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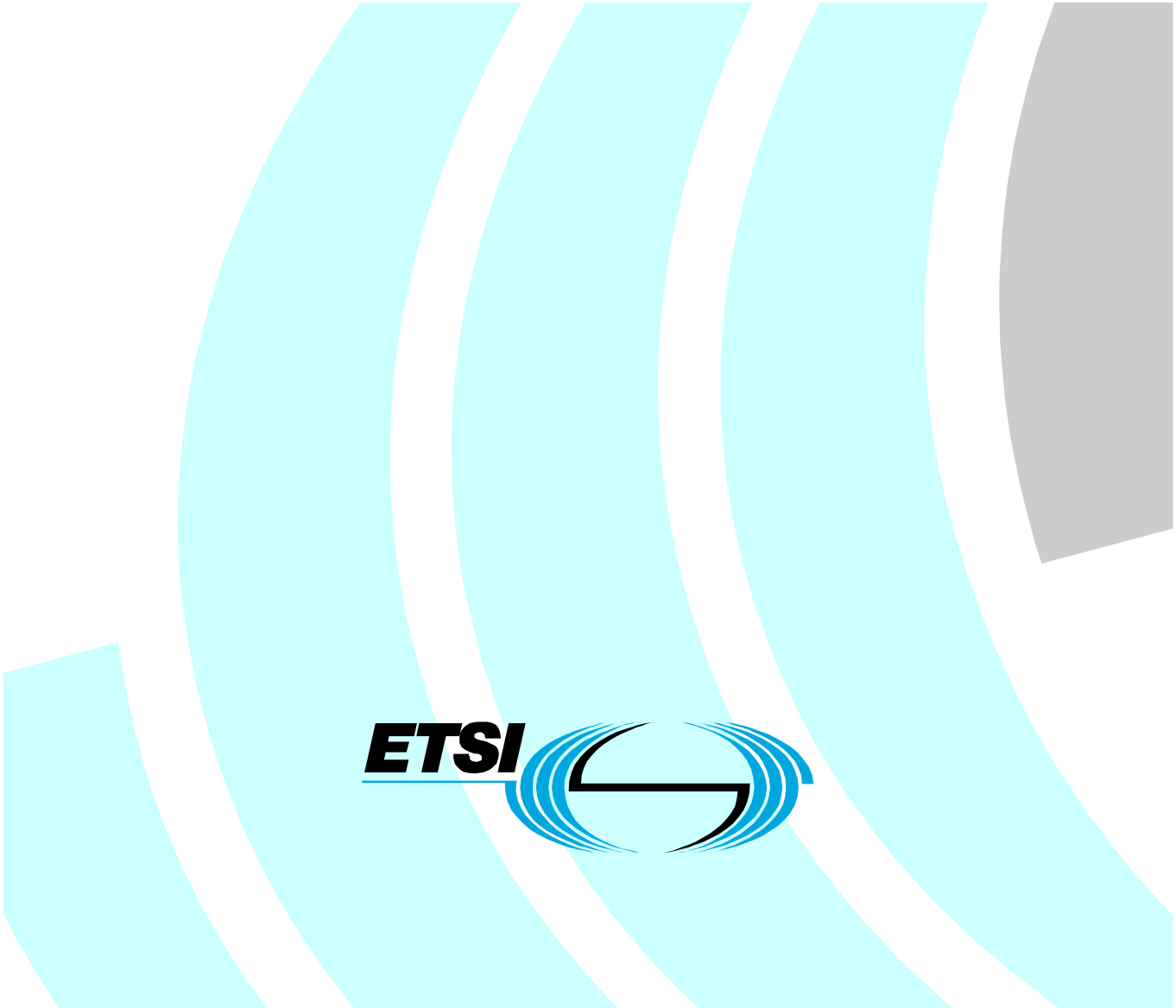
Technical Report

Access and Terminals (AT); Ringing without DC for Terminal Equipment (TE), Terminal Support Interfaces (TSI) and Local Exchange Interfaces (LEI)



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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Access and Terminals (AT).

Introduction

The present document describes proposed (additional) requirements for Terminal Equipment (TE), Terminal Support Interfaces (TSI) and Local Exchange Interfaces (LEI), when ringing without DC is used.

