Recommendation T/TR 02-02 (Innsbruck 1981, revised in Montpellier 1984 and Copenhagen 1987)

RACK/TELECOMMUNICATIONS CENTRE POWER SUPPLY INTERFACE

Recommendation proposed by Working Group T/WG 12 "Transmission" (TR)

Text of Recommendation adopted by the "Telecommunications" Commission:

"The European Conference of Posts and Telecommunications Administrations,

considering

— that telecommunications equipments usually be installed in telecommunications centres and held in racks, cabinets or other mechanical structures,

— that the installation of racks from various origins require to be standardised,

— that the existing CCITT and CCIR Recommendations in such matters do not ensure the required standardisation,

— that the CCITT and CCIR do not envisage standardising the rack/telecommunications centre power supply interface,

— that the Administrations are amenable to the harmonisation of equipment and telecommunications, which will lead to a lowering of development and manufacturing costs for the industry which is supplying equipment to several countries,

recommends

that the members of the CEPT should apply the rack/telecommunications centre power supply interface specifications contained in this Recommendation."

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1. AREA OF APPLICATION

The power supply interface (Interface "A") of Figure 1 (T/TR 02-02) applies to:

— Secondary power supply of telecommunications centres.
— Secondary power distribution.
— All telecommunications equipment installed in telecommunications centres, except electromechanical switching equipments.
— Administrations telecommunications equipment installed in subscriber's premises.

The equipment concerned should be developed in such a way that the power supply specification is observed at a physical point, located between the rack input and the power cabling of the telecommunications centre or subscriber's premises.

The specification of the AC primary (e.g. mains/local AC generator) supply is not included in this Recommendation.

2. OBJECTIVES

— To use the same secondary supply for all telecommunications equipment defined in the area of application.
— To facilitate the harmonisation of telecommunications equipment.
— To facilitate the installation, operating and maintenance in the same network, of equipment and telecommunications systems from different origins.
— To define the power supply interface between the rack or other mechanical structure and telecommunications centres or subscriber's premises.

3. SPECIFICATIONS

3.1. Number of secondary voltages (main supply) introduced into the rack

One or two voltages may be introduced into the rack (for instance 2 × 48V DC or 48V DC and another voltage, e.g. 220V AC) independent of the number of inputs.

3.2. Nominal values of the secondary voltages (main supply)

The specified nominal values are: 48V DC
60V DC
220V AC/50 Hz

Notes.

1. The nominal value of secondary voltage is a designation for the type of supply. The actual voltage at Interface "A" during normal service is any value between those defined in section 3.4.
2. The majority of Administrations have selected for the long term a nominal voltage of 48V DC. Some Administrations continue to use a nominal voltage of 60V DC.
3. In this Recommendation, it is not specified how the secondary supply is produced.
   — The DC secondary voltage may be derived from the AC primary supply with or without a buffer battery.
   — The AC secondary voltage may be derived from
     (a) a stabilised AC supply (e.g. inverter or AC conditioner);
     (b) directly from the AC primary supply where the quality of this supply is sufficient for telecommunications equipment to meet its specification.
4. When a main voltage of 400/230V AC is adopted in Europe following the IEC study the nominal value and permitted tolerances of the 220V AC supply will be reconsidered.
5. During a transitional period, other DC voltages may be used in existing stations.
6. The 220V AC supply can be constituted either by two phases of a 3-phase secondary voltage or by one phase and neutral.

3.3. Secondary voltages (supplementary supply) introduced into the rack

3.3.1. If for rack alarm signalling equipment as well as for the rack alarm indication units (e.g. alarm lamps), a power supply at Interface "A" other than those mentioned in 3.2. is necessary, the voltage used shall either be 48V DC or 60V DC.

Notes.

1. The majority of Administrations have selected for the long term a nominal voltage of 48V DC. Some Administrations continue to use a nominal voltage of 60V DC.
2. The specifications of points 3.4. and after do not apply for this supplementary supply unless otherwise specified by the Administrations.

3.3.2. Where a 220V AC socket in the rack is specified for measuring instruments, soldering irons, or illuminating equipment it should be possible to use distributed AC voltage as specified in section 3.2.

3.4. Permitted tolerances of secondary voltages in normal service

The permitted tolerances are respectively:

For 48V DC nominal:	40.5 to 57V DC (*Note 2*)
For 60V DC nominal:	50 to 72V DC
For 220V AC nominal:	198 to 242V AC/50 Hz ± 2 Hz (*Note 3*)

Notes.

1. "Normal Service" means that the supply voltage is such that all the specifications are met by the equipment.
2. For an intermediate period, it is tolerated that the specifications of some equipments may be slightly degraded in the voltage range 40.5 to 44V DC. In the longer term all the equipment will be guaranteed to meet its specifications over the whole range.
3. Telecommunications equipment tolerates frequency deviations of the supply voltage in the range ± 2 Hz without alteration of the specifications. Certain peripherals require a closer tolerance, typically ± 1 Hz or less. For this equipment a stabilised AC supply may be specified in accordance with IEC Publication 686.

3.5. Permitted tolerance of secondary voltages in accidental service

Note. By accidental service one means that the secondary voltage is such that equipments do not meet their specifications but do not suffer any damage.

3.5.1. *Accidental service under settled conditions*

In this case, telecommunications equipment should not suffer any damage in the following voltage ranges:

0 to 40.5V DC and	57 to 60V	for 48V DC nominal
0 to 50V DC and	72 to 75V	for 60V DC nominal
0 to 198V AC and	242 to 254V	for 220V AC nominal

The frequency tolerance for 220V AC, 50 Hz nominal is ± 5 Hz.

After the restoration of nominal voltage conditions, the equipment should work again without manual intervention being necessary. The accidental service should not lead to the disconnection of power supply units by tripping circuit breakers or blowing fuses.

For particular equipment (e.g. master oscillators, pilot frequency generators, etc.) Administrations will define a maximum permitted time for that equipment to meet its specifications after the restoration of normal conditions. This time interval will be related to the duration of the accidental conditions.

3.5.2. *Accidental service under temporary conditions*

In this case, telecommunications equipment should not suffer any damage when a transient voltage of up to 200V DC is present for up to 100 microseconds on the 48V DC and 60V DC nominal supplies. After the restoration of nominal voltage conditions, the equipment should work again without manual intervention being necessary. The accidental service should not lead to the disconnection of power supply units by tripping circuit breakers or blowing fuses.

Note. Lower values of transient voltage may exist for longer periods of time but these are not included in this Recommendation.

Common-mode overvoltage: In order to prevent damage to equipment caused by common-mode transient overvoltages superimposed on the secondary power distribution, it is required that the equipment withstand a waveform produced by the generator G shown in Figure 4 (T/TR 02-02), applied as shown in Figure 5A (T/TR 02-02). The value of the open-circuit voltage is under study; it should be chosen in accordance with IEC Publication 664.

Differential-mode overvoltage: In order to prevent damage to equipment caused by differential-mode transient overvoltages superimposed on the secondary power distribution, it is required that the equipment withstand a waveform produced by the generator G shown in Figure 4 (T/TR 02-02), applied as shown in Figure 5B (T/TR 02-02). The value of the open-circuit voltage is under study; it should be chosen in accordance with IEC Publication 664.

The impulsive test waveform should be applied to the equipment under test (EUT) 10 times, 5 for each polarity, with an interval of 30 seconds between subsequent applications.

3.6. Voltage changes due to regulation of the secondary voltage

3.6.1 *DC supplies*

Where the technique of regulation of battery voltage by the connection of cells is used, equipment specifications should be met under maximum transition rates of 5V/ms for both the fall and rise of the secondary supply.

The voltage at Interface "A" should remain within the limits of section 3.4., i.e. in the range 40.5 to 57V DC for 48V DC nominal and 50 to 72V DC for 60V DC nominal supplies respectively.

3.6.2 *AC power supply: voltage changes due to regulating action or intervention of continuity units*

Voltage interruptions: In the case of automatic switching of power supplies (for continuity purposes) short interruptions of voltage may occur. The equipment shall meet its specifications when the duration of the interruption is equal to or less than 50ms.

Slow voltage fluctuations: In the case of regulation of secondary voltage following load changes, slow voltage fluctuations and frequency variations may occur. The equipment shall meet its specifications when the envelope of the voltage fluctuations is as shown in Figure 6 (T/TR 02-02) and the frequency variation is up to $\pm$ 3 Hz with a recovery time of 5 seconds.

3.7. Maximum value of supply current

3.7.1. *Transmission rack*

The maximum value of the power supply current at the minimum voltage as specified in section 3.4. should be as follows:

DC Supply: 2.0A for the rack of Type A (*Note 1*)
10.0A for the rack of Type B (*Note 1*)

AC Supply: 0.8A RMS for the rack of Type A (*Note 4*)
3.5A RMS for the rack of Type B (*Note 4*)

Notes.

1. The limits are derived from the values for the maximum rack dissipation as defined in Recommendation T/TR 02-03 and related to Type A (nominal width 120mm) and Type B (nominal width 600mm) racks, of the nominal height of 2,600mm, as described in Recommendation T/TR 02-01.
2. The values refer to normal working and may be exceeded in the case of partial rack failure; in consequence they will be applied for the planning of the secondary power room and not for gauging the protection devices against overloads.
3. For racks which supply power to remote equipment the values of the power supply current may be higher.
4. The ratio between the peak and RMS value of the current should not exceed 3.5 : 1.

3.7.2. *Switching rack*

This point is related to the study of mechanical structures for future telecommunications equipment (e.g. ISDN) and is therefore not included in this Recommendation.

3.8. Protection at the input of the rack converters

The supply of the racks should be protected upstream of Interface "A" by fuses or circuit breakers placed in a power distribution bay. Before putting equipment in service it should be possible to suppress the action of any possible fuses placed between Interface "A" and the converters.

