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SEMIAUTOMATIC |
IN-CIRCUIT ECHO SUPPRESSOR TESTING SYSTEM (ESTS)

(Geneva, 1976; amended Melbourne, 1988)

1 General

The CCITT semiautomatic *in-circuit* echo suppressor testing system is intended to test the sensitivity-related operational characteristics of echo suppressors assigned to all categories of international circuits.

The ESTS is suitable for testing echo suppressors complying with Recommendation G.161 [1] of the *Orange Book* . It may also be found suitable for certain applications on circuits employing echo suppressors complying with Recommendation G.164 [2].

Recommendation O.25

The ESTS will consist of two parts: a) *directing equipment* at the outgoing end and b) *responding equipment* at the incoming end. The directing equipment will be manually connected to the circuit under test after a connection has been established to a responder at the incoming end. The responding equipment will be accessed via a test call over the circuit under test.

In order to simplify the test equipment design and its operation, quantitative measurement results will not be given. The two-way circuit loss, noise and the echo suppressor tests will be made and reported on a *pass* /*fail* basis. The test results shall be indicated only at the outgoing end by the directing equipment. The Administrations in charge of the incoming end need not be notified of the test results except as required to eliminate a deficiency evidenced by the test results.

The ESTS shall be capable of testing a full echo suppressor located at either the outgoing or incoming end as well as both echo suppressors when split echo suppressors are used. This equipment can be used on any circuit routed completely on terrestrial facilities, or any circuit routed on terrestrial facilities and not more than one satellite link

This equipment will not provide reliable test results for a circuit which is routed through a circuit multiplication system (CMS) employing interpolation techniques [this includes the case where a circuit is routed over time division multiple access/digital speech interpolation (TDMA/DSI) satellite channels], and therefore should not be used in this instance unless a permanent trunk-channel association in both directions of transmission can be made for the duration of the test sequence. The reason for this is that without such a trunk-channel association, circuit continuity may not be maintained within the CMS in the absence of a signal and during very low signal level conditions.

2 Kinds of tests

A loss test will be made in both directions of transmission to ensure that the circuit loss is within ± | .5 dB of nominal value.

A noise test will be made in both directions of transmission to determine if the circuit noise exceeds —40 dBm0p and is therefore likely to interfere with echo suppressor measurements.

The suppression and break-in sensitivities of the echo suppressor(s) are tested to ensure that they are within established limits.

3 Method of access

3.1 *Outgoing international exchange*

Access to the circuit under test at the outgoing international exchange will be on a 4-wire basis on the exchange side of the near-end echo suppressor.

The attachment of the directing equipment to the circuit under test will be done on a manual basis, such as at a testboard.

3.2 *Incoming international exchange*

Access to the responding equipment, by the circuit under test, at the incoming international exchange will be gained via the normal exchange switching equipment on a 4-wire basis.

3.3 *Address information*

The address information to be used to gain access to the responding equipment at the incoming international exchange is specified in Recommendation O.11, § 2.4.

4 Operating principles

4.1 After a switched connection has been established at the incoming end between the circuit under test and the responding equipment, the directing equipment is attached to the circuit at the outgoing end. It shall then be possible to make any number of circuit loss, circuit noise and echo suppressor tests without releasing the connection.

4.2 The tests shall be manually initiated at the outgoing end, which can either be accomplished on a test-by-test basis or the full overall test sequence can be programmed and initiated by a single control.

4.3 A fail or pass indication for each test shall be provided to the outgoing end. In order to avoid possible ambiguities in the interpretation of the test results, all suppressor tests [i.e. tests e) to l) in § 5.3.3 below] should be made during any test sequence.

4.4 The echo suppressor tests should be made only after the two-way loss tests are completed satisfactorily. A programmed test sequence should not continue beyond a failed loss test.

5 Testing procedure

5.1 *Establishment of connection*

5.1.1 When the outgoing circuit is seized, the appropriate address information is transmitted (see § 3.3 above).

5.1.2 When the access is gained to the responding equipment, the answer signal will be transmitted. If the responding equipment is occupied, a busy indication will be returned to the outgoing end in accordance with normal signalling arrangements for the circuit.

5.1.3 Upon receipt of the answer signal the directing equipment is manually attached to the circuit under test and the tests initiated as described in § 5.2 below.

5.1.4 The responding equipment will transmit a high level monitor tone at the time of access. This can be monitored at the outgoing end to assure that the responding equipment has been accessed and activated.

5.1.5 When the tests are completed the attachment of the directing equipment to the circuit under test is removed and the circuit is immediately released.

5.1.6 The responding equipment shall automatically time out and initiate a clear back if it has been accessed continuously for more than 15 minutes.

5.2 *Test initialization*

5.2.1 Each test is initiated by the sending of an associated multi-frequency command signal from the directing to the responding equipment. Before sending a multi-frequency command signal, the directing equipment shall assume a quiescent state so as to avoid interference with the proper detection of the command signal by the responding equipment.

5.2.2 Upon the detection of a valid multi-frequency (MF) command signal at any time, the responding equipment shall be returned to its quiescent state. Immediately after the cessation of the command signal the responding equipment will send a 610-Hz acknowledgement signal for a period of 500 ± 25 ms. The responding equipment will also begin sending a monitor tone and other test tones as required for the tests described below. The responding equipment shall time out and return to its quiescent state 10 seconds after the cessation of an MF command signal.

5.2.3 After sending an MF command signal the directing equipment shall be conditioned to detect the receipt of the acknowledgement signal for an interval of time up to 1400 ms. If acknowledgement is not received by the directing equipment during this interval a failure shall be indicated and the test should not proceed any further.

5.2.4 600 ± 30 ms after the cessation of the acknowledgement signal the directing equipment shall begin sending test and/or monitor tones for the various tests as described below.

5.3 *Test description*

5.3.1 Tone detection will be made by the directing equipment for the purpose of determining whether a test passed or failed during a 375 ± 25 ms test interval. This interval will begin 1000 ± 50 ms after the directing equipment begins sending test and/or monitor tones. This delay is required to permit the exchange of test and monitor tones on circuits with long delay (one satellite and long terrestrial facilities).

5.3.2 The responding equipment shall be designed to send a monitor tone whenever it is not receiving a monitor tone from the directing equipment, except during the near-to-far loss and noise tests. For the near-to-far loss and noise tests the responding equipment shall stop sending a monitor tone to indicate to the directing equipment a test failure condition.

5.3.3 Under the control of the directing equipment the ESTS will be capable of making 12 tests from the near end.

a) near-to-far loss,

b) far-to-near loss,

c) near-to-far noise,

d) far-to-near noise,

e) near-end suppressor non-operate,

f) near-end suppressor operate,

g) near-end break-in non-operate,

h) near-end break-in operate,

i) far-end suppressor non-operate,

j) far-end suppressor operate,

k) far-end break-in non-operate,

l) far-end break-in operate.

5.3.4 These tests are described below. The descriptions begin at the cessation of the acknowledgement signal as referred to in § 5.2.4 above. For all tests the responding equipment has started sending monitor and any required test tones as noted in § 5.2.2 above.

5.3.5 *Near-to-far loss test*

The responding equipment is silent. The directing equipment sends a —10 dBm0 test tone at 820 Hz for 100 ± 10 ms. If the test tone is within ± | .5 dB of —10 dBm0 as measured at the far end, the responding equipment will send high level monitor tone. The detection of monitor tone by the directing equipment during the test interval will indicate that the test has passed.

5.3.6 *Far-to-near loss test*

The responding equipment is sending a —10 dBm0 test tone at 1020 Hz. The directing equipment measures the test tone during the test interval. If the test tone is within ± | .5 dB of —10 dBm0, the test has passed.

5.3.7 *Near-to-far noise test*

The responding equipment is silent. The directing equipment terminates the transmit path in 600 ohms. Six hundred milliseconds after transmitting the acknowledgement signal, the responding equipment measures the noise during the following 375 ± 25 milliseconds. If the noise is below —40 dBm0p, the responding equipment will send a high level monitor tone. The detection of this monitor tone by the directing equipment during the test interval will indicate that the test has passed.

5.3.8 *Far-to-near noise test*

The responding equipment terminates its transmit path in 600 ohms. The directing equipment measures the noise during the test interval and if the noise is below —40 dBm0p the test has passed.

5.3.9 *Near-end suppressor non-operate test*

The responding equipment is sending a monitor tone and a —40 dBm0 test tone at 1020 Hz. The directing equipment starts sending a monitor tone. Upon detection of the monitor tone from the directing equipment, the responding equipment stops sending its monitor tone. The absence of the monitor tone received from the responding equipment during the test interval indicates to the directing equipment that the near-end suppressor has not operated and that the test has passed.

5.3.10 *Near-end suppressor operate test*

The responding equipment is sending a monitor tone and a —26 dBm0 test tone at 1020 Hz. The directing equipment starts sending a monitor tone. If the near-end suppressor has operated, the monitor tone from the directing equipment will not reach the responding equipment. The responding equipment will therefore continue sending a monitor tone and the detection of this monitor tone by the directing equipment during the test interval will indicate that the test has passed.

5.3.11 *Near-end break-in non-operate test*

The responding equipment is sending a monitor tone and a —15 dBm0 test tone at 1020 Hz. After the detection of the 1020-Hz test tone sent out by the responding equipment, the directing equipment starts sending a high level monitor tone and a —20 dBm0 test tone at 820 Hz. If break-in does not occur at the near-end suppressor, the monitor tone from the directing equipment will not reach the responding equipment. The responding equipment will therefore continue sending a monitor tone and the detection of this monitor tone by the direction equipment during the test interval will indicate that the test has passed.

5.3.12 *Near-end break-in operate test*

The responding equipment is sending a monitor tone and a —15 dBm0 test tone at 1020 Hz. After the detection of the 1020-Hz test tone sent out by the responding equipment the directing equipment starts sending a high-level monitor tone [see § 6.1.2 c) below] and a —10 dBm0 test tone at 820 Hz. If break-in does occur at the near-end suppressor, the monitor tone from the directing equipment will reach the responding equipment. The responding equipment, upon detection of the monitor tone from the directing equipment, will stop sending its monitor tone and this absence of monitor tone during the test interval will indicate to the directing equipment that the test has passed.

5.3.13 *Far-end suppressor non-operate test*

The responding equipment is sending a monitor tone. The directing equipment starts sending a —40 dBm0 test tone at 1020 Hz. If the far-end suppressor does not operate, the monitor tone from the responding equipment will continue to reach the directing equipment, and the detection of the monitor tone by the directing equipment during the test interval will indicate that the test has passed.