Existing TE standards like TBR 021 [3] do not describe or specify requirements or tests for this situation, so they are studied in the present document.

At present a number of standards exist or are being developed to specify interfaces for analogue PSTN TE, like the ones fulfilling TBR 021 [3] The most relevant of these documents is ES 201 970 [6], but other examples are EG 201 188 [2], EG 201 185 [1], TS 101 909-18 [7], EN 300 659 [8].

At present , there is a growing number of apparatus delivering ringing signal to TE while the ringing voltage is not superimposed on the DC line feed voltage. This is called "Ringing **without** DC". This is in contrast with the existing practice in PSTN networks in which "ringing **with** DC" is used. It is important that TE can handle this and that good interworking is assured. Existing TE standards like TBR 021 [3] do not describe or specify requirements for TE for this situation. So existing TE is not tested for this.

The present document investigates the necessary requirements for the Terminal Equipment and for the apparatus/interface (e.g. TSI and LEI) delivering the ringing signal to the TE (for TSI there are already some requirements).

Ringing without DC is especially used in the situation that the apparatus, delivering the ringing signal, are located at the users premises. Examples are TA, PBX, VoDSL (Voice over DSL). The interface delivering the ringing signal in this case is called "Terminal Support Interface" (TSI), see EG 201 185 [1]. To cover most situations, also the Local Exchange Interfaces (LEI) is considered when delivering the ringing signal without DC. The name LEI in the present document is also applicable if the interface is located somewhere in the access network e.g. in "remote" exchange equipment.

In case of ringing without DC it is necessary that functions which may be possibly influenced by this method of ringing should be considered e.g.:

- functioning of the ringer of the TE and other ringing signal related/dependant TE functions;
- reliable detection of a TEs "on-hook" to "off-hook" transition by the interface, during a ringing pulse (ring trip);
- short ring trip;
- reliable operation on all aspects involved;
- prevention for false "off-hook" detection;

- test methods for TE and TSI or LEI for this type of ringing.

The subject of this study is considered to be relevant for (updating of):

- ES 201 970 [6] (the base interface offered to analogue PSTN TE);
- TBR 021 [3] (which describes attachment requirements for Terminal Equipment);
- EG 201 185 [1] "Terminal support interface for harmonized analogue PSTN terminals";
- TR 101 768 [5] "Study on the generation of analogue ringing signals";
- EN 301 437 [4] (which describes attachment requirements for "voice" Terminal Equipment);
- ES 201 970 [6] "Harmonized specification of physical and electrical characteristics at a 2-wire analogue presented Network Termination Point (NTP)".

NOTE: For the exact title of the documents, see clause 2.

1 Scope

The present document studies the necessary additional requirements for analogue Terminal Equipment (TE), for the analogue Terminal Support Interface (TSI) and for the analogue Local Exchange Interface (LEI) in case of "ringing without DC".

2 References

For the purposes of this Technical Report, the following references apply:

[1] ETSI EG 201 185: "Terminal support interface for harmonized analogue PSTN terminals".

[2] ETSI EG 201 188: "Public Switched Telephone Network (PSTN); Network Termination Point (NTP) analogue interface; Specification of physical and electrical characteristics at a 2-wire analogue presented NTP for short to medium length loop applications".

[3] ETSI TBR 021: "Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling".

[4] ETSI EN 301 437: "Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE supporting the voice telephony service in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling".

[5] ETSI TR 101 768: "Public Switched Telephone Network (PSTN); Study on the generation of analogue ringing signals".

[6] ETSI ES 201 970: "Access and Terminals (AT); Public Switched Telephone Network (PSTN); Harmonized specification of physical and electrical characteristics at a 2-wire analogue presented Network Termination Point (NTP) ".

[7] ETSI TS 101 909-18: "Digital Broadband Cable Access to the Public Telecommunications Network; IP Multimedia Time Critical Services; Part 18: Embedded Media Terminal Adapter (e-MTA) offering an interface to analogue terminals and Cable Modem".

