Under Test (LUT).
2	Observe the EQPT ST lamp for the following circuit conditions: (a) Steady Lamp—Idle Line (b) 120 IPM Flash—Maintenance Busy or High and Wet Line (c) 60 IPM Flash—Service Busy Line
3A	If line is service busy, suspend tests until it becomes idle.
3B	If line is high and wet, determine reason and clear trouble.
3C	If line is idle, proceed with tests.
4	Ring on line and establish contact with test personnel at station.
5	Request far end to transmit 1004-Hz at 0 dBm0 (TLP level) or -13 dBm0 (TLP -13 dBm on a data carrying line) for a predetermined length of time and return to the LUT.
6	Measure the received tone at the TLTP or other test point selected. ***Note 1:*** When CTX-8 or later generic program has been installed, measurements are made at the TLTP using the LAT. Either the panel TMS or an external 900-ohm TMS may be used with the LAT jack. ***Note 2:*** When generic program earlier than CTX-8 is installed, transmission tests must be made at test points external to the TLTP. These test points may be miscellaneous test jacks, terminating set 2-wire line jacks, testboard appearances, etc. Distributing frame terminals, although not recommended, may have to be used. These test points must be at known impedances and TLPs, and include all active transmission equipment on the LUT.
7	Record the far-to-near 1004-Hz loss deviation.
8	Return to the talk state and wait for the station test personnel to return to the line.
9	Request the far-end personnel to measure 1004-Hz test tone and return to the line.
10	Transmit 1004 Hz at 0 dBm0 (-13 dBm0 for a data carrying circuit) for a length of time to allow far-end measurements. ***Note:*** If CTX-8 or later generic program is installed, the TLTP test tone source may be used. In those cases where earlier generic programs are installed, an external OSC is

STEP	PROCEDURE
	connected to another test point. (See Step 6, Note 2.) The OSC impedance must be the same as the test point impedance. The 1004-Hz output level is adjusted for 0 dBm0 (-13 dBm0 for a data carrying line) at the test point.
11	Return to the talk state and obtain the 1004-Hz level measurement and the TLP at the test point used at the station.
12	Record the near-to-far 1004-Hz loss deviation.
13	Refer to Section 309-200-300 for 1004-Hz loss deviation requirements.
14	If requirements are met, proceed with additional tests as necessary or restore the line to service. When requirements are not met, arrange for circuit lineup per local procedures.

C. Attenuation Distortion (Frequency Response)

7.13 Attenuation distortion measurements are performed using the same test arrangement as the 1004-Hz loss deviation tests except that a variable frequency OSC is used as the test tone source.

7.14 The OSC is connected and adjusted as follows:

(a) With expanded test features available—Connect the KS-19260 OSC in the AUT bay to the transmission measuring circuit by the operation of keys when available. When an external OSC must be used, it should be connected to the EXT GEN jack at the TLTP or STTP. The OSC should be adjusted to 900-ohm impedance and 0 dBm (-13 dBm for data carrying circuits) output.

(b) Without expanded test features available—When testing trunks, connect a 900-ohm OSC to the AT jack associated with the TAT being used. The OSC output should be adjusted to -2.0 dBm. When testing lines, the OSC is connected in the same manner as for 1004-Hz loss deviation tests. The OSC output levels are adjusted to the test point TLP for voice only circuits and TLP - 13 dBm for data carrying circuits.

(c) When the KS-19260 or other pushbutton type OSC is used for the tone source, it is not necessary to verify the test tone frequencies. When other types of OSC are used, the frequencies should be checked and adjusted (see 5.06) as follows:

(1) The received tone frequencies are measured at the AT jack (without expanded test features) or at the EXT DET jack (with expanded test features) with the 72A frequency meter or equivalent. The frequency meter must be removed before level measurements are made.

(2) The transmitted tone frequencies may be measured at the CK MW jacks when expanded test features are available and the OSC is connected to the TAT by key operations. When the OSC is to be connected to the EXT GEN jacks or AT jacks by patch cords, the OSC should be patched to the frequency meter and the frequency adjusted before connecting to the circuit under test.

