TCN 68-188: 2000

Terminal Equipment to be connected to an Analogue Subscriber Interface in the PSTN
General Technical Requirements
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FOREWORD


The Technical Standard TCN 68 - 188: 2000 "Terminal Equipment to be Connected to an Analogue Subscriber Interface in the PSTN- General Technical Requirements" is drafted by Research Institute of Posts and Telecommunications. Editing group includes engineer Cao Thi Thuy, who presides over, engineer Vu Trong Liem, engineer Tran Quoc Tuan and other technological officers.


SCIENCE-TECHNOLOGY
& INTERNATIONAL COOPERATION DEPARTMENT
TERMINAL EQUIPMENT TO BE CONNECTED TO AN ANALOGUE SUBSCRIBER INTERFACE IN THE PSTN

GENERAL TECHNICAL REQUIREMENTS

(Issued together with the Decision No. 1209/2000/QD-TCBD of the Secretary General of Department General of Posts and Telecommunications of 19, Dec. 2000)

1. Scope

This technical standard TCN 68-188: 2000 specifies general requirements for electrical and mechanical interface and access control protocol of terminal equipment which is capable of 2-wire access to and interworking with an analogue Public Switched Telephone Network (PSTN) to ensure interworking between terminal equipment with the network.

For each requirement in this standard a test is given, including measurement methods.

The technical standard TCN 68-188: 2000 does not specify requirements to ensure interoperating between terminal and terminal.

Where the origination or reception of calls by the TE is invoked, or otherwise controlled, by other equipment external to the TE, the TE still needs to be capable of fulfilling the essential requirements in this standard. This technical standard requires the manufacturer or supplier of the TE to declare the conditions met by such external devices so that their use does not cause the TE to fail to meet the essential requirements.

The technical standard TCN 68-188: 2000 is used as the basis for approving terminal equipment including PABXs (excluding PABXs connected to the PSTN via digital trunk interface) which is capable of originating circuit-switched calls using Dual Tone Multi Frequency (DTMF) signaling.

The technical standard TCN 68-188: 2000 is used as one of the basis for designing, manufacturing, choosing, developing and maintaining terminal equipment.

2. Definitions and abbreviations

2.1 A. Call attempt
The process by which the TE seizes the PSTN line and sends signaling characters of the network address with which the TE wishes to communicate.

2.2 A. 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.
2.3 A. Network Termination Point (NTP)
The physical point at the boundary of the PSTN intended to accept the connection of a TE.

2.4 A. Reference impedance $Z_R$
The complex impedance made up of 270 Ω in series with a parallel combination of 750 Ω and 150 nF. This is shown in annex A, figure A.1.

2.5 A. Terminal Connection Point (TCP)
The point of the TE intended to be connected to the PSTN (see figure 1).

Figure 1: Terminal Connection Point and Network Termination Point

2.6 A. States
- Loop state: The state where the TE draws sufficient DC current to activate the exchange.
- Loop steady state: A loop state excluding the transitions from and to quiescent state.
- Quiescent state: The state where the TE draws insufficient DC current to activate the exchange.

2.7 Abbreviations
The following abbreviations are used in this Technical Standard:
AC
ADSI
DC
DTMF
TBR
LCL
NTP
OSB
PSTN
SCWID
TCP
TBR-RT
TE

### 3. Technical requirements

#### 3.1 Physical characteristics of the connection to the PSTN

**Requirement:** The TE shall provide a 4-pin or 6-pin connector either as a plug or as a socket. The connector,
- If a plug, shall be capable of connecting with a socket;
- If a socket, shall be capable of connecting with a plug.

The connector is often used in network:
- The 4-pin kind: 623K, terminal connection points are 2 & 3;
- The 6-pin kind: RJ11, terminal connection points are 3 & 4.

**Test:** The interworking capability shall be verified through the tests in annex A.

#### 3.2 Requirement in polarity of line

**Requirement:** The TE shall operate with both polarities. The TE shall conform to the requirements of this TBR for both polarities of line feeding voltage.

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

#### 3.3 General requirements in quiescent state

##### 3.3.1 DC resistance

**Requirement:** 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. The current drawn by the TE when connected to a source of: 25 VDC; 50 VDC; 100 VDC, shall not exceed that which would be drawn by a 1 MΩ resistor
replacing the TE. This requirement applies 30 seconds after the voltage has been applied. The values of the maximum current are given in table 1.

<table>
<thead>
<tr>
<th>U, VDC</th>
<th>I_{\text{max}}, \mu\text{A}</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

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

3.3.2 Characteristics of TE for ringing signals

3.3.2.1 Impedance

**Requirement:** Interworking with the PSTN is assured by requiring the TE to present an impedance to ringing signals that is sufficiently high. The impedance of the TE at frequency of 25 Hz shall not be less than 4 kΩ when tested at 30 V rms.

**Test:** The test shall be conducted according to annex A, subclause A.4.4.2.1.

3.3.2.2 Transient response

**Requirement:** Interworking with the PSTN is assured by limiting the current transient at the beginning of a ringing signal. When ringing signals are applied to the terminal equipment in the quiescent state, the resulting current shall not cause the public exchange to detect a loop state. The current shall be:
- Equal to or less than 25 mA, 1 ms after commencement of the excitation;
- Equal to or less than 10 mA, 6 ms after commencement.

**Test:** The test shall be conducted according to annex A, subclause A.4.4.2.2

3.3.2.3 DC current

**Requirement:** Interworking with the PSTN is assured by requiring the TE to avoid creating DC current due to asymmetric load of the ringing signal. The resulting DC current during the ringing signal, tested with a 25 Hz AC signal at a voltage of 90 V rms superimposed on a DC voltage of 60 V, shall be less than 0.6 mA.

**Test:** The test shall be conducted according to annex A, subclause A.4.4.2.3.

3.3.3 Impedance unbalance about earth

**Requirement:** The impedance unbalance about earth in quiescent state is expressed as the Longitudinal Conversion Loss (LCL).
Where the supplier's instructions state 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.

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

<table>
<thead>
<tr>
<th>Frequency range, Hz</th>
<th>Minimum value, dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 600</td>
<td>40</td>
</tr>
<tr>
<td>600 to 3400</td>
<td>46</td>
</tr>
</tbody>
</table>

**Figure 2: Longitudinal Conversion Loss, minimum values**

3.3.4 Resistance to earth

**Requirement:** 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. The DC resistance between each line terminal of the TE and earth in the quiescent state when tested at 100 VDC, shall be not less than 10 MΩ.

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

3.4 Ringing signal detector sensitivity

**Requirement:** The TE is required to detect valid ringing signals. If a ring detect function is provided and enabled, the TE shall be able to respond to ringing signals of:
- Voltage: 30 V rms;
- Frequency: from 16 to 25 Hz;
- Cadence: \( \frac{0.67}{1.5} \) s ON and \( \frac{3}{5} \) s OFF; superimposed on a 50 VDC feeding voltage.

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

### 3.5 Transition from quiescent to loop state

#### 3.5.1 Acceptance of breaks in the loop in a call attempt

**Requirement:** The TE shall accept breaks in the loop current during establishment of loop state.

If, during the transition from quiescent to the loop state for the purpose of making a call, the line feeding current has first reached and remained at a value greater than 12.8 mA for a duration of between 30 ms and 500 ms, the current is interrupted for a period of 400 ms. When the source of the feeding current is reconnected:

- The line current shall have reached a value greater than 12.8 mA within 20 ms;
- During the period between 20 ms and 100 ms following the reconnection of the feeding source, the current shall not drop below 12.8 mA for more than 7 ms.

For the purpose of this requirement, any periods during which the current is less than 12.8 mA are aggregated and the total shall not exceed the limit stated.

