Emerging Standards for

EMC Emissions & Immunity

Requirements for Industrial, Scientific, Medical & Information Technology Equipment

CE Marking requirements are the path to increased market access

Powerful Globalization forces will encourage "harmonized" products designed for World markets rather than simply regional markets

Overview of Testing Requirements

	Emissions	Immunity
Conducted	**CISPR 11, 22**	**EN 61000-4-6**
Radiated	**CISPR 11, 22**	**EN 61000-4-3**
Power-line	**Harmonics / Flicker**	**EN 61000-4-8, -11**
E. S. D.		**EN 61000-4-2**
E.F.T.		**EN 61000-4-4**
Surge		**EN 61000-4-5**

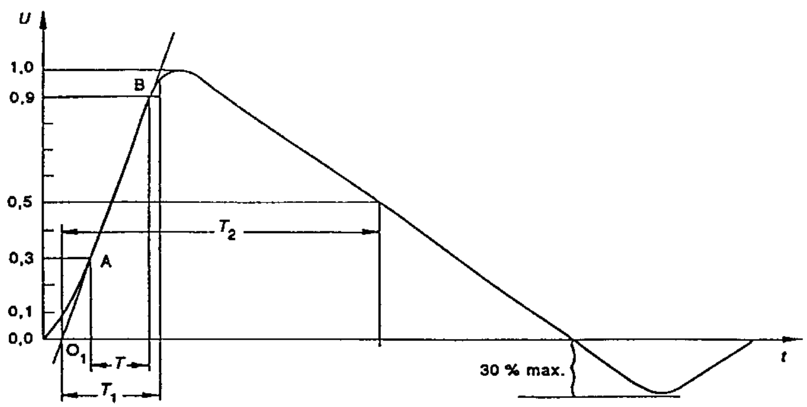
Emerging Test Requirements:

(required in 2001)

EN 61000-4-5	**Lightning Strike (Surge) 7/1/01**
EN 61000-4-6	**Conducted R.F. Voltages 7/1/01**
EN 61000-4-8	**50Hz Magnetic Fields 7/1/01**
EN 61000-4-11	**Power line slow variations 7/1/01**
EN 61000-3-2	**Power line Harmonics 1/1/01**
EN 61000-3-3	**Power line Flicker 1/1/01**
EN 55011(98)	**Industrial, Scientific, Medical 1/1/01**
EN 55022(98)	**Computer / Telco emissions 8/1/01**
EN 55024(98)	**Computer / Telco immunities 7/1/01**

EN 61000-4-5

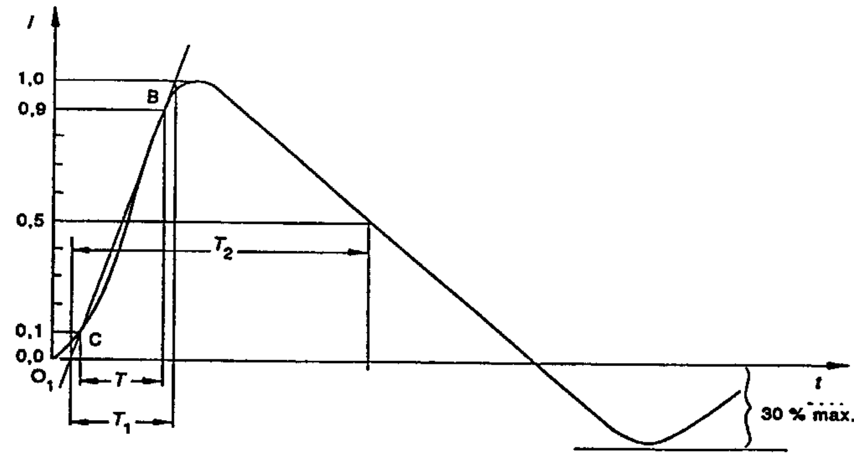
Lightning Strike (Surge)



Front time: T_1 = 1,67 × T = 1,2 µs ± 30 %

Time to half-value: T_2 = 50 µs ± 20 %.

Waveform of open-circuit voltage (1,2/50 µs)
(waveform definition according to IEC 60-1)



Front time: T_1 = 1,25 × T = 8 µs ± 20 %

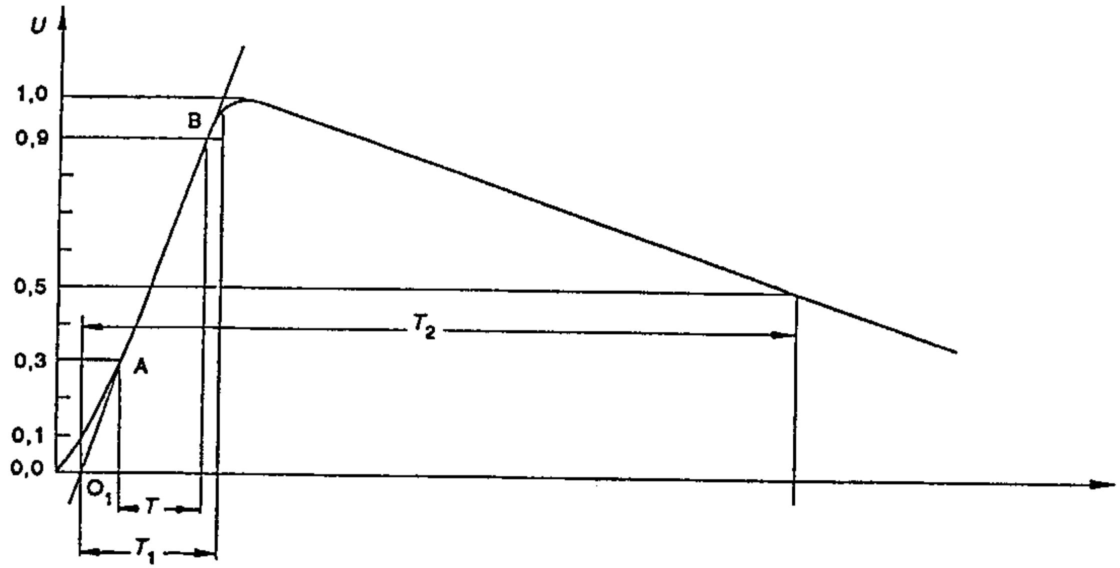
Time to half-value: T_2 = 20 µs ± 20 %.

Waveform of short-circuit current (8/20 µs)
(waveform definition according to IEC 60-1)

Combination wave definitions

EN 61000-4-5

Lightning Strike (Surge)



Front time: $T_1 = 1{,}67 \times T = 10\ \mu s \pm 30\ \%$

Time to half-value: $T_2 = 700\ \mu s \pm 20\ \%$.

Waveform of open-circuit voltage (10/700 µs)
(waveform definition according to CCITT)

Telecomm (CCITT) wave definition

EN 61000-4-5

Lightning Strike (Surge)

Level	Open-circuit test voltage ± 10 % kV
1	0,5
2	1,0
3	2,0
4	4,0
x	Special
NOTE – x is an open class. This level can be specified in the product specification.	

Test levels for Surge testing

EN 61000-4-5

Lightning Strike (Surge)

Installation classes for Surge testing:

Class 0	Well-protected electrical environment, often within a special room
Class 1	Partly protected electrical environment
Class 2	Electrical environment where cables are well separated, even at short runs
Class 3	Electrical environment where cables run in parallel
Class 4	Electrical environment where interconnects are running outdoors, along with power cables, and are used for both electronic and electric circuits
Class 5	Electrical environment with equipment connected to telecommunications lines & overhead power lines in rural areas
Class x	Special conditions specified in the product specification

EN 61000-4-5

Lightning Strike (Surge)

Installation class	Test levels							
	Power supply Coupling mode		Unbalanced operated circuits/lines, LDB Coupling mode		Balanced operated circuits/lines Coupling mode		SDB, DB[1)] Coupling mode	
	Line to line kV	Line to earth kV	Line to line kV	Line to earth kV	Line to line kV	Line to earth kV	Line to line kV	Line to earth kV
0	NA	NA	NA	NA	NA	NA	NA	NA
1	NA	0,5	NA	0,5	NA	0,5	NA	NA
2	0,5	1,0	0,5	1,0	NA	1,0	NA	0,5
3	1,0	2,0	1,0	2,0 [3)]	NA	2,0 [3)]	NA	NA
4	2,0	4,0 [3)]	2,0	4,0 [3)]	NA	2,0 [3)]	NA	NA
5	[2)]	[2)]	2,0	4,0 [3)]	NA	4,0 [3)]	NA	NA
x								

1) Limited distance, special configuration, special layout, 10 m to max. 30 m: no test is advised at interconnection cables up to 10 m, only class 2 is applicable.

2) Depends on the class of the local power supply system.

3) Normally tested with primary protection.

Explanation:

DB = data bus (data line)
SDB = short-distance bus
LDB = long-distance bus
NA = not applicable

EN 61000-4-6

Conducted R.F. Voltages

This Standard describes the Conducted Immunity testing requirements for electrical & electronic equipment to continuos interference from intended RF transmitters operating from 150 kHz - 80 MHz. (optional to 230MHz) Amplitude Modulation (AM) is applied during the test to simulate these emitters.

<u>Four coupling methods</u> are outlined in the Standard:

1. **Coupler Decoupler Networks (CDN's)**
2. **Direct Injection (Direct or "S" series CDN's)**
3. **Electromagnetic Clamp (EM Clamp)**
4. **Bulk Current Injection (BCI, 150 & 50 ohms)**

Each method requires a "calibration" to measure the required drive level for that coupling method, test level, and test setup. This "drive table" is then played back by the Computer (with 80% AM modulation) during the test run, with an appropriate dwell time (usually 3 seconds) at each frequency, and the performance of the Equipment Under Test (EUT) is monitored by the Auxiliary Equipment (AE) for failures.

EN 61000-4-6

Conducted R.F. Voltages

When interference is applied, failures can occur in four types:

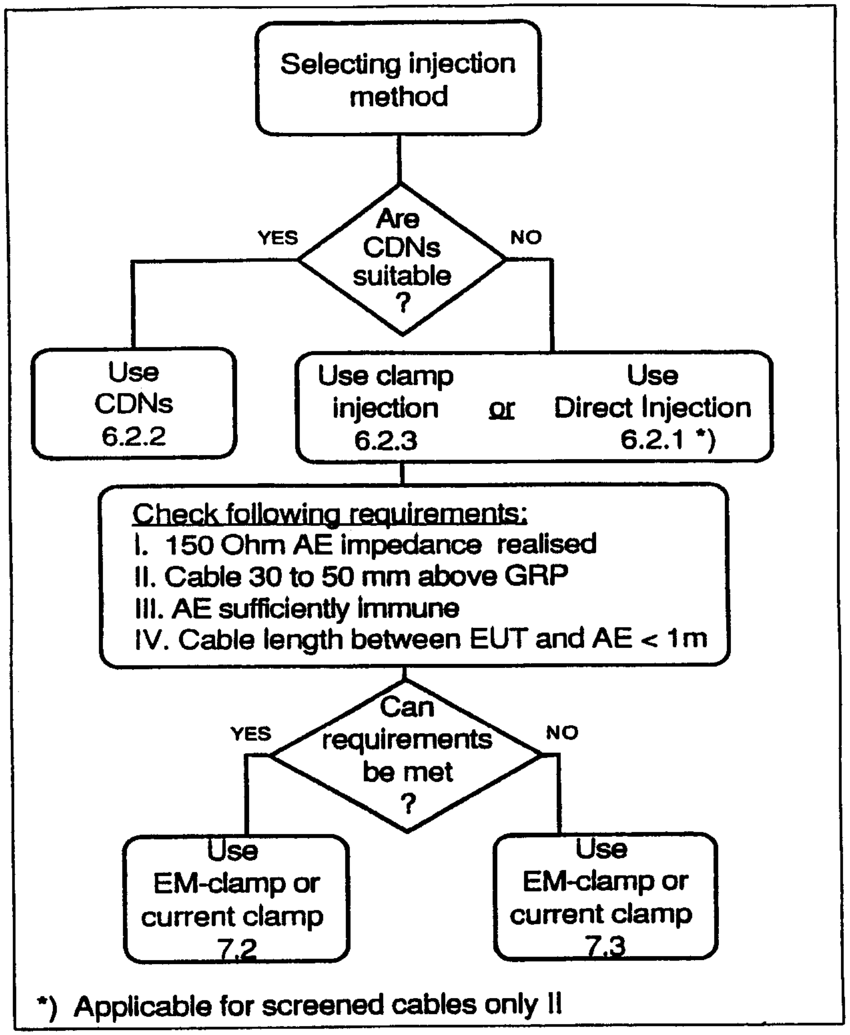
Type A No failures are observed
Type B Unit is upset, recovers when interference is removed
Type C Unit is upset, requires operator intervention to re-set
Type D Unit does not recover (damaged)

Frequency range .15 MHz - 80 MHz		
Level	Voltage level (e.m.f.) U_o [dBuV]	U_o [V]
1	120	1
2	130	3
3	140	10
X[1]	special	

1) X *is an open level.*

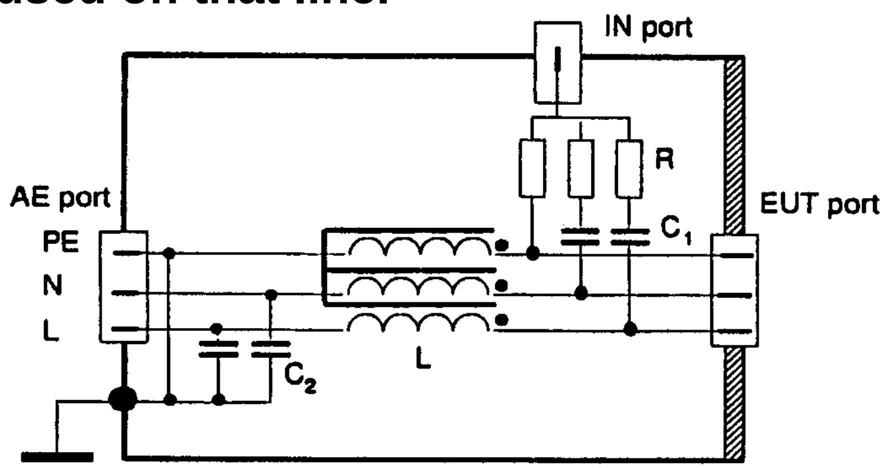
EN 61000-4-6

Conducted R.F. Voltages



Rules for selecting the injection method

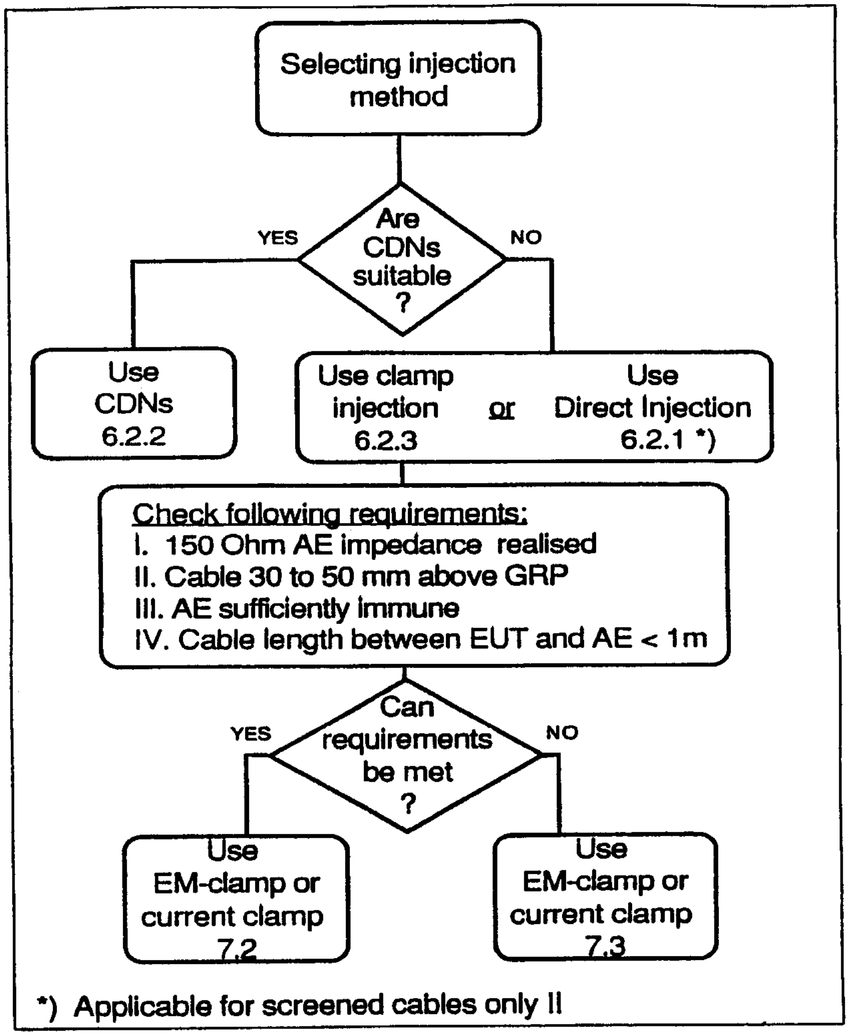
The Standard uses a logical decision tree to guide in the choice of coupling method. First, it asks; **Are CDN's suitable?** If a terminated CDN is inserted into the Power or I/O lines of the EUT, and those lines continue to function, then that CDN should be used on that line.