5.3.14 *Far-end suppressor operate test*

The responding equipment is sending a monitor tone. The directing equipment starts sending a —26 dBm0 test tone at 1020 Hz. If the far-end suppressor does operate, the monitor tone from the responding equipment will be prevented from reaching the directing equipment, and this absence of monitor tone during the test interval will indicate to the directing equipment that the test has passed.

5.3.15 *Far-end break-in non-operate test*

The responding equipment is silent. The directing equipment starts sending a —10 dBm0 test tone at 1020 Hz. Fifty milliseconds after detection of the 1020-Hz test tone from the directing equipment, the responding equipment starts sending a high level monitor tone and a —15 dBm0 test tone at 820 Hz. If break-in does not occur at the far-end suppressor, the monitor tone from the responding equipment will be prevented from reaching the directing equipment and this absence of monitor tone during the test interval will indicate to the directing equipment that the test has passed.

5.3.16 *Far-end break-in operate test*

The responding equipment is silent. The directing equipment starts sending a —20 dBm0 test tone at 1020 Hz. Fifty milliseconds after detection of the 1020-Hz test tone from the directing equipment, the responding equipment starts sending a high level monitor tone and a —15 dBm0 test tone at 820 Hz. If break-in does occur at the far-end suppressor, the monitor tone from the responding equipment reaches the directing equipment and detection of the monitor tone by the directing equipment during the test interval will indicate that the test has passed.

6 Specifications for transmission measuring equipment

The following specifications apply over a temperature range of +5 | (deC to +50 | (deC.

6.1 *Sending apparatus of the directing and responding equipment*

6.1.1 *Signal and tone frequencies*

a) test tones: 820 ± 9 Hz

test tones: 1020 ± 11 Hz,

b) monitor tone: 510 ± 5.5 Hz,

c) acknowledgement signal: 610 ± 6.5 Hz.

6.1.2 *Signal and tone levels*

a) for loss measurements:

—10 ± 0.1 dBm0,

b) for test tones:

—10 ± 0.2 dBm0 (directing equipment only),

—15 ± 0.2 dBm0 (responding equipment only),

—20 ± 0.2 dBm0 (directing equipment only),

—26 ± 0.2 dBm0,

—40 ± 0.2 dBm0,

c) for monitor tone:

—42 ± 0.5 dBm0 (normal level),

—29 ± 0.5 dBm0 (high level),

d) for acknowledgement signal:

—29 ± 0.5 dBm0.

6.1.3 *Output impedance* (frequency range 300 Hz to 4 kHz)

— Balanced, earth free 600 ohms

— Return loss ≥" 30 dB

— Output signal balance ≥" 40 dB

6.1.4 *Distortion and spurious-modulation supression*

Better than 25 dB.

6.2 *Receiving apparatus of the directing and responding equipment*

6.2.1 *Measuring ranges*

a) for loss measurement:

from —7.5 ± 0.2 dBm0 to —12.5 ± 0.2 dBm0,

b) for noise measurement:

test threshold —40 ± 1.0 dBm0p measured with psophometric weighting as specified in Recommendation P.51 [3],

c) for monitor tone and acknowledgement signal detection:

test threshold of —54 ± 2.0 dBm0 measured with selective receivers having sufficient discrimination to reject other tones and noise that may be present on the circuit under test.

6.2.2 *Test interval*

375 ± 25 ms.

6.2.3 *Input impedance* (frequency range 300 Hz to 4 kHz)

— Balanced, earth free 600 ohms

— Return loss ≥" 30 dB

— Input longitudinal interference loss ≥" 46 dB

7 Command signals from the directing equipment to the responding equipment

Each test shall be initiated by the sending of a unique multi-frequency (MF) command signal from the directing equipment to the responding equipment.

The signal sender and signal receiver are those specified for the CCITT No. 5 Interregister Signalling System and the equipment used should be as specified in Recommendations Q.153 [4] and Q.154 [5], except that the MF command signals will be sent for 500 ± 100 ms and that the MF receiver shall respond to MF command signals between —26 dBm0 and —3 dBm0.

CODE No.	FREQUENCY (Hz)	TEST
1	700 + 900	Near-to-far loss
2	700 + 1100	Far-to-near loss
3	900 + 1100	Near-to-far noise
4	700 + 1300	Far-to-near noise
5	900 + 1300	Near-end suppressor non-operate
6	1100 + 1300	Near-end suppressor operate
7	700 + 1500	Near-end break-in non-operate
8	900 + 1500	Near-end break-in operate
9	1100 + 1500	Far-end suppressor non-operate
10	1300 + 1500	Far-end suppressor operate
11	700 + 1700	Far-end break-in non-operate
12	900 + 1700	Far-end break-in operate

References

[1] CCITT Recommendation *Echo-suppressor suitable for circuits having either short or long propagation times* , Orange Book, Vol. III-1, Rec. G.161, ITU, Geneva, 1977.

[2] CCITT Recommendation *Echo suppressors* , Vol. III, Rec. G.164.

[3] CCITT Recommendation *Artificial ear and artificial mouth* , Vol. V, Rec. P.51.

[4] CCITT Recommendation *Multifrequency signal sender* , Green Book, Vol. VI.2, Rec. Q.153, ITU, Geneva, 1973.

[5] CCITT Recommendation *Multifrequency signal receiver* , Green Book, Vol. VI.2, Rec. Q.154, ITU, Geneva, 1973.

Recommendation O.27

IN-STATION ECHO CANCELLER TEST EQUIPMENT

(Melbourne, 1988)

1 General

The in-station echo canceller test equipment (ISET) is intended to test type C and D echo cancellers including tone disablers as specified in Recommendation G.165 [1]. Two test modes are provided as described below. The tests performed in each test mode are listed in Table 1/O.27.

2 Test modes

2.1 *Routine test mode*

In this test mode, ISET provides 7 simplified tests of echo canceller performance under normal circuit conditions with the adaptation and

non-linear processing logic activated. Access to the echo canceller being tested is on a 4-wire basis, and these simple performance tests are made by applying test signals to the receive-in ($R_{i\backslash dn}$) and the send-in ($S_{i\backslash dn}$) ports of the echo canceller. Test results are measured at the send-out ($S_{o\backslash du\backslash dt}$) port. A functional block diagram of the test arrangement is shown in Figure 1/O.27.

Figure 1/O.27, p.

2.2 *Diagnostic test mode*

In this mode, all performance tests are made according to procedures specified in Recommendation G.165 [1]. The adaptation and non-linear processing logic is disabled when necessary by controlling the echo canceller that is being tested.

3 Operating principles

3.1 *Method of access*

When an echo canceller to be tested is fitted to a particular circuit, a reserved echo canceller should be substituted so that the tests can be made without causing any disturbance to the circuit. If no reserved echo canceller is available, the circuit should be blocked from service while the tests are being performed.

ISET may be connected to an echo canceller under test either manually at local access points or remotely by access arrangements through a switching system. Administrations may wish to provide remote access capability to echo cancellers for routine tests as shown in Figure 2/O.27. Local access as shown in Figure 3/O.27 is for diagnostic tests where the use of control signals to inhibit the H register, adaptation and center clipper logic are needed.

Figure 2/O.27, p.

Figure 3/O.27, p.

3.2 *Testing sequences*

When access has been established, a series of tests is performed manually or automatically. The tests to be performed in the routine and diagnostic test modes are given in Table 1/O.27. Measurement results for each test shall be provided to the maintenance personel by a visual display or printed message.

If an echo canceller fails any of the routine tests, it should be completely tested in the diagnostic test mode.

H.T. [T1.27]
TABLE 1/O.27
Test Procedures

No.	Type of Test	G.165 [1] Reference	Test modes	
			Routine	Diagnostic
1 Steady state residual and returned echo level test }	{ 3.4.2.1 |	0	0	
2	Convergence test	3.4.2.2 |	0	0
3 Double talk detection oversensitivity test }	{ 3.4.2.3.1	0	0	
4 Double talk detection undersensitivity test }	{ 3.4.2.3.2	0	0	
5	Leak rate test	3.4.2.4 |		0
6 Infinite return loss convergence test }	{ 3.4.2.5 |	0	0	
7 Tone disabler send side sensitivity test }	{ | .2 | |	0	0	
8 Tone disabler receive side sensitivity test }	{ | .2 | |	0	0	
9	Tone disabler guard band test	| .3 | |		0
10 Tone disabler holding band test }	{ | .4 | |		0	
11 Tone disabler operate time test }	{ | .5 | |		0	
12 Tone disabler release time test }	{ | .8 | |		0	
13 External disabler control test }	{ | .3 | |		0	

Table 1/O.27 [T1.27], p.

4 Test procedures and test requirements

4.1 *Routine test mode*

Different echo cancellers may be designed to work satisfactorily for different echo path delays depending on their application in various networks. Thus Δ represents the echo path delay for which the echo canceller is designed. Each Administration may choose a delay value of Δ appropriate for their equipment.
Figure 1/O.27 shows a functional arrangement for the routine test mode. The following seven tests should be repeated with an appropriate echo path delay Δ ms set in the adjustable echo delay unit.

At the beginning of each of the seven tests, a conditioning tone is applied for 1 second to the $R_{i\backslash dn}$port for initialization of the echo canceller to be tested. The conditioning tone is a 2100 Hz signal of —10 dBm0 with periodic phase reversals occurring every 0.45 seconds and is also used to disable echo cancellers. During this initialization period the H register of the canceller is cleared. After the conditioning tone is disconnected, no signal is applied to the canceller for at least 0.4 seconds to allow it to return to an enabled state. Further information on the characteristics of echo canceller tone disablers may be found in § 4 and Annex B of Recommendation G.165 [1].

4.1.1 *Check of steady state residual and returned echo level*

Step 1: A random noise signal (A) of —10 dBm0 is applied to the $R_{i\backslash dn}$port. With the echo path loss set at 10 dB, an echo appears at the $S_{i\backslash dn}$port.

Step 2: After 2 seconds the returned echo level at the $S_{o\backslash du\backslash dt}$port is measured.

Requirement: The returned echo level must be less than —65 dBm0.

4.1.2 *Check of convergence*

Step 1: A random noise signal (A) of —10 dBm0 is applied to the $R_{i\backslash dn}$port. With the echo path loss set at 6 dB, an echo is appears at the $S_{i\backslash dn}$ port.

Step 2: A second random noise signal (B) of —10 dBm0 is applied to the $S_{i\backslash dn}$ port as shown in Figure 1/O.27.

Step 3: After 0.5 seconds noise signal (B) is disconnected, and 0.5 seconds later the returned signal level at the $S_{o\backslash du\backslash dt}$ port is measured.

Requirement: The signal level must be less than —37 dBm0.

