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European Standard (Telecommunications series)

**Environmental Engineering (EE);
Power supply interface at the input to
telecommunications equipment;
Part 2: Operated by direct current (dc)**



Reference

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document concerns the requirements for the interface between telecommunications equipment and its power supply, and includes requirements relating to its stability and measurement. Various other references and detailed measurement and test arrangements are contained in informative annexes.

The present document is part 2 of a multi-part deliverable covering Environmental Engineering (EE); Power supply interface at the input to telecommunications equipment, as identified below:

Part 1: "Operated by alternating current (ac) derived from direct current (dc) sources";

Part 2: "Operated by direct current (dc)";

Part 3: "Operated by rectified current source, alternating current source or direct current source up to 400 V".

National transposition dates	
Date of adoption of this EN:	17 January 2003
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1 Scope

The present document contains requirements for:

- the output performance of the direct current (dc) power equipment at the interface "A";
- the input of the telecommunications equipment connected to interface "A" powered by dc.

The dc voltage at interface "A" may be derived from the AC primary supply. The dc supply may incorporate a backup battery.

If any other equipment e.g. datacom equipment, are connected to interface "A" in parallel to telecommunications equipment, all requirements addressed in clause 4 of the present document must be fulfilled.

The present document aims at providing compatibility between the power supply equipment and the power consuming telecommunications equipment, and also between different system blocks connected to the same power supply.

NOTE 1: The present document is applicable only to $-48 V_{dc}$ power supply interfaces. However, during a transitional period, other dc voltages may be used in existing installations. Annex A gives guidance on working in conjunction with existing $-60 V_{dc}$ supply systems.

The power supply interface, interface "A", is a physical point to which all the requirements are related (see figure 1).

This point is situated between the power supply system(s) and the power consuming telecommunications equipment.

NOTE 2: Interface "A" is located at the power terminals of the telecommunications equipment. Subject to the installation preconditions this point may be located at any other point between the power supply system and the telecommunications equipment by mutual agreement of the relevant parties.

The requirements at interface "A" apply to:

- the output of the power supply equipment or power supply installation of telecommunications centres;
- the power supply input of telecommunications equipment installed at telecommunication centres;
- telecommunications equipment, installed in customers' premises, whose dc interface "A" is also used by equipment requiring a supply to this specification.

NOTE 3: Normally there is more than one load unit connected to interface "A". In these cases, interface "A" will undergo further restrictions with respect to noise limits or other disturbances specified in clause 4.8.

NOTE 4: Disturbances on the power supply interface "A" relating to the continuous wave phenomena below 20 kHz are covered within the present document.

NOTE 5: An example of a configuration in which interface "A" is identified is given in annex D.

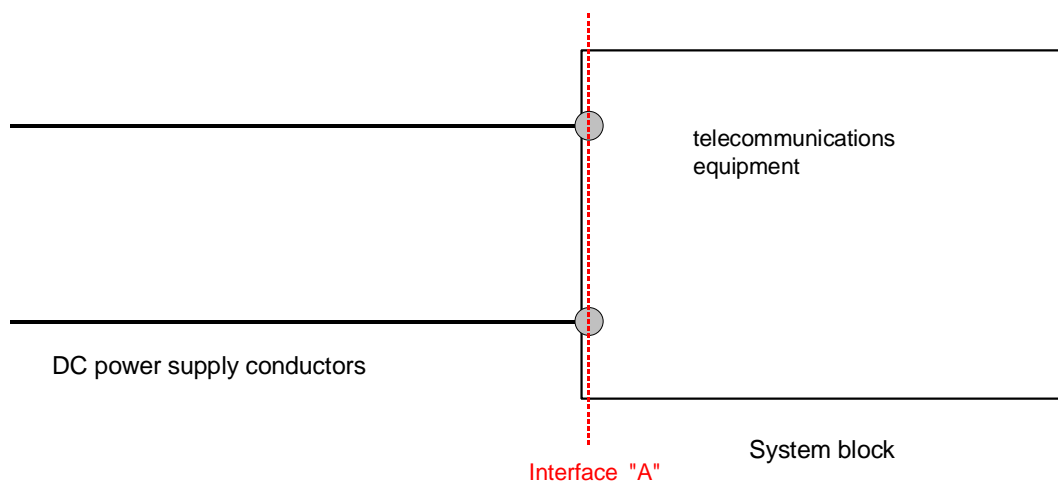


Figure 1: Identification of interface "A"

The purpose of the present document is:

- to use a power supply system with the same characteristics for all telecommunications equipment defined in the area of application;
- to facilitate inter working of different (types of) load units;
- to facilitate the standardization of telecommunications equipment;
- to facilitate the installation, operation and maintenance in the same network of equipment and telecommunications systems from different origins.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

- [1] IEC 60269-1: "Low-voltage fuses - Part 1: General requirements".
- [2] EN 60934: "Circuit-breakers for equipment (CBE)".
- [3] ETSI EN 300 253: "Environmental Engineering (EE); Earthing and bonding of telecommunication equipment in telecommunication centres".
- [4] ITU-T Recommendation Q.551: "Transmission characteristics of digital exchanges".
- [5] ITU-T Recommendation Q.552: "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".
- [6] ITU-T Recommendation Q.553: "Transmission characteristics at 4-wire analogue interfaces of digital exchanges".

- [7] ITU-T Recommendation Q.554: "Transmission characteristics at digital interfaces of digital exchanges".
- [8] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

abnormal voltage range: range of steady-state voltage over which the equipment will not be expected to maintain normal service but will survive undamaged

customer premises: any location which is the sole responsibility of the customer

interface "A": terminals at which the power supply is connected to the system block

NOTE 1: See also figure 1.

