

CROSSTALK TESTS ON MESSAGE TRUNKS

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1. GENERAL

1.01 The reception of intelligible crosstalk creates subscriber annoyance and violates privacy. Nonintelligible crosstalk does not violate privacy; however, it is annoying because of its syllabic nature, the subscriber may try to understand the crosstalk by listening intently. Unintelligible crosstalk is more annoying to the subscriber than random noise. This section describes the causes of crosstalk and measurement requirements.

1.02 This replaces Issue 4, May 1955. Changes made with this issue are:

- (1) Noise measurements made with the 2-type noise measuring set have been eliminated.
- (2) Table C from Section 103-611-100 is used to separate crosstalk from noise and crosstalk.
- (3) All reference to dBa has been eliminated.
- (4) A table has been added to allow source tone measurements to be made with the 3-type noise measuring set.

1.03 Interference from sources outside the channel of interest is measured for two general purposes. The first purpose is to determine the magnitude of the interference in the disturbed circuit irrespective of the source or method of coupling. This type of measurement might be made to evaluate common battery supply noise, power hum, or impulse noise. Until the magnitude of the problem is evaluated the mode of coupling and means for reducing the interference are of secondary importance. The second purpose is to determine the coupling loss between a disturbing and disturbed circuit. This measurement establishes the fact that a suspected source of interference involves a particular circuit. This test also determines the degree of coupling loss improvement required.

1.04 The use of the words intelligible and unintelligible can also be applied to nonvoice circuits. In such cases, intelligible implies that the crosstalk interference is the same type as the desired signal and thus could be amplified and decoded if the desired signal were absent. Unintelligible crosstalk for nonvoice circuits results from crosstalk between different types of systems. As a consequence, it is usually considered noise rather than unintelligible crosstalk.

1.05 Message trunks should first meet the noise and transmission circuit order requirements outlined in Section 660-450-301. Circuits which fail

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SECTION 660-403-503

to meet circuit order noise requirements may require noise crosstalk level and/or crosstalk coupling tests. These tests will aid in eliminating noise from external sources. Noise level and coupling tests come under the general heading of crosstalk tests:

(a) Monitoring and Crosstalk Volume Tests

(b) Crosstalk Coupling Tests

(1) Near-End Test

(2) Far-End Test.

1.06 Crosstalk volume measurements and coupling tests are made with a 3-type noise measuring set. Measurements, methods, and terminations for crosstalk are similar to those used for noise measurements.

2. MONITORING AND CROSSTALK LEVEL MEASUREMENT

2.01 The crosstalk that is present on a circuit often involves more than one disturbing circuit. Monitoring should be done during busy hours when the circuits are most likely to be busy with traffic and when likely disturbing circuits are known to be in use. In order to be of value, the monitoring period should be between one and ten minutes duration.

Note: In the case of crosstalk that can be identified as a singing-repeater, monitoring may be more productive if done during nonbusy hours.

2.02 Monitoring and measurements should be at normal trunk test levels and with the regular arrangements used to monitor trunks, and making circuit order tests.

2.03 If crosstalk or interference from external sources is observed, it should be measured with the 3-type noise measuring set (or equivalent), its source and character should be noted indicating whether it is from program, message trunk, or some other external source. An indication should also be noted as to whether or not it is intelligible.

2.04 When crosstalk from a program circuit is observed, coupling tests should be made in accordance with Section 320-165-500.

3. MONITORING AND CROSSTALK REQUIREMENTS

3.01 Any intelligible crosstalk observed when a circuit is in normal operating condition indicates the need for investigation and correction.

3.02 Crosstalk should be considered intelligible if four or more consecutive words can be understood or if any program material is overheard.

3.03 Measured noise, crosstalk, and unwanted interference regardless of their nature of origin should not exceed message trunk noise limits.

4. CROSSTALK LEVEL MEASUREMENT

4.01 The 3-type noise measuring set (or equivalent) is used to measure crosstalk level. The following procedure applies:

(a) Using C MESSAGE WTG and the proper input circuit, adjust the DBRN dial to 85.

(b) The DAMP-NORM switch is operated to NORM.

