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SECTION 3

AUTOMATIC AND SEMI-AUTOMATIC

MEASURING SYSTEMS

Recommendation O.22

CCITT AUTOMATIC TRANSMISSION MEASURING

AND SIGNALLING TESTING EQUIPMENT ATME No. 2

(Geneva, 1972; amended Geneva, 1980, Malaga-Torremolinos, 1984 and

Melbourne, 1988)

1 General

The CCITT automatic transmission measuring and signalling testing equipment (ATME No. 2) is intended to make transmission measurements, echo canceller tests and signalling system functional tests on all categories of international circuits terminating in exchanges with 4-wire switching.

The ATME No. 2 will consist of two parts, namely:

1) directing equipment at the outgoing end, and

2) responding equipment at the incoming end.

The responding equipment will be available in the following forms:

a) a signalling system functional testing *and* transmission measuring device (Type a),

b) a signalling system functional testing device (Type b)

It is not possible for the signalling system functional testing devices as found in Types a and b to check the busy flash signal. For this purpose a separate test call must be established using an appropriate test code. Arrangements will therefore be provided to force the transmission of the busy flash signal over the circuit under test by the incoming international exchange equipment. This may be carried out by examination of the test code in the exchange equipment or by the provision of a separate responding equipment. The busy flash signal should be transmitted as the result of a simulation of exchange or circuit congestion. For the purposes of this specification, the equipment providing this busy test arrangement shall be referred to as responding equipment Type c.

The text of this Recommendation has been established under the responsibility of Study Groups IV and XI. Any modification to this text must be submitted for approval to these Study Groups.

The concept of *functional texts* excludes marginal testing.

The CCITT directs the attention of Administrations to the advantages of providing sufficient signalling system functional testing devices (Type b) to permit several signalling system functional tests to be conducted simultaneously and to permit signalling system functional tests to be conducted more frequently than transmission tests. (For the application of ATME No. 2, see Recommendation M.605 [1].)

Responding equipment Type a is always required. Type b is optional; when used in addition to Type a, it is expected to provide an economical means for making more frequent signalling tests without occupying the transmission measuring equipment. Type c responding equipment is required in cases when the signalling system used on the circuits to be tested provides a busy flash line signal.

For both-way circuits, directing and responding equipments are required at both ends for making signalling system functional tests. For transmission measurements over both-way circuits, the outgoing end is normally that which is the responsibility of the control station, and the incoming end is that which is the responsibility of the sub-control station. However, these may be interchanged by mutual agreement.

The equipment shall be of modular construction in order that only those features desired by the using Administrations need to be included. The present specification already takes account of operating over circuits using CCITT Signalling Systems Nos. 3, 4, 5, 6, 7, R1 and R2.

Results of measurements shall be recorded only at the outgoing end, that is by the directing equipment. However, arrangements can be made by the Administrations or operating agencies involved to send the results of the measurements to the Administrations in charge of the incoming end and other points as desired, by mutually acceptable means. ATME No. 2 can be used on circuits incorporating circuit multiplication systems (CMSs) if the CMS concerned is so designed that a 2800 Hz can be used to hold the circuits during absence of the normally transmitted signals. TASI is an example of a CMS which accepts 2800 Hz as the holding tone

2 Kinds of measurements and tests

Transmission measurements of the following kinds will be made in both directions of transmission with Type a responders:

a) absolute power level measurement at 1020 Hz ;

b) absolute power level measurement at 400, 1020 and 2800 Hz (loss/frequency distortion);

c) noise measurements;

d) signal-to-total-distortion (including quantizing distortion) ratio measurements at values of holding tone (i.e. —10 and —25 dBm0);

e) an in-circuit echo canceller testing system (ECTS) sequence, intended to test both near-end and far-end cancellers on a circuit under test. The ECTS is suitable for testing echo cancellers complying with Recommendation G.165 [2];

f) on wholly digital circuits between digital exchanges, measurements by the director of a director generated digital test pattern looped back by a Type a responder.

In addition to tests of the normal signalling functions required in the process of setting up the test call, line signals such as the following will also be tested:

— clear back,

— forward transfer,

— busy flash (this requires a separate test call to a separate test line, see Rec. O.11).

In addition to the transmission measurements made between directors and responders it shall also be possible to make measurements from a director to a digital loopback test line as described in Recommendation O.11

The equipment will be designed in such a way that further measurements and tests can be incorporated at a later date.

3 Equipment for making transmission measurements and processing the results

For further information about the choice of the test signal frequency refer to Recommendation O.6

The directing and responding equipments shall each be provided with features for making absolute power level, digital test pattern tests, echo canceller tests, signal-to-total-distortion ratio and noise measurements, as described below. In addition, the directing equipment shall have the capability, where required, of receiving the results of the measurements made by both the directing and responding equipments, making the necessary adjustments to these results, as discussed below, and converting the results to the proper form for transmission to the output device. The output device is also considered to be part of the directing equipment.

3.1 *Absolute power level measurements*

3.1.1 *Sending end*

At the access point at the input to the path to be measured there will be connected a *sending equipment* which will send a tone of the appropriate frequency and level as specified in §§ 6.3 and 9.1.

3.1.2 *Measuring end*

At the access point at the output from the path to be measured there will be connected a measuring device whose specifications are given in §§ 6.3 and 9.1.

The measuring device shall provide results in the form of a deviation, expressed in dB, from the nominal absolute power level of the circuit at the virtual switching point at the receiving end. This assumes that for the responding equipment (see § 3.6), the relative level at the receiving end virtual switching point is —4 dBr. A level higher than nominal shall be indicated as positive ‘‘ | | *U and a level lower than nominal shall be indicated as negative ‘‘ | (em | *U. For the total distortion measurements, the results should give the signal-to-total-distortion ratio in decibel. The transmission parameters of the switched access path between the virtual switching point and the measuring device shall be allowed for (see Recommendation M.560 [3]).

If the equipment is capable of detecting an interruption or a condition of instability experienced during a measurement (see § 10.5) the result shall be indicated as shown in Table 3/O.22.

3.2 *Noise measurements*

Note — When ATME No. 2 is implemented using digital signal processing techniques, noise measurement is inherently limited to 4 kHz when using an 8 kHz sampling frequency.

3.2.1 *Sending end*

At the access point at the input to the path to be measured there will be connected a 600-ohms terminating resistance or a CMS locking tone in accordance with §§ 6.4.19 or 6.4.20 and 9.3.

3.2.2 *Measuring end*

At the access point at the output from the path to be measured, there will be connected a noise measuring device whose specifications are given in § 9.2 below.

The noise measuring device shall provide results in terms of absolute power level with psophometric weighting referred to 0 level (dBm0p), assuming for the responding equipment that the relative level at the receiving end virtual switching point is —4.0 dBr (see § 3.6). The transmission parameters of the switched access path between the virtual switching point and the noise measuring device shall be allowed for (see Recommendation M.560 [3]).

3.3 *Signal-to-total-distortion ratio measurements*

3.3.1 *Sending end*

At the access point at the input to the path to be measured, there will be connected a sending equipment which will send tones at two different levels (—10 and —25 dBm0) as specified in § 9.1.

3.3.2 *Measuring end*

The signal-to-total-distortion ratio measurements will be carried out in two steps.

Step 1

At the access point at the output from the path to be measured, there will be connected a noise measuring device connected with a 1000 to 1025 Hz signal rejection filter. The noise measuring device and the signal rejection filter are specified in § 9.2.

Step 2

At the access point at the output from the path to be measured there will be connected a measuring device whose specifications are given in §§ 6.3 and 9.1.

The measuring device shall provide results in the form of the signal-to-total-distortion ratio in decibel. A bandwidth correction for the loss of effective noise bandwidth due to the rejection filter must be incorporated.

3.4 *Echo canceller testing system (ECTS)*

As part of the ECTS, the directing and responding equipments shall each be provided with features for making absolute power level, echo performance ratio and noise measurements, as described below. In addition, the directing equipment shall have the capability of receiving the results of the measurements made by both the directing and responding equipments, making the necessary adjustments to these results, as discussed below, and converting the results to the proper form.

3.4.1 *Absolute power level measurements*

3.4.1.1 *Sending end*

At the access point at the input to the path to be measured, there will be connected a *sending equipment* which will send a tone of the appropriate frequency and level as specified in §§ 5.2 and 9.4.