4.1.3 *Check of double talk detection oversensibility*

Step 1: A random noise signal (A) of —10 dBm0 is applied to the $R_{i\backslash dn}$ port. With the echo path loss set as 6 dB, an echo appears at the $S_{i\backslash dn}$ port.

Step 2: After 0.5 seconds, a second random noise signal (B) of —25 dBm0 is applied to the $S_{i\backslash dn}$ port.

Step 3: One second later noise signal (B) is disconnected and the returned echo level at the $S_{o\backslash du\backslash dt}$ port is measured.

Requirement: The returned echo level must be less than —25 dBm0.

4.1.4 *Check of double talk detection undersensitivity*

Step 1: With the echo path loss set at 10 dB, a random noise signal (A) of —10 dBm0 is applied to the $R_{i\backslash dn}$ port.

Step 2: After 1 second the noise signal (A) at the $R_{i\backslash dn}$ port is disconnected.

Step 3: After an interval of 0.5 seconds, the noise signal (A) is reapplied to the $R_{i\backslash dn}$ port. Simultaneously a second noise signal (B) of 0 dBm0 is applied to the $S_{i\backslash dn}$ port.

Step 4: 0.5 seconds later the noise signal (B) is disconnected and the residual echo level at the $S_{o\du\dt}$ port is measured.

Requirement: The returned echo level must be less than —26 dBm0.

4.1.5 *Check of infinite return loss convergence*

Step 1: With the echo path loss set at 6 dB, a random noise signal (A) of —10 dBm0 is applied to the $R_{i\dn}$ port.

Step 2: After 1 second the echo path between $R_{o\du\dt}$ and $S_{i\dn}$ is disconnected while noise signal (A) remains connected to the $R_{i\dn}$ port.

Step 3: 0.5 seconds later the returned echo level at the $S_{o\du\dt}$ port is measured.

Requirement: The returned echo level must be less than —37 dBm0.

4.1.6 *Check of tone disabler send-side sensitivity*

There are two parts to this test to ensure that the disabler tone detection circuit on the send side is not oversensitive or under-sensitive.

Step 1: A 2100 Hz signal of —36.5 dBm0 with periodic phase reversals every 0.45 seconds is applied for one second to the $S_{i\dn}$ port.

Step 2: A random noise signal (A) of —10 dBm0 is applied to the $R_{i\dn}$ port.

Step 3: After 0.5 seconds the returned echo level at the $S_{o\du\dt}$ port is measured.

Requirement: The returned echo level must be less than —32 dBm0 to show that the disabler is not operated.

Step 4: The conditioning tone is re applied for one second to the $R_{i\dn}$ port. After at least 0.4 seconds, the 2100 Hz signal with periodic phase reversals every 0.45 seconds is reapplied to the $S_{i\dn}$ port at a level of —29.5 dBm0 for one second.

Step 5: Then the random noise signal (A) of —10 dBm0 is reapplied to the $R_{i\dn}$ port with the echo path loss set at 10 dB.

Step 6: After 0.5 seconds the returned echol level at the $S_{o\du\dt}$ port is measured.

Requirement: The returned echo level must be between —29.5 dBm0 and —26.5 dBm0 to show that the disabler is operated.

4.1.7 *Check of tone disabler receive-side sensitivity*

There are also two parts to this test to ensure that the disabler tone detection on the receive side is not oversensitive or under-sensitive.

Step 1: A 2100 Hz signal of —36.5 dBm0 with period periodic phase reversals every 0.45 seconds is applied for one second to the $R_{i\dn}$ port.

Step 2: A random noise signal (A) of —10 dBm0 is applied to the $R_{i\dn}$ port. With the echo path loss set at 10 dB, an echo appears at the $S_{i\dn}$ port.

Step 3: After 0.5 seconds the returned echo level at the $S_{o\du\dt}$ port is measured.

Requirement: The returned level must be less than —32 dBm0 to show that the disabler is not operated.

Step 4: The conditioning tone is reapplied for one second to the $R_{i\dn}$ port. After at least 0.4 seconds, the 2100 Hz signal with periodic phase reversals every 0.45 seconds is reapplied to the $S_{i\dn}$ port at a level of —29.5 dBm0 for one second.

Step 5: Then the random noise signal (A) of —10 dBm0 is reapplied to the $R_{i\dn}$ port with the echo path loss set at 10 dB.

Step 6: After 0.5 seconds the returned echo level at the $S_{o\du\dt}$ port is measured.

Requirement: The returned echo level must be between —29.5 dBm0 and —26.5 dBm0 to show that the disabler is operated.

4.2 *Diagnostic test mode*

In this mode diagnostic tests are performed as specified in Recommendation G.165. § 3.3.2 and § 4 [1].

5 **Specifications for transmission measuring equipment**

The following specifications apply for climatic conditions specified in Recommendation O.3.

5.1 *Signal generator*

5.1.1 *Range of frequency*

0.3 to 3.4 kHz in 0.01 kHz steps.

5.1.2 *Range of level*

—40 to 0 dBm0 in 0.1 dB steps.

5.1.3 *Accuracy*

Frequency ± | .01 kHz

Level ± | .1 dB.

5.2 *Level meter*

5.2.1 *Range of measurement*

—70 to + 3.2 dBm0.

5.2.2 *Accuracy*

± | .1 dB (above —40 dBm0).

5.2.3 *Dynamic response time*

Under study

A meter with a rapid response time will be needed to meet the timing requirements of some of the tests specified above.

5.3 *Random noise source*

5.3.1 *Level*

—40 to + 0 dBm0.

5.3.2 *Noise signal*

The noise test signal is a band-limited white noise (300-3400 Hz).

5.4 *Echo path*

5.4.1 *Echo loss*

0 dB to 40 dB in 0.1 dB steps.

5.4.2 *Echo delay*

0 to Δ ms in 1 ms steps.

5.4.3 *Bandwidth*

0.3 to 3.4 kHz.

6 Calibration

6.1 *Calibration of measuring equipment*

Calibration features should be provided to check that the accuracy requirements are met.

6.2 *Self-check of operational function*

A local self-checking facility should be provided to make sure that the testing functions are operating properly.

7 Optional arrangements

7.1 *Automatic test function*

A function to perform tests in sequence automatically according to the predetermined procedure, may be provided.

7.2 *Automatic start function*

A timed automatic start function which enables the unattended operations, may be provided.

References

[1] CCITT Recommendation *Echo Cancellers* , Vol. III, Rec. G.165.

AUTOMATIC MEASURING EQUIPMENT FOR SOUND-PROGRAMME CIRCUITS

(Geneva, 1972; amended at Geneva, 1976)

1 General

The CCITT automatic measuring equipment for sound-programme circuits is capable of rapidly measuring all relevant parameters necessary for checking the quality of such circuits. The measuring results are recorded by means of an analogue recorder and/or digital receiver. The results of the measurements are suitable for subsequent documentation and not only permit an immediate decision by the staff in the field on whether the sound-programme circuit or sound-programme connection respectively can be used for service, but they also provide the basis for later exact evaluation by the responsible transmission engineer.

The overall time for the measurements amounts to 136 seconds. It is thus short enough to check the quality also of international chains of sound-programme circuits interconnected on a short-term basis during the preparatory and lining-up period according to Recommendation N.4 [1]. Measurements for this purpose, made by the ISPCs involved in accordance with Recommendations N.12 [2] and N.13 [3], do not require any preceding agreement.

2 Quality criteria to be checked

With the CCITT automatic measuring equipment for sound-programme circuits the following quality criteria can be checked:

a = deviation of the received absolute power level of the 0.8-kHz reference frequency from the nominal value;

b = weighted and unweighted noise;

c = nonlinear distortion measured selectively as harmonic distortion of the 2nd order (k_2) and 3rd order (k_3) and as a difference tone distortion of the 3rd order (d_3);

d = compandor functioning test;

e = loss/frequency distortion.

The complete measuring programme comprises three subroutines which can be chosen individually. The quality criteria to be checked are allotted to the subroutines in the following way:

Subroutine 1: $s + a$

Subroutine 2: $b + c + d$

Subroutine 3: e

where

in subroutine 1, *s* is the station coding of the sending unit.

Within the subroutine the timing of the programme in the sending unit and in the receiving unit is synchronized by means of a series of pulses provided by a generator within the equipment.

3 Specifications

3.1 *Sending unit*

3.1.1 *Start, stop and time base for synchronization and selection of measuring mode*

By means of a locking press-button in the sending unit the measuring programme for single or permanent mode of operation can be started. The timing of the measuring programme is controlled by a pulse generator. The smallest time base that can be programmed is fixed at 1.33 second. The synchronizing frequency related to this time base gives 0.75 Hz and has to be kept within ± | %. A second press-button offers the possibility of stopping the measuring programme. By the activation of this press-button a means is provided whereby the locking mechanism of the start press-button for permanent operation is simultaneously released. Start, synchronization and stop of the receiving unit are triggered by coded pulses (1.3 kHz at —12 dBm0).

Every subroutine is preceded by coded pulses which serves as a start signal. By means of a special stop signal which is triggered by pressing the stop button, the progress of the measuring programme can be interrupted at any time and another programme, selected with the aid of a switch, can be started instead. Operating the stop button will also reset the time pulse generator to the starting condition.

The start and stop signals consist of four pulses whose duration can be fixed at 60 ms (value O) or 120 ms (value L) by means of digital coding. The time between the beginning of every pulse within the coded signal is 240 ms.

The coding of the pulses is as follows:

a) Start signals for:

— Subroutine 1: OOOL

— Subroutine 2: OOLO

— Subroutine 3: OLOO

b) Stop signal: LLLL

The start signals are read from right to left, as is usual in the case of digital codes, and are transmitted in the same time sequence.

The sending of the coded signal (duration 960 ms) which is controlled by the time pulse generator must be delayed 370 ms (in order to comply with the time pulse duration of 1330 ms).

3.1.2 *Station coding*

The measuring programme is preceded by the code of the sending station using the Morse alphabet. For this purpose 19 timing intervals are allocated. The station code is sent by keying a 0.8-kHz tone between a level of —32 dBm0 and the reference test level. The duration of Morse dots and dashes shall be about 10% and 35% respectively, of one timing interval.

3.1.3 *Test level sent for the measurement of level at the reference frequency and level/frequency response* (quality criteria *s* , *a* and *e*)

The test level sent for loss measurements at the reference frequency (0.8 kHz) and for the measurement of level/frequency response should be —12 dBm0 (see Recommendation N.21 [4]). The measurements of level/frequency response are to be carried out with the aid of a sweep generator covering the frequency range from 0.03-16 kHz. Each octave — the first one beginning at 0.05 kHz — is marked by short pulses (1.3 kHz/—12 dBm0 from 50 to 100 ms duration). The speed of this sequence of operations for the frequency range from 30-16 | 00 Hz which covers 9.06 octaves should be 5 seconds/octave so that the recording device dealt with in § 3.2.7 below records one octave over 10 mm and 3.3 mm respectively.