Note — CDN-M3, C_1(typ) = 10 nF, C_2(typ) = 47 nF, R = 300 Ω, L ≥ 280 μH at 150 kHz
CDN-M2; C_1(typ) = 10 nF, C_2(typ) = 47 nF, R = 200 Ω, L ≥ 280 μH at 150 kHz
CDN-M1; C_1(typ) = 22 nF, C_2(typ) = 47 nF, R = 100 Ω, L ≥ 280 μH at 150 kHz

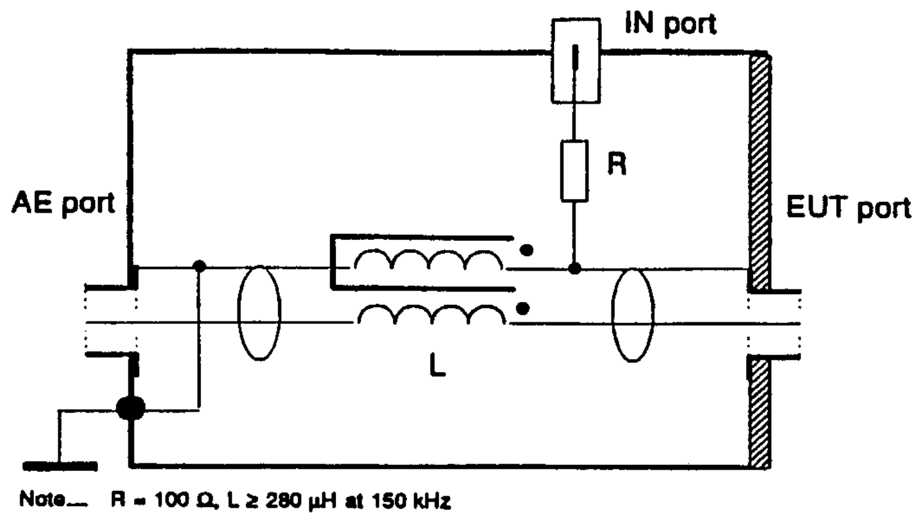
EN 61000-4-6

Conducted R.F. Voltages



Rules for selecting the injection method

If a Coupler Decoupler Network (CDN) is not suitable, is the line shielded (screened)? If so, you may use the "S" series CDN if suitable.

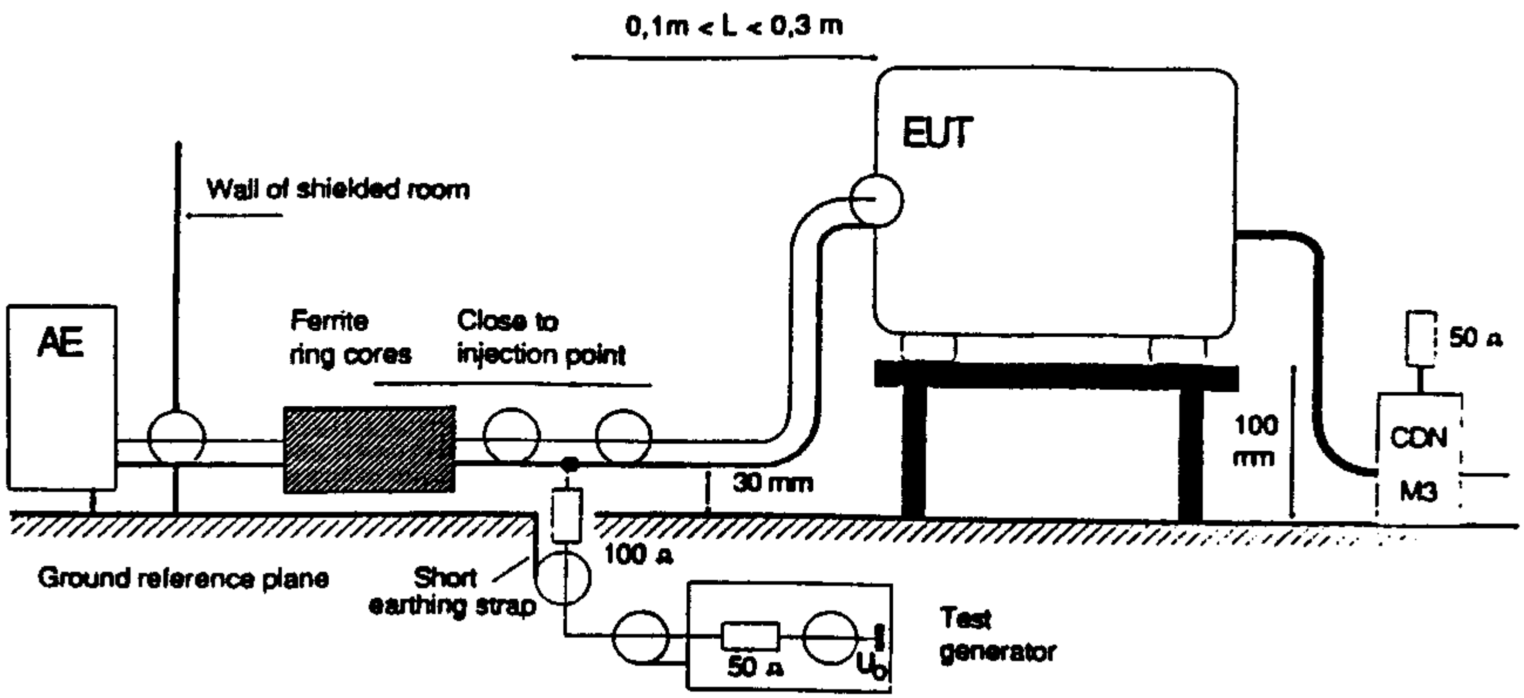


“S” series CDN (S-1)

EN 61000-4-6

Conducted R.F. Voltages

You may also use Direct Injection (through the R-100) onto the shield (screen) of the cable under test. Separate decoupling with the Ferrite Decoupler is then recommended.



Principle of direct coupling to screened cables.

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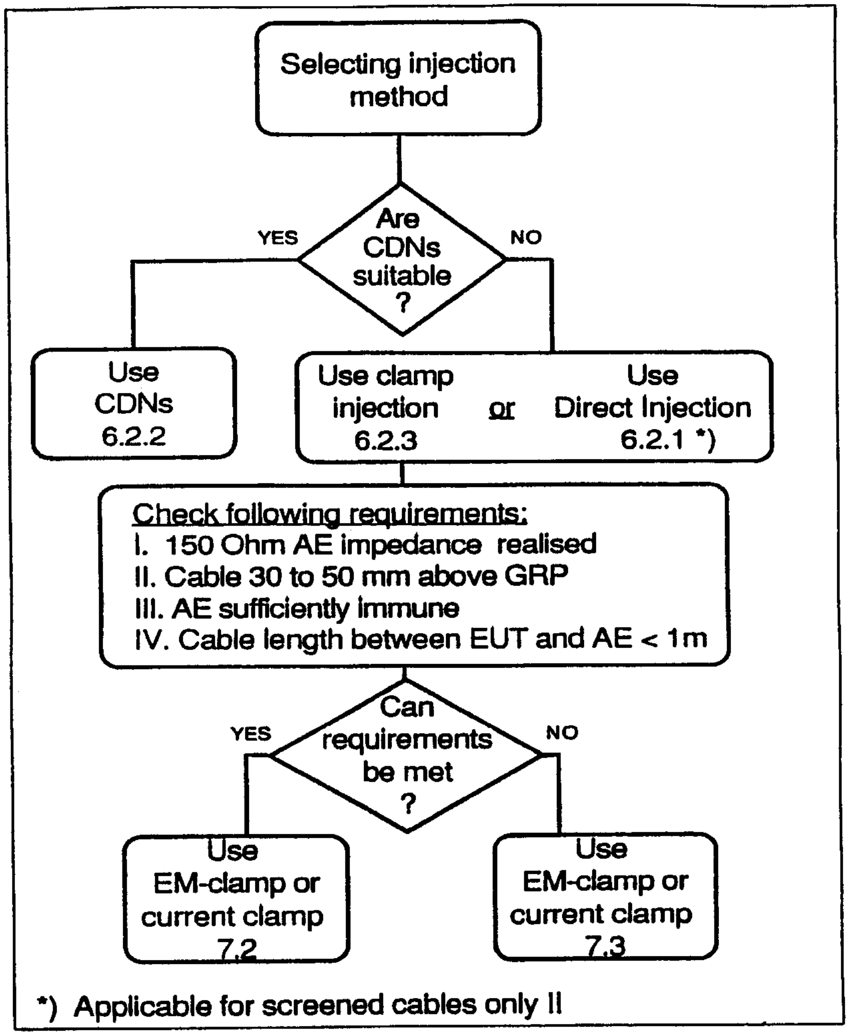
Conducted R.F. Voltages



Rules for selecting the injection method

If neither of these methods is suitable, clamp injection techniques are allowed. However, injected currents must be monitored with a monitor current probe and Spectrum Analyzer for both the BCI probe (150 & 50 ohms) as well as for the EM Clamp (150 ohms) methods. The use of a Ferrite Decoupler to protect the AE is recommended for both clamp injection techniques. The test setup shall present the 150 ohm common mode impedance required in Paragraph 6.2 and the functional installation conditions as closely as possible.

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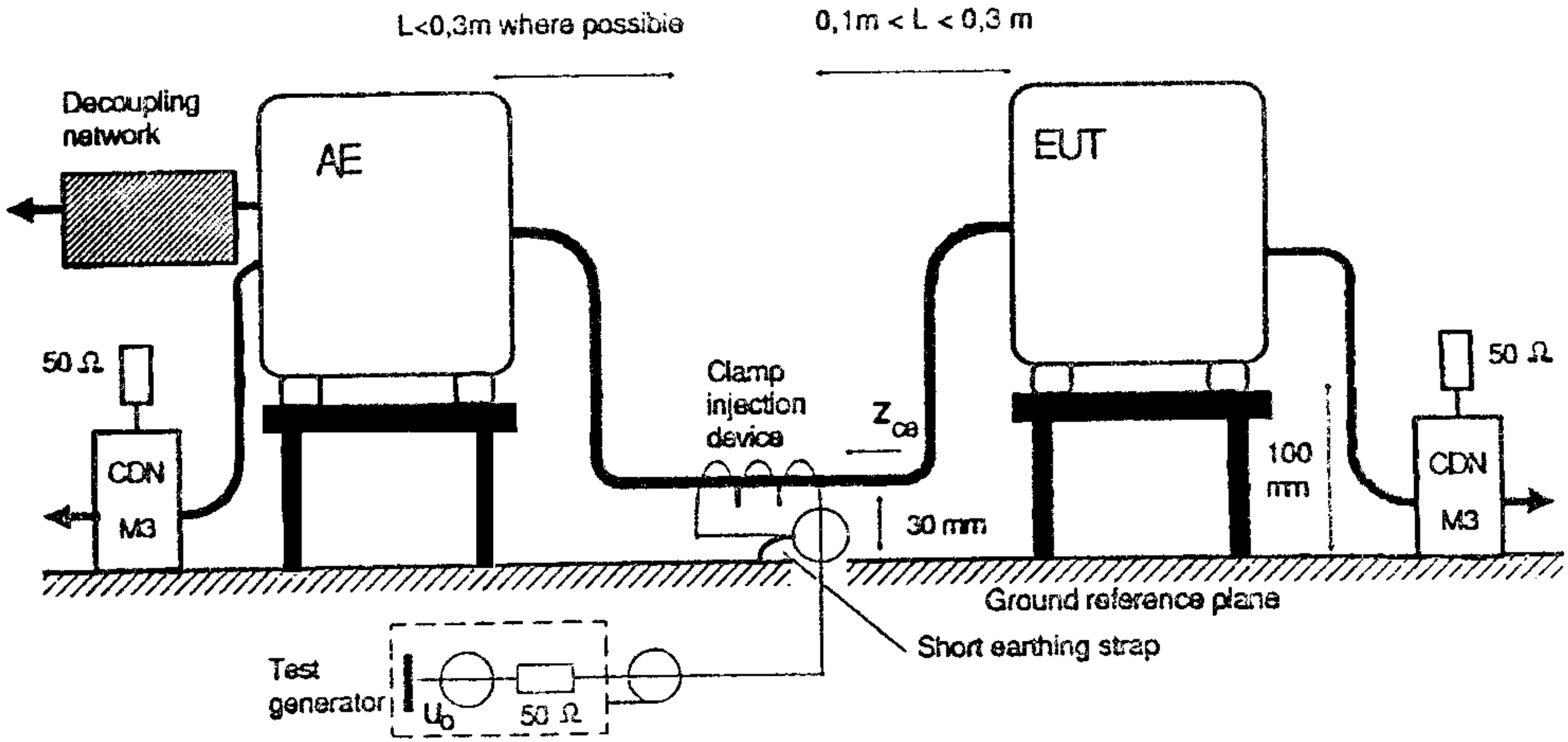
Conducted R.F. Voltages



Example of Clamp injection methods (EM Clamp or BCI)

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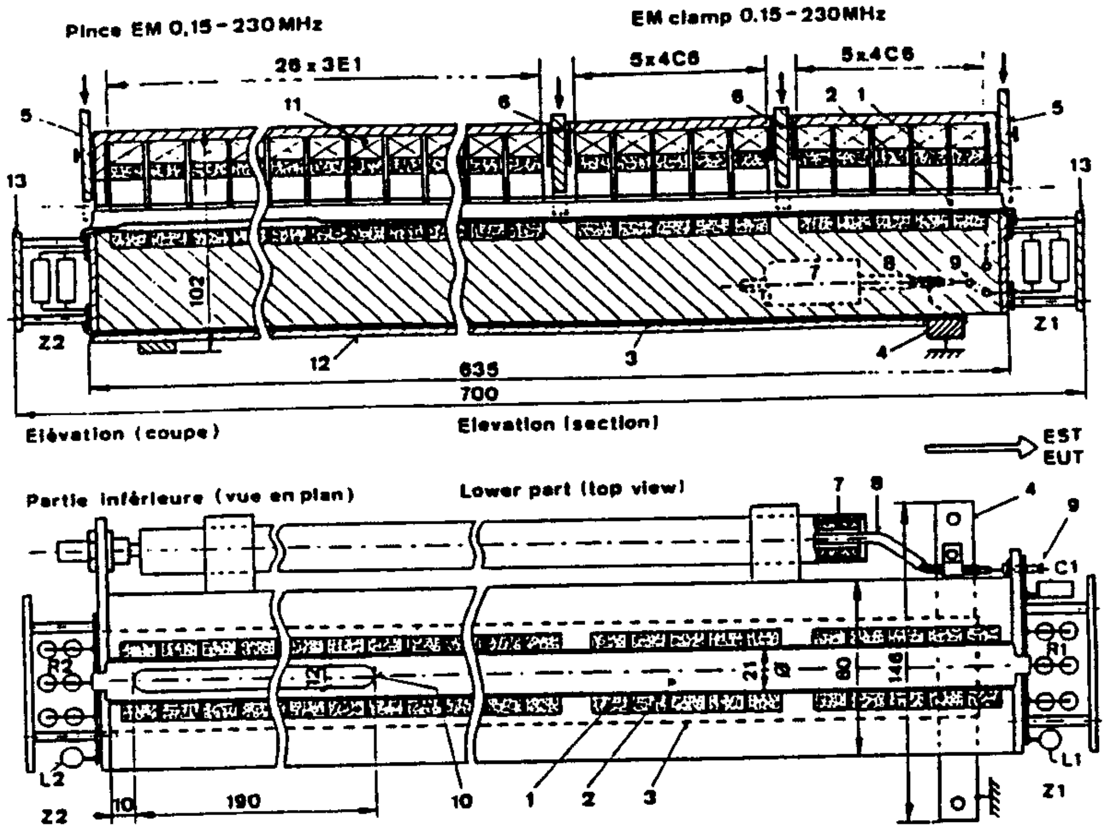
Conducted R.F. Voltages



