



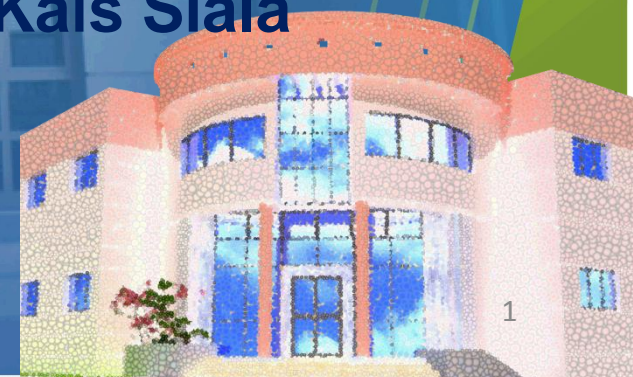
ITU Training on Conformance and Interoperability
for ARB and AFR Regions
CERT, 23-27 June 2014



Speed up your compliance

EMC standards

Presented by: Karim Loukil & Kaïs Siala



Immunity tests



Performance Criteria for Immunity Tests



Results of immunity tests are classified into four categories:

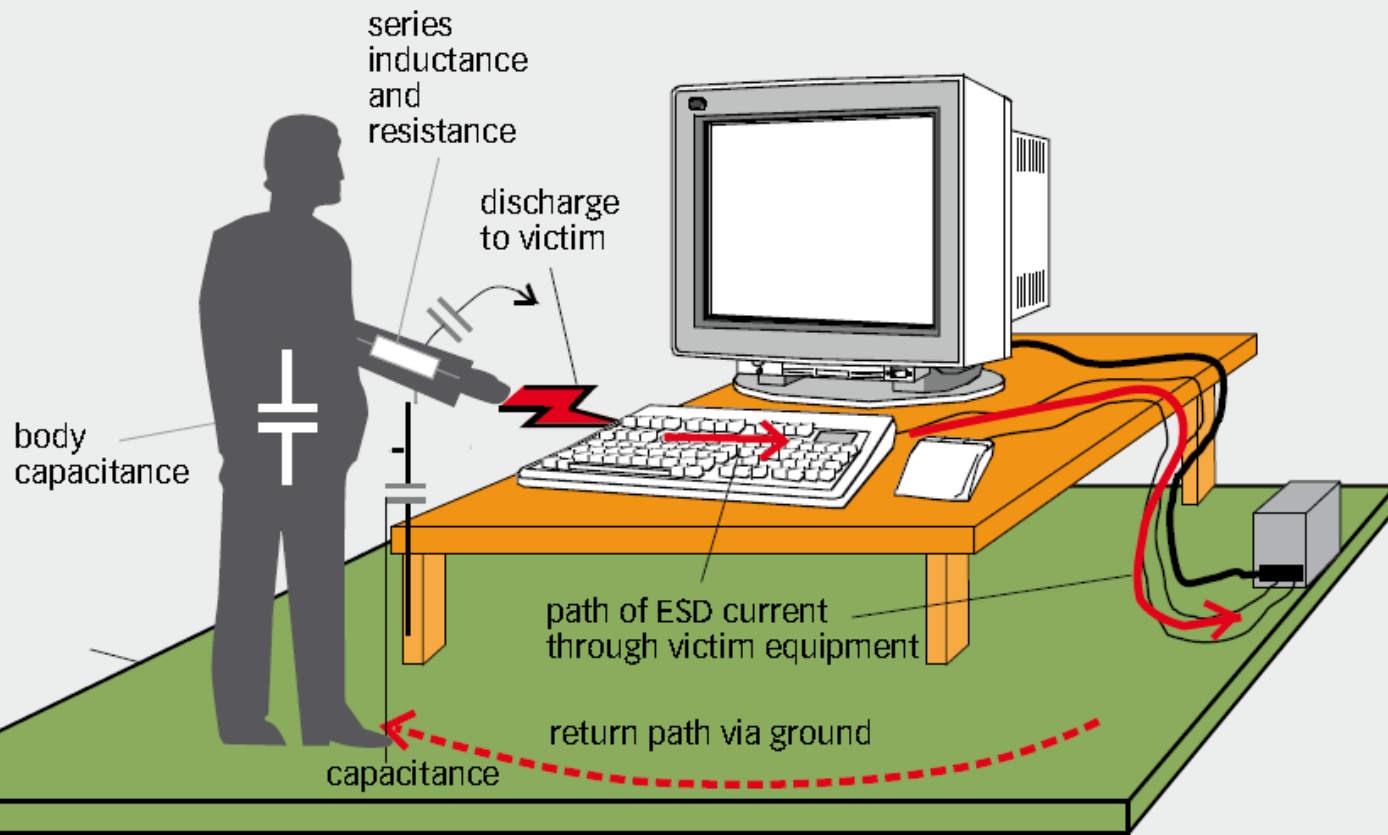
- Performance Criteria A – ‘Performance within specification limits’
- Performance Criteria B – ‘Temporary degradation which is self-recoverable’
- Performance Criteria C – ‘Temporary degradation which requires operator intervention’
- Performance Criteria D – ‘Loss of function which is not recoverable’



ESD

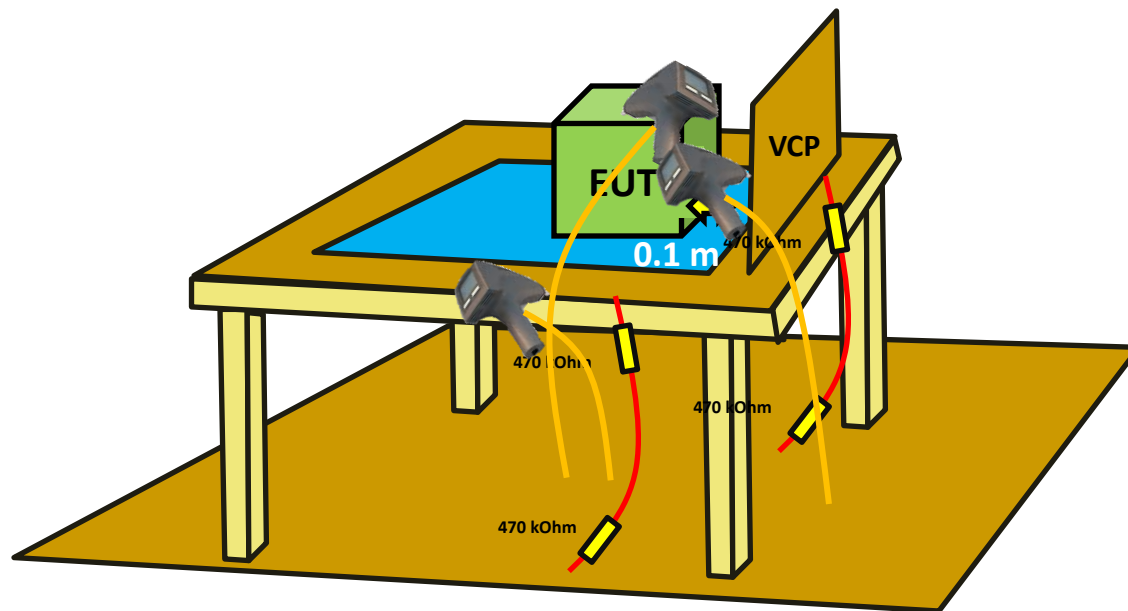
IEC 61000-4-2

The discharge event



- Test purpose
- Evaluate the performance of a device submitted to human electric discharge
- Needed instruments:
 - ✓ ESD generator
 - ✓ Ground plane (horizontal and vertical)
 - ✓ Isolant surface
 - ✓ 470 k Ω loads





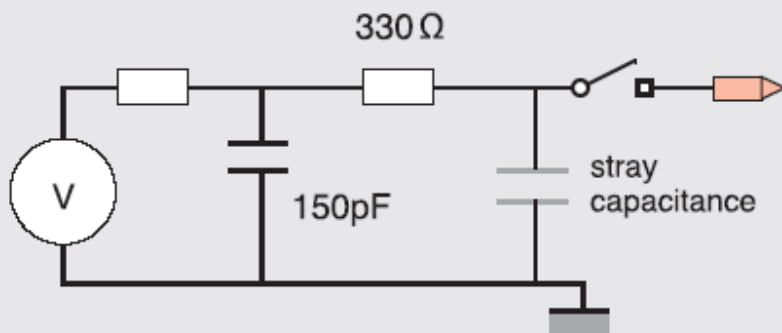
Conducting surface



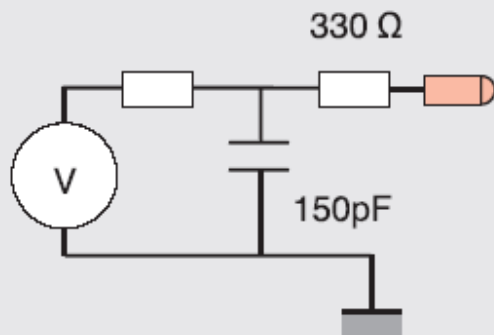
Dielectrical material



Isolating surface



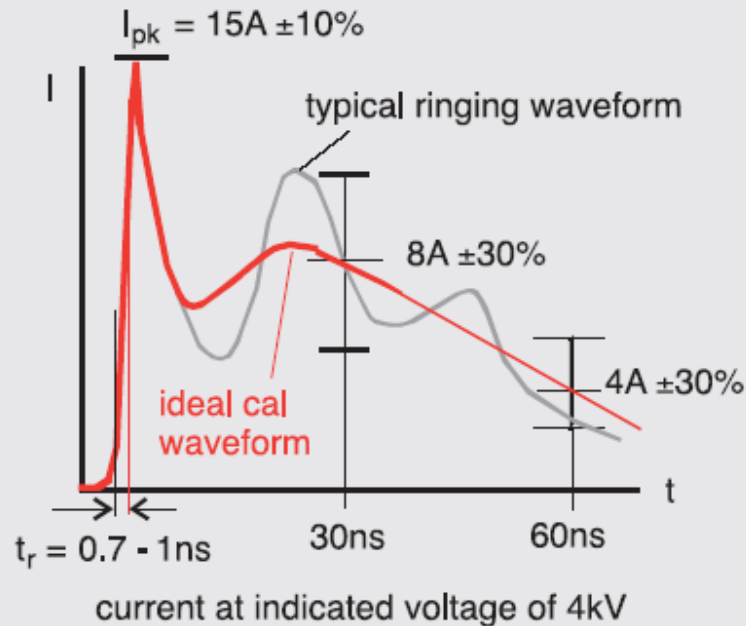
Contact discharge



Air discharge

ESD generator equivalent circuit

Schaffner NSG 435



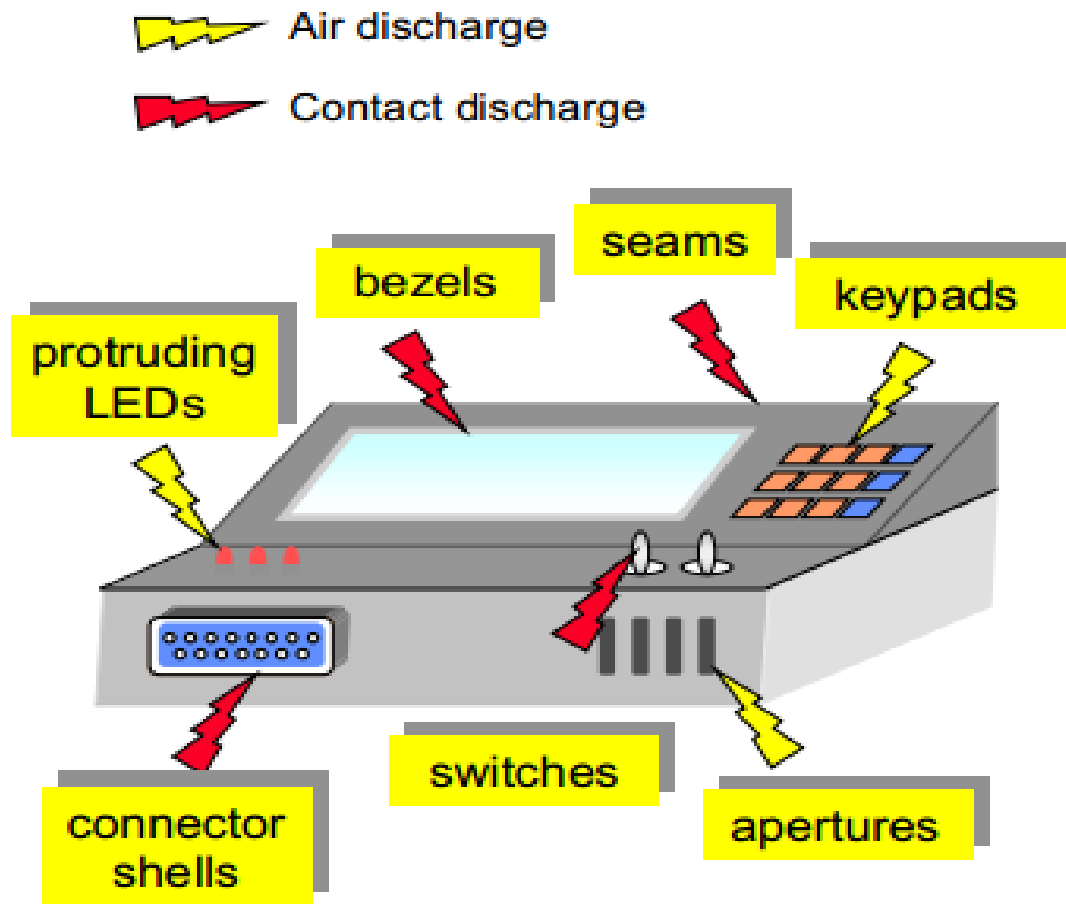
Calibration waveform

Table 1 – Test levels

1a – Contact discharge		1b – Air discharge	
Level	Test voltage kV	Level	Test voltage kV
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15
x ¹⁾	Special	x ¹⁾	Special

1) "x" is an open level. The level has to be specified in the dedicated equipment specification. If higher voltages than those shown are specified, special test equipment may be needed.

