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Telecommunications equipment - Subscriber equipment - Attachment requirements for analogue connection to a public switched telephone network

Telekommunikationsutrustning – Abonnentutrustning – Tekniska krav för analog anslutning av abonnentutrustning till ett allmänt tillgängligt telefonnät

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0 Introduction

This standard is based on ETSI draft prTBR 21, dated 8 March 1996. By this edition 2, a further alignment to the ongoing work on TBR 21 is achieved.

The approval requirements in this standard are related to the capability of the PSTN. A single terminal may consume all of this (given) capability, or it can be shared by a number of terminals all being connected to the user's network termination point in an arbitrary combination of parallel and/or series connection in which case the performance of each individual terminal will need to be better than required by this standard to ensure satisfactory interworking with the network. Guidance for connection of terminal equipment in series and/or parallel may be found in a draft ETSI Technical Report (prETR "installation").

1 Scope

This standard specifies the technical characteristics (electrical and mechanical interface requirements and access control protocol) under Articles 4(d) and 4(f) of the EEC Council Directive 91/263/EEC to be provided by a single TE which is capable of 2-wire access to an analogue PSTN line at the network termination point.

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The objective of this standard is to ensure that no harm occurs to the public network, and to ensure interworking between network and terminal so that calls can be routed successfully through the network, but without any guarantee of terminal to terminal interoperability. There are no requirements in this standard under Article 4(g) of the Directive.

This standard covers TE which is intended for originating a circuit-switched call using DTMF signalling and/or receiving an incoming circuit-switched call.

For each requirement in this standard a test is given, including measurement methods. Requirements apply at that interface of the TE which connects directly (by galvanic means) to the PSTN via a network termination point. The TE may be stimulated to perform the test by additional equipment if necessary.

This standard specifies the connection arrangements (plug or socket, at the suppliers choice) to be provided by the TE. An adapter may be required between the terminal and the existing national network termination point in individual countries. Requirements on such an adapter is outside the scope of this standard.

Where the origination or reception of calls by the TE is invoked, or otherwise controlled, by other equipment external to the TE, the TE must still be capable of fulfilling the essential requirements under Articles 4(d) and 4(f) at the interface to the public network. This standard requires the manufacturer or supplier of the TE to declare the conditions that must be met by such external devices so that their use does not cause the TE to fail to meet the essential requirements.

This standard also covers TE intended only for line monitoring or signal detection.

2 Normative references

The following standards contain requirements, which through reference constitute requirements of this standard.

[1] Miniature 6-position plug as described in FCC 47, CFR 68.500: Code of Federal Regulations (USA); Title 47 Telecommunication; Chapter 1 Federal Communications Commission, Part 68 Connection of Terminal Equipment to the Telephone Network, Subpart F Connectors; Section 68.500 Specification

ITU-T Recommendations:

[2]	P.64 (1993)	Determination of sensitivity/frequency characteristics of local telephone systems.
[3]	P.79 (1993)	Calculation of loudness ratings for telephone sets.
[4]	G.100	Definitions used in fascicle III. 1.

3 Definitions and abbreviations

3.1 Definitions

3.1.1 ***automatic repeat call attempts:*** An automatic repeat call attempt made by the TE to the same network address as the result of the failure of the previous call attempt and not as a result of an external stimulus to the TE.

3.1.2 ***call attempt:*** The process by which the TE seizes the PSTN line and sends signalling characters of the network address with which the TE wishes to communicate.

3.1.3 ***Longitudinal Conversion Loss (LCL):*** As described in ITU-T Recommendation G.117 subclause 4.1.3.

3.1.4 ***Network Termination Point (NTP):*** The physical point at the boundary of the PSTN intended to accept the connection of a TE.

NOTE: See figure 1.

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3.1.5 ***Output Signal Balance (OSB):*** As described in ITU-T Recommendation G.117 subclause 4.3.1.

3.1.6 ***peak to peak voltage:*** Peak to peak voltage in this document is the difference between the maximum and minimum voltage during any 10 ms window.

3.1.7 ***power level:*** The power level (in dBm) is based on apparent power and is obtained as

$$10\log_{10}\left(\frac{1000U_{meas}^2}{|Z_{1020}|}\right)$$

where U_{meas} is the measured voltage rms value and $|Z_{1020}|$ is the absolute value of the measuring impedance at 1 020 Hz.

3.1.8 ***Public Switched Telephone Network (PSTN):*** The term is used to describe the ordinary telephone system including subscriber lines, local exchanges and the complete system of trunks and the exchange hierarchy which makes up the network.

3.1.9 ***reference impedance (Z_R):*** The complex impedance made up of 270 ohms in series with a parallel combination of 750 ohms and 150 nF.

NOTE: See figure A.1.

3.1.10 ***repeat call attempt:*** A further call attempt to the same network address resulting from a failure to establish communication during the previous call attempt.

3.1.11 ***repeat call attempt sequence:*** A series of internally generated automatic repeat attempts made in response to an initial call attempt.

NOTE: Additional, but separate, call requests are permitted to initiate separate repeat attempt sequences.

3.1.12 ***return loss:*** As described in ITU-T Recommendation G. 100 [4] subclause 1.5.

3.1.13 ***Terminal Connection Point (TCP):*** The point of the TE that is intended to be connected to the PSTN, via a mechanical adapter or installation facilities, if needed. See figur 1.

3.1.14 ***Terminal Equipment (TE):*** Equipment intended to be connected to the PSTN i.e.:

a) to be connected directly to the termination of the PSTN, or

b) to interwork with the PSTN being connected directly or indirectly to the termination of PSTN in order to send, process or receive information.

3.1.15 ***loop state:*** The state where the TE draws sufficient DC current to activate the exchange.

3.1.16 ***loop steady state:*** A loop state excluding the transitions from and to quiescent state.

3.1.17 ***quiescent state:*** The state where the TE draws insufficient DC current to activate the exchange.

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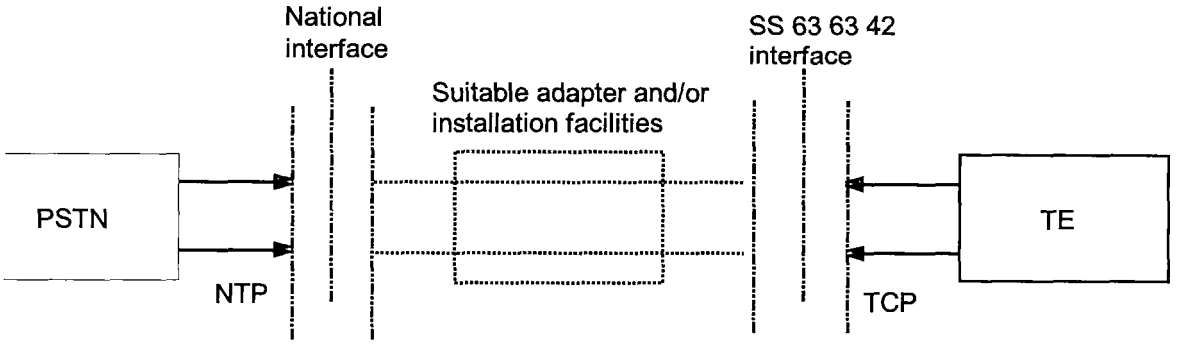

Figure 1 – Network Termination Point (NTP) and Terminal Connection Point (TCP)

3.2 Abbreviations

AC	Alternating Current
DC	Direct Current
DTMF	Dual Tone Multi-Frequency (MFPB or MF)
EMC	Electromagnetic Compatibility
LCL	Longitudinal Conversion Loss
NTP	Network Termination Point
OSB	Output Signal Balance
PSTN	Public Switched Telephone Network
rms	root mean square
SLR	Send Loudness Rating
TCP	Terminal Connection Point
TE	Terminal Equipment

4 Technical requirements

4.1 General requirement

Justification: Where the origination or reception of calls by the TE is invoked, or otherwise controlled by other equipment external to the TE, the TE shall still be capable of fulfilling the essential requirements under Articles 4(d) and 4(f) of directive 91/263/EEC at the interface to the public network.

Requirement: Where the origination or reception of calls by the TE is invoked, or otherwise controlled by other equipment external to the TE, the manufacturer or supplier of the TE shall declare the conditions that need to be met by such external devices so as to enable the user to ensure that their use does not cause the TE to fail to meet the essential requirements.

Test: By confirming the presence of such declaration.

4.2 Physical characteristics of connection to the PSTN

Justification 91/263/EEC, Article 4(f); Interworking with the PSTN is assured by requiring the TE to have a known type of connection arrangement.

Requirement: The TE shall provide a connector either as a plug or as a socket. The connector, if a plug, shall be capable of connecting with a miniature 6-position socket as specified in 47 CFR 68.500 [1] clause (b) and, if a socket, shall be capable of connecting with a miniature 6-position plug as specified in 47 CFR 68.500 [1] clause (a).

NOTE 1: The TE may include a means (e.g. a lead) which adapts an interface of the TE to the connector described in this clause upon which the TCP is presented. The requirements of this standard apply at the TCP and this means is considered to be an integral part of the TE.

NOTE 2: This connector is often referred to as RJ 11/12.

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Table 1 – Contact assignments

Contact number	*Contact function*
1	Unspecified
2	Unspecified
3/4	TCP
5	Unspecified
6	Unspecified

Test: By visual inspection. The interworking capability is verified through the tests in annex A.

4.3 Requirements in all conditions

4.3.1 *Polarity*

Justification 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to operate with both polarities, since a fixed polarity is not guaranteed.

Requirement: The TE shall conform to the requirements of this standard for both polarities of line feeding voltage.

Test: Where tests with both polarities are needed this is indicated in relevant clauses in annex A.

4.4 Requirements in quiescent state

4.4.1 *DC resistance*

Justification: 91/263/EEC, Article 4(f); Interworking with the PSTN is assured by requiring the TE to present a sufficiently high DC resistance in quiescent state so as not to disturb the basic call control and to prevent the malfunction of network call control equipment.

Requirement: The current drawn by the TE when connected to a source of:

a) 100 VDC

b) 50 VDC

c) 25 VDC

shall not exceed that which would be drawn by a MΩ resistor replacing the TE.

Test: The test shall be conducted according to annex A, subclause A.4.4.1.

4.4.2 *Impedance for ringing signals*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to present an impedance to ringing signals that is sufficiently high.

Requirement: The impedance of the TE at frequencies of 25 Hz and 50 Hz shall not be less than 4 kΩ when tested at 30 V rms.

NOTE: TE designer should notice that in order to ensure proper function of TEs that will be connected in parallel and/or series to an NTP, the impedance for ringing signals should have a significantly higher value e.g. at least 12 k(.

Test: The test shall be conducted according to annex A, subclause A.4.4.2.

4.4.3 *Impedance unbalance about earth*

Justification 91/263/EEC, article 4(d); Protection of the PSTN from harm. Unbalance may cause crosstalk. The impedance unbalance about earth is expressed as the Longitudinal Conversion Loss.

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Requirement: Where the supplier's instruction states that a connection to earth is intended, the Longitudinal Conversion Loss when the AC termination of the TE is 600 Ω shall be at least the values given in table 2 and figure 2.