Example of EM Clamp construction

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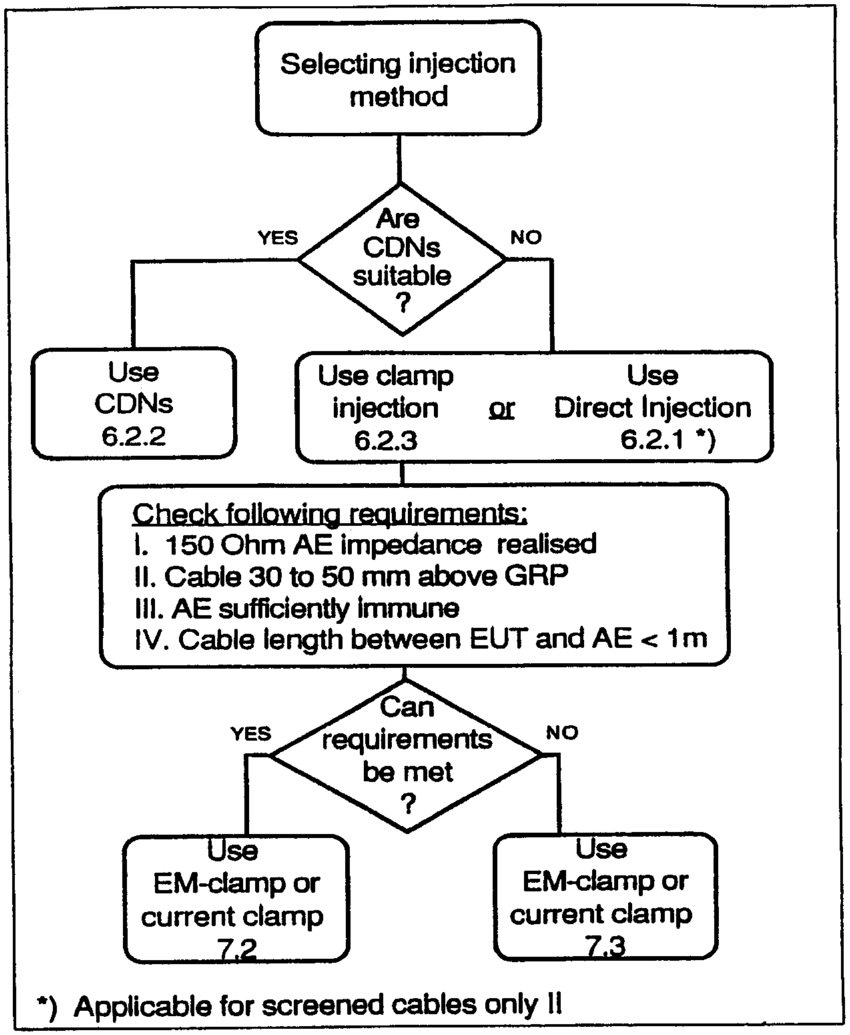
Conducted R.F. Voltages



Rules for selecting the injection method

To ensure the 150 ohm common mode impedance is realized, check that the following conditions of 7.2 are met:

- **Each AE is placed on a 100mm support above the ground plane**
- **All cables touching each AE shall be provided with a Ferrite Decoupler and kept 30-50mm above the ground plane**
- **Cable lengths are kept short (< 0.3M)**
- **Terminated CDN's are used on all other AE power & I/O lines**

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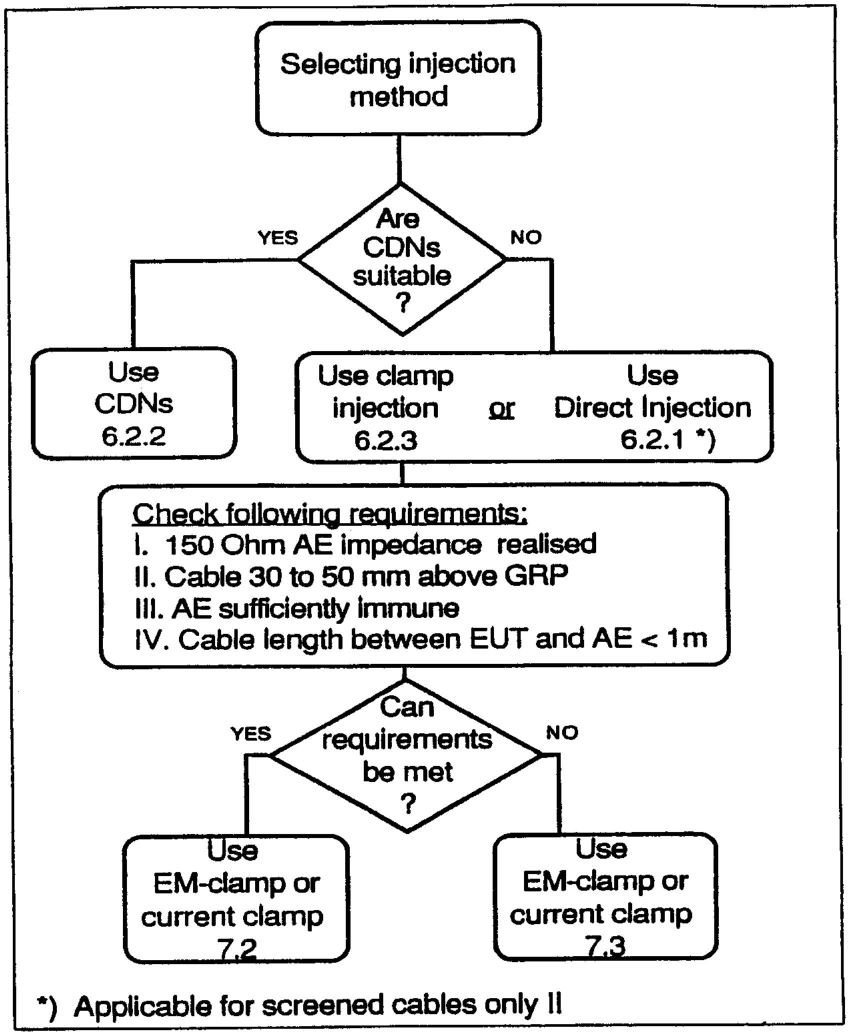
Conducted R.F. Voltages



Rules for selecting the injection method

If one or more of these conditions cannot be met, it is necessary to ensure that the common mode impedance of the AE is less than or equal to the common mode impedance of the EUT port being tested. If not, measures must be taken to lower this AE impedance, such as decoupling capacitors at the AE port, etc. Check that the following conditions are met:

- **Each AE and EUT shall be installed in a typical, functional way**

- **The injected current shall be monitored to ensure never exceeding I (max) which equals V(emf)/150 ohms.**

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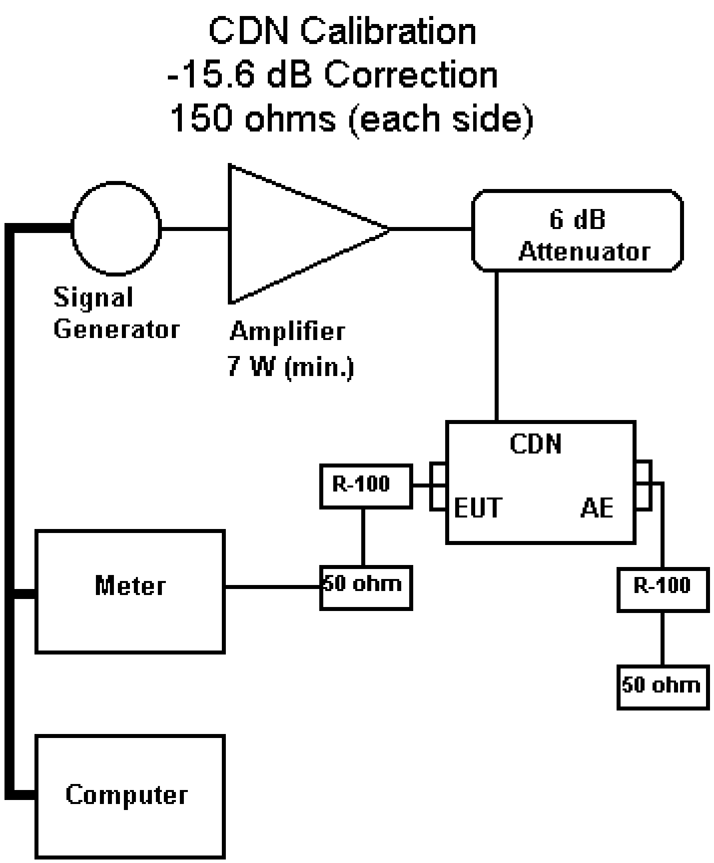
Conducted R.F. Voltages



Test Level: **Meter Reading:**

1 volt (emf)
(120dBuV) - (15.6dB) - (107dB) = -2.6dBm

3 volt (emf)
(130dBuV) - (15.6dB) - (107dB) = 7.4dBm

10 volt (emf)
(140dBuV) - (15.6dB) - (107dB) = 17.4dBm

The frequency is incremented in 1% steps, and the drive level out of the Signal Generator (dBm) is adjusted to give the Power Meter readings shown above. This becomes the "drive table" played back by the Computer during the test run.

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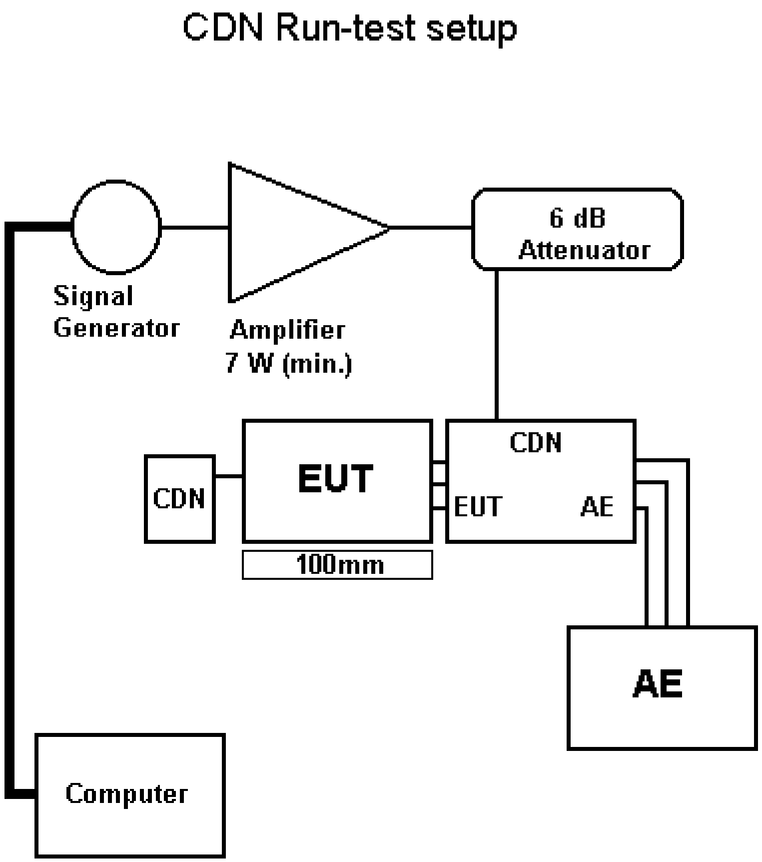
Conducted R.F. Voltages



After completion of the "drive table," disconnect the Calibration Adapters from the CDN, and connect it into the test setup as shown. Notice that the EUT is elevated 100mm above the ground plane, and all EUT ports are to be fitted with terminated CDN's. The "drive table" is played back by the Computer with 80% AM modulation, and the EUT is monitored for failures.

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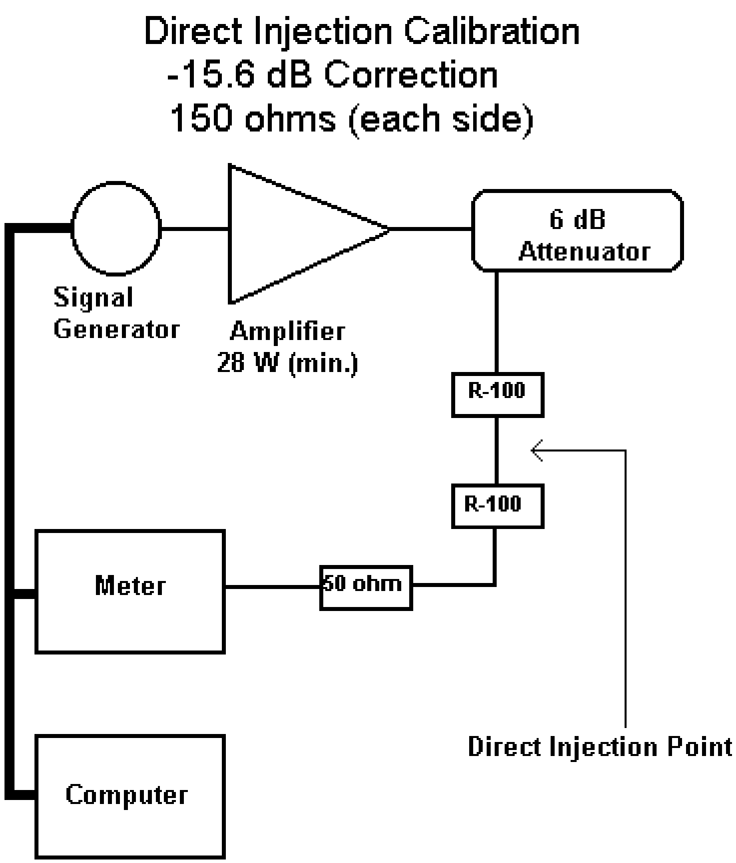
Conducted R.F. Voltages



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(120dBuV) - (15.6dB) - (107dB) = -2.6dBm

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10 volt (emf)
(140dBuV) - (15.6dB) - (107dB) = 17.4dBm

The frequency is incremented in 1% steps, and the drive level out of the Signal Generator (dBm) is adjusted to give the Power Meter readings shown above. This becomes the "drive table" played back by the Computer during the test run.

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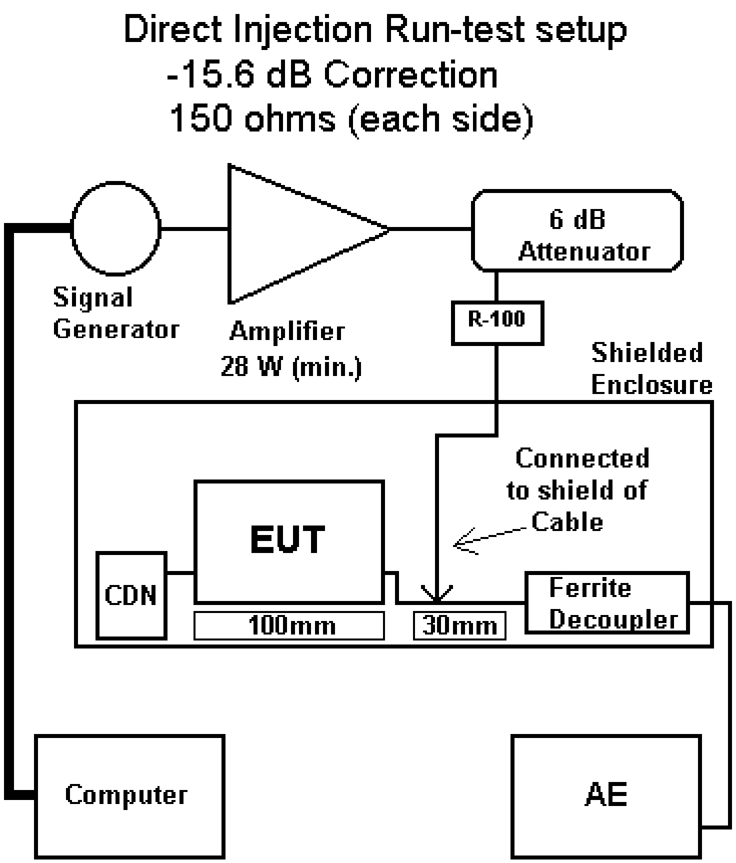
Conducted R.F. Voltages



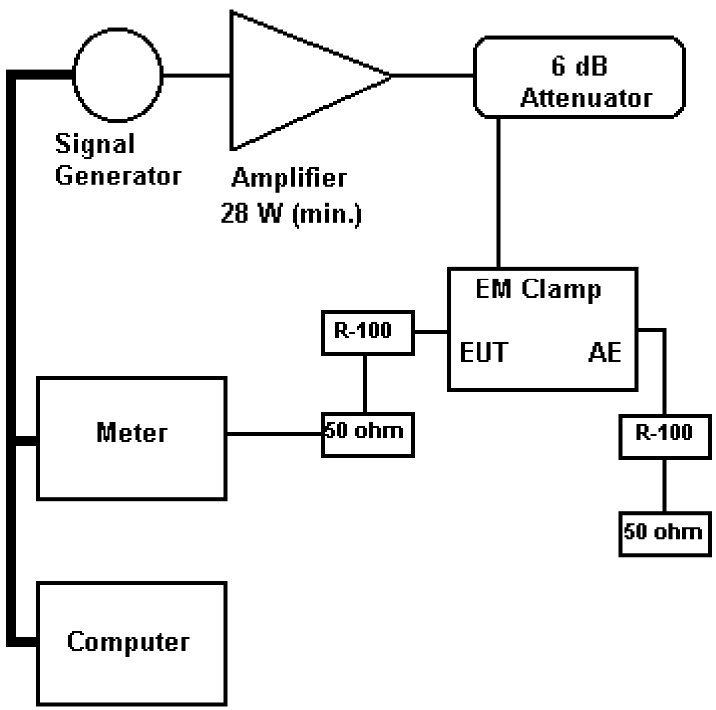
NOTE: In many cases, an "S" Series CDN may be used for Direct Injection. If these are not appropriate, the R-100 and Ferrite Decoupler may be used as shown.

After completion of the "drive table," disconnect the Calibration Adapters from the “S” series CDN or R-100, and connect it into the test setup as shown. Notice that the EUT is elevated 100mm above the ground plane, and all EUT ports are to be fitted with terminated CDN's. The "drive table" is played back by the Computer with 80% AM modulation, and the EUT is monitored for failures.

EN 61000-4-6

Conducted R.F. Voltages

EM Clamp Calibration
-15.6 dB correction
150 ohms (each side)



Test Level: **Meter Reading:**

1 volt (emf)
(120dBuV) - (15.6dB) - (107dB) = -2.6dBm

3 volt (emf)
(130dBuV) - (15.6dB) - (107dB) = 7.4dBm

10 volt (emf)
(140dBuV) - (15.6dB) - (107dB) = 17.4dBm

The frequency is incremented in 1% steps, and the drive level out of the Signal Generator (dBm) is adjusted to give the Power Meter readings shown above. This becomes the "drive table" played back by the Computer during the test run.