7.15 When performing attenuation distortion measurements, it is desirable to have a communication channel with the far end other than the circuit under test. When this is not possible, testing coordination becomes more difficult. The following procedure assumes a separate communication channel. When not available, test personnel must return to the circuit after the measurement of each frequency.

7.16 The following procedure describes attenuation distortion measurements.

STEP	PROCEDURE
1	Initiate a test call on the circuit under test from the TLTP/STTP to the far-end 101 test line, TLTP/STTP, PBX test number, or station.
2	When the far-end test personnel have been contacted, request them to transmit 1004-Hz test tone at 0 dBm0 (-13 dBm0 for a data carrying circuit) using a variable frequency OSC. The OSC output should be adjusted using a TMS before being applied to the circuit.
3	At the TLTP/STTP, verify the test tone frequency received (see 5.06 and 7.14).
4	At the TLTP/STTP or other test point when necessary, measure the level of the received test tone.
5	Determine the 1004-Hz loss deviation and verify that it is within limits before proceeding.

STEP	PROCEDURE
6	When it has been determined that the 1004-Hz loss deviation is within limits, record the level obtained in Step 4.
7	Without changing the test arrangement, request the far end to adjust the OSC to the first frequency to be measured. (See Section 309-200-300 for the frequencies required based on the type of circuit under test.) The OSC output level should be measured and adjusted as necessary to maintain the same level as used in Step 2.
8	At the TLTP/STTP or other test point, verify the test tone frequency (see 5.06 and 7.14).
9	Measure and record the received tone level.
10	Repeat Steps 7 through 9 for each of the remaining test frequencies.
11	Calculate and record the attenuation distortion in the far-to-near direction of transmission. ***Note:*** Attenuation distortion is expressed in dB loss relative to 1004 Hz. To determine the attenuation distortion, calculate the difference between the 1004-Hz loss and the loss of each of the other test frequencies. Frequencies with losses greater than the 1004-Hz loss are (+) deviations and frequencies with losses less than the 1004-Hz loss are (-) deviations.
12	Refer to Section 309-200-300 for attenuation distortion limits.
13	Perform attenuation distortion measurements in the near-to-far direction of transmission by connecting an OSC in place of the TMS at the TLTP/STTP or other test point and replacing the OSC at the far end with a TMS. ***Note:*** By measuring the test tone frequencies at the TLTP/STTP before connecting them to the circuit under test, the need for a 72A frequency meter or equivalent is eliminated at the far end.
14	Restore the circuit to service or continue with other tests as required.

D. Message Circuit Noise and Single Frequency Interference Measurements

7.17 Message circuit noise (steady state noise) is measured at each end of the circuit with the far end terminated in its characteristic impedance.

7.18 Single frequency interference is the presence of a tone in the audible band that, when present, contributes to the total message circuit noise. Single frequency noise tests are necessary only when the message circuit noise is higher than 3 dB below the requirements.

7.19 Message circuit noise is measured at the same points in the circuit as is the 1004-Hz loss. Loop around tests on PBX access lines and intermachine trunks may be performed when the necessary equipment is available.

7.20 A 3-type Noise Measuring Set (NMS) equipped with a C-message weighting filter is usually used for message circuit noise measurements. Other test equipment may be used if preferred (see Part 3).

7.21 As noise is in part caused by crosstalk and intermodulation on carrier facilities, it should be measured during peak traffic loads when possible.