Table 2 – Longitudinal Conversion Loss, minimum values

Frequency range Hz	***Minimum value*** dB
50 to 600	40
600 to 3 400	46

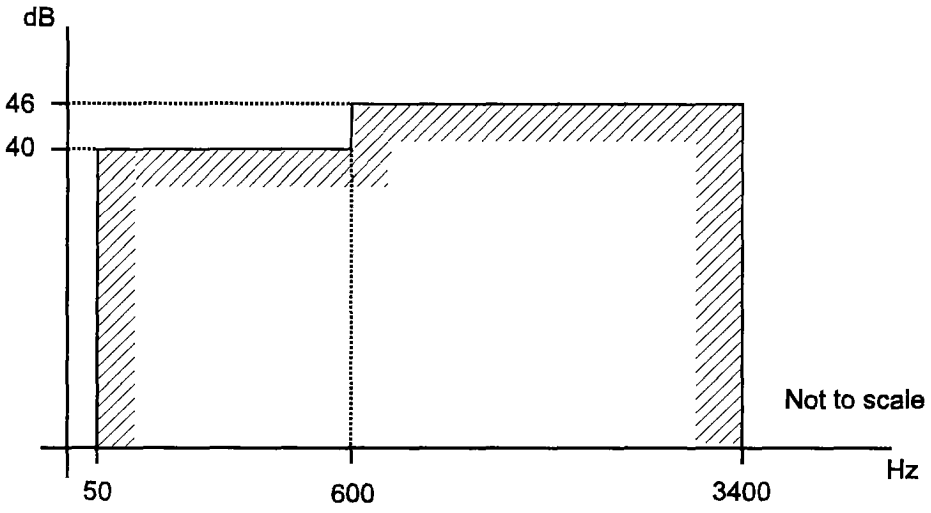

Figure 2 – Longitudinal Conversion Loss, minimum values

Test: The test shall be conducted according to annex A, subclause A.4.4.3.

4.4.4 *Resistance to earth*

Justification: 91/263/EEC, Article 4(f); Interworking with the PSTN is assured by requiring the TE to present a sufficiently high DC resistance to earth in the quiescent state to prevent the malfunction of network call control equipment.

Requirement: Where the supplier's instruction states that a connection to earth is intended, the DC resistance between each line terminal of the TE and earth in quiescent states when tested at 100 V DC shall be not less than 10 MΩ.

Test: The test shall be conducted according to annex A, subclauses A.4.4.4.

4.4.5 *AC impedance*

There is no mandatory requirement under this standard.

NOTE: TE designers should notice that in order to ensure proper function of TEs that will be connected in parallel and/or series to an NTP, the impedance in the frequency range 300 Hz to 3400 Hz and at 12 kHz should exceed 10 kΩ.

4.5 Ringing signal detector sensitivity

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to detect valid ringing signals.

Requirement: If a ring detect function is provided and enabled, the TE shall be able to respond to ringing signals of 30 Vrms at 25 Hz and 50 Hz with a cadence of 1 s ON and 5 s OFF superimposed on a 50 VDC feeding voltage.

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The response shall be as stated by the supplier.

NOTE 1: For example, a TE might

– generate a signal denoting an incoming call in accordance with the supplier's instruction;

or be configured to seize the line.

NOTE 2: TE designers should notice that the following two types of ringing signals are also frequently used in the PSTN:

– 25 Hz with a cadence of 330 ms ON, 330 ms OFF, 330 ms ON and 5000 ms OFF;

– 25 Hz with a cadence of 300 ms ON and 400 ms OFF.

NOTE 3: PSTN test signals and unintended induction from power lines may cause significant signal levels to appear on the line. Such conditions may cause incorrect interworking if the TE does not provide sufficient immunity.

Test: The test shall be conducted according to annex A, subclause A.4.5.

4.6 Acceptance of breaks in the loop in a call attempt

There is no mandatory requirement under this standard.

NOTE: TE designers should notice that in certain areas of Sweden the PSTN executes a line test before dial tone sending when loop state has been established for the purpose of making a call. During this line test the feeding voltage may be interrupted for a period of up to 0,85 s.

4.7 General loop steady state requirements

The requirements during the loop steady state apply when the TE has been in the loop state for a minimum of 1,2 s with a line feeding current which can be obtained when the TE is connected to a source of 50 VDC in series with a resistor within the range of 850 Ω to 3 200 Ω.

NOTE: TE designers should notice that in certain areas of Sweden and in exceptional cases the PSTN may provide lower line feeding currents. The lowest current that can be obtained corresponds to a source of 50 V DC in series with a resistor of 3 800 Ω.

4.7.1 *DC characteristics*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to have an appropriate DC characteristic.

Requirement The DC voltage across the TE shall not exceed the limits given in table 3 and shown in figure 3 when connected to a source of 50 V DC in series resistances within the range 850 Ω to 3 200 Ω.

Table 3 – TE voltage/current characteristics

Point	***Current*** **mA**	***Voltage*** **V**
A	0	9,0
B	20,0	9,0
C	42,0	14,5
D	50,0	40,0
Limits for intermediate currents are found by drawing a straight line between the break points on a linear (current) - linear (voltage) scale.		

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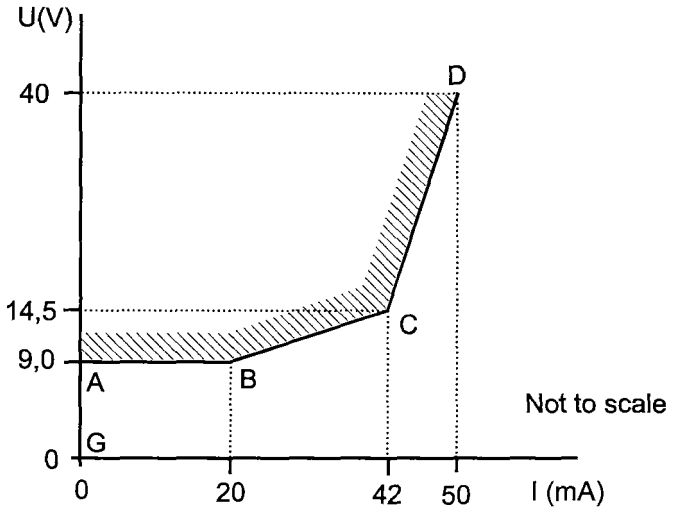

Figure 3 – TE voltage/current characteristics

Test: The test shall be conducted according to annex A, subclause A.4.7.1.

4.7.2 *Impedance*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to present an impedance which will allow proper functioning of call control and to maintain stability in the PSTN.

Requirement: The return loss against the reference impedance Z_R shall be at least 6 dB within the frequency range 200 Hz to 300 Hz and at least 8 dB within the frequency range 300 Hz to 4 000 Hz.

Test: The test shall be conducted according to annex A, subclause A.4.7.2.

4.7.3 *Sending power limitations, where the output signal is generated electrically within the TE*

4.7.3.1 *Mean sending level*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm is assured by limiting the signal sent into the PSTN by the TE so that the interfering effects of the signal can be predicted and avoided.

Requirement: The mean sending level in the frequency range 200 to 3 800 Hz in any one-minute period shall not be greater than -9 dBm when the TE interface is terminated with the reference impedance Z_R. This requirement does not apply to DTMF signals.

Test: The test shall be conducted according to annex A, subclause A.4.7.3.1.

4.7.3.2 *Instantaneous voltage*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm is assured by limiting the signal sent into the PSTN by the TE so that the interfering effects of the signal can be predicted and avoided.

Requirement: The peak to peak voltage in the frequency range 200 to 3 800 Hz shall not exceed 5,0 V when the TE interface is terminated with the reference impedance Z_R.

Test: The test shall be conducted according to annex A, subclause A.4.7.3.2.

4.7.3.3 *Power level in a 10 Hz bandwidth*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm is assured by limiting the signal sent into the PSTN by the TE so that the interfering effects of the signal can be predicted and avoided.

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Requirement: The power level within a 10 Hz bandwidth centred at any frequency within the range 30 Hz to 4 300 Hz, and wholly contained within that frequency range, shall not exceed the limits given in table 4 and figure 4 when the TE interface is terminated with the reference impedance Z_R. The requirement does not apply during sending of DTMF signals.

Table 4 – Power level in a 10 Hz bandwidth

Point	*Frequency* kHz	*Power level* dBm
A	0,03	-33
B	0,1	-10
C	0,2	-6
D	3,8	-6
E	3,9	-10
F	4,0	-16
G	4,3	-44
Limits for intermediate frequencies are found by drawing a straight line between the break points on a logarithmic (Hz) - linear (dB) scale.		

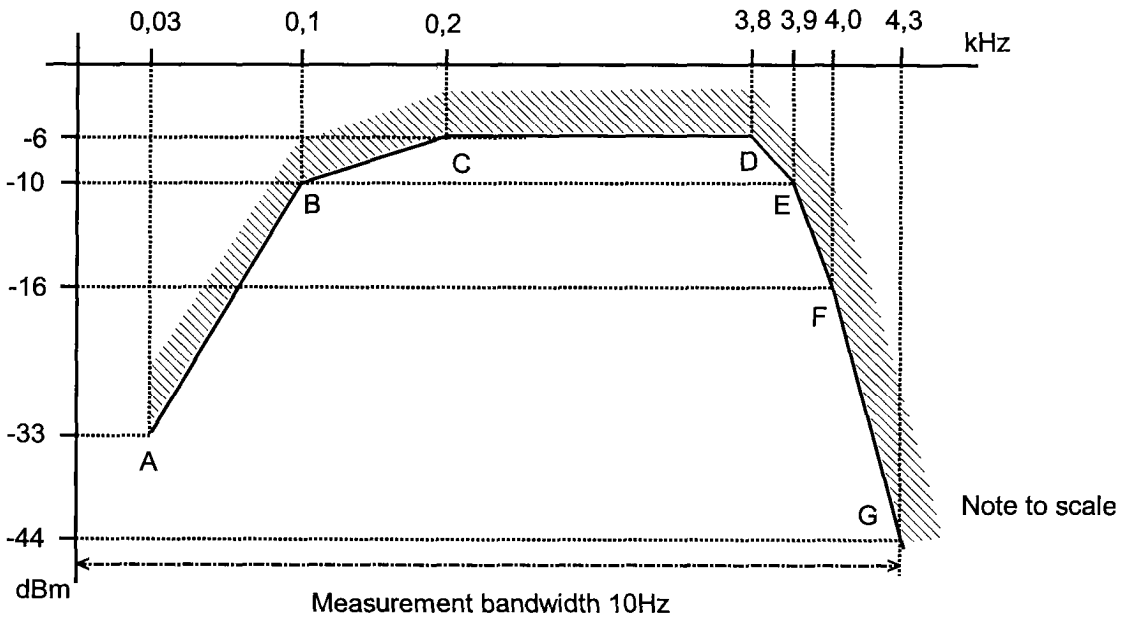

Figure 4 – Power level in a 10 Hz bandwidth

Test: The test shall be conducted according to annex A, subclause A.4.7.3.3.

4.7.3.4 *Sending power level above 4,3 kHz*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm is assured by limiting the signal sent into the PSTN by the TE so that the interfering effects of the signal can be predicted and avoided.

Requirement: The total power level in a bandwidth defined in table 5 wholly contained within the frequency range 4,3 kHz to 100 kHz, arising from normal operation of the TE, when terminated with the reference impedance Z_R, shall not exceed the limits shown in table 5 and figure 5. However during tone signaling (e.g. DTMF signaling, and exchange of control signals end to end) the limits given in table 5 and figure 5 do not apply and are replaced by the following:

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The level of any single frequency component in the range 4,3 kHz to 20 kHz, shall not exceed -35 dBm.

The level of any single frequency component in the range 20 kHz to 100 kHz, shall not exceed -40 dBm.