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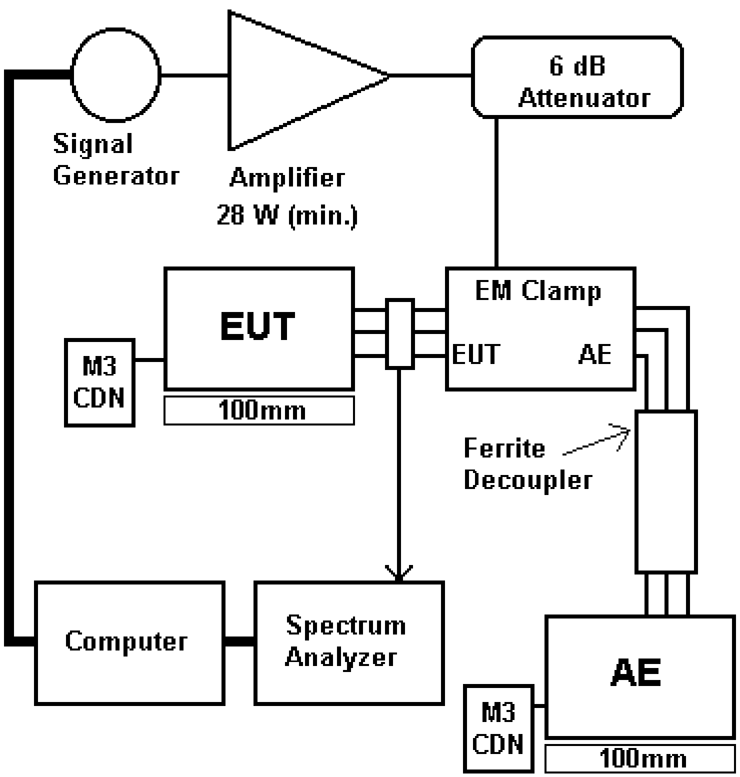
Conducted R.F. Voltages

EM Clamp run-test setup



After completion of the "drive table," disconnect the Calibration Adapters from the EM Clamp, and connect it into the test setup as shown. Notice that the EUT is elevated 100mm above the ground plane, and all EUT ports are to be fitted with terminated CDN's. The "drive table" is played back by the Computer with 80% AM modulation, and the EUT is monitored for failures. During the test, the injected current is monitored with a monitor current probe and Spectrum Analyzer to ensure that I (max) is never exceeded.

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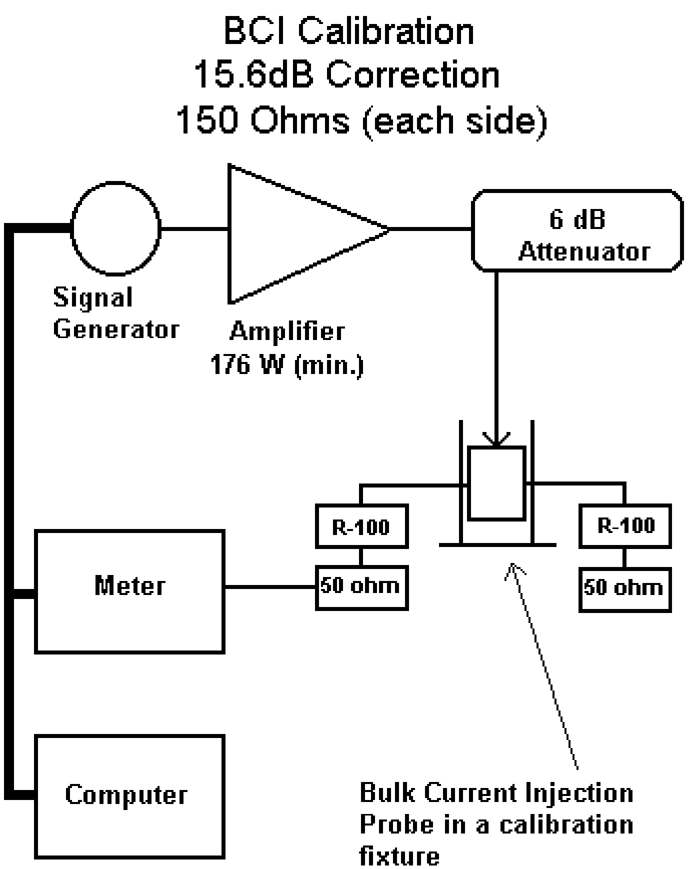
Conducted R.F. Voltages



Test Level: **Meter Reading:**

1 volt (emf)
(120dBuV) - (15.6dB) - (107dB) = -2.6dBm

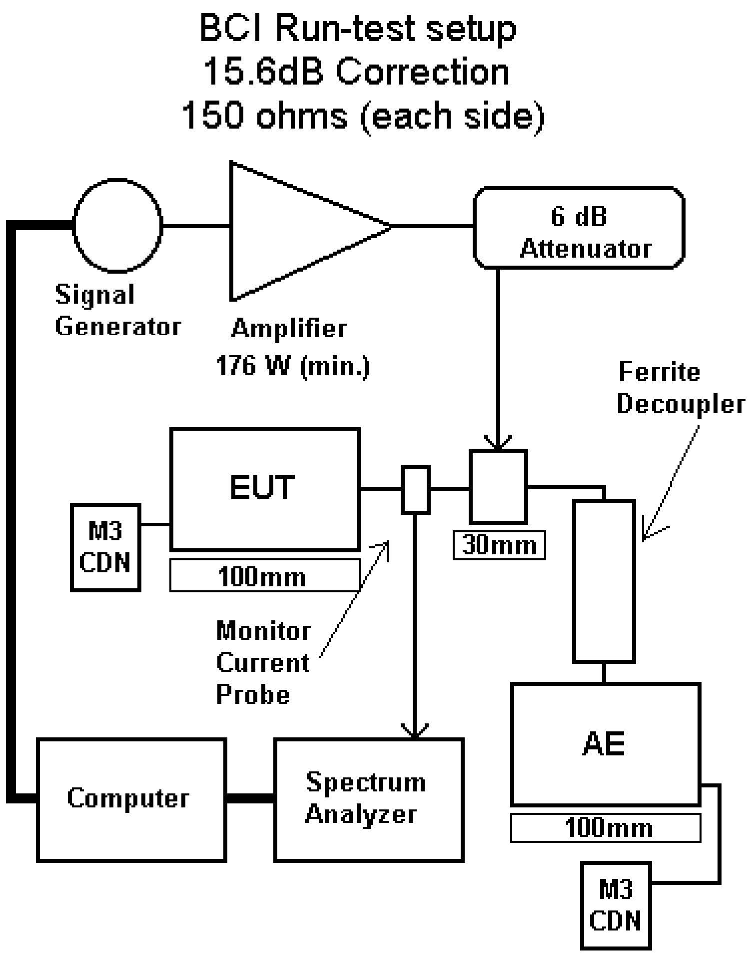
3 volt (emf)
(130dBuV) - (15.6dB) - (107dB) = 7.4dBm

10 volt (emf)
(140dBuV) - (15.6dB) - (107dB) = 17.4dBm

The frequency is incremented in 1% steps, and the drive level out of the Signal Generator (dBm) is adjusted to give the Power Meter readings shown above. This becomes the "drive table" played back by the Computer during the test run.

EN 61000-4-6

Conducted R.F. Voltages



After completion of the "drive table," disconnect the Calibration Adapters from the BCI probe, and connect it into the test setup as shown. Notice that the EUT & AE are elevated 100mm above the ground plane, and all EUT ports are to be fitted with terminated CDN's. The "drive table" is played back by the Computer with 80% AM modulation, and the EUT is monitored for failures. During the test, the injected current is monitored with a monitor current probe and Spectrum Analyzer to ensure that I (max) is never exceeded.

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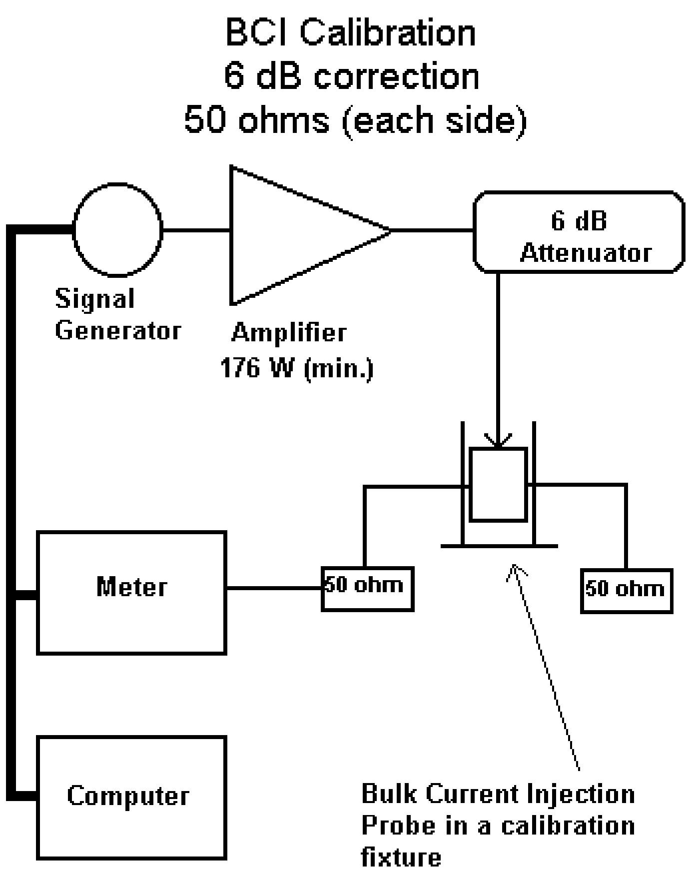
Conducted R.F. Voltages



Test Level: **Meter Reading:**

1 volt (emf)
(120dBuV) - (6 dB) - (107dB) = +7.0dBm

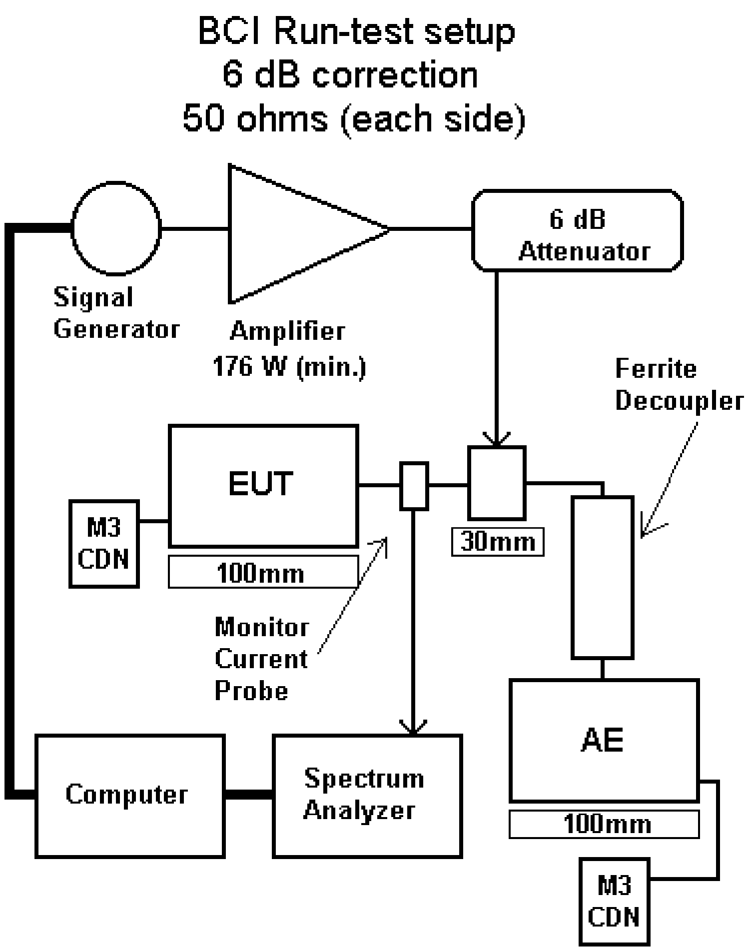
3 volt (emf)
(130dBuV) - (6 dB) - (107dB) = +17.0dBm

10 volt (emf)
(140dBuV) - (6 dB) - (107dB) = +27.0dBm

The frequency is incremented in 1% steps, and the drive level out of the Signal Generator (dBm) is adjusted to give the Power Meter readings shown above. This becomes the "drive table" played back by the Computer during the test run.

EN 61000-4-6

Conducted R.F. Voltages



After completion of the "drive table," disconnect the Calibration Adapters from the BCI probe, and connect it into the test setup as shown. Notice that the EUT & AE are elevated 100mm above the ground plane, and all EUT ports are to be fitted with terminated CDN's. The "drive table" is played back by the Computer with 80% AM modulation, and the EUT is monitored for failures. During the test, the injected current is monitored with a monitor current probe and Spectrum Analyzer to ensure that I (max) is never exceeded.

EN 61000-4-8

50Hz Magnetic Fields

This Standard is intended to demonstrate the immunity of equipment subjected to power frequency magnetic fields related to its specific location and installation conditions. These fields are generated by currents flowing in nearby conductors or transformers near the equipment.

The Standard differentiates between:

- **Current under normal operating conditions, producing steady magnetic fields with relatively small amplitudes;**
- **Current under fault conditions, which can produce relatively high magnetic fields of short duration, until the protection devices operate**

Steady magnetic fields apply to all types of equipment.

Short-duration magnetic fields are related to fault conditions, with the highest values applying to equipment installed in electrical plants.

EN 61000-4-8

50Hz Magnetic Fields

Test levels for continuous field

Level	Magnetic field strength A/m
1	1
2	3
3	10
4	30
5	100
x[1)]	special

Test levels for short duration: 1 to 3 s.

Level	Magnetic field strength A/m
1	n.a. [2)]
2	n.a. [2)]
3	n.a. [2)]
4	300
5	1000
x[1)]	special

NOTES

1 - "x" is an open level. This level, as well the duration of the test for short duration field, can be given in the product specification.

2 - "n.a." = not applicable

Severity Levels: 10 dB steps (1A/m=1.26uT)

EN 61000-4-8

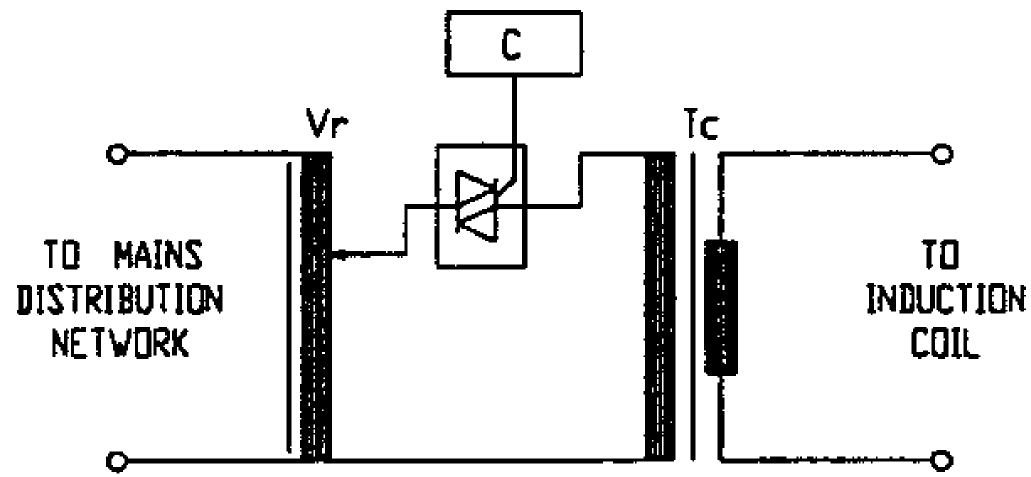
50Hz Magnetic Fields

Selection of the test levels

Class 1:	**Sensitive electron-beam devices are used, like monitors or electron microscopes**
Class 2:	**Well-protected environment like households, offices, or hospital protected areas**
Class 3:	**Protected environment like commercial, light industrial or control buildings**
Class 4:	**Typical industrial environment or power control room**
Class 5:	**Severe industrial environment or switchyard areas**
Class x:	**Special environment, higher or lower than those above**