3.9. Surge current on connection of rack

3.9.1. The ratio of instantaneous surge current I_t to maximum current I_m at Interface "A" under any random sequence of switching operations should not exceed the limits shown in Figure 2 (T/TR 02-02) for 48V or 60V DC and in Figure 3 (T/TR 02-02) for 220V AC. The time origin of Figure 2 (T/TR 02-02) shall be taken at the time ordinate where I_t/I_m equals 8 or at 1.5ms from switch-on, whichever time is smaller.

Parameters are defined as follows:
I_t equals the instantaneous surge current.
I_m equals the maximum current at Interface "A" drawn by the rack or converter under test when supplied at the minimum voltage specified in section 3.4.

Notes.

1. It will be a national practice to refer the specification to the rack type or to the convertor type.
2. For 220V AC supplies I_m equals the maximum RMS current.

3.9.2. The circuit for measuring the surge current drawn by the equipment should be as shown in Figure 2A (T/TR 02-02) for 48V and 60V DC supplies or Figure 3A (T/TR 02-02) for 220V AC supply. The measurement should be made with the equipment powered at the nominal secondary voltage and rated load condition.

3.9.3. The energy content of the inrush characteristic should be taken into account when specifying equipment and the protective devices upstream of Interface "A". The values will be specified by Administrations according to national practices.

3.10. Maximum levels of noise present on the 48V and 60V DC supplies

3.10.1. *Narrow band noise*

Figure 8 (T/TR 02-02) specifies the maximum levels of noise which may be superimposed on to secondary voltage (Interface "A", Figure 1 (T/TR 02-02)). The values indicated refer to the following maximum bandwidths.

Frequency Range	Bandwidth
25 Hz to 1,000 Hz	10 Hz
1,000 Hz to 100 kHz	100 Hz
100 kHz to 100 MHz	10 kHz

Measurements should be made with a spectrum analyser having the bandwidths shown above for the relevant frequency ranges. The measuring circuit should be as shown in Figure 9 (TR 02-02).

3.10.2. *Wideband noise*

It is recommended that the maximum wideband noise levels should be as follows:
Band 1: 25 Hz-5 kHz via CCITT Weighting Filter for commercial telephone circuits: 10mV RMS
Band 2: 4 kHz-100 MHz: 50mV/MHz

The measurements should be made with the following instruments:
Band 1: A psophometer for commercial telephone circuits conforming to CCITT Recommendation P.53.
Band 2: A true RMS voltmeter capable of measuring 1 MHz bandwidths over the range.

The measurement circuit shall be as shown in Figure 9 (T/TR 02-02).

3.10.3. *Susceptibility of equipment*

To ensure that converters and other rack equipments meet their specifications in the presence of the maximum noise levels specified in 3.10.1. at Interface "A", sinusoidal voltages should be superimposed at Interface "A" using the arrangement shown in Figure 10 (T/TR 02-02).

The level of voltage to be supplied by the generator is shown in Figure 10A (T/TR 02-02).

Note. E (dBm) represents the open-circuit level of the signal generator. The actual level applied to the equipment under test (a-b) will differ from E (dBm), being a function of the input impedance of the equipment under test. If this is high, input noise levels similar to those shown in Figure 8 (T/TR 02-02) would be measured by a 50 ohm instrument connected across a-b.

3.11. Maximum level of noise re-injected by each noise source connected to the secondary distribution of power at Interface "A"

3.11.1. *Narrow band noise*

The limits of narrow band noise re-injected on to the secondary supply voltage are indicated in Figure 11 (T/TR 02-02). The values refer to the following bandwidths.

Frequency Range	Bandwidth
25 Hz to 1,000 Hz	10 Hz
1,000 kHz to 100 kHz	100 Hz
100 kHz to 100 MHz	10 kHz

The measurement should be made with a spectrum analyser having the bandwidths shown above for the relevant frequency ranges. The measurement circuit should be as shown in Figure 12 (T/TR 02-02). During the measurement the equipment should be powered at the nominal secondary voltage and rated load condition.

3.11.2. *Wideband noise*

It is recommended that the maximum wideband noise levels should be as follows:
Band 1: 25 Hz-5 kHz via CCITT Weighting Filter for commercial telephone circuits: 2mV RMS
Band 2: 4 kHz-100 MHz: 20mV/MHz

The measurement should be made with the following instruments:
Band 1: A psophometer for commercial telephone circuits conforming to CCITT Recommendation P.53.
Band 2: A true RMS voltmeter capable of measuring 1 MHz bandwidths over the range.

The measurement circuit shall be as shown in Figure 12 (T/TR 02-02). During the measurement the equipment should be powered at the nominal secondary voltage and rated load condition.

3.12. Electromagnetic radiations emitted into the immediate surroundings by each noise source in the rack (provisional)

It is recommended that the levels of magnetic and electric fields radiated by the equipment should be as shown in Figures 13A (T/TR 02-02) and 13B (T/TR 02-02). Measurements should be made in accordance with Figures 14A (T/TR 02-02) and 14B (T/TR 02-02) for the magnetic and electric fields respectively. The measuring equipment should be a spectrum analyser and the values refer to the following frequency range/bandwidths.

Frequency Range	Bandwidths
25 Hz to 1 kHz	10 Hz
1 kHz to 100 kHz	100 Hz
above 100 kHz	10 kHz

Electric field measurements shall be made with a rod antenna having a length of 1m.

Magnetic field measurements shall be made with air coils screened against electric fields; suitable diameters shall be between 5 and 50cm. The equipment should be powered at the nominal secondary voltage and rated load condition.

3.13. Acoustic disturbances emitted by each noise source in the rack in both audible and ultrasonic ranges

The level of acoustic noise (SPL) should be measured via a microphone at a distance of 0.5m from each surface, all round the equipment, which should be installed in a rack of typical configuration placed in an "anechoic" chamber.

The worst level of acoustic noise generated by the equipment should not exceed the limits shown in Figure 7 (T/TR 02-02) per ⅓ octave band, nor a frequency weighted value of 30dBA (i.e. measured via the IEC weighting network A).

The measurements associated with Figure 7 (T/TR 02-02) should be made using ⅓ octave band filters in accordance with IEC Publication 225 extended upwards to 40 kHz.

The weighted measurement should be made with a soundmeter in accordance with IEC Publication 179 using weighting network A.

3.14. Connections at Interface "A"

The connection of secondary voltages to the rack should be possible by cable.

Note. It is permitted to connect to the rack by power supply bars if the rack configuration permits, in the case of DC power supply.

3.15. Earthing of the rack

The HF and protection earth is carried by cables or bars having large cross-sections. The positive pole of the secondary DC supply voltage is earthed at the rack level and/or in the power room, according to the station earthing system. The other earths (for instance signalling earth) are not taken in consideration by this Recommendation.

Note. Star type and multipoint earth systems are in use. It is also necessary to take account of safety problems:
— for the protection earth especially in the case of a lightning strike on the lines;
— for telecommunications centres in mountainous regions, having poor earth conductivity, special means may be taken.

3.16. Remote power supplies for buried equipment

3.16.1. *Symmetric pair cables*

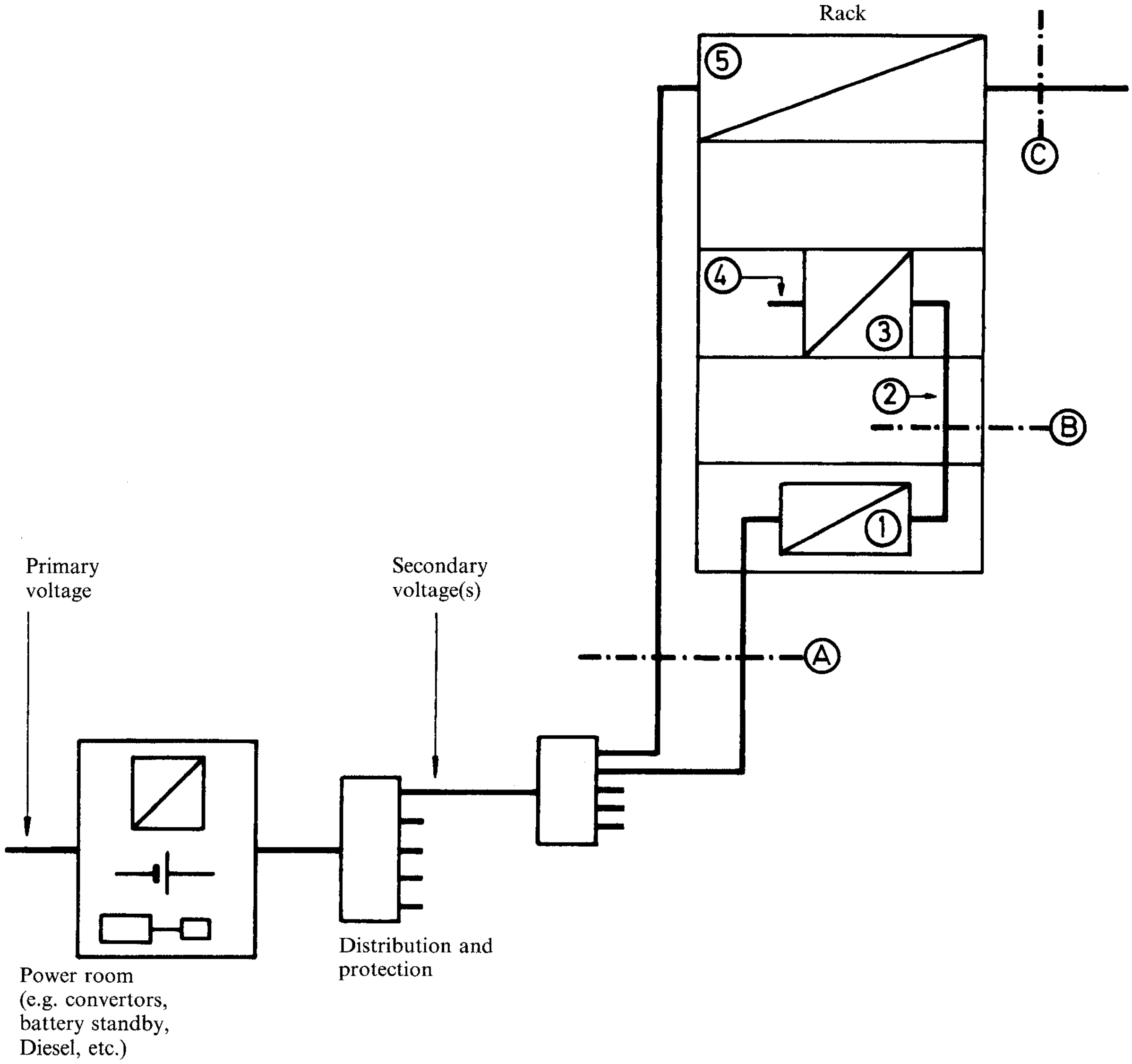
For symmetric pair cables maximum values of nominal line current and voltage not requiring specific safety measures are 50mA and ± 75V DC.