NOTE 2: This is a functional definition and not an exact depiction of the physical location.

load unit: power-consuming equipment, that is part of a system block

maximum continuous input current: maximum continuous input current, stated by the manufacturer, for a fully-equipped equipment under test connected to interface "A", at nominal voltage (accordance clause 4.7.1 of EN 300 132-2)

normal service: service mode where telecommunications equipment operates within its specification

normal service voltage range: range of steady-state voltages over which the equipment will maintain normal service

nominal voltage: nominal value of the voltage that designates the type of supply

power supply: power source to which telecommunications equipment is intended to be connected

system block: functional group of equipment depending for its operation and performance on its connection to the same power supply

NOTE: A system block may consist of equipment or a functional group of equipment. Different examples of configurations at interface "A" are given in annex D.

telecommunication centre: location where telecommunications equipment is installed and which is the sole responsibility of the operator

3.2 Symbols

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

I_t	instantaneous surge current (see clause 4.7.1)
I_m	maximum continuous input current
L	inductance of inductive element of LISN
R	resistance of resistive element of LISN
t	time
Z_c	capacitive impedance of immunity measurement circuit
Z_m	resistive impedance of immunity measurement circuit

3.3 Abbreviations

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

dc	direct current (also when used as a suffix to units of measurement)
EUT	Equipment Under Test
LISN	Line Impedance Stabilization Network
rms	root mean square (also when used as a suffix to units of measurement)

4 Requirements

4.1 Nominal voltage

The nominal value of the voltage at interface "A" shall be $-48 V_{dc}$ (positive conductor is connected to earth).

NOTE 1: In most cases the voltage of interface "A" will be complemented by a 24 cell lead-acid battery.

NOTE 2: During a transitional period, other dc voltages may be used in existing installations. Annex A gives guidance on merging equipment with existing $-60 V_{dc}$ supply systems.

4.2 Normal service voltage range at interface "A"

The normal service voltage range for the $-48 V_{dc}$ nominal supply at interface "A" shall be $-40,5 V_{dc}$ to $-57,0 V_{dc}$.

NOTE 1: The minimum voltage is based on the voltage drop in the distribution network and a battery cell end of discharge voltage.

NOTE 2: The voltages specified are measured at interface "A". It should be noted that if interface "A" is at any point other than the telecommunications equipment interface there will be a voltage drop between interface "A" and the equipment terminals.

NOTE 3: When the voltage is in the range $-40,5 V_{dc}$ to $-44,0 V_{dc}$ it is recognized that there may be a slight degradation of service performance.

4.3 Abnormal service voltage range at interface "A"

4.3.1 Abnormal service voltage under steady-state conditions

Telecommunications equipment operated at $-48 V_{dc}$ shall not suffer any damage when subjected to the following voltage ranges:

$0,0 V_{dc}$	to	$-40,5 V_{dc}$ and
$-57,0 V_{dc}$	to	$-60,0 V_{dc}$

4.3.2 Recovery from steady state abnormal voltage

Following the restoration of the supply to the normal voltage range, the power conversion and management systems on the load side of interface "A" shall automatically restore service. The telecommunications equipment shall then resume operation according to its specifications. The abnormal service voltage shall not lead to the disconnection of the power supply e.g. by causing circuit breakers, fuses or other such devices to operate.

NOTE: It is acceptable that the system may restart when the voltage is $-40,5 V$ or greater within the nominal service voltage range and/or after a time delay.

4.3.3 Voltage transients

Voltage transients may occur at interface "A" when faults occur in the power distribution system. These transients are characterized by a voltage drop in the range: $0 V_{dc}$ to $-40,5 V_{dc}$, followed by an overvoltage often in excess of the maximum steady state abnormal service voltage range and dependent upon the power distribution up to interface "A" and the equipment connected to interface "A".

Telecommunications equipment operated at a nominal $-48 V_{dc}$ shall not be damaged when subjected to these transients.

NOTE: TR 100 283 provides guidance for the protection of telecommunications equipment from the transients.

4.3.4 Recovery from voltage transients

After the occurrence of a voltage transient, as described in clause 4.3.3, telecommunications equipment shall continue to function within its operational specification without requiring manual intervention. The abnormal service shall not lead to the disconnection of power supply units e.g. by causing circuit breakers, fuses and other such devices to operate.

NOTE 1: In sensitive equipment, momentary and temporary interruption of the service may occur as a result of such transients at interface "A". Lengthening of the interruption to service (equipment is not functioning as intended) due to the recovery of software shall be taken in account. More detailed information about the service interruption shall be provided by the manufacturer on the request of the operator.

NOTE 2: To prevent system malfunctioning additional arrangements concerning the power supply system may be necessary.

For example:

- Dual feeding system.
- High Ohmic distribution system.
- Independent power distribution.

4.4 Voltage changes due to the regulation of the power supply

Telecommunication equipment may be subjected to a voltage change at interface "A" as a result of regulation of the voltage by the power supply system e.g. end cell switching.

This test applies to the telecommunication equipment connected to interface "A". The test can also be applied separately to each subpart of the equipment connected to the same interface "A".

4.4.1 Test conditions

Telecommunication equipment shall be subjected to a single maximum transition rate of the voltage at interface "A" with an amplitude of $6 V \pm 10 \%$ for both the fall and rise time of the voltage and a change rate within the range $3 V/ms$ to $7 V/ms$.

It is assumed that the voltage at interface "A" remains within the normal service voltage range during the test.