EN 61000-4-8

50Hz Magnetic Fields



Vr: Voltage regulator

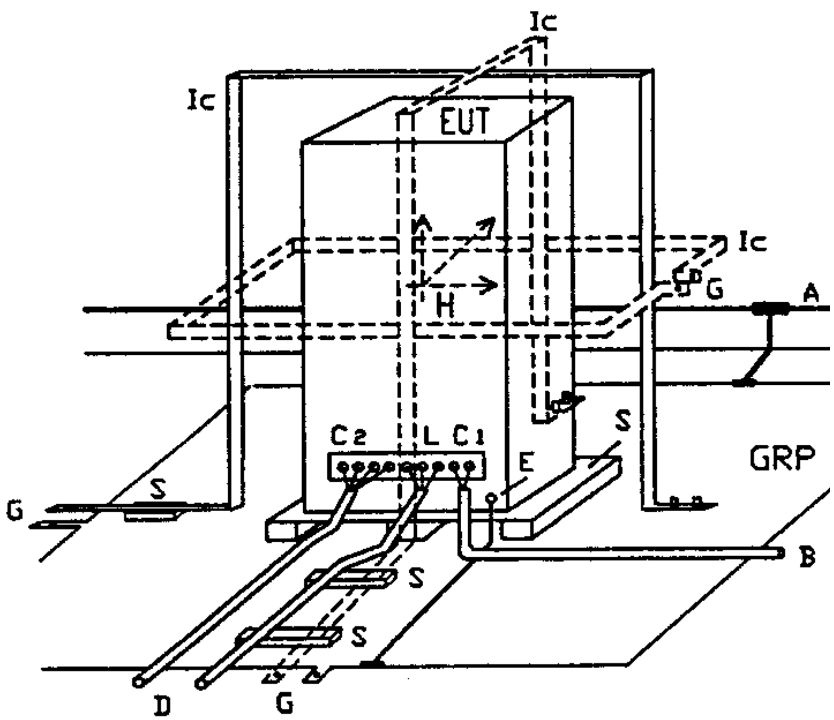
C: Control circuit

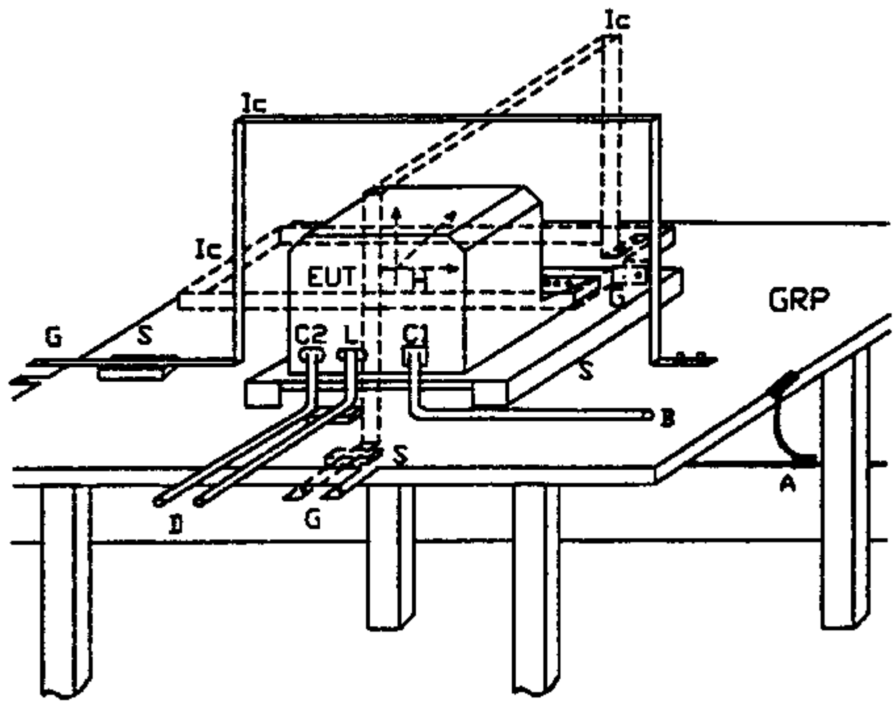
Tc: Current transformer

Schematic circuit of the test generator for power frequency magnetic field.

EN 61000-4-8

50Hz Magnetic Fields





Test set-ups for floor-standing and table-top equipment

EN 61000-4-8

50Hz Magnetic Fields

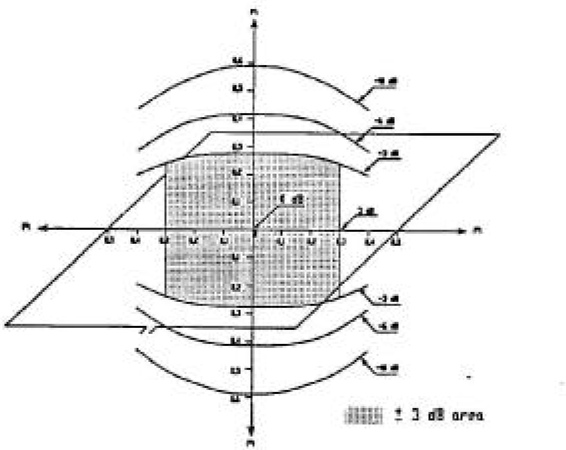


Figure B.3 - 3 dB area of the field generated by a square induction coil (1 m side) in the mean orthogonal plane (component orthogonal to the plane of the coil).

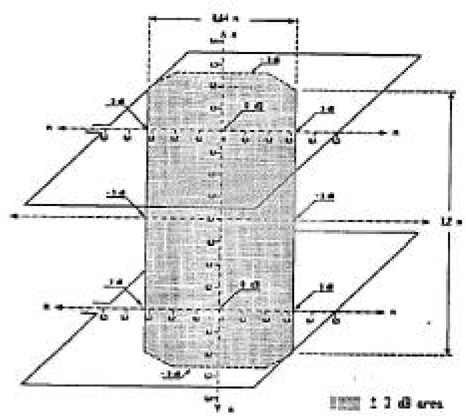


Figure B.5 - 3 dB area of the field generated by two square induction coils (1 m side) 0,8 m spaced, in the mean orthogonal plane (component orthogonal to the plane of the coils).

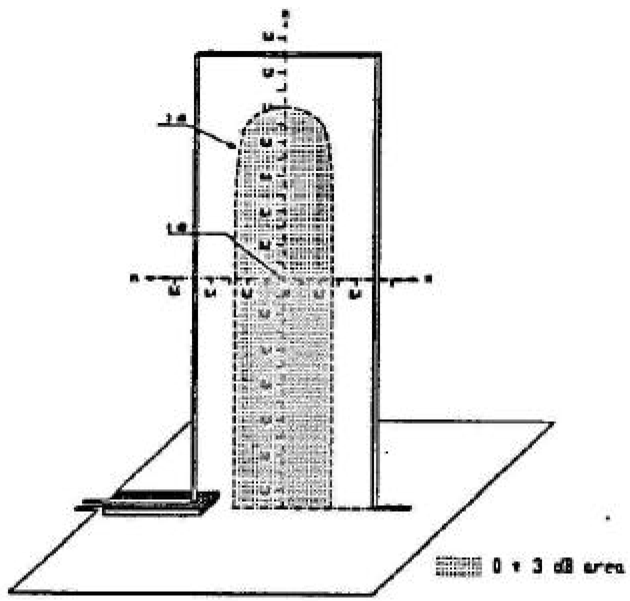
Field Uniformity (3dB) for single & double induction coils

NOTE:

A uniform field <u>cannot be generated</u> over a GRP when the coil is within 50cm of GRP.

EN 61000-4-8

50Hz Magnetic Fields



FRONT

Figure B.7 - 3 dB area of the field generated by a rectangular induction coil (1 m x 2,6 m) in its plane (ground plane as a side of the induction coil).

Field Uniformity (3dB) for single induction coil with GRP return

EN 61000-4-8

50Hz Magnetic Fields

Magnetic field calibration:

The voltage delivered from the AC Power Source (and hence the current in the induction coil) is adjusted to calibrate the magnetic field in the center of the coil.

A narrow-band instrument with a small multi-turn loop or "Hall Effect" sensor is employed to calibrate the "induction factor" of the coil. (H/A or Field Strength / Current) The AC Power Source can be programmed to deliver the corresponding voltages for Continuos and Short-term tests.

Standard induction coils:

- **Single square (1M x 1M) - test volume (EUT) = 0.6 x 0.6 x 0.5H**
- **Double square, 0.6M separation - test volume = 0.6 x 0.6 x 1H**
- **Double square, 0.8M separation - test volume = 0.6 x 0.6 x 1.2H**
- **Single rectangular (1M x 2.6M) - test volume = 0.6 x 0.6 x 2H**

EN 61000-4-11

Voltage dips, interrupts & variations

Scope:

This Standard defines the immunity test methods and levels for electrical & electronic equipment connected to the low-voltage mains for voltage dips, short interruptions, and voltage variations. It applies to all electrical & electronic equipment with rated input currents of 16 AMPS per phase, single or three-phase. (excludes DC or 400Hz networks)

Voltage dips and interruptions are caused by faults in the network or installation, or by sudden, large changes in load. These phenomena are random and not always abrupt.

Voltage dips simulate the effects of sudden voltage change. Rotating machines can act as generators when spinning down and prevent rapid voltage changes in some installations, hence the voltage variation tests use gradual changes in voltage.

EN 61000-4-11

Voltage dips, interrupts & variations

Preferred test levels and durations for voltage dips and short interruptions

Test level % U_T	Voltage Dip/int % U_T	Duration (in period)
0	100	0,5* 1 5 10 25 50 x
40	60	
70	30	

* For 0,5 period, test shall be made in positive and negative polarity, i.e. starting at 0° and 180° respectively.

Notes:

1) One or more of the above test levels and durations may be chosen.

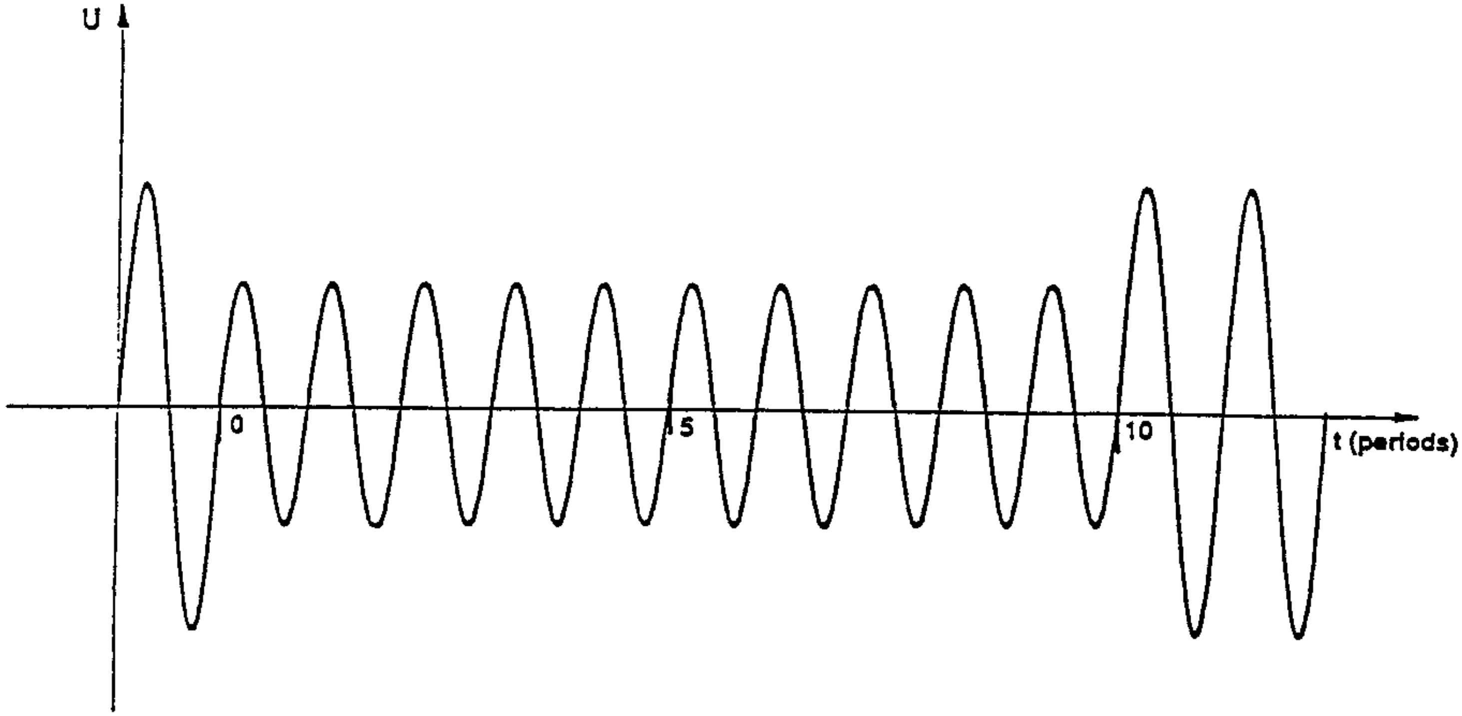
2) If the EUT is tested for voltage dips of 100 %, it is generally unnecessary to test for other levels for the same durations. However, for some cases (safeguard systems or electromechanical devices) it is not true. The product specification or product committee shall give an indication of the applicability of this note.

3) 'x' is an open duration. This duration can be given in the product specification. Utilities in Europe have measured dips and short interruptions of duration between 1/2 a period and 3000 periods, but duration less than 50 periods are most common.

4) Any duration may apply to any test level.

EN 61000-4-11

Voltage dips, interrupts & variations



Voltage dips test

Note: The voltage decrease to 70% for 10 periods. Step at zero crossing

EN 61000-4-11

Voltage dips, interrupts & variations

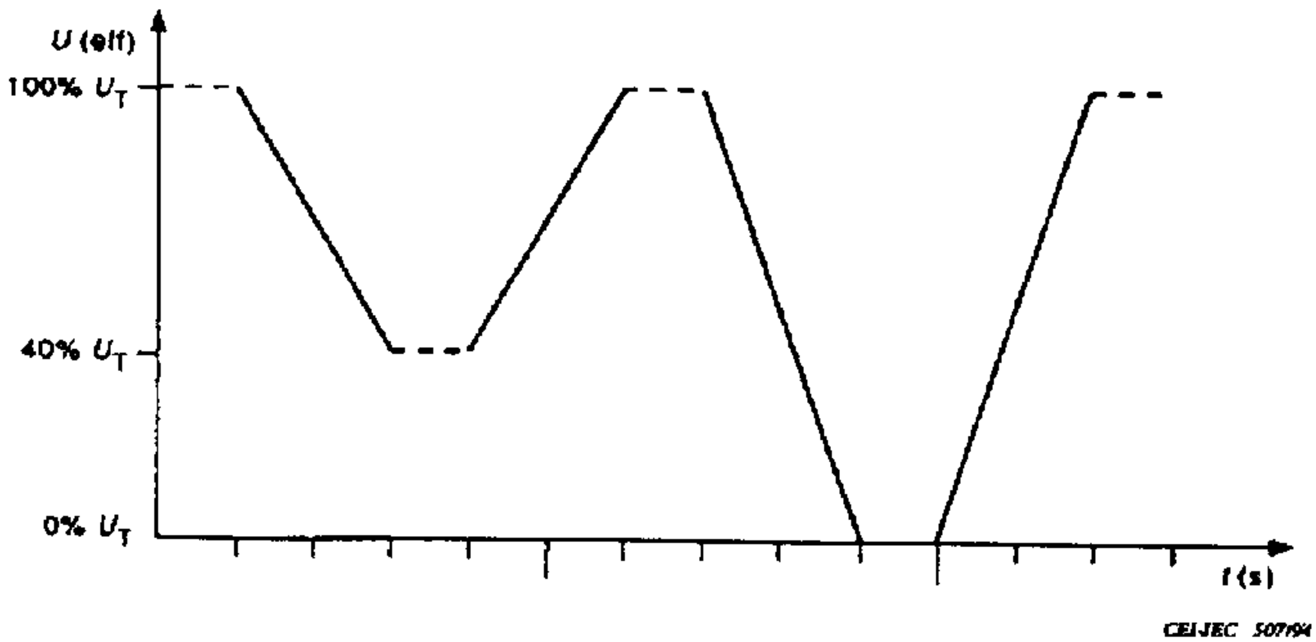
Timing of short term supply voltage variations

Voltage Test Level	Time for decreasing voltage	Time at reduced voltage	Time for increasing voltage
40 % U_T	2 s ± 20 %	1 s ± 20 %	2 s ± 20 %
0 % U_T	2 s ± 20 %	1 s ± 20 %	2 s ± 20 %
	x	x	x

Note: x represents an open set of durations and can be given in the product specification.

EN 61000-4-11

Voltage dips, interrupts & variations



NOTE – La tension d'essai diminue graduellement

NOTE – The voltage gradually decreases.

Figure 2 – Variation de tension
Voltage variation

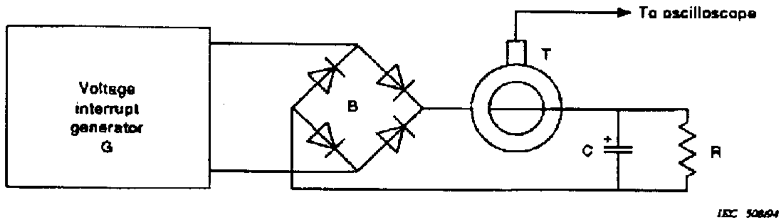
EN 61000-4-11

Voltage dips, interrupts & variations

Power source requirements:

The generator peak inrush capability is verified using a bridge rectifier, R-C load and current probe.

The maximum inrush of the EUT is also verified with the same current probe, and shall not exceed 70% of the measured inrush drive capability of the generator.



where

G is the voltage interrupt generator, switched on at 90 and 270°;
T is the current probe, with monitoring output to oscilloscope;
B is the rectifier bridge;
R is the bleeder resistor, not over 10 000 Ω or less than 100 Ω;
C is the 1 700 μF ±20 % electrolytic capacitor.