This requirement applies when the line feeding current is provided by a source of 50 VDC in series with a resistance of 850 \( \Omega \).

**Test:** The test shall be conducted according to annex A, subclause A.4.6.1.

#### 3.5.2 TE current characteristics

**Requirement:** The TE shall seize the line.

The TE current determined by the TE shall:

- exceed the value of \( I_{f1} \) before \( t_1 \) after the seizure; and
- remain above \( I_{f1} \) for at least a further \( (t_2 - t_{b1}) \) time; and
- remain above \( I_{f2} \) between \( t_2 \) and \( t_3 \), for conditions of the table 4 and figure 4.

| Table 3: TE current characteristics with feeding resistors that are not used during the loop steady state |
|---|---|---|---|
| Feeding voltage, VDC | Feeding resistance, k\( \Omega \) | Time, ms | Current, mA |
| \( V_f \) | \( R_f \) | \( t_{1-0} \) | \( t_{2-01} \) | \( I_{f1} \) |
| 50 | 150 | 400 | 400 | 0,30 |
| 50 | 36 | 400 | 400 | 1,25 |
| 50 | 24 | 400 | 400 | 1,86 |
| 50 | 8 | 400 | 400 | 5,00 |
Figure 3: TE current characteristics with feeding resistors that are not used during the loop steady state

Table 4: TE current characteristics with feeding resistors which are used during the loop steady state

<table>
<thead>
<tr>
<th>Condition</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding voltage, VDC</td>
<td>Feeding resistance, $\Omega$</td>
</tr>
<tr>
<td>$V_f$</td>
<td>$R_f$</td>
</tr>
<tr>
<td>50</td>
<td>3200</td>
</tr>
<tr>
<td>50</td>
<td>230</td>
</tr>
</tbody>
</table>

Figure 4: TE current characteristics with feeding resistors which are used during the loop steady state
The limit values \((t_1 - t_0), (t_2 - t_{01}), (t_3 - t_{01}), I_{f1} \) and \(I_{f2}\) are given in tables 3 and 4 and shown in figures 3 and 4 and:

- \(t_0\) is the reference moment of seizure, when the TE current exceeds 0.1 mA for the first time with a feeding voltage of 50 VDC and stays above this value for more than 5 ms;
- \(t_{01}\) is the reference moment, when the TE current exceeds the current \(I_{f1}\) for the first time with a feeding voltage of 50 VDC and stays above this value for more than 5 ms; and
- transient periods are permitted during which the TE current drops below the limits stated in this clause, as long as when aggregated, they do not exceed 7 ms.

**Test:** The test shall be conducted according to annex A, subclause A.4.6.2.

### 3.6 Requirements in steady state

During the loop steady state the requirements are applied 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 230 \(\Omega\) to 3200 \(\Omega\).

#### 3.6.1 DC characteristics

**Requirement:** The TE shall present a sufficiently low DC resistance in loop state. The DC voltage/current characteristics of the TE shall not exceed the limits given in table 5 and shown in figure 5.

<table>
<thead>
<tr>
<th>Point</th>
<th>Voltage, V</th>
<th>Current, mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9.0</td>
<td>0.0</td>
</tr>
<tr>
<td>B</td>
<td>9.0</td>
<td>20.0</td>
</tr>
<tr>
<td>C</td>
<td>14.5</td>
<td>42.0</td>
</tr>
<tr>
<td>D</td>
<td>40.0</td>
<td>50.0</td>
</tr>
<tr>
<td>E</td>
<td>40.0</td>
<td>60.0</td>
</tr>
<tr>
<td>F</td>
<td>0.0</td>
<td>60.0</td>
</tr>
<tr>
<td>G</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**NOTE:** Limits for intermediate currents can be found by drawing a straight line between the break points on a linear voltage/current scale.
3.6.2 Impedance

Requirement: Interworking with the PSTN is assured by requiring the TE to present an impedance which allows proper functioning of call control and to maintain stability in the PSTN.

The TE shall meet the following requirements:
- at frequencies greater than 300 Hz, but less than or equal to 4000 Hz, the return loss calculated with respect to the reference impedance $Z_R$ (at the same frequency) shall not be less than 8 dB; and
- at frequencies that are greater than or equal to 200 Hz and less than or equal to 300 Hz: the return loss calculated with respect to the reference impedance $Z_R$ (at the same frequency) shall not be less than 6 dB; and the reactive component of the impedance shall not be greater than 500 Ω inductive.

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

3.6.3 Sending level limitations

Limiting the signal sent into the PSTN by the TE so that the interfering effects of the signal can be predicted and avoided.

3.6.3.1 Instantaneous voltage

Requirement: The peak to peak voltage measured across the load $Z_L = 600 \ \Omega$ in the frequency range 300 Hz to 3800 Hz shall not exceed 1.74 Volts.

Test condition: $\Delta V_f = 50 \ \text{V}$, $\Delta R_f = 400 \ \Omega$ (min), $\Delta I_f = 25 \div 100 \ \text{mA}$.

Test: The test shall be conducted according to annex A, subclause A.4.7.3.1.
3.6.3.2 Mean sending level

**Requirement:** The mean sending level, measured across the load $Z_L = 600 \, \Omega$, in the frequency range 200 Hz to 3800 Hz in period of:
- 10 s to voice signals, music signals in recorded/simulated/factual forms;
- 200 ms to code signals or data shall not be greater than -9.7 dBm.
This requirement does not apply to DTMF signals.
Test condition: $\Delta V_f = 50 \, V$, $\Delta R_f = 400 \, \Omega$ (min), $\Delta I_f = 25 \div 100 \, mA$.
**Test:** The test shall be conducted according to annex A, subclause A.4.7.3.2

3.6.3.3 Sending level

**Requirement:** The sending level, measured across the load $Z_L = 600 \, \Omega$, in the frequency range 30 Hz to 4000 Hz shall not exceed the limits given in table 6 and figure 6.
In addition to, in the A region, TE shall conform to following requirements:
- if there is one signals in the A region, in the B region (dot line in figure 6), it shall occur with one or more than one signals which have sending level not less 12 dB lower than that in the A region;
- for TE with a user-controlled sending level control, all sending level limitations are applied when mean sending level in 1-minute period is -9 dBm or the control at the setting where the sending level is as close as possible to and lower than -9 dBm;
if there is no signal in the B region, sending level in the frequency range 2200 to 2340 Hz shall not exceed -33 dBm.

<table>
<thead>
<tr>
<th>Table 6: Sending level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limitation</strong></td>
</tr>
<tr>
<td><strong>Frequency , Hz</strong></td>
</tr>
<tr>
<td><strong>curve</strong></td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>3000</td>
</tr>
<tr>
<td>3200</td>
</tr>
<tr>
<td>4000</td>
</tr>
<tr>
<td>Frequency, Hz</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>1000</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2130</td>
</tr>
<tr>
<td>900</td>
</tr>
<tr>
<td>4000</td>
</tr>
<tr>
<td>4000</td>
</tr>
<tr>
<td>3800</td>
</tr>
</tbody>
</table>

NOTE 1: Signals sent in region C at allowed upper limits may be decreased quite much in the network so TE receives less efficiently. Specially, in region D, TE may not receive signals.

NOTE 2: Curve is shown in figure 7. Recommend to reject signals which have levels lower than -30 dB (at frequencies below than 30 Hz).

NOTE 3: Sending level values are measured by testers which have 10 Hz bandwidth.

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

3.6.3.4 Sending level above 4 kHz

Requirement: The total voltage level, measured across load $Z_L = 600 \, \Omega$, in 3 kHz bandwidth within the frequency range above 4 kHz shall not exceed the limits shown in table 7 and figure 7.