[8] ETSI EN 300 659 (all parts): "Access and Terminals (AT); Analogue access to the Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

ringing signal: signal used to alert a terminal for an incoming call

NOTE: The ringing signal is composed of a number of "ringing pulses", separated by "ringing pauses".

ringing pulse: period (e.g. 1 s) in which "ringing voltage" is applied at the interface

ringing voltage: AC-voltage with a frequency of 25 Hz or 50 Hz and an amplitude of tenths of V (more than 30 Vrms), used to alert a TE for an incoming call

ringing pause: period (e.g. 4 s) between "ringing pulses"

Terminal Support Interface (TSI): analogue interface at which TE is connected. The interface is specified in EG 201 185 and is mainly used at the users premises in TAs, PBXs etc.

Local Exchange Interface (LEI): analogue interface at which TE is connected via a local loop of short, medium or long length

NOTE: The interface is mainly used in the local exchanges of (existing) public telephone networks (e.g. the line card of the local exchange). Typical loops lengths in an access networks are in the range 0 km (short loop) up to 5 km (long loop).

ringing with DC: delivering ringing signal to (alert) TE while the (AC) ringing voltage is superimposed on the DC line feeding voltage

ringing without DC: delivering ringing signal (to alert TE) in which during ringing pulses no DC line feeding voltage is present at the interface

modulus: magnitude of a signal

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
DC	Direct Current
DSL	Digital Subscriber Line
EMF	Electro Motive Force
LEI	Local Exchange Interface
PBX	Private Branch eXchange
TA	Terminal Adapter
TE	Terminal Equipment
TSI	Terminal Support Interface
VoDSL	Voice over DSL

4 Ringing without DC

In PSTN networks, the ringing voltage is normally superimposed on the DC line feeding voltage (this is called "ringing with DC").

Today there is a growing demand for "ringing without DC". This demand arises from equipment installed at the users premises like Terminal Adapters (e.g. to connect analogue TE to an ISDN line), PBXs, VoDSL equipment etc.

In the present document the terms "TSI" (Terminal Support Interface) and LEI (Local Exchange Interface) are used for the interface that supplies the ringing signal (without DC). The use of the terms "TSI" and "LEI" in the present document seems to be more clear then only the term "interface".

In existing standards like TBR 021 [3], "ringing without DC" is not considered, and for that reason there are no requirements and tests specified.

To make reliable "ringing without DC" possible, both the TE and the TSI/LEI should fulfil some (additional) requirements for this purpose to assure proper interworking. Those (proposed) requirements are described in the next clauses.

Requirements are necessary for:

- The interface that supplies the ringing signal (TSI or LEI), (e.g. reliable recognizing "on-hook" to "off-hook" transition, minimizing ring trip, etc.). Those requirements are described in clause 5.
- Terminal Equipment (TE), (e.g. impedance at 25 Hz/50 Hz in off-hook state etc.). Those requirements are described in clause 6.

5 Requirements for the Terminal Support Interface (TSI) and the Local Exchange Interface (LEI)

In this clause are the requirements studied for the interface (TSI/LEI) that supplies the ringing signal. These are existing requirements, but now used for applications with "ringing without DC", and new requirements necessary for "ringing without DC".

5.1 Ringing signal

5.1.1 Ringing signal (existing requirements)

For "ringing without DC", the TSI/LEI shall fulfil the following existing ringing related requirements:

1) The ringing voltage, as specified in ES 201 970 [6], EG 201 188 [2], EG 201 185 [1] and TR 101 768 [5], shall have a frequency of 25 Hz ± 2 Hz [2], [5] or 50 Hz ± 5 Hz [1].

2) The maximum, open circuit, AC ringing voltage level shall be less than 100 Vrms; as specified in EG 201 188 [2] and TR 101 768 [5].

3) As specified in EG 201 185 [1], clause 12.1 and TR 101 768 [5], the peak to rms voltage ratio shall be in the range 1,2 to 1,6; The waveform should be essentially symmetrical with an even order harmonic content not exceeding 5 %.