4.4.2 Performance criteria

During and after the occurrence of such a transition voltage, the telecommunication equipment shall fulfil the following performance criteria.

The tested part of the telecommunication equipment shall operate according to the specification and no loss of data or false alarm shall occur.

4.5 Supply protection at interface "A"

The supply at interface "A" shall be protected by circuit breakers, fuses or other such devices.

The energy content of the inrush current shall also be taken into account when specifying the power supply system up to interface "A".

4.6 Maximum current drain following abnormal service

The maximum current drain at any voltage in the normal and abnormal voltage range at interface "A" lasting for longer than 1 second shall not exceed 1,5 times the current drain at nominal working voltage of $-48 V_{dc}$.

NOTE 1: The current should not exceed this level at any time, also when the equipment is feed by a nearly empty battery, not only during restoration. This is mandatory to protect fuses.

NOTE 2: For shorter times see Inrush Current Graph (see figure 2).

4.7 Surge current on connection of interface "A"

4.7.1 Limits

Refer to the test configuration of figure 3. The ratio of the instantaneous surge current I_t to maximum current I_m at interface "A", when the switch is closed at nominal voltage $-48V_{dc}$, shall not exceed the limits shown in figure 2.

The parameters are defined as follows:

- I_t inrush current (magnitude of instantaneous value);
- I_m maximum continuous input current, stated by the manufacturer, for a fully-equipped equipment under test connected to interface "A", at nominal voltage.

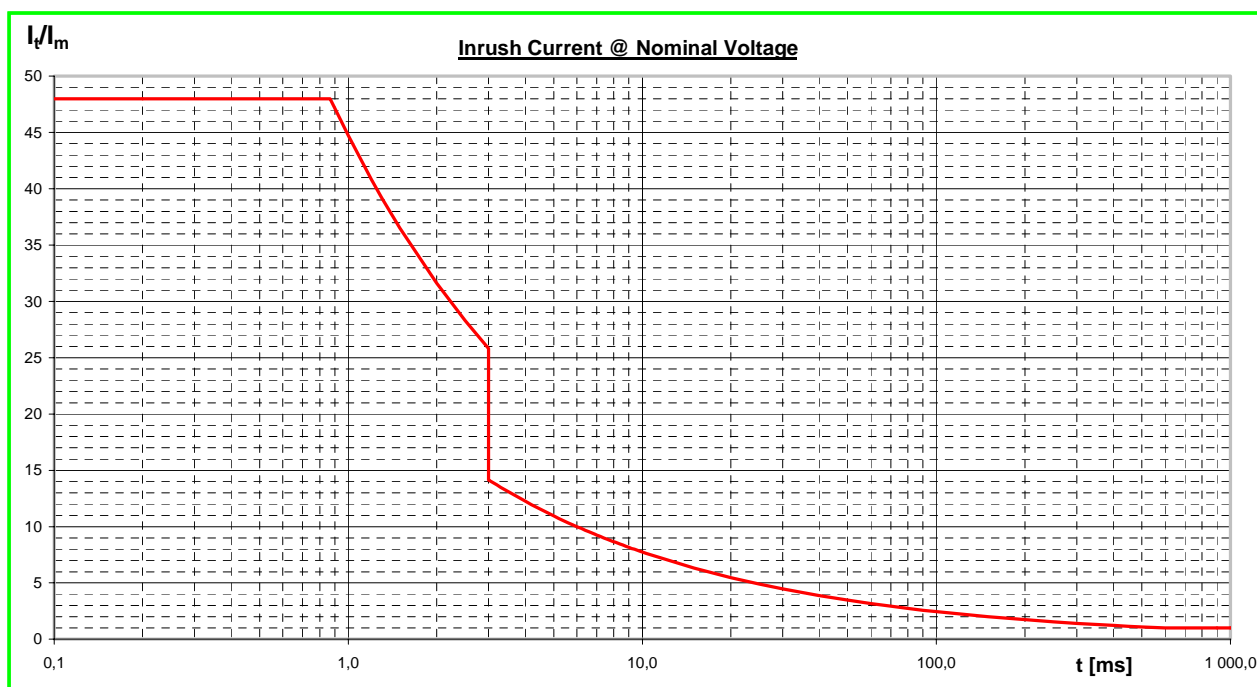


Figure 2: Maximum inrush current characteristics for telecommunications equipment at nominal voltage and maximum load

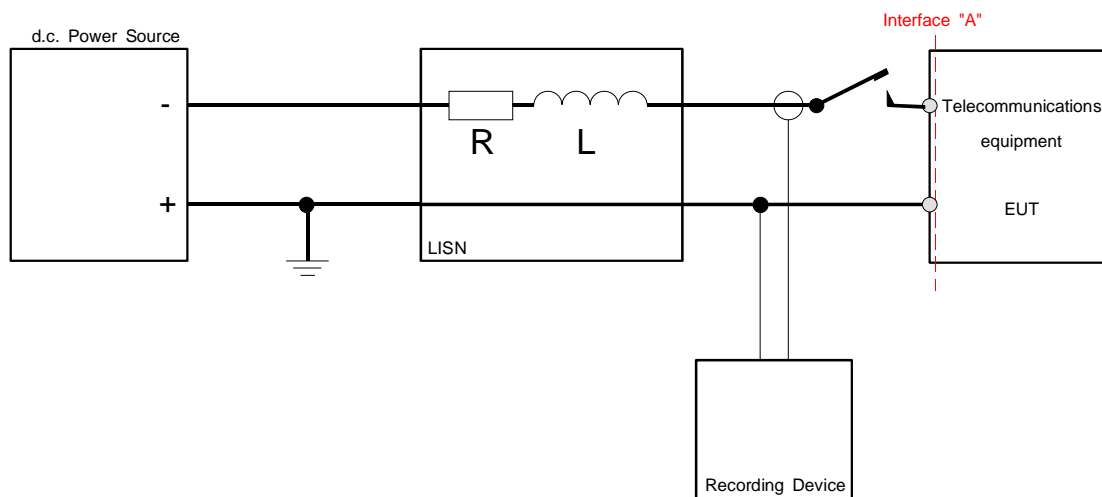
NOTE 1: This graph is a combined graph for both fuses and (Hydraulic) Magnetic Circuit Breakers. Fuses according IEC 60269-1 [1] (gG type), Magnetic Circuit Breakers according EN 60934 [2].

