IMPULSE NOISE
TRUNKS
TEST PROCEDURES AND INVESTIGATION

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CONTENTS PAGE

1. INTRODUCTION

1.01 This section provides information on the investigation and mitigation of impulse noise on telephone trunks and the facilities over which they work. The methods described are applicable to all types of trunks and facilities. These procedures are recommended for investigation of suspected impulse noise troubles and are not recommended as a routine measurement tool.

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

1.03 A ***trunk*** consists of an originating switch and associated trunk circuit equipment, a transmission facility and associated terminal equipment, and a completing switch and associated trunk circuit equipment. Measurements on trunks are made from the outgoing (OG) switch appearance to the OG switch appearance of the distant office. A termination is included at the distant end.

1.04 ***Facilities*** are measured from voice-frequency patch bay (VFPB) to VFPB (or equivalent). Facility measurements are referred back to the zero transmission level point (0 TLP).

1.05 General information about impulse noise is contained in Section 331-100-101. Sampling techniques used in this section are described in Section 331-200-100.

2. TRUNK AND FACILITY MEASUREMENTS

A. General

2.01 Whenever a report is received involving an impulse noise problem, the first step is to evaluate the trunk group in which the complaint occurred. After evaluation, individual trunks are investigated within the group of trunks involved.

2.02 The basic procedure for evaluation of impulse noise on trunks and facilities is known as sequential sampling. Only a brief discussion of this procedure is presented in this section.

2.03 Briefly, sampling eliminates the necessity of measuring all trunks or facilities in a group. If a specified number of trunks or facilities passes or fails a given limit, the group of trunks or facilities is either turned up for service or is rejected as not being acceptable because of impulse noise impairment. Section 331-200-100 provides the required limits for accepting or rejecting a trunk or facility group.

2.04 Impulse noise measurements on trunks need not be made at the time circuit order tests are made and, therefore, no circuit limits are specified. Impulse noise measurements will be required at the time of initial lineup of trunk facilities when so specified in the trunk facilities sections of the Bell System Practices.

B. Measuring Techniques

2.05 To measure impulse noise, the DBRN switch on the impulse counter should be set to the value corresponding to the threshold requirement specified in Table A of Section 331-200-100 corrected

by the level at the transmission level point (TLP) at which the measurement is being made. For example, if an impulse noise measurement is being made on a trunk (assuming the trunk meets the specified loss measurement) that has a threshold requirement of 59 dBrnc0, measurements made at the +7 TLPs will require a DBRN switch setting of

THRESHOLD REQUIREMENT + TLP = DBRN SWITCH SETTING

59 + 7 = 66.

This same trunk measured at the −16 TLPs will require a DBRN switch setting of

59 + (−16) =
59 −16 = 43.

2.06 In order to justify marginal measurements, the deviation of the actual measured loss (AML) from the expected measured loss (EML) must be included in the DBRN switch setting. This changes the above statement to

THRESHOLD REQUIREMENT + TLP + LOSS DEVIATION = DBRN SWITCH SETTING.

The following data should be considered when making corrections for loss deviations:

EML ±AML	LOSS DEVIATION
0 - 0.5	0
0.6 - 1.5	±1
1.6 - 2.5	±2
2.6 - 3.0	±3
3.1 - Up	Exceeds all maintenance guides. Correct loss problem.

Rule 1: If the AML is greater than the EML, *subtract* the loss deviation.

Rule 2: If the AML is less than the EML, *add* the loss deviation.

If the trunk in the above example (2.05) is measured at the 0 TLP and the trunk AML is 1.2-dB greater than the EML, the DBRN switch setting is

59 + 0 + (−1.0) =
59 −1.0 = 58.

If the trunk is measured at the −16 TLP, the DBRN switch setting is

59 + (−16) + (−1.0) =
59 − 16 −1.0 = 42.

2.07 Requirements for trunks consisting of compandored facilities and mixed compandored and noncompandored facilities are stated separately from those for noncompandored facilities. On compandored facilities, a holding tone is required to keep the expandor operating at a fixed loss. The C-notched weighting network is used with the impulse counter when measuring noise on these facilities. The requirements in Section 331-200-100 are based on the statistical behavior of impulse noise across trunk groups and its effect on facility groups. When single trunk or single channel measurements are made, the same level is used but the testing time is extended to 15 minutes and the count to 15.

C. Loss Measurements

2.08 Before impulse noise measurements are made, 1004-Hz transmission loss measurements should be made. If the loss deviates from the EML by more than the maintenance guides in Section 660-402-300, the trunk should be investigated for a possible trouble condition and corrective action taken. If the deviation is too excessive in either direction, erroneous results will be encountered when making impulse noise measurements.

2.09 Levels specified for measurements with the 6-type noise measuring set are referred to 0 TLP. Points other than 0 TLP are referred to 0 TLP using the loss or gain experienced by a 1004-Hz tone transmitted at 0 dBm 0 from the far end to the point of measurement. See Section 660-450-300.

D. Holding Tone—Compandored Carrier

2.10 Noise measurements on compandored carrier system channels or mixed compandored and noncompandored system channels are made with a 2804-Hz holding tone at −13 dBm0 applied at the distant end. Since present testing procedures do not provide this tone, two people are required to perform the tests on compandored facilities. A notched filter is used at the impulse noise counter to block this holding tone. T-carrier is considered to be compandored carrier.

> ***Note:*** If equipment with C-notched 995- to 1020-Hz filters is available, use a holding tone of 1004 Hz.

2.11 The holding tone should be applied and measurements made at test points that will include compandored action. The DO-DG jacks on N2 and N3 carrier do not include the compandor and should not be used as test points (except for trouble-locating procedures).

> ***Caution: If holding tone is used on trunks having 2600-Hz signaling, the oscillator should not be swept through 2600 Hz.***

E. Measurement Time

2.12 Whereas the tests for impulse noise on trunks are not of a routine nature, the measurements of impulse noise using the procedures outlined in this section should be made during the time when the subscriber is experiencing the trouble. In most cases, this time will coincide with the time at which the switching activity within the office (or offices) is at its highest rate.

3. INITIAL PROCEDURES

A. General

3.01 The basic procedure for evaluation of impulse noise on trunks and facilities is to use a sequential sampling plan. A look at the cumulative value of some parameter after each test or measurement is completed will provide the answer to the following questions:

(a) Should the lot under test be accepted,

(b) Should the lot be rejected, or

(c) Is another test in order?

3.02 The following step procedures are required on each trunk or facility within the trunk or facility group being measured. The sample form provided with Section 331-200-100 may be duplicated locally if desired.

B. Apparatus

3.03 The following apparatus is required to perform the procedures described in this section.

TEST APPARATUS	REMARKS
6F or 6H impulse noise measuring set (NMS) or equivalent equipped with 497G or 497J network.	C-notched filter required for compandored facilities.
3C NMS or equivalent	
7A carrier frequency noise measuring set (CFNMS)	For use in the investigation of N-type carriers.
120-H coil	Wired per Fig. 1.
Variable-frequency oscillator	Must be able to provide 2804-Hz holding tone at −29 to −6 dBm0. See Note in 2.10.

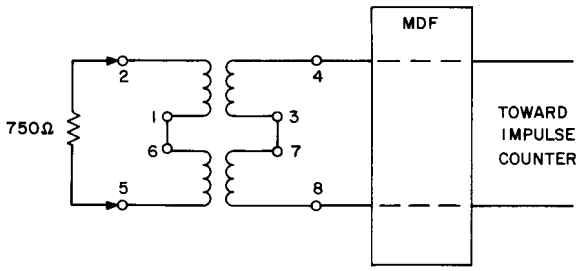


Fig. 1—120H Coil Wired for Terminating Cable at MDF

C. Procedures for Sequential Sampling

3.04 A trunk group is defined as all trunks between common test points. For example, all those trunks between two testboard appearances would comprise an intertoll trunk group.

3.05 Trunk groups will require measurements at both ends when investigations are made for impulse noise. Section 660-402-300 defines outgoing switch appearances and lists other sections containing information relative to testing methods at various types of offices. Section 660-450-301 provides a list of sections that will serve as references for the user of this section. Section 660-450-300 contains

explanations of terms used in this section. Although these sections refer mostly to circuit order or trunk order tests, the information is of value in noise investigations.