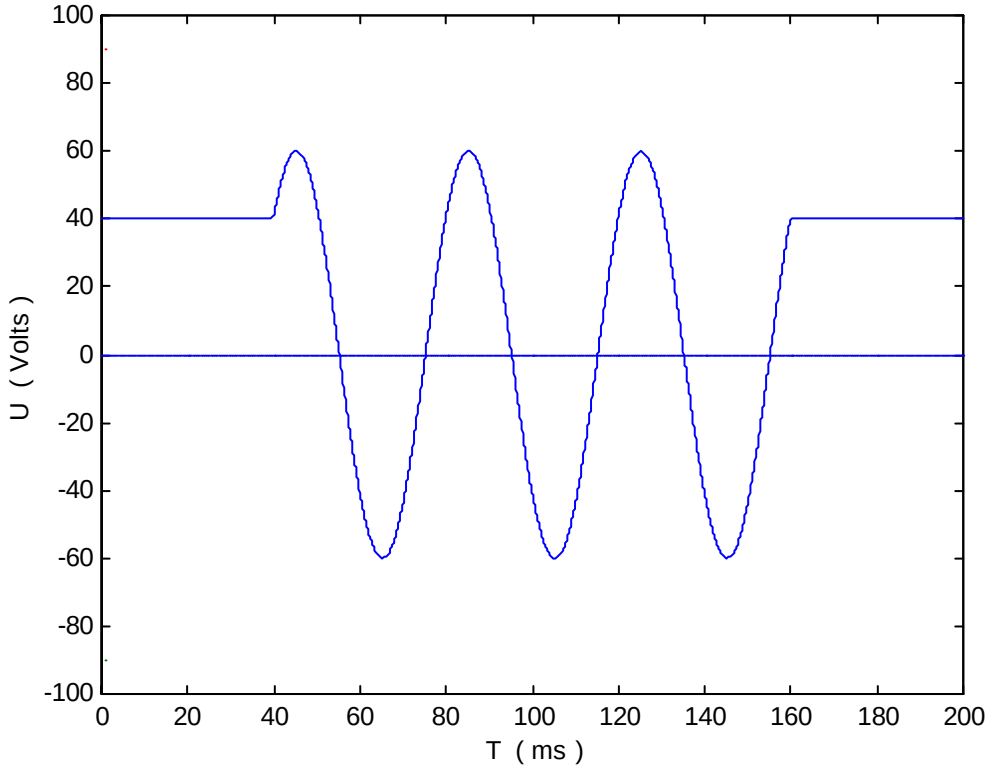
4) A line feeding DC voltage shall be present during the ringing pause, as specified in EG 201 185 [1], clause 12.1.

5) The ring cadence shall be as specified in EG 201 185 [1] and TR 101 768 [5].

5.1.2 Ringing signal (additional requirements)

For "ringing without DC", the TSI/LEI should fulfil the following additional ringing related requirement:

1) It is recommended that the change from DC to ringing voltage and vice versa is made in a smooth way. The best way to accomplish this is to start, and also to stop, the ringing voltage when it has the same (voltage) level as the DC feeding voltage level (see figure 1).Otherwise there could be transients due to loading and unloading of the TEs ringer capacitor at the beginning and the end of the ringing pulse. This transient has a steep slope and could be disturbing to xDSL signals.



NOTE: To make the picture more clear, only 3 periods of the ringing voltage are shown.

Figure 1: Example of the principle of switching the ringing voltage on and off at the right moment

2) To prevent for strong transients, the TSI/LEI should fulfil the following requirement:

- At the transition from DC line feed voltage to ringing voltage (and from ringing voltage to DC), the modulus of the change of the current to the load, measured in an infinite small time span (|dI/dt|), shall be less than 300 A/s. During the test, the interface shall be terminated in an AC load impedance with an impedance of about 100 Ω at higher frequencies (i.e. DSL frequencies). For this test load the following network is proposed: 100 Ω + 0,8 µF.

5.2 Ringing drive capability

5.2.1 Ringing drive capability (existing requirements)

For "ringing without DC", the TSI/LEI shall fulfil the following existing ringing related requirements:

1) The TSI/LEI shall, as specified in EG 201 185 [1], clause 12.3 and TR 101 768 [5], be able to supply a ringing voltage of 35 V or more to an AC load of 4 000 Ω. Test loads are specified in clause 5.2.2.

2) In EG 201 185 [1], clause 12.1, it is also recommended that the TSI can supply 35 V to a load of 2 000 Ω (4 000 Ω is mandatory, 2 000 Ω is recommended). It has been reported that using some older TE, a test load of 4 000 Ω is not sufficient and 2 000 Ω is necessary.