Notes.

1. Where systems require higher currents or voltages, safety measures should be adopted to reduce these to safe values under abnormal conditions.
2. The Recommendations of IEC Publication 479 shall apply.

3.16.2. *Coaxial cables*

For coaxial cables harmonisation of nominal current and voltage is not considered necessary. However, appropriate safety measures should be adopted to ensure that under abnormal conditions the requirements of IEC Publication 479 are met.



(A) Power interface at input of rack

(B) Power interface between rack convertor(s) and equipment(s)

(C) Power feeding interface

(1) Rack convertor

(2) Tertiary voltage(s)

(3) Possible equipment convertor

(4) Possible quaternary voltage(s)

(5) Power feeding equipment

Figure 1 (T/TR 02-02). Power supply interfaces.

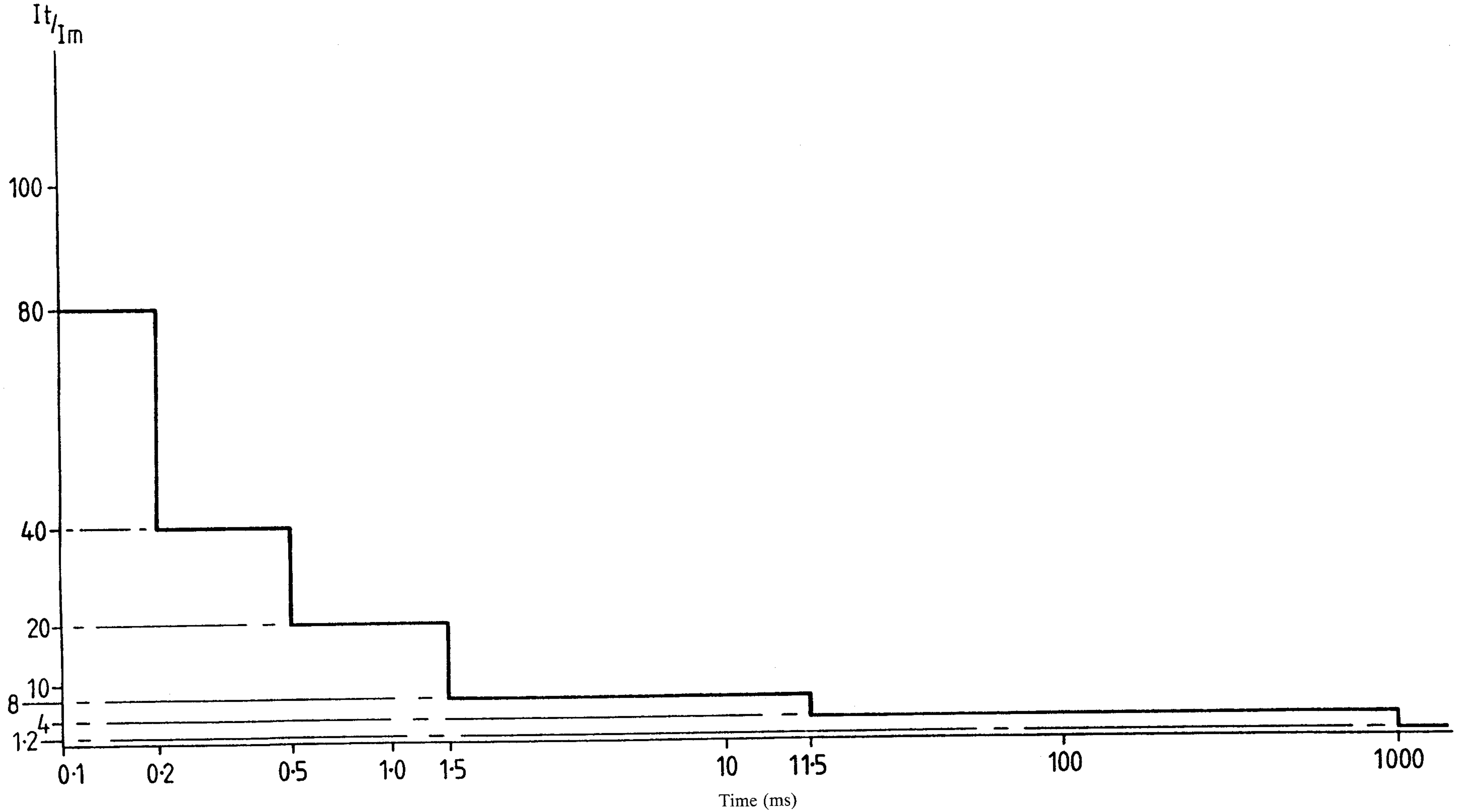


Figure 2 (T/TR 02-02). Limits for ratio of instantaneous surge current to maximum current at Interface "A" for 48V DC and 60V DC supplies.

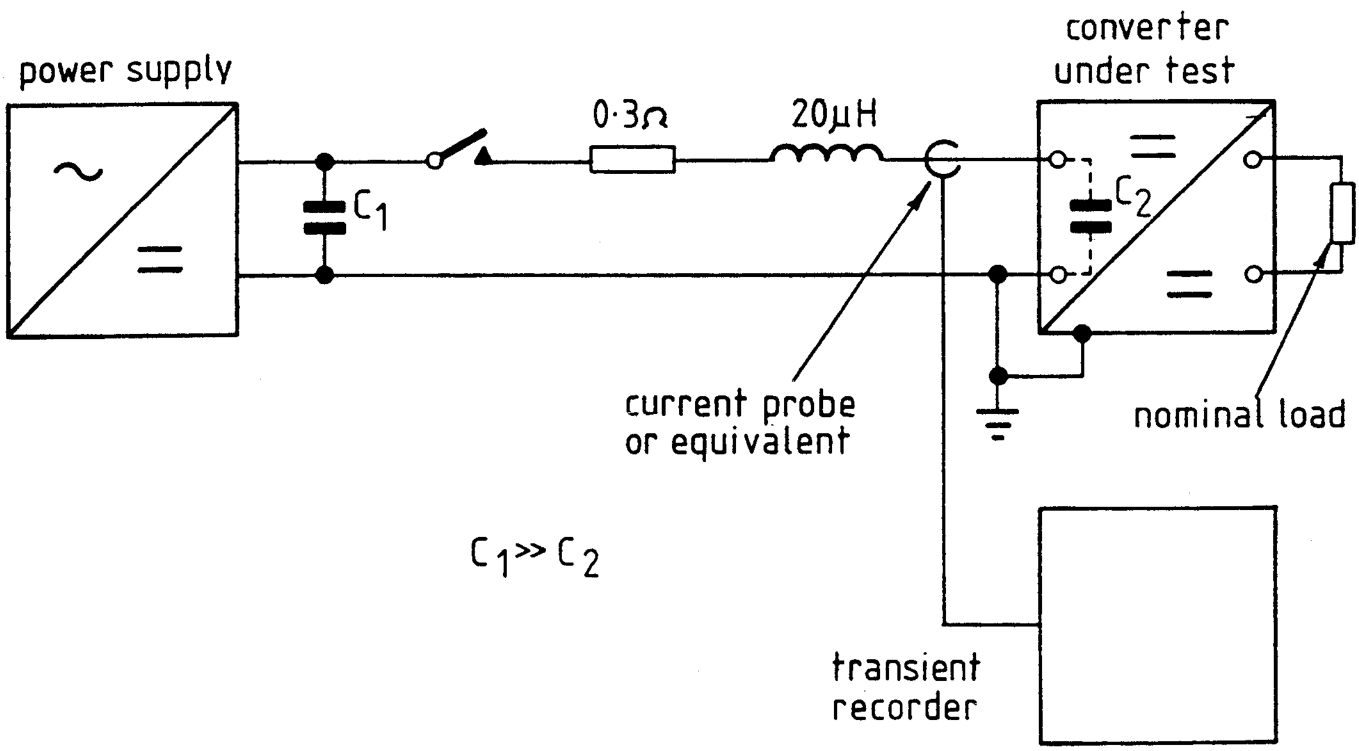


Figure 2A (T/TR 02-02). Surge current test circuit for maximum ratios of I_t/I_m (see Figure 2 (T/TR 02-02) and paragraph 3.9.).