(c) Slowly decrease the setting of the DBRN switch until the average indication of the meter is between +2 and +9.

(d) Read the meter and observe for the maximum of frequently occurring peaks, excluding the occasional high peaks.

(e) The approximate crosstalk level in dBm is equal to the total dBm (dial and meter) minus 90.

4.02 Part of the indication on the measuring set may be contributed by noise on the circuit under test. Allowance for this may be made by making a reading when the crosstalk is absent (as determined by monitoring), in addition to a reading when both crosstalk and noise are present. Then subtract from the latter reading a correction factor obtained from Table A.

4.03 The level measurement is useful in determining the effectiveness of corrective measures taken to reduce crosstalk.

5. COUPLING TESTS

5.01 Noise and crosstalk coupling usually occur at locations where wiring or apparatus of the disturbed circuit is exposed to similar portions of the disturbing circuit. In some cases, the exposure may not be directly from the disturbing circuit or equipment but via some other circuit or group of circuits. These are sometimes described as "tertiary" or "interaction" paths. Such paths must be coupled to the disturbing as well as the disturbed circuit. The interference, therefore, travels from the point where it is generated in the disturber, and where it may be a desired signal, via associated wiring to a coupling either directly to the disturbed circuit or via intermediate circuitry or interaction path. If such a path is involved, the noise travels along its wiring to a coupling path and on to the disturbed circuit. Finally the noise travels to the telephone receiver of the disturbed telephone set or apparatus via the normal transmission path.

5.02 There are three basic causes of crosstalk:

- (a) Nonlinearities within a frequency division multiplex system.
- (b) Time slot interchange in a time division multiplex system.
- (c) Electrical coupling between various transmission media.

5.03 Couplings between pairs within a cable can introduce noise into telephone interconnections. The following factors govern the amount of inductively and capacitively coupled noise between cable pairs within a cable:

- (a) Magnitude of the disturbing currents.
- (b) Amount of coupling between the disturbing and disturbed circuit.
- (c) Susceptibility of the disturbed circuit.

5.04 Exposure in cables may vary from a few feet to many miles. Separation between cable pairs is small. The magnitude of couplings between cable pairs is important because of the variety of noise producing circuits that can be connected.

- (a) Telemetry circuits
- (b) Telegraph circuits
- (c) Unfiltered PBX battery
- (d) Poorly balanced subscriber lines
- (e) Revertive pulsing
- (f) Exposure to power lines
- (g) Central office equipment
- (h) Central office power circuits
- (i) Single frequency signaling tone.
- (j) High data levels
- (k) MF signalling tones

6. UNIT OF CROSSTALK COUPLING

6.01 A unit often used in crosstalk computations is the dBx, which is equal to the dB difference between 90 dB loss and the transmission loss of the coupling path, at 1000 Hz. For example, if the coupling loss between two circuits is 60 dB this fact is expressed by saying that the coupling is 30 dBx. The dBx was introduced in order that the number of dB would increase as *couplings* became tighter, rather than decrease as in the case of *coupling* loss. Thus as crosstalk coupling becomes worse, the number in dBx gets larger.

6.02 Crosstalk coupling tests should be made on a circuit when monitoring observations indicate intelligible or objectionable crosstalk.

6.03 The disturbing circuit (or circuits) should be located and its terminals identified noting the terminal at which the crosstalk originates.

6.04 One practical method of locating disturbing circuits is to first monitor on the disturbed circuit, while at the same time monitoring all likely candidates which could possibly cause the unwanted disturbance. When the interference between trunks "match" a disturbing circuit has been located. The disturbed circuit can also be monitored by an external speaker while searching for the disturbing trunk with a headset.

7. COUPLING MEASUREMENTS

7.01 No intelligible crosstalk or crosstalk from program circuits is allowed on message trunks. The criterion of intelligibility is taken as the ability to understand four consecutive words or if any program material is overheard.

7.02 Crosstalk coupling expressed in dBx for near-end or far-end measurements shall not exceed 30 dBx.

8. COUPLING TEST METHODS

8.01 Crosstalk coupling tests should be made on a circuit when monitoring observations indicate intelligible or objectionable crosstalk. The disturbing circuit (or circuits) should be located and identified noting the terminal at which the crosstalk originates.