3.4.1.2 *Measuring end*

At the access point at the output from the path to be measured there will be connected a measuring device whose specifications are given in §§ 6.7 and 9.1.

The measuring device shall provide results in the form of a deviation, expressed in decibel, from the nominal absolute power level of the circuit at the virtual switching point at the receiving end. This assumes that for the responding equipment (see § 3.6), the relative level at the receiving end virtual switching point is —4.0 dBr. A level higher than nominal shall be indicated as positive ''+'' and a level lower than nominal shall be indicated as negative ''—''. The transmission parameters of the switched access path between the virtual switching point and the measuring device shall be allowed for (see Recommendation M.560 [3]).

If the equipment is capable of detecting an interruption or a condition of instability experienced during a measurement (see § 11.5), the result shall be indicated as described in § 3.6.

3.4.2 *Noise measurements*

(To determine echo noise floor in step 1 of echo performance test.)

3.4.2.1 *Sending end*

At the access point at the input to path to be measured, there will be connected a 600-ohms terminating resistance in accordance with §§ 6.7 and 9.4.3.

3.4.2.2 *Measuring end*

At the access point at the output from the path to be measured, there will be connected a noise measuring device whose specifications are given in § 9.5.1.

The noise measuring device shall provide results as noise ratios which are the relative power level with psophometric weighting referred to the —10 (dBm0p) sending level, assuming for the responding equipment that the relative level at the receiving end virtual switching point is —4.0 dBr (see § 3.6).

Note — This noise level is referred to —10 dBm0p rather than 0 dBm0p to make it represent the minimum measurable noise ratio in steps 2 and 3 of the echo performance tests in § 3.4.3. The transmission parameters of the switched access path between the virtual switching point and the noise measuring device shall be allowed for (see Recommendation M.560 [3]).

3.4.3 *Echo performance ratio measurements*

(Steps 2 and 3 of echo performance tests)

3.4.3.1 *Sending end*

At the access point at the input to the path to be measured, there will be connected a sending equipment which will send a —10 dBm0 noise test signal as specified in § 9.4.1e).

3.4.3.2 *Measuring end*

At the access point at the ouput form the path to be measured, there will be connected an echo performance (noise) measuring device whose specifications are given in § 9.5.1.

The measuring device shall provide results in terms of relative power level ratio with psophometric weighting referred to the —10 dBm0 noise test signal in § 3.4.3.1, assuming for the responding equipment that the relative level at the receiving end virtual switching point is —4.0 dBr (see § 3.6). The transmission parameters of the switched access path between the virtual switching point and the noise measuring device shall be allowed for (see Recommendation M.560 [3]).

3.5 *Digital loopback tests*

3.5.1 *Digital test pattern tests to a digital loopback test line*

3.5.1.1 *Sending end*

At the access point at the input to the path to be measured, there will be connected a sending equipment which will provide a pseudo-random digital test pattern as specified in Recommendation O.152, § 2.

3.5.1.2 *Measuring end*

At the access point at the output from the path to be measured, there will be connected a receiving equipment as specified in Recommendation O.152. This measuring equipment should be capable of measuring bit-error ratio, block-error ratio, and errored time intervals as defined in Recommendation G.821 [4].

3.5.2 *Transmission tests to a digital loopback test line*

3.5.2.1 *Sending end*

At the access point at the input to the path to be measured, there will be connected a sending equipment which will send tones of the appropriate frequency and level as specified in §§ 6.3, 9.1, 9.2 and 9.3.

3.5.2.2 *Measuring end*

At the access point at the output from the path to be measured there will be connected measuring equipment provided with features for making absolute power level, noise, and signal-to-total-distortion ratio measurements and as specified in §§ 3.1.2, 3.2.2 and 3.3.2 respectively.

It should be noted that measurements made through the digital loopback test line will experience twice the circuit distance and delay characteristics experienced by a far end measurement device. Therefore, measurement results must be compared to circuit maintenance limits which are modified to reflect a doubling of circuit distance and quantizing distortion units (QDUs).

3.6 *Adjustment results*

Circuits that may be used in international transit connections are operated with a nominal loss of 0.5 dB, that is, the relative level at the receiving virtual switching point is —4.0 dBr. However, circuits which are not intended to be used in international transit connections may be operated with nominal losses greater than 0.5 dB (see Recommendation G.131 [5]).

The results of measurement of absolute power level deviations and noise sent by the responding equipment to the directing end will assume a —4.0 dBr virtual switching point for all circuits. Thus, a measured value corresponding to —5.0 dBm at the virtual switching point will always be transmitted to the directing equipment as a deviation of —1.0 dB. Where a circuit is operated with a nominal loss greater than 0.5 dB, i.e. the actual relative level at the virtual switching point is more negative than —4.0 dBr, the directing equipment shall apply the appropriate correction to the results of the measurement of absolute power level deviation and noise received from the responding equipment. The signal-to-total-distortion and the echo performance measurements are not affected as the results are presented as signal-to-total-distortion ratio in dB or noise signal to echo signal ratio in dB.

3.7 *Recording and presentation of output*

The output shall be recorded by suitable means, to be decided by the Administration concerned. For absolute power level measurements at 1020 Hz the results shall be presented, with the appropriate algebraic sign, as deviations from the nominal absolute power level at the virtual switching point. The results of measurements at 400 and 2800 Hz shall be presented as

deviations from the measured absolute power level at 1020 Hz. Results of noise measurements shall be expressed in dBm referred to 0 level (dBm0p). The signal-to-total-distortion measurements are in the form of signal-to-total-distortion ratios expressed in dB. The echo performance measurements are in the form of noise signal to echo signal ratios expressed in dB.

An example is given in Table 1/O.22 for measurements made by the responding equipment.

H.T. [T1.22]

TABLE 1/O.22

Example of measurements made by the responder

Measurement	{				
Level	1020 400 2800	—13.7 —14.4 —14.6	+0.3 —0.4 —0.6	+0.3 —0.7 —0.9	+1.3 —0.7 —0.9
Value at receiving virtual switching point at responding equipment } Value transmitted from responding equipment to directing equipment (a relative level of —4.0 dBr at the virtual switching point is assumed) }	{ {				
Noise power (dBm0)	—50 | ua)	—46	—46	—45	
{ Signal-to-total-distortion ratio | ua) or noise ratio (dB) }	34 | ua)	+34	34	34	

a) With a received total distortion test signal level of —13.7 dBm and a total distortion power of —48 dBm.

Table 1/O.22 [T1.22], p.

Distinct indications will be given under the following conditions:

a) the absolute power level deviation exceeds the assigned maintenance limit;

b) the noise power value is outside the assigned maintenance limit;

c) the signal-to-total-distortion ratio is outside the assigned maintenance limit;

d) the absolute power level deviation is so great that the circuit is rendered unfit for service;

e) the noise power value is so great that the circuit is rendered unfit for service;

f) the signal-to-total-distortion ratio is so low that the circuit is rendered unfit for service;

g) the echo performance ratio is outside the assigned maintenance limits for any dely value at either end. (When this happens, the noise floor value measured in step 1 of the test must also be recorded);

h) digital error performance values greater than the assigned maintenance limit;

i) failure to complete the test call;

j) failure to meet the requirements of the signalling tests.

In cases i) and j) the point in the programme at which a given failure occurs should be indicated.

The form that the output should take has not been specified, and international agreement on this point does not appear to be necessary, except concerning the following printout conventions (see Table 3/O.22 and § 11.5):
Results of the measurements out of range at the upper end + + +

(printout interpretation of three Code 11 signals) Results of the measurements out of range at the lower end — — —

(printout interpretation of three Code 12 signals) XX represents the results of the measurement.
Interruption in measurement tone during absolute power level measurements 9XX or 7XX
Instability during absolute power level measurements 8XX or 6XX

It should be noted that when an interruption and instability are both detected during a power level measurement only the interruption will be recorded in the printout and no indication of the instability will be given (see § 11.5).

If directed by the input programme, the date and time (to the nearest minute) shall be recorded.

The possibility shall be included to provide a complete record of the results of all measurements and signalling tests and the identification of all circuits which could not be measured or tested because the circuit was occupied or because the responding equipment could not be reached. A different indication shall be given for each of the latter two categories.

In addition a shortened record should be obtainable which omits information concerning circuits which were within maintenance limits and on which no instability or interruption was indicated.