NOTE: "Normal operation of the TE" is defined in the test, see annex A, subclause A.1.3.

Table 5 – Sending power level above 4,3 kHz

Points	*Frequency range* kHz	*Power level in a specified bandwidth* dBm	*Measurement bandwidth* kHz
G to H	4,3 to 5,1	-39,3 decreasing to -43,3	0,3
H to I	5,1 to 8,9	-43,3	0,3
I to J	8,9 to 11	-43,3 decreasing to -57,8	0,3
J to K	11 to 100	-57,8	1
Limits for intermediate frequencies are found by drawing a straight line between the break points on a logarithmic (Hz) - linear (dB) scale.			

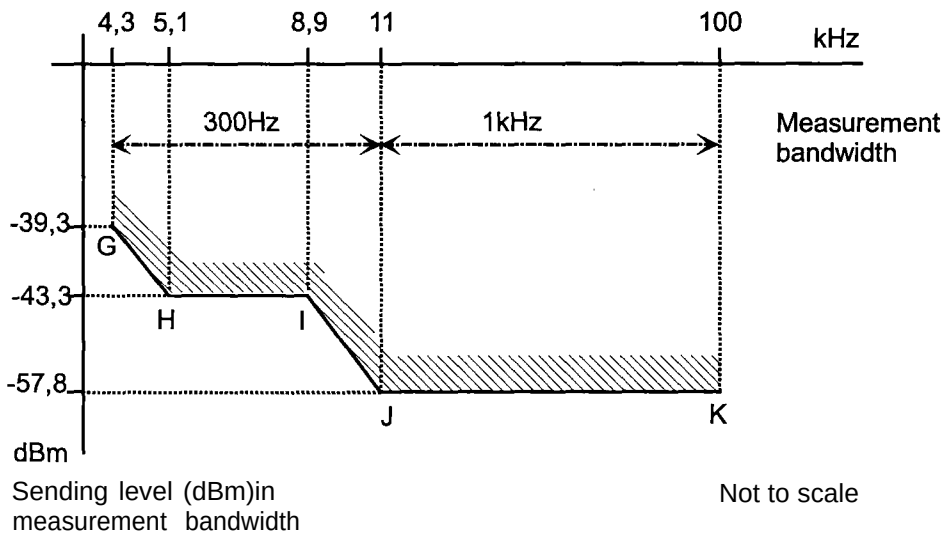

Figure 5 – Sending power level above 4,3 kHz

Test: The test shall be conducted according to annex A, subclause A.4.7.3.4.1 and A.4.7.3.4.2.

4.7.4 *Sending power limitations in case the output signal is generated in real time from an integral acoustic source*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm is assured by limiting the signal sent into the PSTN by the TE so that the interfering effects of the signal can be predicted and avoided.

Requirement: The minimum SLR of the TE, when terminated with the reference impedance Z_R, shall be greater than or equal to -5 dB.

NOTE: The minimum SLR refers to the actual measured value rather than the nominal value, i.e. there is no tolerance on the specified value.

Test: The test shall be conducted according to annex A, subclause A.4.7.4.

4.7.5 *Impedance unbalance about earth*

4.7.5.1 *Longitudinal Conversion Loss*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm. Unbalance may cause crosstalk.

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Requirement: Where the supplier's instruction states that a connection to earth is intended, the Longitudinal Conversion Loss when the AC termination of the TE is 600 Ω shall be at least the values given in table 6 and figure 6.

Test: The test shall be conducted according to annex A, subclause A.4.7.5.1.

4.7.5.2 *Output Signal Balance*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm. Unbalance may cause crosstalk.

Requirement: Where the supplier's instruction states that a connection to earth is intended, the Output Signal Balance when the AC termination of the TE is 600 Ω shall be at least the values given in table 6 and figure 6. This requirement only applies at frequencies where the unbalance level exceeds -65 dBm with the method shown in clause A.4.7.5.2.

Test: The test shall be conducted according to annex A, subclause A.4.7.5.2.

Table 6 – Output Signal Balance and Longitudinal Conversion Loss, minimum values

Frequency range Hz	***Minimum value*** dB
50 to 600	40
600 to 3 400	46
3 400 Hz to 3 800 Hz	40

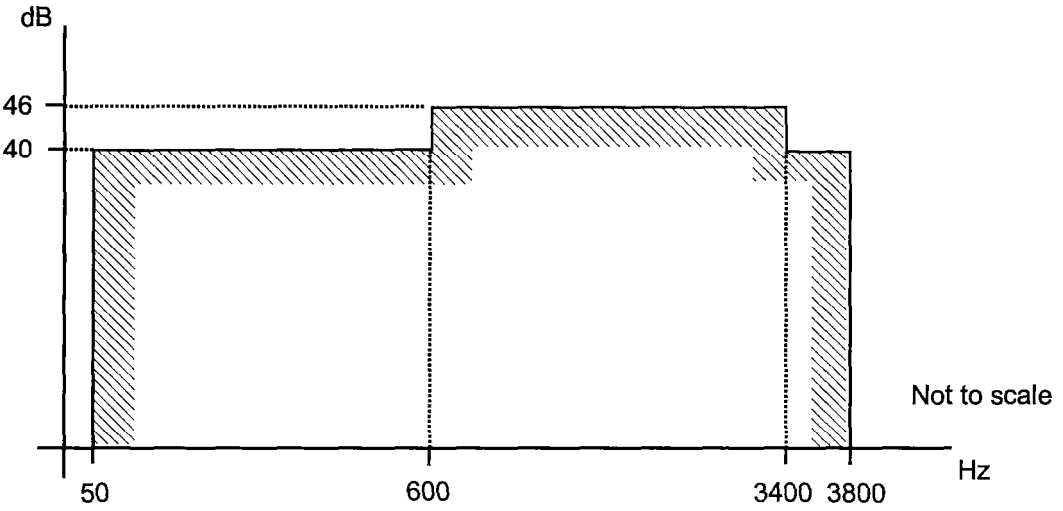

Figure 6 – Output Signal Balance and Longitudinal Conversion Loss, minimum values

4.7.6 *Resistance to earth*

Justification: 91/263/EEC, Article 4(f); Interworking with the PSTN is assured by requiring the TE to present a sufficiently high DC resistance to earth in the loop state so as not to disturb the basic call control function.

Requirement: Where the supplier's instruction states that a connection to earth is intended, the DC resistance between a line terminal of the TE and earth in loop state when tested at 100 V DC shall be not less than 1 MΩ.

Test: The test shall be conducted according to annex A, subclauses A.4.7.6.

4.8 Call attempt

All requirements in clause 4.7 do also apply during call attempt.

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4.8.1 *Automatic dialling*

This requirement applies only to a TE with an automatic seizing and dialling function. It applies when the TE is in automatic dialling mode.

NOTE: TE designers should notice that in certain areas of Sweden the PSTN is not ready to receive the digits following the country code of an international number until the PSTN has presented a second dial tone.

4.8.1.1 *Dialling without dial tone detection*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring a TE with automatic dialling to start sending its digits during the time period when the PSTN is ready to receive digits under normal conditions.

Requirement: The TE shall start dialling not earlier than 2,7 s but shall commence dialling before 8 s has elapsed after the loop state is established. Where adjustments are available to the user, resulting in a lower value, this is acceptable as long as the 2,7 s limit remains within the available range.

Test: The test shall be conducted according to annex A, subclause A.4.8.1.1.

4.8.1.2 *Dialling with dial tone de detection*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring a TE with automatic dialling to start sending its digits during the time period when the PSTN is ready to receive digits.

Requirement: If the TE is intended for automatic dialling with an automatic dial tone detection, and this facility is enabled in accordance with the supplier's instruction, it shall start dialling within 8 s of the start of the application of a continuos dial tone.

For the purposes of this requirement, the dial tone is defined as a single tone signal, delivered from a generator with a source impedance equal to Z_R, in the frequency range 300 Hz to 500 Hz, whose level is between -35 dBm and -0 dBm when measured across the reference impedance Z_R which substitutes the TE.

NOTE: TE designers should notice that in conjunction with common supplementary services (e.g. Call Forwarding) the PSTN delivers a cadenced dial tone with a frequency of 425 ± 15 Hz consisting of a repeated sequence with a period of 320 ±30 ms ON followed by 25 ± 15 ms OFF.

Test: The test shall be conducted according to annex A, subclause A.4.8.1.2.

4.8.2 *DTMF signaling*

4.8.2.1 *Frequency combinations*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to send digits that the network will accept.

Requirement: The TE shall use DTMF signalling characters according to table 7. However, the number of characters supported by the TE can be restricted, in which case only those frequencies assigned to the supported characters shall be used. The tolerances on the frequencies for the characters supported shall be ± 1,5 %.

Table 7 – DTMF signalling frequency combinations

Low group	***High group***			
Hz	1209 Hz	1336 Hz	1477 Hz	1633 Hz
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

Test: The test shall be conducted according to annex A, subclause A.4.8.2.1.

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4.8.2.2 *Signalling levels*

4.8.2.2.1 *Absolute levels*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to send digits that the network will accept.

Requirement: The level of any tone in the DTMF high frequency group shall be -8,3 dBm + 2,0/- 2,5 dB and the level of any tone in the low frequency group shall be -10,3 dBm +2,5/(2,0 dB when the TE interface is terminated with the reference impedance Z_R.

Test: The test shall be conducted according to annex A, subclause A.4.8.2.2.

4.8.2.2.2 *Level difference*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to send digits that the network will accept.

Requirement: During sending of any DTMF frequency combination, the level of the tone in the high frequency group shall be 1 dB to 4 dB higher than the level of the tone in the low frequency group.

Test: The test shall be conducted according to annex A, subclause A.4.8.2.2.

4.8.2.3 *Unwanted frequency components*

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to send digits that the network will accept.

Requirement: When transmitting any DTMF tone combination during a call attempt, the total power level of all unwanted frequency components in the frequency range 250 Hz to 4300 Hz shall be at least 20 dB below the low group frequency component.

Test: The test shall be conducted according to annex A, subclause A.4.8.2.3.

4.8.2.4 *Tone duration*

This requirement applies where the DTMF signalling tone duration is controlled automatically by the TE.

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to send DTMF tones for a minimum period of time in order that the receivers in the exchange can recognise the digit being sent.

Requirement: The TE shall provide a setting whereby the duration for which any individual DTMF tone combination is sent is not less than 65 ms. The time shall be measured from the instant when the tone reaches 90 % of its steady-state value, until it has dropped to 90 % of its steady-state value.

Test: The test shall be conducted according to annex A, subclause A.4.8.2.4.

4.8.2.5 *Pause duration*

This requirement applies where the DTMF signalling pause duration is controlled automatically by the TE.

Justification: 91/263/EEC, article 4(f); Interworking with the PSTN is assured by requiring the TE to provide a minimum period of ”Tone Off” between DTMF digits in order that the receivers in the exchange can differentiate the end of one digit from the start of the next.

Requirement: The TE shall provide a setting whereby the duration of the pause between any individual DTMF tone combination is not less than 65 ms. The time shall be measured from the instant when the tone has dropped to 10 % of its steady-state value, until it has risen to 10 % of its steady-state value.

Test: The test shall be conducted according to annex A, subclause A.4.8.2.5.

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4.8.3 *Automatically repeated call attempts*

Justification: 91/263/EEC, article 4(d); Protection of the PSTN from harm is achieved by restricting the automatically repeated call attempts from the TE.