3.06 The following procedures are used when measuring impulse noise on trunks by sequential sampling.

STEP	PROCEDURE
	Initial Procedures
1	Use a test sheet similar to the form provided in Section 331-200-100. In the appropriate spaces provided, enter the trunk group, date, and the office in which the tests are being made. Use common language codes as described in Section 795-400-100.
2	In the column designated CUMULATIVE NUMBER OF TRUNKS MEASURED, list numbers according to the number of trunks being measured.
3	In the REMARKS column, enter "compandored" opposite the trunk number for those trunks using compandored facilities. ***Note:*** If a holding tone is to be used on all measurements, this column may be left blank.
4	Obtain the test level for each trunk from Table A of Section 331-200-100, and enter this value in the TEST LEVEL column.
5	From Section 331-200-100, obtain the decision number of 0's or 1's required to determine whether the group will be accepted or rejected.
6	Using the procedures described in the BSP sections listed in Section 660-450-301 that apply to the type of office or location at which the impulse noise is to be measured, seize the first trunk to be tested and dial the number for the 102-type test line at the distant office.
7	Measure the loss of the trunk.
8a	If the difference between the AML in Step 7 and the EML of the trunk exceeds the deviation limit of the maintenance guides in Section 660-402-300, correct the loss problem before continuing with these procedures. Start the procedures again at Step 6.
8b	If the difference between the AML in Step 7 and the EML of the trunk is within the deviation limit of the maintenance guides in Section 660-402-300, continue with these procedures. See 2.06 for possible correction to the DBRN switch setting.
9	Release the 102-type test line.
10	Set up and calibrate the impulse counter as described in Section 103-620-100 (6A or 6E), 103-620-101 (6H or 6HR), or 103-626-100 (6F or 6FR). Equip the impulse counter with the appropriate C-notched weighting network.
11	Set the DBRN switch of the impulse counter to the threshold requirement listed in Table A (or the TEST LEVEL from the sample form) of Section 331-200-100. Make any corrections described in 2.06 for deviations between the EML and the AML.

STEP	PROCEDURE
	Measurements to 100-Type-Test Lines—No Holding Tone Required
12	Dial the far-end central office quiet termination.
	Note: If the quiet termination line returns repetitive on-hook supervision, use the 101-type test line and have the trunk terminated manually at the 101 jack. Have the distant office return to the 101 test line after the specified test interval.
13	Connect the impulse counter to the trunk.
14	Operate the timer switch to 5 minutes and reset the counter.
15	At the end of the test interval, read the number of impulses registered. Go to Step 25 for instructions on how to record the count.
16a	Measure the impulse noise in the opposite direction of transmission. ***If the trunk is a one-way trunk*** and the quiet termination was used in Step 12, release it. Call the distant office on the 101-type test line. Measure the trunk loss from the near to the distant office. Terminate the trunk at the near office and measure the impulse noise at the distant office. Methods are similar to Steps 7 through 15.
16b	Measure the impulse noise in the opposite direction of transmission. ***If the trunk is a 2-way trunk*** and the quiet termination was used in Step 12, release it. Have the distant office repeat Steps 6 through 15 at the OGT appearance of the trunk to measure the impulse noise with the OGT circuit at the distant office and incoming trunk circuit at the near office included in the measurement.
17	Repeat Steps 6 through 9 and 12 through 16 for all trunks to be measured to a 100-type test line.
	Measurements to 101-Type Test Lines—Holding Tone Used
18	Dial the 101-type test line of the distant office.
19	Have the distant office send a 2804-Hz holding tone at −13 dBm0 to hold the compandor at a fixed loss. Have the distant office return to the 101 test line after the specified test interval.
20	Connect the impulse counter to the trunk.
21	Operate the timer to 5 minutes and reset the counter.
22	At the end of the test interval, read the number of impulses registered. Go to Step 25 for instructions on how to record the count.
23a	Measure the impulse noise in the opposite direction of transmission. ***If the trunk is a one-way trunk,*** measure the trunk loss from the near to the distant office. Place a 2804-Hz holding tone at −13 dBm0 on the trunk at the near office. Measure the impulse noise at the distant office.

STEP	PROCEDURE
23b	Measure the impulse noise in the opposite direction of transmission. ***If the trunk is a 2-way trunk,*** have the distant office repeat Steps 6 through 11 and 18 through 22 at the OGT appearance of the trunk to measure the impulse noise with the OGT circuit at the distant office and incoming trunk circuit at the near office included in the measurement.
24	Repeat Steps 6 through 9 and 18 through 23 for all trunks requiring holding tone.
	Recording Impulses and Decision Requirements
25a	If the counter reads 5 or less counts, enter a 1 in the CUMULATIVE 0's column opposite the 1 in the column designated CUMULATIVE NUMBER OF TRUNKS MEASURED.
25b	If the counter reads more than 5 counts, enter a 1 in the column designated CUMULATIVE 1's opposite the 1 in the column designated CUMULATIVE NUMBER OF TRUNKS MEASURED.
26	Continue measuring the remaining trunks of the group as described above. Record the next trunk with 5 or less counts as a "2" in the CUMULATIVE 0's column, and so on as testing progresses. The same applies to the CUMULATIVE 1's column. When the cumulative 0's or 1's exceed the decision number, stop testing. ***Note:*** If the count appears excessive (20 or more per minute) while measurements are being made, the trunk should be checked for C-message noise with a 3-type NMS. If the message circuit noise is greater than the immediate action limit shown in Section 660-403-500, clear the message noise problem before continuing with impulse noise measurements.
27a	If the exceeding cumulative number (determined from Step 5) appears in the CUMULATIVE 0's column, ***accept the group.***
27b	If the exceeding cumulative number (determined from Step 5) appears in the CUMULATIVE 1's column, ***reject the group.***
27c	If neither 0's nor 1's exceeds the decision number after the maximum number of tests, and if there are equal 0's and 1's, ***accept the group.***

4. SECTIONALIZATION PROCEDURES—OVERALL

A. General

4.01 The investigation of impulse noise on trunks may begin with either the central office equipment or the facility. A logical approach would be an attempt to sectionalize the trunk by observing the central office equipment and facilities assigned to the trunks within the trunk group tested which exceed the 5 counts in 5 minutes limitation to see whether some common item could be the source of the impulse noise. For example, if the trunks were all assigned to a common N-type carrier group, it is more than likely that there is a problem with the N-carrier group. This sectionalization should include both central offices with regard to common equipment.

4.02 The basic steps in the investigation for impulse noise on trunks are as follows:

(a) Measure the trunk loss. Correct the level if it is out of maintenance limits.

(b) Measure impulse noise count. If requirements are not met, continue.

(c) Sectionalize the trunk. Make an impulse noise count on each section.

(d) When trouble has been cleared, remeasure both impulse noise and trunk loss.

Central Office Equipment

4.03 The major causes of impulse noise in the telephone network are the transients generated by switching operations. This is especially true in step-by-step switching offices equipped with rotary-out trunk switches (ROTS). Crossbar and electronic switching offices are not significant generators of impulse noise.

4.04 Properly adjusted and maintained switching equipment will greatly reduce the impulse noise in a central office. This is the first item that should be checked and the most easily corrected. Unbalanced windings of relays or unmatched capacitors in the transmission path of trunk circuits cause the trunks to be more susceptible to message and impulse noise. Unbalanced equipment is difficult to detect, and about the only action that can be taken by a repair person is to replace the items of equipment that are suspected of being unbalanced. Central office battery supplies are also a source of impulse noise if they are improperly distributed and poorly filtered. The methods discussed in Sections 331-700-100 through 331-700-505 for cross-office noise testing, Section 331-701-501 for central office battery supply noise measurements, and Section 331-701-500 for impulse noise investigations in central offices should be followed.

Facilities

4.05 Impulse noise generated by switching operations is transmitted to cables and carrier systems as longitudinal voltages which are induced on other trunks common to the facility group. As mentioned in Section 331-100-101, impulse noise appears on many channels (or pairs) within a common entity. The longitudinal voltages are converted to metallic noise because of irregularities in the facility layout. Some mitigation of impulse noise is possible by maintenance personnel. Further improvement may require an engineering program. Impulse noise measured on T-carrier facilities, while registering on an impulse counter, may actually be caused by nonlinear distortion. A test for nonlinear distortion should, therefore, be made (using 4-tone techniques) to determine which parameter is at fault.

Requirements and Investigation on Single Trunks

4.06 The requirements for investigating impulse noise on a single trunk are the same as those used for the sampling procedure given in Section 331-200-100 with one exception: the time interval is lengthened from 5 minutes to 15 minutes with 15 counts.