3.1.4 *Test level sent for nonlinear distortion measurements*

The sent level of the test frequencies corresponds to the peak programme level (see the Recommendation cited in [5]), that is, the single tones for the nonlinear distortion measurements lead to the same peak loading as the double tone for the difference tone factor measurements (single tone of +9 dBm0 equivalent to 2.2 $V_{r\d.\dm\d.\ds\d.}$ = 3.1 $V_{p\d0}$ and double tone each of +3 dBm0 equivalent to (because it is stuck to ‘‘2’’ in the Orange Book) 2 × 1.1 $V_{r\d.\dm\d.\ds\d.}$ = 2 × 1.55 $V_{p\d0}$ referred to = 3.1 $V_{p\d0}$ a zero relative level point). In order to avoid overload of carrier-frequency transmission systems, only frequencies below 2 kHz (with regard to circuits equipped with equipped with pre- and de-emphasis techniques) are applied and the duration of transmission is automatically reduced to the length of a single timing pulse following test frequencies should be used:

a) *For the measurement of nonlinear distortion in the lower audio-frequency range:*

c_1 = 0.09 kHz/+9 dBm0 for the k_2-measurement;

c_2 = 0.06 kHz/+9 dBm0 for the k_3-measurement.

b) *For the measurement of nonlinear distortion in the carrier-frequency range of a frequency division multiplex channel:*

c_3 = 0.8 kHz/+3 dBm0 and 1.42 kHz/+3 dBm0 for the d_3-measurement.

c) *For the measurement of nonlinear distortion in the medium audio-frequency range:*

c_4 = 0.8 kHz/+9 dBm0 for the k_2-measurement;

c_5 = 0.533 kHz/+9 dBm0 for the k_3-measurement.

3.1.5 *Signal sent for compandor functioning test* | (quality criterion *d*)

In order to detect a noncomplementary behaviour of regulating amplifiers in compandors a 0.8-kHz signal is injected, the level of which is switched between the values +6, —6, +6 dBm0 for three consecutive timing intervals.

3.1.6 *Remote control of the sending unit*

Provision should be made for sending up to 16 command signals. These signals may be applied to the sending equipment in either binary code or by applying earth to 16 signal paths. In case of binary coding for starting the complete measuring programme the coded signal LOOL should be used in addition to the start signal given under § 3.1.1 above.

3.2 *Receiving unit*

3.2.1 *Start, stop and synchronization*

In the receiving unit the coded pulses must be detected and separated by means of a selective process. A guard circuit similar to the one normally used for signal receivers is required to protect against false operation. In combination with the above-mentioned guard circuit the 4-bit code chosen offers a highly reliable protection against the possibility that the starting mechanism might be activated by sound-programme signals. Thus, the receiving unit can remain continuously connected to a sound-programme circuit and can record the measuring programme without intervention by an operator.

It shall be possible for the signal sent for the measurement of nonlinearity distortion to be included in or omitted from the test cycle at will (for example, under control of a switch). Whether or not the nonlinearity distortion measurement is admissible must be determined for each circuit by the users of the equipment, and in a manner ensuring that the prescriptions of Recommendation N.21 [4] are respected.

Other methods are under study by the CCITT.

This test is intended for provisional use. A change will be necessary when, after further study, the CCITT issues Recommendations for compandors and appropriate methods of their testing.

The timing schedule must be in conformity with the requirements specified for the sending unit (see § 3.1.1 above).

The time pulse generator shall be triggered after the reception of the start signal. Reception of the stop signal shall cause the time pulse generator to be reset to the starting condition.

3.2.2 *Measuring ranges*

The measuring device should have a logarithmic characteristic, and a linear measuring range of ± | 0 dB referred to the respective centre-of-range should be provided.

For the particular measuring function the following centres-of-range should be provided:

— station coding, level measurement at 0.8 kHz and measure of level/frequency response (*s* , *a* , *e*) —12 dBm0

— noise level weighted (b_1) and unweighted (b_2) —51 dBm0

(signal/noise ratio, referred to +9 dBm0 60 dB)

— nonlinear distortion

k_2- and k_3-measurements (c_1, c_2, c_4, c_5) —31 dBm0

(ratio, referred to +9 dBm0 40 dB)

d_3-measurement (c_3) —37 dBm0

(ratio, referred to +3 dBm0 40 dB)

— level step signal (*d*) 0 dBm0

The quality criteria *a* , *c* , *d* and *e* are expressed in terms of r.m.s. values.

3.2.3 *Noise measurements*

The quality criteria b_1 and b_2 (weighted and unweighted noise measurements) are measured in a quasi-peak mode. The dynamic properties of the rectifier circuitry and the network for weighted noise measurement (b_1) should meet the requirements of CCIR Recommendation 468 [6].

3.2.4 *Provision of filters and their characteristics*

Two bandpass filters should be provided for selecting the nonlinear distortion products, one for 0.18 kHz and the other for 1.6 kHz. They should be used as follows:

0.18-kHz filter

— for k_2-measurement of 0.09 kHz (c_1),

— for k_3-measurement of 0.06 kHz (c_2),

— for d_3-measurement of 0.8/1.42 kHz (c_3);

1.6-kHz filter

— for k_2-measurement of 0.8 kHz (c_4),

— for k_3-measurement of 0.533 kHz (c_5).

With the 0.18 kHz filter only the lower d_3-product (2 × 0.8 kHz —1.42 kHz = 0.18 kHz) is measured. The measurement of the upper d_3-product at 2.04 kHz (= 2 × 1.42 kHz — 0.8 kHz) is not made. To compensate for this, two times the lower d_3-product at 0.18 kHz is taken.

The bandpass filters should meet the following selectivity requirements:

— passband defined by insertion loss values less than 1 dB:

0.18 kHz filter: ± | 3 Hz

1.6 kHz filter: ± | 4 Hz⌋ ⎬ referred to the centre frequency

— rejection frequency range defined by insertion loss values greater than 70 dB:

0.18 kHz filter: < | .09 kHz and > | .36 kHz

1.6 kHz filter: < | .8 kHz and > | .2 kHz

3.2.5 *Additional markers provided at digital receivers*

Additional markers can be generated in the digital receiver as required by making use of the octave markers received from the sending unit as a timing base.

3.2.6 *Programming of digital receivers*

Where a digital receiver is used it shall be possible to programme it so as to check that the circuits tested meet the required tolerances.

3.2.7 *Recording device*

The transient response time of the recording device should not exceed 200 ms. In connection with the rectifier circuitry of the receiving unit for noise measurements the requirements of CCIR Recommen dation 468 [6] should be fulfilled.

Paper width and speed may be chosen according to national standards. The following values have proved to be practicable:

— paper width 100 mm;

— paper speed 2 mm/s and 2/3 mm/s.

These paper speeds should be manually adjustable.

The above-mentioned values yield (on the 20-dB level range) a level scale of 2 dB/10 mm and (on the 136-seconds overall time) a record length of 272 mm and 90.7 mm respectively.

In addition to the recording device it would be desirable to provide appropriate access points for the use of an oscilloscope.

3.3 *Sequence of operations*

The sequence of operations of the measuring programme and the associated time units is shown in Annex A.

3.4 *Long-term measurements of noise*

3.4.1 *Automatic measurements*

After a period of 10 time intervals following the end of a complete measuring programme, and without receipt of a start signal, the receiver will automatically commence long-term noise measurements. Weighted noise will be measured over a period of 60 time intervals and unweighted noise over a period of 20 time intervals. The same centre-of-range as given in § 3.2.2 above for noise, weighted and unweighted will be used.

3.4.2 *Manual measurements*

In order to make measurements of weighted or unweighted noise continuously for unspecified periods of time, it must be possible to make the timing mechanism inoperative. Where an analogue receiver is used, a manually controlled switch should be provided, so that the centre-of-range can be changed by 10 dB in either direction.

3.5 *Matching characteristics*

According to the lining-up procedure for sound-programme circuits using the constant voltage method the following impedances are to be provided:

— output impedance of the sending unit < | 0 ohms,

— input impedance of the receiving unit > | 0 kohms.

Both values may be changed by internal switching to 600 ohms if, for the lining-up of the sound-programme circuit, the impedance matching method is applied. It should be possible to adjust the sending and receiving units by means of a switch to the following relative levels:

+6 dBr

| u4) = nominal value at the repeater stations of Administrations;

0 dBr = nominal value at the studios of broadcasting organizations.

For certain purposes a level of —3 dBr or lower may be used.

3.6 *Accuracy of sending and receiving units*

3.6.1 *Sending unit*

a) *Individual frequency oscillators* — level tolerance ± | .2 dB
— frequency tolerance < | .0%
— harmonic distortion at 2*f* .PS 10 and 3*f* .PS 10 < | .1%

b) *Sweep frequency oscillator* .PS 10 — level tolerance at 0.8 kHz ± | .2 dB
— level/frequency response referred to 0.8 kHz ± | .2 dB

3.6.2 *Receiving unit*

Tolerances, including recording device:
— mid-scale value —12 dBm0 and 0 dBm0 ± | .3 dB
— mid-scale value —51 dBm0 and —31 dBm0 ± | .0 dB

Operational stability should be reached within 15 minutes after switching on. As far as the details of the division of the tolerances are concerned, reference is made to the values given in Supplement No. 3.1 at the end of this fascicle.

The tolerances may then be reduced by calibrating the sending and receiving units when interconnected on a loop basis (in order to compensate residual errors).

Blanc

ANNEX A
(to Recommendation O.31)

H.T. [T1.31]
TABLE A-1/O.31
Sequence of operations
MONTAGE: TABLEAU A RECUPERER DU LIVRE ROUGE, SANS CORRECTIONS.
blanc

H.T. [T1.32]
TABLE 1/O.32
Measurement of quality criteria
a
to *i* **, sender and receiver requirements**
MONTAGE: TABLEAU A RECUPERER DU LIVRE ROUGE, SANS CORRECTIONS.
blanc

H.T. [T2.32]
TABLE 2/O.32

Mains routines	Subroutines								
	Monophonic	1	2	3	Stereophonic				
	1	2	3	4	5	6	7	8	9
Quality criteria	*s* *a*	{							
b									
c									
d									
}	*e*	*a* *f*	{						
b									
c									
d									
}	*e*	*g*	*h*	*i*					

Table A-1/O.31 [T1.31], p.