3.8 *Remeasurement and retest arrangements*

Arrangements are required to provide an input data record for circuits which were occupied on initial measurement or test and for circuits on which the responding equipment could not be reached. This input data record should be capable of expansion to include all circuits except those which are found to be within maintenance limits and on which no instability or interruption was indicated. The input data record shall be in such a form that it may be used to control the directing equipment so as to permit the reexamination of these circuits in any grouping as desired by the using Administration.

4 Method of access

4.1 In general, access arrangements will conform to Recommendation M.560 [3].

4.2 *Outgoing international exchange*

Access to the circuit for test at the outgoing international exchange shall conform to Recommendation M.565 [6].

4.3 *Incoming international exchange*

Access to the responding equipment at the incoming international exchange will be gained via a maintenance access line associated with the normal switching equipment. The address information to be used to gain access to either Type a or Type b responding equipment or to a digital loopback test line at the incoming exchange is specified in § 2.4 of Recommendation O.11.

5 Operating principles

It shall be possible to perform any one, two or more of the measurements and tests mentioned in § 2 on the same circuit under the control of the directing equipment without releasing the connection except when the busy flash test is performed, or when tests to a digital loopback test line are performed.

5.1 When the directing equipment has indicated to the responding equipment the kind of measurement to be made, the measurement is first made at the directing equipment with the responding equipment sending a measurement tone or providing a 600-ohm termination. The directing equipment then sends the measurement tone or provides a 600-ohm termination while the responding equipment makes the measurement.

5.2 Directing equipment which has access to circuits equipped with echo suppressors and/or echo cancellers must be provided with arrangements to transmit the echo suppressor/canceller disabling tone specified in § 9.3. Arrangements must be included in the directing equipment to provide for the transmission of this tone only on circuits equipped with echo suppressors and/or echo cancellers. These features may be omitted in equipments which do not have access to such circuits, but provision must be made to add them when required.

5.3 Directing and responding equipment which has access to circuits on routes incorporating a CMS system, or to circuits equipped with echo suppressors and/or echo cancellers, must be provided with means for transmitting the CMS locking tone as specified in § 9.3. Means are required in the directing equipment to transmit this tone only on such routes or circuits. If these features are not provided initially, arrangements must be made so that they can be added when required.

5.4 Initially Echo canceller testing system (ECTS) signals will be sent by the directing equipment to disable or lock-up any echo suppressor or circuit multiplication equipment that is present on the circuit under test.

Next, loss tests will be made in both directions of transmission to ensure that the circuit loss is within nominal values.

Then a series of echo performance (noise ratio) measurements will be made toward an echo canceller at the distant end of a circuit corresponding to each of three circuit conditions provided by its terminating equipment:

a) quiet termination of both directions of transmission,

b) 2 dB gain loop with prescribed amount of delay to test each stage (cascaded delay section) of the canceller, and

c) 10 dB loss loop with prescribed amount of delay.

The process will then be reversed so as to test both the far-end and near-end echo cancellers with one access of the circuit under test.

6 Signalling system testing and transmission measuring procedure—director to responder

6.1 *Establishment of connection and signalling test sequence*

6.1.1 When the outgoing circuit is seized, the appropriate address information is transmitted in accordance with the specification for the signalling system in use.

6.1.2 When access is gained to the responding equipment, the answer signal (answer, no charge in Signalling System No. 6 will be transmitted. If the responding equipment is occupied, a busy indication will be returned to the directing equipment in accordance with normal signalling arrangements for the circuit and for the access arrangements concerned. If the busy indication is received, this will be recorded by the directing equipment and the circuit released (see § 3.7.)

6.1.3 If no signal is received by the directing equipment within 15 ± 5 seconds of transmission of the address information, then a fault will be recorded and the circuit released.

6.1.4 When the indication that the answer signal has been received is passed to the directing equipment and transmission measurements are desired with a responding equipment Type a, transmission measurement cycles may take place as described in § 6.4. These cycles will end with the *end of transmission measuring programme* signal (Code 15) transmitted by the directing equipment, followed by the acknowledgement signal (Code 13) transmitted by the responding equipment in accordance with the normal responding sequence.

6.1.5 When the indication that the answer signal has been received is passed to the directing equipment and transmission measurements are not desired, or if the responding equipment is of Type b, or if the transmission measurement cycles have been completed and a complete signalling functional test is required, the directing equipment will transmit the forward transfer signal, or if this signal is not provided, the Code 11 signal.

Where the forward transfer signal is part of the signalling system it should be used by the directing equipment to initiate the complete signalling function test

a) *Forward transfer signal provided*

The transmission of the line signals initiated by ATME No. 2 equipment on the international circuit is performed by exchange line signalling equipment in accordance with normal signalling procedures. Consequently, the actual times at which the various signals are transmitted and received depend upon the signalling system employed and the circuit propagation time in any particular case.

If transmission measurements have been made, a forward transfer signal will be initiated by the directing equipment 500 ± 100 ms after the end of the transmission measuring programme signal. If transmission measurements have not been made or if Type b equipment is used, the transmission of the forward transfer signal will be initiated by the directing equipment 500 ± 100 ms after the indication that the answer signal has been received is passed to the directing equipment fitted or not fitted with echo suppressors/cancellers.

b) *Forward transfer signal not provided*

If transmission measurements have been made the Code 11 signal will be transmitted after the end of the transmission measuring programme signal. The directing equipment will transmit the CMS locking tone between the Code 15 and Code 11 signals on circuits equipped with echo suppressors/cancellers to ensure that they remain disabled. When the acknowledgement to the Code 15 signal is recognized by the directing equipment the Code 15 command signal will be disconnected and the CMS locking tone will be connected within 60 ms. When the end of the command acknowledgement signal is recognized by the directing equipment the CMS locking tone will be removed and the Code 11 command signal will be connected 55 ± 5 ms after the disconnection of the CMS locking tone. If transmission measurements have not been made or if Type b equipment is used, the transmission of the Code 11 signal will be preceded by transmission of the echo suppressor/canceller disabling tone as specified in § 6.4.1. When the acknowledgement of the Code 11 signal (return of Code 13) is recognized by the directing equipment, the Code 11 command signal will be disconnected.

6.1.6 If shortened signalling functional tests alone are desired, the directing equipment will initiate a clear-forward signal on receipt of the answer signal if transmission measurements have not been made, or on receipt of the acknowledgement signal (Code 13) following the end of transmission measuring programme signal when transmission measurements have been made.

6.1.7 When a complete signalling functional test is carried out, the indication that a forward transfer signal has been received will cause the responding equipment to initiate a clear-back signal. For systems without a forward transfer signal (see § 6.1.5) the receipt of a Code 11 signal will initiate the transmission of a clear-back signal 500 ± 100 ms after the command acknowledgement signal.

The responding equipment will initiate a reanswer signal 500 ± 100 ms after the clear-back signal has been initiated

Note — It is possible that with a 500-ms gap between the initiation of the clear-back and reanswer signals a CMS circuit may release the CMS channel. This may also happen in other parts of the signalling test sequence.

If the clear-back signal is not received by the directing equipment within 5 to 10 seconds of sending the forward transfer signal or the Code 11 signal, or if the reanswer signal is not received 5 to 10 seconds after the receipt of the clear-back signal, a fault will be recorded and the circuit released.

When the reanswer signal is recognized, the directing equipment will initiate a clear-forward signal.

It should be noted that although the forward transfer signal may be part of a signalling system, it may not be provided for in some international exchanges using such a signalling system. In these cases a complete signalling function test will not be possible, unless the use of Code 11 [see § 6.1.5, |)] is agreed on a bilateral basis.

6.1.8 When the clear-forward signal is transmitted (in accordance with §§ 6.1.6 or 6.1.7), a check should be made that the outgoing circuit has been released and is available for future use. If the outgoing circuit is not fully released within 5 to 10 seconds of the initiation of the clear-forward signal by the directing equipment, a fault will be recorded. It should be noted that the test for the release of the circuit may not be possible on certain designs of equipment.

6.2 *Busy flash test*

The busy flash signal may be tested by establishing a call using the address code specified in § 2.4 of Recommendation O.11, to force transmission of a busy flash signal by the incoming exchange equipment. On receipt of the busy flash signal the circuit will be released.

If the busy flash signal is not received within 10 to 20 seconds of transmission of the address information then a fault will be recorded and the circuit released.