- Application of discharge:
 - ✓ Direct: on the surface of the device under test
 - ✓ Indirect: in the coupling planes
- Types of discharges:
 - ✓ In contact: the conductive surface (head pointed gun)
 - ✓ In air: on insulating surfaces (gun head rounded)
- Maximum 1 per second discharge
- 10 discharges + and - by point of application
- 4 test levels
- For high levels we must pass by intermediate levels



- The discharge return cable of the ESD generator shall be connected to the ground reference plane. The total length of this cable is in general 2 m.

Fundamental Principals

- In the case of air discharge testing, the climatic conditions shall be within the following ranges:
 - ✓ ambient temperature: 15 °C to 35 °C;
 - ✓ relative humidity: 30 % to 60 %;
 - ✓ atmospheric pressure: 86 kPa (860 mbar) to 106 kPa (1 060 mbar).

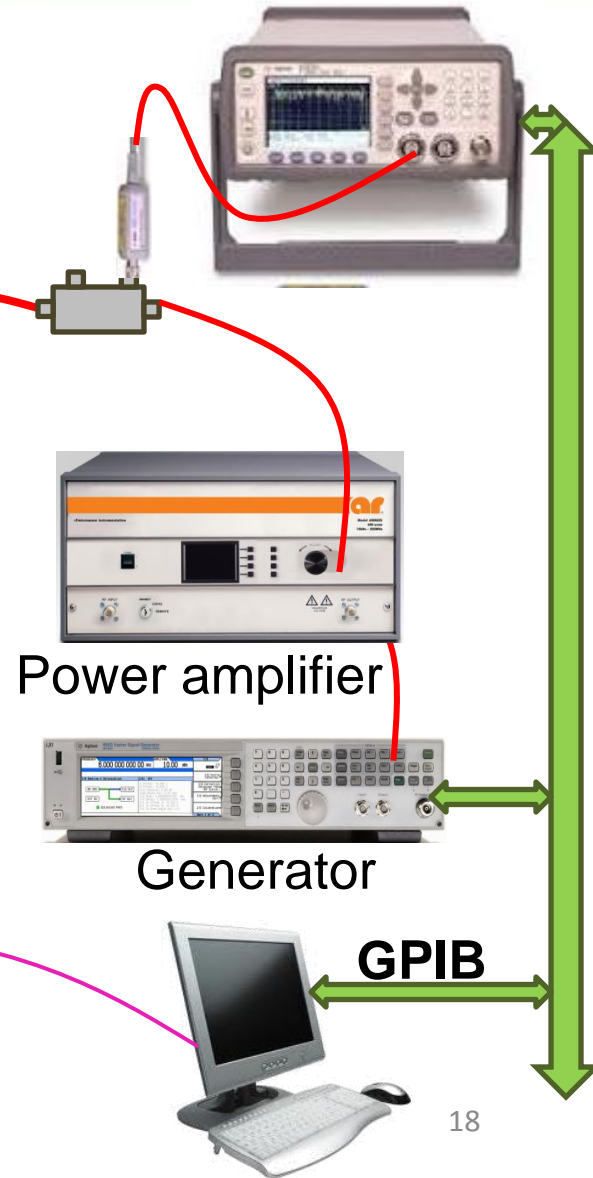
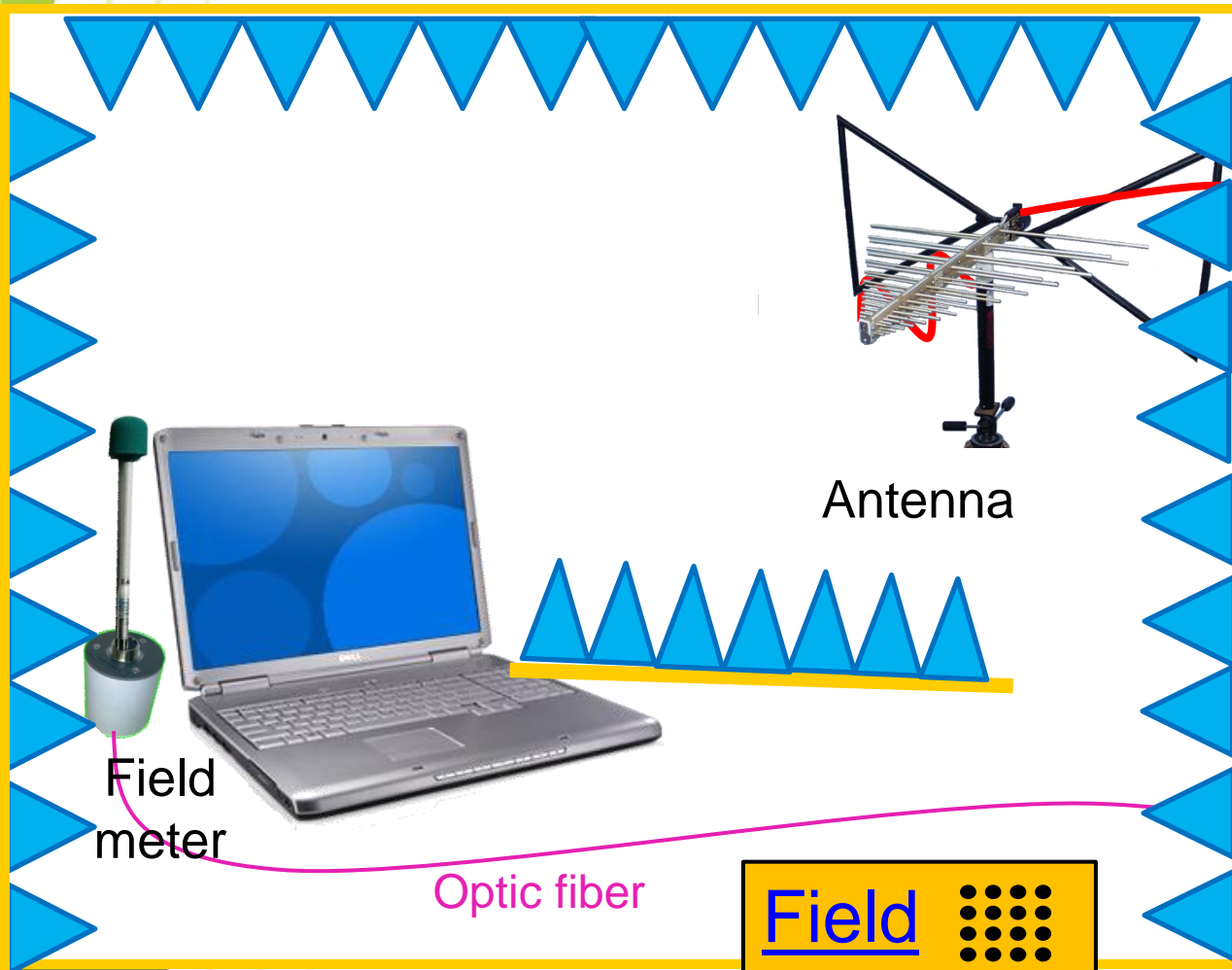
The testing shall be performed by direct and indirect application of discharges to the EUT according to a test plan. This should include:

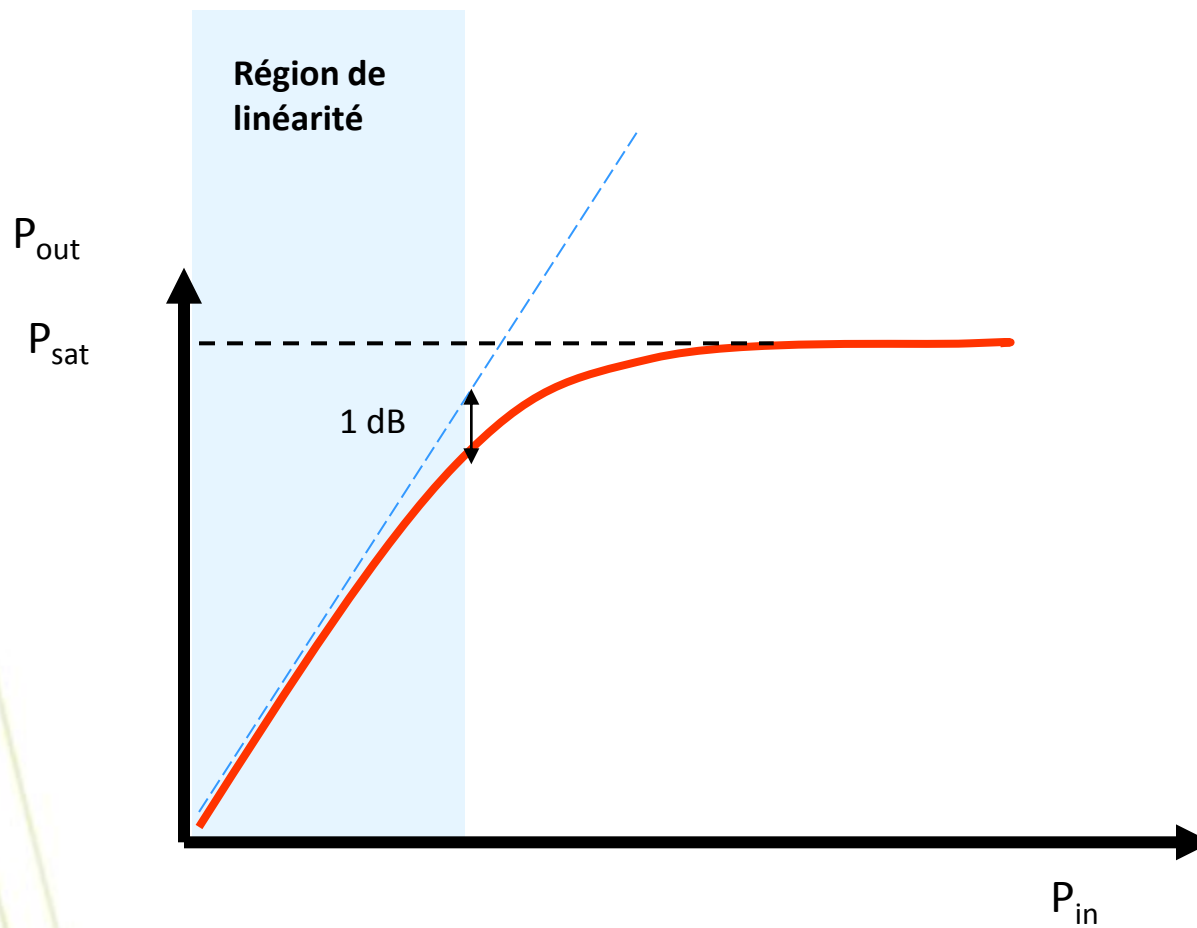
- ✓ representative operating conditions of the EUT;
- ✓ whether the EUT should be tested as table-top or floor-standing;
- ✓ the points at which discharges are to be applied;
- ✓ at each point, whether contact or air discharges are to be applied;
- ✓ the test level to be applied;
- ✓ the number of discharges to be applied at each point for compliance testing;
- ✓ whether post-installation tests are also to be applied.

- In the case of contact discharges, the tip of the discharge electrode shall touch the EUT, before the discharge switch is operated.
- In the case of air discharges, the round discharge tip of the discharge electrode shall be approached as fast as possible (without causing mechanical damage) to touch the EUT.
- [Link to the standard IEC 61000-4-2](#)

Radiated immunity

IEC 61000-4-3







Uniform field calibration



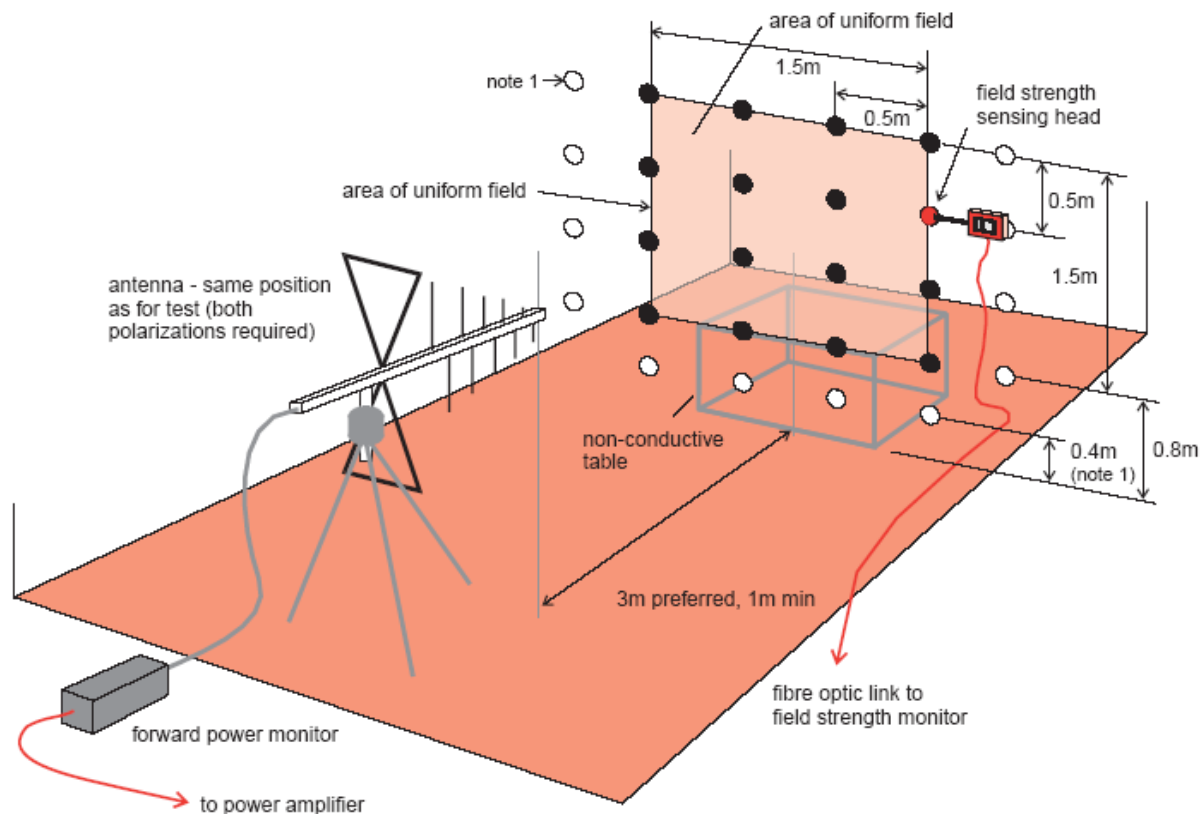
- Performed at 1.8 times the desired field strength.
- For testing at 10V/m the calibration is run at 18V/m
- The reason of running a test at 1.8x the level is to verify the RF amplifier has the ability to reach the required field when the 80% 1KHz Amplitude Modulation is applied.
- An EMC Lab performing testing at multiple levels 1V/m, 3V/m, 10V/m, 30V/m, and/or others, they need only to perform the calibration at 1.8x the max level they will test to and then the can scale the power down.