APPENDIX I
(to Recommendation O.31)

Example of the record of measurements made by a tipical model

of the automatic measuring equipment

Figure I, p.

References

[1] CCITT Recommendation *Definition and duration of the line-up period and the preparatory period* , Vol. IV, Rec. N.4.

[2] CCITT Recommendation *Measurements to be made during the line-up period that precedes a sound-programme transmission* , Vol. IV, Rec. N.12.

[3] CCITT Recommendation *Measurements to be made by the broadcasting organizations during the preparatory period* , Vol. IV, Rec. N.13.

[4] CCITT Recommendation *Limits and procedures for the lining-up of a sound-programme circuit* , Vol. IV, Rec. N.21.

[5] CCITT Recommendation *Measurements to be made by the broadcasting organizations during the preparatory period* , Vol. IV, Rec. N.13, Note.

[6] CCIR Recommendation *Measurement of audio-frequency noise in sound broadcasting* , Vol. X, Rec. 468, ITU, Geneva, 1986.

AUTOMATIC MEASURING EQUIPMENT FOR

STEREOPHONIC PAIRS OF SOUND-PROGRAMME CIRCUITS

(Geneva, 1972)

1 General

An equipment designed in accordance with this Recommendation is intended for use on stereophonic pairs of sound-programme circuits. The equipment is very similar to the equipment specified in Recommendation O.31. The stereophonic and monophonic equipments are compatible for the testing of monophonic sound-programme circuits.

The differences between the monophonic and the stereophonic equipment are as follows:

The monophonic equipment (Recommendation O.31) measures 5 different parameters in 136 seconds; the stereophonic set measures the same 5 parameters in channels A and B of the stereophonic pair; in addition it measures the level and phase difference between channels A and B, and the crosstalk at three specified frequencies between the two channels. The overall time for the stereophonic measurements therefore amounts to approximately 371 seconds.

2 Quality criteria and measuring routines

2.1 *Quality criteria to be checked*

Table 1/O.32 gives the various quality criteria, designated by the letters *a* to *i* , including the criteria of Recommendation O.31.

2.2 *Main routines*

The measuring programmes for monophonic and for stereophonic circuits can be chosen as main routines, the monophonic programme being in accordance with the complete measuring programme of Recommendation O.31.

Each main routine consists of the subroutines shown in Table 2/O.32 which can be chosen individually (in subroutine 1, *s* is the station coding of the sending unit).

2.3 *Subroutines*

2.3.1 *Subroutine 1* | station coding and monophonic quality criterion *a*)

A station coding signal is sent in accordance with § 3.1.2 below followed by measurement of the level of channel A at the reference frequency.

2.3.2 *Subroutine 2* | monophonic criteria *b* , *c* , and *d*)

Subroutine 2 comprises three steps:

1) measurement of the weighted and unweighted noise level of channel A (b_1, and b_2);

2) nonlinear distortion of channel A measured selectively as harmonic distortion of the 2nd and 3rd order and as a difference tone distortion of the 3rd order (c_1 . | | c_5);

3) compandor functioning test of channel A (*d*).

2.3.3 *Subroutine 3* | monophonic criterion *e*)

Measurement of the level/frequency response of channel A.

2.3.4 *Subroutine 4* | monophonic quality criterion *a* and stereophonic quality criterion *f*)

Subroutine 4 comprises 3 steps: the first step checks received level at the reference frequency in channel B (monophonic criterion corresponding to subroutine 1). The second and third steps are used to determine the sum (f_1) and difference (f_2) levels of channels A and B. Both measured values serve for the polarity check and the approximate assessment of phase differences exceeding the range fixed in subroutine 8 (stereophonic criterion *h*). In the case of negligible level and phase differences between channels A and B, the resulting sum level must exceed the received level at the reference frequency on the individual channel by 6 dB and in this case the difference level is so small that it is not indicated. If the channels are of opposite polarity ($\Delta\Phi$ = 180°), the sum level and the difference level behave inversely.

Large phase differences can be estimated from Table 3/O.32.

H.T. [T1.32]

TABLE 1/O.32

Measurement of quality criteria

a

to

i

, sender

and receiver requirements

MONTAGE: TABLEAU A RECUPERER DU LIVRE ROUGE, SANS CORRECTIONS.

blanc

H.T. [T2.32]

TABLE 2/O.32

		Subroutines

Mains routines	Monophonic 1	1 2	2 3	3 4	Stereophonic 5	6	7	8	9
Quality criteria	*s a*	{							
b									
c									
d									
}	*e*	*a f*	{						
b									
c									
d									
}	*e*	*g*	*h*	*i*					

Table 1/O.32 [T1.32], p.

H.T. [T2.32]

TABLE 2/O.32

		Subroutines

Mains routines	Monophonic 1	1 2	2 3	3 4	Stereophonic 5	6	7	8	9
Quality criteria	*s a*	{							
b									
c									
d									
}	*e*	*a f*	{						
b									
c									
d									
}	*e*	*g*	*h*	*i*					

Table 2/O.32 [T2.32], p.

H.T. [T3.32]
TABLE 3/O.32

Sum level Δn *(dB)* *Difference level* Δn *(dB)* *}*	*{* *Phase difference* $\Delta \Phi$	
+6.0	*—∞ |*	*0/360°*
+5.7	*—5.7*	*30/330°*
+4.8	*0 |*	*60/300°*
+3.0	*+3.0*	*90/270°*
0 |	*+4.8*	*120/240°*
—5.7	*+5.7*	*150/210°*
—∞ |	*+6.0*	*180°*

Note — The above table is derived from the following formulae:

$\Delta n = 3 \text{ dB} + 10 \log [1 - \cos (180 - \Delta\Phi)]$

$\Delta n = 3 \text{ dB} + 10 \log (1 - \cos \Delta\Phi)$

Table 3/O.32 [T3.32], p.

2.3.5 *Subroutine 5* | monophonic criteria *b* , *c* and *d*)

Measurement of weighted and unweighted noise levels and nonlinear distortion and compandor functioning test, as specified in subroutine 2, but for channel B.

2.3.6 *Subroutine 6* | monophonic criterion *e*)

Measurement of the level/frequency response of channel B. (Corresponds to subroutine 3 for channel A.)

2.3.7 *Subroutine 7* | stereophonic criterion *g*)

The level difference between channels A and B, determined as a function of the frequency.

2.3.8 *Subroutine 8* | stereophonic criterion *h*)

The phase difference between channels A and B, measured as a function of the frequency.

2.3.9 *Subroutine 9* | stereophonic criterion *i*)

The signal-to-crosstalk ratio between channels A and B at frequencies of 180, 1600 and 9000 Hz.

3 Specifications

The following specifications for carrying out the measurements of the monophonic quality criteria *a* to *e* are identical with those laid down in Recommendation O.31 for the monophonic version of such equipment.

3.1 *Sending unit*

3.1.1 *Start, stop and time base for synchronization and selection of measuring mode*

By means of a locking press-button in the sending unit the measuring programme for single or permanent mode of operation can be started. The timing of the measuring programme is controlled by a pulse generator. The smallest time base that can be programmed is fixed at 1.33 second. The synchronizing frequency related to this time base is 0.75 Hz and has to be kept within ± | %. A second press-button offers the possibility of stopping the measuring programme. By the activation of this press-button a means is provided whereby the locking mechanism of the start press-button for permanent operation is simultaneously released. Start, synchronization and stop of the receiving unit are triggered by coded pulses (1.3 kHz at —12 dBm0).

Every subroutine is preceded by coded pulses which serve as a start signal. By means of a special stop signal which is triggered by pressing the stop button, the progress of the measuring programme can be interrupted at any time and another programme, selected with the aid of a switch, can be started instead. Operating the stop button will also reset the time pulse generator to the starting condition.

The start and stop signals consist of four pulses whose duration can be fixed at 60 ms (value O) or 120 ms (value L) by means of digital coding. The time between the beginning of every pulse within the coded signal is 240 ms.

The coding of the pulses is as follows:

a) Start signals for:

— Subroutine 1: OOOL

— Subroutine 2: OOLO

— Subroutine 3: OLOO

— Subroutine 4: LOOO

— Subroutine 5: OOLL

— Subroutine 6: OLLO

— Subroutine 7: LLOO

— Subroutine 8: OLOL

— Subroutine 9: LOLO

b) Stop signal: LLLL

The start signals are read from right to left, as is usual in the case of digital codes, and are transmitted in the same time sequence.

The sending of the coded signal (duration 960 ms) which is controlled by the time pulse generator must be delayed 370 ms (in order to comply with the time pulse duration of 1330 ms).

3.1.2 *Station coding*

The measuring programme is preceded by the code of the sending station using the Morse alphabet. For this purpose, 19 timing intervals are allocated. The station code is sent by keying a 0.8-kHz tone between a level of —32 dBm0 and the reference test level. The duration of Morse dots and dashes shall be about 10% and 35% respectively, of one timing interval.

3.1.3 *Test level for the measurements of level at the reference frequency and level/frequency response*

The test level sent for level measurements at the reference frequency (0.8 kHz) and for the measurements of level/frequency response should be —12 dBm0 (see Recommendation N.21 [2]). The measurements of level/frequency response are to be carried out with the aid of a sweep generator comprising the frequency range from 0.03 to 16 kHz. Each octave — beginning at 0.05 kHz — is marked by short pulses (1.3 kHz/—12 dBm0 from 50 to 100 ms duration). The speed of this sequence of operations for the frequency range from 30-16 | 00 Hz which covers 9.06 octaves should be 5 seconds/octave so that the recording device dealt with in § 3.2.9 below records one octave over 10 mm and 3.3 mm respectively.

3.1.4 *Test level sent for nonlinear distortion measurements*

It shall be possible for the signal sent for the measurement of nonlinearity distortion to be included in or omitted from the test cycle at will (for example, under control of a switch). Whether or not the nonlinearity distortion measurement is admissible must be determined for each circuit by the user of the equipment, and in a manner ensuring that the prescriptions of Recommendation N.21 [2] are respected.