Note — There is no need to make such a test in Signalling Systems Nos. 6 and 7 or in Systems R1 and R2.

6.3 *Transmission measuring procedure and exchange of information between directing and responding equipments*

Individual measurement cycles are specified in two groups known as ‘‘Layer 1’’ and ‘‘Layer 2’’. One code in Layer 1 has been designated to indicate that a measurement cycle in Layer 2 is being requested.

6.3.1 *Layer 1 procedures*

The signalling sequence for each Layer 1 individual measurement cycle is specified in § 6.4 and the frequencies and codes in Tables 2/O.22, 3/O.22 and 4/O.22. An example of the signalling sequence for a cycle involving the measurement of absolute power level is shown in Figure 1/O.22. The signalling scheme adopted for the command signals between directing and responding equipments consists of multi-frequency (MF) signals transmitted in compelled sequence; results are transmitted from the responding equipment to the directing equipment by means of multi-frequency pulse-type signals.

All transmission measurements should be performed with a tone level of —10 dBm0 (total distortion measurements may also use a —25 dBm0 level). Certain older responding equipment may be equipped to test with two tone levels, i.e. 0 dBm0 and —10 dBm0. In these circumstances a signal will be sent to inform the responding equipment of the measurement level to be used. (See Table 2/O.22 and § 9.1.) It should be noted that the sensitivity of the measuring equipment must be arranged to accommodate both levels.

The signal sender and signal receiver chosen are those specified for the CCITT interregister Signalling System No. 5 and the equipment used should be as specified in Recommendations Q.153 [7] and Q.154 [8] (see Annex A to this Recommendation concerning the sensitivity of the signalling receiver.)

6.3.2 *Layer 2 procedures*

The signalling sequence for each Layer 2 individual measurement cycle is specified in § 6.6 and the frequencies and codes in Tables 4/O.22 and 5/O.22. Multi-frequency pulse-type signals are used in Layer 2 both for command signals between directing and responding equipments and for transmitting results from the responding equipment to the directing equipment. When a Layer 2 procedure has been completed, a designated multi-frequency pulse-type signal command returns the dialogue to Layer 1.

6.4 *Description of transmission measuring cycles*

6.4.1 When the indication that the answer signal has been received is passed to the directing equipment, the echo suppressor/canceller disabling tone will be transmitted from the directing equipment for 2 seconds ± 250 ms.

Note 1 — This period takes into account the delay necessary for connection to a CMS channel, the time necessary for the assured disablement of the echo suppressor or echo canceller, the long propagation time likely to be experienced on satellite circuits and the delays attributable to the functioning of the signalling system. For circuits not using a line-signalling system involving an answer acknowledgement signal (such as Signalling Systems Nos. 3 and 4) it will be sufficient to send a disabling tone for at least 800 ms. If, however, the circuit to be tested is not equipped with echo suppressors/cancellers (see § 5), the procedure in § 6.4.1 will be omitted.

Note 2 — The specifications for the echo suppressor/canceller disabling tone and the CMS locking tone are given in § 9.3.

H.T. [T2.22]
TABLE 2/O.22
Command signals from directing equipment to responding equipment

Code No.	Interpretation
1	**{**
Measure absolute power level at 1020 Hz (sent level 0 dBm0)	
}	
2	**{**
Measure absolute power level at 400 Hz with a sent level indicated by the 1020 Hz	
}	
3	**{**
Measure absolute power level at 2800 Hz measurement command signal	
}	
4	**{**
Measure psophometric noise power (no CMS locking tone applied) | ua)	
}	
5	**{**
Measure psophometric noise power (with CMS locking tone applied)	
}	
6	**{**
Measure absolute power level at 1020 Hz and subsequent level measurements in the programme with a sent level of —10 dBm0	
}	
7	**{**
Measure total distortion with —10 dBm0 signal	
}	
8	**{**
Measure total distortion with —25 dBm0 signal	
}	
9	**Shift to Layer 2**
11	**{**
Used instead of forward transfer when this signal is not provided	
}	
13	**{**
Reverse the direction of measurement	
}	
14	**(Reserved for national use)**
15	**End of transmission measurement programme**

a) Applies to circuits on routes which do not incorporate a CMS system and are not equipped with echo suppressors and/or cancellers.

Tableau 2/O.22 [T2.22], p. 2

H.T. [T3.22]
TABLE 3/O.22
Signals from responding equipment to directing equipment

Code No.	Interpretation
1-10 Digits 1, . | | | 9, 0 (measurement results information) }	{
11 + (prefix for transmission measurements) }	{
12 — (prefix for transmission measurements) }	{
9 + (prefix to indicate measurement tone interruption) }	{
7 — (prefix to indicate measurement tone interruption) }	{
8 + (prefix to indicate measurement tone instability) }	{
6 — (prefix to indicate measurement tone instability) }	{
13	Command acknowledgement
11 (3-times) *(out of range at the upper end* printed out as ‘‘+++’’) }	{
12 (3-times) *(out of range at the lower end* printed out as ‘‘———’’) }	{
15 Recognition of faulty multi-frequency signal }	{

Tableau 3/O.22 [T3.22], p. 3

Figure 1/O.22, p. 4

H.T. [T4.22]

TABLE 4/O.22

Frequency allocation and codes

Code No.	Frequencies (compound) (Hz)
1	700 + 900
2	700 + 1100
3	900 + 1100
4	700 + 1300
5	900 + 1300
6	1100 + 1300
7	700 + 1500
8	900 + 1500
9	1100 + 1500
10	1300 + 1500
11	700 + 1700
12	900 + 1700
13	1100 + 1700
14	1300 + 1700
15	1500 + 1700

Tableau 4/O.22 [T4.22], p. 5

H.T. [T5.22]
TABLE 5/O.22
Layer 2 command signals from directing equipment to responding equipment

Code No.	Layer 2 Interpretation
1	{
Echo canceller test system — automatic	
}	
2	Reserved
3	{
Loop-around test — digital	
}	
5	Return to Layer 1

Tableau 5/O.22 [T5.22], p. 6

6.4.2 When the echo suppressor/canceller disabling tone is removed, the directing equipment will transmit a multi-frequency (MF) command signal to the responding equipment. The interval between cessation of the tone and transmission of the command signal will be 55 ± 5 ms. If, however, the disabling tone has not been sent (see § 5) the MF command signal will be sent within 60 ms, following the indication that the answer signal has been received.

6.4.3 When the command signal is received by the responding equipment a MF command acknowledgement signal will be transmitted.

6.4.4 When the command acknowledgement signal is recognized by the directing equipment, the command signal will be disconnected and the CMS locking tone, if it is to be sent (see § 5), will be connected within 60 ms.

6.4.5 When the cessation of the command signal is recognized by the responding equipment the command acknowledgement signal is disconnected and the measurement tone is connected within 60 ms.

6.4.6 The time required for the directing equipment to detect the cessation of the command acknowledgement signal and connect the measuring equipment will not be less than 60 nor more than 120 ms. However, it should be as close to 60 ms as possible to reduce the probability of CMS switching during noise measurement.

6.4.7 The level measurement should be completed within 500 ms after connection of the measuring equipment. When the measurement is completed, the measuring equipment will be disconnected and the CMS locking tone mentioned in § 6.4.4, if present, will be disconnected.

6.4.8 Following disconnection of the CMS locking tone mentioned in § 6.4.7, a MF command signal will be connected. The interval between the tone and the signal will be 55 ± 5 ms. If, however, the CMS locking tone was not sent, the command signal will be connected 55 ± 5 ms after the measuring equipment has been disconnected.

6.4.9 When the MF command signal is recognized by the responding equipment, the measurement tone will be removed and a multi-frequency command acknowledgement signal will be transmitted. The interval between cessation of the measurement tone and the commencement of the MF command acknow ledgement signal will be 55 ± 5 ms.

6.4.10 The recognition of the command acknowledgement signal by the directing equipment will cause the disconnection of the command signal and the connection of the measurement tone within 60 ms of the end of the command signal.

6.4.11 When the cessation of the MF command signal is detected by the responding equipment, the command acknowledgement signal will be disconnected and the CMS locking tone, if provided in the responding equipment, will be connected within 60 ms of the end of the command acknowledgement signal.

6.4.12 The time required for the responding equipment to detect the cessation of the command signal and connect the measuring equipment will not be less than 60 nor more than 120 ms. However, it should be as close to 60 ms as possible to reduce the probability of CMS switching during noise measurement.