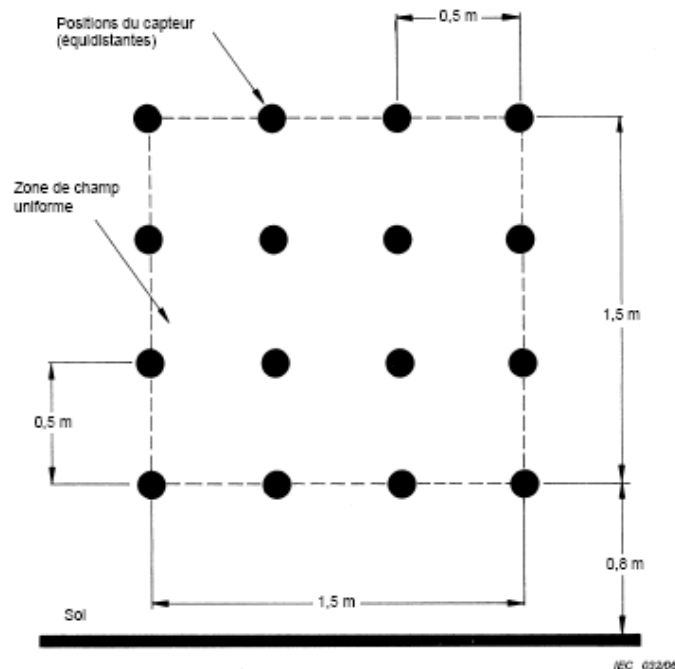
Frequency range



- The tests are normally carried out in the frequency range 800 MHz to 960 MHz and 1.4 GHz to 6 GHz.
- Pause adapted to the device under test
- 80% at 1 kHz modulation



Field Uniformity definition



- Fields considered uniform if the amplitude of at least 12 points is between 0 and 6 dB of the nominal value.
- A tolerance of up to 10 dB is permitted for max 3% test frequency



EFT

IEC 61000-4-4

Electric Fast Transients EFT – Burst – EN 61000-4-4



Wave form generator



Coupling/decoupling Network



0.1 m

Dielectric material

0.1 m

Ground plane

Burst generator
With integrated CDN

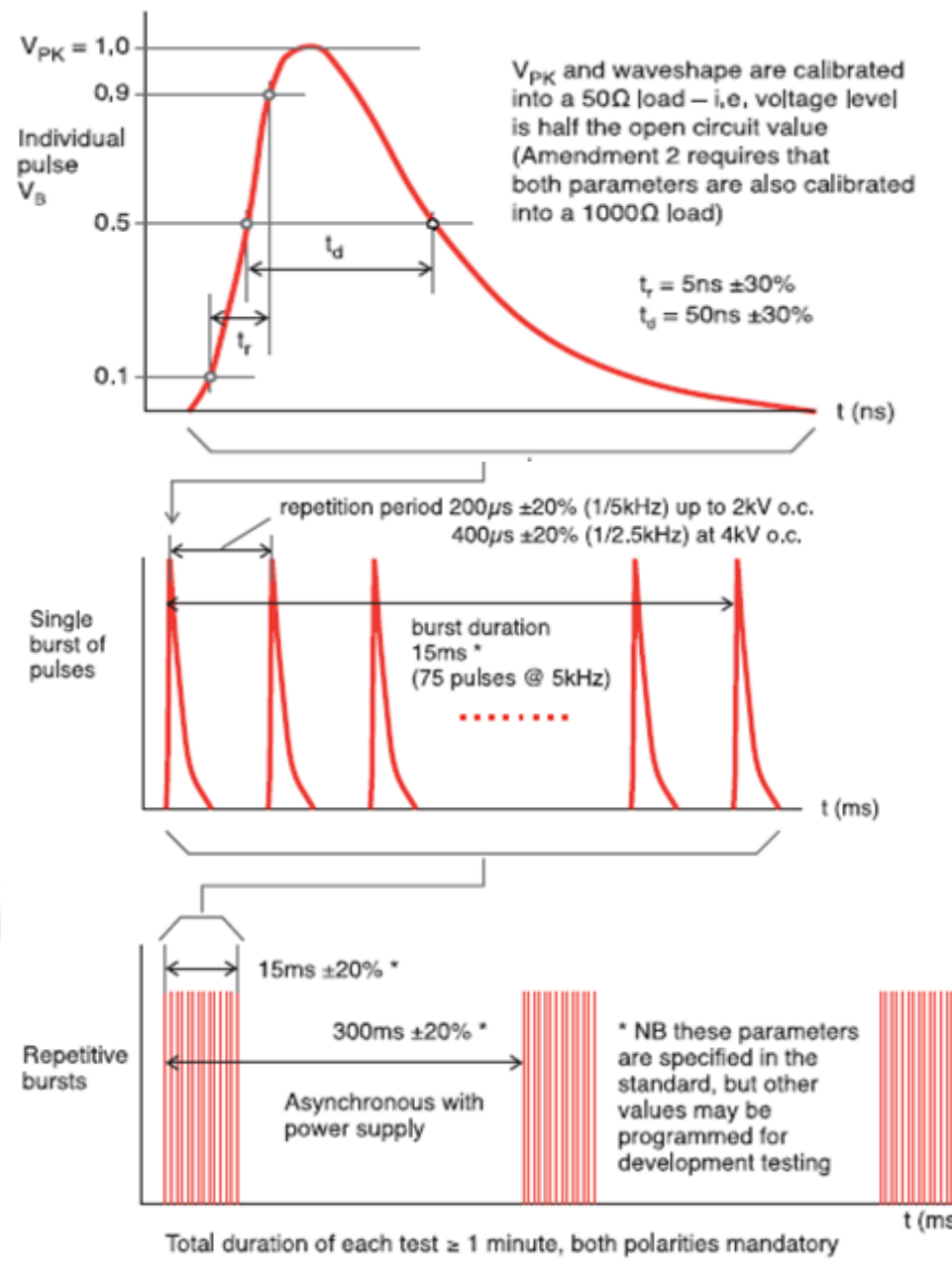
- Purpose of test:
Immunity test when subjected to transient disturbances like switching transients.
- Materials needed:
 - ✓ EFT generator
 - ✓ Coupling & decoupling device (internal or external)
 - ✓ Capacitive coupling clamp for telecom line coupling
 - ✓ Capacity of 33 nF for direct injection
 - ✓ Ground plane

Open circuit output test voltage and repetition rate of the impulses				
Level	On power port, PE		On I/O (input/output) signal, data and control ports	
	Voltage peak kV	Repetition rate kHz	Voltage peak kV	Repetition rate kHz
1	0,5	5 or 100	0,25	5 or 100
2	1	5 or 100	0,5	5 or 100
3	2	5 or 100	1	5 or 100
4	4	5 or 100	2	5 or 100
X ^a	Special	Special	Special	Special

NOTE 1 Use of 5 kHz repetition rates is traditional; however, 100 kHz is closer to reality. Product committees should determine which frequencies are relevant for specific products or product types.

NOTE 2 With some products, there may be no clear distinction between power ports and I/O ports, in which case it is up to product committees to make this determination for test purposes.

^a "X" is an open level. The level has to be specified in the dedicated equipment specification.



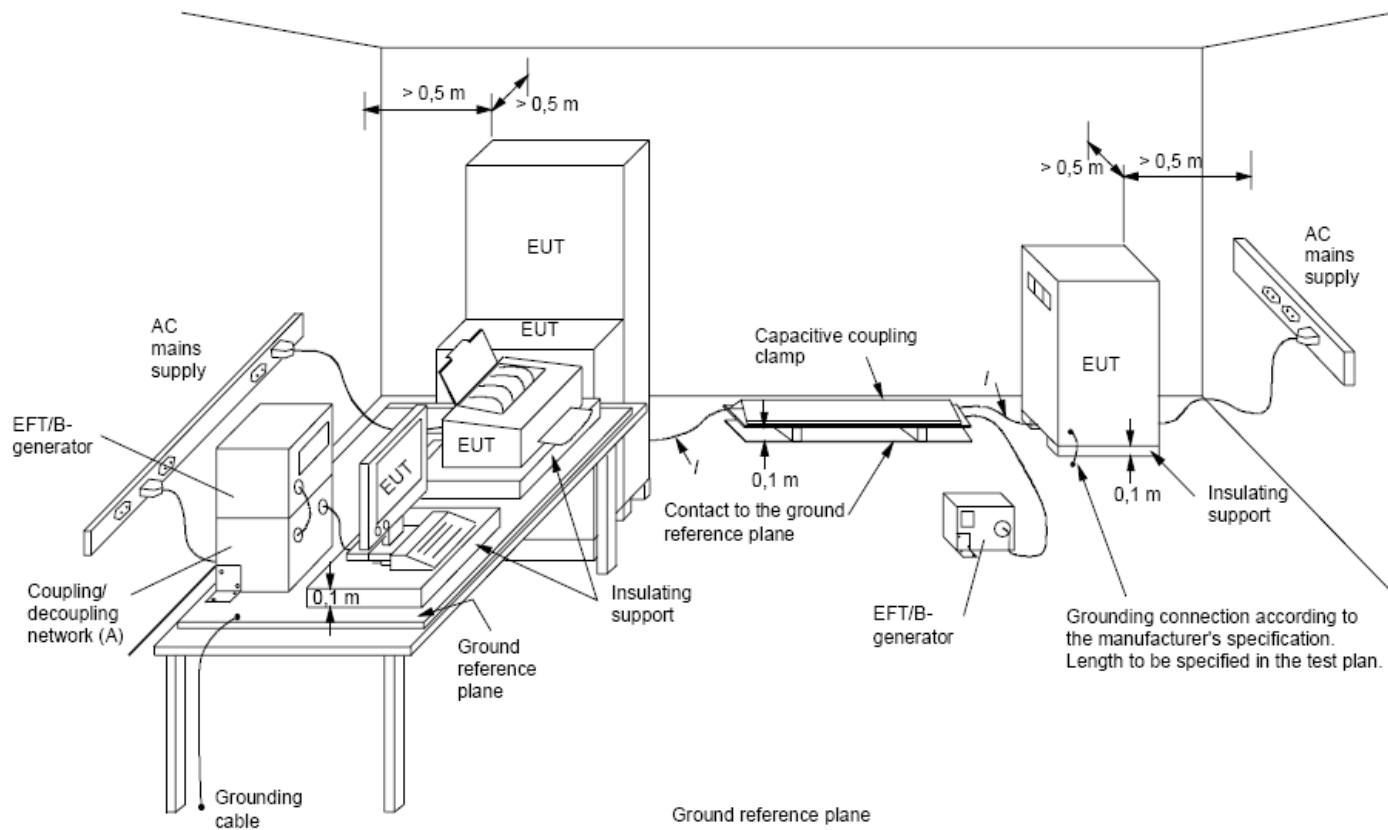
EFT wave form

- On each conductor
- For at least 1 min
- polarity + And –
- Test levels and intermediate levels

- Table-top equipment : EUT located 0,1 m above the ground plane.
- The test generator and CDN placed directly on, and connected to, the ground plane.
- All cables connected to the EUT shall be placed on the insulation support 0,1 m above the ground reference plane.

- Either a direct coupling network or a capacitive clamp shall be used for the application of the test voltages.
- Decoupling networks shall be used to protect auxiliary equipment and public networks.

- The test procedure includes:
- the verification of the laboratory reference conditions;
- the preliminary verification of the correct operation of the equipment;
- the execution of the test;
- the evaluation of the test results.