5.2.2 Ringing drive capability (new requirements/tests)

For "ringing without DC", the TSI/LEI should fulfil the following (new) ringing related requirements/tests:

1) Requirement 1 of clause 5.2.1 (supply ≥ 35 V to a load of 4 000 Ω) could be tested with:

   - a load impedance with a modulus of 4 000 Ω and a phase angle of -70 ° to -1 ° at 25 Hz, for interfaces supplying 25 Hz (see note 4);

   - a load impedance with a modulus of 4 000 Ω and a phase angle of -70 ° to -1 ° at 50 Hz, for interfaces supplying 50 Hz (see note 4).

   For this test, a resistor, representing the maximum length "loop", is connected between the interface and the load specified above. The value of this resistor is (see also note 2):

   - 100 Ω, if the interface is intended for short loops (TSI);

   - 1 000 Ω, if the interface is intended for short, medium and long loops (LEI).

2) Fault conditions (during ringing) may not damage the interface or the wiring connected. Examples of fault conditions are: a short cut or unintended connections to earth.

NOTE 1: It is expected that TE shows a capacitive load at 25 Hz and 50 Hz (in the on-hook state).

NOTE 2: The maximum loop resistance for a short loop, defined in EG 201 185 [1], is 100 Ω. The resistor of 1 000 Ω representing the maximum loop resistance of a long loop is expected to be adequate for the LEI test.

NOTE 3: There are no requirements in TBR 021 [3] concerning the behaviour of TEs with ringing signals without a DC superimposed voltage, or the off-hook impedance of TEs at 25 Hz. As a consequence, it cannot be assured that a TE complying with TBR 021 [3] will correctly interwork with networks delivering AC ringing signals without a DC superimposed voltage. Increasing the ringing voltage from 35 V to 55 V (on the loads specified in the present document) may improve the probability of correct interworking of these terminals in the area of ring detection where ringing is not superimposed on a DC component.

NOTE 4: The phase angle of -1 degree has been chosen to indicate that the load shall show a very high DC resistance to prevent that the interface recognizes the off-hook state caused by a DC current. It is proposed that the load is composed of a resistor in series with a capacitor.

5.3 Recognizing "off-hook" (ring trip)

5.3.1 Recognizing "off-hook" (existing requirements)

For "ringing without DC", the TSI/LEI shall fulfil the following existing ringing related requirements:

1) The TSI shall, as specified in EG 201 185 [1], clause 12.3 and TR 101 768 [5], regard an answer signal (off-hook condition) when an impedance not exceeding 700 Ω (at 25 Hz/50Hz) is applied at the interface.

2) The TSI/LEI shall, as specified in EG 201 185 [1], clause 12.3, remove the ringing signal within 100 ms after an answer signal from the TE ("answer signal" is the situation in which the TE has reached the low impedance state, defined in clause 6.3.2, item 1). Also for this reason the TE shall fulfil the "Transient response" requirement, see clause 6.2.1, item 4.

5.3.2 Recognizing "off-hook" (new requirements/tests)

For "ringing without DC", the TSI/LEI should fulfil the following (new) ringing related requirements:

1) It is expected that for a TSI (intended for short loops) tests with resistors in the range 100 Ω to 700 Ω are sufficient to test requirement 1 in clause 5.3.1. For that reason a test with 100 Ω and 700 Ω is recommended.

2) An LEI (intended for the whole range of short, medium and long loops) shall recognize an impedance of 1 700 Ω or less as an off-hook state. This is tested with a resistors of 100 Ω and 1 700 Ω, applied at the interface.

3) Another option to detect an off-hook condition is to monitor the reduction in the impedance at the ringing frequency, as detected by the line interface card, caused by the on-hook to off-hook transition of the TE.

   A reduction of the impedance at ringing frequencies of at least 35 % may be expected, as seen from the local exchange line card with the longest loop length.

   For an interface only used for a short loop (TSI), the reduction of the impedance is much greater than 35 %.

4) The TSI and LEI shall also recognize a transition of the TE to the loop state when this happens during a "ringing pause". This is possible because requirement 4 in clause 5.1.1 recommends that the DC feeding voltage is present during the "ringing pauses" (off parts) of the ringing signal.

5) The TSI shall restore the DC feeding voltage within 10 ms after removal of the ringing signal caused by a ring trip.