7.22 The following procedure covers straightaway message circuit noise measurements.

STEP	PROCEDURE
1	At the TLTP/STTP, originate a test call to the far-end 101 test line, TLTP/STTP, PBX test number, or station.
2	When the far-end test personnel have been contacted, request a termination in the transmit direction for a predetermined length of time. ***Note:*** The termination must be of the same impedance as the test point being terminated. (The 3-type NMS provides a good termination at 600- or 900-ohm impedance points.)
3	At the TLTP/STTP, transfer the circuit to the LAT or TAT. Connect the 3-type NMS or equivalent to the LAT or TAT by operating keys (with expanded test features) or with a patch cord (without expanded test features). When other test points are used, connect the NMS with suitable patch cords to the receive test point.
4	Operate the NMS controls for 900-ohm impedance; read and record the indicated noise power level.
5	Monitor the 3-type NMS or equivalent at the measurement level for a single frequency tone and/or intelligible conversation. (Intelligible conversation is an indication of trouble which must be cleared before turning circuit up.)
6	Convert the far-to-near NMS reading (dBrnc) to dBrnc0 and record. ***Note:*** To convert dBrnc to dBrnc0, determine from the CLR the TLP at the point where the measurement is being taken. Subtract the TLP value from the NMS reading. The difference is the noise level expressed in dBrnc0. ***Example:*** TLP = -5.0 NMS reads 36 dBrnc 36 - (-5) = 41 dBrnc0 noise level
7	Refer to Section 309-200-300 to determine if message circuit noise is within limits.

STEP	PROCEDURE
8	If the noise level is less than 3 dB below the requirement and a single tone interference was found in Step 5, it should be isolated and cleared.
9	Repeat Steps 2 through 8 in the opposite direction of transmission to measure near-to-far message circuit noise.
10	Restore the circuit to service or continue with further tests as required.

7.23 Message circuit noise on trunks may be measured using the loop around method for routine and trouble location tests only. Loop around measurements are not accurate and are for turndown requirements only.

7.24 The following procedure describes message circuit noise measurements on trunks using the loop around method. Reference to Fig. 3 may be helpful.

STEP	PROCEDURE
	Far-End to Near-End Noise—Loop Around Method
1	On the first trunk to be tested in a trunk group, initiate a test call from the TLTP or STTP to the far-end 100-type balance test termination.
2	Transfer the test call to a TAT and connect a 3-type NMS or equivalent to the TUT by key operations or patch cords as necessary.
3	Operate the NMS controls for 900-ohm impedance; read and record the indicated noise power level.
4	Monitor the NMS at the measurement level for a single frequency tone and/or intelligible conversation. Intelligible conversation is an indication of trouble which must be cleared before turning the circuit up for service.
5	Convert the far-end to near-end NMS reading (dBrnc) to dBrnc0 and record.
6	Refer to Section 309-200-300 to determine if far-end to near-end message circuit noise is within requirements. ***Note:*** If the noise level is less than 3-dB below the requirement and a single tone interference was found in Step 4, the trouble should be isolated and cleared.
7	Repeat Steps 1 through 6 for each trunk in the group to be tested.
	Near-End to Far-End Noise—Loop Around Method
	Note: Near-end to far-end noise measurement using the loop-around method is largely an estimate and the most that can be accomplished is a determination that immediate action limits (trouble) are not being exceeded.
8	Select from the trunks being measured the one with the least far-end to near-end noise as measured in Steps 1 through 7. This will be the reference trunk and will be used in measuring the near-end to far-end noise of the remaining trunks to be tested.
9	Using the reference trunk, initiate a test call to the first appearance of the far-end loop around test line.
10	Transfer the reference trunk to TAT 2 and connect the 3-type NMS or equivalent adjusted for 900-ohm impedance to TAT 2.
11	Using a trunk to be tested (TUT), dial the second appearance of the far-end loop around test line.

STEP	PROCEDURE
12	Transfer the TUT to TAT 1 and terminate TAT 1 by operating the TR, XMSN (TAT 1), and TRFR (MTL) keys.
13	Read the noise indicated on the NMS and correct to dBrnc0. Record this value (looped noise) on the test sheet of the TUT.
14	Calculate the estimated near-end to far-end noise of the TUT as follows:
	(a) Subtract the reference line far-end to near-end noise value (Step 5) from the looped noise value (Step 13). This difference will be the noise contributed by the TUT in the near-to-far direction.
	(b) In Table B locate the difference in column A (to nearest dB) and add the indicated correction in column B to reference line far-to-near noise.
	(c) Determine from the CLR the difference in TLPs at the loop around point. Add this difference to the value obtained in (b). The result will be the estimated noise in dBrnc0 of the TUT in the near-to-far direction.
	(d) Refer to Section 309-200-300 to determine if noise is within limits.