Requirement: The TE shall not automatically initiate an internally generated repeat call attempt less than 5 s after the termination of the previous call attempt in the same repeat attempt sequence. The previous call attempt is considered to be terminated when the TE returns to the quiescent state. There shall be no more than 15 repeated call attempts in a repeated call attempt sequence.

NOTE: Although this standard permits repeat call attempts to be made after an interval of 5 seconds, the interval between repeat call attempts, in most practical applications, will usually be set to be considerably greater than this so as to provide an appropriate compromise between the rate of redialling and the likelihood of the repeat call attempt being successful. Where this interval is user adjustable, TE supplier's are recommended to provide guidance to users on how to select a setting that would best suit the types of applications for which the TE is intended (e.g. taking into account the typical holding times for calls).

Test: The test shall be conducted according to annex A, subclause A.4.8.3.

4.8.4 *Decadic dialling*

There is no mandatory requirement under this standard.

NOTE: Decadic dialling, if provided by the TE, should be implemented in accordance with ETS 300 001.

4.9 Register recall

There is no mandatory requirement under this standard.

NOTE: TE designers should notice that in order to ensure proper functioning, the register recall signal, if provided by the TE, should be implemented in accordance with ETS 300 001.

4.10 Reception of metering pulses

There is no mandatory requirement under this standard.

NOTE: TE designers should notice that in order to ensure proper functioning, the reception of 12 kHz call meter pulses, if provided by the TE, should be implemented in accordance with ETS 300 001.

4.11 Safety

There are no safety requirements under this standard.

NOTE: Safety requirements are imposed under directive 73/23/EEC, and articles 4(a) and 4(b) of EC Directive 91/263/EEC.

4.12 EMC

There are no EMC requirements under this standard.

NOTE: There are no specific EMC requirements arising from article 4(c) in directive 91/263/EEC, and consequently all EMC aspects are covered by EC Directive 89/336/EEC.

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Annex A
(normative)

Test methods

A.1 Scope

This annex describes the test principles to determine the compliance of a PBX against the requirements of this Swedish Standard.

Subclauses under A.4, Test methods, specify test methods for corresponding clauses of the requirements, clause 4. Any subclause omitted is non-relevant.

If inconsistencies are discovered between this test annex and the requirements then the requirements shall take precedence in problem resolution.

A.2 General

TE may require the provision of external termination or stimuli in order to assess its conformity with this standard. In this case, such termination or stimuli shall need to be provided in order for the tests to be carried out but shall not influence the results of measurements which shall be obtained under the normal operating condition of the TE. In order to do this, it may be necessary for the supplier to provide additional equipment or information for the purpose of test.

The test configurations given do not imply a specific realisation of test equipment or arrangement or use of specific test devices for conformance testing. The test parameters defined in this annex are ”ideal” parameters. Equipment accuracies or component tolerances are not prescribed for test implementations, with the exception of guidance and information notes. Any deviations from the ideal which are present when using real test implementations shall be taken into account in calculating measurement uncertainty. Correction of systematic effects may be used to reduce measurement uncertainty.

Where test methods other than those specified are used the test report shall include statements that uniquely identify the selected test methods. However full technical details of the test methods need not be included in the test report.

NOTE: This is intended to allow traceability where alternative test methods are used

The test equipment shall be a device, or group of devices, generating a stimulus signal and providing the test conditions (e.g. feeding conditions) conforming to this annex and capable of monitoring the received signal from the interface.

A.3 Test conditions

A.3.1.1 *Equipment connection*

The tests shall be applied at the Terminal Connection Point (see figure 1).

Contact number	*Test socket connected to*
1	Unconnected, see note 1 below
2	Unconnected, see note 1 below
3/4	TCP
5	Unconnected, see note 1 below
6	Unconnected, see note 1 below

NOTE 1: For special application, pins (other than 3 and 4) may be intended to be additionally in contact with the NTP. In this case the supplier shall indicate the function of such pins and during the test they will be connected as would be intended during normal operation.

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NOTE 2: See subclause A.3.1.4 for additional connections for performing measurements to earth.

NOTE 3: A special test adapter may be needed to connect the TE with the test instruments, however this adapter should not modify the characteristics of the TE.

A.3.1.2 *Environment*

All tests shall be performed at

- an ambient temperature in the range from + 15 ºC to + 35 ºC;
- a relative humidity in the range from 5 % to 75 %.

For terminal equipment which is not designed to operate within the specified environmental range, all tests shall be performed at any point within the operational range specified by the supplier.

For terminal equipment which is directly powered (either wholly or partly) from the mains supply, all tests shall be carried out within ± 5 % of the rated voltage of that supply. If the equipment is powered by other means and those means are not supplied as part of the apparatus (e.g., batteries, DC supplies, stabilised AC supplies) all tests shall be carried out within the power supply limit declared by the supplier. If the power supply is AC, the test shall be conducted within ± 4 % of the rated frequency.

A.3.1.3 *Powered state*

Tests should be carried out with the TE powered under normal operating conditions defined by the supplier.

A.3.1.4 *Measurements to earth*

Where a measurement to earth is defined and the supplier's instruction states that a connection to earth is intended, then the following points should be connected to the earth:

points in the TE which are intended to be connected to the mains earth.;

connector points which are likely to be connected to earth during the normal operation of the TE.

Where the TE has no facility for connection to earth, for example by one of the above points, then the test does not apply.

A.3.1.5 *Reference levels*

Unless otherwise stated, test signal levels are defined across the reference impedance. The specified levels, expressed in dBm, are defined as the logarithmic ratio between the measured voltages rms value and the voltage that corresponds to an apparent power level of 0 dBm at 1020 Hz.

NOTE: The apparent power level of 0 dBm at 1020 Hz corresponds to a voltage of 918 mV.

A.3.1.6 *Additional information to support the test*

It is necessary for the supplier to provide facilities to allow all tests to be carried out. Examples of these facilities could be the following:

1) a facility to remain in the loop state without transmitting signals; and

2) a facility to transmit all types of signal (e.g. all data rates) that the TE transmits while not receiving any signal.

NOTE: The special test facilities such as those in 1) and 2) above need not to be provided in the product finally marketed, but provided by the supplier when needed.

However if alternative methods are feasible these are also acceptable.

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A.3.2 Test impedances

A.3.2.1 *Reference impedance*

Where the test defines the use of the reference impedance then this shall be as follows:

Reference impedance Z_R: This is a complex impedance made up of 270 Ω in series with a parallel combination of 750 Ω and 150 nF as shown in figure A. 1.

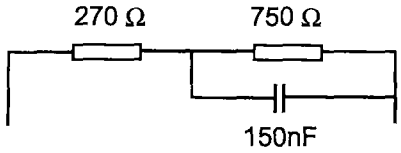

Figure A.1 – Reference impedance

NOTE 1: At 1020 Hz the modulus of the reference impedance is 842 Ω and the phase is -25,0 degrees

NOTE 2: Specific realisations of the reference impedance required for the performance of the tests should have a return loss against Z_R exceeding 40 dB over the range 200 Hz to 4 300 Hz.

A.3.2.2 *Non-reactive line termination*

NOTE All resistors specified in this annex for testing shall be nominally non-reactive, such that any resistor or group of resistors shall have a reactive impedance at any frequency in the range to be measured, not exceeding 0,5 % of the nominal impedance.

A.3.3 Feeding bridge

The feeding bridge specified in this annex is a configuration of test equipment used to:

- apply to the TE terminals electrical conditions consistent with those defined in the test;
- suitably couple measurement equipment to the TE terminals.

The feeding bridge is assumed to be ideal, so that

- DC feeding and AC termination of the TE are as defined in the test;
- all measurements are referenced to the TE terminals (e.g. the feeding bridge does not cause an attenuation or delay, in the parameter to be measured, between the TE terminals and the measuring equipment).

If requested by the supplier (e.g. for TE with an adaptive filter) the TE shall be reset before repeating a test with a different feeding condition.

Within individual test cases, ”AC termination of TE” defines the total AC impedance to be seen by the TE including all test equipment (feeding bridge, measuring equipment, reference impedance fixtures, etc.).

A.4 Test methods

One test may cover more than one requirement. The scope of each testis defined under the heading ”purpose”.

NOTE The numbering below refers to the numbering in the main document, clause 4. Only those subclauses inferring test methods are included in this annex.

A.4.1 General requirement

Test by visual inspection.

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A.4.2 Physical characteristics of connection to the PSTN

Test by visual inspection.

A.4.3 Requirements in all conditions

A.4.3.1 *Polarity*

Where tests with both polarities are needed this is indicated in relevant clauses in this annex.

A4.4 Requirements in quiescent state

A.4.4.1 *DC Resistance*

Requirement: Subclause 4.4.1

Purpose: To check whether the TE presents a resistance of at least 1 M when tested at 25 VDC, 50 VDC and 100 V DC in the quiescent state.

Measurement principle:

Preamble: Set the TE in quiescent state.
Test state: Quiescent state.

Test configuration:

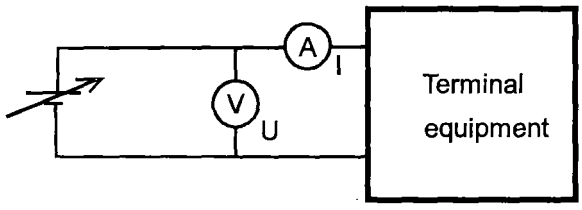

Figure A.2

Measurement points: U = 25 VDC, 50 VDC and 100 V DC.

Measurement execution:

Apply test voltage U between the TE line terminals for at least 30 s before measuring DC current I. The test is carried out for both polarities of the applied voltage.

Formal processing: None

Verdict: If when tested at voiltage U the current I is $\leq I_{max}$ in table A.1 then Pass; else Fail.

Table A.1

U (VDC)	I_{max} (µA)
25	25
50	50
100	100

Guidance: None

A.4.4.2 *Impedance for ringing signals*

Requirement: Subclause 4.4.2.

Purpose: To determine whether the TE presents an impedance in the quiescent state during ringing within the specified range.

Measurement principle:

Preamble: Set the TE in quiescent state with any auto answering facility disabled.
Test state: Quiescent state.

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Test configuration:

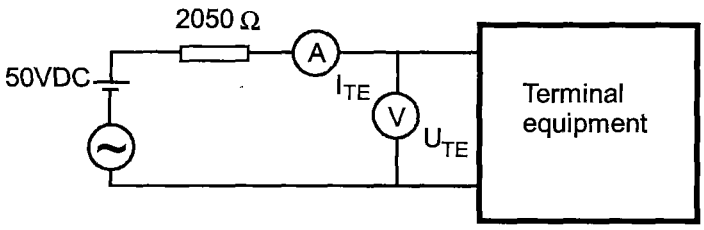

Figure A.3

DC feeding arrangement: 50 V DC.
AC feeding arrangement Sinusoidal source with frequency 25 Hz and 50 Hz adjusted to U_{TE} = 30 V rms.
Measurement points: Voltage U_{TE} and current I_{TE} measured for frequencies of 25 Hz and 50 Hz.

Safety Warning: This test presents the potential for a shock hazard; ensure that satisfactory safety precautions are implemented to reduce the risk of electric shock.

Measurement execution:
Using the test configuration shown apply the ringing signal continuously to the TE. Adjust the source voltage (UO) to set the voltage across the TE (U_{TE}) to 30 V rms. However, if U_{TE} is less than 30 V rms for a source voltage of 90 V rms then the source voltage is not increased further and the test is deemed completed. Otherwise, measure the current (I_{TE}) flowing in the circuit.