6.4.13 The measurement should be completed within 500 ms after the connection of the measuring equipment. When the measurement is completed, the measuring equipment will be disconnected.

6.4.14 When the responding equipment is ready to transmit measurement results information to the directing equipment, the CMS locking tone mentioned in § 6.4.11 will be disconnected if it has been sent. The first MF pulse to be used for the transmission of results will follow after an interval of 55 ± 5 ms from the disconnection of the CMS locking tone. If the locking tone was not sent, the first MF pulse will be sent within 60 ms after disconnection of the measuring equipment.

6.4.15 Measurement result information will be transmitted as three MF pulses in the form of a prefix followed by two digits of Codes 1 to 10 as appropriate (see Table 4/O.22). The last two digits will be sent in order of significance (most significant digit first). The pulse-length will be 55 ± 5 ms and the interval between pulses 55 ± 5 ms. The digit zero is represented by Code 10.

6.4.16 If the responding equipment is provided with a CMS locking tone this tone will be applied within 60 ms after the third MF pulse has been sent.

6.4.17 When the third MF pulse is recognized by the directing equipment, the measurement tone will be disconnected. A MF command signal will be sent by the directing equipment after an interval of 55 ± 5 ms from disconnection of the measurement tone. If the responding equipment has sent the CMS locking tone mentioned in § 6.4.16, this tone will be disconnected on recognition by the responding equipment of the MF command signal sent by the directing equipment. The responding equipment must send the command acknowledgement signal 55 ± 5 ms after cessation of the CMS locking tone. If the MF command signal sent by the directing equipment is the start of a new measurement cycle the new test sequence will proceed from the point described in § 6.4.4 and will consist of a repetition of the sequence in §§ 6.4.4 to 6.4.17.

6.4.18 If the foregoing test sequence completes the transmission measuring programme, the MF command signal mentioned in § 6.4.17 will be the *end of programme signal* .

6.4.19 In the case of all noise measurements, the measurement tone mentioned in §§ 6.4.5, 6.4.9, 6.4.10 and 6.4.17 must be replaced by a 600-ohm terminating resistor.

6.4.20 In the case of noise measurements carried out on routes incorporating a CMS system or on circuits equipped with echo suppressors/cancellers, to ensure that the CMS locking tone is on in the direction which is not being measured, the CMS locking tone mentioned in §§ 6.4.4, 6.4.11 and 6.4.16 must be applied.

6.4.21 In the case of noise measurements, the responding equipment is informed of the necessity for the CMS locking tone mentioned in § 6.4.20 by the MF command signal, *measure psophometric noise power (with CMS locking tone applied)* (see Table 2/O.22).

6.4.22 The signal-to-total-distortion measurement will be carried out in two steps:

a) detection of the total distortion measuring signal using the same method as for idle noise but with the 2800 Hz stop filter replaced by the 1000-1025 Hz rejection filter;

b) measuring of the level using the 1004-1020 Hz test signal at either —10 or —25 dBm0 depending on the requested test.

6.4.23 When making total distortion measurements, the measurement tone mentioned in §§ 6.4.5, 6.4.9, 6.4.10 and 6.4.17 must be replaced by the proper level total distortion test signal (either —10 or —25 dBm0).

6.5 *End-of-programme procedure*

When transmission measurement is complete, the remainder of the operations will be continued in accordance with §§ 6.1.4 through 6.1.8, insofar as they apply.

6.6 *Description of Layer 2 transmission measuring cycles*

After a compelled MF Code 9 has been used in Layer 1 to enter Layer 2 and MP command acknowledgement has been detected (not waiting for it to cease), a MF pulse-type signal is used to select a measurement cycle (see Table 5/Q.22). Some Layer 2 measurement cycles contain no-signal intervals of a length sufficient to cause a CMS circuit to switch the CMS connecting channel.

The directing equipment may exit a Layer 2 measurement cycle by sending a pulse-type MF Code 5. If required as specified in § 6.4.1, the directing equipment will then send the echo suppressor/canceller disable tone. This assures that echo suppressors and/or cancellers will not interfere with the compelled MF commands used in Layer 1.

6.7 *Description of echo canceller testing cycles*

6.7.1 The test descriptions in this section follow the test sequence shown in Figures 2/O.22 and 3/O.22. All gaps between the MF pulse bursts and other actions shall be 80 ± | ms unless otherwise specified Timing and other error conditions are covered in § 6.8.

6.7.2 The director sends a Code 9 MF command to indicate that a Layer 2 cycle is being specified.

6.7.3 When the command signal is received by the responding equipment a MF command acknowledgement signal will be transmitted.

6.7.4 When the command acknowledgement signal is recognized by the directing equipment the command signal will be disconnected and a pulsed MF command sent (§ 6.7.6).

6.7.5 When the cessation of the command signal is recognized by the responding equipment the command acknowledgement signal is disconnected.

6.7.6 The directing equipment begins the test sequence by transmitting to the responder an MF priming burst which specifies a 1020 Hz test tone and automatic test timing (see §§ 6.3 and 6.4 and Table 5/O.22).

6.7.7 Following the initial MF priming burst, the director pauses for 500 ms to ensure that echo cancellers are enabled. It then sends an 800 ms period of 2100 Hz tone, if required, which disables any echo suppressors which may be on the circuit under test and provides lockup for any circuit multiplication equipment employed on the circuit.

6.7.8 Next the director sends test tone (1020 Hz) at —10 dBm0 to the responder while it waits for the responder to measure the received level of the tone and return a measurement result.

6.7.9 The responder detects the presence of the test tone, measures the level, and returns the results of the measurement as pulsed MF digits. It then applies test tone (1020 Hz) at —10 dBm0 toward the director.

6.7.10 Upon receipt of the measurement result from the responder, the director removes test tone and waits for receipt of test tone from the responder upon which it makes a level measurement.

6.7.11 The director next sends MF priming bursts to specify the test sequence for the far-end echo canceller (at the responder end) or for the near-end echo canceller (at the director end). The following steps test the far-end echo canceller.

6.7.12 After sending the priming digit specifying a far-end echo canceller test, the director applies a noise test signal and waits for an MF confirmation burst from the responder.

6.7.13 Upon receiving the priming burst indicating a far-end echo canceller test, the responder removes the test tone it had been sending, returns an MF confirmation burst, and provides a quiet termination on both transmit and receive paths of the circuit under test as the step 1 condition.

6.7.14 Upon receiving the step 1 confirmation MF burst, the director continues the noise signal for 500 ms to allow the far-end echo canceller to zero its internal registers on receipt of the noise signal, and then the director makes a noise ratio measurement which is an indication of the far-to-near circuit noise. (This measurement is only an indication of the noise performance of the circuit under test but is intended to assure that excessive circuit noise problems are not distorting the canceller tests.) The director then sends an MF priming burst to advance the responder to step 2 conditions and indicates, using two more MF priming bursts, the amount of delay to be provided in the 2 dB gain loop. The requested value of delay in the loop should be continuously variable from 0 to 75 ms in steps of 1 ms. After the priming is completed, it then resumes sending the noise signal toward the responder.

6.7.15 Upon receiving the step 2 priming from the director, the responder removes the step 1 terminations, provides a 2 dB gain loop with the specified delay, and returns the step 2 priming confirmation MF burst.

6.7.16 The director receives the step 2 confirmation MF, continues the noise signal for 500 ms to allow the far-end canceller to adjust to the two-talker state, and then makes a noise ratio measurement of the looped-back signal. It then sends an MF priming burst to advance the responder to the step 3 condition which is a 10 dB loss loop with the same delay and applies the noise signal toward the responder.

6.7.17 Upon receiving the step 3 priming MF burst from the director, the responder applies the step 3 conditions and returns a confirmation MF burst.

6.7.18 The director receives the step 3 confirmation MF burst, continues the noise signal for 500 ms to allow the far-end echo canceller to attempt to cancel the looped noise, and then makes a noise ratio measurement of the returned signal.

6.7.19 If the far-end canceller has additional delay stages to be tested, the director may repeat the step 2 and step 3 sequences with the appropriate values of delay for testing each stage.

