



EUROPEAN
TELECOMMUNICATION
STANDARD

ETS 300 132-2

September 1996

Source: ETSI TC-EE

Reference: DE/EE-02001.2

ICS: 33.020

Key words: Power supply

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

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Equipment Engineering (EE) Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETS concerns the requirements for the interface between telecommunications equipment and its power supply, and includes requirements relating to its stability and measurement. References are also made to the safety aspects, in various IEC and CENELEC documents which are normative to this ETS. Various other references and detailed measurement and test arrangements are contained in informative annexes.

This ETS consists of 2 parts as follows:

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

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

Transposition dates	
Date of adoption of this ETS:	16 August 1996
Date of latest announcement of this ETS (doa):	31 December 1996
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	30 June 1997
Date of withdrawal of any conflicting National Standard (dow):	30 June 1997

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1 Scope

This European Telecommunication Standard (ETS) 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 buffer battery.

This ETS also makes reference to safety and EMC standards which are in accordance with the relevant European standards.

This ETS 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: To ensure satisfactory performance, the connection of telecommunications equipment into installations is subject to the prevailing conditions of that installation and is subject to the agreement of both parties.

NOTE 2: This ETS 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" of figure 1, is a physical point to which all the requirements are related. This point is situated between the power supply system(s) and the power consuming telecommunications equipment.

NOTE 3: 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 4: 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 subclause 4.8.

NOTE 5: Disturbances on the power supply interface "A" relating to the continuous wave phenomena above 20 kHz is not covered within this ETS. ETS 300 386-1 [3] is applicable for this frequency range.

NOTE 6: The transients to which immunity is specified in this ETS are characterized by a high energy content such that electrical stress may be caused. Fast transients, the effects of which appear mainly as interference, are covered by ETS. ETS 300 386-1 [3] which details the electromagnetic compatibility of telecommunications equipment.

NOTE 7: An example of a configuration in which the interface "A" is identified is given in annex E.

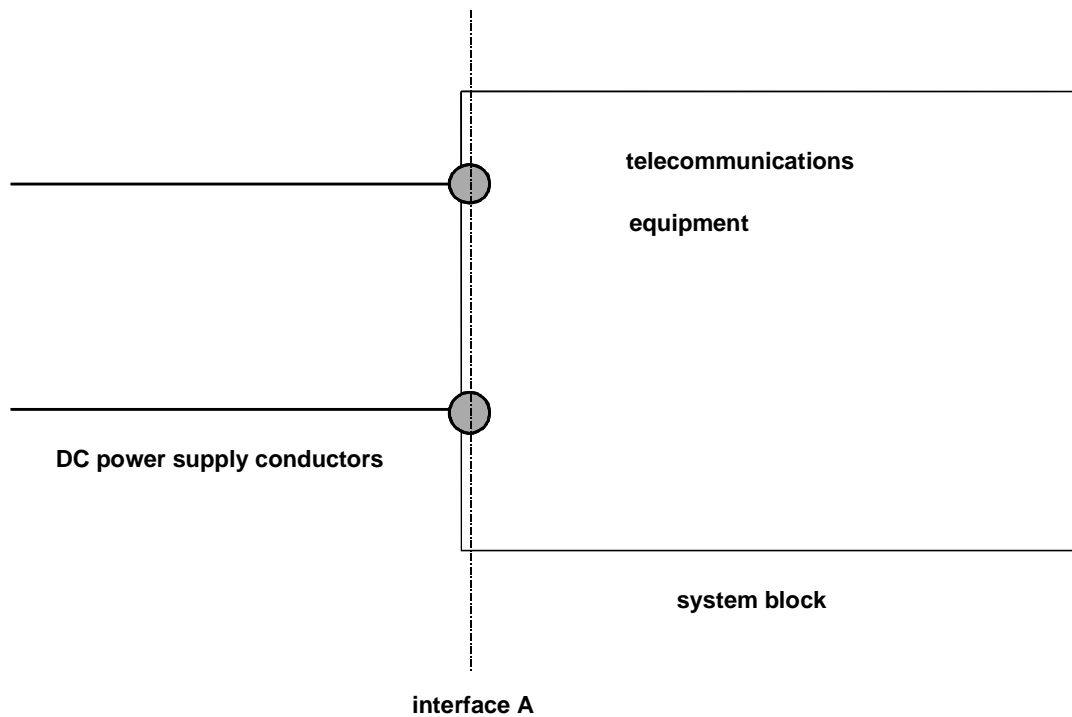


Figure 1: General identification of the power interface "A"

The purpose of this ETS is:

- to use a power supply system with the same characteristics for all telecommunications equipment defined in the area of application;
- to facilitate interworking 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 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- [1] EN 60950: "Safety of information technology equipment, including electrical business equipment".
- [2] ETS 300 253: "Equipment Engineering (EE); Earthing and bonding of telecommunication equipment in telecommunication centres".
- [3] ETS 300 386-1 (1994): "Equipment Engineering (EE); Public telecommunication network equipment; Electro-Magnetic Compatibility (EMC) requirements; Part 1: Product family overview, compliance criteria and test levels".
- [4] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".
- [5] ITU-T Recommendation Q.551: "Transmission characteristics of digital exchanges".