Figure A.1 – Circuit for determining the inrush current drive capability of the short interruptions generator

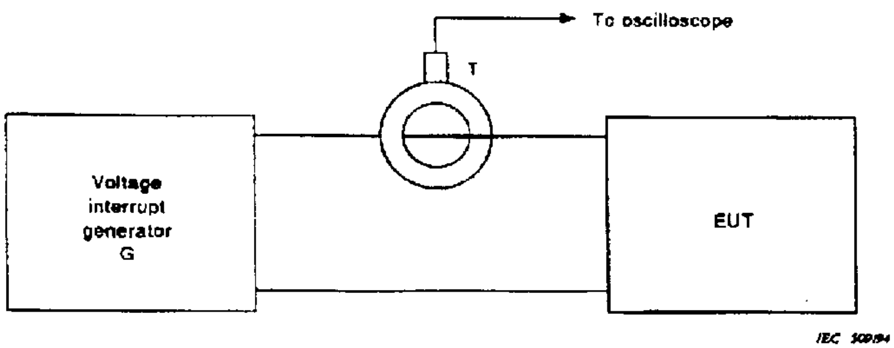


Figure A.2 – Circuit for determining the peak inrush current requirement of an EUT

EN 61000-4-11

Voltage dips, interrupts & variations

Output current capability of 16 A r.m.s. per phase at rated voltage. The generator should supply 23 A at 70% of rated voltage, and 40 A at 40% of rated voltage for a duration of up to 5 seconds.

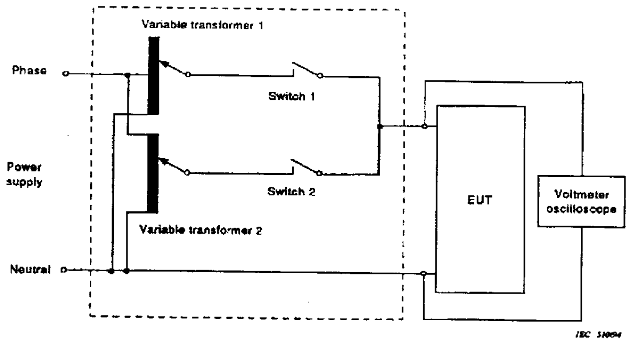


Figure C.1 a – Schematic of test instrumentation for voltage dips and short interruptions using variable transformers and switches

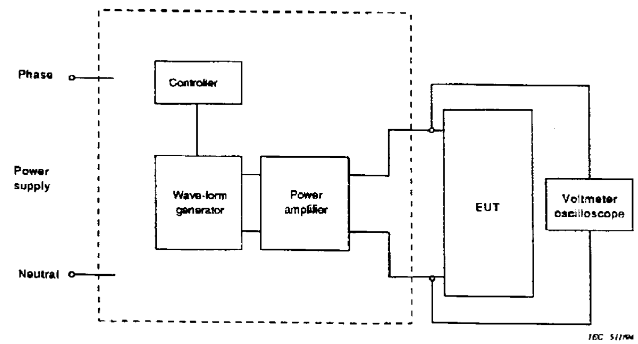


Figure C.1 b – Schematic of test instrumentation for voltage dips, short interruptions and variations using power amplifier

Voltage change at 100% output (0-16A) < 5%

Voltage change at 70% output (0-23A) < 7%

Voltage change at 40% output (0-40A) < 10%

Abrupt load change rise (fall) time with 100 ohm load: 1uS - 5uS

EN 61000-3-2

Harmonic Current Emissions

This Standard applies to electrical & electronic equipment drawing up to 16 Amps per phase from the public low-voltage distribution system.

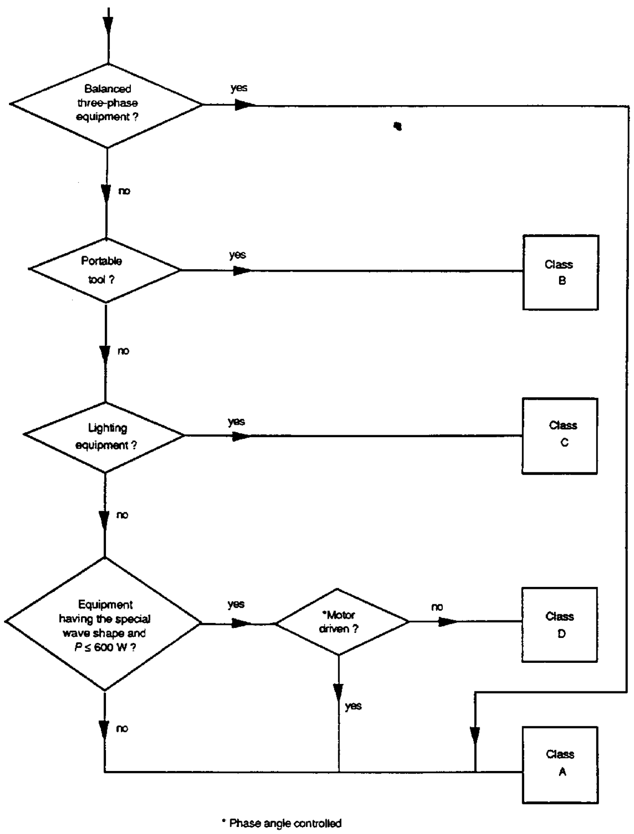


Figure 2 – Flow-chart for the classification of equipment

Classification of Equipment

Class A: Balanced 3-phase & all other equipment not classified below

Class B: Portable tools

Class C: Lighting equipment & dimmers

Class D: "Special wave shape" equipment

EN 61000-3-2

Harmonic Current Emissions

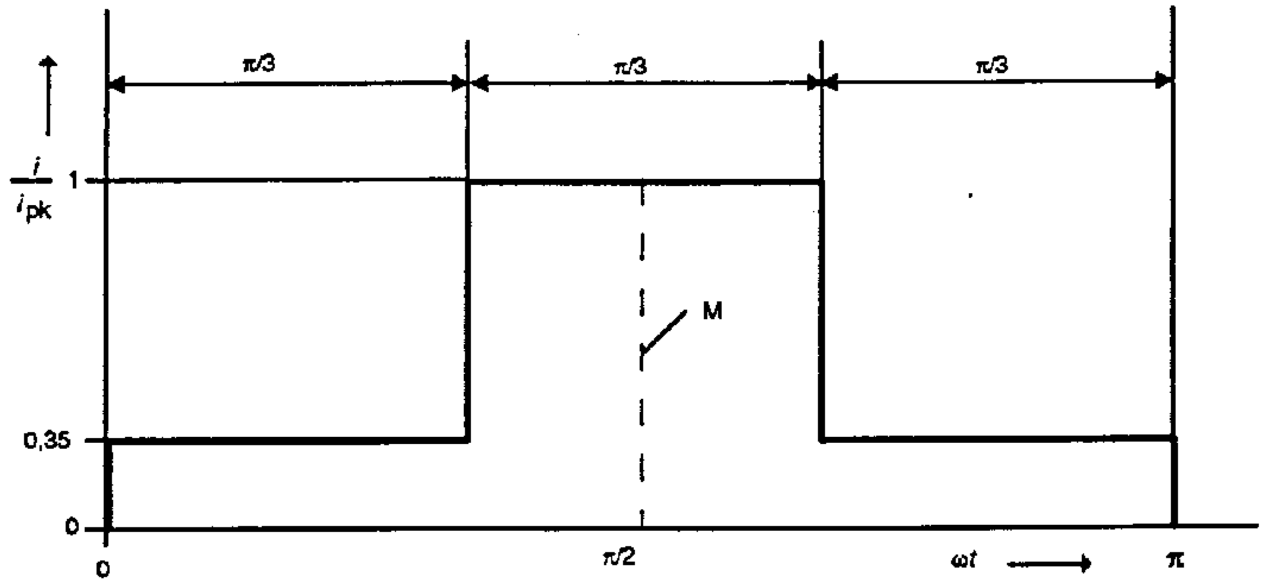


Figure 1 – Envelope of the input current to define the "special wave shape" and to classify equipment as Class D

Whatever their wave shape, Class B(tools), Class C(lighting) or motor-driven equipment with phase angle control are not considered Class D equipment.

EN 61000-3-2

Harmonic Current Emissions

Table 1 - Limits for Class A equipment

Harmonic order n	Maximum permissible harmonic current A
Odd harmonics	
3	2,30
5	1,14
7	0,77
9	0,40
11	0,33
13	0,21
$15 \leq n \leq 39$	$0{,}15 \frac{15}{n}$
Even harmonics	
2	1,08
4	0,43
6	0,30
$8 \leq n \leq 40$	$0{,}23 \frac{8}{n}$

Class B limits: multiply values above by 1.5 for harmonic current limits

EN 61000-3-2

Harmonic Current Emissions

Table 2 – Limits for Class C equipment

Harmonic order n	Maximum permissible harmonic currrent expressed as a percentage of the input current at the fundamental frequency %
2	2
3	$30 \cdot \lambda$ *
5	10
7	7
9	5
$11 \le n \le 39$ (odd harmonics only)	3
* λ is the circuit power factor	

Table 3 – Limits for Class D equipment

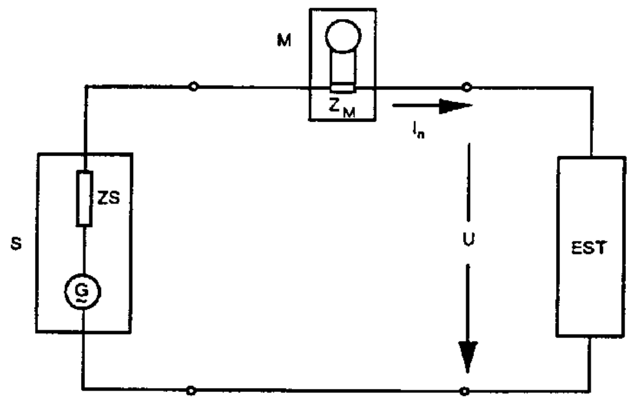
Harmonic order n	Maximum permissible harmonic current per watt mA/W	Maximum permissible harmonic current A
3	3,4	2,30
5	1,9	1,14
7	1,0	0,77
9	0,5	0,40
11	0,35	0,33
$13 \le n \le 39$ (odd harmonics only)	$\frac{3,85}{n}$	See table 1

Class C limits for lighting equipment

Class D limits for "Special wave shape"

EN 61000-3-2

Harmonic Current Emissions



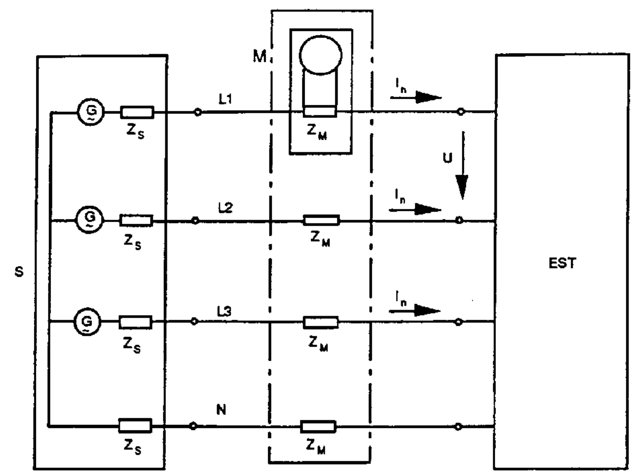
S power supply source
M measurement equipment
EUT equipment under test
U test voltage
Z_M input impedance of measurement equipment
Z_S internal impedance of the supply source
I_n harmonic component of order n of the line current
G open-loop voltage of the supply source

NOTES

1 Z_S and Z_M are not specified, but have to be sufficiently low to suit the test requirements. For the value of Z_M, see annex B.2 b).

2 In some special cases, particular care may be necessary to avoid resonance between the internal inductance of the source and the capacitances of the equipment under test.

Figure A.1 – Measurement circuit for single-phase equipment



S power supply source
M measurement equipment
EUT equipment under test
G open-loop voltage of the supply source
Z_M input impedance of the measurement equipment
Z_S internal impedance of the supply source
I_n harmonic component of order of the line current
U test voltage (shown as an example between phases L1 and L2)

NOTES

1 Z_M and Z_S are not specified, but have to be sufficiently low to suit the test requirements. For the value of Z_M, see annex B.2b).

2 In some special cases, particular care may be necessary to avoid resonance between the internal inductance of the source and the capacitances of the equipment under test.

Figure A.2 – Measurement circuit for three-phase equipment

EN 61000-3-2

Harmonic Current Emissions

General Test Conditions:

For equipment not covered, set controls for maximum harmonic currents.

Specific Test Conditions:

If possible, use the Test Conditions below for:

TV Receivers	Audio Amplifiers	Video Cassette Recorder
Lamps	Luminaires	Ballasts & converters
Lamp Dimmers	Vacuum cleaners	Washers & Dryers
Microwave ovens	Computers	Induction heaters

EN 61000-3-3

Voltage Fluctuations & Flicker Emissions

This Standard applies to electrical & electronic equipment drawing up to 16 Amps per phase from the public low-voltage distribution system. (220 - 250 VAC - 50Hz L-N)

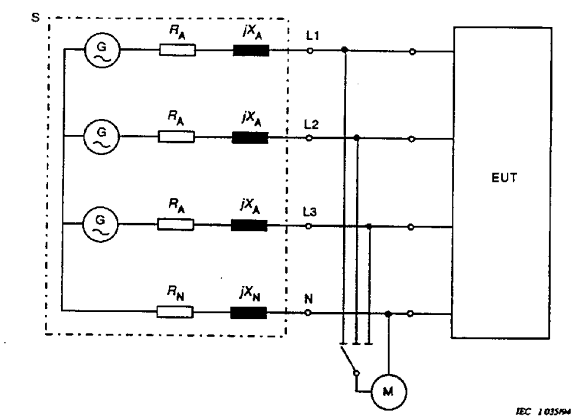
Short-term Flicker Pst is the flicker severity evaluated over a short period (about ten minutes); where Pst = 1 is the conventional threshold of irritability.

Long-term Flicker Plt is the flicker severity evaluated over a long period (about two hours); using successive Pst values.

EN 61000-3-3

Voltage Fluctuations & Flicker Emissions

1000-3-3 © IEC:1994 – 27 –



EUT equipment under test

M measuring equipment

S supply source consisting of the supply voltage generator G and reference impedance Z with the elements:

R_A = 0,24 Ω; jX_A = 0,15 Ω at 50 Hz;

R_N = 0,16 Ω; jX_N = 0,10 Ω at 50 Hz.

The elements include the actual generator impedance.

When the source impedance is not well defined, see 6.2.

G voltage source in accordance with 6.3.

NOTE – In general, three-phase loads are balanced, and R_N and X_N can be neglected, as there is no current in the neutral wire.

Figure 1 – Reference network for single-phase and three-phase supplies derived from a three-phase, four-wire supply

Power Source Requirement:

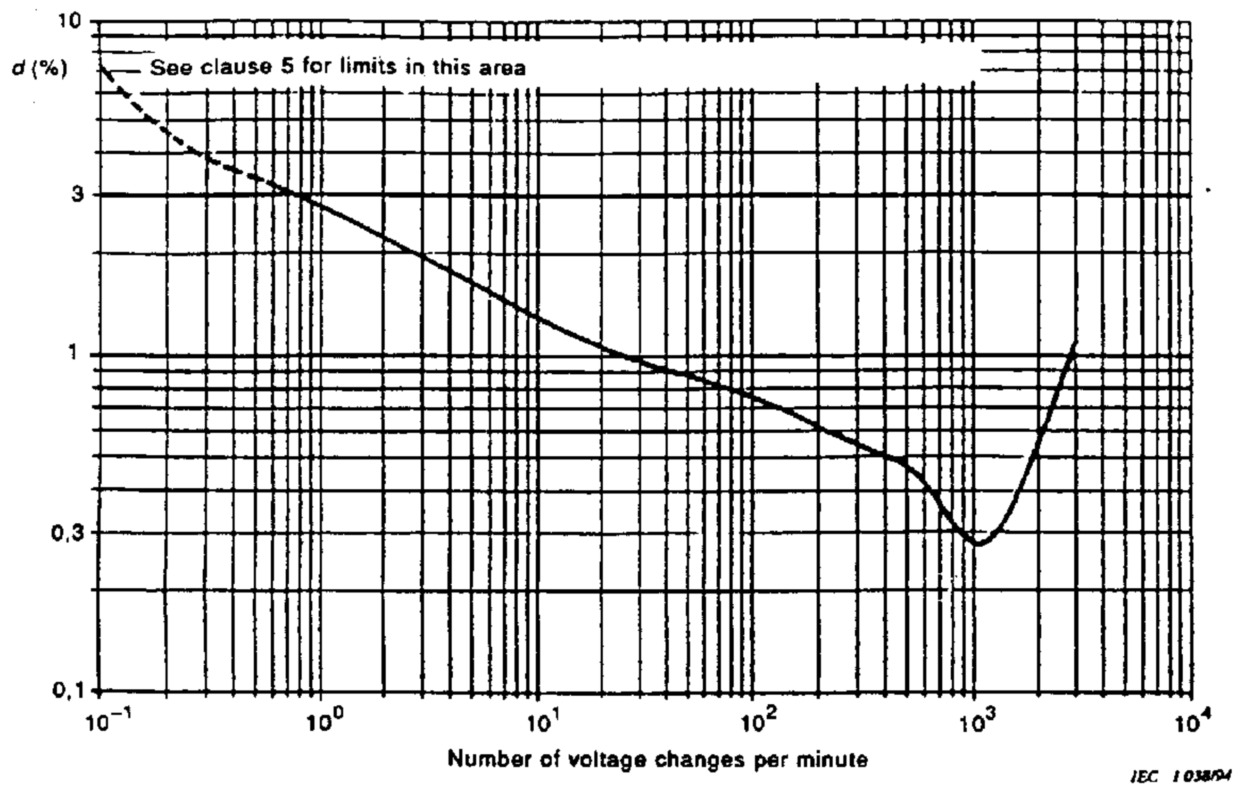
Z_A= 0.24 +j 0.15 ohms @ 50 Hz

Z_N= 0.16 +j 0.10 ohms @ 50 Hz

(actual R-L network to IEC 725)

EN 61000-3-3

Voltage Fluctuations & Flicker Emissions



NOTE – 1 200 voltage changes per minute give 10 Hz flicker.