The sent level of the test frequencies corresponds to the peak programme level (see the Recommendation cited in [3]), that is, the single tones for the nonlinear distortion measurements lead to the same peak loading as the double tone for the difference tone factor measurements (single tone of +9 dBm0, equivalent to 2.2 Vr\d.\dm\d.\ds\d. = 3.1 Vp\d0and double tone each of +3 dBm0, equivalent to $2 \times 1.1\ V_{r\d.\dm\d.\ds\d.} = 2 \times 1.55\ V_{p\d0} = 3.1\ \ V_{p\d0}$ referred to a zero relative level point). In order to avoid overload of carrier-frequency transmission systems, only frequencies below 2 kHz (with regard to circuits equipped with pre- and de-emphasis techniques) are applied and the duration of transmission is automatically reduced to the length of a single timing pulse following test frequencies should be used:

a) *For the measurement of nonlinear distortion in the lower audio-frequency range*

c_1 = 0.09 kHz/+9 dBm0 for the k_2-measurement,

c_2 = 0.06 kHz/+9 dBm0 for the k_3-measurement.

b) *For the measurement of nonlinear distortion in the carrier-frequency range of a frequency division multiplex channel*

c_3 = 0.8 kHz/+3 dBm0 and 1.42 kHz/+3 dBm0 for the d_3-measurement.

c) *For the measurement of nonlinear distortion in the medium audio-frequency range*

c_4 = 0.8 kHz/+9 dBm0 for the k_2-measurement,

c_5 = 0.533 kHz/+9 dBm0 for the k_3-measurement.

3.1.5 *Signal sent for compandor functioning test* |

In order to detect a noncomplementary behaviour of regulating amplifiers in compandors a 0.8-kHz signal is injected, the level of which is switched between the values +6, —6, +6 dBm0 for three consecutive timing intervals.

3.1.6 *Crosstalk between channels A and B*

The signal-to-crosstalk ratio between channels A and B is measured at the frequencies 180, 1600 and 9000 Hz. The sent level should be —12 dBm0.

3.1.7 *Remote control of the sending unit*

Provision should be made for sending up to 16 command signals. These signals may be applied to the sending equipment in either binary code or by applying earth to 16 signal paths. In the case of binary coding for starting the monophonic or stereophonic main routine, the coded signals LOOL or LLLO respectively should be used in addition to the start signals given under § 3.1.1 above.

3.2 *Receiving unit*

3.2.1 *Start, stop and synchronization*

In the receiving unit the coded pulses must be detected and separated by means of a selective process. A guard circuit similar to the one normally used for signal receivers is required to protect against false operation. In combination with the above-mentioned guard circuit the 4-bit code chosen offers a highly reliable protection against the possibility that the starting mechanism might be activated by sound-programme signals. Thus, the receiving unit can remain continuously connected to a sound-programme circuit and can record the measuring programme without intervention by an operator.

The timing schedule must be in conformity with the requirements specified for the sending unit (see § 3.1.1).

The time pulse generator shall be triggered after the reception of the start signal. Reception of the stop signal shall cause the time pulse generator to be reset to the starting condition.

Other methods are under study by the CMTT.

This test is intended for provisional use. A change will be necessary when, after further study, the CCITT issues Recommendations for compandors and appropriate methods of their testing.

3.2.2 *Measuring ranges*

The measuring device should have a logarithmic characteristic, and a linear measuring range of ± | 0 dB referred to the respective centre-of-range should be provided.

For the particular measuring function the centres-of-range as indicated in Table 1/O.32 should be provided.

3.2.3 *Noise measurements*

The quality criteria b_1 and b_2 (weighted and unweighted noise measurements) are measured in a quasi-peak mode. In this case, the dynamic properties of the rectifier circuitry and the network for weighted noise measurement (b_1) should meet the requirements of CCIR Recommendation 468 [1].

3.2.4 *Provision of filters and their characteristics*

Two bandpass filters should be provided for selecting the nonlinear distortion products, one for 0.18 kHz and the other for 1.6 kHz. They should be used as follows:

0.18-kHz filter

— for k_2-measurement of 0.09 kHz (c_1),

— for k_3-measurement of 0.06 kHz (c_2),

— for d_3-measurement of 0.8/1.42 kHz (c_3);

1.6-kHz filter

— for k_2-measurement of 0.8 kHz (c_4),

— for k_3-measurement of 0.533 kHz (c_5).

With the 0.18-kHz filter only the lower d_3-product (2 × 0.8 kHz —1.42 kHz = 0.18 kHz) is measured. The measurement of the upper d_3-product at 2.04 kHz (= 2 × 1.42 kHz — 0.8 kHz) is not made. To compensate for this, two times the lower d_3-product at 0.18 kHz is taken.

The bandpass filters should meet the following selectivity requirements:

— passband defined by insertion loss values less than 1 dB:

0.18 kHz filter: ± | 3 Hz

1.6 kHz filter: ± | 4 Hz referred to centre frequency;

— rejection frequency range defined by insertion loss values greater than 70 dB:

0.18 kHz filter: < | .09 kHz and > | .36 kHz,

1.6 kHz filter: < | .8 kHz and > | .2 kHz.

3.2.5 *Measurement of the phase difference between channels A and B*

The phase difference between channels A and B is measured as a function of the frequency. For this purpose, a phase discriminator is required which is independent of the level difference between the two channels. Because of the chosen linear scale of 5°/cm and the recommended recording width, the measurement range is limited to 0-50°. Larger phase differences can be estimated from the stereophonic criterion *f* of subroutine 4.

3.2.6 *Measurement of crosstalk between channels A and B*

The crosstalk ratio between channels A and B at the measuring frequencies of 180, 1600 and 9000 Hz is measured selectively. The filters for the first two frequencies may be the same as those used for the nonlinearity measurements in subroutines 2 and 5.

One additional filter is required for 9 kHz.

This bandpass filter should meet the following selectivity requirements:

— passband defined by insertion loss values of < | dB: ± | .8 kHz referred to the centre frequency;

— rejection frequency range defined by insertion loss values of > | 4 dB: < | .5 kHz and > | 8 kHz referred to the centre frequency.

The measurable signal-to-crosstalk ratio is confined to the critical range between 30 and 50 dB.

3.2.7 *Additional markers provided at digital receivers*

Additional markers can be generated in the digital receiver as required, by making use of the octave markers received from the sending unit as a timing base.

3.2.8 *Programming of digital receivers*

Where a digit receiver is used, it shall be possible to programme it so as to check that the circuits tested meet the required tolerances.

3.2.9 *Recording device*

The transient response time of the recording device should not exceed 200 ms. In connection with the rectifier circuitry of the receiving unit for noise measurements the requirements of CCIR Recommenda tion 468 [1] should be fulfilled.

Paper width and speed may be chosen according to national standards. The following values have proved to be practicable:

— Paper width 100 mm.

This value yields (on the 20-dB level range) a level scale of 2 dB/10 mm.

— Paper speed 2 mm/s and 2/3 mm/s.

These paper speeds should be manually adjustable.

In addition to the recording device it would be desirable to provide appropriate access points for the use of an oscilloscope.

3.3 *Sequence of operations in the programme*

The sequence of operations of the stereophonic measuring programme including all subroutines is shown in Annex A. The first and second time pulse of each subroutine are provided for the start signal and a pause, respectively.

3.4 *Long-term measurements of noise*

3.4.1 *Automatic measurements*

After completion of the monophonic or stereophonic main routines, automatic long-term measurements of noise are performed on channel A and channel B respectively, without initiation or control by the sending unit. The sequence should be as follows:

time intervals	*receiver programme*	*channel*
10	pause	
60	weighted noise	|
20	unweighted noise	|
2	pause	
60	weighted noise	| B
20	unweighted noise	| B

3.4.2 *Manual measurements*

In order to make measurements of weighted or unweighted noise continuously for unspecified periods of time it must be possible to make the timing mechanism inoperative. Where an analogue receiver is used, a manually controlled switch should be provided, so that the centre-of-range can be changed by 10 dB in either direction.

3.5 *Matching characteristics*

According to the lining-up procedure for sound-programme circuits using the constant voltage method the following impedances are to be provided:

— output impedance of the sending unit < | 0 ohms,

— input impedance of the receiving unit > | 0 kohms.

Both values may be changed by internal switching to 600 ohms if, for the lining-up of the sound-programme circuit, the impedance matching method is applied. It should be possible to adjust the sending and receiving units by means of a switch to the following relative levels:

+6 dBr = nominal value at the repeater stations of Administrations;

0 dBr = nominal value at the studios of broadcasting organizations.

3.6 *Accuracy of sending and receiving units*

3.6.1 *Sending unit*

a) *Individual frequency oscillators* — level tolerance ± | .2 dB
— frequency tolerance < | .0%
— harmonic distortion at 2*f* .PS 10 and 3*f* .PS 10 < | .1%

b) *Sweep frequency oscillator* .PS 10 — level tolerance at 0.8 kHz ± | .2 dB
— level frequency response referred to 0.8 kHz ± | .2 dB

3.6.2 *Receiving unit*

Tolerances, including recording device:
— mid-scale value —12 dBm0 and 0 dBm0 ± | .3 dB
— mid-scale value —51 dBm0 and —31 dBm0 ± | .0 dB

Operational stability should be reached within 15 minutes of switching on. As far as the details of the division of the tolerances are concerned, reference is made to the values given in Supplement No. 3.1 at the end of this fascicle.

The tolerances may then be reduced by calibrating the sending and receiving units when interconnected on a loop basis.

For certain purposes a level of —3 dBr or lower may be used.

ANNEX A

(to Recommendation O.32)

H.T. [1T4.32]

TABLE A-1/O.32

Sequence of operations of stereophonic main routine measuring programme

MONTAGE: TABLEAU A RECUPERER DU LIVRE ROUGE, SANS CORRECTIONS.

blanc

H.T. [2T4.32]

TABLE A-1/O.32 *(end)*

MONTAGE: TABLEAU A RECUPERER DU LIVRE ROUGE, SANS CORRECTIONS.

blanc

H.T. [T1.33]

Measurement sequence for monophonic sound-programme circuits

Time interval (seconds)	Sending unit		Programme number: 00
	Frequency (Hz)	Level (dBm0)	Measuring function
1 Start/source/programme identification }	1650/1850	—12	{
1	1 | 20	0	Received level
1 1 1	1 | 20 | 40 | 80	—12 —12 —12	Frequency response
1	| 00	—12	
1	| 00	—12	
1	| 20	—12	
1	1 | 00	—12	
1	3 | 00	—12	
1	5 | 00	—12	
1	6 | 00	—12	
1	9 | 00	—12	
1	11 | 00	—12	
1	13 | 00	—12	
1 1 — | 60	15 | 00 1 | 20 — +9	—12 +9 Total harmonic distortion	1 | ua) 1
1 | 20 | 20	| 20 —6 +6	+6 Compandor test	1 1
8	—	—	Signal-to-noise ratio

a) Waiting interval.

Table A-1/O.32 [1T4.32], p.