- [6] ITU-T Recommendation Q.552: "Transmission characteristics at 2-wire analogue interfaces of digital exchange".
- [7] ITU-T Recommendation Q.553: "Transmission characteristics at 4-wire analogue interfaces of a digital exchange".
- [8] ITU-T Recommendation Q.554: "Transmission characteristics at digital interfaces of a digital exchange".
- [9] IEC 364-4-41 (1982): "Electrical installations of buildings - Part 4: Protection for safety - Chapter 41: Protection against electric shock".
- [10] US Department of Defense MIL-STD-462: "Electromagnetic interference characteristics, measurement of".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETS, the following definitions apply:

abnormal voltage range: The 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": The terminals at which the power supply is connected to the system block (see figure 1).

NOTE 1: 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.

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

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

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

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

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

NOTE 2: A system block may consist of equipment or a functional group of equipment. Different examples of configurations at interface "A" are given in annex E.

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

3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

dc	direct current (also when used as a suffix to units of measurement)
EUT	Equipment Under Test
I_m	maximum current (see subclause 4.7.1)
I_{nom}	nominal current
I_t	instantaneous surge current (see subclause 4.7.1)

L	inductance of inductive element of LISN
LISN	Line Impedance Stabilization Network
...p	(subscripted letter following unit) psophometrically weighted
R	resistance of resistive element of LISN
rms	root mean square (also when used as a suffix to units of measurement)
t	time
Z _c	capacitive impedance of immunity measurement circuit
Z _m	resistive impedance of immunity measurement circuit

4 Requirements

4.1 Nominal value of the supply 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 $-40,5$ to $-57,0 V_{dc}$.

NOTE 1: 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 2: When the voltage is in the range $-40,5$ 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 to $-40,5 V_{dc}$; and
 $-57,0$ 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.

4.3.3 Short duration voltage transients

Short duration 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 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 Vdc shall not be damaged when subjected to these transients.

NOTE: ETR 283 is in preparation to provide guidance for the protection of telecommunications equipment from the transients.

4.3.4 Recovery from short duration voltage transients

After the occurrence of a short duration voltage transient, as described in subclause 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: In some sensitive equipment, momentary and temporary corruption of data may occur as a result of such transients at interface "A". More detailed statements of performance of the system during and following the transient may be required by the operator.

4.4 Voltage changes due to the regulation of the power supply

Telecommunications equipment shall operate according to the specifications and no loss of data or false alarms shall occur under a single maximum transition rate of the voltage at interface "A" for both the fall and rise of the voltage of:

$$\frac{dV_{dc}}{dt} \max = 5 \text{ V / ms}$$

The voltage at interface "A" shall remain within the normal service voltage range.

NOTE: This voltage change may occur as a result of regulation of the voltage by the power supply system e.g. end cell switching.

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 during restoration to normal voltage at interface "A" shall not exceed 1,5 times the current drain at nominal working voltage of -48 V_{dc}.

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, 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.