NOTE 2: See also annex B.

4.7.2 Measurements

The circuit for measuring the surge current drawn by the equipment shall be as shown in figure 3. The test circuit is designed to operate with a single switch as shown.

Annex C gives guidance on taking these measurements.



$$R \leq \frac{1V}{I_m(@48V)}$$

$$10\mu H \leq L \leq 20\mu H$$

NOTE 1: Resistance R includes the resistance of inductor L.

NOTE 2: The LISN could be the connecting cable (EUT to power supply), providing that the length has an inductance of 10 μ H to 20 μ H and an equivalent resistance.

NOTE 3: The intention of the LISN is to simulate a power network over which a voltage drop of 1 V will appear in case of nominal current.

NOTE 4: While carrying out the surge current test, the voltage of the dc Power Source at the input of the LISN, as shown in figure 3, shall fall by no more than 2 V due to current limitation or internal impedance of the dc Power Source.

Figure 3: Inrush current test circuit for dc interfaces

4.8 Conducted immunity requirements of the telecommunications equipment at interface "A"

NOTE: Annex C gives an example of a test arrangement for the injection of noise at interface "A".

4.8.1 Immunity to narrowband noise

The telecommunications equipment shall meet its specification when the level of narrowband noise at interface "A" does not exceed the limits shown in figure 4.

The values shown refer to the maximum bandwidths as given in table 1.

Table 1

Frequency range	Resolution bandwidth
25 Hz to 10 kHz	10 Hz
>10 kHz to 20 kHz	200 Hz or 300 Hz

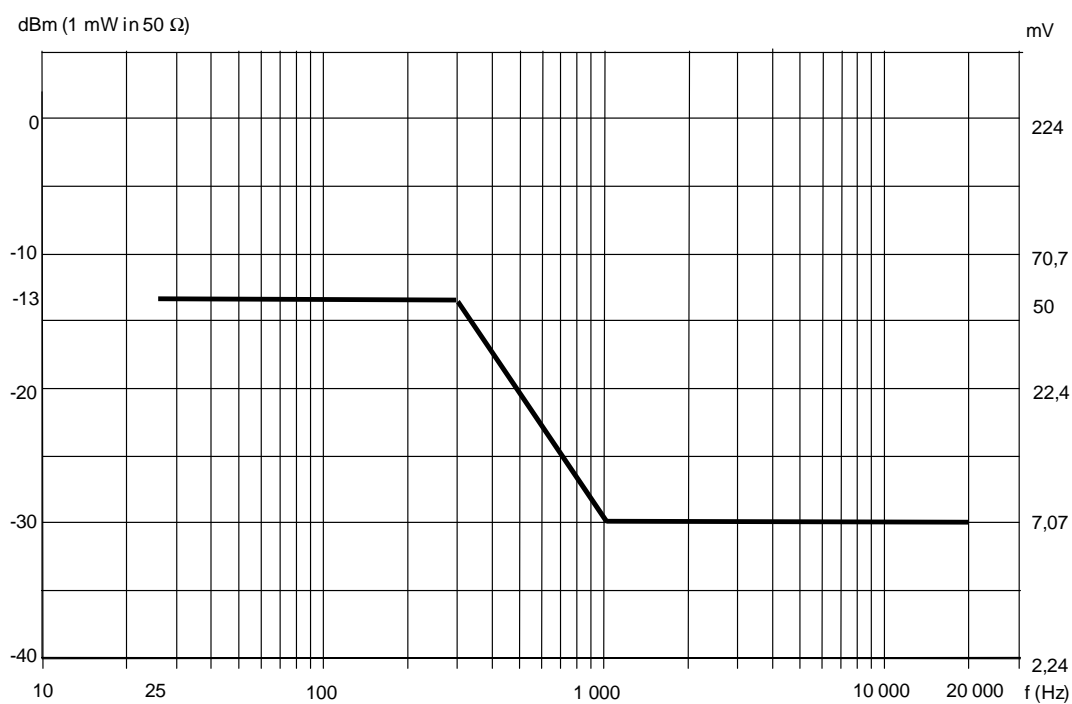


Figure 4: Immunity level of narrow-band noise at interface "A"

The recommended method of measurement is with a spectrum analyser having the bandwidths shown in table 1 for the relevant frequency ranges. The measuring circuit is shown in figure 5.