H.T. [2T4.32]

TABLE A-1/O.32 *(end)*

MONTAGE: TABLEAU A RECUPERER DU LIVRE ROUGE, SANS CORRECTIONS.

blanc

H.T. [T1.33]

Measurement sequence for monophonic sound-programme circuits

Time interval (seconds)	Sending unit		Programme number: 00
	Frequency (Hz)	Level (dBm0)	Measuring function
1 Start/source/programme identification }	1650/1850	—12	{
1	1 | 20	0	Received level
1 1 1	1 | 20 | 40 | 80	—12 —12 —12	Frequency response
1	| 00	—12	
1	| 00	—12	
1	| 20	—12	
1	1 | 00	—12	
1	3 | 00	—12	
1	5 | 00	—12	
1	6 | 00	—12	
1	9 | 00	—12	
1	11 | 00	—12	
1	13 | 00	—12	
1 1 — | 60	15 | 00 1 | 20 — +9	—12 +9 Total harmonic distortion	1 | ua) 1
1 | 20 | 20	| 20 —6 +6	+6 Compandor test	1 1
8	—	—	Signal-to-noise ratio

a) Waiting interval.

Table A-1/O.32 [2T4.32], p.

References

[1] CCIR Recommendation *Measurement of audio-frequency noise in sound broadcasting* , Vol. X, Rec. 468, ITU, Geneva, 1986.

[2] CCITT Recommendation *Limits and procedures for the lining-up of a sound-programme circuit* , Vol. IV, Rec. N.21.

[3] CCITT Recommendation *Measurements to be made by the broadcasting organizations during the preparatory period* , Vol. IV, Rec. N.13, Note.

Recommendation O.33

AUTOMATIC EQUIPMENT FOR RAPIDLY MEASURING STEREOPHONIC PAIRS

AND MONOPHONIC SOUND-PROGRAMME CIRCUITS, LINKS AND CONNECTIONS

(Malaga-Torremolinos, 1984; amended at Melbourne, 1988)

1 General

An automatic measuring equipment for sound-programme circuits must be capable of rapidly measuring all relevant parameters necessary for checking the quality of such circuits. The parameters to be measured and the facilities that must be offered by the equipment are outlined in this specification but neither the measurement method nor the processing of the results are specified in detail. Manufacturers are thus free to adopt any appropriate design that will fulfil the requirements of this specification. However, it is evident that it would be advantageous to control the measurement sequence by stored programs. The use of different measuring sequences, each suited to the requirements of individual users and individual applications should be possible.

It should be noted that the equipment will meet the requirements of Recommendations N.12 [1] and N.13 [2]. However, measurement of every parameter specified in Recommendations N.10 [3], N.21 [4] and N.23 [5] is not possible, e.g., group delay/frequency response.

2 Basic design

The equipment shall consist of either two units, send and receive, or a combined sending and receiving unit of modular construction permitting a send-only or receive-only facility.

The measurement results should be made available by a direct display via a storage mechanism to permit a long-term display of any measured parameter.

The results of the measurements are not only to permit an immediate decision by the staff in the field, but also to provide the basis for later exact evaluation by the responsible transmission engineer. It is preferred that the results be available also as a 110- and 300-baud ISO-7 bit serial data output [6] at a standard RS 232-C [7] interface, selectable between 110 and 300 bauds, or optionally, at a standard IEEE 488/IEC 625 [8] interface.

In each case, the parameters measured must be clearly identified and the source code given (see § 2.1).

The equipment must be capable of measuring at least the following parameters:

a) received level (insertion gain);

b) frequency/attenuation distortion (frequency response);

c) harmonic distortion (nonlinear distortion);

d) signal-to-noise ratio unweighted, and weighted in accordance with CCIR Recommendation 468 [9];

e) compandor linearity;

f) programme modulated noise and expanded noise.

These parameters are further defined in § 4.

In addition, the equipment must be capable of measuring in channels A and B at least the following parameters:

g) interchannel difference in gain and phase;

h) interchannel crosstalk and circuit transposition.

The stereo parameters are further defined in § 5.

The physical design should preferably be such that this capability is provided by user conversion of the monophonic equipment by the addition of appropriate plug-in units and, possibly, minor internal wiring changes.

The equipment will be required to send audio test signals at amplitudes consistent with that required at the user's test point. Since the nominal working levels vary from broadcasting organization to broadcasting organization, and from PTT Administration to Administration, it is not desirable to specify absolute levels. ''TEST'' level has therefore been defined as the level 9 dB below the maximum permitted level at the point at which the measurement is made. TEST level corresponds to an absolute value of 0 dBm0 when measured at a point of zero relative level (0 dBr) [10]. Manufacturers of automatic measurement equipment should therefore choose to make TEST level equal to a convenient level (e.g. 0 dBm0).

At this fixed level, the send frequency amplitudes in the programme measurement sequences will conform to the definitions for permitted maximum level (+9 dBm0s), alignment level (0 dBm0s) and measuring level (—12 dBm0s) given in Recommendation N.15 [11].

Switching should be provided so that TEST level may be set to +6 dB, 0 dB, or —3 dB with respect to 0.775 V r.m.s. This switch must be protected, particularly for absolute values greater than 0 dBm0, against unintentional operation, e.g. by mounting it inside the instrument. Consideration should also be given to providing —20 dB with respect to 0.775 V r.m.s.

2.1 *Start/source/program identification*

The measurement sequence will be chosen to suit the requirements of individual applications. Defined measurement programs are annexed to this Recommendation. The sequence of operations of the measurement program together with the associated time units are shown.

The sequence of audio test signals is to be preceded by a start/source/program identification signal which will:

— instruct the receiving unit to start the measurement sequence;

— identify the source of the test signals;

— indicate which of the stored measurement programs is to be used.

The start/source/program identification signal using the ISO-7 [6] code with one even parity bit and two stop bits, is to be sent by frequency-shift keying with a mark frequency of 1650 Hz and a space frequency of 1850 Hz, at a transmission rate of 110 bauds.

The message structure of the identification signal is formed by the following order of characters:

— Start of heading (character ''SOH'');

— Source identification (four alphanumeric characters);

— Special signalling (one character);

— Start of text (character ''STX'');

— Measurement program identification (two numeric characters 00-99);

— End of text (character ''ETX'').

The mark frequency shall be transmitted for at least 18 ms (two bits) before the start bit of the SOH character.

The end of the second stop bit of the ETX character defines the start of the measurement sequence.

The start/source/program identification signal shall be set at 12 dB below TEST level.

2.2 *Modes of operation*

It shall be possible to operate the equipment in automatic or manual modes.

2.2.1 *Automatic mode*

In the automatic mode, the sending unit shall cycle once through a complete programmed test sequence on receipt of a start signal given either by a push-button on the sending unit or by the momentary closing of a remote pair of contacts. The receiver shall, on receipt of the identification signal from the sending unit, cycle once through the complete programmed measurement sequence, storing and/or printing the results for subsequent examination.

2.2.2 *Manual mode*

2.2.2.1 *Sending unit*

In the manual mode, it shall be possible to cycle the sending unit through the measuring sequence to any chosen test element, upon which the appropriate test signal will be sent continuously. This mode should thus permit the sending unit to operate with manual measuring equipment. It shall also be possible to manually adjust the output signal to any frequency within the range 40 to 15 | 00 Hz to a resolution of better than 5 Hz. The output shall be adjustable within the range —12 dB to +15 dB with respect to 0.775 V r.m.s. with a resolution of 0.2 dB. The instrument shall indicate the output frequency and level. A flashing warning light shall operate when the output level exceeds 0.775 V r.m.s.

2.2.2.2 *Receiving unit*

In the manual mode, it shall be possible to cycle the receiving unit through the measuring sequence to any chosen parameter measurement to permit the instrument to be used with manual sending equipment. It would be advantageous to display the frequency of the incoming signal.

2.2.3 *Remote control*

Both the sending and receiving units should optionally offer the possibility of remote control. This could be either the RS 232-C [7] or IEEE 488/IEC 625 [8] interface.

3 Design and construction

It should be noted that the group delay encountered on long circuits may lead to measurement error, particularly at low frequencies. The design of measurement circuits should therefore be such that measurements are made only after sufficient time has been allowed for the received waveform to stabilize.

In general, the design and construction of the equipment shall conform to national and international provisions, especially in relation to safety requirements and protection against electric shock [12].

4 Parameters

4.1 *Received level (insertion gain)*

1020 Hz is sent at TEST level; the received level shall be measured and the result expressed in dB with reference to TEST level.

4.2 *Frequency/attenuation distortion (frequency response)*

The received level shall be measured at a number of discrete frequencies. These frequencies are defined in the individual measurement program. The sending level shall be 12 dB below TEST level.

The results shall be displayed in dB relative to the received level at 1020 Hz sent at 12 dB below TEST level. It is not considered acceptable to use the level received from the parameter in § 4.1.

4.3 *Distortion*

Total harmonic distortion shall be measured at 60 Hz and 1020 Hz. Second harmonic distortion, k_2, shall be measured at 1020 Hz. Third harmonic distortion, k_3, shall be measured at 60 Hz.

The sending level shall be 9 dB above TEST level. The receiving instrument shall given an r.m.s. indication of the harmonic content and the results shall be expressed in dB with respect to the received levels of the fundamentals.

In order to avoid overload of carrier-frequency transmission systems, the sending of test frequencies at the maximum permitted level should be strictly in accordance with the prescriptions of Recommendation N.21 [4]. Programs which include distortion measurements should therefore limit the duration of transmission to a single time interval (1 s) and a pause of at least one interval must be allowed when successive distortion measurements are to be made.

It shall be possible to insert the test cycle, the measurement of nonlinearity distortion by either duplication of the stored programmes with and without this measurement or by the use of a non-locking switch.

Note — The frequency of 1020 Hz has been chosen to avoid using a sub-multiple of a digital sampling rate.

4.4 *Signal-to-noise ratio*

The sending unit shall suitably terminate the input to the circuit under test and the receiving unit shall measure the highest quasi-peak value, either weighted or unweighted, over a period of eight seconds, consistent with CCIR Recommendation 468 [9]. The results shall be given in dB with respect to the received TEST level at 1020 Hz or at maximum permitted level (+ 9 dBm0). Selection of the weighted or unweighted characteristic and the level reference shall be made by a manually operated switch on the receiving unit. The switch shall be protected against unintentional operation and its position shall be indicated in the results. The normal position will correspond to the weighted characteristic.

4.5 *Compandor linearity*

820 Hz tone is sent during three consecutive time intervals, at +6 dB, —6 dB and +6 dB with respect to TEST level.

The receiving unit shall indicate the levels as received.

4.6 *Expanded noise*

The time interval used for the measurement of distortion at 60 Hz may also be used for the measurement of expanded noise. A high-pass filter (f_0 400 Hz, and ≥" 60 dB/60 Hz) is used to eliminate second and third order harmonics. The remaining noise will be measured, either weighted or unweighted, with a quasi-peak response.