Apart from single signal which has frequency of $(24+8n)$ kHz with tolerance of $(1.2+0.4n)$ Hz ($n= 0\div396$) may get values higher than limits but shall not exceed -50 dBm.
Table 7: Sending level above 4.3 kHz

<table>
<thead>
<tr>
<th>Center frequency, kHz</th>
<th>Sending level at 3 kHz, dBm</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>-40</td>
</tr>
<tr>
<td>8.9</td>
<td>-40</td>
</tr>
<tr>
<td>50</td>
<td>-70</td>
</tr>
<tr>
<td>1000</td>
<td>-70</td>
</tr>
<tr>
<td>2000</td>
<td>-58</td>
</tr>
<tr>
<td>4000</td>
<td>-46</td>
</tr>
<tr>
<td>7998.5</td>
<td>-34</td>
</tr>
</tbody>
</table>

NOTE: Limits are drawn in figure 7. Recommend to reject signals which have levels lower than -34 dBm (at frequencies above 8 MHz).

![Figure 7: Sending level above 4 kHz](image)

**Test:** The test shall be conducted according to annex A, subclauses A.4.7.3.4.

3.6.4 Impedance unbalance about earth

The impedance unbalance about earth is expressed as:
- Longitudinal Conversion Loss (LCL) when in the receiving mode; and
- Output Signal Balance (OSB) when in the transmitting mode.
Test: The test shall be conducted according to annex A, subclause A.4.7.4.

3.6.4.1 Longitudinal Conversion Loss
Requirement: Where the supplier's instructions state that a connection to earth is intended, the LCL when the termination of the TE is 600 Ω shall be at least the values given in table 8 and figure 8.

3.6.4.2 Output Signal Balance
Requirement: Where the supplier's instructions state that a connection to earth is intended, the OSB when the termination of the TE is 600 Ω shall be at least the values given in table 8 and figure 8. This requirement only applies at frequencies where the unbalance level exceeds -70 dBV.

Table 8: Output Signal Balance and Longitudinal Conversion Loss, minimum values

<table>
<thead>
<tr>
<th>Frequency range, Hz</th>
<th>Minimum value, dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 600</td>
<td>40.0</td>
</tr>
<tr>
<td>600 to 3400</td>
<td>46.0</td>
</tr>
<tr>
<td>3400 to 3800</td>
<td>40.0</td>
</tr>
</tbody>
</table>

Figure 8: Output Signal Balance and Longitudinal Conversion Loss, minimum values

Test: The test shall be conducted according to annex A, subclause A.4.7.4.2.

3.6.5 Resistance to earth
The TE shall present a sufficiently high DC resistance to earth in loop state so as not to disturb the basic call control function.

Requirement: The DC resistance between each 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, subclause A.4.7.5.

3.7 Call attempt
This clause only applies for terminals intended for outgoing calls.

3.7.1 Automatic dialing
This requirement applies only to a TE with an automatic seizing and dialing function.

3.7.1.1 Dialing without dial tone detection
The TE shall automatically dial to start sending its digits during the time period when the network is ready to receive digits under normal conditions. **Requirement:** The TE shall start dialing not earlier than 2.7 s and before 8 s has elapsed after the loop state is established. **Test:** The test shall be conducted according to annex A, subclause A.4.8.1.1.

3.7.1.2 Dialing with dial tone detection
The TE shall automatically dial to start sending its digits during the time period when the network is ready to receive digits. **Requirement:** The TE shall start dialing within 8 s of the start of the application of:
- a continuous dial tone; and
- a cadenced dial tone whose cadence comprises a repeated sequence of: 200 ms ON, followed by 200 ms OFF, followed by 600 ms ON, followed by 1 000 ms OFF.

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 $-35.7$ dBV and $-0.7$ dBV when measured across the reference impedance $Z_R$ which substitutes the TE. **Test:** The test shall be conducted according to annex A, subclause A.4.8.1.2.

3.7.2 DTMF signaling
The TE shall send digits that the network accepts.

3.7.2.1 Frequency combinations
**Requirement:** The TE shall use DTMF signaling characters according to table 9. 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 $\pm 1.5\%$. 


Table 9: DTMF signaling frequency combinations

<table>
<thead>
<tr>
<th>Low group, Hz</th>
<th>High group, Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>1209</td>
<td>1336</td>
</tr>
<tr>
<td>1336</td>
<td>1477</td>
</tr>
<tr>
<td>1477</td>
<td>1633</td>
</tr>
<tr>
<td>697</td>
<td>1</td>
</tr>
<tr>
<td>770</td>
<td>4</td>
</tr>
<tr>
<td>852</td>
<td>7</td>
</tr>
<tr>
<td>941</td>
<td>*</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
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<td>2</td>
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<tr>
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<td>9</td>
<td>C</td>
</tr>
<tr>
<td>#</td>
<td>D</td>
</tr>
</tbody>
</table>

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

3.7.2.2 Signaling levels

**a. Absolute levels**

**Requirement:** The level of any tone:
- in the DTMF high frequency group shall be -9.0 dBV +2.0/-2.5 dB and
- in the low frequency group shall be -11.0 dBV +2.5/-2.0 dB.

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

**b. Level difference**

**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.

**c. Unwanted frequency components**

**Requirement:** When transmitting any DTMF tone combination during a call attempt, the total sending level of all unwanted frequency components in the frequency range 250 Hz to 4 300 Hz shall be at least 20 dB below the low frequency group component.

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

**d. Tone duration**

The TE shall send DTMF tones for a minimum period in order that the receivers in the exchange can recognize the digit being sent.

**Requirement:** The duration for which any individual DTMF tone combination sent is not less than 65 ms. The time shall be measured from the time 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.

**NOTE:** For correct operation of supplementary services such as SCWID (Spontaneous Call Waiting Identification) and ADSI (Analogue Display Services Interface), DTMF tone bursts will need to be no longer than 90 ms.

**e. Pause duration**
The TE shall provide a minimum period of "Tone Off" between DTMF digits in order that the receivers in the exchange can determine the end of any digit from the start of the next.

**Requirement:** The duration of the pause between any individual DTMF tone combination is not less than 65 ms. The time shall be measured from the time 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.

3.7.3 Pulse Signaling

The TE shall send pulse signals.

**Requirement:** Pulse signaling characteristics shall conform to requirements given in table 10.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value, minimum</th>
<th>Value, maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Break of the pulse, ms</td>
<td>53</td>
<td>80</td>
</tr>
<tr>
<td>Make of the pulse, ms</td>
<td>33</td>
<td>---</td>
</tr>
<tr>
<td>Acceptable pulse speed, pulse/s</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Ratio of the break to the duration, %</td>
<td>58</td>
<td>72</td>
</tr>
<tr>
<td>Inter-digital Pause, s</td>
<td>0.5</td>
<td>3</td>
</tr>
</tbody>
</table>

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

3.7.4 Automatically repeated call attempts

Protection of the PSTN from harm is achieved by restricting 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 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.

**Test:** The test shall be conducted according to annex A, subclause A.4.8.4.

3.8 Transition from loop to quiescent state

The TE shall correctly release the line.

**Requirement:** When the TE is connected to a source of 50 VDC in series with a resistor of 2 050 Ω and initiates the transition from the loop to the quiescent state in order to release a call, the current drawn by the TE shall:
- drop to a value below 0.5 mA not later than 200 ms after the reference moment of the release; and
- in the case of automatic release and subsequent automatic seize for the purposes of making a new call, remain below a value of 0.5 mA for a minimum of a further 1.5 s. In this case, it is permitted for there to be transient periods during which the current exceeds 0.5 mA, as long as, when aggregated, they do not exceed 20 ms.