Formal processing: The impedance of the TE during ringing can be calculated using the following formula:

$$|Z_{Ri}| = \frac{U_{TE}}{I_{TE}}$$

Verdict: If it is possible to apply 30 V rms at the TE terminals with a source voltage of less than or equal to 90 V rms and if $|Z_{Ri}|$ equal to or greater than 4 kΩ then Pass; else Fail.

Guidance: True rms reading instruments should be used because voltages and currents across the TE may not be sinusoidal.

A.4.4.3 *Impedance unbalance about earth*

Requirement: Subclause 4.4.3.

Purpose: To ensure that the impedance unbalance about earth expressed as longitudinal conversion loss meets the requirements.

Measurement principle:
Preamble: Set the TE in quiescent state.
Test state: Quiescent state.

Test configuration:

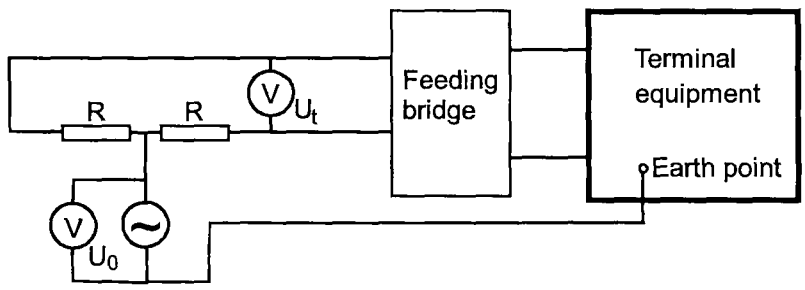

Figure A.4

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DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 850 Ω. The test shall be made with both polarities.

Measurement points: The resistors R shall be 300 Ω.
U. shall be a sinusoidal signal with a constant level of 1,0 V throughout the specified frequency range (50 Hz to 3400 Hz in 1/3 octave steps).
Measurement of the transversal voltage U_t shall be performed with a suitable frequency selective voltmeter.

Measurement execution:

Measure the voltage U_t across the specified frequency range. The test shall be carried out for both polarities of feed voltage.

Formal processing: The measured value of U_t is used to calculate the Longitudinal Conversion Loss by using the following formula at all the measurement points:

$$\text{Longitudinal Conversion Loss} = 20\log_{10}\left|\frac{U_o}{U_t}\right| \text{ dB}$$

Verdict: If the Longitudinal Conversion Loss is greater than the specified limit in table 2 and figure 2 then Pass; else Fail.

Guidance: True rms reading instruments should be used because voltages and currents across the TE may not be sinusoidal.

A.4.4.4 *Resistance to earth*

Requirement: Subclause 4.4.4.

Purpose: To check whether the TE complies with subclause 4.4.4 in the quiescent state.

Measurement principle:

Preamble: Set the TE in quiescent state.
Test state: Quiescent state.

Test configuration:

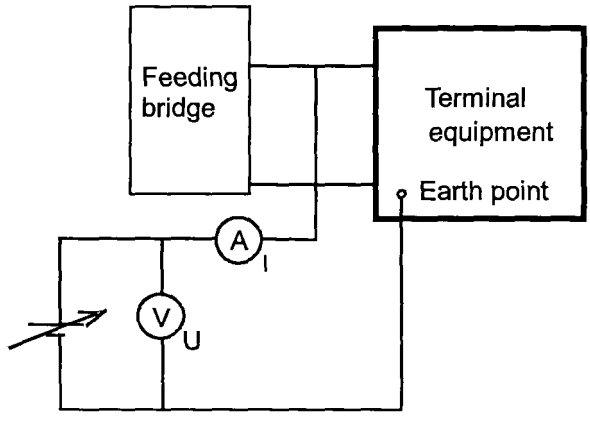

Figure A.5

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 805 Ω.
Measurement points: U = 100 volts DC.

Measurement execution:

Apply test voltage U between one of the line terminals and the earth connection point or points specified by the supplier's instruction for at least 30 s before measuring current I. The test shall be carried out for both line terminals and for both polarities of the applied test voltage and applied feeding voltage.

Formal processing: Resistance to earth (R)= U/I.

Verdict: If R ≥ 10 MΩ then Pass; else Fail.

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Guidance: None.

A.4.5 Ringing signal detector sensitivity

Requirement: Subclause 4.5.

Purpose: To determine the ability of the TE to detect ringing signals as specified by the supplier.

Measurement principle:

Preamble: Set the TE in quiescent state with any auto answering facility enabled.
Test state: Quiescent state.

Test configuration:

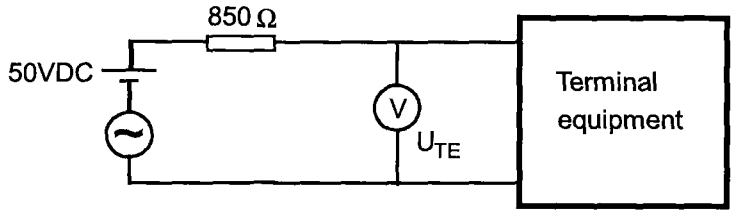

Figure A.6

DC feeding arrangement: Feed voltage= 50 V DC.

Measurement points: The ringing signal shall have a sinusoidal source of 25 Hz and 50 Hz and a cadence of 1 s ON and 5 s OFF. U_{TE} = 30 Vrms.

Safety Warning: This test presents the potential for a shock hazard. Ensure that satisfactory safety precautions are implemented to reduce the risk of electric shock.

Measurement execution:

Using the test configuration shown in figure A.6, apply, one at a time, each one of the ringing signals described in "Measurement points" to the circuit to determine whether they are detected by the TE as stated by the supplier.

Formal processing: None.

Verdict: If TE detects both the ringing signals above described in "Measurement points" then Pass; else Fail.

Guidance: For automatic answering TE, after the stimulation to cause the seizure, the requirement 4.7.1 and its associated test case apply.

A.4.7 General loop state requirements

A.4.7.I *DC characteristics*

Requirement: Subclause 4.7.1.

Purpose: To verify that the steady-state DC loop characteristics are within the templates given in table 3, and shown in figure 3. The test only applies to TE which are capable of reaching the loop state.

Measurement principle:

Preamble: Set the TE in quiescent state.
Test state: Loop state. Test configuration:

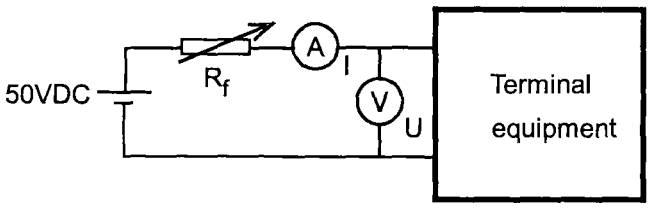

Figure A.7

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DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, 2 050 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

Measurement execution:

The measurement is started with the lowest feed resistance. Cause the TE to enter the loop state. When the TE has been in the loop state for at least 1,2 s measure the DC current drawn by the TE and the DC voltage across the TE. Allow sufficient settling time to ensure that the measured value is stable within ± 2 % for at least 0,2 s. Then repeat the test sequence for the next feed condition.

Formal processing: None.

Verdict: If the DC loop characteristics are within the templates aa given in table 3, and shown in figure 3 then Pass; else Fail. This Fail verdict shall include the situation where the DC loop characteristics are outside the templates because the TE does not maintain the loop state for minimum feeding condition.

Guidance: Allowing "sufficient settling time" is useful to ensure test repeatability and reproducibility. Nevertheless if the stated stability cannot be found, the settling time shall be limited to 3 s. In this latter case a measurement accuracy improvement may be obtained by averaging several measurement readings made during the settling time.

A.4.7.2 *Impedance*

Requirement: Subclause 4.7.2.

Purpose: To verify that the return loss of the input impedance (Z_i) of the TE in relation to the reference impedance Z_R is within the limits specified below.

Measurement principle:

Preamble: Set the TE in the loop state.
Test state: Loop state.

Test configuration:

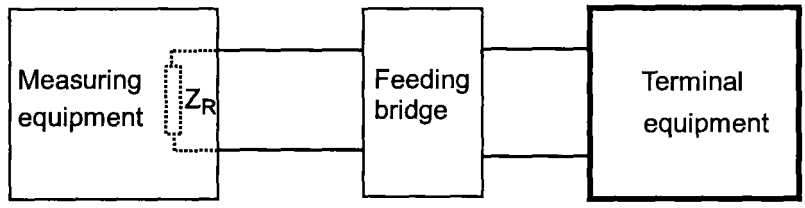

Figure A.8

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, 2 050 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

AC termination of TE: Z_R

Measurement points: The test signal shall be sinusoidal with a constant voltage, whose level shall be pre-set to that required to achieve a level of-10 dBm at the TCP. F_{min} = 200 Hz, f_{max} = 4 000 Hz with step intervals of not more than 1/3 of an octave.

Measurement execution:

When the TE has been in the loop state for at least 1,2 s measure the modulus and phase of the voltage and current flowing at the measurement frequency. Calculate the complex impedance (Z_i) of the TE.

Formal processing: Return loss $= 20\log_{10}\left|\frac{Z_R + Z_i}{Z_R - Z_i}\right|$

where Z_R is the reference impedance and Z_i is' the impedance of the TE.

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Verdict: If the return loss Ω 8 dB within the frequency range 300 Hz to 4 000 Hz and ≥ 6 dB within the frequency range 200 Hz to 300 Hz then Pass; else Fail.

Guidance: None.

A.4.7.3 *Sending power limitations, where the output signal is generated electrically within the TE*

A.4.7.3.1 *Mean sending level*

Requirement: Subclause 4.7.3.1

Purpose: To check that the mean power level in the frequency range 200 Hz to 3 800 Hz over a one-minute period is not greater than -9 dBm when the TE interface is terminated with the reference impedance Z_R.

Measurement principle:

Preamble: Set the TE in loop state.

Test state: The TE shall be in loop state and sending representative signals continuously.

Test configuration:

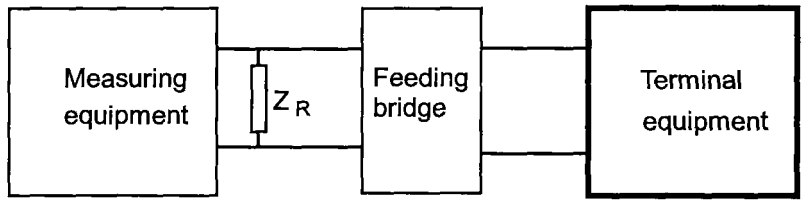

Figure A.9

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

AC termination of TE: Z_R.

Measurement points: The TE is operated in accordance with its intended use to send representative combinations of its declared output signals.

Measurement execution:

The TE is set in loop state, transmitting representative signals continuously. The mean power in the frequency range 200 Hz to 3 800 Hz transmitted across the termination points of the TE shall be determined over a one-minute period.

Formal processing: None.

Verdict: If the maximum level ≤ –9 dBm then Pass; else Fail.

Guidance: TE with adjustable output level is set up in accordance with the supplier's instruction for intended use, or in the absence of instruction, is set to send at its maximum level. The TE is then operated in accordance with its intended use. For data equipment (e.g. modems), any output signal may be a test message consisting of a representative bit pattern or a scrambled signal. For answering machines or similar equipment where the output is derived from recorded speech, any recorded signal shall have been prepared in accordance with the supplier's instruction for intended use.

A.4.7.3.2 *Instantaneous voltage*

Requirement: Subclause 4.7.3.2.