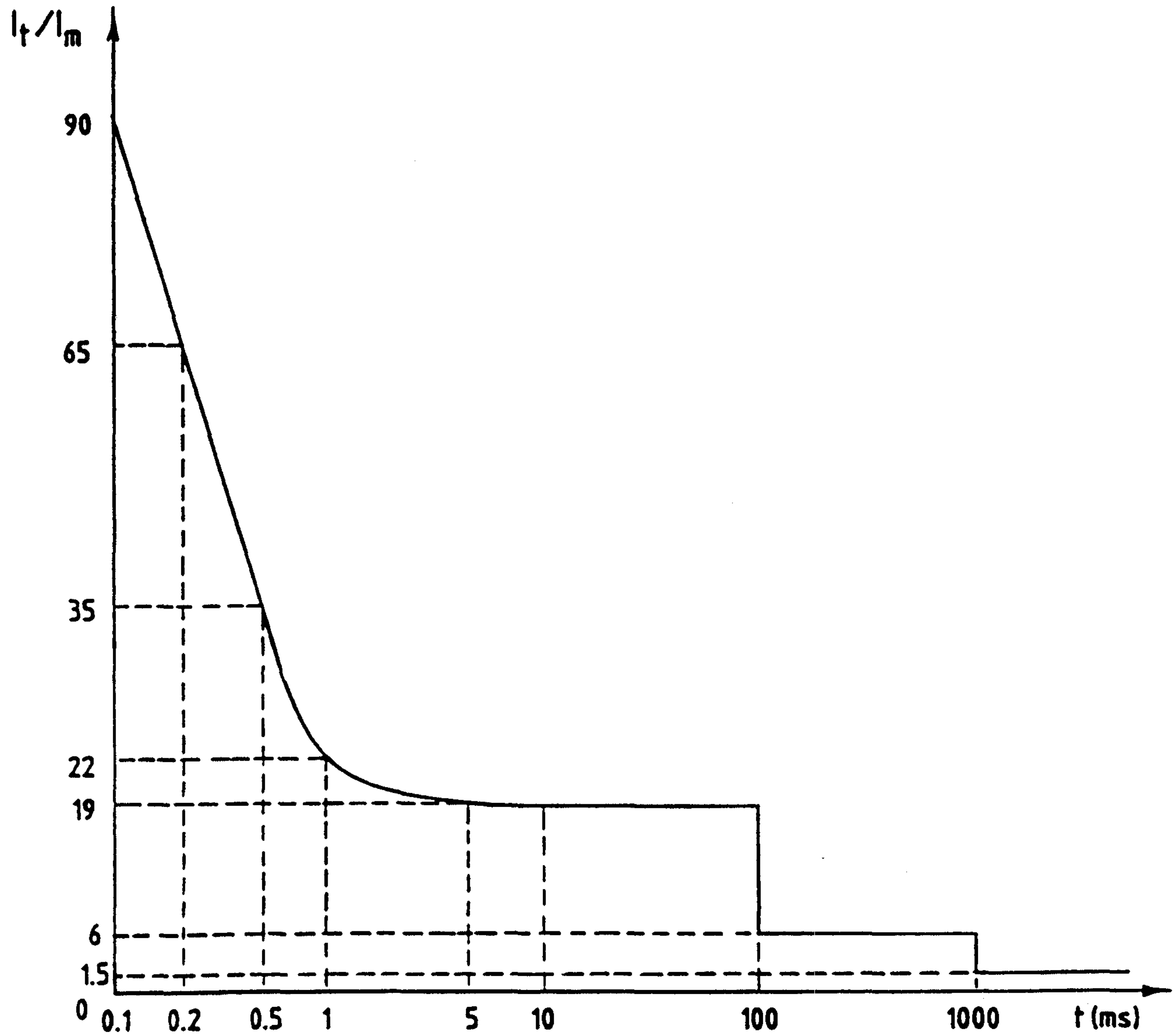


Figure 3 (T/TR 02-02). Limits for ratio of instantaneous surge current to maximum RMS current at Interface "A" 220V AC supplies.

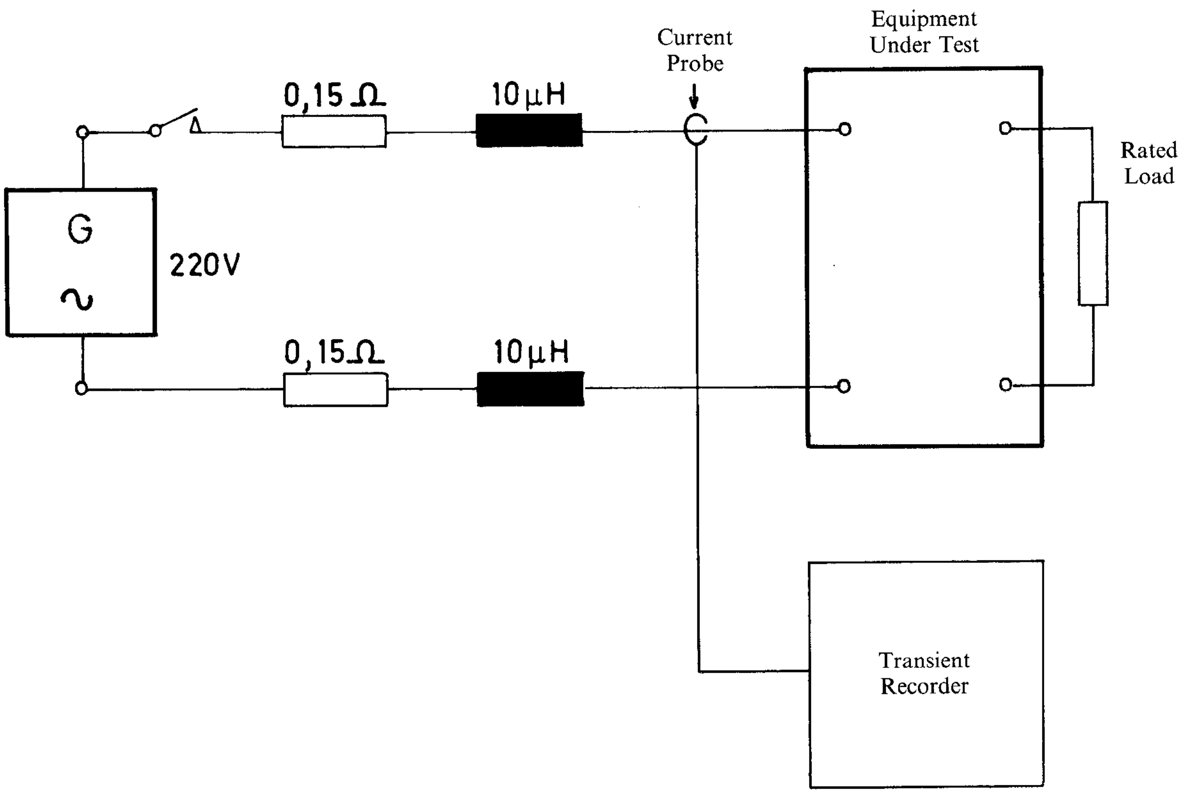


Figure 3A (T/TR 02-02). Surge current test circuit for AC power supplies.

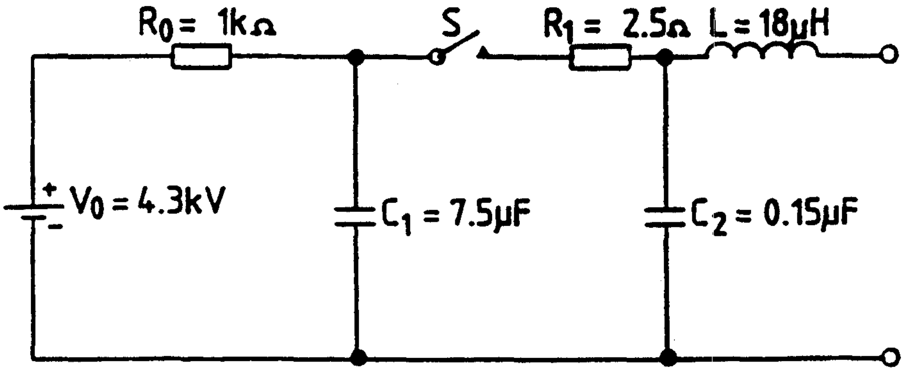


Figure 4 (T/TR 02-02). Schematic diagram of generator G.

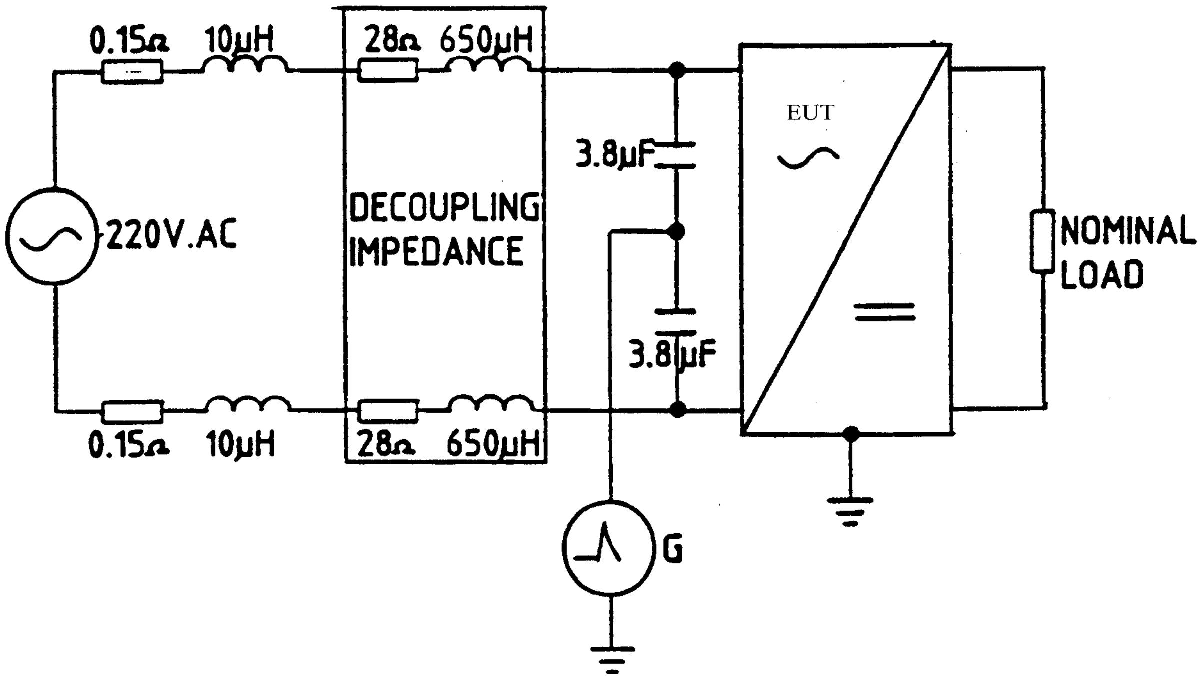


Figure 5A (T/TR 02-02). Common - mode overvoltage test (example for open-circuit voltage 4kV – 1.2/50μs).