8.02 A tone at 0 dBm is connected to the disturbing circuit at the measuring end of the trunk for a near-end test and at the distant terminal for a far-end test. The disturbing circuit is terminated in a noise and balance test termination, code 100, or other suitable noise test termination.

8.03 A 201-type noise generator or 1000 Hz at 0 dBm is used as a tone source to the disturbing circuit. Zero level measured with a 3-type noise measuring set, C message weighting is 88 dBrc when measuring the level of the 201-type noise generator and 90 dBrc when measuring the 1000 Hz tone (Fig. 1).

8.04 When measurements are made with a 3-type noise measuring set equipped with C message weighting, the dBrc is equal to the setting of the DBRN switch plus the meter reading.

9. DEFINITIONS OF TERMS USED TO DESCRIBE NOISE

Babble or Crosstalk Crosstalk usually describes unwanted speech in message channels. It may describe intelligible words and phrases, but may also be present as unintelligible "babble" from multiple sources. Babble may include modulation products of carrier frequency crosstalk, and may also include intermodulation products. Signaling tones, data, etc, transmitted at voice frequencies also appear as crosstalk in message circuits.

Clicks Digital carrier systems may introduce clicks when loss of frame occurs below the threshold level for trunk processing.

Hum Hum usually describes the audible effect of the harmonics of 60 Hz. Hum may also apply to dial tone and to other sustained low-frequency sounds occasionally heard as noise. When more than one 60-Hz harmonic is present, as frequently happens in the case of inductive interference, they may "beat" to produce variations in amplitude, pitch or both.

Intermodulation Intermodulation describes a number of noise sounds produced by the many complex frequencies present in carrier and radio systems. These sounds may resemble babble, hiss, and even at times be impulse-like. Intermodulation increases as the system load increases.

Singing Howling repeaters frequently introduce tones into the transmission path. Two or three tones of closely related pitch or frequencies may "beat" to produce variations in pitch, amplitude, or both.

Frying Metal parts coming into contact with wire or switch contacts which carry current will create a noise which resembles frying.