4.07 Sectionalization of a trunk into the distant office, the facility, and the originating office may be done at locations such as MDFs and VFPBs, whichever is applicable to the particular trunk being investigated. In most instances when a section is removed, the impulse count will drop 50 percent from the overall count if the section that is removed contains a source of impulse noise or if the section is susceptible (due to electrical unbalance) to impulse noise generated externally to the trunk. If the count does not drop by at least 50 percent, further investigation by sectionalization is in order (if possible). The source of impulse noise may now be in the remaining section and/or in both sections. The person making the investigation should always be aware that an overall impulse noise measurement is required after any section has been cleared of an impulse noise problem.

B. 1004-Hz Loss Measurement

4.08 Measure the overall 1004-Hz loss of the trunk and, if the loss exceeds the maintenance limits specified in Section 660-402-300, realign the circuit before proceeding with these procedures.

C. Impulse Noice Measurement

4.09 Measure the overall impulse noise of the trunk from the originating central office to the quiet termination of the distant office (or to the 101-type termination if a holding tone is required).

Note: When using the quiet termination at the distant office, be sure that it is not of the timed-disconnect type since this would produce an erroneous count. The 101-type test line with 900-ohm termination may be used.

D. Sectionalization Procedures

4.10 The methods for sectionalization of trunks are divided into the type of trunk (functional use) and the type of facility assigned to the trunk.

One-Way, Two-Wire Trunk (See Fig. 2)

4.11 There are three sections to be investigated on a one-way trunk assigned to cable facilities. These are

(a) The originating office, outgoing path

(b) The cable pair

(c) The completing office, incoming path.

The following is the procedure for sectionalizing one-way, 2-wire trunks.

STEP	PROCEDURE
1	At the originating office, measure the 1004-Hz loss of the trunk.
2a	If the loss exceeds the deviation limits of the maintenance guides in Section 660-402-300, correct the loss problem before proceeding with these procedures.
2b	If the loss is within the deviation limits, make any necessary correction to the DBRN switch setting on the impulse counter as specified in 2.06.
3	Measure the impulse noise to the completing office code 100 or code 101 test line termination. Set the timer for 15 minutes.
4a	If the impulse count is 15 or less in 15 minutes, return the trunk to service.
4b	If the impulse count is greater than 15, have a 120-H coil placed on the cable pair at the MDF at the completing office (Fig. 1). Measure the impulse noise. Set the timer for 15 minutes.

STEP	PROCEDURE
5a	If, in Step 4b, the count is reduced 50 percent or more of the count in Step 3, investigate the completing office incoming path.
5b	If, in Step 4b, the count is not reduced 50 percent of the count in Step 3, have a 120-H coil placed on the cable pair at the originating office MDF (Fig. 2). Measure the impulse noise. Set the timer for 15 minutes.
6a	If, in Step 5b, the count is reduced 50 percent or more of the count in Step 4b, refer the problem to personnel responsible for the maintenance of the facility.
6b	If, in Step 5b, the count is not reduced 50 percent of the count in Step 4b, investigate the originating office outgoing path.
7	Measure the overall impulse noise of the trunk again to be sure that the facility requirements given in Section 331-200-100 are met.

Two-Way, Two-Wire Trunk (See Fig. 2)

4.12 There are five sections to be investigated on a 2-way trunk assigned to a 2-wire cable facility. These are

(a) The originating office, outgoing path

(b) The originating office, incoming path

(c) The cable pair

(d) The completing office, outgoing path

(e) The completing office, incoming path.

The sectionalization procedures are the same as described in 4.11 but include measurements made at the completing office in the direction of the originating office and include the completing office outgoing path and the originating office incoming path.

One-Way Trunk, Carrier Facility (See Fig. 3)

4.13 On all trunks working on carrier facilities, each direction of transmission must be measured for impulse noise. There are four sections to be investigated on one-way trunks assigned to carrier facilities. These are

(a) The originating office, outgoing path

(b) The carrier channel, transmitting from originating office to completing office

(c) The carrier channel, transmitting from completing office to originating office

(d) The completing office, incoming path.

The following is the procedure for sectionalization of a one-way trunk on a carrier facility.

STEP	PROCEDURE
1	If it was not determined that the trouble was in one direction only, make an impulse noise measurement to the completing office quiet termination. Dial the 101 test line, have the distant office place a −13 dBm0 holding tone on the trunk, and measure the impulse noise through the notched filter.
2a	If, in Step 1, the impulse count is 15 or less, return the trunk to service.
2b	If, in Step 1, the impulse count is more than 15, have the completing office terminate the DEMOD OUT jack and apply a −29 dBm holding tone to the MOD IN jack at the VFPB. Measure the impulse noise.
3a	If, in Step 2b, the impulse count is reduced by 50 percent or more from the count in Step 1, investigate the completing office incoming path.
3b	If, in Step 2b, the impulse noise count is not reduced by 50 percent of the count in Step 1, the trouble could be in the facility, the originating office, or both. Isolate the facility by terminating the trunk at the EQ OUT jacks and applying a −6 dBm holding tone in the EQ IN jack at the originating office VFPB. This is to maintain the same test condition as in Step 1. Measure the impulse noise.
4a	If, in Step 3b, the impulse noise count is reduced by 50 percent of the count in Step 2b, investigate the carrier facility for trouble. See references at the end of this section for methods.
4b	If, in Step 3b, the impulse noise count is not reduced by 50 percent of the count in Step 2b, investigate the originating office outgoing path.
5	Measure the overall impulse noise again to be sure that the carrier facility meets the requirement.
6	If the trouble is not found in Steps 1 through 5, have the completing office make impulse noise measurements toward the originating office to check the other direction of transmission on the carrier channel only.

Two-Way Trunk, Carrier Facility (See Fig. 3)

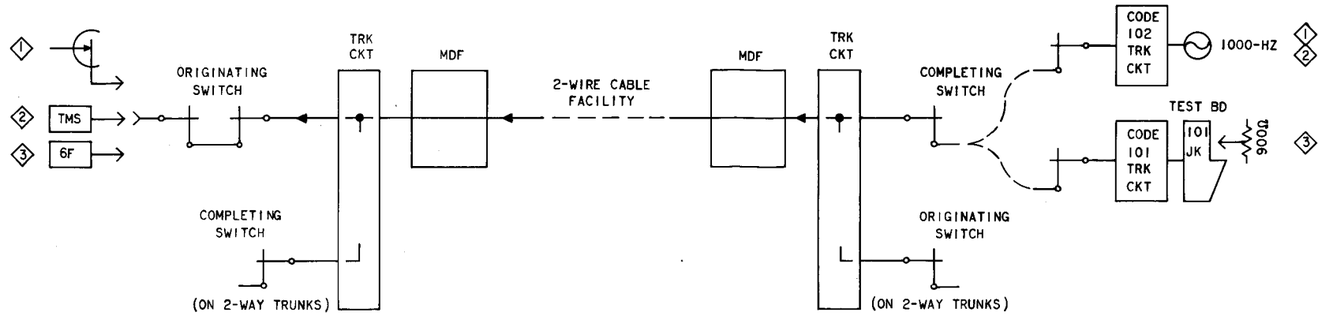
4.14 On 2-way carrier trunks, there are six sections to be investigated. They are

(a) The originating office, outgoing path

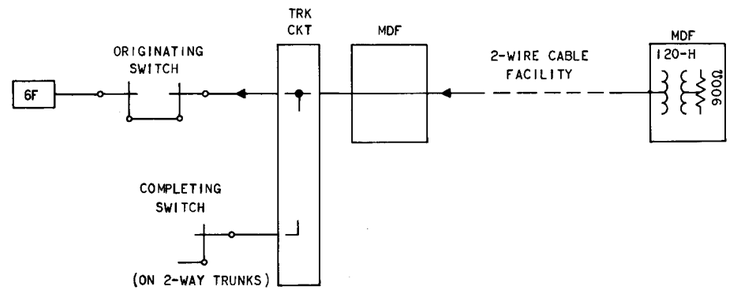
(b) The originating office, incoming path

(c) The carrier channel, transmitting from the originating office to the completing office

(d) The carrier channel, transmitting from the completing office to the originating office