5 Stereo parameters

5.1 *Interchannel difference in gain and phase*

When the stereo modules are used, the equipment shall measure simultaneously the difference in phase and level between the signals present at its two inputs A and B. Measurements shall be made at all frequencies specified for the measurement of frequency/attenuation distortion. The instrument shall preferably indicate the polarity of the error.

The results shall be expressed in dB and degrees, taking the A channel as reference.

Equipment not employing simultaneous measurement techniques may be acceptable if it can be established that they provide results equivalent to those obtained with simultaneous measurement. The caution given in Recommendation N.21, § 3.8 [4], on avoiding certain frequencies should be observed.

5.2 *Interchannel crosstalk and circuit transposition*

The transmitter shall send a tone at 2040 Hz at a level of 12 dB below TEST level first from output A and then from output B, the unused circuit being correctly terminated. The receiver shall measure the level of the unwanted signal in the terminated circuit.

The results shall be expressed in dB relative to the level in the used circuit.

The crosstalk test signal shall be used to test for circuit transposition and an indication shall be given if the channels are interchanged.

6 Equipment characteristics — sending unit

Value does not take account of any transformer needed to comply with the requirements of Recommendation N.11 [13] in regard to impedance and balance with respect to earth.

Output impedance : < 10 ohms

Level error: < 0.2 dB

Frequency error: < 1%

Total harmonic distortion at maximum output level,

(+21 dB): except 60 Hz and 1020 Hz < 0.5%

at 60 Hz and 1020 Hz < 0.1%

Weighted noise level output: —80 dBq0ps

Level difference between outputs A and B: < 0.2 dB

Phase difference between outputs A and B: < 2°

7 Equipment characteristics — receiving unit

7.1 *Input impedance* | *:* > 20 kohms

7.2 *Minimum accuracy and range*

7.2.1 *Level measurements*

Range:

Signal: +20 dB to —45 dB

Noise: —20 dB to —70 dB

with respect to 0.775 V r.m.s.

Error:

± | .2 dB over the range +15 to —20 dB

± | .5 dB over the range —20 to —50 dB

± | .0 dB over the range —50 to —60 dB

± | .0 dB over the range —60 to —70 dB

Note — Noise measurements are band limited to comply with the frequency response given in Annex 1, CCIR Recommendation 468 [9].

Frequency range: | 0 Hz-50 kHz

7.2.2 *Distortion measurement*

Range: down to 0.3% (—50 dB)

Error: (± | dB)

7.2.3 *Phase measurement*

Range: ± | 80°

Error: +2° over whole range

8 Operating equipment

The electrical performance requirements shall be met when operating at the climatic conditions as specified in Recommendation O.3, § 2.1.

ANNEX A
(to Recommendation O.33)

H.T. [T1.33]
Measurement sequence for monophonic sound-programme circuits

Time interval (seconds)	Sending unit Frequency (Hz)	 Level (dBm0)	Programme number: 00 Measuring function
1 Start/source/programme identification }	1650/1850	—12	{
1	1 | 20	0	Received level
1 1 1	1 | 20 | 40 | 80	—12 —12 —12	Frequency response
1	| 00	—12	
1	| 00	—12	
1	| 20	—12	
1	1 | 00	—12	
1	3 | 00	—12	
1	5 | 00	—12	
1	6 | 00	—12	
1	9 | 00	—12	
1	11 | 00	—12	
1	13 | 00	—12	
1 1 — | 60	15 | 00 1 | 20 — +9	—12 +9 Total harmonic distortion	 1 | ua) 1
1 | 20 | 20	| 20 —6 +6	+6 Compandor test	1 1
8	—	—	Signal-to-noise ratio

a) Waiting interval.

Table A/O.33 [T1.33], p.

ANNEX B
(to Recommendation O.33)

–v'1P'

H.T. [T2.33]
Measurement sequence for stereophonic pairs of sound-programme circuits

Time interval	Channel A Sending unit	Channel B Sending unit	Programme number: 01		
Seconds	Frequency (Hz)	Level (dBm0)	Frequency (Hz)	Level (dBm0)	Measuring f
1 Start/source/programme identification }	1650/1850	—12	—	—	{
1	1 | 20	0	1 | 20	0	Received level
1 Frequency response interchannel Gain and phase } 1 1	1 | 20 | 40 | 80	—12 —12 —12	1 | 20 | 40 | 80	—12 —12 —12	 {
1	| 00	—12	| 00	—12	
1	| 00	—12	| 00	—12	
1	| 20	—12	| 20	—12	
1	1 | 00	—12	1 | 00	—12	
1	3 | 00	—12	3 | 00	—12	
1	5 | 00	—12	5 | 00	—12	
1	6 | 00	—12	6 | 00	—12	
1	9 | 00	—12	9 | 00	—12	
1	11 | 00	—12	11 | 00	—12	
1	13 | 00	—12	13 | 00	—12	
1 1 1 | ua) 1	15 | 00 1 | 20 — | 60	—12 +9 — +9	15 | 00 1 | 20 — | 60	—12 +9 — +9	 Total harmonic
1 Crosstalk and circuit transposition } 1	2 | 40 —	—12 —	— 2 | 40	— —12	 {
1 1 1	| 20 | 20 | 20	+6 —6 +6	| 20 | 20 | 20	+6 —6 +6	 Compandor tes
8	—	—	—	—	Signal-to-noise

a) Waiting interval.

Table B/O.33 [T2.33], p.

ANNEX C
(to Recommendation O.33)

H.T. [T3.33]
Measurement sequence for medium band sound-programme circuits

Time interval (Secs.)	Sending unit Frequency (Hz)	Level (dBm0)	Programme number: 02 Measuring function
1 Start/source/programme identification }	1650/1850	—12	{
1	1 | 20	0	Received level
1 1 1	1 | 20 | 40 | 80	—12 —12 —12	Frequency response
1	| 00	—12	
1	| 00	—12	
1	| 00	—12	
1	| 20	—12	
1	1 | 00	—12	
1	3 | 00	—12	
1	5 | 00	—12	
1	6 | 00	—12	
1	7 | 00	—12	
1	8 | 20	—12	
1 1 — | 60	10 | 00 1 | 20 — +9	—12 +9 Total harmonic distortion	 1 1
1 | 20 | 20	| 20 —6 +6	+6 Compandor test	1 1
8	—	—	Signal-to-noise ratio

Table C/O.33 [T3.33], p.

ANNEX D
(to Recommendation O.33)

H.T. [T4.33]
Measurement sequence for narrow-band (telephone type) circuits

Time interval (Secs.)	Sending unit Frequency (Hz)	Level (dBm0)	Programme number: 03 Measuring function
1 Start/source/programme identification }	1650/1850	—12	{
1	1 | 20	0	Received level
1 1 1	1 | 20 | 00 | 00	—10 —10 —10	Frequency response
1	| 00	—10	
1	| 00	—10	
1	| 20	—10	
1	1 | 00	—10	
1	1 | 00	—10	
1	2 | 00	—10	
1	2 | 00	—10	
1	2 | 00	—10	
1	3 | 00	—10	
1	3 | 00	—10	
1 1	3 | 00 1 | 20	—10 +9	Total harmonic distortion
8	—	—	Signal-to-noise ratio

Table D/O.33 [T4.33], p.

ANNEX E
(to Recommendation O.33)

H.T. [T5.33]
Measurement sequence for narrow-band (telephone-type) circuits

used for sound-programme transmissions which are fitted with compandors

Time interval (Secs.)	Sending unit Frequency (Hz)	Level (dBm0)	Programme number: 04 Measuring function
1 Start/source/programme identification }	1650/1850	—12	{
1	1 | 20	0	Received level
1 1 1	1 | 20 | 00 | 00	—10 —10 —10	Frequency response
1	| 00	—10	
1	| 00	—10	
1	| 20	—10	
1	1 | 00	—10	
1	1 | 00	—10	
1	2 | 00	—10	
1	2 | 00	—10	
1	2 | 00	—10	
1	3 | 00	—10	
1	3 | 00	—10	
1 1	3 | 00 1 | 20	—10 +9	Total harmonic distortion
1 | 20 | 20	| 20 —6 +6	+6 Compandor test	1 1
8	—	—	Signal-to-noise ratio

Table E/O.33 [T5.33], p.

ANNEX F
(to Recommendation O.33)

H.T. [T6.33]
Measurement sequence for the CMTT three-level test signals

(without station announcement)

for the alignment of international sound-programme connections

Time interval	Channel A sending unit	Channel B sending unit	Programme number: 05		
Seconds	Frequency (Hz)	Level (dBm0)	Frequency (Hz)	Level (dBm0)	Measuring Fu
1 Start/Source/Programme identification }	1650/1850	—12	—	—	{
1	—	—	—	—	Pause
1 1	1 | 20 1 | 20	—12 —12	1 | 20 1 | 20	—12 —12	Measurement le
1 1 1	1 | 20 1 | 20 1 | 20	0 0 0	1 | 20 1 | 20 1 | 20	0 0 0	Alignment leve
1	1 | 20	0	1 | 20	0	
1	1 | 20	0	1 | 20	0	
1	1 | 20	0	1 | 20	0	
1	1 | 20	0	1 | 20	0	
1 1 Permitted maximum | ua) level (PML) } 1	1 | 20 1 | 20 1 | 20	0 0 | ua) 0 | ua)	1 | 20 — —	0 — —	{
1 1 1	— — —	— — —	— — —	— — —	Pause
1 Permitted maximum | ua) level (PML) }	—	—	1 | 20	0 | ua)	{

a) Provisionally 0 dBm0 level is to be used. The resulting two-level test signal is required until all transmission systems are capable of carrying sinusoidal signals at +9 dBm0s without producing excessive channel loading or crosstalk into other channels. The active incorporation of the +9 dBm0 level into this sequence will need to be confirmed by CMTT and CCITT.

1 — — 1 | 20 0 | ua)

Table F/O.33 [T6.33], p.

References

[1] CCITT Recommendation *Measurements to be made during the line-up period that precedes a sound-programme transmission* , Vol. IV, Rec. N.12.

[2] CCITT Recommendation *Measurements to be made by the broadcasting organizations during the preparatory period* , Vol. IV, Rec. N.13.

[3] CCITT Recommendation *Limits for the lining-up of international sound-programme links and connections* , Vol. IV, Rec. N.10.

[4] CCITT Recommendation *Limits and procedures for the lining-up of a sound-programme circuit* , Vol. IV, Rec. N.21.

[5] CCITT Recommendation *Maintenance measurements to be made on international sound-programme circuits* , Vol. IV, Rec. N.23.

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