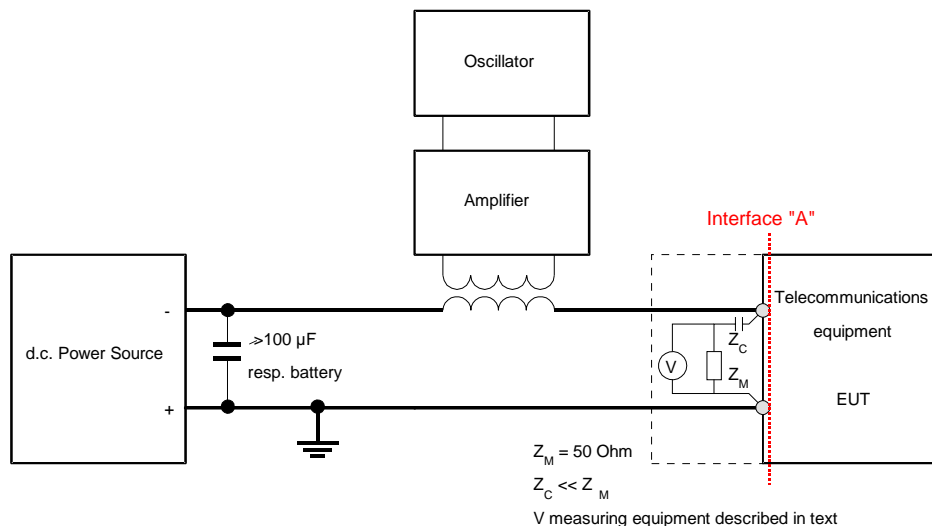


Figure 5: Example of a typical test arrangement for immunity measurement at interface "A"

When checking compliance to this requirement the rms value of the injected noise current shall be limited to 5 % of the actual dc current level. Compliance is achieved when the first of the following levels is reached:

- the maximum noise voltage value; or
- the maximum injected noise current level.

4.8.2 Immunity to wideband noise

The telecommunications equipment shall meet its specification when the maximum level of wideband noise at interface "A" does not exceed the following limits:

- a) 25 Hz to 5 kHz: $U_{\text{pso,eff}} = 10 \text{ mV}$: (psophometrically, via ITU-T weighting filter for commercial telephone circuits);

NOTE 1: "This test is to be applied to equipment which hosts analogue boards which have to comply with ITU-T Recommendations Q.551 to Q.554 [4] to [7]".

This test can also be applied to the relevant subpart of the equipment connected to the same interface "A".

NOTE 2: In ITU-T Recommendations Q.551 [4] to Q.554 [7] (digital exchanges) the analogue noise contribution is limited to 200 picowatts psophometrically weighted, corresponding to -67 dBm_p (reference 1 mW). This limitation may require dedicated precautions to reduce the wideband noise present on the dc distribution to a lower level (e.g. $2 \text{ mV}_{\text{pso, eff}}$).

- b) 25 Hz to 20 kHz: $50 \text{ mV}_{\text{rms}}$: (flat/unweighted).

In both instances the reference method of measurement is with a psophometer conforming to ITU-T Recommendation O.41 [8], using the measurement circuit shown in figure 5.

NOTE 3: When using a psophometer the regular measuring circuit for the psophometric measurement can also be used instead of the 50Ω "probe" of figure 5.

When checking compliance to this requirement the rms value of the injected noise current shall be limited to 5 % of the actual dc-current level. Compliance is achieved when the first of the following levels is reached:

- the maximum noise voltage value; or
- the maximum injected noise current level.

4.9 Conducted emissions requirements of the telecommunications equipment at interface "A"

NOTE: Noise above 20 kHz and all radiated emissions are covered in relevant EMC standards.

4.9.1 Emissions of narrow-band noise

The maximum level of noise re-injected to the power supply system at interface "A" from the telecommunications equipment is shown in figure 6.

The values shown refer to the bandwidths as given in table 2.

Table 2

Frequency range	Resolution bandwidth
25 Hz to 10 kHz	10 Hz
>10 kHz to 20 kHz	200 Hz or 300 Hz

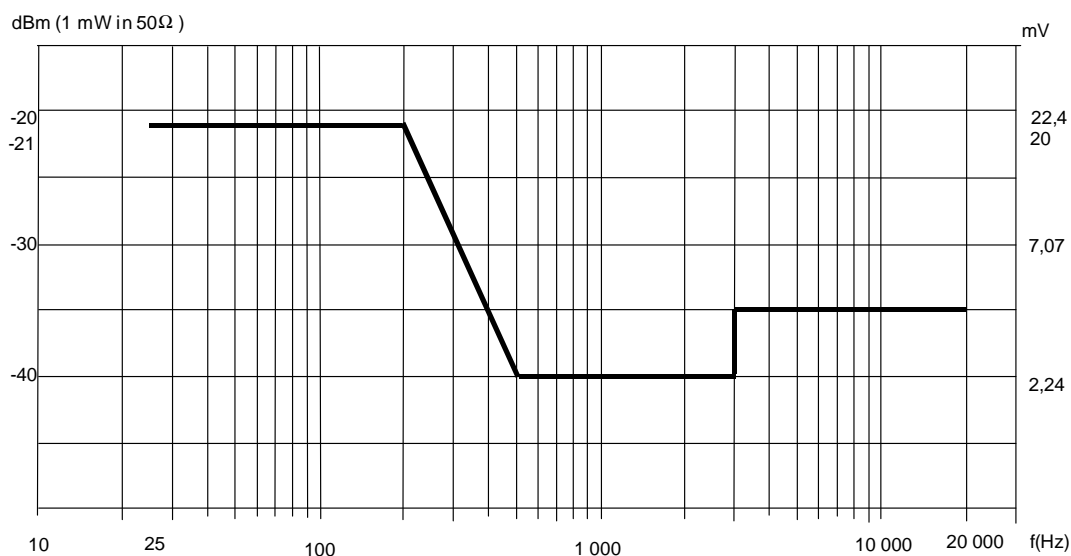
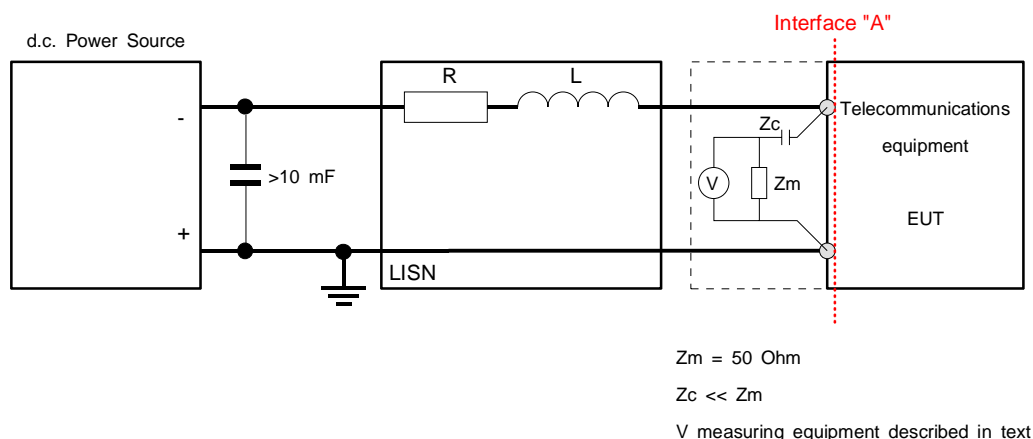