TABLE B

A DIFFERENCE (dB)	B CORRECTION (dB)
0	−8
1	−6
2	−3
3	0
4	+2
5	+4
6	+5

E. C-Notched Noise Measurements

7.25 C-notched noise measurements are performed to measure the noise level on a line when a signal is present. In making this measurement, a tone of 1004 Hz, 2804 Hz, or 2750 Hz is applied at the transmitting end of the circuit at -13 dBm0 which simulates a data signal. The purpose of this tone is to operate compandors and other signal dependent devices. At the receiving end of the line, the tone is removed by a narrow band elimination filter (notched filter) and the noise is measured through a C-message filter. These measurements are performed at the same test points as the 1004-Hz loss measurements.

7.26 The 3C NMS equipped with a KS-21567 L1 notch filter (preferred) or a 497-type weighting network may be used to determine whether the C-notched noise is less than 53 dBrnc0. The 497E network (2804 Hz) and the 497G network (2750 Hz) do not provide enough rejection of the holding tone to measure C-notched noise below about 53 dBrnc0. The KS-21567 L1 filter (1004 Hz), however, allows measurements below 53 dBrnc0.

7.27 Other test equipment capable of performing C-notched noise measurements are the H/P 4940A TIMS, the Telecommunications Technology, Inc. 1105 level/noise digital test set, and the Collins link analyzer (CLA101).

7.28 A thorough discussion on C-notched noise is contained in Section 314-410-500.

F. Impulse Noise Tests

7.29 Impulse noise measurements are performed at the same test points as the 1004-Hz loss deviation measurements.

7.30 Impulse noise is a function of crosstalk and cross-modulation, and the main cause of impulse noise is switching activity; therefore, tests should be conducted during periods of normal to high traffic, when possible.

7.31 Impulse noise is usually measured with a WECo 6-type impulse noise counter or the H/P 4940A TIMS. A holding tone is transmitted on the circuit at -13 dBm0 to operate compandors and other tone sensitive equipment. When the H/P 4940A TIMS is used, the holding tone is 1004 Hz. When the 6-type impulse noise counter is used, a KS-21567 L2 C-notch filter (if available) should be used with a 1004-Hz holding tone. If the KS-21567 L2 filter is not available, 497E or 497G weighting networks may be used with holding tones of 2750 Hz and 2804 Hz, respectively. The 1004-Hz holding tone is preferred and should be used if possible.

7.32 When performing impulse noise tests, the impedance of the holding tone source must be the same as the characteristic impedance of the test point where applied.

7.33 The threshold setting values for the impulse counter and requirements are covered in Section 309-200-300.

7.34 A more thorough discussion and test procedures are covered in Sections 314-410-500 and 231-131-501.

G. Frequency Shift Tests

7.35 Frequency shift tests are performed in case of repeated trouble reports on lines used for data transmission. These tests are necessary only on the carrier portions of an access line as physical plant cannot cause frequency shift.

7.36 Frequency shift requirements are specified in Section 309-200-300. Testing procedures are given in Section 314-410-500.

H. Phase Jitter Measurements

7.37 Various sources cause the instaneous phase or zero crossings of a signal to jitter at rates usually under 300 Hz. Phase jitter is typically caused by ripples in the dc power supply appearing in the master oscillator of LMX carrier supplies.

7.38 A thorough discussion of phase jitter is contained in Section 314-410-500 and should be referred to when phase jitter tests are required.

I. Envelope Delay Measurements

7.39 Envelope delay measurements should be made at the TLTP/STTP when possible. If this is not feasible, the measurements may be made at circuit patch bays or equivalent 4-wire test points.

7.40 The 25A or 25B Gain and Delay Measuring Set is the most commonly used set for measuring envelope delay, however, others such as the H/P 4940A TIMS may also be used.

7.41 When using the 25-type sets, it is necessary to have a transmission path from the far-end set to the near-end set. This return path can be any VF facility as the delay characteristics of the return path have no affect on the measurements.