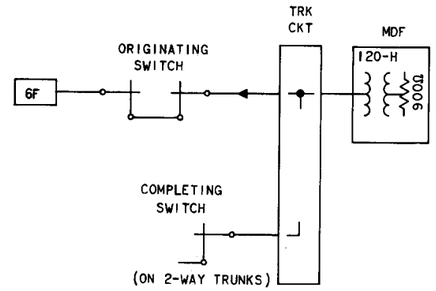


A. OVERALL IMPULSE NOISE MEASUREMENT

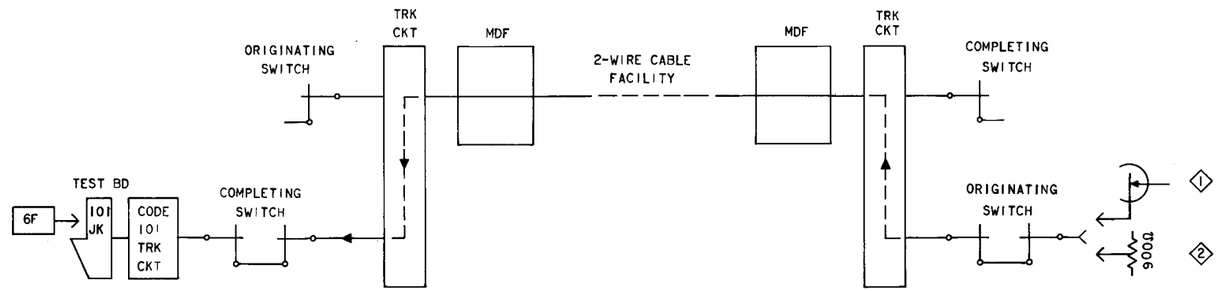


B. ISOLATING DISTANT OFFICE

Fig. 2—Sectionalization of Trunk on 2-Wire Cable Facility (Sheet 1 of 2)

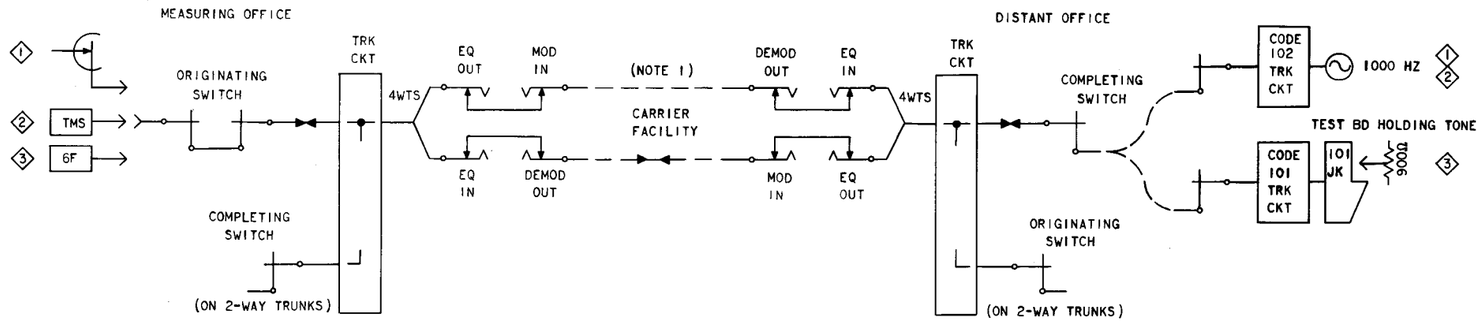


C. ISOLATING FACILITY

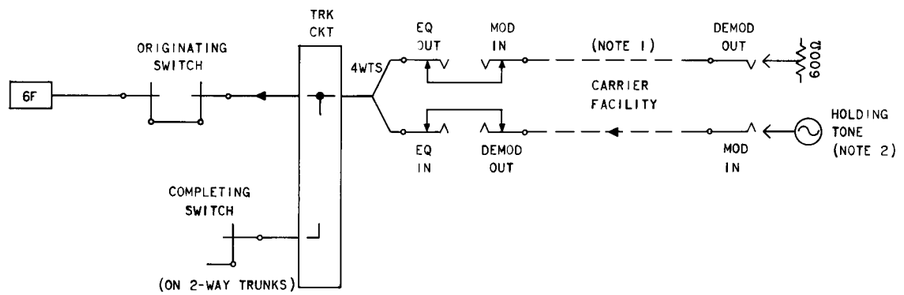


MEASURING OTHER SWITCHING
D. PATHS ON 2-WAY TRUNKS

Fig. 2—Sectionalization of Trunk on 2-Wire Cable Facility (Sheet 2 of 2)



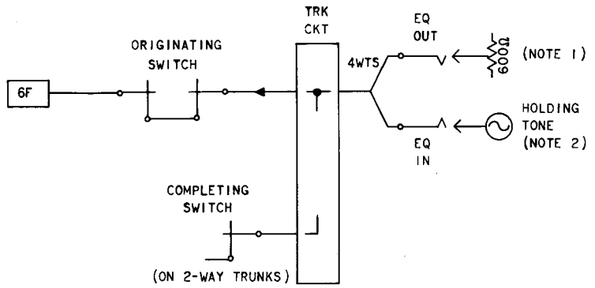
OVERALL IMPULSE NOISE MEASUREMENT -
A. DISTANT OFFICE TOWARDS MEASURING OFFICE



B. ISOLATING DISTANT OFFICE

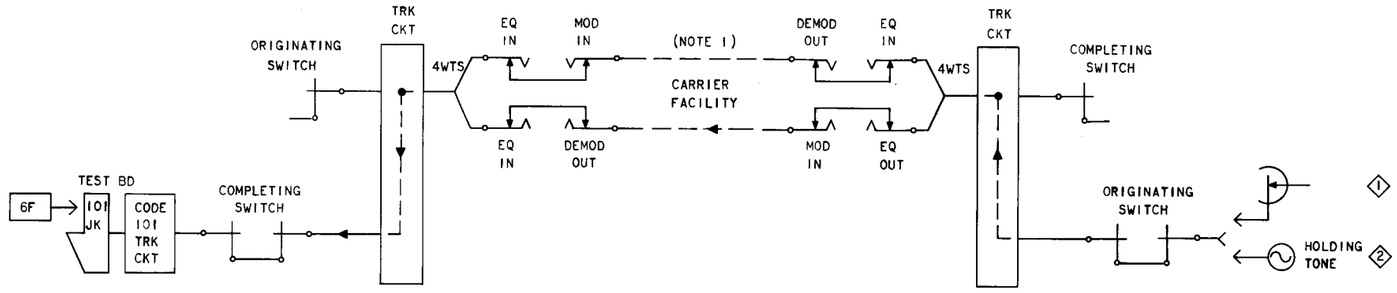
NOTES:
1. TO MEASURE THE OTHER DIRECTION OF TRANSMISSION ON THE CARRIER FACILITY, THE DISTANT OFFICE AND MEASURING OFFICE ARE REVERSED AND THE ISOLATION PROCEDURE IS PERFORMED AS INDICATED.
2. IF IMPULSE COUNT DROPS 50% OF THE PREVIOUS MEASUREMENT, INVESTIGATE THE SECTION OF THE TRUNK WHICH HAS BEEN REMOVED. IF NOT, CONTINUE TO ISOLATE SECTIONS OF THE TRUNK OR INVESTIGATE THE LAST REMAINING SECTION IF TRUNK CANNOT BE FURTHER DIVIDED.

Fig. 3—Sectionalization of Trunk on Carrier Facility (Sheet 1 of 2)



C. ISOLATING FACILITY

NOTES:
1. TO MEASURE THE OTHER DIRECTION OF TRANSMISSION ON THE CARRIER FACILITY, THE DISTANT OFFICE AND MEASURING OFFICE ARE REVERSED AND THE ISOLATION PROCEDURE IS PERFORMED AS INDICATED.
2. IF IMPULSE COUNT DROPS 50% OF THE PREVIOUS MEASUREMENT, INVESTIGATE THE SECTION OF THE TRUNK WHICH HAS BEEN REMOVED. IF NOT, CONTINUE TO ISOLATE SECTIONS OF THE TRUNK OR INVESTIGATE THE LAST REMAINING SECTION IF TRUNK CANNOT BE FURTHER DIVIDED.



MEASURING OTHER SWITCHING
D. PATHS ON 2-WAY TRUNKS

Fig. 3—Sectionalization of Trunk on Carrier Facility (Sheet 2 of 2)

(e) The completing office, incoming path

(f) The completing office, outgoing path.

The sectionalization procedure is the same as described in 4.13 but includes measurements made at the completing office in the direction of the originating office and includes the completing office output path and the originating office incoming path.