**Test:** The test shall be conducted according to annex A, subclause A.4.9.
APPENDIX A. TEST METHODS (Normative)

A.1 General requirements

− This annex describes the test principles to determine the compliance of a TE against the requirements of this Technical Standard.
− TE may require the provision of external termination or stimulus in order to assess its conformity with this Technical 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.
− The test configurations given do not imply a specific realization of test equipment or arrangement or use of specific test devices for conformance testing.
− The test parameters defined in this annex are "ideal" parameters.
− The test equipment shall be a device, or group of devices, generating a stimulus signal and providing the test conditions conforming to this annex and capable of monitoring the received signal from the interface.

A.1.1 Equipment connection

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

<table>
<thead>
<tr>
<th>Contact number</th>
<th>Test socket connected to</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unconnected</td>
</tr>
<tr>
<td>2</td>
<td>Unconnected</td>
</tr>
<tr>
<td>â</td>
<td>TCP</td>
</tr>
<tr>
<td>5</td>
<td>Unconnected</td>
</tr>
<tr>
<td>6</td>
<td>Unconnected</td>
</tr>
</tbody>
</table>

A.1.2 Test environment

All tests shall be performed under non-condensing conditions at:
- an ambient temperature in the range from + 15°C to + 35 °C;
- a relative humidity in the range from 5 % to 85 %;
- an air pressure in the range 86 kPa to 106 kPa.

For TE that is not designed to operate over the entire specified environmental range, all tests shall be performed at any point within the operational range specified by the supplier.

For TE that is directly powered from the mains supply, all tests shall be carried out within ±5 % of the rated voltage of the TE. If the equipment is powered by other means (e.g. batteries, DC supplies and stabilized 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.1.3 Powered state
Tests shall be carried out with the TE powered on, under normal operating conditions defined by the supplier.

A.1.4 Measurements to earth
Where a measurement to earth is defined, all the following points, as applicable, shall be connected to the earth point:
- a point in the TE which is intended to be connected to mains earth;
- connector points which are intended to be connected to earth during the normal operation of the TE.

A.1.5 Equivalent test methods
Laboratories may use other test methods provided they are electrically equivalent to those specified.

A.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.
a. a facility to remain in the loop state without transmitting signals; and
b. a facility to transmit all types of signal that the TE transmits while not receiving any signal.
However, if alternative methods are feasible these are also acceptable.

A.2 Test impedance

A.2.1 Reference impedance
**Reference impedance** $Z_R$ : This is a complex impedance made up of 270 $\Omega$ in series with a parallel combination of 750 $\Omega$ and 150 nF as shown in figure A.1.

![Figure A.1: Reference impedance](image)

A.2.2 Non-reactive line termination
All resistors specified in this annex for testing should be nominally non-reactive. Any resistor or group of resistors should have a impedance at any frequency in the range to be measured, not exceeding 0.5% of the nominal impedance.

A.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).

A.4 Test methods
One test may cover more than one requirement. The scope of each test is defined under the heading "purpose".

A.4.1 General requirements
Test by visual inspection.

A.4.2 Physical characteristics of connection to the PSTN
Test by visual inspection.

A.4.3 Requirements in all conditions
Where tests with both polarities are needed this is indicated in relevant clauses in this annex.

A.4.4 General requirements in quiescent state

A.4.4.1 DC Resistance

Requirement: Subclause 3.3.1.
Purpose: To check whether the TE presents a resistance of at least 1 MΩ when tested at 25 VDC, 50 VDC and 100 VDC 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 VDC.
Measurement execution:
Apply the test voltage $U$ between the line terminals of the TE for at least 30 s before measuring DC current $I$. The test shall be carried out for both polarities of the applied voltage.
Verdict: When tested at $U$, the current shall equal to or be less than the values in table A.2:

<table>
<thead>
<tr>
<th>$U$, VDC</th>
<th>$I_{\text{max}}$, $\mu$A</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

A.4.4.2 Characteristics of TE for ringing signals

A.4.4.2.1 Impedance

Requirement: Subclause 3.3.2.1.
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.
- Test configuration: figure A.3
DC feeding arrangement: Feed Voltage = 50 V DC.
AC feeding arrangement: Sinusoidal source $U_0$ 25 Hz, $U_{\text{TE}} = 30$ V rms, measured across the TE.
- Measurement points: Voltage $U_{\text{TE}}$ and current $I_{\text{TE}}$ measured for the frequencies of 25 Hz.
Measurement execution:
Apply the ringing signal continuously to the TE. Adjust the source voltage \( (U_0) \) 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.

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

\[
|Z_{ril}| = \frac{U_{TE}}{I_{TE}}
\]

Verdict: If it is possible to apply 30 V rms at the TE terminals with a source voltage \( \leq 90 \) V rms and if \( |Z_{ril}| \) is equal to or greater than 4 kW then Pass; else Fail.

Guidance: True rms reading instruments should be used because voltages and currents

A.4.4.2.2 Transient response

Requirement: Subclause 3.3.2.2.

Purpose: To check that the transient DC characteristics of the TE in quiescent state comply with subclause 4.4.2.2.

Measurement principle:
- Preamble: Set the TE in quiescent state with the line terminals shorted together.
- Test state: Quiescent state. The TE shall have been in the quiescent state for not less than 1 minute.
- Test configuration: Figure A.4
- DC feeding arrangement: Feed Voltage = 60 V DC.
- Measurement points: Measure current 1 ms and 6 ms after the connection of the voltage source.

Measurement execution:
Connect the voltage source to the TE with the switch S and monitor the line current. Verdict: If the line current is less than or equal to 25 mA 1 ms after the connection and less than or equal to 10 mA, 6 ms after the connection then Pass; else Fail.
A.4.4.2.3 DC current

Requirement: Subclause 3.3.2.3.
Purpose: To determine the DC component of the ringing current.
Measurement principle:
- Preamble: Set the TE in quiescent state with any auto answer facility disabled.
- Test state: Quiescent state.
- Test configuration: figure A.5

![Figure A.5](image)

DC feeding arrangement: Feed Voltage = 60VDC.
AC feeding arrangement: Sinusoidal source \( U_0 = 90 \text{ V rms, 25 Hz} \) and.
Measurement execution:
Continuously apply the ringing signal. After 400 ms measure the current \( I_{DC} \) for one or more complete cycles of the DC voltage. The test shall be carried out for both polarities of the feeding voltage.
Verdict: If the magnitude of \( I_{DC} \) is less than or equal to 0.6 mA then Pass; else Fail.
Guidance: The sampling rate should be chosen to give an even integer of samples in one cycle.

A.4.4.3 Impedance unbalance about earth

Requirement: Subclause 3.3.3.
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.6
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 230 Ω. The test shall be made with both polarities.
Measurement points: The resistors R shall be 300 Ω.
U₀ shall be a sinusoidal signal with a constant voltage of 0.775 Vrms throughout the specified frequency range (50 Hz to 3 400 Hz).
Measurement of the transverse voltage Uₜ shall be performed with a suitable frequency selective voltmeter.

**Measurement execution:**
Measure the voltage Uₜ across the specified frequency range. The test shall be carried out for both polarities of feeding.

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

\[
\text{Longitudinal Conversion Loss} = 20 \log \left( \frac{U₀}{Uₜ} \right), \text{dB}
\]

**Verdict:** If the Longitudinal Conversion Loss is greater than or equal to the specified limits in table 2 and figure 2 then Pass; else Fail.

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

A.4.4.4 Resistance to earth

**Requirement:** Subclause 3.3.4.
**Purpose:** To check whether the TE complies with subclause 3.3.4 in the quiescent state.