6.7.20 If there are no additional far-end echo canceller delay stages to test and there is no near-end echo canceller to be tested, and if no completed tests are to be repeated, nor has a test of the far-end canceller disabler been requested, the director sends an MF priming burst instructing the responder to return to Layer 1.

a) If there is no near-end canceller to be tested and the disabler function of the far-end canceller is to be tested, that test is performed at this time. (Note that if there is also a near-end canceller, testing of the far-end canceller disabler function is done after the near-end canceller has been tested.)

b) To test the operation of the far-end echo canceller disabler, it is assumed that the previously described sequence has been applied to the far-end canceller and exited with the 10 dB loss loop still applied by the responder while it awaits additional commands.

c) The director removes the noise signal used for the 10 dB loss loop measurement and sends for 800 ms an echo canceller disable signal consisting of a 2100 Hz burst with phase reversed 180° | ediodically (see § 9.4.1 c). Upon receipt of this signal, the disabler in the echo canceller should operate, thus disabling the canceller action.

d) The director removes the disable signal, sends an MF priming burst, and applies the noise signal upon which the far-end canceller should now take no action. Upon receiving the MF burst, the responder removes the 10 dB loss loop with delay, returns an MF confirmation burst, and applies a 10 dB loss loop with no delay. Upon receipt of the MF confirmation burst from the responder, the director continues the noise signal for 500 ms and then makes a noise ratio measurement of the returned signal (which should differ from the previous 10 dB loss loop measurement because the canceller has been disabled).

e) The director then removes the noise signal and sends an MF priming burst instructing the responder to return to Layer 1.

6.7.21 If there is a near-end echo canceller to be tested, the director sends an MF priming burst which instructs the responder to assume the control function and indicates the number of stages to be tested in the near-end canceller. The director then applies test tone toward the responder (see Figure 3/O.22).

6.7.22 Upon receipt of the command to assume test control, the responder sends a step 1 priming MF burst to the director. The responder then applies a noise signal and awaits a step 1 confirmation MF burst from the director. The 3-step sequence proceeds as for the far-end canceller except that the responder returns by MF bursts the results of the previous step's measurement immediately after sending the MF priming burst requesting the next step conditions.

6.7.23 When testing of the near-end canceller is completed, the responder sends an MF burst indicating return of control to the director and applies test tone.

a) If testing only the near-end canceller disabler function has been requested, the director sends an MF priming instructing the responder to perform a series of operations while the director applies a quiet termination.

b) Upon receipt of the disabler test MF priming burst, the responder removes the test tone and applies for 800 ms the echo canceller disable signal (see § 9.4.1 c)). The responder then sends an MF priming burst and applies the noise test signal. Upon receipt of the MF priming burst, the director returns an MF confirmation burst and applies a 10 dB loss loop with no delay. Upon receipt of the MF confirmation burst, the responder continues the noise signal for 500 ms upon which the disabled near end canceller should take no action. The responder next makes a noise ratio measurement of the returned signal. The responder returns the result as MF bursts, preceded by an MF burst indicating return of control to the director, and awaits the next command. Upon receipt of these MF bursts, the director removes the 10 dB loss loop and pauses 500 ms to allow the canceller to become enabled.

c) If testing both near-end and far-end disablers has been requested, the sequence described in b) proceeds to the point where the 10 dB noise ratio value, measured with the near-end canceller disabled, has been returned by the responder. Since the far-end disabler is also to be tested, the responder returns test tone (with no pause) and awaits further director command.

d) Upon receiving the near-end disabler test result, the director removes the 10 dB loss loop (no delay) test condition, sends an MF burst requesting the 10 dB loop and applies the noise signal.

e) Upon receiving the command, the responder removes the test tone, provides a 10 dB loss loop (no delay), and returns a confirmation MF burst.

f) Upon receipt of the confirmation MF burst, the director continues the noise signal for 500 ms upon which the disabled far-end canceller should now take no action. The director then makes a noise ratio measurement of the returned signal (which should indicate no cancellation).

g) After making the measurement, the director pauses 500 ms to allow the canceller(s) to become enabled.

6.7.24 The director sends an MF priming burst instructing the responder to return to Layer 1. Note, at this point any CMS on the circuit may have been released during the 500 ms pause. (See Figures 2/O.22 and 3/O.22).

6.8 *Echo canceller test timing and error considerations*

6.8.1 *Automatic testing — director function*

6.8.1.1 If no response is received from the responder within 5 seconds of a prompt, send a return to Layer 1 MF command to the responder and report timeout.

6.8.1.2 If an MF burst is received that is out of sequence, undefined, or bad (e.g., more than two MF frequencies received) record an MF digit error condition, remain at current position in the test sequence, and restart the timeout timer. If correct MF is not received by the next timeout, report ‘‘MF error’’ and return to Layer 1. If correct MF is received, continue with normal sequence.

6.8.1.3 If an MF error report is received from the responder indicating that it has perceived receipt of an undefined, out-of-sequence, or bad MF digit, report that disposition, send a return to Layer 1 MF to the responder, and return to Layer 1.

6.8.2 *Automatic testing — responder function*

If an MF burst is out of sequence, undefined, or bad, send a ‘‘bad MF’’ report MF (Code 13) to the director and remain at current position in test sequence.

6.9 *Responder digital loopback test*

6.9.1 The director sends a Code 9 MF command to indicate that a Layer 2 cycle is being specified.

6.9.2 When the command signal is received by the responding equipment an MF command acknowledgement signal will be transmitted.

6.9.3 When the command acknowledgement signal is recognized by the directing equipment the command signal will be disconnected and a pulsed Code 3 MF command sent.

6.9.4 When the cessation of the command signal is recognized by the responding equipment the command acknowledgement signal is disconnected and the digital loopback is applied in response to the Code 3.

6.9.5 The directing equipment begins the test sequence by transmitting the digital test pattern and analyzing the looped return signal.

Figure 2/O.22, p. 7

Figure 3/O.22, p. 8

6.9.6 At the conclusion of the test, the director removes the test pattern and sends a Code 5 pulsed multi-frequency command instructing the responder to return to Layer 1. If a Code 5 is not received within 30 seconds of the application of the digital loopback, the responder will remove the digital loopback and return to Layer 1. However, the director may begin a new 30 second test interval by sending a pulsed multi-frequency Code 3 command instead of a Code 5 before the current 30 second interval has expired.

6.10 *System supervision*

6.10.1 Each MF signal must consist of two, and only two, frequencies. If one or more than two frequencies are received by the directing equipment, the measurement is recorded as faulty and the connection is released. If one or more than two frequencies are received by the responding equipment it shall be arranged to return Code 15 in place of the command acknowledgement signal Code 13. The directing equipment will then recognize the signal, record the measurements as a fault and release the connection.

6.10.2 In the transmission of measurement results, the code signals must comprise three, and only three, digits. When this is not the case, the measurement is recorded as faulty, and the connection is released.

6.10.3 Arrangements must be provided at the directing equipment to monitor the full duration of the programme. In addition to the time out requirements given in other parts of this specification, if at any time the programme fails to progress for a period of 20 to 40 seconds then the test is recorded as faulty and the connection is released. An alarm may be given to the maintenance staff.

7 Description of tests to digital loopback test lines

7.1 The directing equipment shall be capable of making the following tests of measurements to a digital loopback test line as specified in Recommendation O.11. The type of test to be made will depend on the type of circuit under test. For all tests it is assumed that any echo suppressors or cancellers have been disabled before the start of the tests using the appropriate disabling tone and/or CMS locking tone (see § 6.4).

7.2 *Analogue tests on all circuit types*

The following tests can be made on analogue, composite digital/analogue and wholly digital circuits.

a) Looped received power at 1020 Hz

b) Looped received noise with and without the CMS locking tone

c) Looped signal-to-total distortion ratio with 1020 Hz test signal at —10 or —25 dBm0 depending on the requested test.

Note — Looped 400 and 2800 Hz measurements are not being specified.

7.3 *Digital tests on wholly digital circuits*

The directing equipment shall be capable of implementing bit integrity tests per Recommendation O.152 to a digital loopback test line for wholly digital circuits between digital exchanges. The interval between removal of the echo canceller/suppressor disabling tone and/or CMS locking tone is removed and application of the test tone or digital test pattern shall be 55 ± | ms. The results shall be capable of being expressed in terms of estimated percent error free seconds and of estimated bit error ratio. The length of test intervals shall be specified in seconds from 10 to 600 as an input parameter.