Purpose: To check that the peak to peak voltage of the TE complies with subclause 4.7.3.2.

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Measurement principle:

Preamble: Set the TE in loop state.

Test state: The TE shall be in loop state and sending representative signals continuously.

Test configuration:

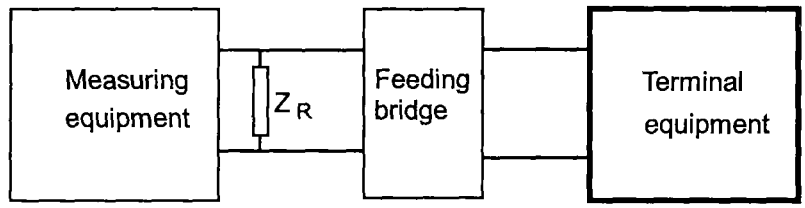

Figure A.10

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

AC termination of TE: Z_R.

Measurement points: The TE is operated in accordance with its intended use to send

a) representative combinations of its declared output signals;

b) DTMF signals.

Measurement execution:

The TE is set in the loop state, transmitting representative signals. The peak to peak voltage in the frequency range 200 to 3 800 Hz transmitted across the termination points of the TE, shall be measured.

Formal processing: None.

Verdict: If the peak to peak voltage ≤ 5,0 V then Pass; else Fail.

Guidance: Terminal equipment with adjustable output level is setup in accordance with supplier's instruction to send at its maximum intended level.

A.4.7.3.3 *Power level in a 10 Hz bandwidth*

Requirement: Subclause 4.7.3.3.

Purpose: To check that the TE complies with subclause 4.7.3.3.

Measurement principle:

Preamble: Set the TE in loop state.

Test state: The TE shall be in loop state and sending representative signals continuously.

Test configuration:

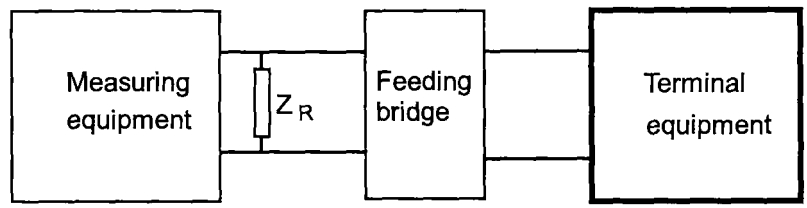

Figure A.11

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

AC termination of TE: Z_R.

Measurement points: The TE is operated in accordance with its intended use to send representative combinations of its declared output signals.

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Measurement execution:

The TE is set in loop state, transmitting representative signals continuously. The power level transmitted across the termination points of the TE is measured. It is determined whether the level within every 10 Hz bandwidth wholly contained in the frequency range 30 Hz to 4 300 Hz is less than or equal to the limits given in table 4 and figure 4. In the case of data equipment (e.g. modems) the power level shall only be measured during the data transfer phase.

Formal processing: None.

Verdict: If the levels are according to table 4 and figure 4 then Pass; else, Fail.

Guidance: TE with adjustable output level is set up in accordance with supplier's instruction to send at its maximum intended level.

A.4.7.3.4.1 *Sending power level above 4,3 kHz during communication*

Requirement: Subclause 4.7.3.4.

Purpose: To check that the TE complies with subclause 4.7.3.4 in communication state.

Measurement principle:

Preamble: Set the TE in loop state.

Test state: The TE shall be in loop state and sending representative signals continuously.

Test configuration:

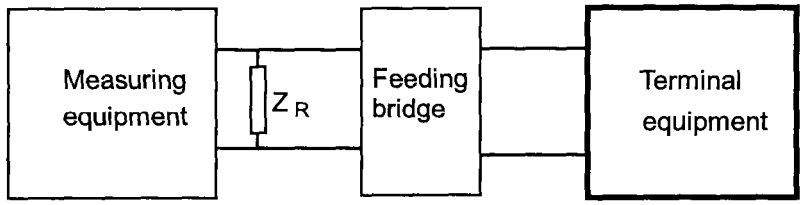

Figure A.12

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following 850 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

AC termination of TE: Z_R.

Measurement points: The TE is operated in accordance with its intended use to send representative combinations of its declared output signals.

Measurement execution:

The TE is set in loop state, transmitting representative signals continuously. The sending level across the termination points of the TE shall be measured. It is determined whether the level in any bandwidth defined in table 5, wholly contained in the frequency range 4,3 kHz to 100 kHz, is less than or equal to the limits of table 5 and figure 5. Where these limits are exceeded it is determined whether exceeding the limits is caused by tone signalling having one or more single frequency component whose individual level is less than or equal to -35 dBm in the range 4,3 kHz to 20 kHz and -40 dBm in the range 20 kHz to 100 kHz.

Formal processing: None.

Verdict: If the power level complies with table 5 and figure 5 then Pass.
If the only non-compliance with table 5 and figure 5 is due to a tone signalling with one or more single frequency components whose individual power levels are less than or equal to -35 dBm in the range 4,3 kHz to 20 kHz and -40 dBm in the range 20 kHz to 100 kHz then Pass; else, Fail.

Guidance: TE with adjustable output level is set up in accordance with supplier's instruction to send at its maximum intended level.

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A.4.7.3.4.2 *Sending power level above 4,3 kHz during DTMF dialling*

Requirement: Subclause 4.7.3.4.

Purpose: To check that the TE complies with subclause 4.7.3.4 when transmitting any DTMF tone combination during call attempt.

Measurement principle:

Preamble: Set the TE in loop state.
Test state: DTMF dialling.

Test configuration:

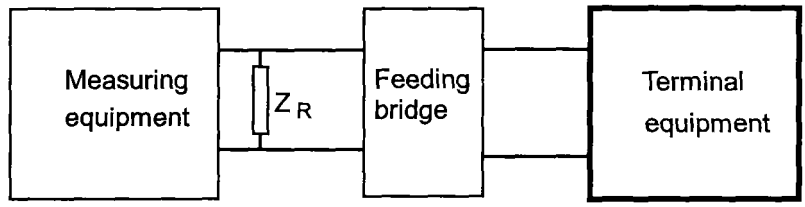

Figure A.13

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.
AC termination of TE: Z_R.
Measurement points: Where all characters of table 7 are available, select digits A, 6, 8 and *; else if all numerals are available, select digits 3, 5, 7 and 0; else select all available digits.

Measurement execution:

The TE is set in the loop state, transmitting DTMF characters to line. Measurement should be made during the tone duration as defined in subclause 4.8.2.4. (minimum duration 65 ms). It shall be determined whether all single frequency components individually have a sending level ≤ -35 dBm in the range 4,3 kHz to 20 kHz and -40 dBm in the range 20 kHz to 100 kHz.

Formal processing: None.

Verdict: If the power level of each single frequency component is less than or equal to -35 dBm in the range 4,3 kHz to 20 kHz and -40 dBm in the range 20 kHz to 100 kHz then Pass; else Fail.

Guidance: All characteristics of the TE are captured for practical purposes when the diagonal in table 7 is used, going from the digit with the largest frequency difference in its combination (highes/lowest frequency) up to the digit with the smallest frequency difference.

A.4.7.4 *Sending power limitations in case the output signal is generated in real time from an integral acoustic source*

Requirement: Subclause 4.7.4.

Purpose: To check the send loudness rating of the TE. The test consists of the performance of a sending sensitivity test at various frequencies and calculating the SLR from the results of the test.

Measurement principle:

Preamble: Set the TE in loop state.
Test state: The TE shall be in loop state.

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Test configuration:

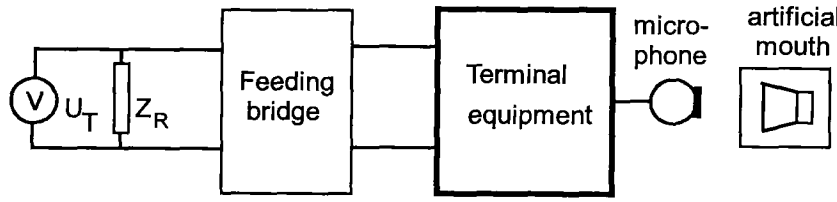

Figure A.14

DC feeding arrangement: Feed voltage: 50 V, Feed resistance: 2 050 Ω.
AC termination of TE: Z_R.

Measurement execution:

An acoustic signal at each of the frequencies shown in table A.2 and at a sound pressure level of -4,7 dBPa shall be applied at the mouth reference point as described in ITU-T Recommendation P.64 [2]. The output voltage U_t shall be measured across the reference impedance Z_R at the fundamental frequency of the stimulus. The sending sensitivity S_{mJ} is determined using the method described in ITU-T Recommendation P.64 [2], clause 9 (clause 6.1 where carbon microphones are involved).

Formal processing: The sending sensitivity at a specified frequency or in a narrow frequency band is expressed as follows:

$$S_{mJ} = 20\log_{10}\frac{U_t}{p_m}\ \text{dB relative to 1 V/Pa}$$

where

U_t is the voltage across the termination and
p_m is the sound pressure at the mouth reference point.

The send loudness rating is derived from the measurements of S_{mJ} obtained at the 14 frequencies shown in table A.2 from the formula

$$SLR = -\frac{10}{0{,}175}\log_{10}\sum_{n=1}^{14}10^{0{,}0175(S_{min} - W_{sn})}$$

where

W_{sn} is the sending weighting factor at frequency fn given in table A.2 and
S_{mJn} is the measured sending sensitivity at frequency fn.

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Table A.2 - Parameters required to calculate SLR

Item n n	*Frequency fn* Hz	*Sending weighting factor* W_{sn} dB
1	200	76,9
2	250	62,6
3	315	62,0
4	400	44,7
5	500	53,1
6	630	48,5
7	800	47,6
8	1 000	50,1
9	1 250	59,1
10	1 600	56,7
11	2 000	72,2
12	2 500	72,6
13	3 150	89,2
14	4 000	117,0
NOTE - The values of Wsn have been taken from ITU-T Recommendation P.79 [3], (table 1/P.79 [3]).		

Verdict: If the value of SLR obtained ≥ –5 dB then Pass; else Fail.

Guidance: None.

A.4.7.5 *Impedance unbalance about earth*

A.4.7.5.1 Longitudinal Conversion Loss

Requirement: Subclause 4.7.5.1.

Purpose: To ensure that the impedance unbalance about earth, expressed as Longitudinal Conversion Loss, meets the requirements.

Measurement principle:

Preamble: Set the TE in loop state.

Test state: Loop state.

Test configuration:

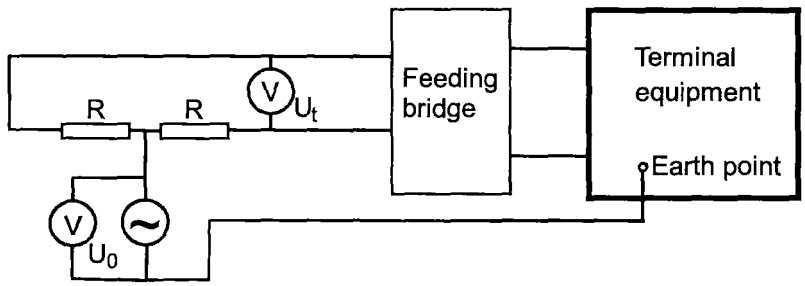

Figure A.15

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, 2 050 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

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Measurement points: The resistors R shall be 300 Ω.
U_o shall be a sinusoidal signal with a constant level of 1,0 V throughout the specified frequency range (50 Hz to 3 800 Hz in 1/3th octave steps). Measurement of the transversal voltage U_t is performed with a suitable frequency selective voltmeter.