Figure 6: Maximum levels of narrowband noise

The measurement shall be made with a spectrum analyser having the bandwidths shown in table 2 for the relevant frequency ranges.

The measurement circuit shall be as shown in figure 7. During the measurement the telecommunications equipment shall be powered at the nominal voltage and operated at rated load conditions.



$$R \leq \frac{1V}{I_m(@48V)}$$

$$10\mu H \leq L \leq 20\mu H$$

Figure 7: Measuring circuit for re-injected narrow-band and wide-band noise

NOTE 1: Resistance R includes the resistance of inductor L.

NOTE 2: The LISN could be the connecting cable (EUT to power supply), providing that the length has an inductance of 10 μ H to 20 μ H and an equivalent resistance.

4.9.2 Emission of wideband noise

The maximum wideband noise levels shall be as follows:

- a) 25 Hz to 5 kHz: $U_{\text{pso,eff}} = 2 \text{ mV}$: (via ITU-T Weighting Filter for commercial telephone circuits);

NOTE 1: In ITU-T Recommendations Q.551 [4] to Q.554 [7] (digital exchanges) the analogue noise contribution is limited to 200 picowatts psophometrically weighted, corresponding to -67 dBm_p (reference 1 mW). This limitation may require dedicated precautions to reduce the re-injected noise on the dc distribution to a lower level (e.g. 0,4 mV_{pso,rms}).

- b) 25 Hz to 20 kHz: $U_{\text{rms}} = 20 \text{ mV}$: (flat/unweighted).

Both measurements shall be made with a psophometer conforming to ITU-T Recommendation O.41 [8]. The measurement circuit shall be as shown in figure 7. During the measurement the telecommunications equipment shall be powered at the nominal voltage (-48 V_{dc}) of interface "A" and the rated load condition.

NOTE 2: When using a psophometer the regular measuring circuit for the psophometric measurement can also be used instead of the 50 Ω "probe" of figure 7. It is necessary to convert the reading from 50 Ω to 600 Ω .

5 Earthing and bonding

Earthing and bonding of the telecommunications equipment in telecommunications centres is covered by EN 300 253 [3].

6 Electrical safety requirements

The present document does not cover safety requirements, they are covered by relevant safety standards.

7 EMC requirements

The present document does not cover EMC requirements, they are covered by relevant EMC standards.

Annex A (informative): -60 V_{dc} systems

When equipment is added to existing -60 V_{dc} systems the requirements given in table A.1, deviating from the requirements of the present document, may be used.

NOTE: This variation may be necessary due to established national practice which cannot be changed for a long period of time, for instance when an existing network structure is based on -60 V_{dc} power feeding.

Table A.1

Nominal value of the supply voltage	-60,0 V _{dc}		
Normal service voltage range at interface "A"	-50,0 V _{dc}	to	-72,0 V _{dc}
Abnormal service voltage range at interface "A"	0 V _{dc}	to	-50,0 V _{dc} and
	-72,0 V _{dc}	to	-75,0 V _{dc}

Annex B (informative): Guide for measuring inrush current and for transferring the recorded pulses onto the limit chart

It is common practice to use fuses or breakers with a nominal trip value, which is $>1,66$ times I_m at nominal voltage. This takes into account:

- The static current into interface "A" will increase when the voltage at interface "A" decreases (constant power load).
- According clause 4.6, the maximum current drain during restoration shall not exceed 1,5 times the nominal current, so the protection device shall withstand $1,5 \times I_m$ as a minimum.
- It is not recommended to load fuses and breakers with the nominal trip current but to use a safety margin (e.g. 90 % or less).
- Equipment inrush current can cause circuit breaker mechanism to "de-latch" earlier than indicated by circuit-breaker time/current characteristic. After de-latching of the circuit-breakers the contacts will open even if the current falls to zero. De-latching performance must therefore be considered when selecting circuit breakers.

B.1 Measurement

- a) Use a storage oscilloscope, which can record values of di/dt of at least $10 \text{ A}/\mu\text{s}$.
- b) When measuring the dc supply, use a time base setting which enables readings of the pulse width to be taken at different current levels (figure B.1 reports a result of inrush pulse simulation measurement).
- c) Take several readings to ensure that the worst case value has been recorded.