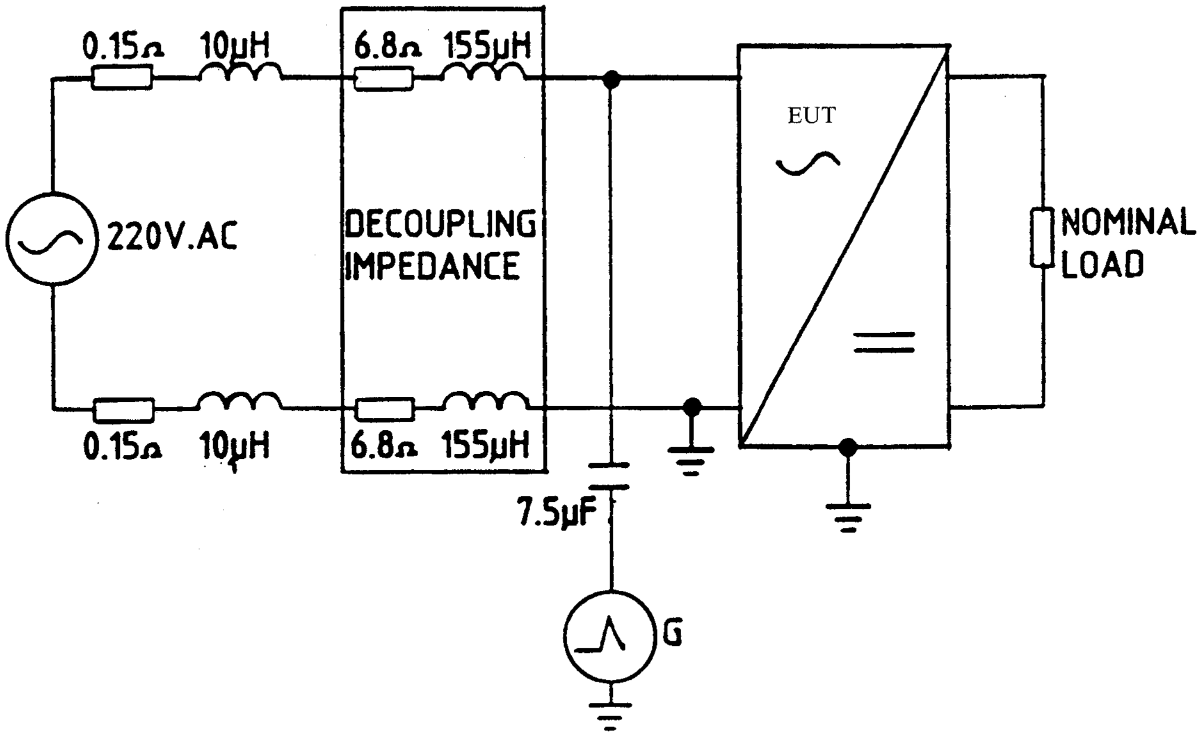
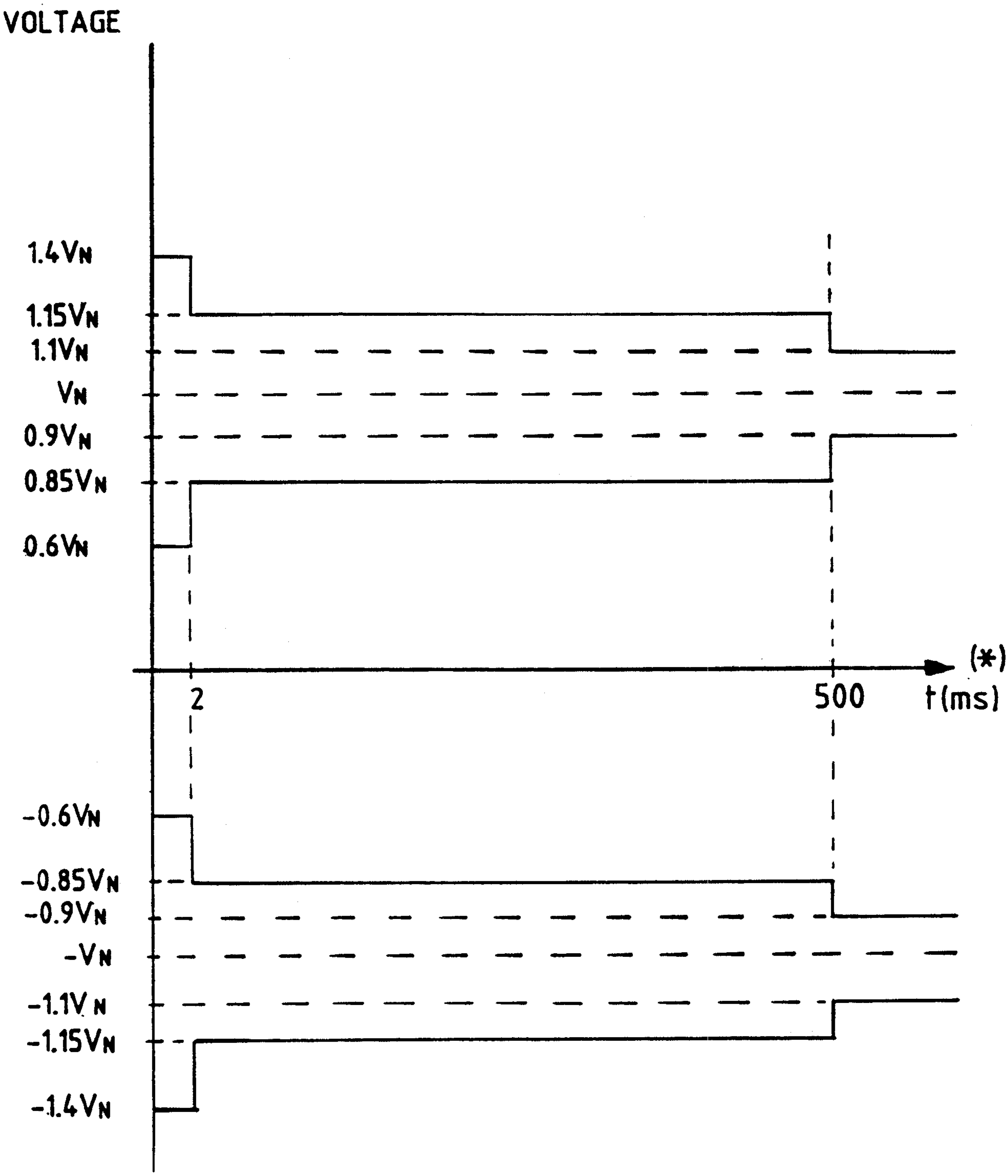
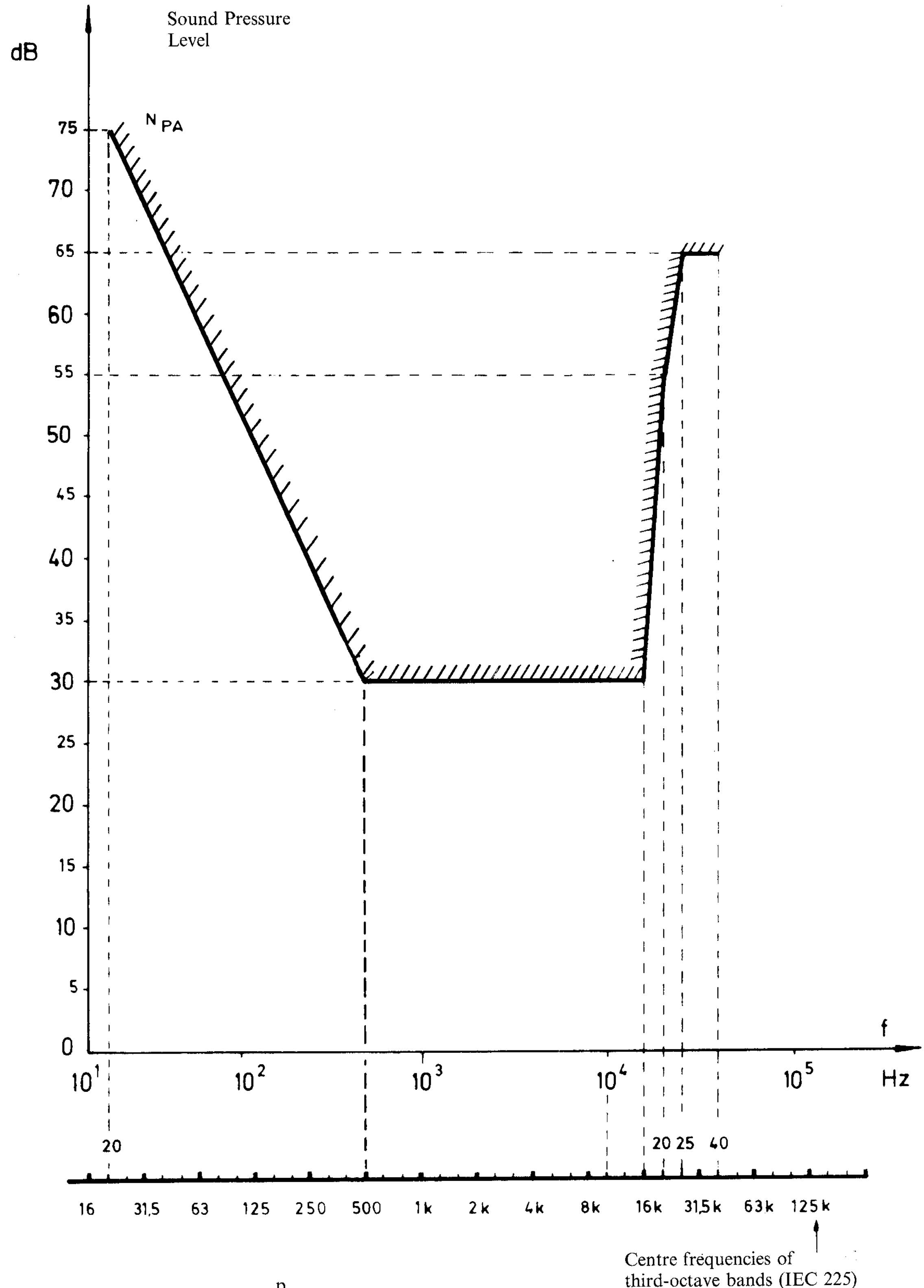


Figure 5B (T/TR 02-02). Differential - mode overvoltage test (example for open-circuit voltage 4kV – 1.2/50μs).