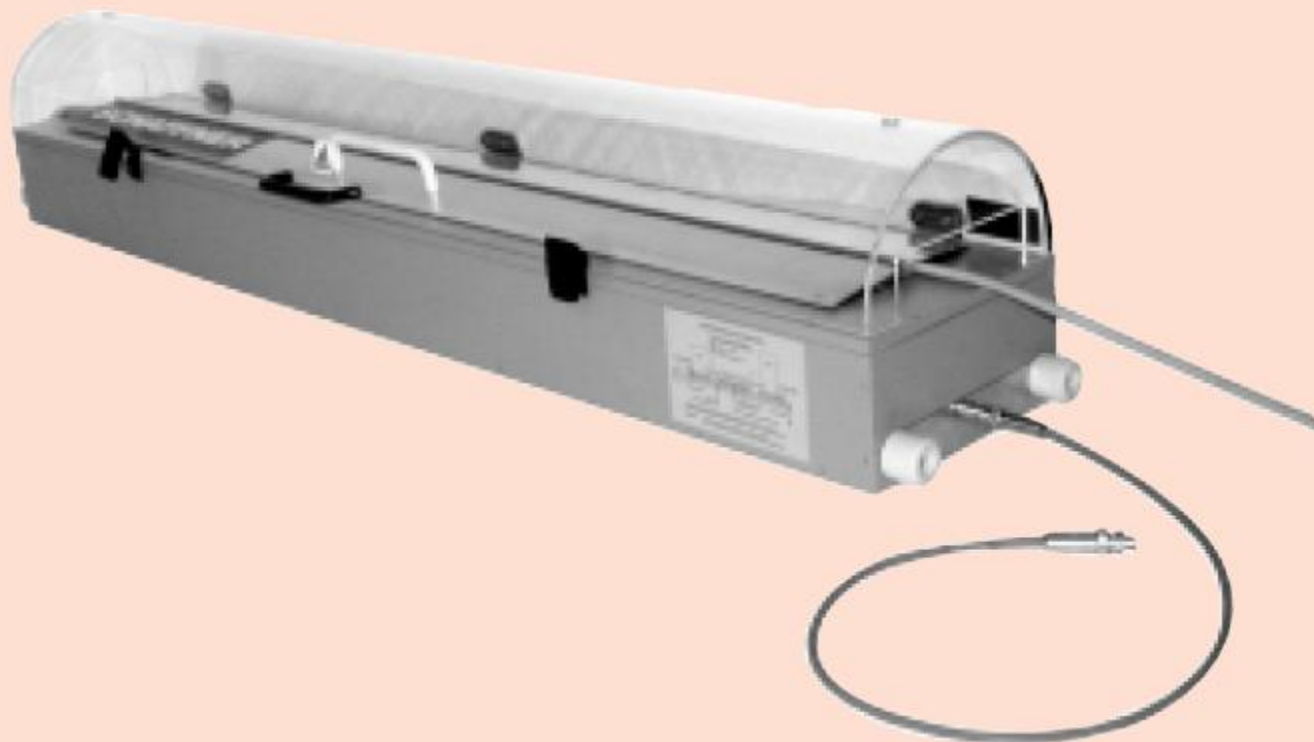


Key

- / length between clamp and the EUT to be tested (should be $0,5\text{ m} \pm 0,05\text{ m}$)
- (A) location for supply line coupling
- (B) location for signal lines coupling

IEC 901/04

The Schaffner CDN 8014 - An example of a coupling clamp

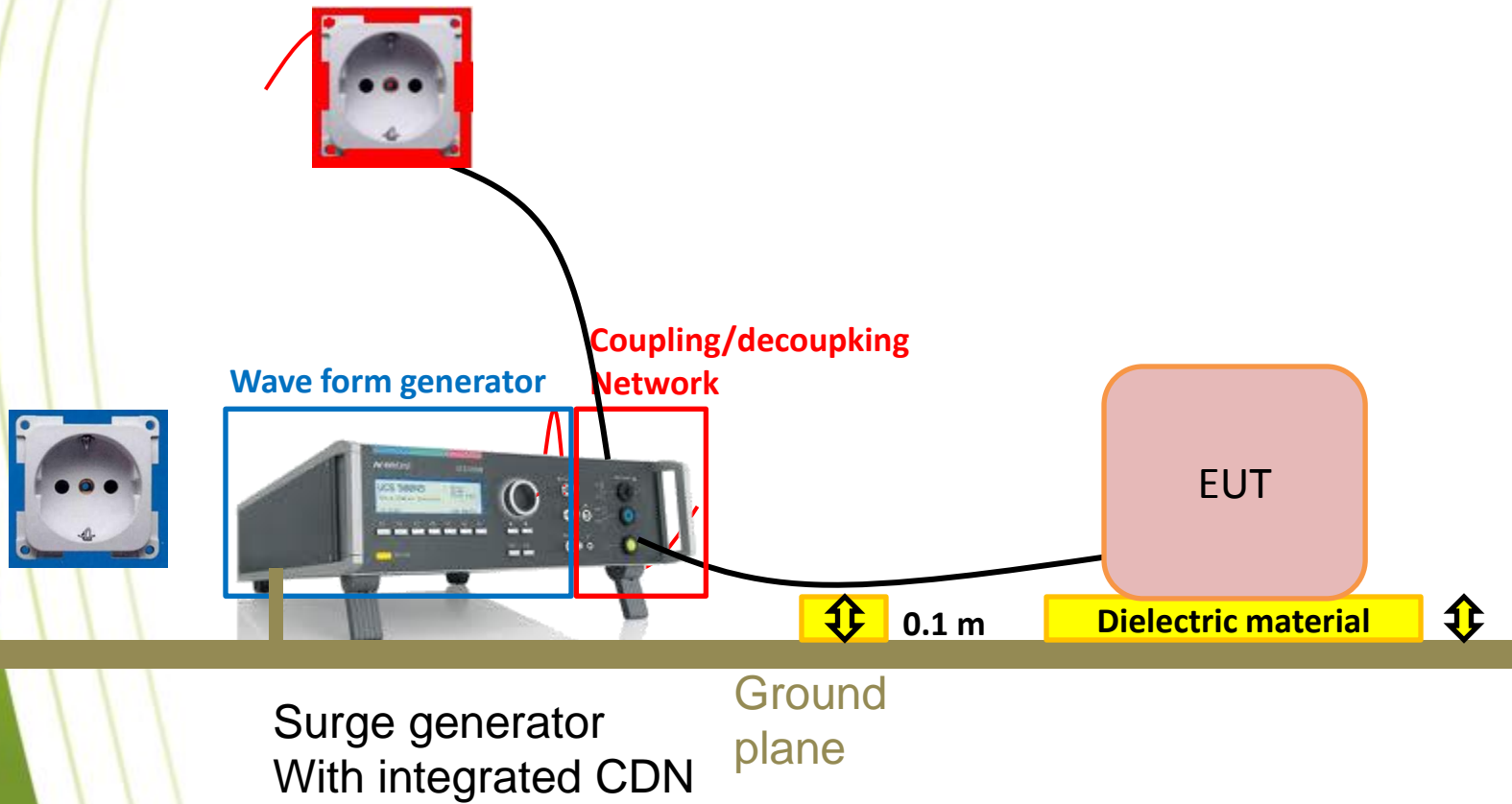


[Link to the standard IEC 61000-4-4](#)

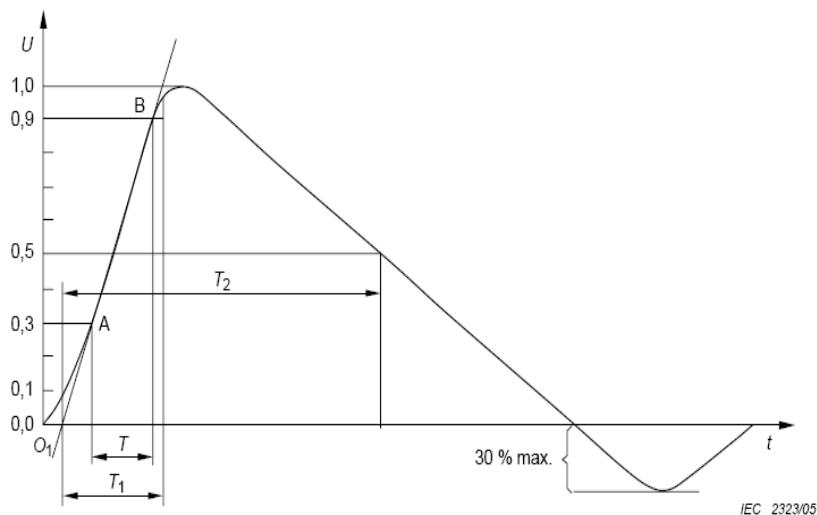


Surge

IEC 61000-4-5

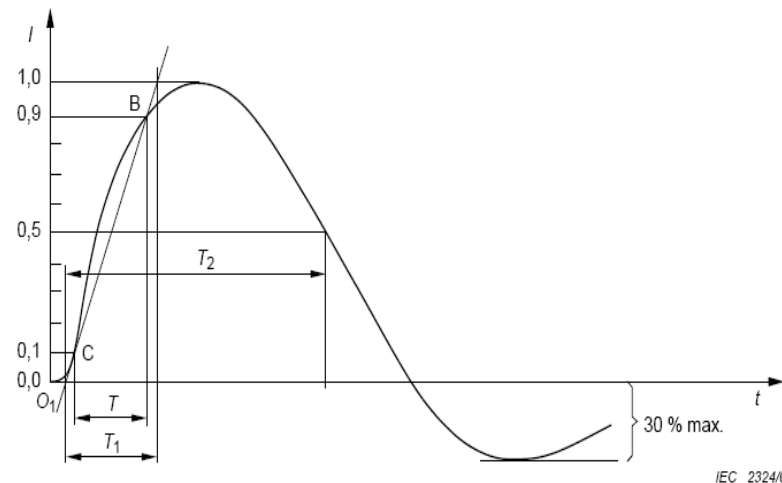


- Purpose of test:
 - ✓ Evaluation the immunity of a device across shock waves caused by transient voltages induced by the residual or lightning impulse
- Materials needed:
 - ✓ Surge wave generator (1.2 / 50 microseconds),
 - ✓ Decoupling/coupling network (internal or external)
 - ✓ Ground plane



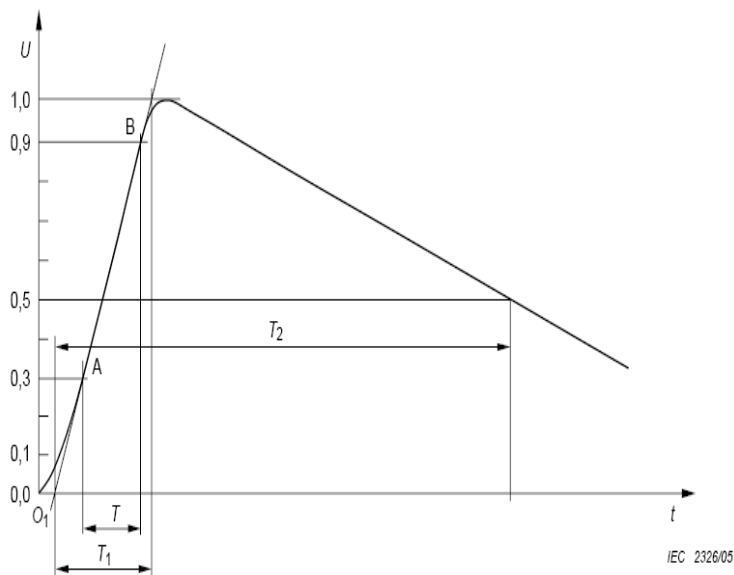
Front time: $T_1 = 1,67 \times T = 1,2 \mu\text{s} \pm 30 \%$
 Time to half-value: $T_2 = 50 \mu\text{s} \pm 20 \%$

Waveform of **open-circuit voltage (1,2/50 μs)**
 at the output of the generator with no CDN
 connected (waveform definition according to
 IEC 60060-1)

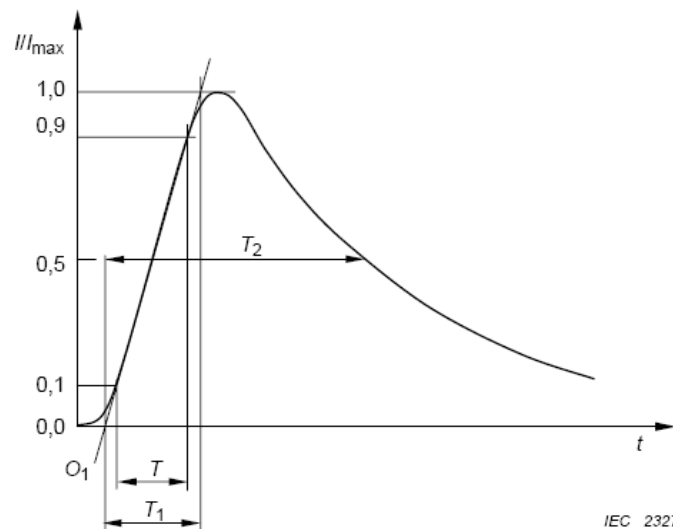


Front time: $T_1 = 1,25 \times T = 8 \mu\text{s} \pm 20 \%$
 Time to half-value: $T_2 = 20 \mu\text{s} \pm 20 \%$

Waveform of **short-circuit current (8/20 μs)**
 at the output of the generator with no CDN
 connected (waveform definition according to
 IEC 60060-1)



Front time: $T_1 = 1,67 \times T = 10 \mu\text{s} \pm 30 \%$
 Time to half-value: $T_2 = 700 \mu\text{s} \pm 20 \%$