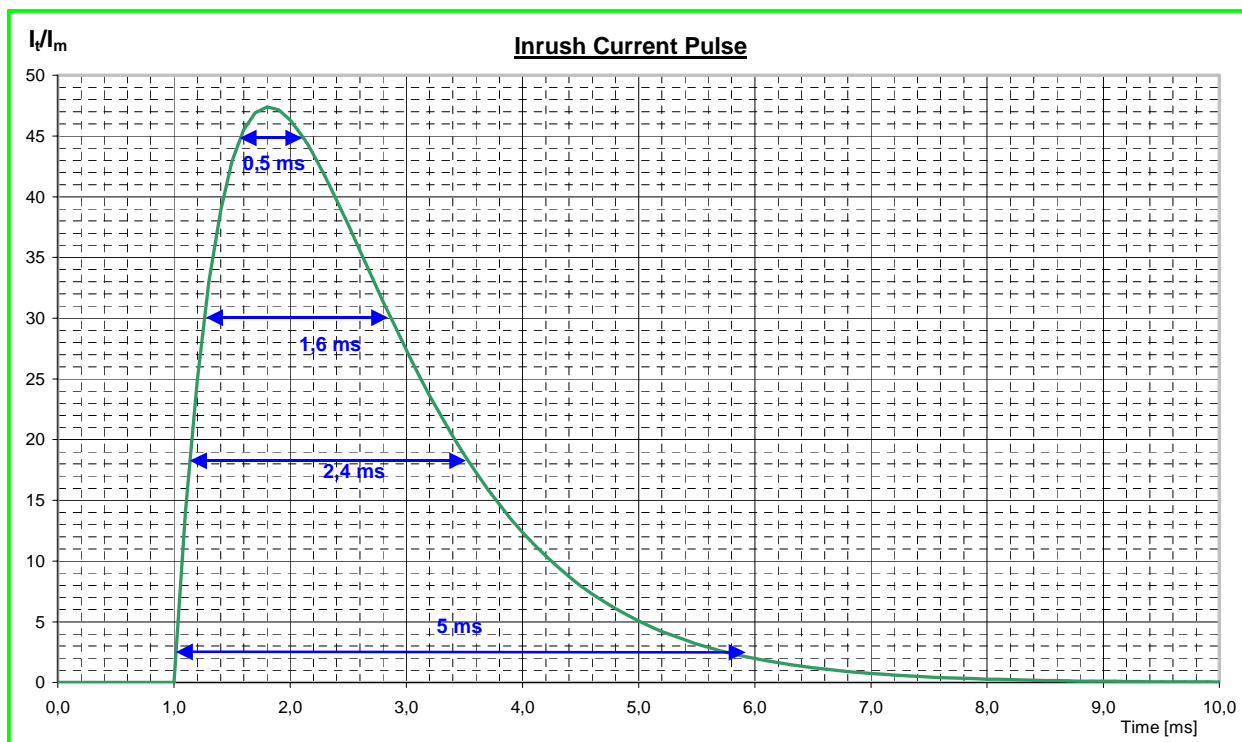


Figure B.1: Example of current pulse and associated measurements

B.2 Pulse waveform transformation

- a) For a single pulse from the dc system, proceed as follows:
 - measure the width of the current pulse at different levels;
 - plot the current ratios against their corresponding time values points onto the limit curve of figure 2;
 - draw an interpolation curve between the plotted points.
- b) The interpolation curve should not cross the limit curve at any point. Use more points from the recorded pulse in critical areas where the interpolated curve has insufficient accuracy. Figure B.2 shows the dc pulse of figure B.1 transferred onto the limit chart of figure 2.

NOTE: Occasionally, more than one inrush pulse may appear, due to special arrangements for limiting the amplitude of single pulses or because the load (telecommunications equipment) starts in sequences. Under these conditions, the limit should be interpreted separately for each different start-up sequence where there is more than 1 second between each. The protective device in the distribution network should not operate.