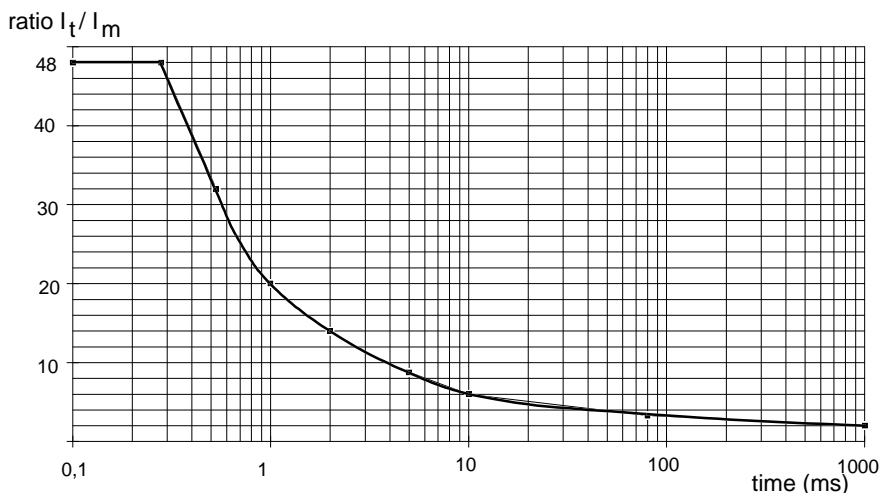
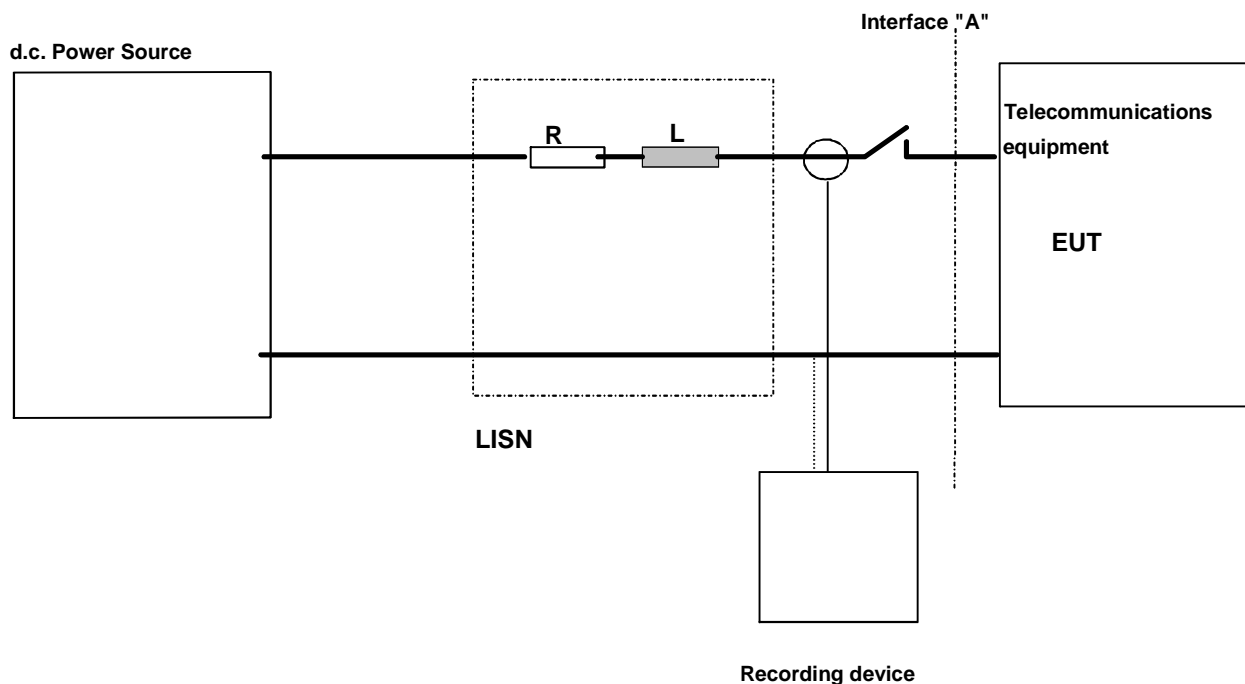


Figure 2: Maximum inrush current characteristics for telecommunications equipment at nominal voltage and maximum load

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.



$$R = \frac{1V}{I_{nom} (@48V)}$$

$$L = 10 \mu H$$

NOTE: While carrying out the surge current test, the voltage at the input of the Line Impedance Stabilization Network (LISN), as shown in figure 3, shall fall by no more than 2 V.

Figure 3: Inrush current test circuit for dc interfaces

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

- NOTE 1: Noise above 20 kHz and all radiated emissions are covered by ETS 300 386-1 [3].
- NOTE 2: The upper limit of 20 kHz has been chosen to allow use of the "flat" measurement facility on the ITU-T psophometer and as a convenient boundary for low frequency noise contained in the power converters.
- NOTE 3: Annex D 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	Bandwidth (-6 dB)
25 Hz to 10 kHz	10 Hz
>10 kHz to 20 kHz	200 Hz