Measurement execution:
Measure the voltage Ut across the specified frequency range for each of the feed conditions. Sufficient settling time shall be allowed at each feed condition to ensure that the measured value is stable to within ± 0,5 % for at least 0,2 s.

Formal processing: The measured value of Ut is used to calculate the Longitudinal Conversion Loss by using the following formula:

$$\text{Longitudinal Conversion Loss} = 20\log_{10}\left|\frac{U_o}{U_t}\right| \text{ dB}$$

Verdict: If the Longitudinal Conversion Loss is greater than the specified limit in table 6 and figure 6 then Pass; else Fail.

Guidance: The test sender output impedance should be less than 500Ω.
The voltmeter input impedance should be greater than 100kΩ.

A.4.7.5.2 *Output Signal Balance*

Requirement: Subclause 4.7.5.2.

Purpose: To ensure that the impedance unbalance about earth, expressed as Output Signal Balance, meets the requirements.

Measurement principle:
Preamble: Set the TE in loop state.
Test state: Loop state.

Test configuration:

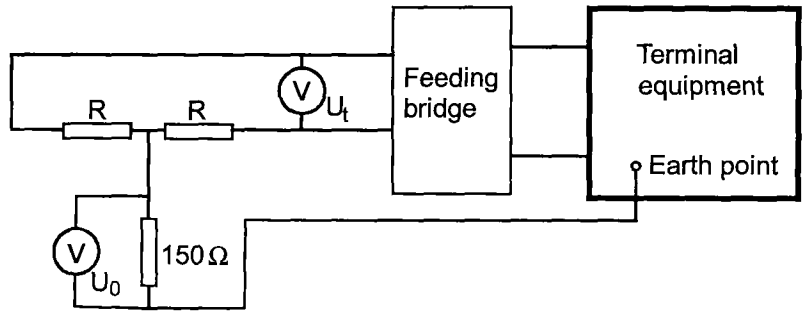

Figure A.16

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, 2 050 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

Measurement points: The resistors R shall be 300Ω.
Measurement of the voltages U_o and U_t are performed with a suitable frequency selective voltmeter.

Measurement execution:
The TE is set in the loop state transmitting representative signals to the line.

Formal processing: The measured values of U_o and U_t are used to calculate the output signal balance by using the following formula:

$$\text{Output signal balance} = 20\log_{10}\left|\frac{U_t}{U_o}\right| \text{ dB}$$

For frequencies at which U_o < -65 dBm the OSB is not calculated.

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Verdict; If the Output Signal Balance is greater than the specified limit in table 6 and figure 6 then Pass; else Fail. For frequencies at which U_o < -65 dBm there is no OSB requirement.

Guidance: The voltmeter input impedance should be greater than 100 kΩ.

A.4.7.6 *Resistance to earth*

Requirement: Subclause 4.7.6

Purpose: To check whether the TE complies with subclause 4.7.6 in the loop state.

Measurement principle:

Preamble: Set the TE in loop state.
Test state: Loop state.

Test configuration:

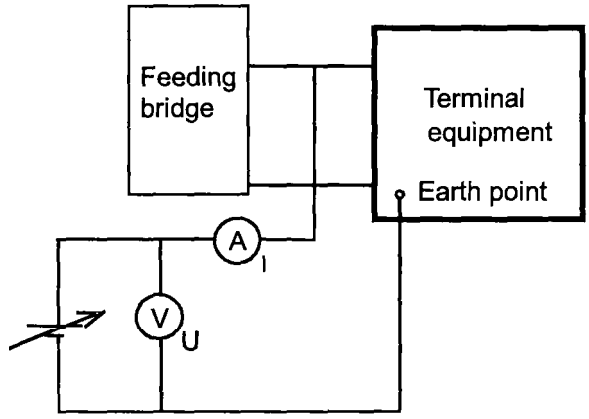

Figure A.17

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 2050 Ω.
Measurement point: U = 100 V DC.

Measurement execution:

Apply test voltage U between one of the line terminals and the earth connection point or points specified by the supplier's instruction for at least 30 s before measuring current I. The test shall be carried out for both polarities of the applied test voltage and applied feed voltage.

Formal processing: Resistance to earth (R)= U/I.

Verdict: If R is greater than or equal to 1 MΩ then Pass; else Fail.

Guidance: None.

A.4.8 Call attempt

A.4.8.1 *Automatic dialling*

A.4.8.1.1 Dialling without dial tone detection

Requirement: Subclause 4.8.1.1.

Purpose: To check whether the TE starts dialling within the allowed period after seizure.

Measurement principle:

Preamble: The TE shall be in quiescent state, tone-detector, if any, disabled. If the pause before dialling is adjustable by the user set it in accordance with the supplier's instruction to the closest available value to the midpoint between 3 and 8 s. If two values are equally close to the mid point, then use the lower value.
Test state: Automatic DTMF dialling.

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Test configuration:

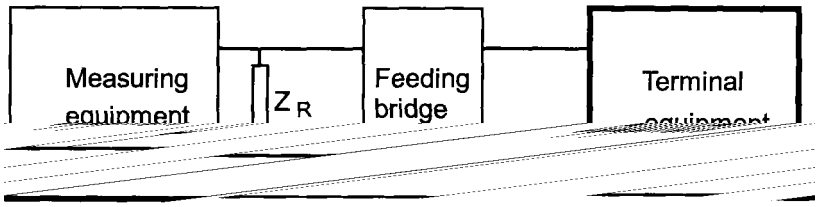

Figure A.18

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 2050 Ω.
AC termination of TE: Z_R.

Measurement execution:
The TE is set in the loop state, transmitting signalling characters to line. The time is measured from seizure up to the start of the first digit.

Formal processing: None.

Verdict: If the time delay ≥ 22,7 s and dialling has started within 8 s then Pass; else, Fail.

Guidance: None.

A.4.8.1.2 *Dialling with dial tone detection*

Requirement: Subclause 4.8.1.2.

Purpose: To check whether after seizure the TE starts dialling within the allowed period after the start of the dial tone.

Measurement principle:
Preamble: Set the TE in quiescent state and dialling tone detector enabled.
Test state: Automatic DTMF dialling.

Test configuration:

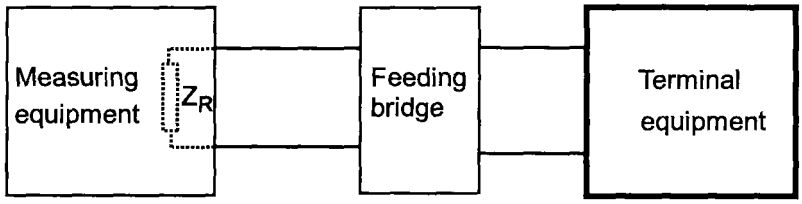

Figure A.19

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 2050 Ω.
AC termination of TE: Z_R.
Measurement points: The detection range that shall be tested is limited by the frequencies and voltage levels given in the table A.3 below. The levels are defined across the reference impedance Z_R.

Table A.3

Frequency Hz	***Level*** dBm
300	0
300	-35
500	-35
500	0

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Measurement execution:

The TE is set in the loop state, ready for transmitting signalling tones to line. A continuous dial tone is activated 3 s after having established the loop state. Time is measured from the start of the dial tone.

Formal processing: None

Verdict: If the TE has started dialling before 8 s, measured from the start of the dial tone, then Pass; else Fail.

Guidance: The level is supplied from a generator such that the total impedance of the generating and feeding circuitry is Z_R. The TE is replaced by a matching reference impedance Z_R for the purpose of level measurement. The TE is in-circuit for the purpose of timing measurement.

A.4.8.2 *DTMF signalling*

Guidance: Dial tone may be necessary to activate dialling.

A.4.8.2.1 *Frequency combinations*

Requirement: Subclause 4.8.2.1.

Purpose: To check whether the TE sends appropriate DTMF signal frequency combinations. The allowed combinations are listed in the table 7.

Measurement principle:

Preamble: Loop state.
Test state: Dialling.

Test configuration:

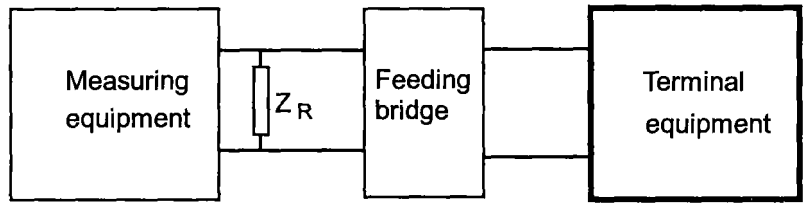

Figure A.20

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 2 050 Ω.
AC termination of TE: Z_R.
Measurement points: All available characters shall be verified. The tolerances on the available frequencies shall be not more than ± 1,5 %.

Measurement execution:

The TE is set in the loop state, transmitting DTMF signals to the line.
Measurement should be made during the tone duration as defined in subclause 4.8.2.4. (minimum duration 65 ms).

Formal processing: None.

Verdict: If all available frequencies are according to table 7, with a tolerance of ± 1,5 % then Pass; else Fail.

Guidance: None.

A.4.8.2.2 *Signalling levels*

Requirement: Subclauses 4.8.2.2.1 and 4.8.2.2.2

Purpose: To check whether the TE sends appropriate DTMF signals. The level of any tone in the DTMF high frequency group shall be -8,3 dBm +2,0/(2,5 dB and the level of any tone in the low frequency group shall be -10,3 dBm +2,5/(2,0 dB when the TE interface is terminated with the reference impedance Z_R. The level of the tone in the high frequency group shall be 1 to 4 dB higher than the level of the tone in the low frequency group.

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Measurement principle:
Preamble Set TE in loop condition. Maximum duration setting.
Test state: Dialling.

Test configuration:

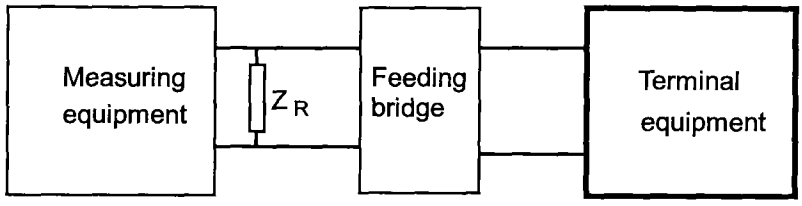

Figure A.21

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following 850 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.
AC termination of TE: Z_R.
Measurement points: Where all characters of table 7 are available, select digits A, 6, 8 and *; else if all numerals are available, select digits 3, 5, 7 and 0; else select all available digits.

Measurement execution:
The TE is set in the loop condition, transmitting DTMF signals to the line. Measurement should be made during the tone duration as defined in subclause 4.8.2.4 (minimum duration 65 ms).

Formal processing: None.

Verdict: If the tone in the high frequency group has a level between -6,3 dBm and -10,8 dBm and if the tone in the low frequency group has a level between -7,8 dBm and -12,3 dBm and if the difference between the levels is between 1 dB and 4 dB then Pass; else Fail.

Guidance: None.

A.4.8.2.3 *Unwanted frequency components*

Requirement: Subclause 4.8.2.3.

Purpose: To check the total power level of all unwanted frequency components in the frequency range 250 Hz to 4 300 Hz. The level shall be at least 20 dB below the low frequency group component, when transmitting any DTMF tone combination during call attempt.