5.3.3 False ring trip (new requirements)

For "ringing without DC", the TSI or LEI should fulfil the following (new) ringing related requirements:

1) The interface shall **not** recognize the ringing current as an "off-hook" condition when:

   - for a TSI intended for application on short local loops (loop resistance less than 100 Ω), an impedance exceeding 1 500 Ω at 25 Hz or 50 Hz is applied at the interface. This could be tested with a test impedance with a modulus of 1 500 Ω and a phase angle of -70 °. This test impedance is composed of a resistor in series with a capacitor which values are in table 1.

   - for a LEI intended for application on networks with different loop lengths (short, medium and long), an impedance exceeding 3 500 Ω at 25 Hz or 50 Hz is applied at the interface. This could be tested with a test impedance with a modulus of 3 500 Ω and a phase angle of -70 °. This test impedance is composed of a resistor in series with a capacitor which values are in table 1.

   - as already mentioned in clause 5.3.2, it is expected that if a TE goes off-hook, the reduction of impedance at ringing frequencies, seen by the line-card, would be at least 35 %, even if the line is "long". So by detecting this impedance change in the line card in a correct way, it is possible to recognize ring trip and due to this to prevent for falls ring trip.

Table 1: Component values for R and C of the test network for the test of "False ring trip"

TSI type	Ringing frequency	Value of the resistor	Value of the capacitor
Interface for short loop length (TSI)	25 Hz	513 Ω	4,52 µF
Interface for short loop length (TSI)	50 Hz	513 Ω	2,26 µF
Interface for different loop lengths (LEI)	25 Hz	1197 Ω	1,94 µF
Interface for different loop lengths (LEI)	50 Hz	1197 Ω	0,97 µF

NOTE 1: Tolerance for R and for C is ≤ 2 %.

NOTE 2: The TSI/LEI shall not recognize the loading or unloading current from the ringer circuit capacitor in the TE as a short "off-hook" event. This is already tested by the test in item 1 of this clause. Also for this reason the TE shall fulfil the "Transient response" requirement, see clause 6.2.1, item 4.

6 Requirements for Terminal Equipment (TE)

6.1 General considerations for TE

For "ringing without DC", the TE should fulfil the following (proposed) ringing related requirements:

1) The performance of the TE shall be equal (or better) as when using "ringing with DC". This is important for all the ringing signal related functions of the TE (and possibly other functions).

2) The TE is able to work on "ringing with DC", as well as "ringing without DC" (without adjustments).

3) The TE shall not misinterpret the "ringing without DC" as another event (e.g. as a reversal of the DC line feed voltage).

6.2 On-hook requirements

6.2.1 On-hook requirements (extension of existing requirements)

For "ringing without DC", the TE should fulfil the following existing ringing related requirements, also when tested with ringing without DC:

1) The TE shall fulfil the same requirements as specified in TBR 021 [3], clause 4.4.2.1, requiring an impedance not less than 4 000 Ω at 25 Hz and 50 Hz in the "on-hook" state.

2) The TE shall fulfil the same requirements as specified in TBR 021 [3], clause 4.5, specifying the ringing signal detector sensivity.

3) The TE shall fulfil the same requirements as specified in TBR 021 [3], clause 4.4.2.3, specifying the maximum DC current during the ringing signal, requiring a DC current less than 0,6 mA.

4) The TE shall fulfil the same requirements as specified in TBR 021 [3], clause 4.4.2.2, specifying the transient response of the TE (see clause 6.3.3).

6.3 Off-hook requirements

6.3.1 Off-hook requirements (extension of existing requirements)

For "ringing without DC", the TE shall fulfil the following existing ringing related requirements:

1) TBR 021 [3], clause 4.6.1 requires the TE to accept breaks in the loop current during establishment of loop state. This requirement also applies when ringing without DC is used.

6.3.2 Off-hook requirements (new requirements)

For "ringing without DC", the TE shall fulfil the following (new) ringing related requirements:

1) When the TE goes off-hook during a ringing pulse, the TE shall draw an AC current, of which the effective value (rms) is equal or more than 36 mA. This should be tested at 25 Hz as well as 50 Hz. This requirement applies for the steady state, some time after the transition of the TE to the loop state has started. The requirement for transition itself is described in clause 6.3.3.