**Measurement principle:**
- Preamble: Set the TE in quiescent state.
- Test state: Quiescent state.
- Test configuration: figure A.7
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 230 \(\Omega\).
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 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:** Calculate the resistance to earth \(R = U/I\).

**Verdict:** If \(R\) is greater than or equal to 10 M\(\Omega\) then Pass; else Fail.

A.4.5 Ringing signal detector sensitivity

**Requirement:** Subclause 3.4.

**Purpose:** To determine the ability of the TE to respond to ringing signals.

**Measurement principle:**
– Preamble: Set the TE in quiescent state with answering facility enabled.
– Test state: Quiescent state.
– Test configuration: figure A.8

DC feeding arrangement: Feed Voltage = 50 V DC.
Measurement points: The ringing signal shall have a sinusoidal source of 25 Hz and a cadence of 1 s ON and 5 s OFF. \(U_{TE} = 30\) Vrms
**Measurement execution:**
Using the test configuration shown in figure A.8, 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.

**Verdict:** If TE detects all the ringing signals then Pass; else Fail.

A.4.6 Transition from quiescent to loop state

A.4.6.1 Acceptance of breaks in the loop in a call attempt

**Requirement:** Subclause 3.5.1.

**Purpose:** To check that the DC characteristics of the TE during the transition from quiescent to loop state comply with subclause 3.5.1.

**Measurement principle:**
- Preamble: Set the TE in quiescent state.
- Test state: In transition from quiescent to loop state.
- Test configuration: figure A.9

**DC feeding arrangement:** Feed voltage: 50 VDC.

**Measurement points:** as in test configuration.

**Measurement execution:**
Monitor the current across the TE line termination. Cause the TE to make a transition from the quiescent to the loop state. When the line feeding current has first reached and remained at a value greater than 12.8 mA for:
- test 1: 30 ms;
- test 2: 500 ms.

Interrupt the current for a period of 400 ms. Continue to monitor the current for a period of 100 ms after restoration.

![Figure A.9](image)

**Formal processing:** If the current drops below 12.8 mA for more than one period of time, then sum all the periods to obtain the total time for comparison with the limit.

**Verdict:** If the line current has reached a value greater than 12.8 mA within 20 ms of the restoration AND if, during the period between 20 ms and 100 ms after the restoration, the current does not drop below 12.8 mA for more than 7 ms, then Pass; else Fail.
A.4.6.2 Loop current characteristics

**Requirement:** Subclause 3.5.2.

**Purpose:** To check that the current/time characteristics of the TE during the transition from quiescent to loop state comply with subclause 3.5.2.

**Measurement principle:**
- **Preamble:** Set the TE in quiescent state for a time greater than 1 minute.
- **Test state:** Cause the TE to make a transition to loop state.
- **Test configuration:** figure A.10

![Figure A.10](image)

DC feeding arrangement: Feed voltage: 50 VDC. Feed resistance $R_f$, each of the following: 150 kΩ, 36 kΩ, 24 kΩ, 8 kΩ 3.2 kΩ, 230 Ω.

Measurement points: Feed resistance listed above in the DC feeding arrangement.

**Measurement execution:**
Before measuring for each resistance value, keep the TE in quiescent state for 1 minute. In sequence, select a $R_f$ resistance value according to the selected feeding resistance and then cause the TE to make a transition from the quiescent to the loop state.
- **Test 1:** For $R_f : 150$ kΩ, 36 kΩ, 24 kΩ and 8 kΩ, monitor $I$ for the period from $t_0$ to $t_2$ as indicated in table 3 and figure 3.
- **Test 2:** For $R_f : 3.2$ kΩ and 230 Ω, monitor $I$ for the period from $t_0$ to $t_3$ as indicated in table 4 and figure 4.

**Formal processing:** For each feeding resistance, calculate the sum of the transient periods where the current $I$ falls under the limit of figure 3 or figure 4 as relevant.

**Verdict:** If for test 1 the TE complies with the limits stated in table 3 and in figure 3 apart from transients whose aggregated period is less than 7 ms and if for test 2 the TE complies with the limits stated in table 4 and in figure 4 apart from transients whose aggregated period is less than 7 ms then Pass; else Fail.

A.4.7 General loop state requirements

**A.4.7.1 DC characteristics**

**Requirement:** Subclause 3.6.1.

**Purpose:** To verify steady-state DC loop characteristics.

**Measurement principle:**
Preamble: Set the TE in quiescent state.
Test state: Loop state.
Test configuration: figure A.11

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 230 Ω, 850 Ω, 2 050 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

**Figure A.11**

**Measurement execution:**
In sequence, select a feed resistance value and then cause the TE to enter the loop state after making sure that the TE has been held at least 1 minute in quiescent state. When the terminal 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 for each of the feed conditions. Allow sufficient settling time, to a maximum of 3 s, to ensure that the measured value is stable.

**Verdict:** If the DC voltage/current characteristics are within the limits given in table 5, and shown in figure 5 then Pass; else Fail.

**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 3.6.2.

**Purpose:** To verify the return loss of the input impedance \((Z_i)\) of the TE in relation to the reference impedance \(Z_R\).

**Measurement principle:**
- Preamble: Set the TE in loop state.
- Test state: Loop state.
- Test configuration: figure A.12
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 230 Ω, 850 Ω, 2 050 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

AC termination of TE: ZR.

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 dBV at the TE line terminals. f min = 200 Hz, f max = 4 000 Hz.

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 (Zi) of the TE.

Formal processing: Return loss  \( \alpha = 20 \log_{10} \left| \frac{Z_R + Z_t}{Z_R - Z_t} \right| \), where ZR is the reference impedance and Zt is the impedance of the TE.

Verdict:
- If for frequencies that are above 300 Hz and not greater than 4 000 Hz, the return loss is greater than or equal to 8 dB;
- and for frequencies that are not less than 200 Hz but are not greater than 300 Hz the return loss is greater than or equal to 6 dB;
- the inductive (reactive) component of impedance is less than 500 Ω then Pass; else Fail.

A.4.7.3 Sending level limitations

A.4.7.3.1 Instantaneous voltage

Requirement: Subclause 3.6.3.1.

Purpose: To check the peak to peak voltage of the TE.

Measurement principle:
- Preamble: Set the TE in loop state.
- Test state: The TE shall be in loop state and sending representative signals.
- Test configuration: figure A.13
Test arrangement: \( V_f = 50 \text{ VDC}; \ R_f (\text{min}) = 400 \ \Omega; \ I_f = 25 \div 100 \text{ mA}; \) carry out the test 2 times with 2 polarities of feed voltage.

AC termination of TE: \( Z_R \).

Measurement points: The TE is exercised to send to the line:
- representative combinations of its declared output capabilities;
- DTMF signals.

**Measurement execution:**
The TE shall be set in the loop state, transmitting representative signals. The peak to peak voltage transmitted across the termination points of the TE, shall be measured.

**Verdict:** If the peak to peak voltage is not higher than 1.74 V then Pass; else Fail.

**A.4.7.3.2 Mean sending level**

**Requirement:** Subclause 3.6.3.2.

**Purpose:** To check the mean sending level in the frequency range 200 Hz to 3 800 Hz.

**Measurement principle:**
- Preamble: Set the TE in loop state.
- Test state: The TE shall be in loop state and sending representative signals continuously.

**Purpose:** To check the peak-peak voltage across the TE.

**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.14
Test arrangement: $V_f = 50 \text{ VDC}$; $R_f \text{ (min) } = 400 \Omega$; $I_f = 25 \div 100 \text{ mA}$; carry out the test 2 times with 2 polarities of feed voltage.
AC termination of TE: $Z_R$.
Measurement points: The TE is exercised to send to the line representative combinations of its declared output capabilities.