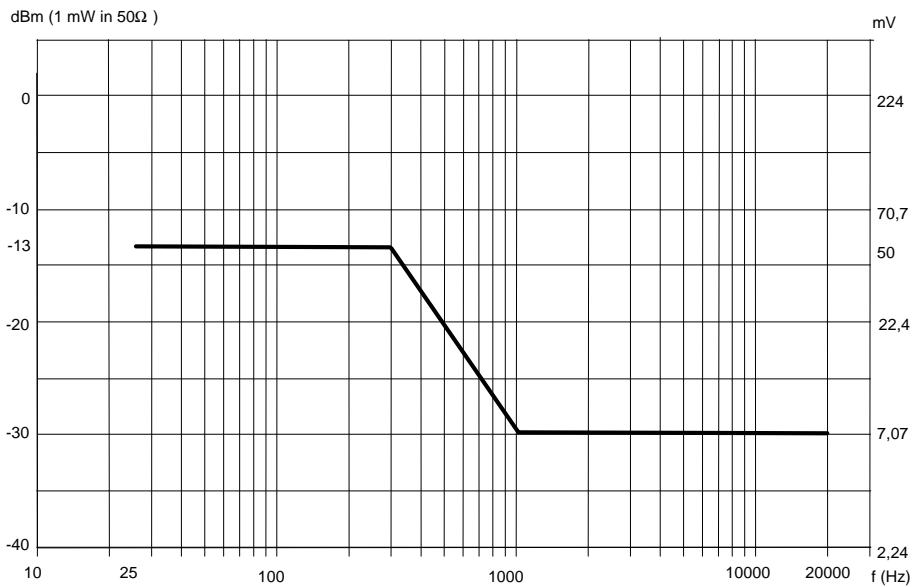


Figure 4: Immunity level of narrowband noise at interface "A"

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.

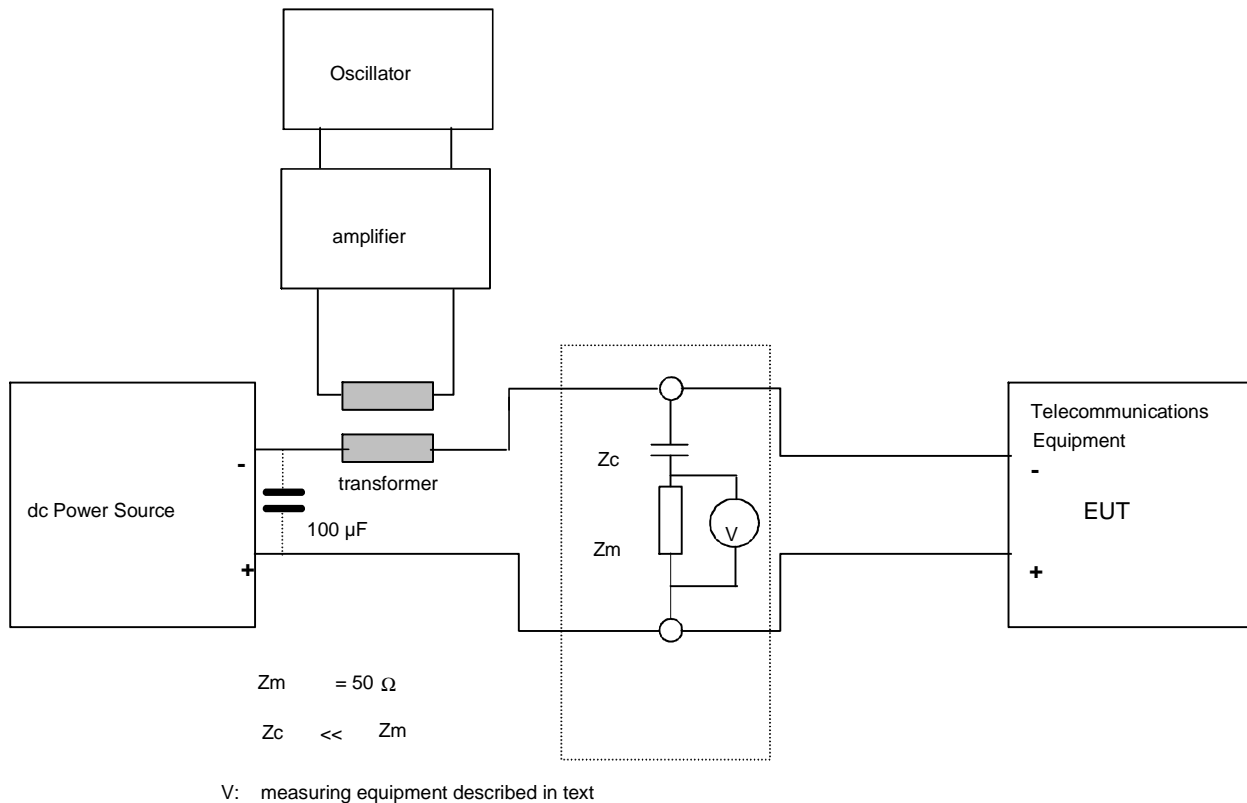


Figure 5: Test arrangements for immunity measurement at interface "A"

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: $U_{\text{pso eff}} = 10 \text{ mV}$

NOTE 1: In ITU-T Recommendations Q.551 to Q.554 (digital exchanges) [5] to [8], the analogue noise contribution is limited to 200 pW_p , 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. $2 \text{ mV}_p \text{ eff}$).