One-Way and Two-Way Trunks—Four-Wire Cable Facility (See Fig. 3)

4.15 Trunks having DX signaling circuits must be held busy by whatever device is used for the type of trunk being measured. This is to permit the opening of the cable pairs at each end of the trunk. One-way trunks have the same number of sections to be measured as described in 4.13. Two-way trunks have the same number of sections as described in 4.14. The procedures are the same as described in 4.11 with the exceptions that an additional pair must be tested and the originating office and completing offices must test incoming and outgoing paths for each direction of transmission.

5. INVESTIGATION AND MITIGATION PROCEDURES—SWITCHING SYSTEMS

5.01 In the following mitigation procedures, some of the procedures are to be performed by maintenance personnel whereas others (such as recabling, installing new equipment, etc) are engineering personnel responsibilities. Local administrative policies determine who will have the responsibility for the procedures.

A. Investigation Procedures

5.02 The detailed investigation of switching systems and VF terminating equipment is also performed by sectionalization of the various items of equipment which make up the outgoing or incoming path of the trunk. In general, the procedures are similar to the ones presented in Section 331-701-500. The procedures are divided by originating switching office and completing switching office.

5.03 Following are lists of items within various switching centers. If, in sectionalizing these items, one is found to be the source of the impulse noise, further investigation of battery and ground supplies should be performed. (See Section 331-701-501.)

Originating Switching Centers, Outgoing Train—Local:

(a) *SXS:*

(1) ROTS (if used)

(2) Pulse repeaters or outgoing trunk circuit

(b) *Crossbar:*

(1) Outgoing trunk circuit

(2) MDF (main distributing frame)

(c) *Four-Wire Terminal Equipment (Carrier or Four-Wire Cable Facility):*

(1) Four-wire terminating set

(2) E-type SF (single-frequency) signaling unit (if used)

(3) VFPB

(4) VF repeater (if used)

(d) *Two-Wire Terminal Equipment:*

(1) VF repeater (if used)

(2) Impedance compensator (if used)

(3) MDF

Originating Switching Centers, Outgoing Train—Toll:

(a) *Crossbar Tandem:*

(1) Office link frame (OLF)

(2) Loop E&M converter (if used)

(3) Testboard T&OS jacks

(4) Switchboard toll line multiple (if used)

(b) *4A, No. 5 Crossbar or SXS:*

(1) Two-way or outgoing trunk (OGT) circuit

(2) Testboard T&OS jacks

(3) Switchboard toll line multiple (if used)

(c) *Four-Wire Terminal Equipment:*

(1) Four-wire terminating set

(2) Circuit patch bay

(3) E-type SF signaling unit (if used)

(4) VFPB

(5) VF repeater (if used)

(d) *Two-Wire Terminal Equipment:*

(1) CX or DX signaling (if used)

(2) VF repeater (if used)

(3) Impedance compensator (if used)

(4) MDF

Completing Switching Centers, Incoming Train—Local:

(a) *Two-Wire Terminal Equipment:*

(1) MDF

(2) Impedance compensator (if used)

(3) VF repeater (if used)

(b) *Four-Wire Terminal Equipment:*

(1) VFPB

(2) E-type SF signaling unit (if used)

(3) Four-wire terminating set

(4) VF repeater (if used)

(c) *Crossbar:*

(1) Incoming trunk circuit

(2) TLF (trunk line frame)

(3) LLF (line link frame)

(4) Balance termination

(d) *SXS:*

(1) Incoming trunk circuit or pulse repeater (if used)

(2) Third, fourth, and fifth selectors

(3) Connector

(4) Balance termination

Completing Switching Centers, Incoming Train—Toll:

(a) *Two-Wire Terminal Equipment:*

(1) MDF

(2) Impedance compensator (if used)

(3) VF repeater (if used)

(4) CX or DX signaling (if used)

(b) *Four-Wire Terminal Equipment:*

(1) VFPB

(2) E-type SF signaling unit (if used)

(3) Circuit patch bay

(4) Four-wire terminating set

(5) VF repeater (if used)

(c) *SXS:*

(1) IT incoming or 2-way trunk circuit

(2) IT auxiliary trunk circuit

(3) Selector train

(4) Outgoing trunk circuit or test line

(5) Balance termination or 101-type test line

(d) *Crossbar:*

(1) Incoming trunk circuit

(2) Incoming link

(3) Outgoing link

(4) Outgoing trunk circuit

(5) Balance termination or 101-type test line.

B. Mitigation Procedures

5.04 Some mitigative measures for SXS (step-by-step), crossbar, and common equipment items (such as battery and ground supplies) are presented in Section 331-701-500. Other mitigation procedures relating to trunk equipment are presented in this section.

SXS—General

5.05 The following items should be considered for SXS offices:

(a) ***New Equipment:*** On new equipment, specify balanced relay options (see Section 873-401-100).

(b) Install new suppression networks where required. Networks that are defective should be replaced.

(c) ***Pulse Repeaters:***

(1) Be sure that partition is provided between twin pulse repeaters on the same base (SD-31779).

(2) Check for and remove any crosses between resistors or capacitors and the cover.

(3) Connect a 2-μF, 400-volt miniature capacitor across talk battery and ground terminals on repeater shelf to improve balance and filtering.

(4) Check the repeater shelf. If it is insulated, ground the shelf.

(d) ***ROTS*** (rotary-out trunk switches): Maintenance personnel can greatly reduce the impulse noise generated in ROTS by using proper cleaning and adjustment procedures covered in Sections 026-706-701 and 069-330-801. In some cases, the methods described in Section 870-100-100 may be applicable to mitigative procedures.

(e) ***POTS*** (plunger-out trunks switches): Remove any present in the office.

Crossbar Tandem

5.06 A problem exists in intertoll trunk circuits SD-27003 where inward dial pulsing is used (***not*** where inward MF pulsing is used). The opening and closing of the loop by the A relay to the CS relay (which pulses the L relay in the sender circuit) creates dial pulses which are transmitted to the 4-wire terminating circuit via the A and B leads. Modification of the trunk circuits to reduce this noise is shown in Fig. 4 and 5.

4A Crossbar—Trunk Circuit SD-68242

5.07 Locate the external line balancing network as closely as possible to the trunk circuit. Cable directly and do not cross-connect.

Miscellaneous

5.08 Apply the following mitigative procedures:

(a) When SXS pulse repeaters are used in crossbar offices, use the procedures described in 5.05(c).

(b) Be sure that all battery and ground supply leads are connected properly to their terminals at equipment locations.

(c) Provide decentralized battery filters on all bays containing the following:

(1) Connectors and pulse repeaters

(2) Toll transmission selectors

(3) Talk battery supplying trunk circuits

(4) E-type signaling units

(5) VF repeaters

(6) N1, K, and L carrier.

(d) Provide dedicated talk battery supply leads to E-type signaling units. This will eliminate transient suppression on M and R or RG relays.