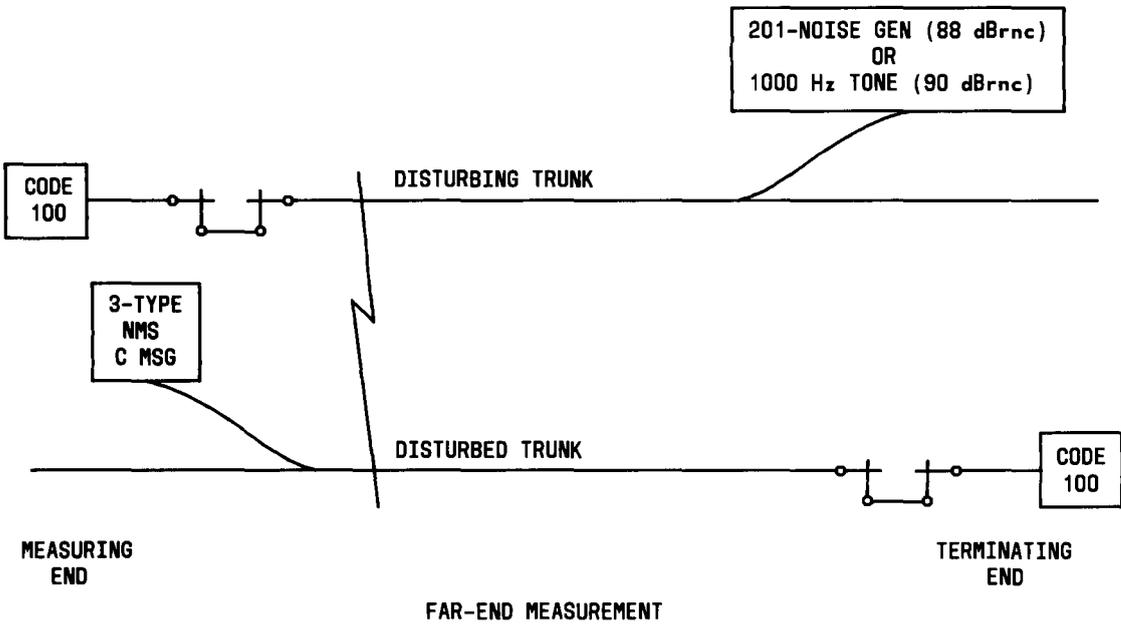
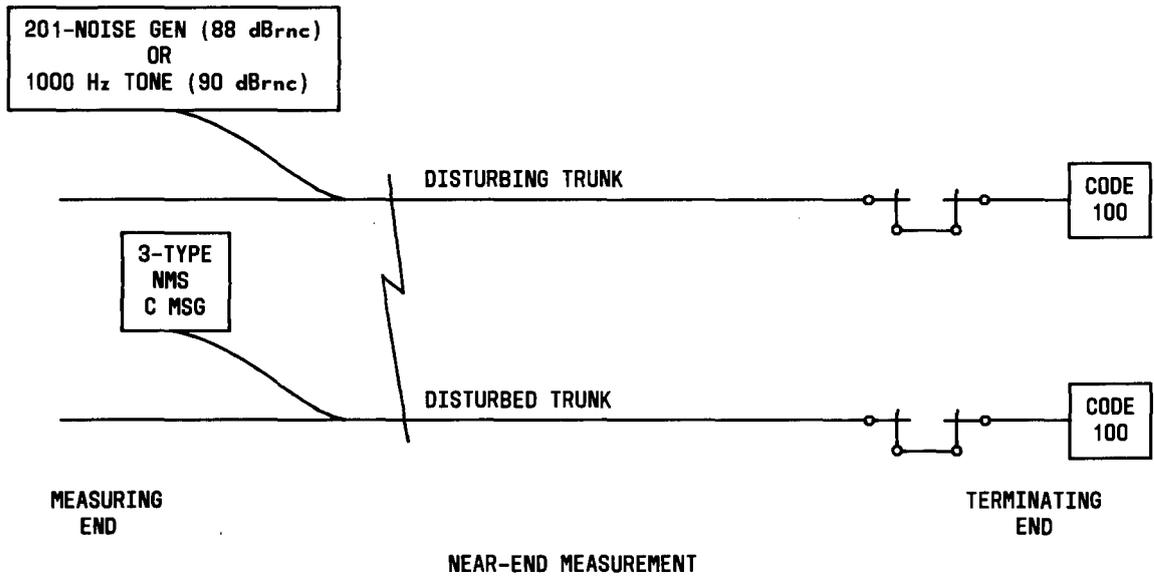
Hissing Hissing describes the effect of thermal noise which originates in components working at elevated temperatures such as electron tubes and resistors.

Impulses Impulses are sharp clicks that rise substantially above the other noise.

Microphonics Microphonics are usually low-pitched bell-like sounds generated within electron tubes. Tapping a tube may cause microphonics and is often used as a test.

Static Static originally referred to the cracking, popping sound produced especially in AM radio sets by nearby lighting discharges. Sources of static in addition to atmospheric noise, include high-voltage discharges in electrical equipment. It may arise as direct induction at voice frequencies, or may be demodulated from higher frequencies.

White Noise White noise makes a "rushing" or "hissing" sound in the telephone receiver.



COMPUTE THE dBx COUPLING AS FOLLOWS:

SOURCE OF TONE	CROSSTALK IN dBx
201-TYPE NOISE GEN. 0dBm OR 88 dBrc	dBrc MINUS 88
1000 Hz TONE 0dBm OR 90 dBrc	dBrc MINUS 90

Fig. 1—Crosstalk Coupling Test

TABLE A
CORRECTIONS TO BE MADE WHEN MEASURING
CROSSTALK IN THE PRESENCE OF NOISE

DB DIFFERENCE BETWEEN READING OF CROSSTALK AND NOISE AND THE READING OF NOISE ALONE	DB CORRECTION-SUBTRACT FROM THE CROSSTALK AND NOISE READING TO GIVE CROSSTALK LEVEL
1	7
2	4
3	3
4 to 5	2
6 to 8	1
Over 8	0