- 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 [4], using the measurement circuit shown in figure 5.

NOTE 2: When using a psophometer, the regular measuring circuit for the psophometric measurement, the psophometer should be connected in parallel with the measuring equipment (50Ω) of figure 5 and it should be used in bridging mode (high impedance).

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"

4.9.1 Emissions of narrowband 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	Bandwidth (-6 dB)
25 Hz to 10 kHz	10 Hz
>10 kHz to 20 kHz	200 Hz

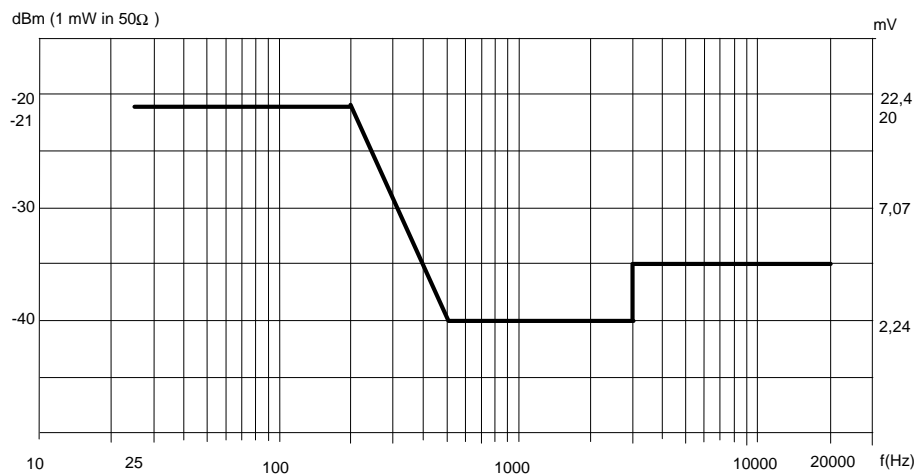
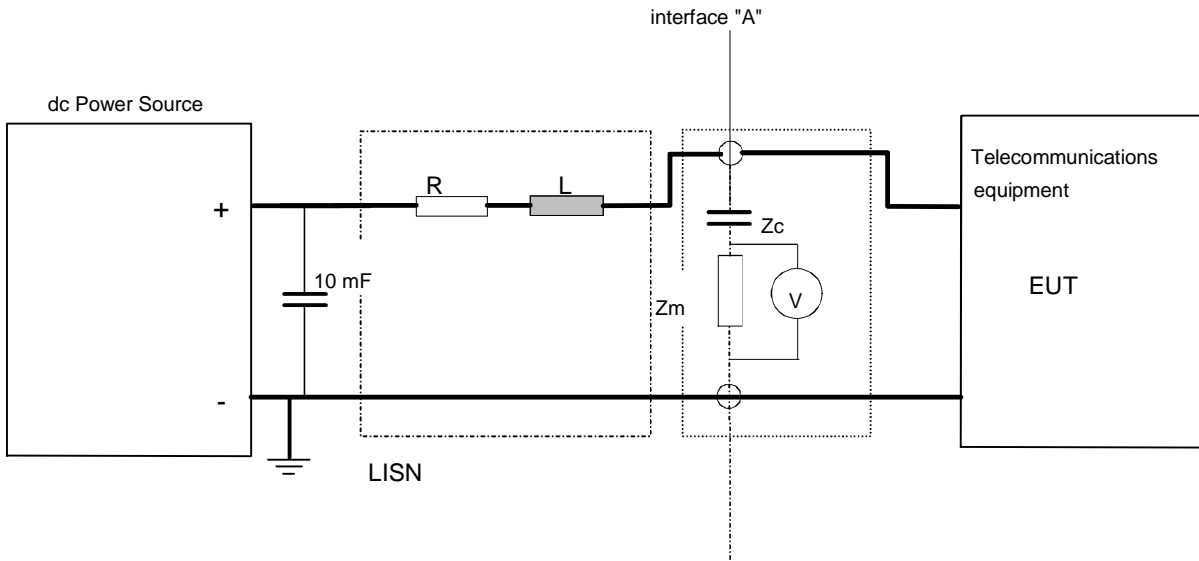


Figure 6: Maximum levels of narrowband noise

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.



$Z_m = 50 \Omega$

$Z_c \ll Z_m$ (e.g. when capacitance = 10 mF)

$$R = \frac{1V}{I_{nom}(@48V)}$$

$$L = 10 \mu H$$

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 10µH and an equivalent resistance.