**Measurement execution:**
The TE shall be set in loop state and transmit representative signals continuously. The mean sending level in the frequency range 200 Hz to 3 800 Hz transmitted across the termination points of the TE shall be determined.

**Verdict:** If the mean level is less than or equal to -9 dBm then Pass; else Fail.

A.4.7.3.3 Sending level

**Requirement:** Subclause 3.6.3.3.

**Purpose:** To check that the TE complies with subclause 3.6.3.3.

**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.15
Test arrangement: $V_f = 50 \text{ VDC}; R_f (\text{min}) = 400 \Omega; I_f = 25 \div 100 \text{ mA}$; carry out the test 2 times with 2 polarities of feed voltage.

AC termination of TE: $Z_R$.

Measurement points: The TE is exercised to send to the line representative signals.

**Measurement execution:**
The voltage level transmitted across the $Z_L$ shall be measured. It shall be determined whether the level within every 10 Hz bandwidth wholly contained in the frequency range 30 Hz to 4 000 Hz is less than or equal to the limits given in table 6 and figure 6. In the case of data equipment (e.g. modems) the level shall only be measured during the data transfer phase.

**Verdict:** If the levels are according to table 6 and figure 6 then Pass; else Fail.

A.4.7.3.4 Sending level above 4 kHz

**Requirement:** Subclause 3.6.3.4.

**Purpose:** To check that the TE complies with subclause 3.6.3.4 when transmitting any DTMF tone combination during a call attempt.

**Measurement principle:**
- Preamble: Set the TE in loop state.
- Test state: DTMF dialing.
- Test configuration: figure A.16

![Figure A.16](image-url)

Test arrangement: $V_f = 50 \text{ VDC}; R_f (\text{min}) = 400 \Omega; I_f = 25 \div 100 \text{ mA}$; carry out the test 2 times with 2 polarities of feed voltage.

AC termination of TE: $Z_R$.

Measurement points: The TE is exercised to send to the line representative signals.

**Measurement execution:**
The TE shall be set in the loop state, transmitting DTMF characters to line. Measurement shall be made at the TE terminals.

**Verdict:** If the levels are according to table 7 and figure 7 then Pass; else Fail.
A.4.7.4 Impedance unbalance about earth

A.4.7.4.1 Longitudinal Conversion Loss

Requirement: Subclause 3.6.4.1.

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.17

![Figure A.17](image)

Figure A.17

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 230 Ω, 850 Ω, 2,050 Ω, and 3,200 Ω. Polarity shall be switched between each feed resistance.

Measurement points: The resistors R shall be 300 Ω. U₀ shall be a sinusoidal signal with a constant voltage of 0.775 V throughout the specified frequency range (50 Hz to 3800 Hz). Measurement of the transverse voltage Uᵣ shall be performed with a suitable frequency selective voltmeter.

Measurement execution:
Measure the transversal voltage Uᵗ across the specified frequency range for each of the feed conditions. Allow sufficient settling time at each feed condition to ensure that the measured value is stable.

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

\[
\text{Longitudinal Conversion Loss} = 20 \log_{10} \left( \frac{U₀}{Uᵣ} \right), \text{dB}
\]

Verdict: If the Longitudinal Conversion Loss is greater than the specified limit in table 8 and figure 8 then Pass; else Fail.

A.4.7.4.2 Output Signal Balance

Requirement: Subclause 3.6.4.2.

Purpose: To check the impedance unbalance about earth, expressed as output signal balance.

Measurement principle:
- Preamble: Set the TE in loop state.
- Test state: Loop state.
- Test configuration: figure A.18

![Figure A.18](image)

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 230 Ω, 850 Ω, 2 050 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.

Measurement points: The resistors R shall be 300 Ω. Measurement of the transverse voltage $U_t$ and $U_0$ shall be performed with a suitable frequency selective voltmeter.

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

**Formal processing:** The measured values of $U_0$ and $U_t$ are used to calculate the OSB by using the following equation:

$$\text{Output Signal Balance} = 20 \log_{10} \left( \frac{U_t}{U_0} \right), \text{dB}.$$  

**Verdict:** If the OSB is greater than the specified limit in table 8 and figure 8 then Pass; else Fail. For frequencies at which $U_0$ is less than -70 dBV there is no OSB requirement.

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

**A.4.7.5 Resistance to earth**

**Requirement:** Subclause 3.6.5.

**Purpose:** To check resistance to earth of the TE in the loop state.

**Measurement principle:**
- Preamble: Set the TE in loop state.
- Test state: Loop state.
- Test configuration: figure A.19
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 230 Ω.
Measurement points: U = 100 VDC.

**Measurement execution:**
Apply test voltage U between one of the line terminals and the earth connection point or points 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 feeding voltage.

**Formal processing:** Calculate resistance to earth (R) = U/I.

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

A.4.8 Call attempt

**A.4.8.1 Automatic dialing**

**A.4.8.1.1 Dialing without dial tone detection**

**Requirement:** Subclause 3.7.1.1.

**Purpose:** To check that the TE starts dialing within the allowed period after seizure.

**Measurement principle:**
- Preamble: Set the TE in quiescent state, tone-detector if any, disabled.
- Test state: Automatic DTMF dialing.
- Test configuration: figure A.20
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 850 Ω.
AC termination of TE: $Z_R$.

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

**Verdict:** If the time delay is equal to or greater than 2.7 s and dialing has started within 8 s then Pass; else Fail.

**A.4.8.1.2 Dialing with dial tone detection**

**Requirement:** Subclause .3.7.1.2.

**Purposes:** To check whether, after seizure, the TE starts dialing within the allowed period after the start of the dial tone.

**Measurement principle:**
- Preamble: Set the TE in quiescent state with dial tone detector enabled.
- Test state: Automatic DTMF dialing.
- Test configuration: figure A.21.

![Figure A.21](image)

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 850 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. The levels are defined across the reference impedance $Z_R$.

**Table A.3**

<table>
<thead>
<tr>
<th>Frequency, Hz</th>
<th>Level, dBV</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>-0.7</td>
</tr>
<tr>
<td>300</td>
<td>-35.7</td>
</tr>
<tr>
<td>500</td>
<td>-35.7</td>
</tr>
<tr>
<td>500</td>
<td>-0.7</td>
</tr>
</tbody>
</table>

**Measurement execution:**
The TE is set in the loop state, ready for transmitting signaling tones to the line. Two tests shall be performed. In both tests the dial tone is activated 3 s after having established the loop state.

- test 1: Send continuous dial tone. Time is measured from the start of the dial tone;
- test 2: Send a repeated sequence of cadenced dial tone whose cadence consists of a period of 200 ms ON followed by 200 ms OFF, 600 ms ON and 1000 ms OFF. Time is measured from the start of the sequence.

**Verdict:** If the TE has started dialing before 8 s in both tests 1 and 2, measured from the start of the dial tone, then Pass; else Fail.

### A.4.8.2 DTMF signaling

#### A.4.8.2.1 Frequency combinations

**Requirement:** Subclause 3.7.2.1.

**Purpose:** To check whether the TE sends appropriate DTMF signal frequency combinations listed in the table 9.

**Measurement principle:**
- Preamble: Set the TE in loop state
- Test state: Dialing.
- Test configuration: figure A.22

![Figure A.22](image)

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 850 Ω.

AC termination of TE: $Z_R$.

Measurement points: All supported 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 line. Measurement shall be made during the tone duration as defined in subclause 3.7.2.4 (minimum duration 65 ms).