8 Programming

The directing equipment will be programmed by manual or automatic means at the option of the using Administration or operating agency. Information to be supplied to the directing equipment will consist of the following:

1) the identification of the circuit to be tested;

2) the kind of circuit (CMS, echo suppressor/canceller equipped, etc.) and the kind of signalling system;

3) the location on the circuit of the echo cancellers: near-end, far-end or both ends;

4) sufficient address to identify the particular type of responding equipment at the incoming international exchange;

5) the measurements to be made, the nominal values, the assigned maintenance limits, and whether the canceller disabler tests are to be performed;

6) whether the results are to be recorded by the output equipment;

7) whether or not the date and time of the test should be recorded by the output equipment;

8) whether there should be a shortened record as described in § 3.7.

9 Specifications for transmission measuring apparatus and for disabling tones and locking tones

The equipment shall perform under the climatic conditions as shown in Recommendation O.3.

9.1 *Absolute power level measuring device*

9.1.1 *Sending equipment*

Level measurements:

Frequencies: | 400 ± 5 Hz, 1020 +2, | (em7 Hz and 2800 ± | 4 Hz.

Absolute power level sent: | 0 dBm0 ± 0.1 dB (or —10 dBm0 ± 0.1 dB, see § 6.3).

Purity of output: | ratio of total output to unwanted signal at least 36 dB.

Total distortion test signal:

Frequency: | The nominal frequency of the total distortion test signal shall be 1020 Hz. The frequency stability of the test signal shall be ± | Hz.

Absolute power level sent: | —10 dBm0 ± | .1 dB and —25 dBm0 ± | .1 dB.

Purity of output: | ratio of total output to unwanted signal at least 36 dB.

Impedance: | 600 ohms balanced - earth free.

Pending the general adoption of a method for measuring the balance with respect to earth, the method to be used is left for agreement between the constructor of the equipment and the Administration concerned.

Any interface equipment provided to meet the signalling requirements of the exchange, or for purposes of controlling functions with the ATME No. 2, must be considered as part of the ATME No. 2 for the purpose of determining the balance to earth.

Longitudinal conversion loss | (see Figure 1/O.9): At least 46 dB between 300 and 3400 Hz ' |

Return loss requirement for older equipment should conform to greater than 30 dB at each of the above sending equipment frequencies.

Return loss: | greater than 46 dB at 1020 Hz and greater than 30 dB between 200 and 4000 Hz.

It is intended that only a single tone in the range 1020 +2, | (em7 Hz will be required and that it can be used for both 1020 Hz level and total distortion measurements.

9.1.2 *Receiving equipment*

Frequency range: | 390-2820 Hz.

Impedance: | 600 ohms balanced - earth free.

Balance with respect to earth: | at least 46 dB between 300 and 3400 Hz, and below 300 Hz increasing such that at least 60 dB at 50 Hz is obtained ’

Return loss: | greater than 46 dB at 1020 Hz and greater than 30 dB between 200 and 4000 Hz.

Measuring range: | from —9.9 dB to +5.1 dB relative to the nominal absolute power level of the —4.0 dBr receiving virtual switching point. It should be borne in mind that the nominal value of absolute power level at the receiving virtual switching point will depend on the absolute power level at the sending end which may be 0 dBm0, —10 dBm0 or —25 dBm0 (see § 6.3).

Accuracy (absolute): | at 1020 Hz, ± | .2 dB; at 400 and 2800 Hz, ± | .2 dB referred to the 1020 Hz value.

Resolution (smallest measurement step): | .1 dB.

9.2 *Noise and total distortion measuring apparatus*

Weighting: | psophometric with requirements as specified in Recommendation O.41.

2800-Hz suppression: | when noise measurements are made on circuits involving a CMS system or on circuits equipped with echo suppressors and/or echo cancellers, a stop filter for 2800 Hz must be inserted before carrying out the noise measurement. The requirements for the filter are given in Figure 4/O.22. When measuring white noise with psophometric weighting the insertion of the filter in the noise measuring circuit shall not cause a difference from the reading without the filter of more than 1 dB.

1000-1025 Hz suppression: | when total distortion measurements are made, a test signal rejection filter for 1000 to 1025 Hz must be inserted before carrying out the total distortion signal measurement. The requirements for the filter are given in Figure 5/O.22. A bandwidth correction for the loss of effective noise bandwidth due to the rejection filter must be incorporated in the ATME No. 2 system.

Method of detection for idle noise: | the method of detection shall be such that if white Gaussian noise, or a sine wave of any frequency between 390 and 2820 Hz is applied at the input in the absence of the 2800-Hz stop filter mentioned above, for a period of 375 ± 25 ms, the output indication will be the same in each case, within ± | dB, as that given by the CCITT psophometer when the same white Gaussian noise or sine wave is applied at its input for a period of 5 seconds.

Method of detection of the signal-to-total-distortion ratio:
| the method of detection of the total distortion signal shall be the same as that for idle noise as given above except with the 1000 to 1025 Hz rejection filter replacing the 2800 Hz stop filter. In addition, the level of the received 1004-1020 Hz test signal must be measured and compared with the total distortion signal to determine the signal-to-total-distortion ratio in dB.

Measuring interval: | 375 ± 25 ms.

Impedance: | 600 ohms balanced.

Input longitudinal interference loss | (see Figure 5/O.9): at least 46 dB between 300 and 3400 Hz, and below 300 Hz increasing such that at least 60 dB and 50 Hz is obtained ’

Return loss: | greater that 46 dB at 1020 Hz and greater that 30 dB between 200 and 4000 Hz.

Measuring range: | —30 to —65 dBm0p.

Accuracy: | ± | dB at calibrating frequency from —30 to —55 dBm0p. Between —55 dBm0p and —65 dBm0p an accuracy of ± | dB is allowed, but ± | dB remains desirable.

Resolution (smallest measurement step): | 1 dB.

9.3 *Disabling and locking tones*

— Echo suppressor/canceller disabling tone: (CMS lock-up or CMS locking tone)

Frequency: | 2100 Hz ± 8 Hz.

Level: | —12 dBm0 ± 1 dB.

The 2100 Hz tone should be periodically interrupted every 450 | (+- | 5 ms by a 180 | (+- | degree phase shift. The interruption interval may be asynchronous with the beginning of the tone-on interval.

— CMS holding tone:

Frequency: | 2800 Hz ± 14 Hz.

Level: | —10 dBm0 ± 1 dB.

— For the two tones:

Impedance: | 600 ohms balanced - earth free.

Input longitudinal interference loss | (see Figure 5/O.9): at least 46 dB between 300 and 3400 Hz. ’

Return loss: | greater than 46 dB at 1020 Hz and greater than 30 dB and 4000 Hz.

This is the same rejection filter characteristic as specified in Recommendation O.132.

Figure 4/O.22, p.

Figure 5/O.22, p.

9.4 *ECTS sending apparatus of the directing and responding equipment*

9.4.1 *Signal and tone frequencies*

a) test tone: 1020 +2, | (em7 Hz

b) disable tone: 2100 Hz ± | Hz (echo suppressors and CMS)

c) disable tone for echo canceller: 2100 Hz ± | Hz. The 2100 Hz tone should be periodically interrupted every 450 ± | 5 ms by a 180 ± | degree phase shift. The interruption interval may be asynchronous with the beginning of the tone-on interval.

d) CMS holding tone: 2800 Hz ± | 4 Hz

e) noise signal: the noise test signal is obtained by passing a wideband quasi random noise source signal through a bandpass filter network meeting the requirements given in Table 6/O.22.

H.T. [T6.22]
TABLE 6/O.22
Filter response

Frequency (Hz)	Loss | ua) (dB)	Tolerance (dB)
200	≥" 30**.8**	—
300	≥" 21.8	± | .3
560	{	
≥"		
3**.8**		
}	± | .4	
750	≥" 0.2	± | .2
1000	{	
≥"		
0**.8**		
}	± | .1	
1500	≥" 0.1	± | .2
1965	{	
≥"		
3**.8**		
}	± | .4	
2400	≥" 10.9	± | .2
3000	≥" 22.9	± | .0
4000	≥" 42.6	± | .0
≥" 5000	45**.8**	—

a) Excluding any flat insertion loss.

Tableau 6/O.22 [T6.22], p.