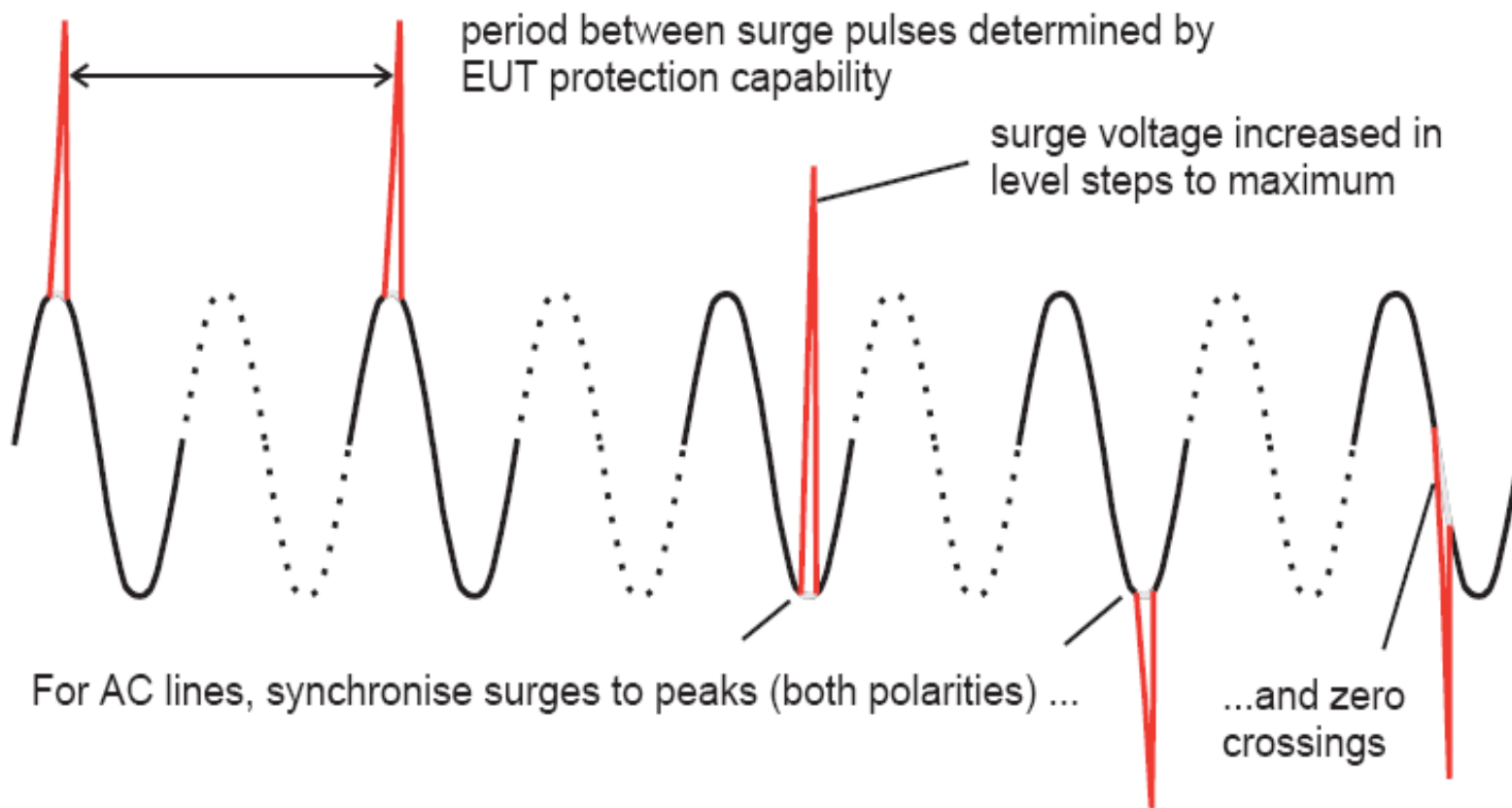


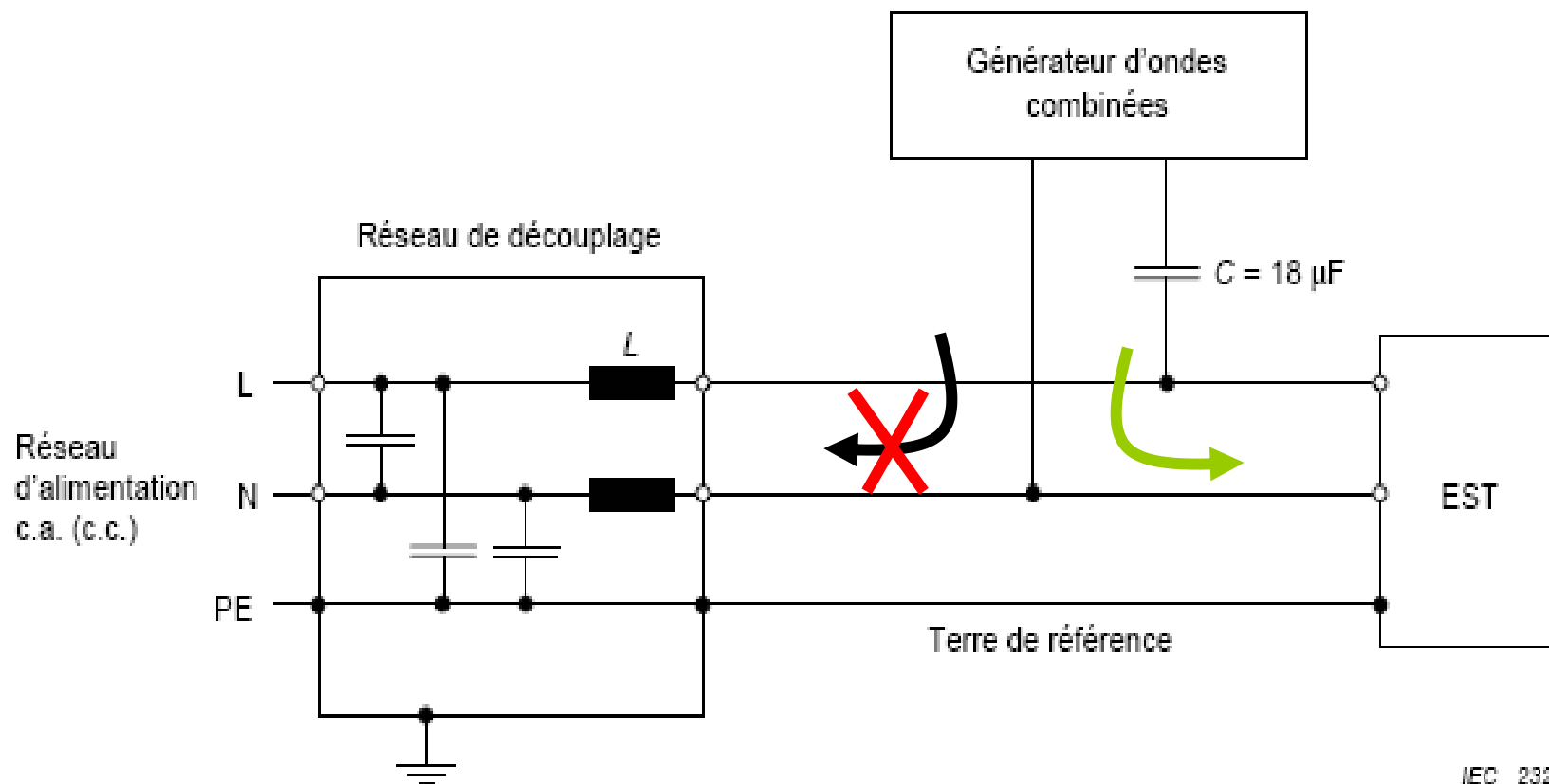
Front time: $T_1 = 1,25 \times T = 5 \mu\text{s} \pm 20 \%$
 Time to half-value: $T_2 = 320 \mu\text{s} \pm 20 \%$

Waveform of **open-circuit voltage (10/700 μs)**
 (waveform definition according to **ITU-T K series**
 and IEC 60060-1)

Waveform of the **5/320 μs short-circuit current** waveform (definition according to **ITU-T K series** and IEC 60060-1)

Surge application



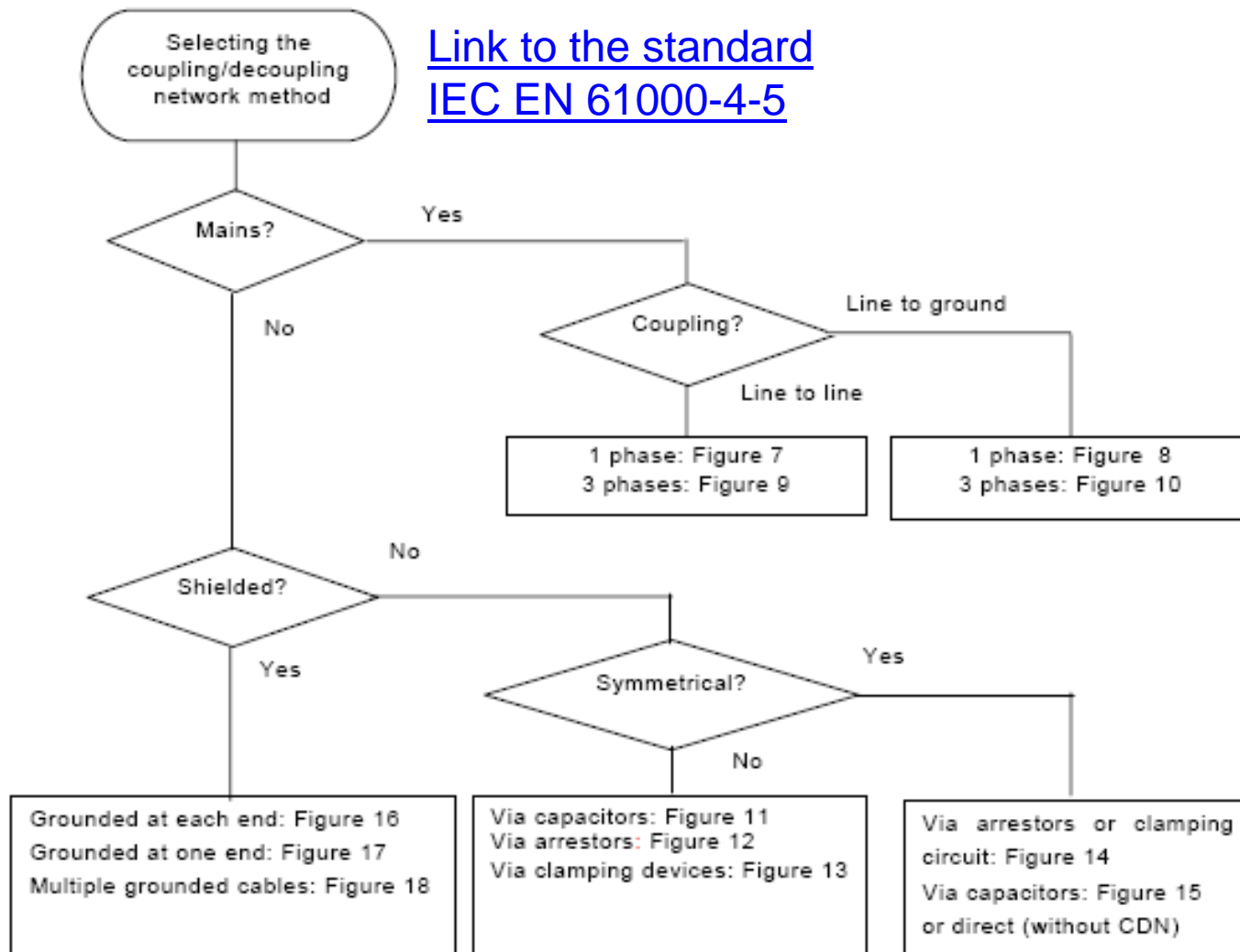


Level	Open-circuit test voltage $\pm 10\%$ kV
1	0,5
2	1,0
3	2,0
4	4,0
X	Special

NOTE X can be any level, above, below or in between the other levels. This level can be specified in the product standard.

- Differential mode and common mode
- In + and – polarity
- Number of pulses: 5 (for each polarity)
- Phase angles 0 °, 90 ° and 270 °
- Test levels and intermediate levels

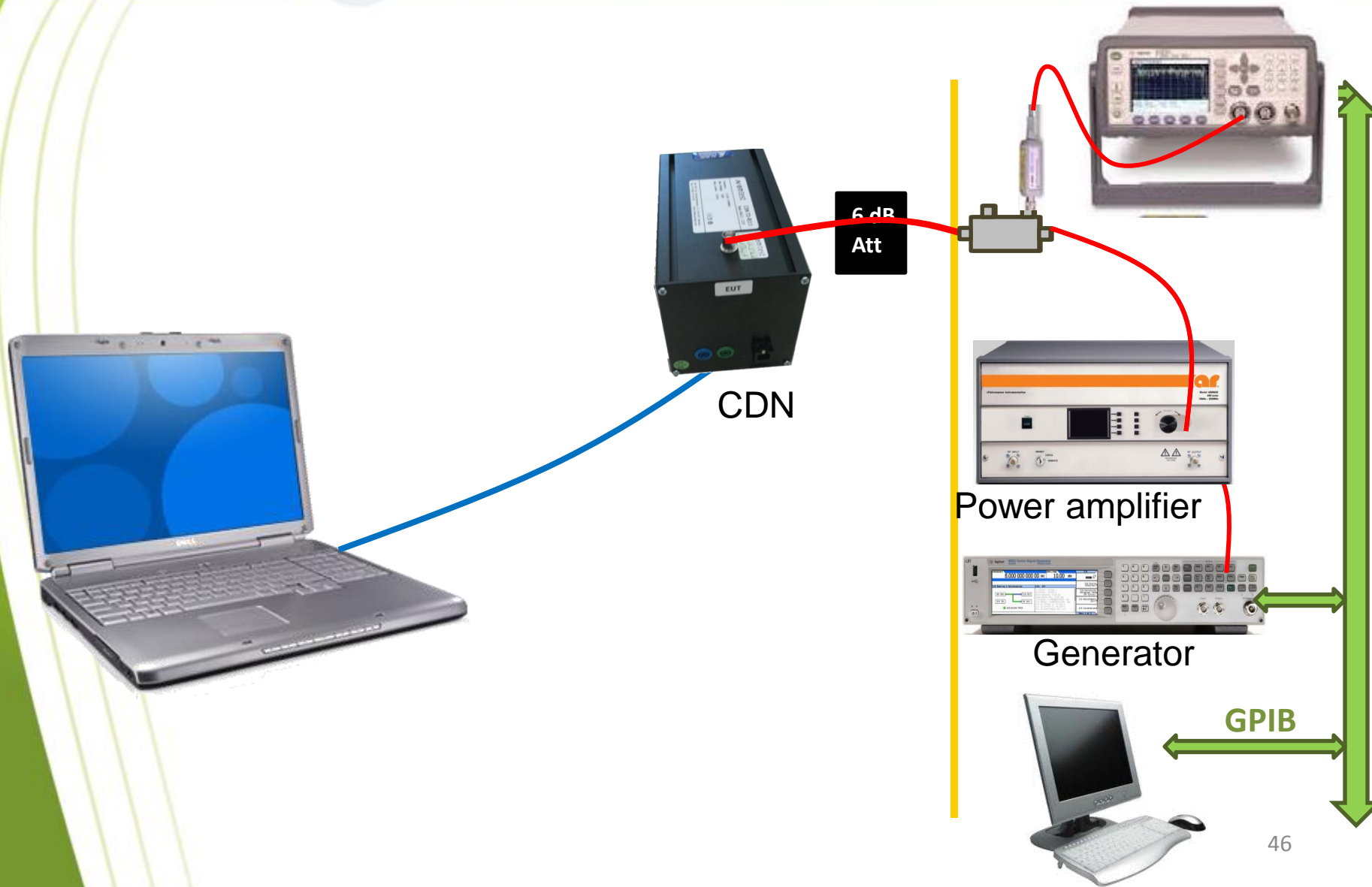
[Link to the standard IEC EN 61000-4-5](#)