(*) The time origin corresponds to the peak of the anomalous half-wave form.

Figure 6 (T/TR 02-02). Envelope of slow voltage fluctuations.



Sound Pressure Level: $SPL = 20 \log_{10} \frac{p}{p_o}$

$p_o = 2 \cdot 10^{-5}$ Pa (Pa = Pascal = 1 Newton per m^2)

Figure 7 (T/TR 02-02). Acoustic noise limits for equipment.

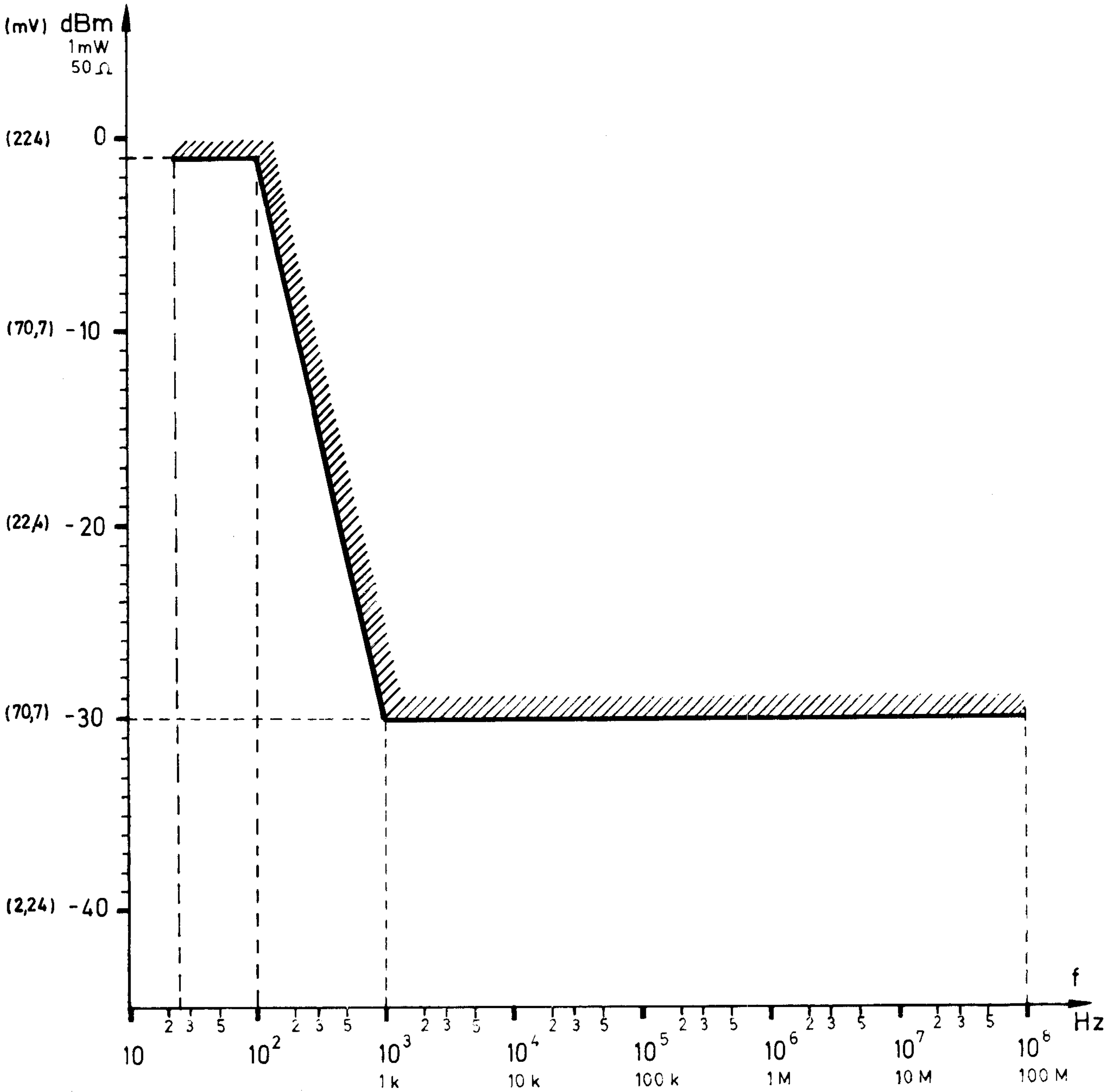


Figure 8 (T/TR 02-02). Maximum level of noise on secondary voltage supply (48V or 60V DC).

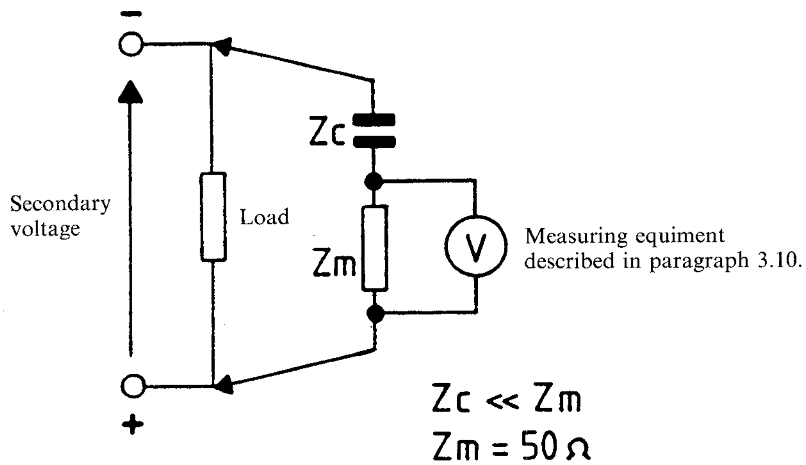


Figure 9 (T/TR 02-02). Measuring circuit for noise levels specified in paragraph 3.10.

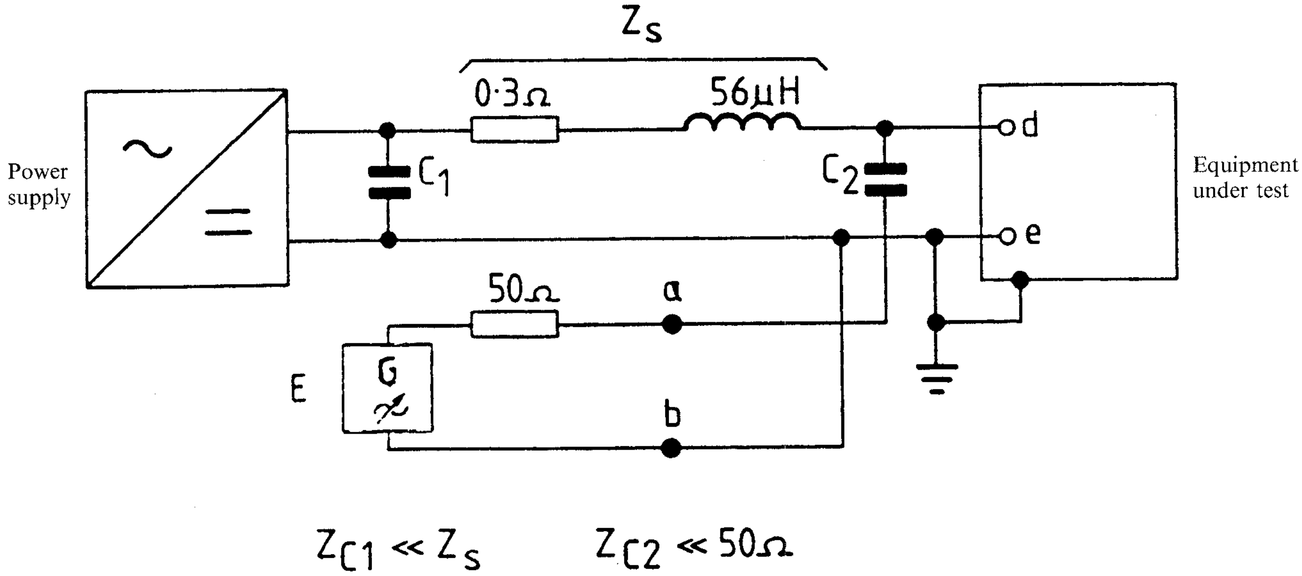


Figure 10 (T/TR 02-02). Measuring circuit for equipment susceptibility against noise levels specified in Figure 8 (T/TR 02-02) for values of "E" (see Figure 10A (T/TR 02-02) and paragraph 3.10.3.).