9.4.2 *Signal and tone levels*

a) for loss measurements: —10 ± | .1 dBm0

b) disable tone: —12 ± | dBm0

c) CMS holding tone: —10 ± | Bm0

d) noise signal: —10 ± | dBm0

9.4.3 *Impedance*

600 ohms balanced with longitudinal conversion ' loss (see Figure 1/O.9) of at least 46 dB between 300 and 3400 Hz. Return loss greater than 46 dB at 1020 Hz and greater than 30 dB between 200 and 4000 Hz.

9.4.4 *Purity of tone output*

Better than 30 dB.

9.4.5 *Loop characteristics*

a) value of loop delay, 0 to 75 ms ± | .2 ms

b) loop gain 2.0 dB ± | .1 dB

c) loop loss 10.0 dB ± | .1 dB

9.5 *ECTS receiving apparatus of the directing and responding equipment*

9.5.1 *Measuring ranges*

a) for loss measurement: from 0 ± | .1 dBm to —40 ± | .1 dBm

b) for echo performance and noise measurement: from 0 to —65 dBm (± | dB to —55 dBm, ± | dB to —65 dBm) using a detector with response per Recommendation O.41, Table 1/O.41.

9.5.2 *Measuring interval*

500 ± | 5 ms.

9.5.3 *Impedance*

600 ohms balanced with input longitudinal interference loss ' (see Figure 5/O.9) of at least 46 dB between 300 and 3400 Hz. Return loss greater than 46 dB at 1020 Hz and greater than 30 dB between 200 and 4000 Hz.

9.6 *ECTS command signals exchanged between the directing equipment and the responding equipment*

Test sequence commands and responses exchanged between the directing and responding equipment will be pulse-type multifrequency (MF) signals. The signal sender and signal receiver are those specified for the CCITT No. 5 Interregister Signalling System per CCITT Recommendation Q.153 [7] and Q.154 [8]. The frequencies and the meaning of the codes are given in Table 7/O.22.

9.7 *Digital pattern generator and detector*

9.7.1 *Test pattern generator*

The test pattern generator shall utilize the pseudorandom test pattern specified in Recommenda- tion O.152, § 2.

9.8 *Test pattern detector*

The detector is designed to measure the error performance of the 64 kbit/s digital path by the direct comparison of the received pseudorandom test pattern with an identical locally generated pseudorandom test pattern as specified in Recommendation O.152.

H.T. [T7.22]

TABLE 7/O.22

ECTS command signals between director and responder

Code No.	Frequency (Hz)	Meaning
1	700 + 900	Automatic test
2	700 + 1100	Reserved
3	900 + 1100	Spare
4	700 + 1300	Spare
5	900 + 1300	Return to Layer 1
6	1100 + 1300	Step 1 priming MF
7	700 + 1500	Request confirmation
8	900 + 1500	Step 2 priming MF
9	1100 + 1500	Step 3 priming MF
10	1300 + 1500	{
Request responder assume control		
}		
11	700 + 1700	Test disablers at both ends
12	900 + 1700	{
Test near-end disabler only		
}		
13	1100 + 1700	MF error condition
14	1300 + 1700	Control returned to director
15	1500 + 1700	Spare

Table 7/O.22 [T7.22], p.

10 Calibration

10.1 *Built-in calibration*

The accuracy desired from the ATME No. 2 makes calibration equipment of laboratory-type accuracy necessary. Such accuracy is seldom provided by normal maintenance equipment available to repeater station staff. Hence, built-in calibration features should be provided. Due regard should be paid to the ease of maintenance, and adequate access facilities should be provided.

10.2 *Self-check*

The responding and directing equipments shall each incorporate a local self-checking facility on the transmission measuring unit which will bring in a local alarm and disable the unit when it is out of tolerance. This self-check should be applied at least daily. If they so wish, user Administrations may incorporate arrangements for making this self-check automatically.

11 Optional arrangements

11.1 *Automatic start*

In the long term, the operation of the ATME No. 2 without any attention by technical personnel will be desirable. The addition of timed automatic start facilities to the ATME No. 2 is required when unattended operation of the ATME No. 2 is intended.

11.2 *Timed automatic selection of particular circuits or groups of circuits*

It may be desirable to select for test a particular circuit, or group of circuits, at specified times according to a prearranged programme, for example noise measurement during busy and non-busy hours.

11.3 *Automatic repeat attempt*

It may be desirable to incorporate an automatic repeat test facility for circuits which have been rejected as faulty. The arrangement should permit an *automatic repeat attempt* of the relevant test cycle immediately following the first test.

A test cycle is defined as a sequence of measurements commencing with command Codes 1 to 9 and not command Code 13.

11.4 *Switching pad test*

Administrations may use their ATME No. 2 directing equipment to test a pad-switching facility provided at the outgoing end of an international circuit.

Such testing must not involve any other Administration in making changes to their signalling, switching or ATME No. 2 equipment or to their operating and maintenance procedures.

11.5 *Interruption and instability during level measurements*

It may be desirable to detect an interruption or a condition of instability during the level measuring interval at the directing and/or the responding equipments. If such indications are available they will always be recorded by the directing equipment (see § 3.7).

When an interruption and instability are both detected during a 500-ms measuring period only the indication of an interruption shall be transmitted and recorded.

11.6 *Nonavailability of responding equipment*

It may happen that, as a result of a failure at the responding end, all attempts made at the directing end to set up a call with a particular responding equipment will be unsuccessful — there may be no reply or the busy tone may be received. As this state of affairs could seriously affect the carrying out of a measurement programme as planned, it would appear to be desirable to ensure either:

— that this situation should give rise to an alarm signal if the directing equipment is operating under supervision;

— or that the directing equipment should be able automatically to select an alternative measurement programme if it is operating without supervision.

ANNEX A
(to Recommendation O.22)

Sensitivity of the signalling receiver

A.1 The multi-frequency signal sender and receiver specified for ATME No. 2 is given in Recommendations Q.153 [7] and Q.154 [8] respectively, as used in CCITT Signalling System No. 5.

The sending level per frequency equals —7 ± 1 dBm0 and therefore the nominal receiving level at the —4.0 dBr virtual switching point equals —11 dBm.

The operating limits of the multi-frequency receiver give a minimum margin of ± | dB on the nominal absolute level of each received signal (i.e. taken to mean per frequency).

Therefore the receiver minimum operate level range at the —4.0 dBr virtual switching point:

= —11 dBm ± 7 dB

= —18 dBm to —4 dBm

A.2 The maximum circuit *loss* | eviation from nominal over which the multi-frequency signals can be received is:

(—11 — 1) — (—18) = +6.0 dB

and the minimum circuit *loss* | eviation from nominal over which the multi-frequency signals can be received is:

(—11 + 1) — (—4) = —6.0 dB

A.3 Therefore the circuit *loss* | eviation limits between which multi-frequency signals can be received is ± | .0 dB about the nominal loss, whereas ATME No. 2 is capable of measuring deviations greater than these values (see § 9.1 of this Recommendation).

A.4 Although the specification for the multi-frequency signal receiver (Recommendation Q.154 [8]) stipulates that a received signal may vary ± | dB about the nominal receive level of —7 dBm0, Recommendation Q.154 [8] also states that the receiver shall not operate to a signal 17 dB below the nominal received signal level, which means that in the range —14 to —24 dBm0 the receiver may or may not operate. It is to be expected therefore that somewhere within this range the receiver will cease to operate.

A.5 In practice multi-frequency receivers are set up to operate to a minimum signal level in this range of —14 to —24 dBm0. Therefore signalling would normally be possible over a circuit with a loss greater than that given in § A.3. In those cases where the multi-frequency receiver fails to operate the circuit test would still be recorded as mentioned in § 6.10.3 of this Recommendation.

References

[1] CCITT Recommendation *Routine maintenance schedule for international public telephony circuits* , Vol. IV, Rec. M.605.

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

[3] CCITT Recommendation *International telephone circuits — principles , definitions and relative transmission levels* , Vol. IV, Rec. M.560, § 2.

[4] CCITT Recommendation *Error performance of an international digital connection forming part of an integrated services digital network* , Vol. III, Rec. G.821.

[5] CCITT Recommendation *Stability and echo* , Vol. III, Rec. G.131, § 2.1.

[6] CCITT Recommendation *Access points for International Telephone Circuits* Vol. IV, Rec. M.565.

[7] CCITT Recommendation *Multifrequency signal sender* , Vol. VI, Rec. Q.153.

[8] CCITT Recommendation *Multifrequency signal receiver* , Vol. VI, Rec. Q.154.

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