**Verdict:** If all available frequencies are according to table 9, with a tolerance of ±1.5 %, then Pass; else Fail.

#### A.4.8.2.2 Signaling levels

**Requirement:** Subclause 3.7.2.2.2a and 3.7.2.2.2b

**Purpose:** To check whether the TE sends appropriate DTMF signals.
Measurement principle:
- Preamble Set the TE in loop state. Maximum duration of tone burst setting.
- Test state: Dialing.
- Test configuration: figure A.23
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 230 Ω, and 3 200 Ω. Polarity shall be switched between each feed resistance.
AC termination of TE: $Z_R$.
Measurement points: All supported characters shall be verified.

![Figure A.23](image)

Measurement execution:
The TE is set in the loop state, transmitting DTMF signals to line. Measurement shall be made during the tone duration as defined in subclause 3.7.2.2 (minimum duration 65 ms).
Verdict: If the tone in the high frequency group has a level between -7.0 dBV and -11.5 dBV and if the tone in the low frequency group has a level between -8.5 dBV and -13.0 dBV and if the difference between the levels is between 1 and 4 dB then Pass: else Fail.

A.4.8.2.3 Unwanted frequency components
Requirement: Subclause 3.7.2.2c.
Purpose: To check the total sending level of all unwanted frequencies in the frequency range 250 Hz to 4 300 Hz.
Measurement principle:
- Preamble: Set the TE in loop state.
- Test state: Dialing.
- Test configuration: Figure A.24

![Figure A.24](image)
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: each of the following: 230 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 9 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 shall be made during the sending period as defined in subclause 3.7.2.2c (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 signal level is at least 20 dB below the level of the lower DTMF component for all available digits then Pass; else Fail.

**Guidance** The total unwanted sending level is calculated from the following formula:

$$\sum = \sqrt{a^2 + b^2 + c^2}$$

A.4.8.2.4 Tone duration

**Requirement:** Subclause 3.7.2.2d

**Purpose:** To check whether the TE sends DTMF signals of the appropriate duration.

**Measurement principle:**
- Preamble: Set the TE in loop state.
- Test state: Automatic Dialing. Tone signal duration according to supplier's instructions.
- Test configuration: Figure A.25

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 850 Ω.

AC termination of TE: $Z_R$. 


Measurement points: Where all characters of table 9 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 signaling duration according to supplier's instructions. The TE is set in the loop state, transmitting DTMF signals to the line. Capture the waveform of the DTMF signal.

**Formal processing:** use three following waveforms:

- Determine waveform A such that at any time the instantaneous value of waveform A is equal to the absolute value of difference between the value of the measured waveform at that time and the mean value of the measured waveform over a period of 10 ms centered on that time.
- Determine waveform B such that at any time its value is the greater of the linear interpolation of the maximum of waveform A, and waveform A.
- Determine waveform C such that at any time its value is the greater of the linear interpolation of the maximum of waveform B, and waveform B.

Determine the reference level such that it is 90 % of the highest level which waveform C exceeds for 20 ms during the burst. The duration of the burst is the duration of the greatest period of time for which waveform C exceeds the reference level.

**Verdict:** If all bursts have a duration greater than or equal to 70 ms then Pass.

**Guidance:** The relationship between the measured waveform and waveforms A, B and C is shown in figure A.26.
A.4.8.2.5 Pause duration

**Requirement:** Subclause 3.7.2.2e.

**Purpose:** To check whether the TE sends DTMF signals with the appropriate pauses.

**Measurement principle:**
- Preamble: Set the TE in loop state.
- Test state: Automatic Dialing.
- Test configuration: Figure A.27

DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 850 Ω.

AC termination of TE: Z_R.

Measurement points: Where all characters of table 9 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.

![Figure A.27](image)

**Measurement execution:**
Set tone signaling duration according to supplier's instructions. The TE is set in the loop state, transmitting DTMF signals to the line. Capture the waveform of the sequence of bursts.

**Formal processing:** Use waveforms A, B, C in subclause A.4.8.2.4
- Determine the reference level such that it is 10% of the highest level which waveform C exceeds for 20 ms during the burst.
- The pause between two bursts is the time between the last instant that waveform C is greater than the reference level for the first burst and the first instant that waveform C is greater than the reference level for the second burst.

**Verdict:**
- If all pauses have a duration greater than or equal to 70 ms then Pass;
- If any pause has a duration of less than 60 ms then Fail;
- If any pause has duration of between 60 ms and 70 ms then the test shall be repeated 10 times, and the mean duration of the pause between each of the pairs on characters calculated. If each mean duration is greater than 65 ms then Pass; otherwise Fail.
A.4.8.3 Pulse Signaling

**Requirement:** Subclause 3.7.3.

**Purpose:** To check pulse signaling characteristic of TE.

**Measurement principle:**
- Preamble: Set the TE in loop state.
- Test state: Automatic dialing.
- Test configuration: Figure A.28

DC feeding arrangement: Feed voltage: 50 V.

Measurement points: $R_1 = 3 \, \Omega$, $R_2 = 100 \, \Omega$.

**Measurement execution:**
Adjust $R_1$ so that the current reaches 23 mA, read and record the make and the break of each pulse, calculate the average ratio of the break pulse to duration pulse.

![Figure A.28](image)

**Verdict:** If all characteristics comply with 3.7.3 then Pass.

A.4.8.4 Automatically repeated call attempts

**Requirement:** Subclause 3.7.4.

**Purpose:** To check that the TE complies with subclause 3.7.4.

**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 Dialing, loop state and quiescent state.
- Test configuration: figure A.29

![Figure A.29](image)
DC feeding arrangement: Feed voltage: 50 V. Feed resistance: 850 Ω.

AC termination of TE: $Z_R$.

**Measurement execution:**
Causes TE to dial out without subsequent successful connection. Monitor TE line terminals. Measure the duration of the shortest interval (t) 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.

**Verdict:** If the interval (t) is greater than or equal to 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.

A.4.9 Transition from loop to quiescent state

**Requirement:** Subclause 3.8.

**Purpose:** To determine whether the TE changes correctly from the loop to the quiescent state.

**Measurement principle:**
- Preamble: Set the TE to loop state.
- Test state: Cause the TE to make a transition to quiescent state.
- Test configuration: Figure A.30

![Figure A.30](image)

**Measurement execution:**
DC feeding arrangement: Feed voltage 50 VDC.
Measurement points: Monitor the current after falling under 10 mA.

**Verdict:** If the TE complies with the limits of subclause 3.8 then Pass, else Fail.
## APPENDIX B. APPLYING TECHNICAL REQUIREMENTS  
(Normative)

### B.1 Condition table

Condition table defines specifications

In the table,
- C.x: C means Condition; x: uniquely identifies the element of the table.
- M: means that the relevant requirements are mandatory;
- N: means that the relevant requirements are not applicable.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Condition</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.1.</td>
<td>Is the TE controlled by an external device for the origination and/or the reception of a call?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.2.</td>
<td>Is the TE intended to have a connection to earth?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.3.</td>
<td>Is the TE intended to be in loop state?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.4.</td>
<td>Is the TE intended for call answer?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.5.</td>
<td>Is the TE intended for call set-up?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.6.</td>
<td>Is the TE intended for dialing with DTMF?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.7.</td>
<td>Is the TE intended for automatic dialing without dial tone detection?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.8.</td>
<td>Is the TE intended for automatic dialing with dial tone detection?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.9.</td>
<td>Is the TE intended for use in receiving mode?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.10.</td>
<td>Is the TE intended for use in transmitting mode?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.11.</td>
<td>Is the TE intended for making internally generated automatically repeated call attempts?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.12.</td>
<td>Is the TE intended for automatically controlled signal tone duration?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.13.</td>
<td>Is the TE intended for automatically controlled signal pause duration?</td>
<td>If YES then M else N</td>
</tr>
<tr>
<td>C.14.</td>
<td>Is the TE intended for pulse dialing?</td>
<td>If YES then M else N</td>
</tr>
</tbody>
</table>
**B.2 Requirements table**

Table B.2 lists specifications of the TE.