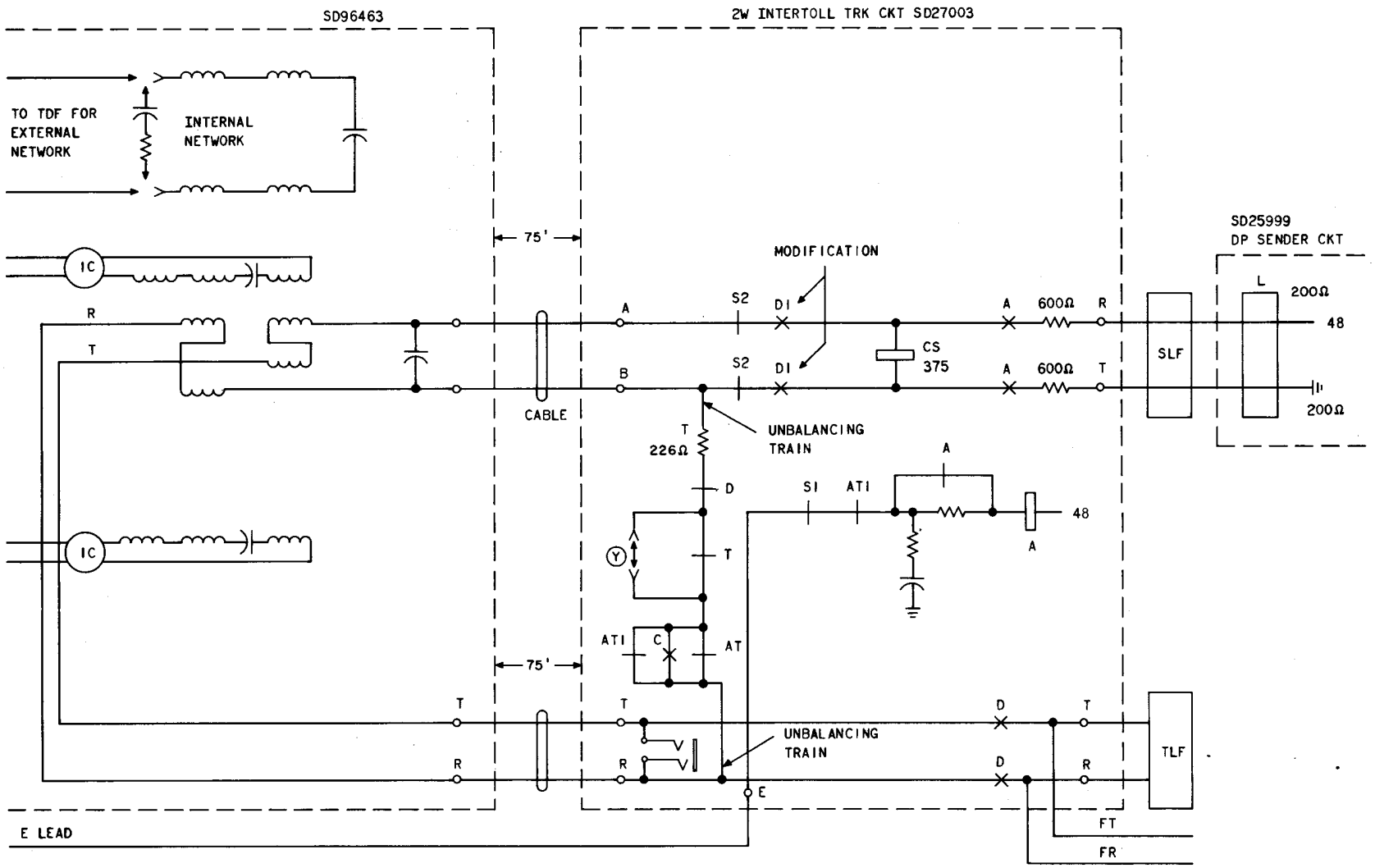


Fig. 4—Modification of Crossbar Tandem IT Trunk to Reduce Impulse Noise

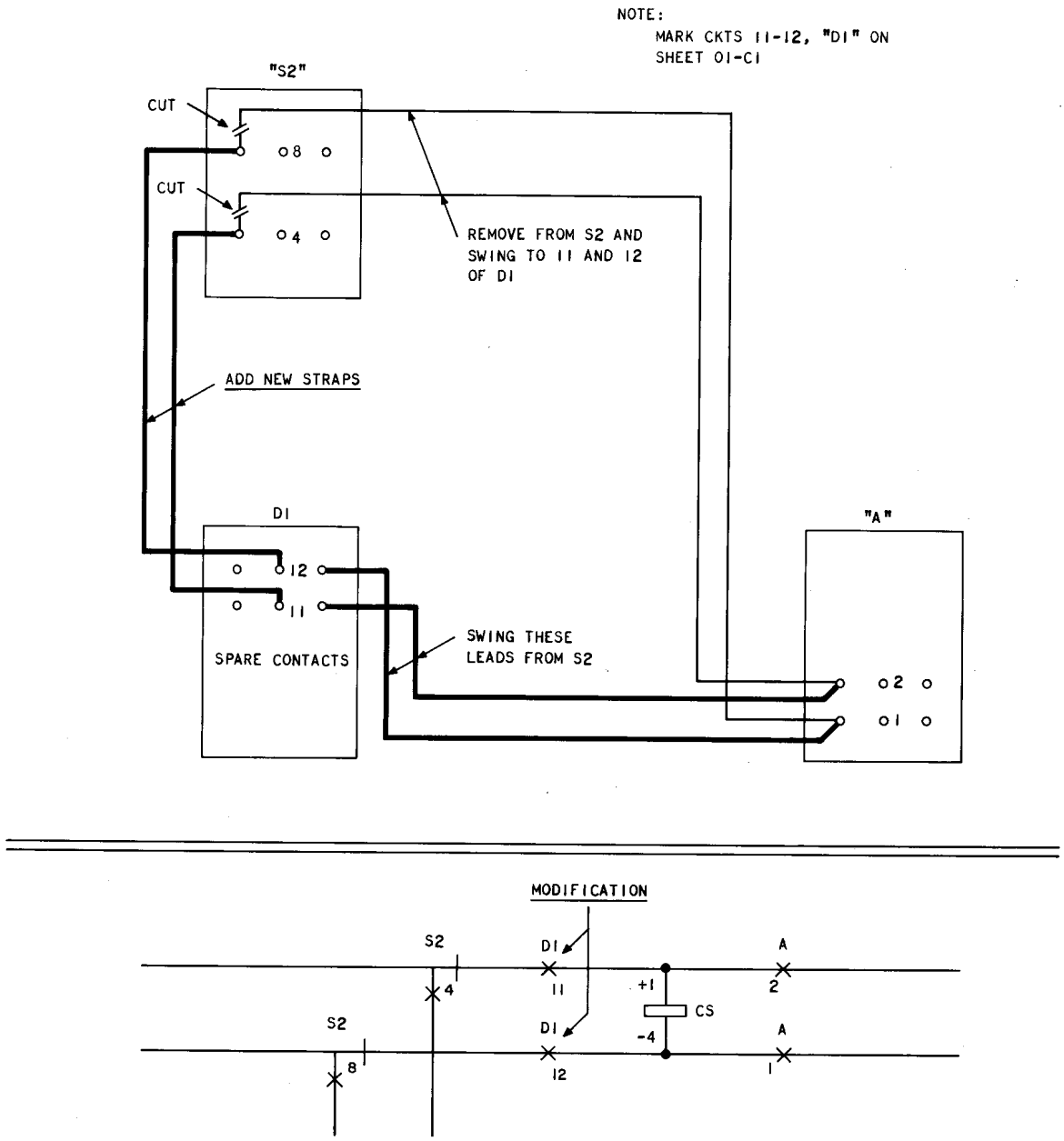


Fig. 5—Modification of Crossbar Tandem IT Trunk (SD-27003)

6. INVESTIGATION AND MITIGATION PROCEDURES—FACILITIES

6.01 In the following mitigation procedures, some of the procedures are to be performed by maintenance personnel whereas others are engineering personnel responsibilities. Due to local administrative policies, this section does not designate who will have the responsibility for the procedures.

A. Carrier Systems

6.02 When a trunk assigned to a carrier channel has been sectionalized and the impulse noise source has been identified as being in the carrier system, further sectionalization must be performed.

The amount of sectionalization which can be performed will depend upon the type of carrier and the availability of test points. The carrier channel is sectionalized between the high-frequency line, the repeaters, and the terminal at each end.

N-Type Carriers—Sectionalization (See Sections 362-305-510, 362-401-501, 362-800-506, and 362-900-506)

6.03 N-type carriers are highly susceptible to impulse noise. Over a period of time, modifications have been available to units of the system to reduce this susceptibility. Engineering groups responsible for N-type carrier systems should be aware of these modifications.

6.04 ***General Method—High-Frequency Line:*** The following procedure is a quick way to sectionalize the high-frequency line from the terminal equipment:

STEP	PROCEDURE
1	Make an impulse noise measurement on one of the channels on the system at the distant end. Terminate the MOD IN jack at the near end and measure at the DEMOD OUT jack at the distant end. If the impulse noise count exceeds the requirements for an N-type facility as given in Table A of Section 331-200-100, continue with these procedures. If the count does not exceed the requirements, make the measurement again at a later time (see 2.12).
2	At the near end, open the transmitting side of the line at the HFXC (high-frequency cross-connect) cabinet. Use a 7A CFNMS and a 6F impulse counter (see Section 103-500-100) and make an impulse noise measurement toward the transmitting terminal.
3	If the impulse noise count in Step 2 is less than 50 percent of the count in Step 1, the impulse noise source is in the high-frequency line (which includes any repeaters). Otherwise, the impulse noise is in the transmitting terminal at the near end. ***Note:*** If a 6F impulse counter is used in Step 2 and the level is more than 2-dB lower for the same count, the impulse noise source is in the high-frequency line.
4	To further sectionalize the channel, measure the impulse noise at the compressor output "F" or "M1" jack as shown in Fig. 6.
5	If the impulse noise count in Step 4 is less than 50 percent of the count in Step 3, the impulse noise source is in the combining multiple or in the shielded wire to the HFXC cabinet. Otherwise, the impulse noise source is in the input or compressor.
6	To sectionalize a long high-frequency line, cut the line in half, terminate the far end, and make measurements to see which half is the impulse noise source. Then divide the noisy section in half and so on until the smallest section is isolated. If the line is a short line, about 4 repeater spans long (or less), measure at the near end and move the far end termination toward the measuring end until a significant drop in impulse noise count is observed. Also, the looping methods of Section 362-420-502 or the procedures outlined in Sections 855-335-106 and 362-401-501 using the band rejection filter with C/N (carrier-to-noise) ration measurements may be used.