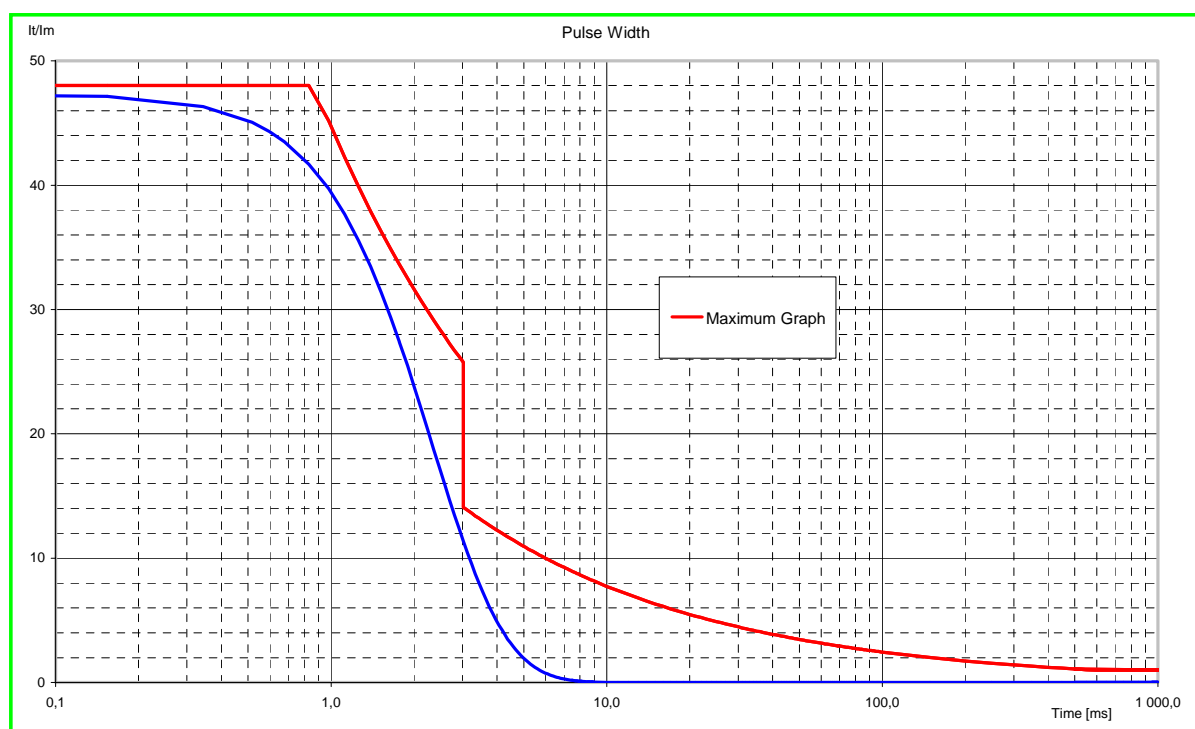


Figure B.2: Example of values for a typical inrush current ratio plotted against limit curve

Annex C (informative): Test arrangements for the injection of electrical noise at interface "A"

- a) Clause 4.8 defines the maximum levels of noise, which may be present at interface "A". The method of injecting noise for testing purposes is not critical provided that the maximum levels in clause 4.8 for both wideband and narrowband noise are not exceeded.
- b) The test configuration shown in figure 5 is an example of how noise may be injected at interface "A". Further details of this test may be found in MIL-STD-462. The required ratio $Z_c \ll Z_m$ is fulfilled with $C = 10\,000\ \mu\text{F}$ and $|Z_c, 25\ \text{Hz}| = 640\ \text{m}\Omega$.

Annex D (informative): Identification of interface "A"

interface "A" is defined as the terminals at which the telecommunications equipment is connected to the power supply (installation). This is shown in figure D.1.

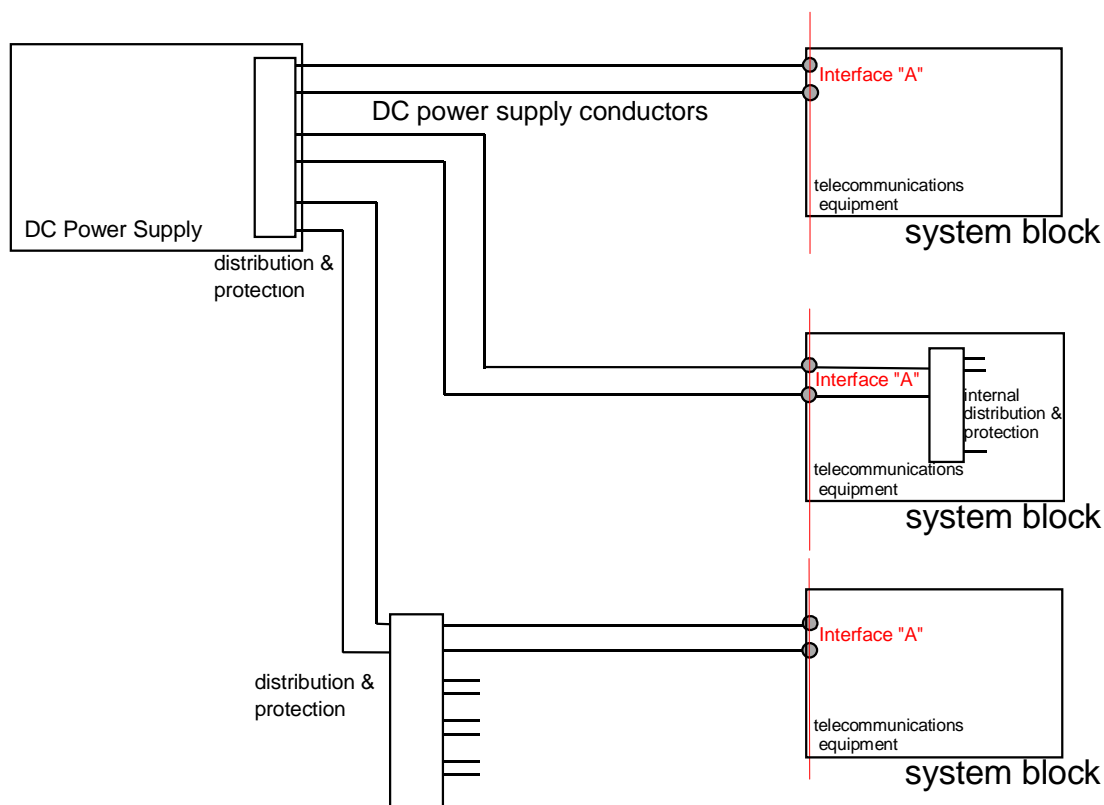


Figure D.1: Identification of interface "A" (three proposed examples)

Annex E (informative): Bibliography

- IEC 60664-1: "Insulation co-ordination for equipment within low voltage systems".
- ETSI TR 100 283: "Equipment Engineering (EE); Transient voltages at interface "A" on telecommunications direct current (dc) power distributions".
- IEC 60364-4-41: "Electrical installations of buildings - Part 4: Protection for safety - Chapter 41: Protection against electric shock".
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