Conducted immunity

IEC 61000-4-6

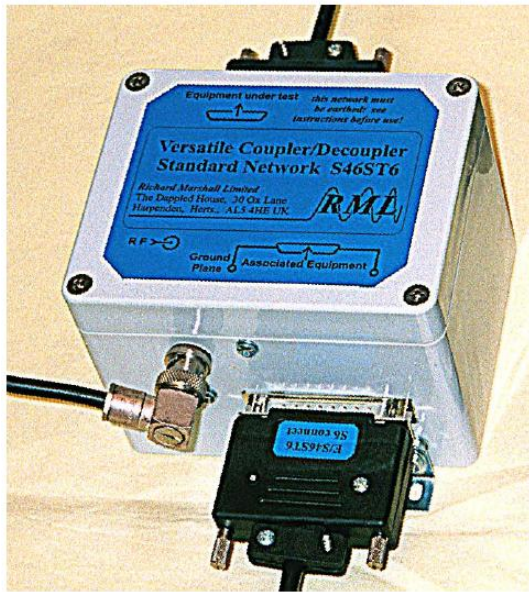
Conducted immunity – IEC 61000-4-6





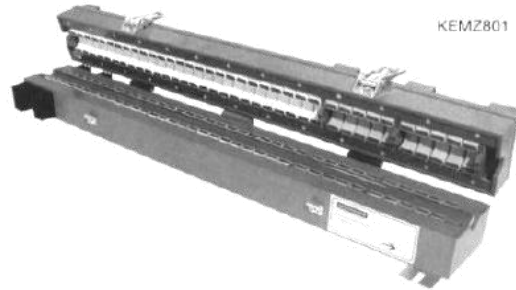
Coupling decoupling network (CDN)

CDN



CDN T8 with ADR T800 adapter set

EM-Clamp

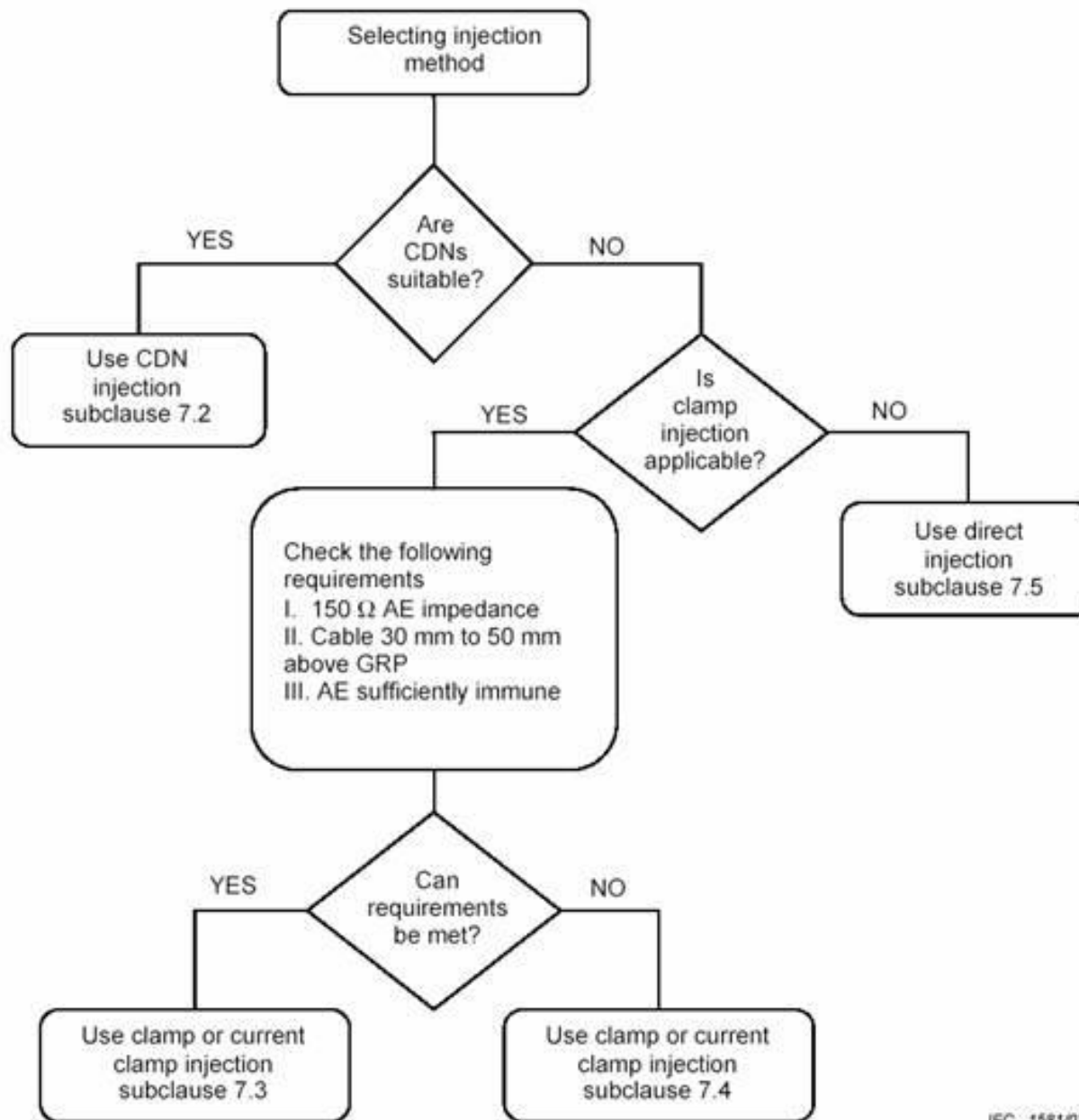


Current injection probe



EM clamp

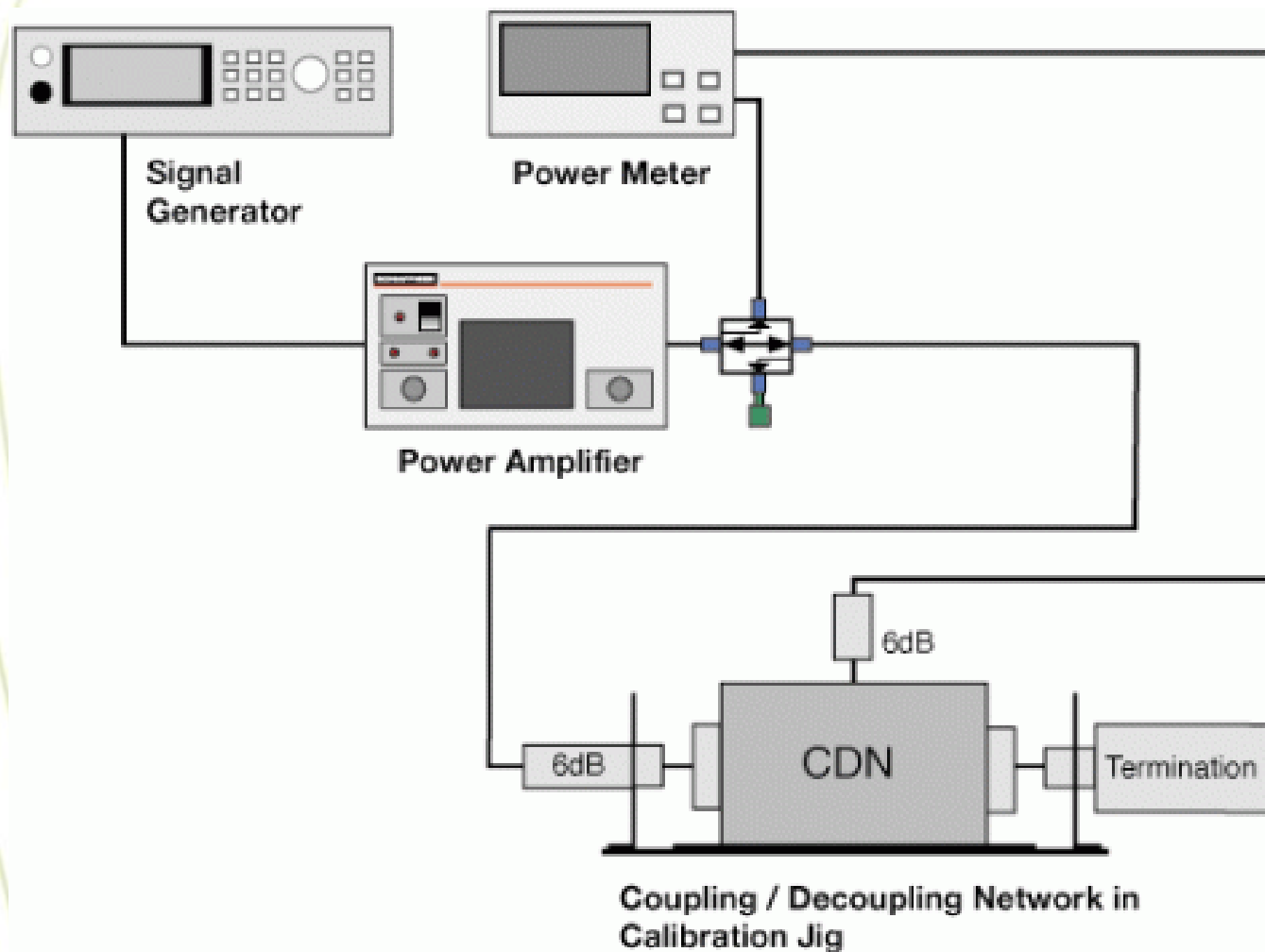
Current injection clamp

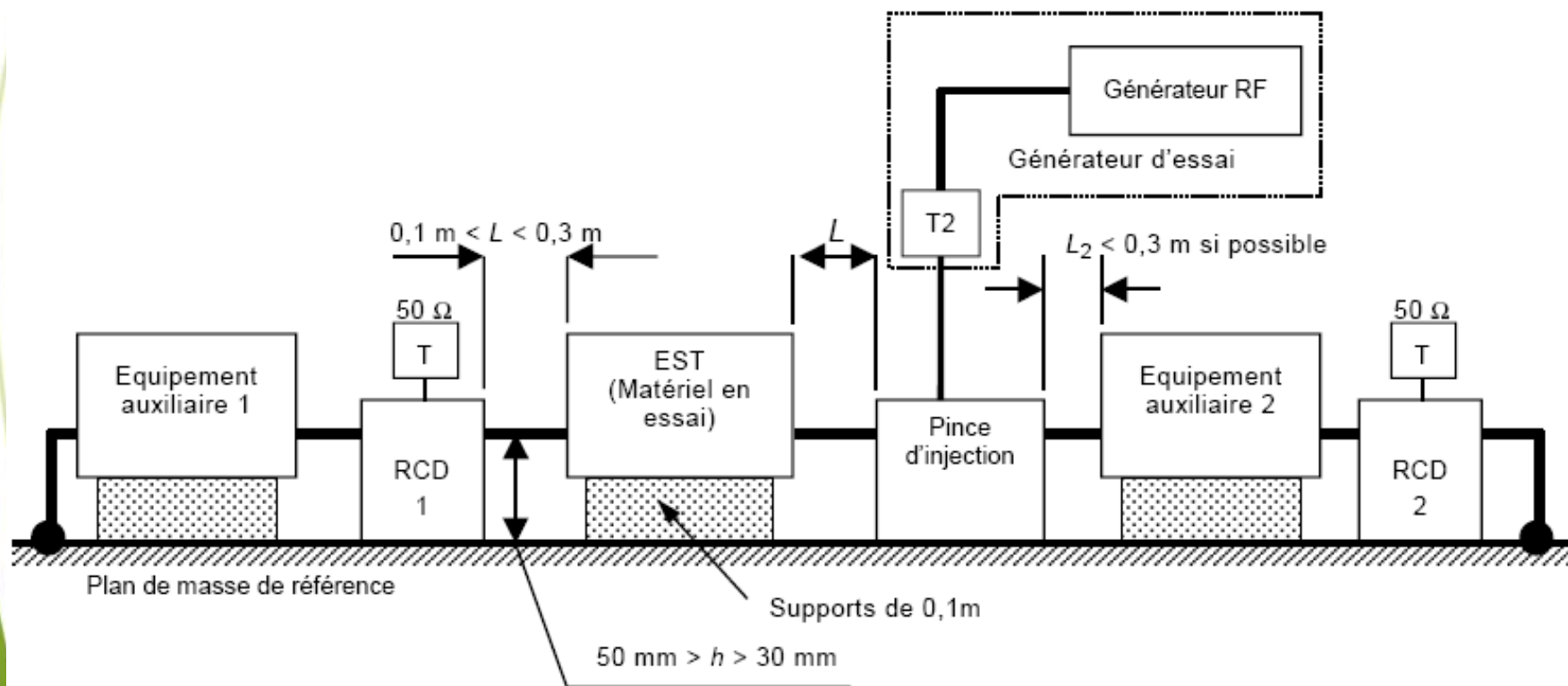


IEC 1581/03

Figure 1 – Rules for selecting the injection method

Why is CDN the preferred method?