Figure 4 – Curve for P_{st}=1 for rectangular equidistant voltage changes

EN 61000-3-3

Voltage Fluctuations & Flicker Emissions

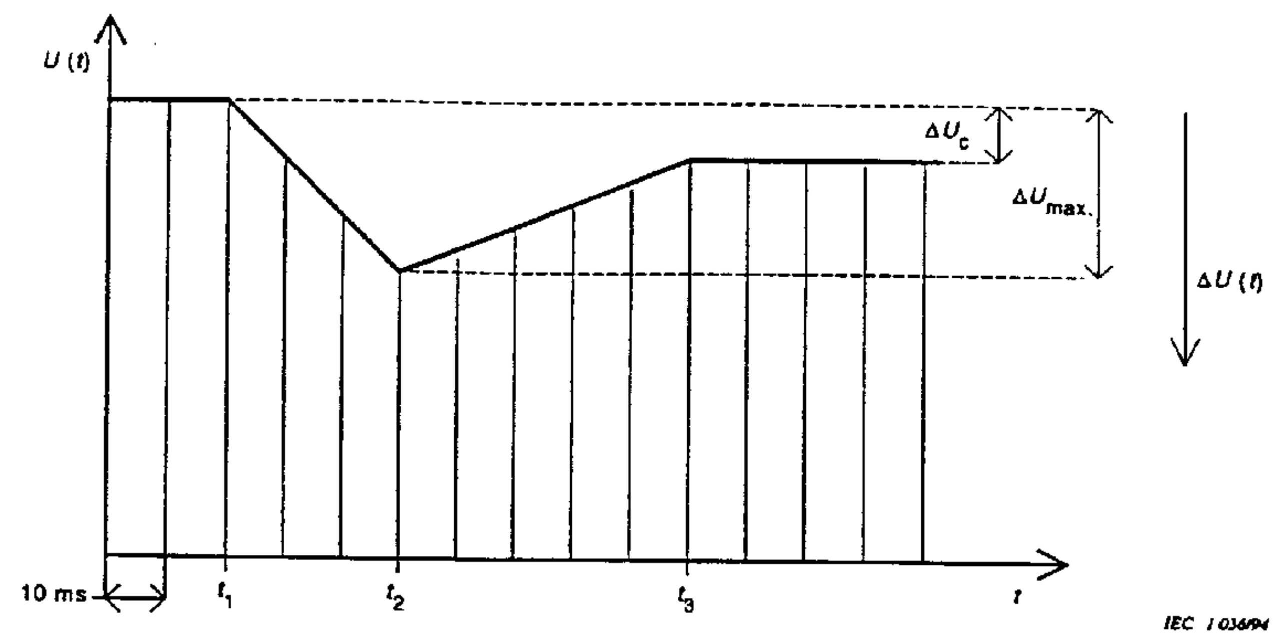


Figure 2 – Histogram evaluation of $U(t)$

EN 61000-3-3

Voltage Fluctuations & Flicker Emissions

Specific Test Conditions:

If possible, use the specific Test Conditions below for:

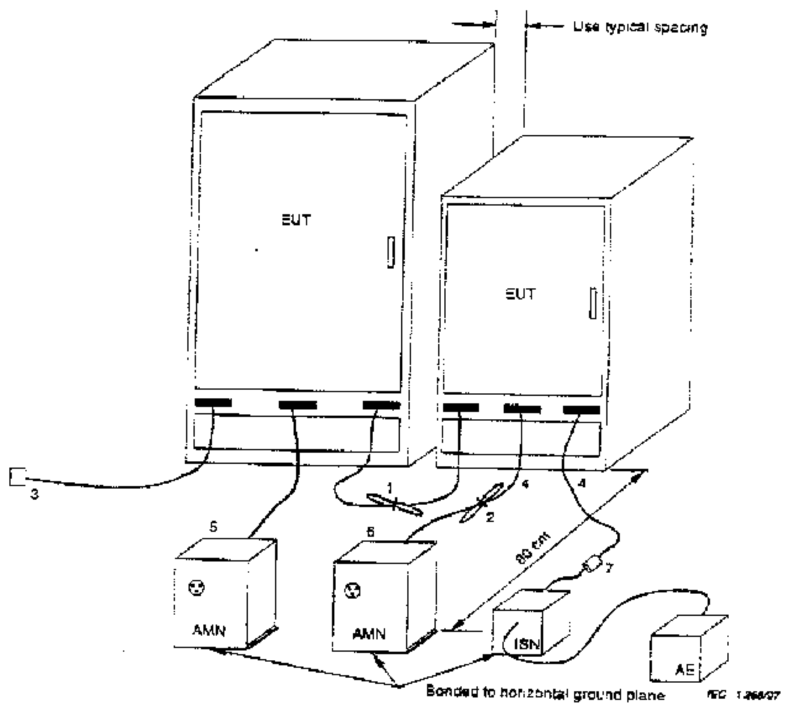
Cookers	Hot Plates	Baking Ovens
Grills	Combinations	Microwave Ovens
Lighting Equipment	Washing machines	Tumbler Dryers
Refrigerators	Copiers, laser printers	Vacuum cleaners
Food mixers	Portable tools	Hairdryers
Consumer Electronics	Water heaters	

EN 55022

Computer & Telecoms Emissions

Changes in the new CISPR 22 (EN55022-1998):

CISPR 22 © IEC:1997 – 59 –



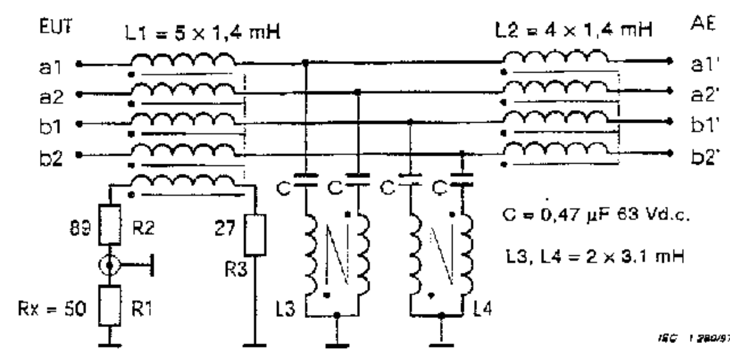
AMN = Artificial mains network
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

Testing to 1GHz independent of internal clock speeds

LISN's used on Power lines

ISN's are used on I/O lines

CISPR 22 © IEC:1997 – 99 –



AE = Associated equipment
EUT = Equipment under test

Figure D.2 – ISN with high longitudinal conversion loss for use with two unscreened single balanced pairs

EN 55022

Computer & Telecoms Emissions

ISN Specifications:

Common-mode Z = 150 ohms / 0 deg.

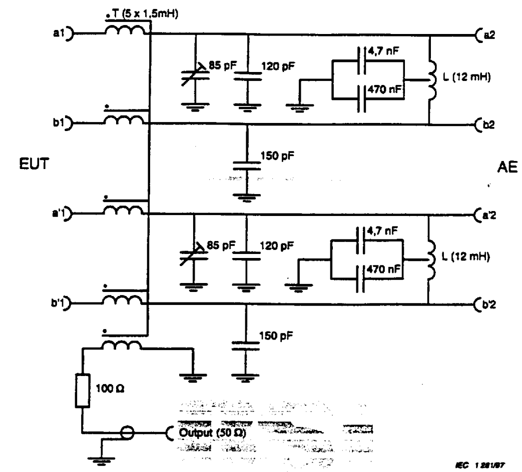
Common-mode isolation = 35-55dB

Longitudinal conversion loss = 80dB

CAT-3 cabling:	**50-25dB**
CAT-5 cabling:	**60-35dB**
other	**80-55dB**

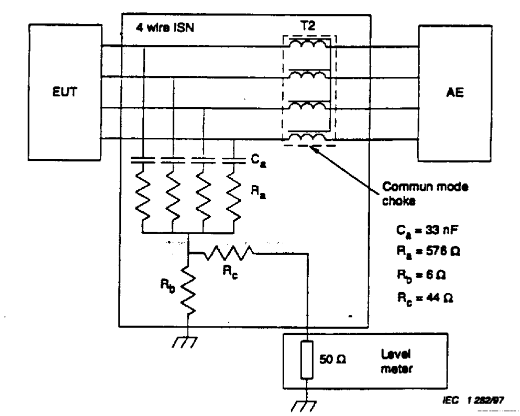
Isolation protects from peripheral noise

Conversion loss expresses ISN balance



AE = Associated equipment EUT = Equipment under test

Figure D.3 – ISN for use with two unscreened single balanced pairs



AE = Associated equipment EUT = Equipment under test

Figure D.4 – ISN for use with two unscreened single balanced pairs

EN 55022

Computer & Telecoms Emissions

COMPLIANCE • SYSTEMS • CORPORATION

Telecom port:

Any analog or digital lines connecting to the telecom network, including LAN ports.

Common mode emissions:

Limits on voltage or current are frequency-dependent

Class A:	**>5mV**	**>32uA**
Class B:	**>1.6mV**	**>10uA**

EN 55022

Computer & Telecoms Emissions

5.2 Limits of conducted common mode (asymmetric mode) disturbance at telecommunication ports 1)

Table 3 – Limits of conducted common mode (asymmetric mode) disturbance at telecommunication ports in the frequency range 0,15 MHz to 30 MHz for class A equipment

Frequency range MHz	Voltage limits dB (μV)		Current limits dB (μA)	
	Quasi-peak	Average	Quasi-peak	Average
0,15 to 0,5	97 to 87	84 to 74	53 to 43	40 to 30
0,5 to 30	87	74	43	30

NOTE 1 – The limits decrease linearly with the logarithm of the frequency in the range 0,15 MHz to 0,5 MHz.

NOTE 2 – The current and voltage disturbance limits are derived for use with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 150 Ω to the telecommunication port under test (conversion factor is $20 \log_{10} 150 / 1 = 44$ dB).

Class A common-mode emissions

Table 4 – Limits of conducted common mode (asymmetric mode) disturbance at telecommunication ports in the frequency range 0,15 MHz to 30 MHz for class B equipment

Frequency range MHz	Voltage limits dB (μV)		Current limits dB (μA)	
	Quasi-peak	Average	Quasi-peak	Average
0,15 to 0,5	84 to 74	74 to 64	40 to 30	30 to 20
0,5 to 30	74	64	30	20

NOTE 1 – The limits decrease linearly with the logarithm of the frequency in the range 0,15 MHz to 0,5 MHz.

NOTE 2 – The current and voltage disturbance limits are derived for use with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 150 Ω to the telecommunication port under test (conversion factor is $20 \log_{10} 150 / 1 = 44$ dB).

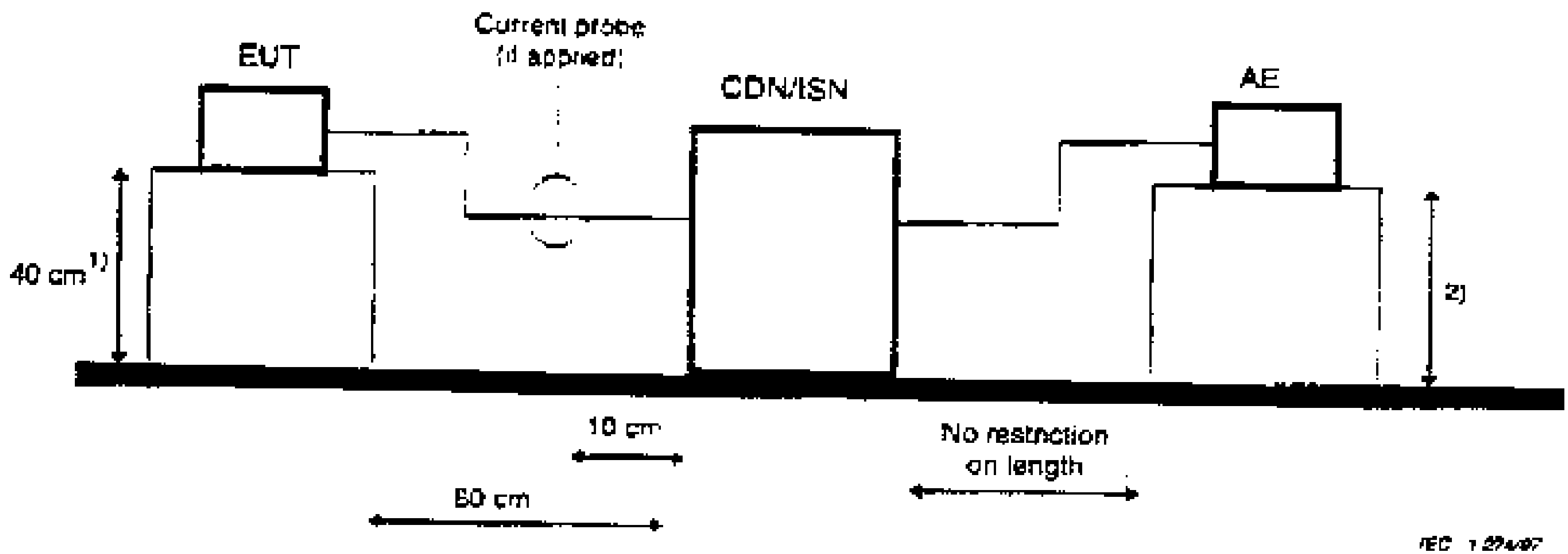
NOTE 3 - Provisionally, a relaxation of 10 dB over the frequency range of 6 Mhz to 30 Mhz is allowed for high-speed services having significant spectral density in this band. However, this relaxation is restricted to the common mode disturbance converted by the cable from the wanted signal. The provisional relaxation of 10 dB will be reviewed no later than three years after the date of withdrawal based on the results and interference cases seen in this period. Wherever possible it is recommended to comply with the limits without the provisional relaxation.

Class B common-mode emissions

EN 55022

Computer & Telecoms Emissions

CDN's from EN61000-4-6 used as ISN's:



AE = Associated equipment
EUT = Equipment under test

1) Distance to the reference groundplane (vertical or horizontal).

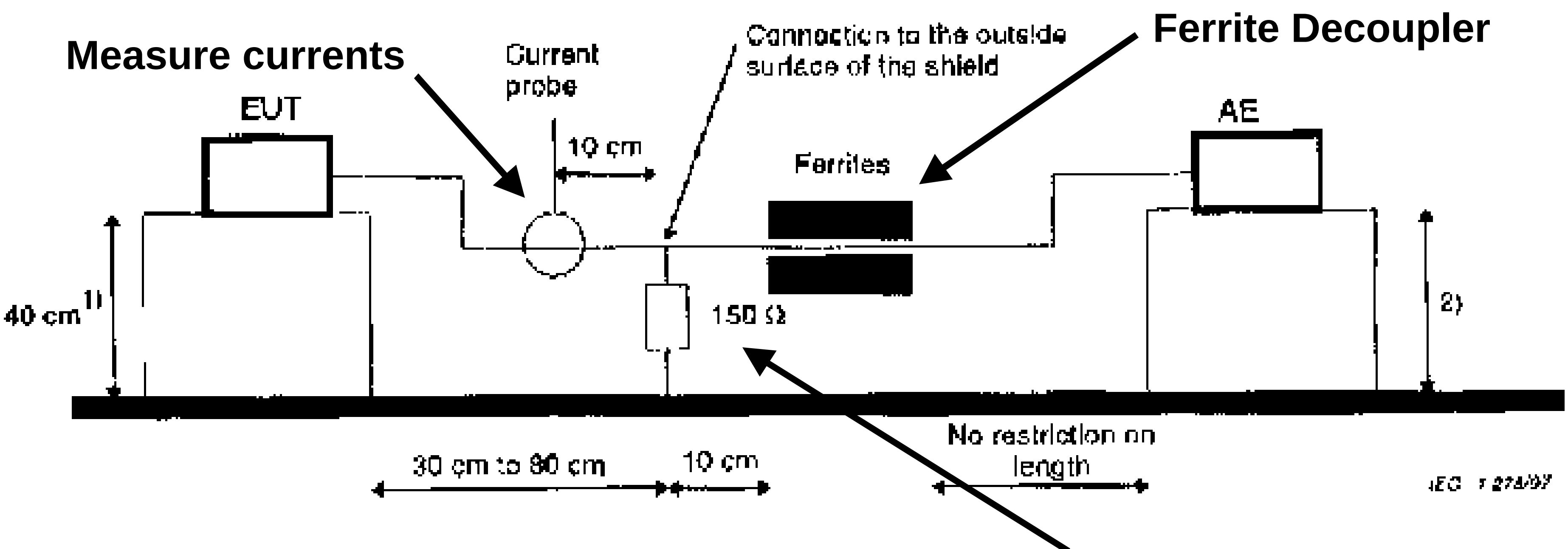
2) Distance to the reference groundplane is not critical.