Figure 7: Measuring circuit for re-injected narrowband and wideband noise

4.9.2 Emissions of wideband noise

The maximum wideband noise levels shall be as follows:

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

NOTE 1: In ITU-T Recommendations Q.551 to Q.554 (digital exchanges) [5] to [8] the analogue noise contribution is limited to 200 pW_p, 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: $U_{rms} = 20\ mV$ (flat/unweighted).

Both measurements shall be made with a psophometer conforming to ITU-T Recommendation O.41 [4]. The measurement circuit shall be as shown in figure 7. During the measurement, the telecommunications equipment shall be powered at the nominal voltage (-48 Vdc) of interface "A" and at the rated load conditions.

NOTE 2: When using a psophometer, the regular measuring circuit for the psophometric measurement, the psophometer shall be connected in parallel with the measuring equipment (50 Ω) of figure 7 and it should be used in bridging mode (high impedance). It is not 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 ETS 300 253 [2].

6 Electrical safety requirements

At interface "A" the following safety requirements apply.

Table 3

Nominal voltage	Requirement	Relevant standard
-48 Vdc	SELV/TNV circuits	EN 60950 [1]

7 EMC requirements

EMC requirements are covered by ETS 300 386-1 [4].

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 this ETS, 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 V _{dc}	
Normal service voltage range at interface "A":	-50,0 to -72,0 V _{dc}	
Abnormal service voltage range at interface "A":	0 to -50,0 V _{dc} and -72,0 to -75,0 V _{dc}	
Electrical safety requirements:	Nominal voltage:	-60 V _{dc}
	Requirement:	as for TNV circuits
	Relevant standard:	EN 60950 [1], clause 6

Annex B (informative): Information and guide on safety

This ETS does not specify the safety requirements for either the telecommunications installation or the telecommunications equipment. These requirements are given in the following documents:

- for the installation: IEC 364-4-41 [9];
- for the equipment to be connected to the telecommunication network: EN 60950 [1].

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

C.1 Measurement

- Use a storage oscilloscope which can record values of di/dt of at least $10 \text{ A}/\mu\text{s}$.
- 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 C.1 refers).
- Take several readings to ensure that the worst case value has been recorded.

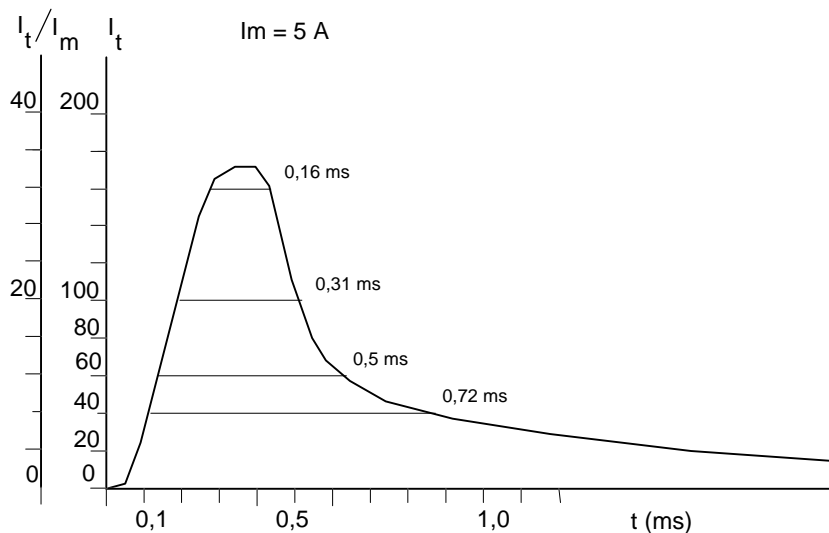


Figure C.1: Current pulse and associated measurements

C.2 Pulse waveform transformation

- 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.
- 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 C.2 shows the dc pulse of figure C.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.