   The requirement is tested by applying ringing voltage to the TE. The AC current to the TE is measured by test-equipment, which measures the effective (rms) value of the AC current.

   The test conditions for this test are in table 2.

Table 2: Test conditions for "off-hook" impedance at ringing frequency

EMF of the Ringing Source	50 Vrms
Impedance of the ringing source	800 Ω

6.3.3 On-hook to off-hook transition (new requirements)

1) The transition from the quiescent state to the loop state should happen in a controlled way (time, current values etc.). TBR 021 [3] describes this for the DC loop current situation. This item will describe requirements for the period while the transition happens during a ringing pulse.

   The transition from the on-hook state to the off-hook state, for an incoming call, can happen during a ringing pause or during a ringing pulse. In TBR 021 [3] there is a requirement for the transition from the on-hook state to the loop state when there is no ringing voltage, and this is tested by measuring the DC current and comparing it with the mask in TBR 021 [3] For the situation when the transition happens during a ringing pulse, using ringing without DC, a test for the transition has been defined below.

   It is recommended that the transition is tested by measuring the AC current to the TE with measurement equipment or a test device that takes samples of the value of the AC current and stores the values in a memory e.g. for calculations.

   The sample rate should be 1 000 samples per second for 25 Hz ringing (and 2 000 samples per second for 50 Hz ringing). The transient is sampled and the samples are integrated in the time domain over a "time sliding window" of 20 ms (10 ms for 50 Hz). The result of the integration shall fall within the mask of figure 2.

NOTE: The length of the "time sliding window" is half a period of the ringing (sine) wave.

The integration is performed by the equitation:

$$I(t) = \frac{1}{20}\sum_{k=1}^{20} |I_k(t)|$$

The test conditions are in table 3.

Table 3: Test conditions for the transient test

EMF of the Ringing Source	50 Vrms
Impedance of the ringing source	800 Ω
I_1	130 % of the steady "on-hook" state AC current value
I_2	36 mA or 80 % of the steady "off-hook" (loop) state AC current value (which ever value is reached first)
$t_1 - t_0$	as short as possible
$t_2 - t_1$	40 ms

t_0 = is the time when the TE goes off-hook, in general this is indicated by opening of the hook switch

t_1 = the time when the current passes value I_1

t_2 = the time when the current becomes remains above value I_2

To have a short ring trip, the time $t_1 - t_0$ should be as short as possible. The time $t_1 - t_0$ is the time between the activation of the hook switch and the time that this results in an increase of the AC current to the TE.

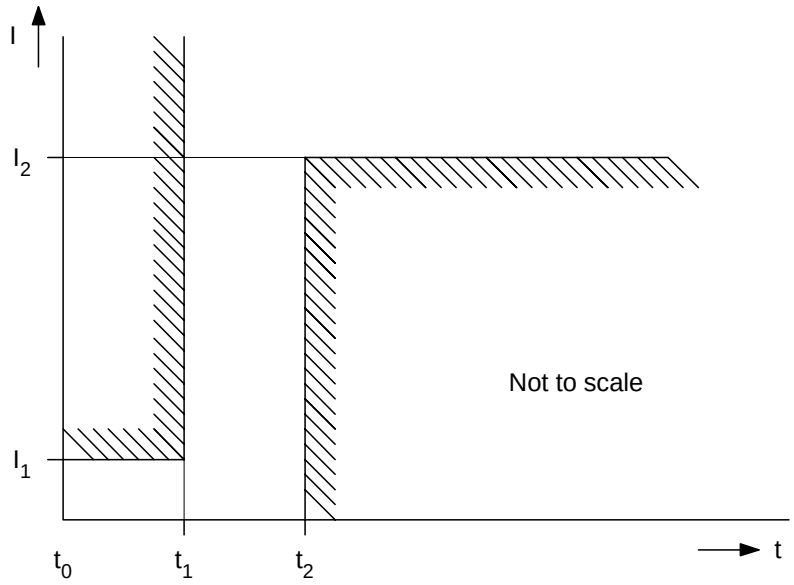


Figure 2: Mask for test of the transition of the TE from the quiescent state to the loop state during a ringing pulse

History

Document history		
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