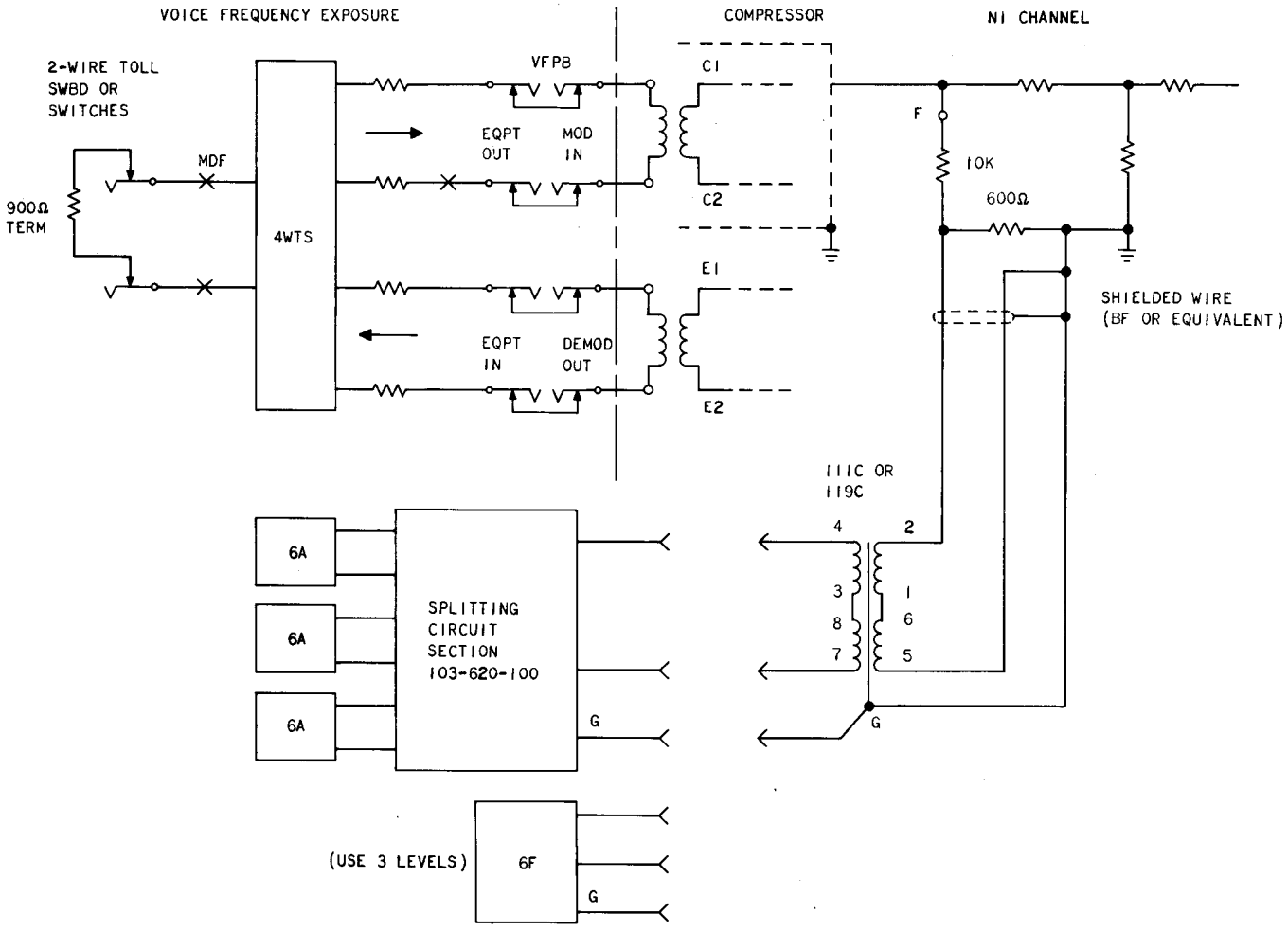


Fig. 6—Measuring Impulse Noise in N1 Carrier for VF Exposure

6.05 ***Common Mode Balance—High-Frequency Line:*** This procedure should be performed only if the above procedures in 6.04 fail to produce the desired results.

STEP	PROCEDURE
1	Use a 7A CFNMS (see Section 103-500-100) to measure longitudinal signals. Measure at the receiving end with the transmitting channel unit at the distant end terminated at the MOD IN and DEMOD OUT jacks.
2	Set the FUNCTION switch of the 7A to BRDG ADD 10 and the MODE switch to CAL TONE. Tune for the frequency of maximum interference. If no maximum interference is found, tune to 240 kHz.
3	Set the FUNCTION switch to NG ADD 30 and the MODE switch to either suppressed-carrier position. Adjust the DBRN switch to obtain an on-scale meter deflection.

STEP	PROCEDURE
4	Add the meter reading, the DBRN switch setting and the FUNCTION switch setting to obtain the N_G.
5	Change the FUNCTION switch to BRDG ADD 10. Do not change the MODE switch or the CARRIER FREQ dial. Adjust the DBRN switch to obtain an on-scale meter deflection.
6	Add the meter reading, the DBRN switch setting, and the FUNCTION switch setting to obtain the N_M.
7	Compute the balance as follows: Balance = $N_G - N_M$.
8	If the balance is less than 55 dB at carrier frequency, check the high-frequency line for an unbalance. Sectionalize the line as described in 6.04, Step 6.

N-Type Carriers—Mitigation Procedures

6.06 ***Common to N1 and N2 Equipment:*** See 6.03. Perform the following actions:

(a) Install one 100D varistor across the expandor input terminals (C1 and C2) to reduce large transients at the start of the SF signaling cycle. This has been done on newer channel units at the factory.

(b) Increase the C4 capacitor of tube V1 from 0.1 μF to 0.5 μF in the compressor unit of N1 carrier channel units.

(c) Check to be sure that terminal and repeater equipment is at least six feet away from switching, rotating, rectifying, and C1 alarm equipment and at least ten feet away from voltage stabilizers.

(d) Check to be sure that the entrance cable is separated from equipment frames and office cabling by at least six inches.

(e) Check to be sure that VF wiring is separated into receive (+7 dB), transmit (−16 dB), and E&M leads to the 4-wire terminating sets.

(f) Check to be sure that battery supply for N carrier is separated from dc telegraph and coin supplies.

(g) Check to be sure that 630-type beat suppression filters have been installed on the high-group receive terminals.

(h) On the N, ON, and O carrier HFXC cabinet (ED-97033-30, Group 2 or similar):

(1) Install a copper busbar at the top of the cabinet and connect it to the main floor ground (not battery supply ground) with a 350,000CM copper wire. Connect the existing vertical #6 wire to the busbar.

(2) Bond the high-frequency wire shield by short leads to the vertical ground wire. (See Section 800-612-164 for proper methods.) The wire shields must be grounded at both ends to carry magnetic shielding current (Section 855-355-106).

(3) Connect the cable terminal grounding screw to the busbar by a #6 wire. Check to be sure that the entrance cable sheath is bonded to the cable terminal.

(i) Bond all HFXC cabinets together with a 350,000CM wire.

(j) If the HFXC cabinet and N-carrier terminals are in different lineups, join the lineup grounds by a #0 wire, following the same route as the shielded pairs.

(k) If switchboard cable is used in lieu of shielded wire, bond and ground both ends of the aluminum shield.

6.07 ***N1 Carrier Equipment:*** See 6.03. Perform the following actions:

(a) *Channel Units—*

(1) Replace the input transformer with a 2580F transformer or replace the repeating coil with a 206C repeating coil to block longitudinal impulse noise from the VF input. Ground the center tap and shield.