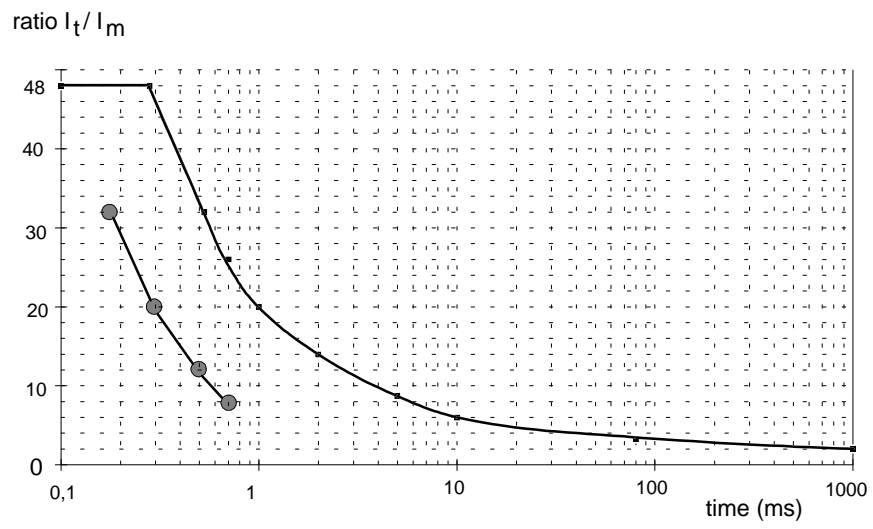


Figure C.2: Maximum values for typical inrush currents plotted against limit curve

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

- a) Subclause 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 subclass 4.8 for both wideband and narrowband noise are not exceeded.
- b) The test configuration shown in figure D.1 is an example of how noise may be injected at interface "A". Further details of this test may be found in MIL-STD-462 [10].

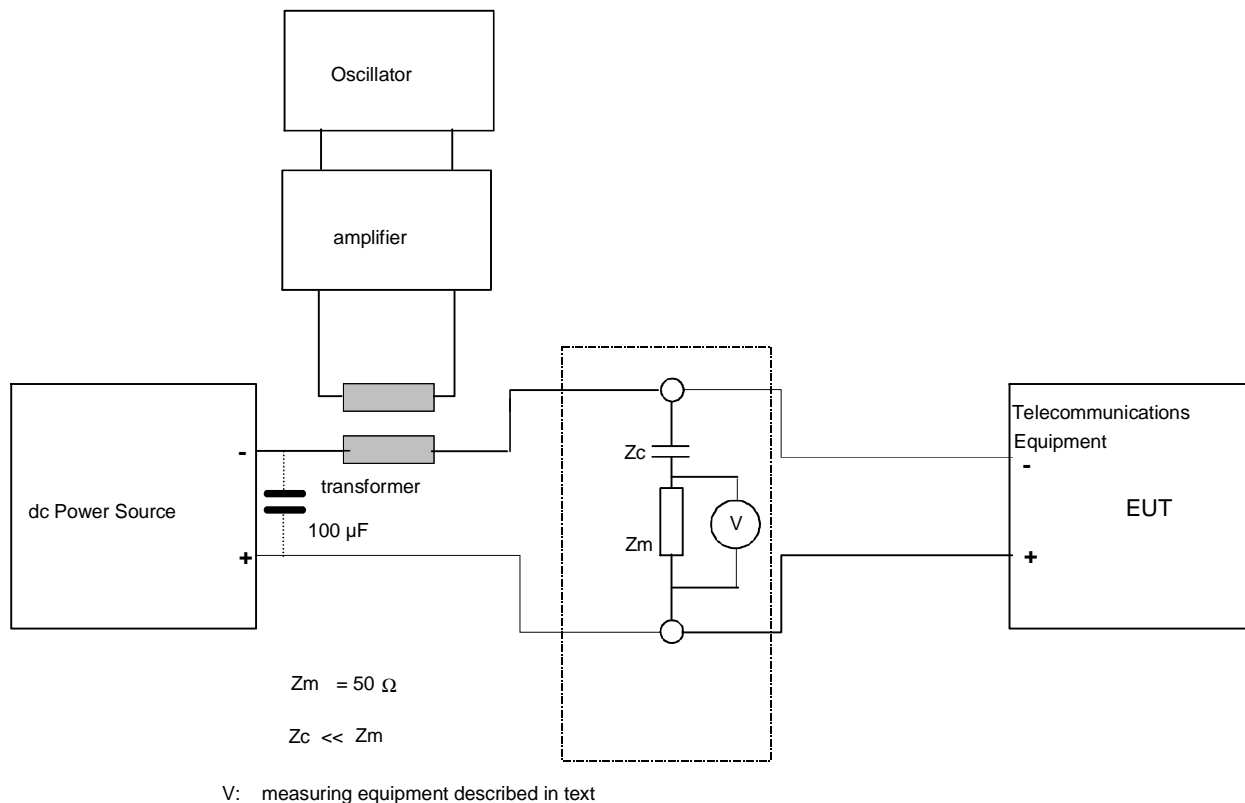


Figure D.1: Test arrangements for the injection of electrical noise at interface "A"

The required ratio $Z_c \ll Z_m$ is fulfilled with $C = 10\,000 \mu\text{F}$. $|Z_{c, 25 \text{ Hz}}| = 640 \text{ m}\Omega$.