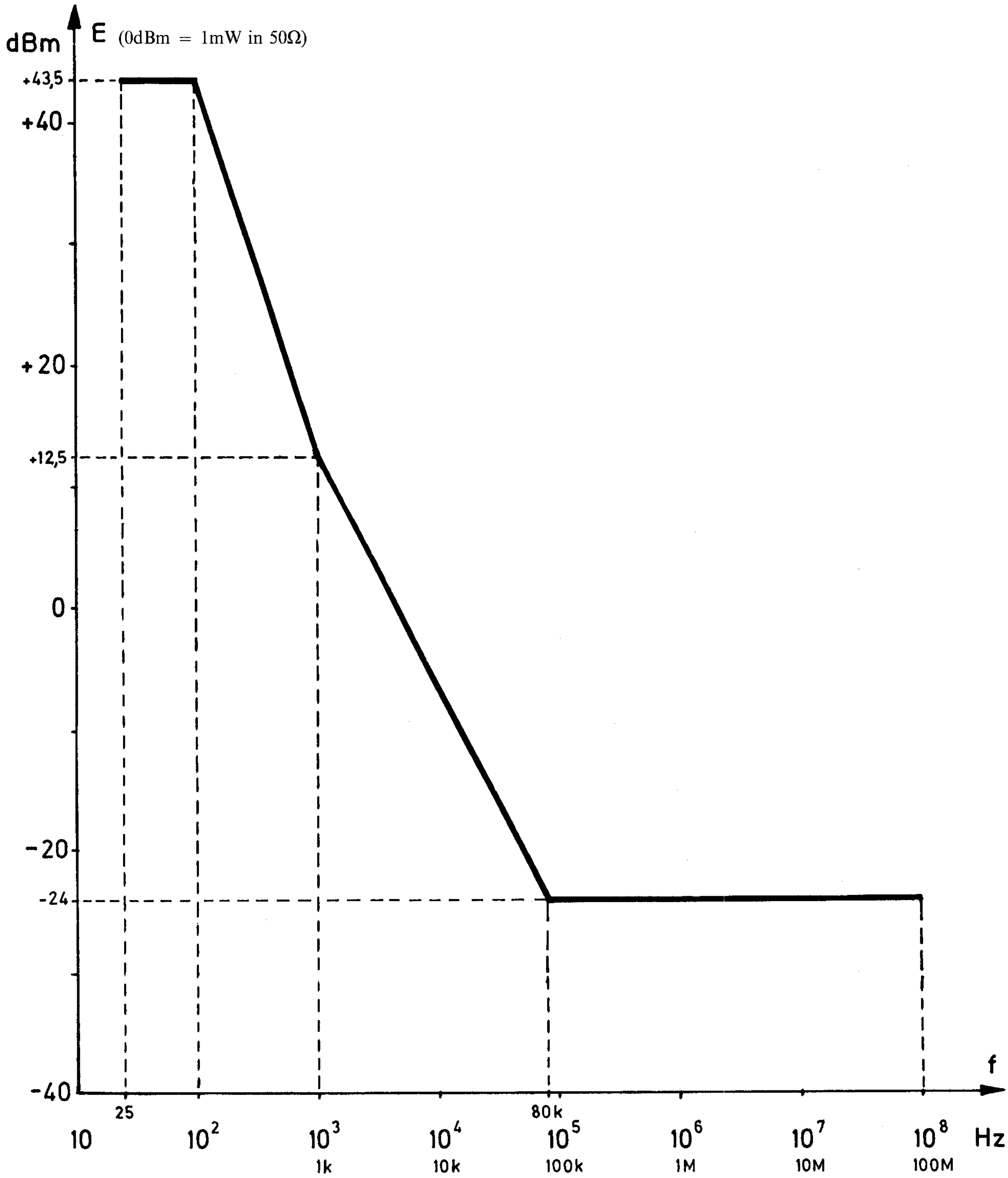


Figure 10A (T/TR 02-02). Voltage level for susceptibility testing of equipment to narrow band noise on 48V DC or 60V DC secondary supply.

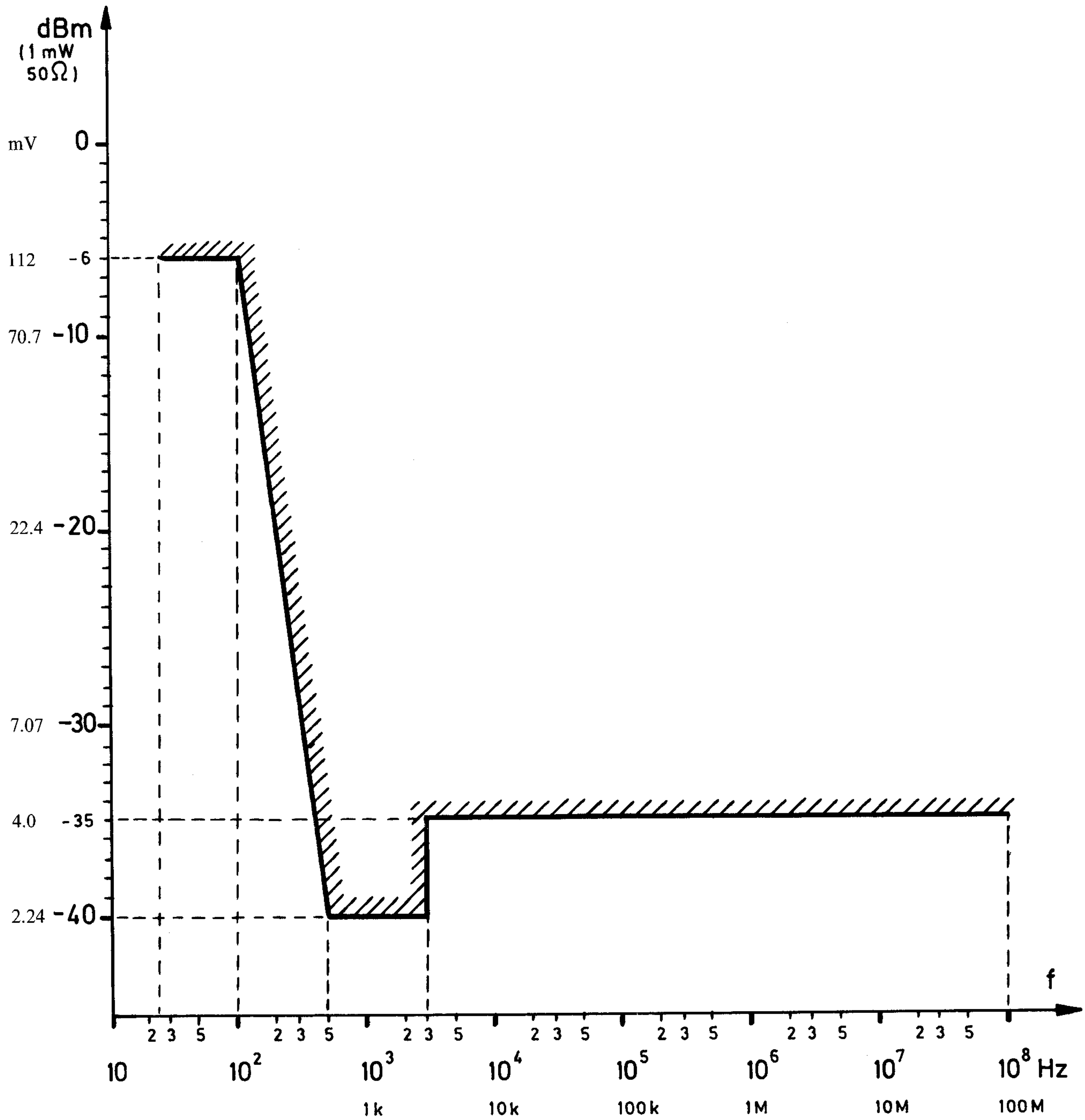
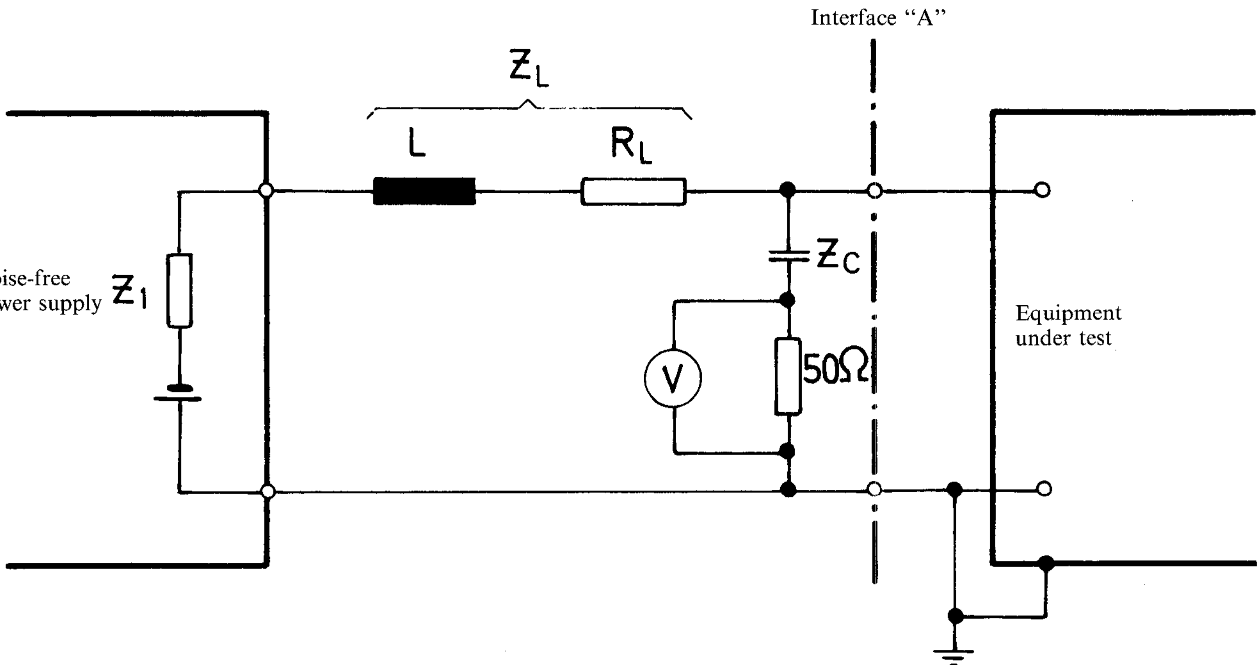


Figure 11 (T/TR 02-02). Maximum levels of noise reinjected onto the secondary voltage supply (48V or 60V DC) at Interface "A".



L = 50 to 56μH R_L = 0.3Ω Z_1 ≪ZL Zc≪50Ω
V = Measuring equipment as described in paragraph 3.11.

Figure 12 (T/TR 02-02). Measuring circuit for noise levels specified in paragraph 3.11.