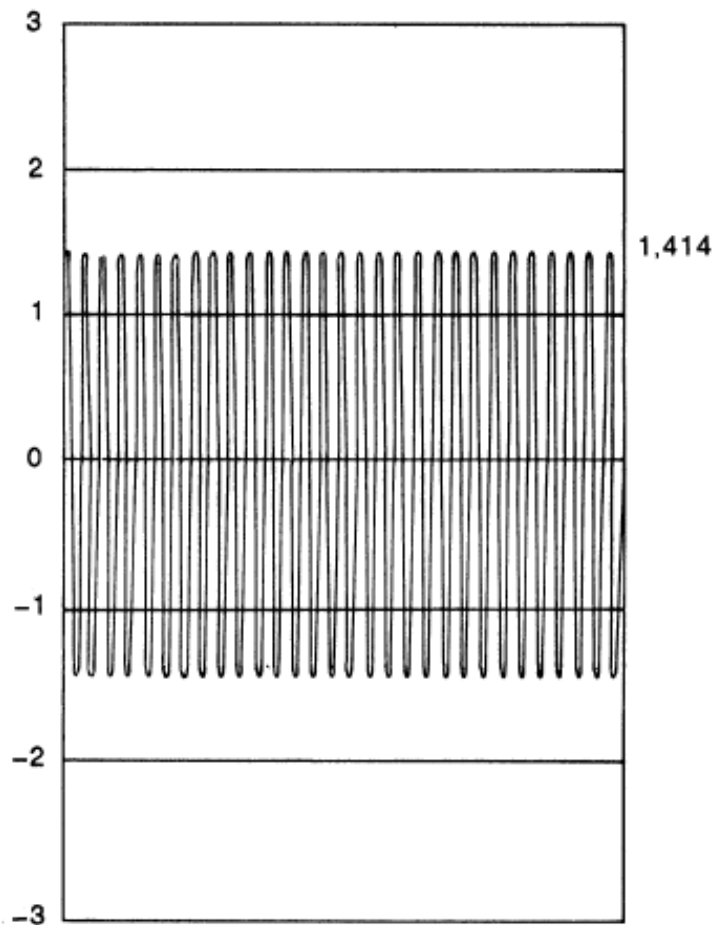


T : charge 50 Ω

T2: atténuateur de puissance (6 dB)

CDN: réseau de couplage/découplage

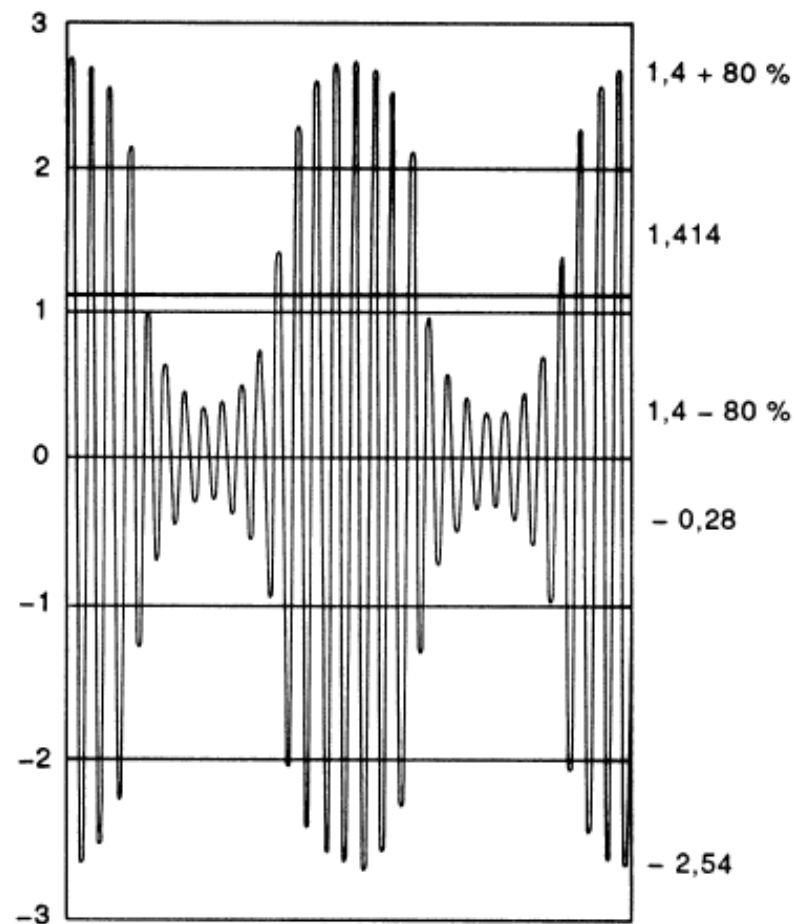
Pince d'injection : pince de courant ou pince EM



IEC 222/96

Figure 4a – Signal radioélectrique non modulé

$$U_{pp} = 2,82 \text{ V}, U_{rms} = 1,00 \text{ V}$$



IEC 223/96

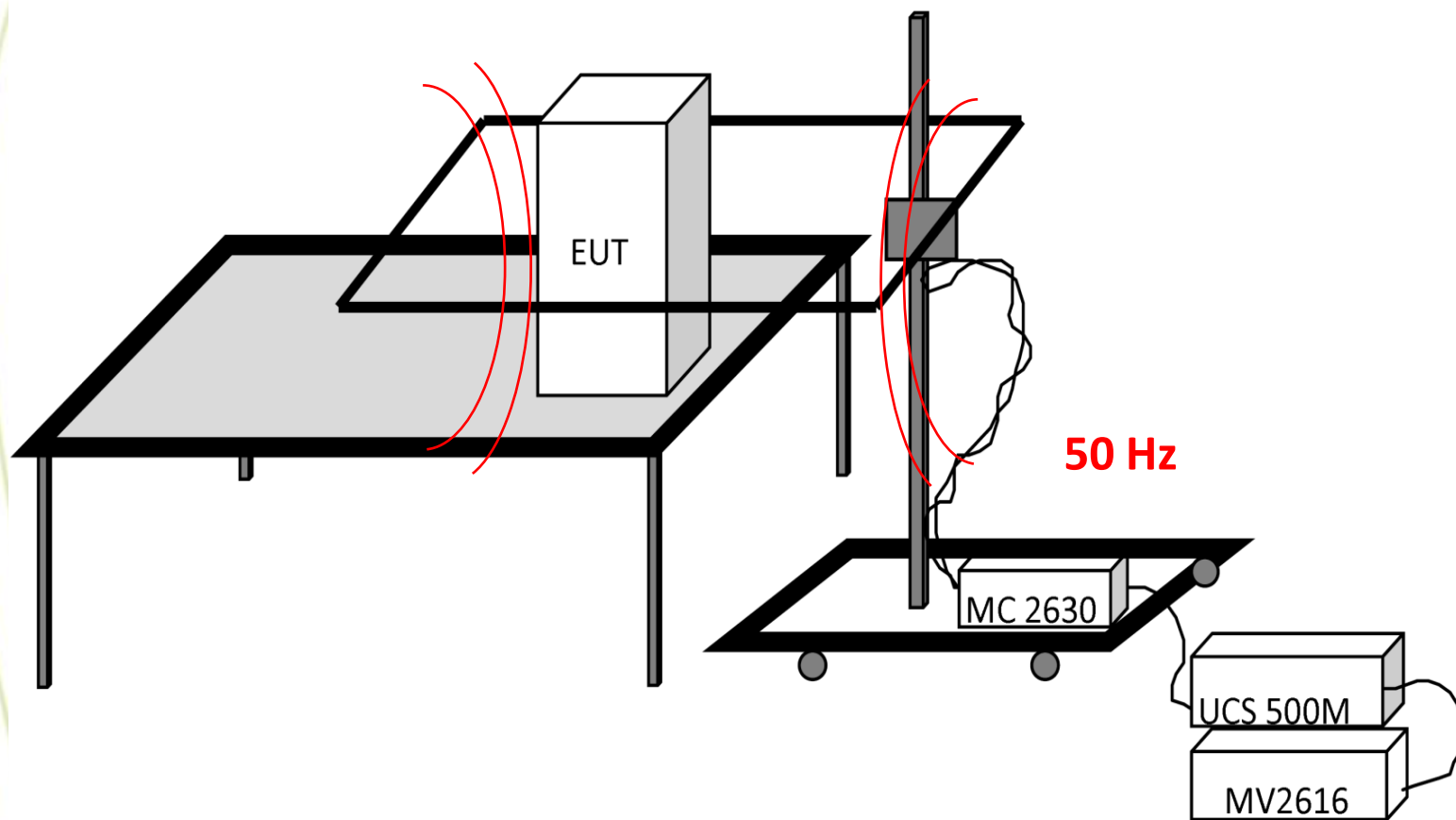
Figure 4b – Signal radioélectrique modulé, VAM 80 %

$$U_{pp} = 5,09 \text{ V}, U_{rms} = 1,12 \text{ V}$$

Immunity to magnetic fields

IEC 61000-4-8

Magnetic field immunity – IEC 61000-4-8



**Immunity to voltage dips
and short interruptions
IEC 61000-4-11**

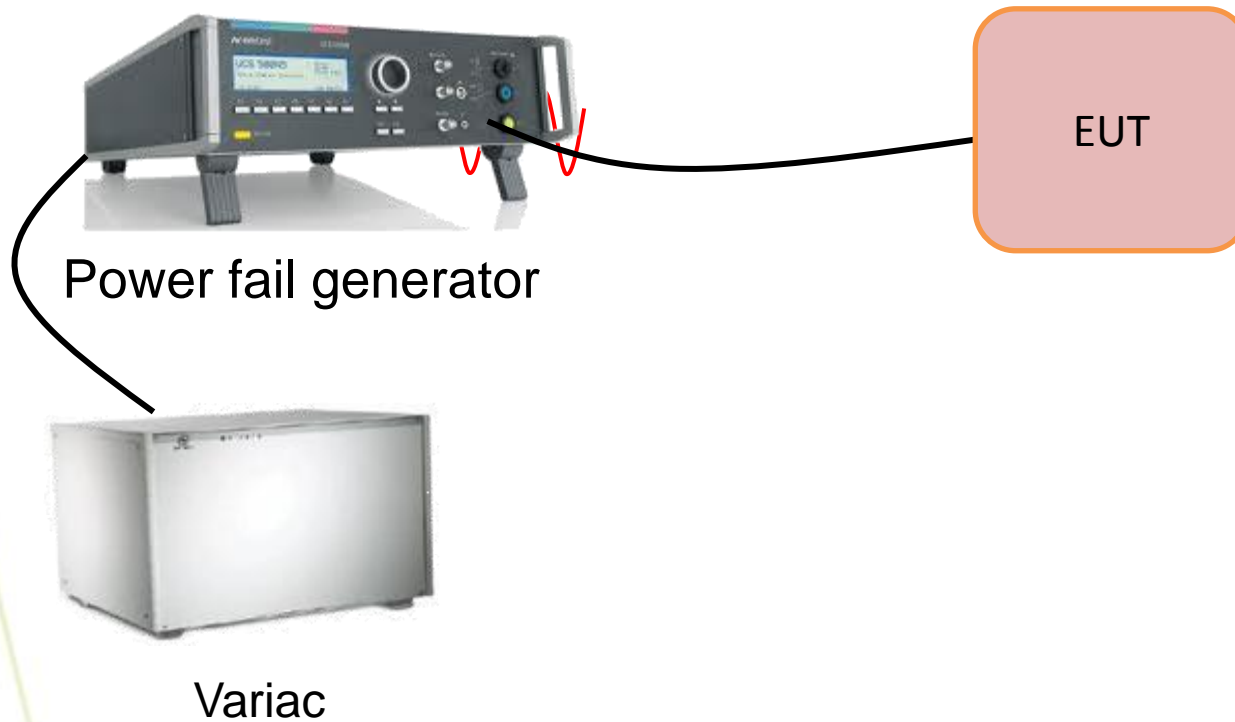


Figure 6M Example of a 'dip'

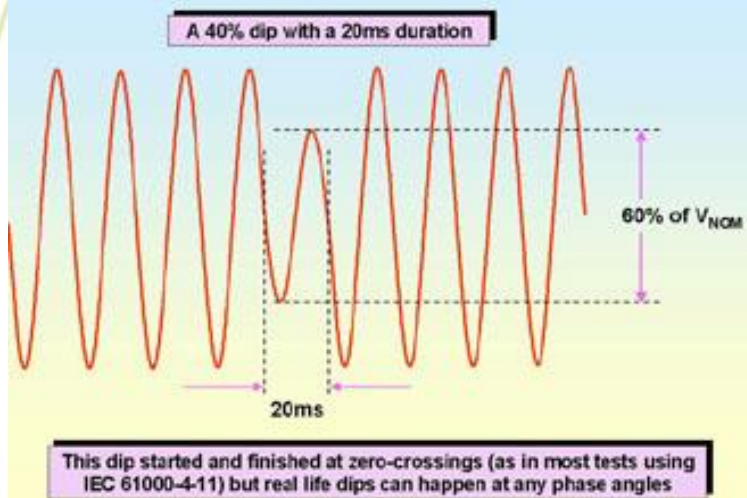


Figure 6N Example of a 'short interruption'

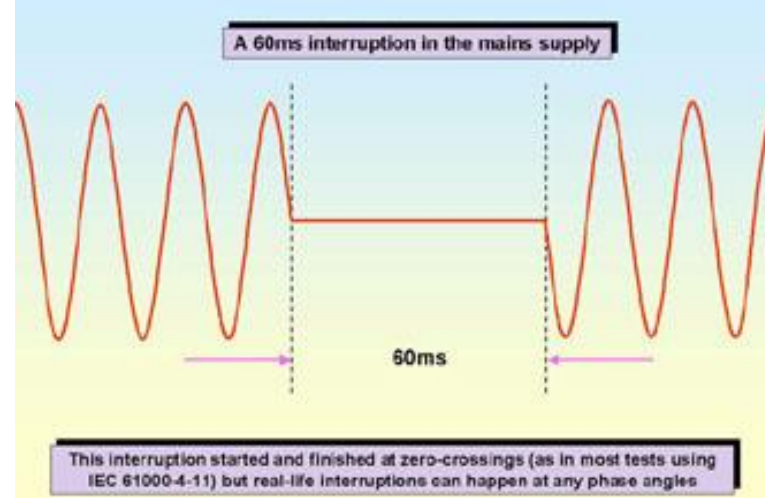
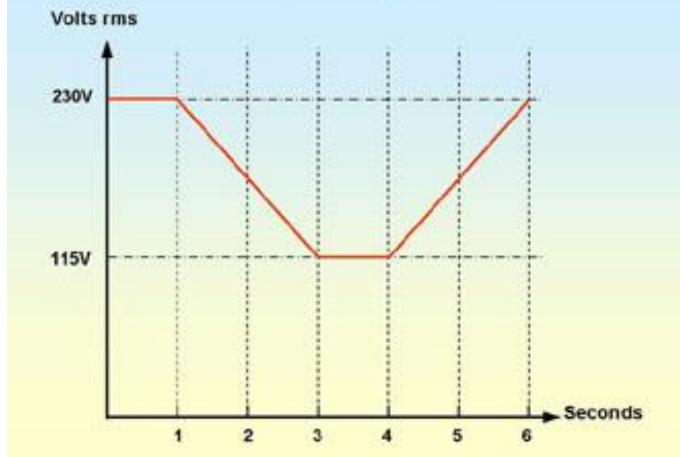


Figure 6S A typical 'sag' test
(example of a 50% sag for 1 second)



Emission tests



Emission

CISPR 22 / EN 55022

- **An ITE is able to perform:**
 - ✓ Receive data from an external source;
 - ✓ Perform treatments
 - ✓ Provide a result

- **The class B ITE is intended primarily for use in a residential area and may include:**
 - ✓ the devices having no fixed location of use, such as portable battery powered or batteries incorporated;
 - ✓ the telecommunication terminal equipment supplied by a telecommunications network;
 - ✓ personal computers and auxiliary devices connected to them.