Annex E (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 E.1.

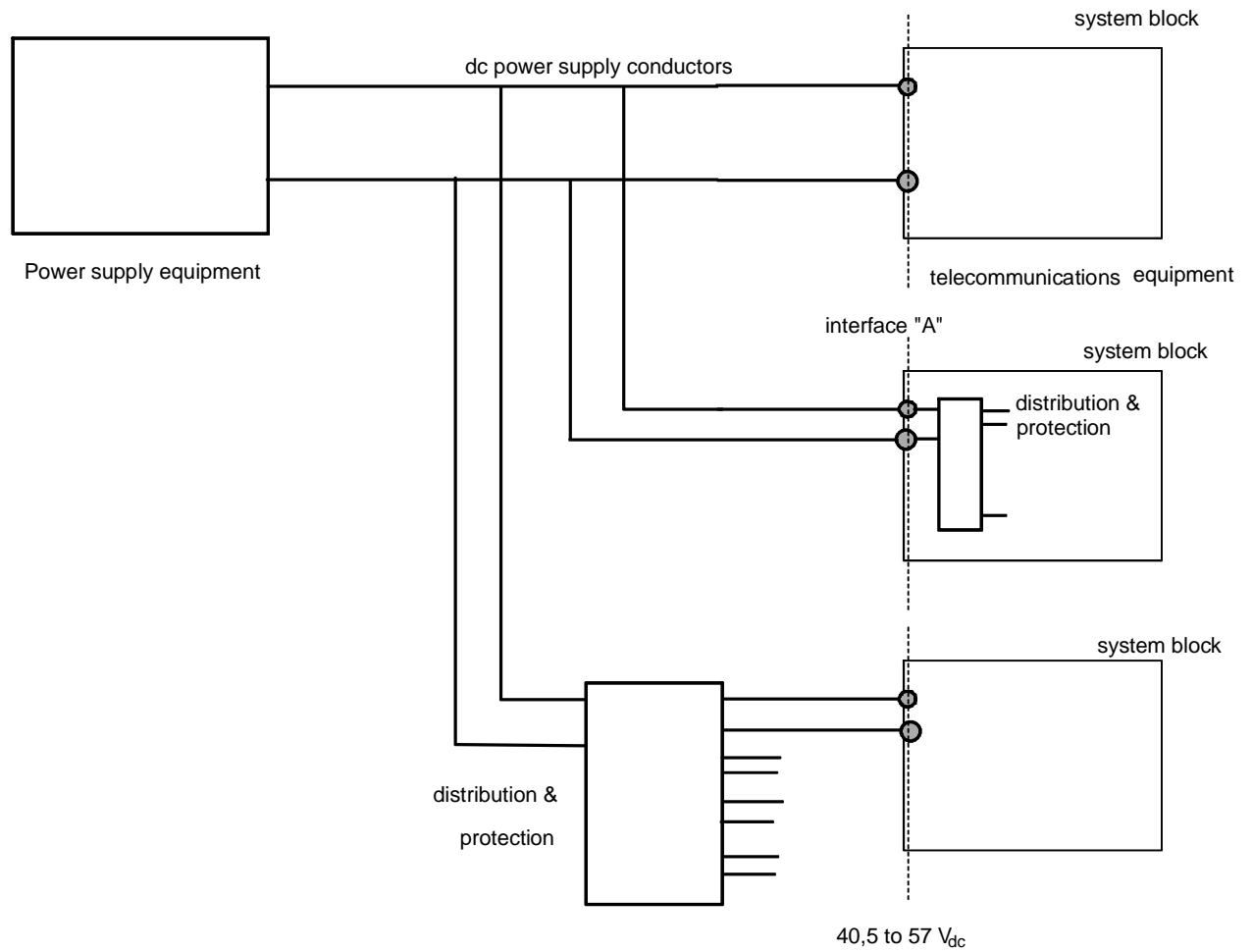


Figure E.1: Identification of interface "A"

Annex F (informative): Bibliography

- IEC 664 (1992): "Insulation co-ordination for equipment within low voltage systems".
- FTZ 19 Pfl1: "Spannungsgrenzen für 60 V Verbraucher in Fernmeldeanlagen der DBP".
- ETR 283: "Equipment Engineering (EE); Transient voltages at interface A on telecommunications direct current (dc) power distributions" (publication anticipated Q2-1996).

History

Document history			
December 1991	Public Enquiry	PE 17:	1991-01-21 to 1995-05-17
December 1994	Public Enquiry	PE 75:	1994-12-05 to 1995-03-31
May 1996	Vote	V 102:	1996-05-06 to 1996-08-09
September 1996	First Edition		