Figure C.1

EN 55022

Computer & Telecoms Emissions

In-situ CDN / ISN Test setup: (coax)



AE = Associated equipment

EUT = Equipment under test

1) Distance to the reference groundplane (vertical or horizontal).

2) Distance to the reference groundplane is not critical.

Figure C.2

EN 55022

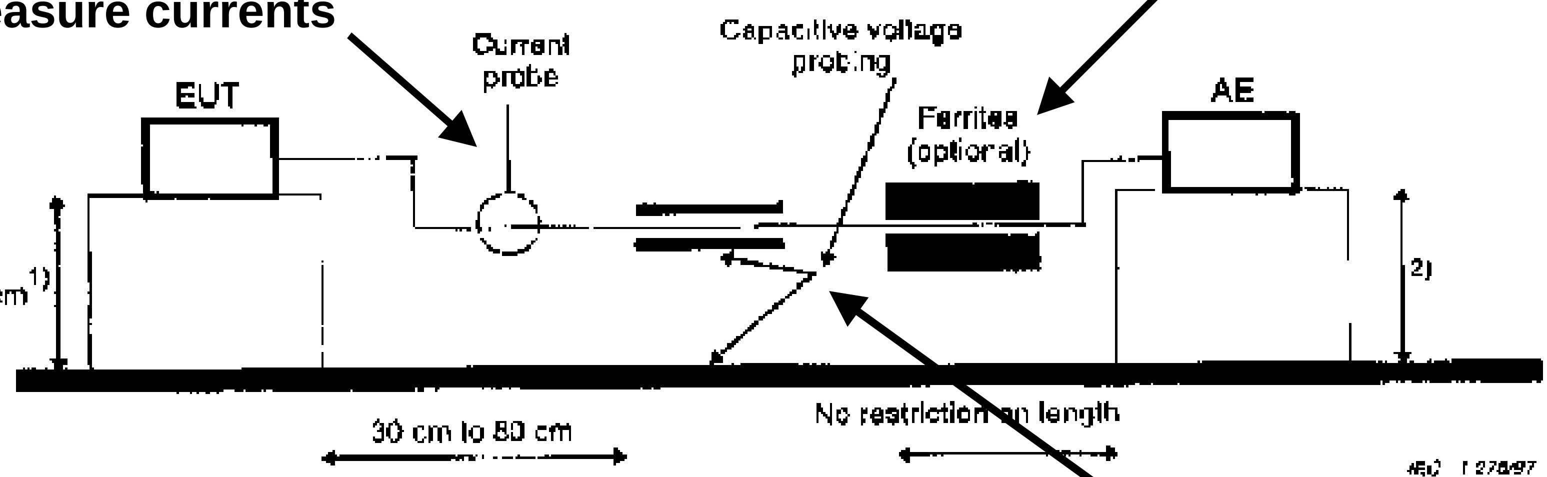
Computer & Telecoms Emissions

Combination current & voltage probe:

CISPR 22 © IEC:1997(E) – 47 –

Ferrite Decoupler

Measure currents



Measure voltage with 1M oscilloscope & capacitive probing fixture

AE = Associated equipment

EUT = Equipment under test

1) Distance to the reference groundplane (vertical or horizontal).

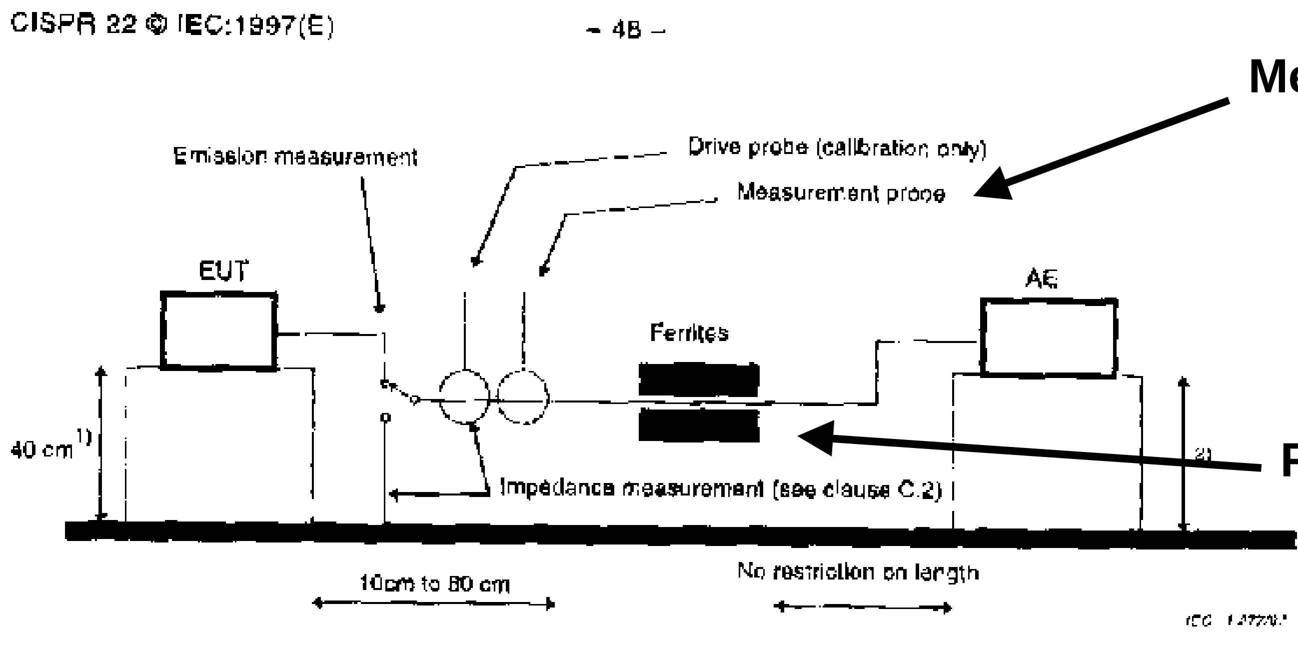
2) Distance to the reference groundplane is not critical.

Figure C.3

EN 55022

Computer & Telecoms Emissions

Measurement of common mode impedance:



1) Distance to the reference groundplane (vertical or horizontal).

2) Distance to the reference groundplane is not critical.

Figure C.4

C.2 Measurement of cable, ferrite and AE common mode impedance

Measure common mode impedance = 50(I_1/I_2)

(if I_2 is half I_1, Z=100)

EN 55022

Computer & Telecoms Emissions

Capacitive Voltage Probe in a fixture:

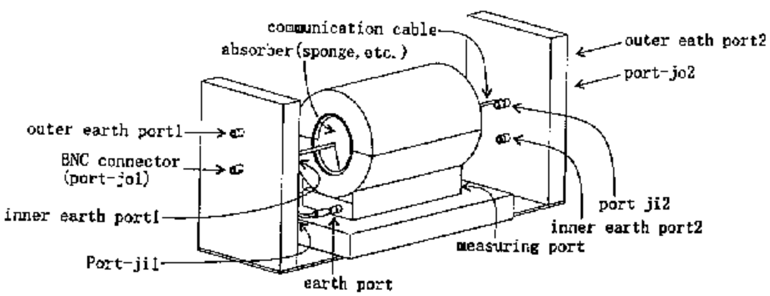


Fig. A.6 Setup for calibration 1

Measurement setup for telecoms:

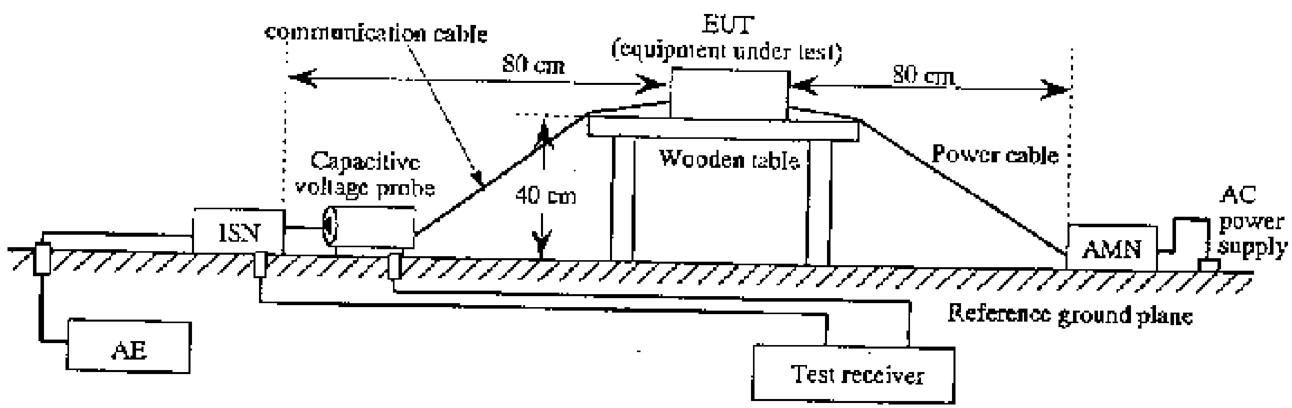
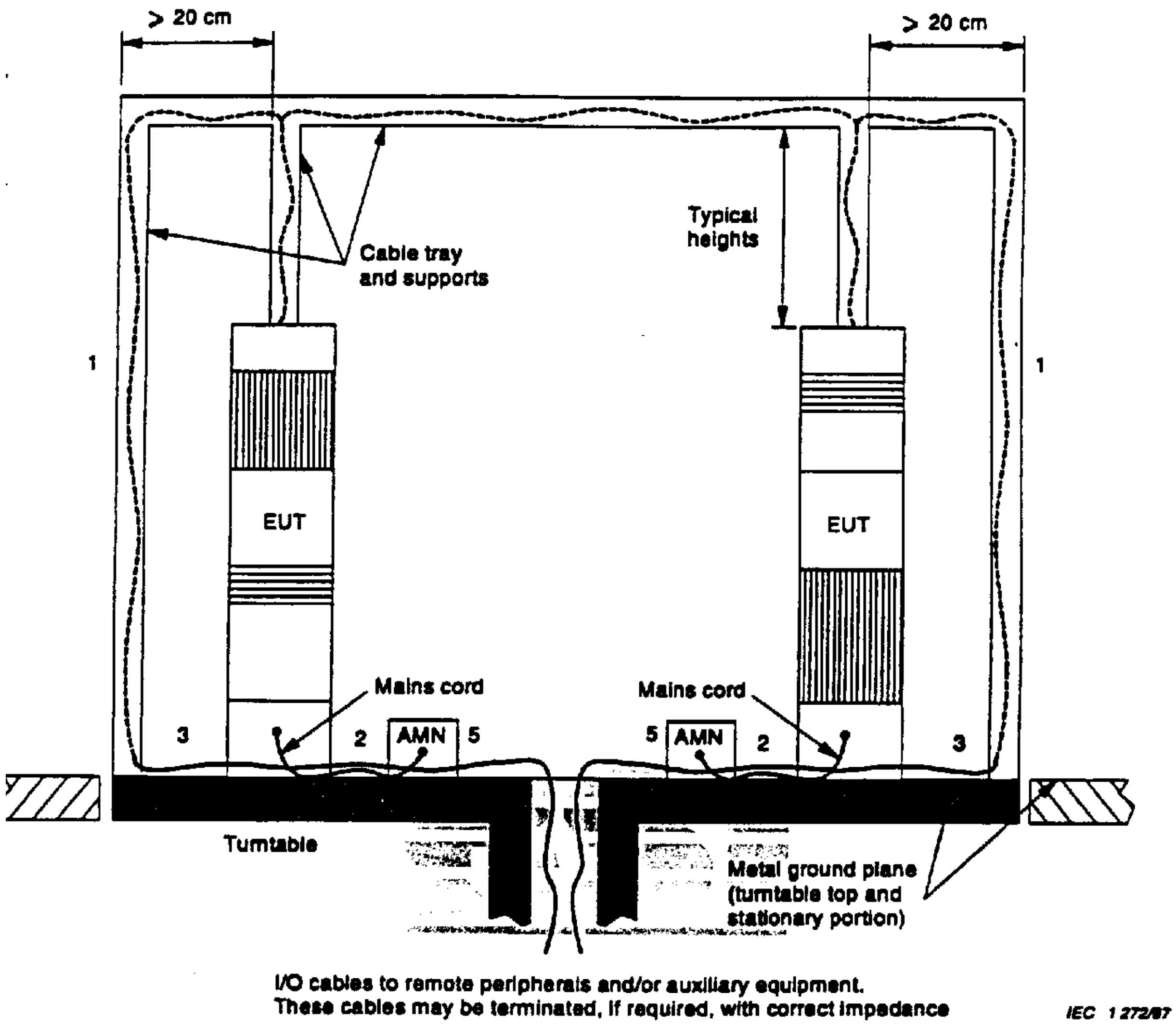


Fig. A.10 Measurement setup of telecommunication line.

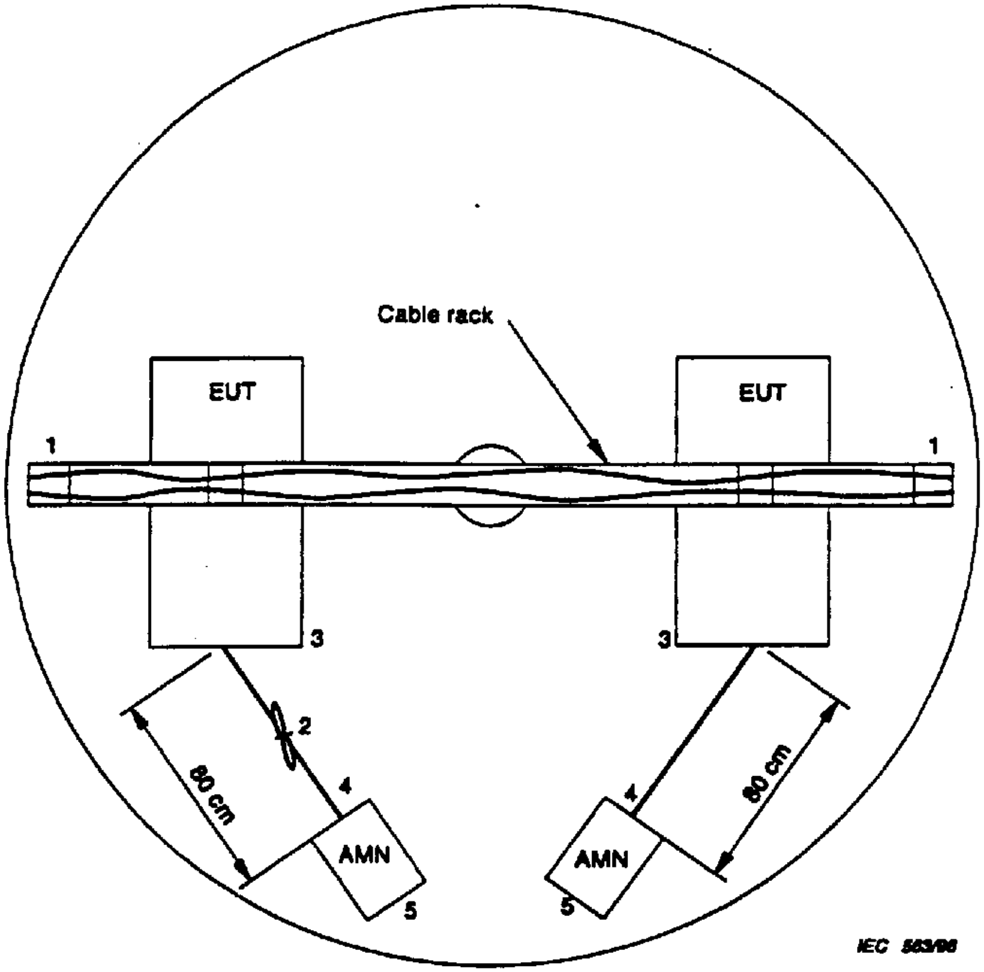
EN 55022

Computer & Telecoms Emissions



EN 55022

Computer & Telecoms Emissions



AMN = artificial mains network
EUT = equipment under test

Emerging Standards for EMC Emissions & Immunity

Requirements for Industrial, Scientific, Medical & Information Technology Equipment

	Emissions	Immunity
Conducted	**CISPR 11, 22**	**EN 61000-4-6**
Radiated	**CISPR 11, 22**	**EN 61000-4-3**
Power-line	**Harmonics / Flicker**	**EN 61000-4-8, -11**
E. S. D.		**EN 61000-4-2**
E.F.T.		**EN 61000-4-4**
Surge		**EN 61000-4-5**

Conclusion: begin pre-testing now to ensure conformity in 2001

Emerging Standards for EMC Emissions & Immunity

Acknowledgements:

Conducted Immunity - Mike Heckrotte, EMC Consultant

Transient Immunity - Tom Revesz, Haefely Test, Inc.

Magnetic Fields - John Smith, Mallinckrodt

EN55022-1998 - Roland Gubisch, Test & Measurement World, 4/2000

Implementation Dates - Paul Rostek, NCR

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