Measurement principle:
Preamble: Set the TE in loop state.
Test state: Dialling.

Test configuration:

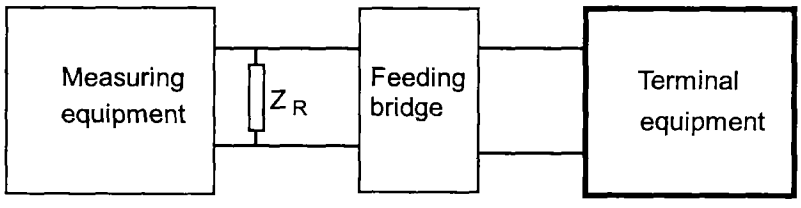

Figure A.22

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 850 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.
AC termination of TE: Z_R.

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Measurement points: Where all characters of table 7 are available, select digits A, 6, 8 and *; else if all numerals are available, select digits 3, 5, 7 and 0; else select all available digits.

Measurement execution:
The TE is set in the loop state, transmitting DTMF characters to the line. Measurement should be made during the sending period as defined in subclause 4.8.2.4 (minimum duration 65 ms).

Formal processing: Integration of all signal levels is divided in 3 parts:

- from 250 Hz up to the lower DTMF component;
- from the lower DTMF component up to the higher DTMF component;
- from the higher DTMF component up to 4 300 Hz.

Summation of all three parts gives the total unwanted sending level result. Frequencies up to 50 Hz on either side of the DTMF components shall be excluded from the summation. This result is compared with the level of the lower DTMF component.

Verdict: If the total unwanted power level is at least 20 dB below the level of the lower DTMF component for all available digits then Pass; else Fail.

Guidance: None.

A.4.8.2.4 *Tone duration*

Requirement Subclause 4.8.2.4.

Purpose: To check whether the TE sends DTMF signals of the appropriate duration. This requirement applies only to a TE with an automatic dialling function. It applies when the TE is in automatic dialling mode. The TE shall provide a setting whereby the duration of any individual DTMF tone combination shall be at least 65 ms measured from the time when the tone level has reached 90 % of its steady-state value (without interruption), until it has dropped to 90 % of its steady-state value.

Measurement principle:
Preamble: Set the TE in loop state. Test state: Automatic dialling. Tone signal duration according to supplier's instruction.

Test configuration:

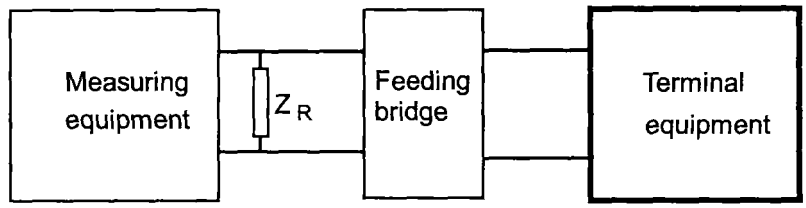

Figure A.23

DC feeding arrangement Feed voltage: 50 V. Feed resistance: 2 050 Ω.
AC termination of TE: Z_R.
Measurement points: Where all characters of table 7 are available, select digits A, 6, 8 and *; else if all numerals are available, select digits 3, 5, 7 and 0; else select all available digits.

Measurement execution:
Set tone signalling duration according to supplier's instruction. The TE shall be set in the loop state, transmitting DTMF signals to the line. Capture the waveform of the DTMF signal.

Formal processing: None.

Verdict: If all bursts have a duration ≥ 65 ms then Pass; else Fail.

Guidance: None.

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A 4.8.2.5 *Pause duration*

Requirement: Subclause 4.8.2.5.

Purpose: To check whether the TE sends DTMF signals with the appropriate pauses. This requirement applies only to a TE with an automatic dialling function. The TE shall provide a setting whereby the duration of the pause between the DTMF tone combinations shall be at least 65 ms. Time is measured from the moment when the tone has dropped to 10 % of its steady-state value, until it has risen to 10 % of its steady-state value.

Measurement principle:

Preamble: Set the TE in loop state.
Test state: Automatic dialling.

Test configuration:

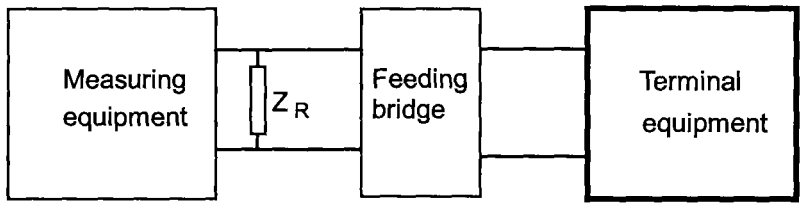

Figure A.24

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 2 050 Ω.
AC termination of TE: Z_R.
Measurement points: Where all characters of table 7 are available, select digits A, 6, 8 and *; else if all numerals are available, select digits 3, 5, 7 and 0; else select all available digits.

Measurement execution:

The TE is set in the loop state, transmitting DTMF signals to the line. Set pause duration in accordance with the supplier's instruction. Capture the waveform of the sequence of bursts.

Formal processing: None.

Verdict: If all pauses have a duration ≥ 65 ms then Pass; else Fail.

Guidance: None.

A.4.8.3 ***Automatically repeated call attempts***

Requirement: Subclause 4.8.3.

Purpose: To check that the TE complies with subclause 4.8.3.

Measurement principle:

Preamble: Set TE for automatic repeat call attempts to the same number. Set number of repeat call attempts to the maximum. Put TE in quiescent state.
Test state: Alternates between DTMF dialling, loop state and quiescent state.

Test configuration:

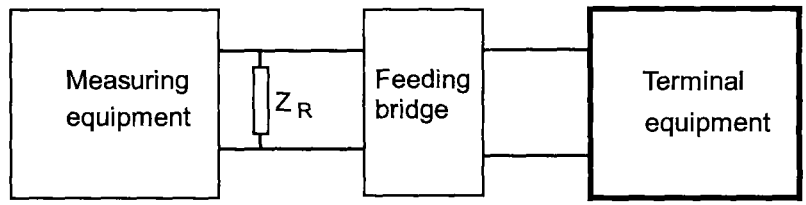

Figure A.25

DC feeding arrangement Feed voltage: 50 V. Feed resistance: 2 050 Ω.

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Measurement execution:

Cause TE to dial out without subsequent successful connection. Monitor TE line terminals after TE assumes loop state for first dialling attempt. Measure the duration of the shortest interval t_{min} between transition to the quiescent state and the loop state for the next automatically initiated, internally generated call attempt. Record the number of repeated call attempts.

Formal processing: None.

Verdict: If the interval $t_{min} \geq 5$ s and if there is no more than 15 repeated call attempts in a call attempt sequence or if the TE does not make any repeated call attempt in the duration of the test then Pass; else Fail.

Guidance: If the interval between call attempts is user adjustable then it shall be set to the minimum interval in accordance with supplier's instruction.

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Annex B
(normative)

Requirements table (RT)

B.1 Guidance for completion of the Swedish Standard-RT

6.1.1 Conditions table

For the requirements there is a table of condition questions.

The Reference column contains references in the form ”C.x”

where

”C” means Condition;

”x” uniquely identifies the element of the table.

The Condition column contains a question, the answer to which determines whether the corresponding requirement(s) in the Requirements Table are mandatory.

The Status column identifies whether a ”Yes” or ”No” answer causes relevant requirements to be mandatory for the TE. The following codes are used:

”M” means that the relevant requirements are mandatory;

”N” means that the relevant requirements are not applicable.

The Support column is left blank for the user to complete.

B.1.2 Requirements table

The Number column provides an unique identifier to each requirement.

The Requirement columns list the subclauses in this standard where the relevant requirements can be found. The subclause numbers and titles are given, supplemented by any additional information necessary to identify the requirement.

The Status column contains one of the following items:

”M” means that the requirement is mandatory;

”C.x” means that the requirement is mandatory if the relevant condition is met.

In some cases, two or more Conditions are included in the status column. The requirement is mandatory if the Boolean combination of them is true.

The Support column is left blank for the user to complete.

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Table B. 1 – Conditions table

Reference	***Condition***	***Status***	***Support*** (Y/N)	***Comment***
C.1	Is the TE controlled by an external device for the origination and/or the reception of a call?	If YES then M else N		
C.2	Is the TE intended to have a connection to earth?	If YES then M else N		
C.3	Is the TE intended to be in loop state?	If YES then M else N		
C.4	Is the TE intended for call answer?	If YES then M else N		
C.5	Is the TE intended for call set-up?	if YES then M else N		
C.6	Is the TE intended for dialling with DTMF?	If YES then M else N		
C.7	Is the TE intended for automatic dialling without dial tone detection?	If YES then M else N		
C.8	Is the TE intended for automatic dialling with a dial tone detection?	If YES then M else N		
C.9	Is the TE intended for use in receiving mode?	If YES then M else N		
C.l0	Is the TE intended for use in transmitting mode?	If YES then M else N		
C.11	Is the TE intended for making internally generated automatically repeated call attempt?	If YES then M else N		
C.12	Is the TE intended for automatically controlled signalling tone duration?	If YES then M else N		
C.13	Is the TE intended for automatically controlled signalling pause duration?	If YES then M else N		
C.14	Is the TE intended for real time speech?	If YES then M else N		

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Table B.2 – Requirements table

No.	Subclause	Requirement in this standard Title	Status	Support (Y/N)
R.1	4.1	General requirement	C.1	
R.2	4.2	Physical characteristics of connection to the PSTN	M	
R.3	4.3.1	Polarity	M	
R.4	4.4.1	DC resistance	M	
R.5	4.4.2	Impedance for ringing signals	M	
R.6	4.4.3	Impedance unbalance about earth	C.2	
R.7	4.4.4	Resistance to earth	C.2	
R.8	4.5	Ringing signal detector sensitivity	C.4	
R.9	4.7.1	DC characteristics	C.3	
R.10	4.7.2	Impedance	C.3	
R.11	4.7.3.1	Mean sending levels	C.3	
R.12	4.7.3.2	Instantaneous voltage	C.3	
R.13	4.7.3.3	Power level in a 10 Hz bandwidth	C.3	
R.14	4.7.3.4	Sending power levels above 4,3 kHz	C.3	
R.15	4.7.4	Sending power limitations in case the output signal is generated in real time from an integral acoustic source	C.14	
R.16	4.7.5.1	Longitudinal Conversion Loss	C.2 and C.3 and C.9	
R.17	4.7.5.2	Output Signal Balance	C.2 and C.3 and C.10	
R.18	4.7.6	Resistance to earth	C.2 and (C.4 or C.5)	
R.19	4.8.1.1	Dialling without dial tone detection	C.7	
R.20	4.8.1.2	Dialling with a dial tone detection	C.8	
R.21	4.8.2.1	Frequency combinations	C.6	
R.22	4.8.2.2.1	Absolute levels	C.6	
R.23	4.8.2.2.2	Level difference	C.6	
R.24	4.8.2.3	Unwanted frequency components	C.6	
R.25	4.8.2.4	Tone duration	C.6 and C.12	
R.26	4.8.2.5	Pause duration	C.6 and C.13	
R.27	4.8.3	Automatically repeated call attempts	C.11	

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Annex C
(informative)

Bibliography

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89/336/EEC Council Directive of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compability (the EMC Directive); OJ L139 23.05.89

91/263/EEC Council Directive of 29 April 1991 on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity (the TTE Directive); OJ L128 23.05.91

ETS 300 001 Attachments to Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subsciber interface in the PSTN

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