7.42 Figure 4 shows a possible test arrangement using the far-to-near direction of the 4-wire facility for a return path while measuring the near-to-far delay distortion. The far-to-near delay is measured in the same manner except that the near-end set is operated in the repeat mode, the far end is operated in the normal mode, and the patch cords and terminations are reversed.

7.43 The H/P 4940A TIMS is capable of measuring envelope delay distortion without a return path and may be used where available.

7.44 The signal transmitted by the transmitting delay test set should be at -13 dBm0 and the signal transmitted by the receiving set on the return path should be at 0 dBm0 for the facility used.

7.45 Sections 103-115-100 and 103-115-101 cover the description and operation of the 25A and 25B gain delay sets, respectively. The H/P 4940A set operation is included in the manufacturers manual covering the set.

J. Nonlinear Distortion Tests

7.46 Nonlinear distortion, previously referred to as harmonic distortion, may be defined as the generation of harmonics that add to the transmitted signal in an undesirable manner.

7.47 There are three methods used for measuring nonlinear distortion; single tone, two tone, and four tone. The four-tone method is superior to the others and should be used whenever possible.

7.48 When using the four-tone method, four equal level tones are transmitted over the facility to be measured. The four tones consist of two pairs of tones centered around 860 and 1380 Hz. The four tones transmitted are 856 Hz and 863 Hz for one pair, and 1374 Hz and 1385 Hz for the second pair. The tones are transmitted at a combined power of -13 dBm0 on the facility. Second order distortion is determined by measuring the received energy through narrow band filters centered at 520 Hz and 2240 Hz. Third order distortion is measured through a narrow band filter centered at 1900 Hz.

7.49 Test equipment capable of measuring harmonic distortion using the four-tone method include the H/P 4940A TIMS and the Hekimian Model 65 or 65LN Test Sets. The instructions for using these test sets are supplied by the manufacturers manuals accompanying the sets.

7.50 A more thorough discussion of nonlinear distortion and its measurement may be found in Section 314-410-500.

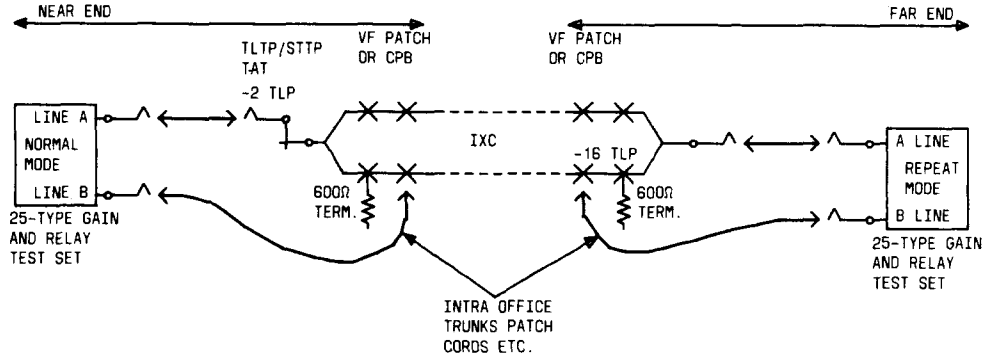


Fig. 4—Test Arrangement for Near to Far Envelope Delay Measurement

7.51 These measurements are required only on carrier facilities and are generally more easily performed at the VF patch bays or circuit patch bays.

8. THROUGH AND TERMINAL BALANCING

8.01 In order to control echo and insure circuit stability on a CCSA network, it is essential that the Echo Return Loss (ERL) and Singing Return Loss (SRL) or Singing Point (SP) requirements be met or exceeded.

8.02 Sections 660-476-ZZZ cover balancing procedures and requirements at No. 1 ESS offices used in the MTS network; however, the information presented is also applicable to CCSA SSNs.

8.03 In order for an office to meet requirements, 50 percent or more of the circuits must meet or exceed the median values indicated for ERL and SRL. Also, no circuits should have ERL and SRL measurements below the minimum values shown.