NOTE: In the table B.2,
- M: means that the requirement is mandatory;
- C.x: means that the requirement is mandatory if the relevant condition in table B.1 is met.

<table>
<thead>
<tr>
<th>No.</th>
<th>Reference</th>
<th>Requirement</th>
<th>Status</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.1.</td>
<td>Physical characteristics of connection to the PSTN</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3.2.</td>
<td>Polarity</td>
<td>M</td>
<td>Both polarities</td>
</tr>
<tr>
<td>3</td>
<td>3.3.1.</td>
<td>DC resistance</td>
<td>M</td>
<td>According to table 1</td>
</tr>
<tr>
<td>4</td>
<td>3.3.2.1.</td>
<td>Impedance</td>
<td>M</td>
<td>( \geq 4 , \text{k}\Omega )</td>
</tr>
<tr>
<td>5</td>
<td>3.3.2.2.</td>
<td>Transient response</td>
<td>M</td>
<td>( \leq 25 , \text{mA after 1 ms} \leq 10 , \text{mA after 6 ms} )</td>
</tr>
<tr>
<td>6</td>
<td>3.3.2.3.</td>
<td>DC current</td>
<td>M</td>
<td>(&lt; 0.6 , \text{mA} )</td>
</tr>
<tr>
<td>7</td>
<td>3.3.3.</td>
<td>Impedance unbalance about earth</td>
<td>C.2</td>
<td>According to table 2 and figure 2</td>
</tr>
<tr>
<td>8</td>
<td>3.3.4.</td>
<td>Resistance to earth</td>
<td>C.2</td>
<td>( \geq 10 , \text{M\Omega} )</td>
</tr>
<tr>
<td>9</td>
<td>3.4.</td>
<td>Ringing signal detector sensitivity</td>
<td>C.4</td>
<td>Satisfied to the worst case</td>
</tr>
<tr>
<td>10</td>
<td>3.5.1.</td>
<td>Acceptable of breaks in the loop in a call attempt</td>
<td>C.5</td>
<td>( \leq 7 , \text{ms} )</td>
</tr>
<tr>
<td>11</td>
<td>3.5.2.</td>
<td>Loop current characteristics</td>
<td>C.3</td>
<td>According to table 3.5 and figure 3.4</td>
</tr>
<tr>
<td>12</td>
<td>3.6.1.</td>
<td>DC characteristics</td>
<td>C.3</td>
<td>According to table 5 and figure 5</td>
</tr>
<tr>
<td>13</td>
<td>3.6.2.</td>
<td>Impedance</td>
<td>C.3</td>
<td>( \alpha \geq 8 , \text{dB (300 Hz &lt; f } \leq 4000 , \text{Hz}) ) ( \alpha \geq 6 , \text{dB (200 Hz } \leq f \leq 300 , \text{Hz}) )</td>
</tr>
<tr>
<td>14</td>
<td>3.6.3.1.</td>
<td>Instantaneous voltage</td>
<td>C.3</td>
<td>( \leq 1.74 , \text{V} )</td>
</tr>
<tr>
<td>15</td>
<td>3.6.3.2.</td>
<td>Mean sending level</td>
<td>C.3</td>
<td>( \leq -9 , \text{dBm} )</td>
</tr>
<tr>
<td>16</td>
<td>3.6.3.3.</td>
<td>Sending level</td>
<td>C.3</td>
<td>According to table 6 and figure 6</td>
</tr>
<tr>
<td>17</td>
<td>3.6.3.4.</td>
<td>Sending level above 4 kHz</td>
<td>C.3</td>
<td>According to table 7 and figure 7</td>
</tr>
<tr>
<td>18</td>
<td>3.6.4.1.</td>
<td>Longitudinal Conversion Loss</td>
<td>C.2; C.3; C.9</td>
<td>According to table 8 and figure 8</td>
</tr>
<tr>
<td></td>
<td>3.6.4.2.</td>
<td>Output signal balance</td>
<td>C.2; C.3 &amp; C.10</td>
<td>According to table 8 and figure 8</td>
</tr>
<tr>
<td>---</td>
<td>---------</td>
<td>-----------------------</td>
<td>-----------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>20</td>
<td>3.6.5.</td>
<td>Resistance to earth</td>
<td>C.2 &amp; (C.4/C.5)</td>
<td>( \geq 1 , \text{M\Omega} )</td>
</tr>
<tr>
<td>21</td>
<td>3.7.1.1.</td>
<td>Dialing without dial tone detection</td>
<td>C.7</td>
<td>( 2.7 , s \leq t \leq 8 , s )</td>
</tr>
<tr>
<td>22</td>
<td>3.7.1.2.</td>
<td>Dialing with dial tone detection</td>
<td>C.8</td>
<td>( t \leq 8 , s )</td>
</tr>
<tr>
<td>23</td>
<td>3.7.2.1.</td>
<td>Frequency combinations</td>
<td>C.6</td>
<td>According to table 9</td>
</tr>
<tr>
<td>24</td>
<td>3.7.2.2 (a)</td>
<td>Absolute levels</td>
<td>C.6</td>
<td>- 9 dBV +2.0/-2.5 dB (for higher frequency group); - 11 dBV +2.5/-2.0 dB (for lower frequency group)</td>
</tr>
<tr>
<td>25</td>
<td>3.7.2.2 (b)</td>
<td>Level difference</td>
<td>C.6</td>
<td>1 ( \div 4 , \text{dB} )</td>
</tr>
<tr>
<td>26</td>
<td>3.7.2.2 (c)</td>
<td>Unwanted frequency components</td>
<td>C.6</td>
<td>20 dB lower than level of the low frequency group</td>
</tr>
<tr>
<td>27</td>
<td>3.7.2.2 (d)</td>
<td>Tone duration</td>
<td>C.6 &amp; C.12</td>
<td>( \geq 65 , \text{ms} )</td>
</tr>
<tr>
<td>28</td>
<td>3.7.2.2 (e)</td>
<td>Pause duration</td>
<td>C.6 &amp; C.13</td>
<td>( \geq 65 , \text{ms} )</td>
</tr>
<tr>
<td>29</td>
<td>3.7.3.</td>
<td>Pulse signal</td>
<td>C.14</td>
<td>Table 10</td>
</tr>
<tr>
<td>30</td>
<td>3.7.4.</td>
<td>Automatically repeated call attempts</td>
<td>C.11</td>
<td>( \leq 15 , \text{times} )</td>
</tr>
<tr>
<td>31</td>
<td>3.8.</td>
<td>Transition from loop to quiescent state</td>
<td>C.3</td>
<td>Decreased current ( \leq 0.5 , \text{mA} ).</td>
</tr>
</tbody>
</table>
REFERENCE

[1] ETSI TBR-21- 1998 "Terminal Equipment (TE) Attachment Requirements for pan-European Approval for connection to the analogue Public Switched Telephone Networks"


[3] ITU - Rec. G.100 -1993 "Definitions used in recommendations on general characteristics of international telephone connection and circuits"

[4] ETS - 300.001 - 1997 "Attachments to Public Switched Telephone Network (PSTN); General technical requirements for equipment to be connected to an analogue subscriber interface in the PSTN"

[5] Telecommunications Authority Hong Kong - 1996 "Compliance test specification for single-line subscriber equipment connected to the public switched telephone network (PSTN) in Hong Kong"

[6] Telecommunication Authority of Singapore Standards & Type Approval Department -1997 "Type Approval Specification for Terminal Equipment for connection to Public Switched Telephone Network (PSTN)"