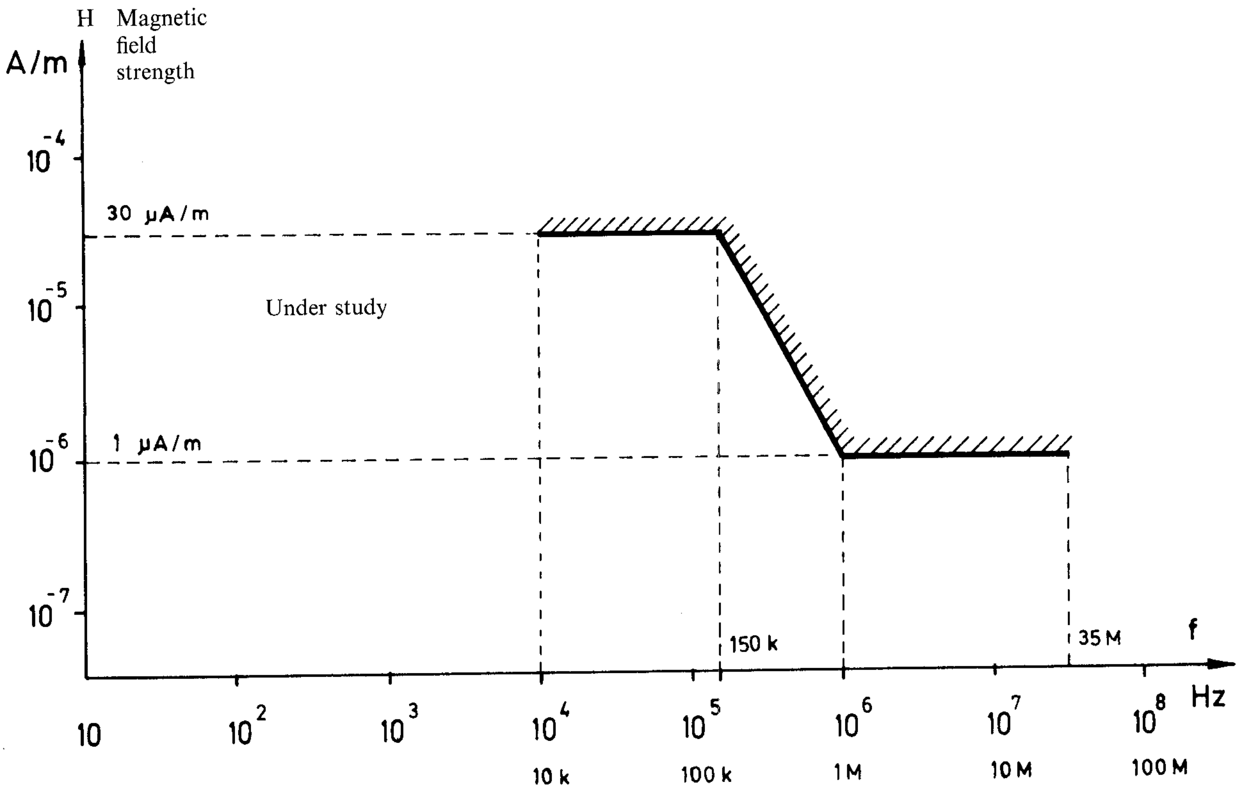


Figure 13A (T/TR 02-02). Maximum level of magnetic field strength.

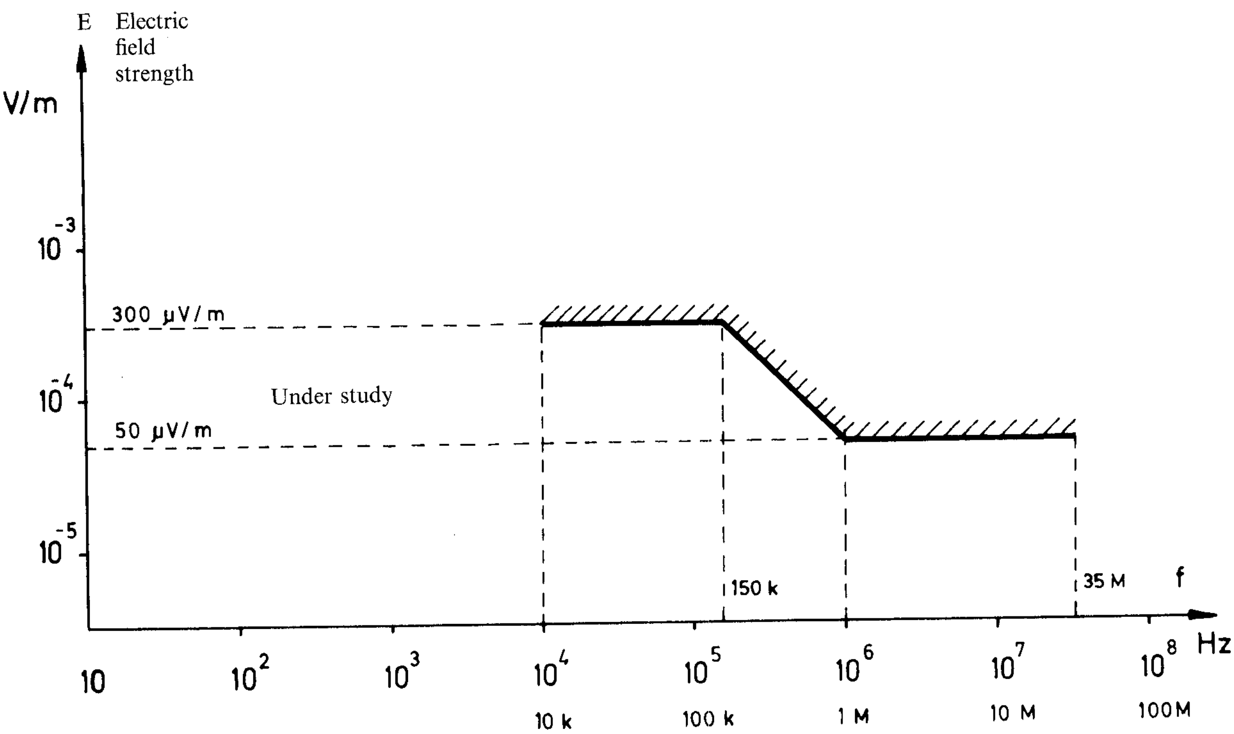


Figure 13B (T/TR 02-02). Maximum levels of electric field strength.

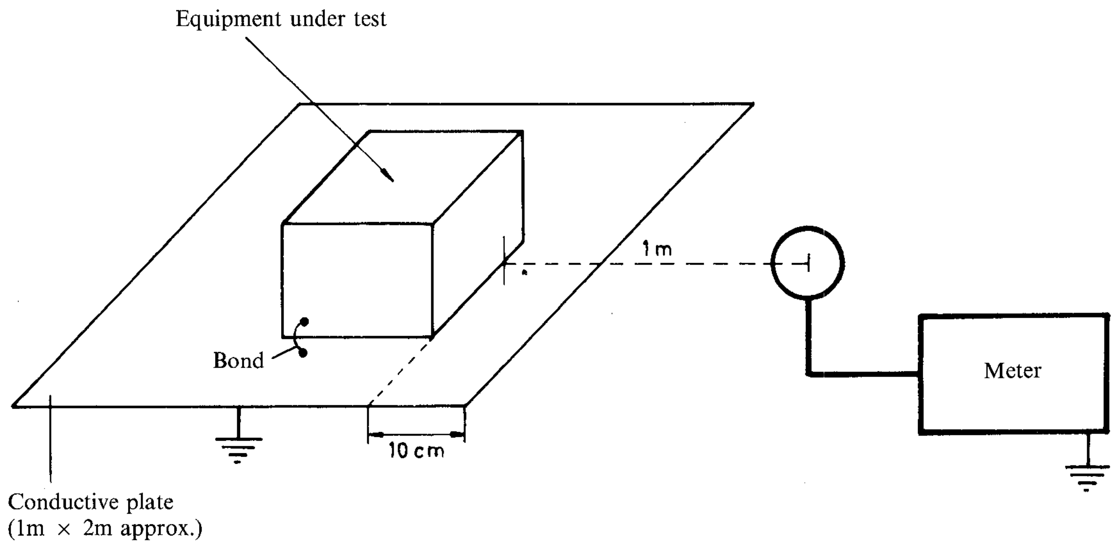


Figure 14A (T/TR 02-02). Measuring circuit for magnetic field strength.

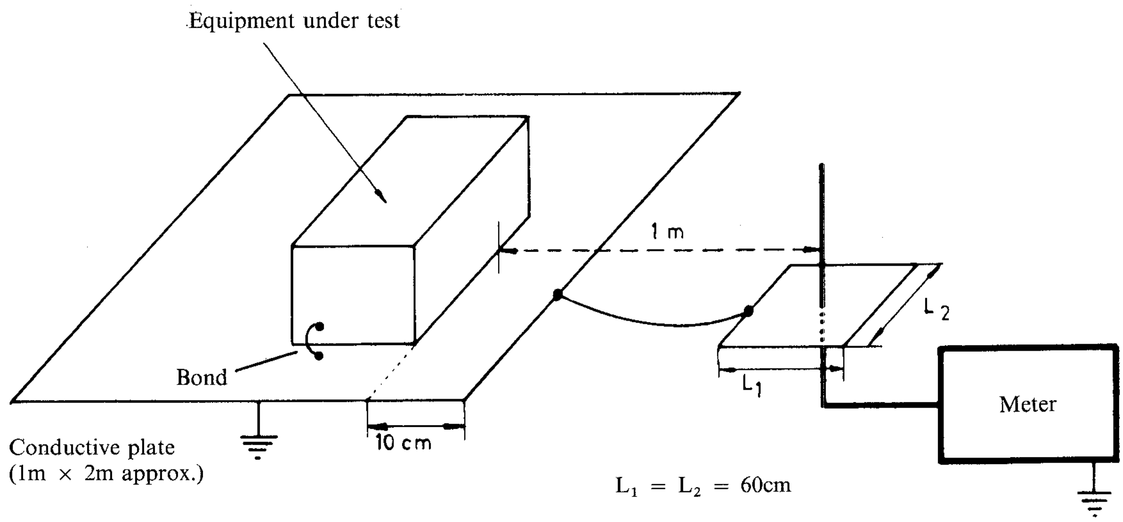


Figure 14B (T/TR 02-02). Measuring circuit for electric field strength.