(2) Add a 40-μF capacitor (602A) to the regulator circuit if a reference voltage diode has been installed to overcome variations in the office +130-volt supply. For all except J98703BP units, this addition is shown as option "CA" on SD-95118-01, Issue 34B. For the J98703BP unit, see option "AA" on SD-95252-02, Issue 5B. This capacitor has been added on newer channel units.

(b) *Terminal Mounting (J98703A)—*

(1) Increase +130-volt battery filter capacitor from 100 μF to 400μF in all terminals on the bay.

(2) Replace paired wiring from the combining multiple to the group transmission unit with shielded paired wiring. Do not exceed maximum length specified on the drawing.

(3) Reduce 3700-Hz signaling tone level by 3 dB to reduce 600-Hz noise in adjacent channels.

(c) *Modulator Varistor*—In the modulator of N1 LG receive and transmit terminals, N1A HL and LH repeaters, and N1 HL and LH repeaters, replace the 48B varistor with a 48QA varistor. Add capacitors per drawing change notices. The total carrier output variation should not exceed $\pm$1.25 dB. The channel noise should not exceed 33 dBrnc and 42 dBrn 3-kHz flat at the +7 TLP.

6.08 ***N2 Carrier Equipment:*** See 6.03. If 2586E input transformers have not been replaced by 2586M transformers, have this done. This applies to compandor units manufactured prior to third quarter of 1964 and coded —63, ═63, ≡63, 63, —64, ═64, and ≡64.

6.09 ***N-Carrier High-Frequency Lines:*** Perform the following actions:

(a) Be sure that LBO bays and cross-connect cabinets are properly wired (see Section 362-440-100). Also check shield and sheath continuity and grounding of these units (see Section 362-440-501).

(b) If dc telegraph circuits are working in N-carrier cables, reassign this service to VF telegraph channels. If VF telegraph channels are not available, be sure that wave-shaping networks are

used. No subscriber loops should be assigned to cable with N carriers. Remove open-wire runoffs. On dc control circuits (coin control, DX and CX signaling, etc) use suppressors (see Section 855-335-106).

(c) Use design methods described in Section 855-335-106 to control slope, bulge, and signal-to-noise ratio.

(d) Provide separate entrance cables for N-carrier.

6.10 ***N-Carrier Terminals and Repeaters:*** Maintain system and channel lineup per Section 362-001-011. Check tubes and replace if filament activity drops by 15 percent instead of the 26 percent normally specified.

LMX Carrier—Mitigative Procedures

6.11 The following measures are suggested:

(a) Check modulator bandpass filters and other plated metal components for "whiskers." Replace as required.

(b) Inspect for soldering defects.

(c) Check framework grounds. If none exists, add a #6 ground wire from the duct-type bays to the main aisle equalizer (see Section 331-701-500).

(d) Rebuild any loose cable shield bonds (see Section 331-701-500).

(e) Check to be sure that coaxial cable plugs and sockets are not assembled with acid core solder.

(f) Check to be sure that high and low signal level cables are well segregated, as specified on the drawings, and that they are not routed over switching or signaling equipment.

(g) Check for stray frequencies on the carrier distributing bus, and, if any are found, return the 104-kHz carrier bus filter.

(h) Ensure that the steady-state noise in the FMT/FMR and radio is more than 18 dB below the required level of impulse noise. Otherwise, the steady-state noise will appear as impulse noise.

(i) Check to be sure that the J87288A converter-regulator has been provided for the LMX-2. If impulse noise cannot be eliminated from the LMX-1 power supply by normal maintenance procedures, use the converter-regulator for the LMX-1 (see Section 161-289-301).

T1 Carrier—Mitigative Procedures

6.12 The following measures are suggested:

(a) Use 258C plugs in inputs to spare channel units in D1 channel banks.

(b) Be sure that T1 equipment is located at least 6 feet from markers and other high noise-producing equipment.

(c) Check to be sure that drawing change notices affecting power supply capacitors and transistors have been applied.

(d) Check harmonic distortion. Keep system lineup current.

(e) Check the line error rate as described in Section 365-225-500.

(f) Perform bank impulse noise tests listed in the maintenance BSP for the bank.

(g) In D1A and D1B channel banks, distortion hits may apear as impulses when impulse noise is being measured. Changing the 4020A compressor network to a 4020AA compressor network should eliminate this problem.

B. VF Cables—Outside Plant

6.13 If, in Part 4, the source of impulse noise is found to be in the cable portion of a VF trunk, the following items may be considered for investigation:

(a) ***Pairs:*** If a pair is found to be the source of the impulse noise, assign the trunk to a new pair and refer the trouble to the personnel responsible for cable maintenance. Investigation of the pair should include the following:

(1) Check to see if the pair is crossed with another pair or grounded.

(2) Check splices and terminations for broken, loose, or corroded joints.

(3) Check to be sure cable is dry.

(4) On loaded cable, check for missing or improperly spaced load coils.

(5) Check for unbalances on longitudinal suppression coils, etc.

(b) ***Sheath:*** Impulse noise sources external to the VF cable must be excluded from the cable through proper shielding and bonding. Some items that may be investigated are

(1) Sheath continuity to see if bonding is sufficient.

(2) Grounding systems to see whether they are properly maintained.

(3) By-pass capacitors used in vaults to see if they are in working condition and of the right type.

7. REFERENCES

7.01 The following list of related sections is provided to assist the user of this section:

SECTION	TITLE
026-706-701	200-, 206-, 209-, and 211-Type Selectors, and 10-, 26-, and 32-Type Banks—Requirements and Adjustment Procedures
069-330-801	Rotors and Associated Banks, 200-, 206-, 209-, and 211-Type Selectors—Cleaning and Treatment
103-500-100	7A Carrier Frequency Noise Measuring Set
103-620-100	6A and 6E Impulse Counters
103-620-101	6H and 6HR Impulse Counters

SECTION	TITLE
103-626-100	6F and 6FR Voiceband Noise Measuring Set
161-289-301	Converter J87288A—Operating Methods
212-246-501	Trunk Transmission Tests—Circuits Terminated on Trunk Link Frame—Using Master Test Frame—No. 5 Crossbar Offices
212-564-501	Toll Connecting Trunk—Manual Transmission Tests Using Trunk Test Circuit SD-68076-01 or SD-68373-01 and Test Trunk Circuit SD-68547-01—No. 4A and 4M Toll Switching Systems
212-590-500	Trunk Transmission Tests—Step-By-Step Office Provided With Manual Outgoing Trunk Test Frame SD-32349-01
314-410-500	Voice Bandwidth Private Line Data Circuits—Tests and Requirements
331-100-101	Impulse Noise—General Information
331-200-100	Impulse Noise—Requirements and Measurements
331-700-ZZZ	Cross Office Noise Testing Methods
331-701-500	Impulse Noise—Central Office Test Procedures and Investigation
331-701-501	Procedures for Making and Evaluating Noise Measurements on Central Office Battery Supply
362-001-011	N-Carrier—Equipment Test List
362-305-510	Type N1, O, and ON Carrier System—Channel Noise Measurement
362-401-501	N, O, and ON Carrier System—Message Noise Measurements at Carrier Frequency
362-420-502	Looping of Individual Repeatered Sections
362-440-100	J99323 Line Build-Out and Cross-Connect Equipment—Description
362-440-501	Line Build-Out and Cross-Connect Equipment—Check of Shielding and Sheath Continuity and Grounding
362-800-506	N2 Carrier—Channel Noise Measurement
362-900-506	N3 Carrier—Channel Noise Measurement
632-YYY-ZZZ	Cable Terminals
633-YYY-ZZZ	Cable Splicing
634-YYY-ZZZ	Splice Closures
660-402-300	Transmission Maintenance—Overall 1000-Hz Loss Measurements on Message Trunks

SECTION	TITLE
660-450-300	Circuit Order and Trunk Order Tests For All Types of Message Trunks—General Information
660-450-301	Circuit Order and Trunk Order Tests For All Types of Message Trunks
795-400-100	Circuit Identification—Message Trunks
800-612-164	Forming, Grounding, Splicing, and Terminating Shielded Wiring and Coaxial and Twin Conductor Shielded Office Cable
855-335-106	N and ON Carrier—Engineering System Application—Noise Considerations
870-100-100	Noise Engineering—Impulse Noise
873-401-100	Inductive Coordination—Susceptibility of Central Office Equipment