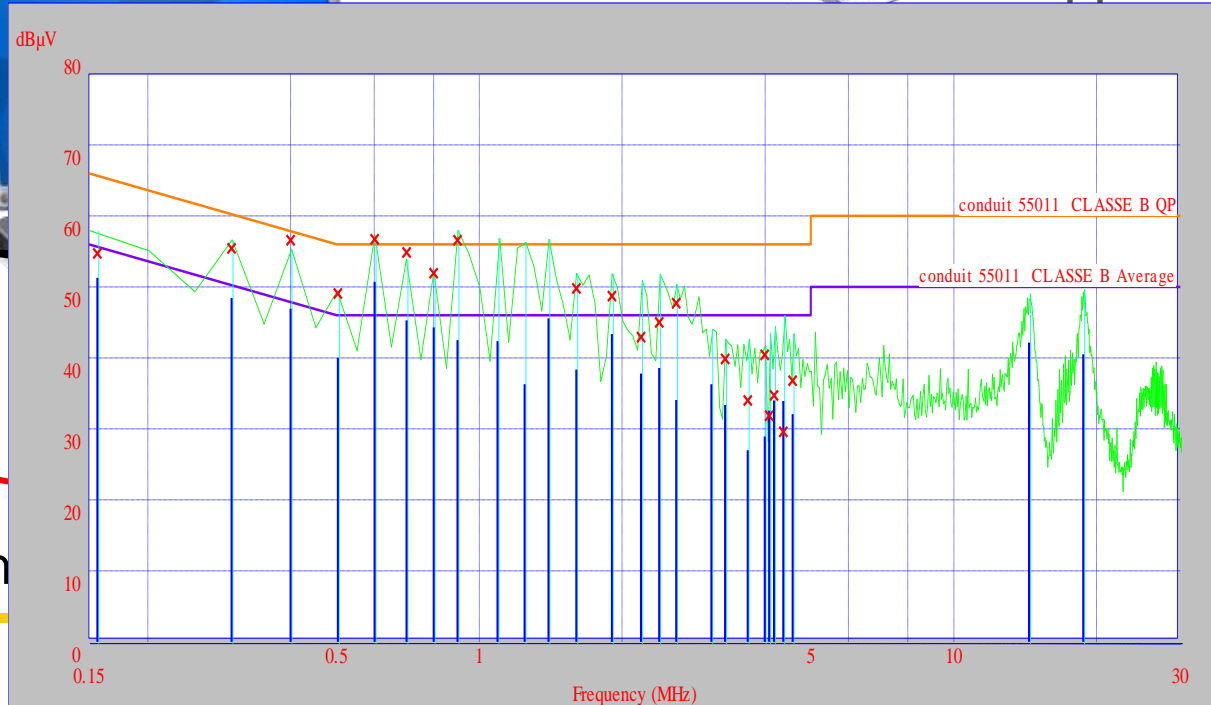
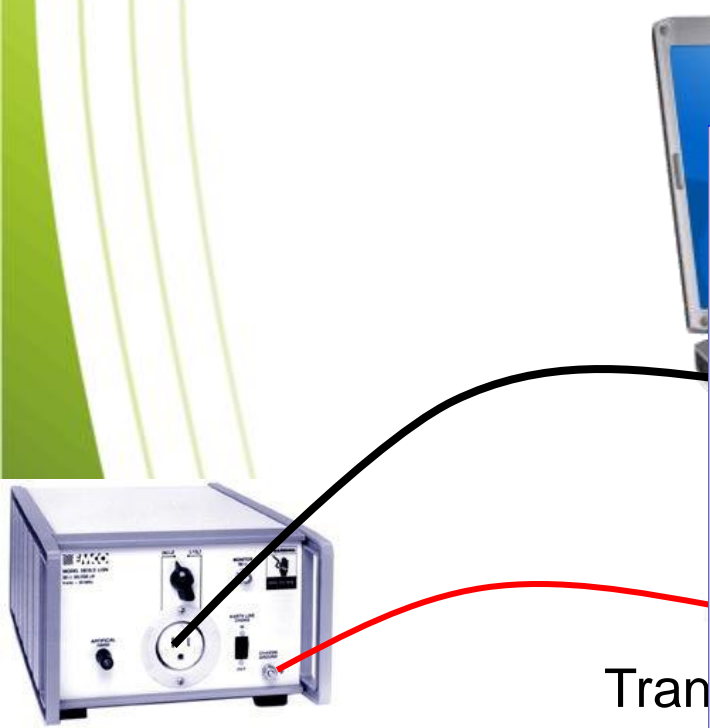
- **Class A consists of all other ATI complying with the limits of disturbance of class A but not those of class B.**
- **Can be used in commercial or industrial environment.**

Conducted emissions CISPR22/EN 55022

- For power supply lines:
 - ✓ LISN (Lines Impedance Stabilisation Network)
- For data lines:
 - ✓ ISN (Impedance Stabilisation Network)
- Transient limiter
- EMI receiver or spectrum analyser
- EMI software



Conducted emission – CISPR22 EN 55022

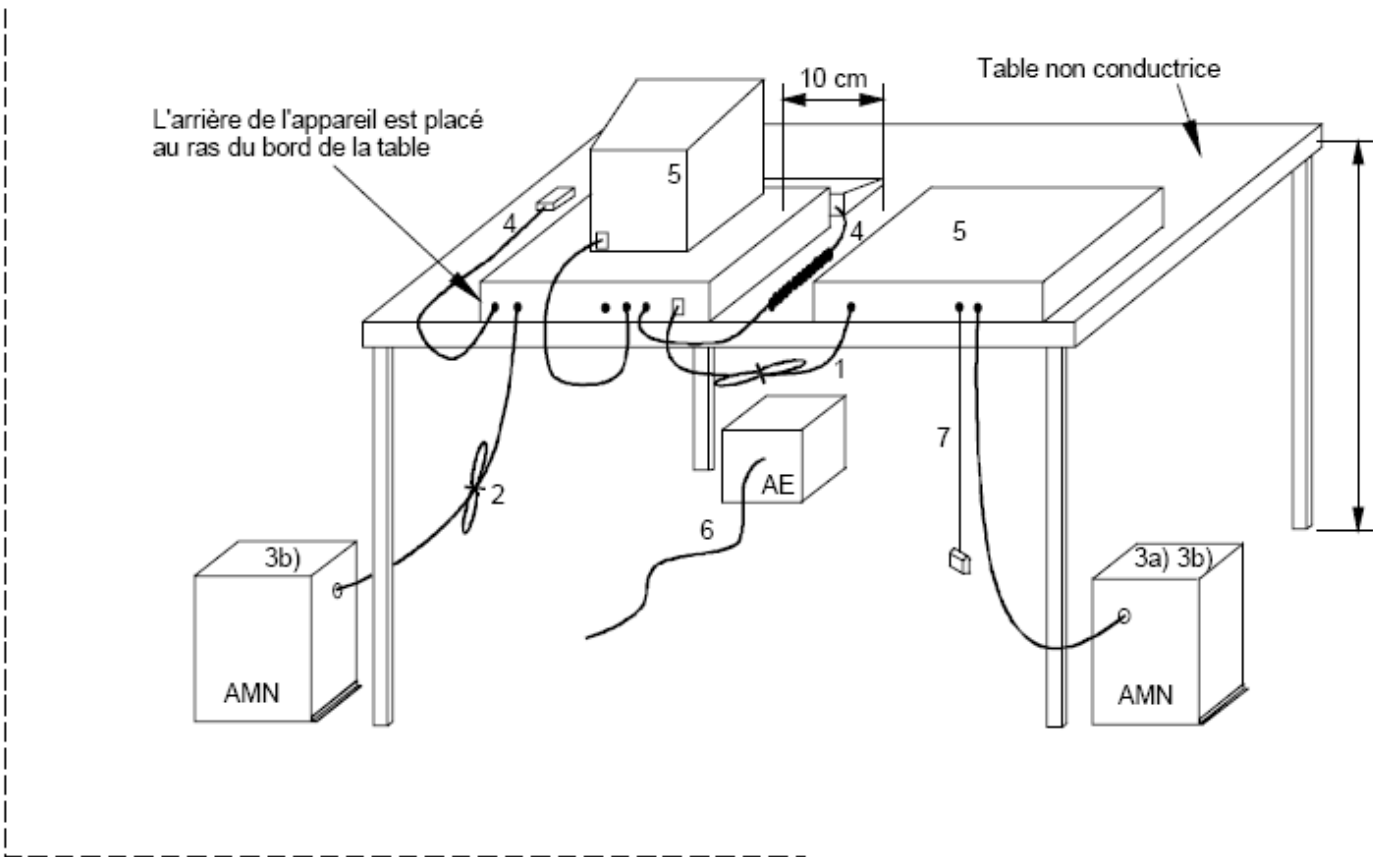


LISN

Trans

GPIB

Conducted emission test setup

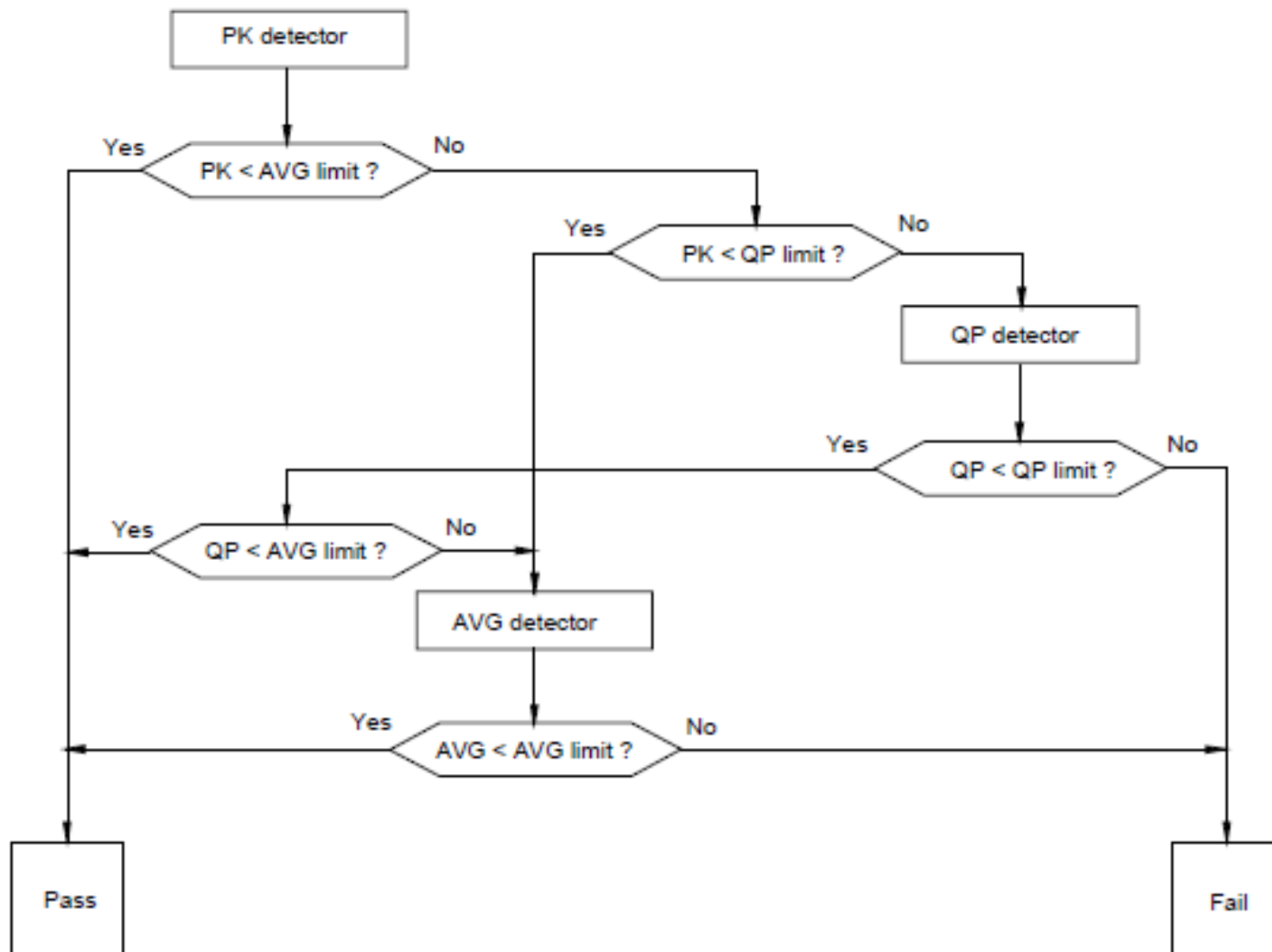


AMN = Réseau fictif
 AE = Appareil auxiliaire
 EUT = Appareil à l'essai
 RSI = Réseau de stabilisation d'impédance

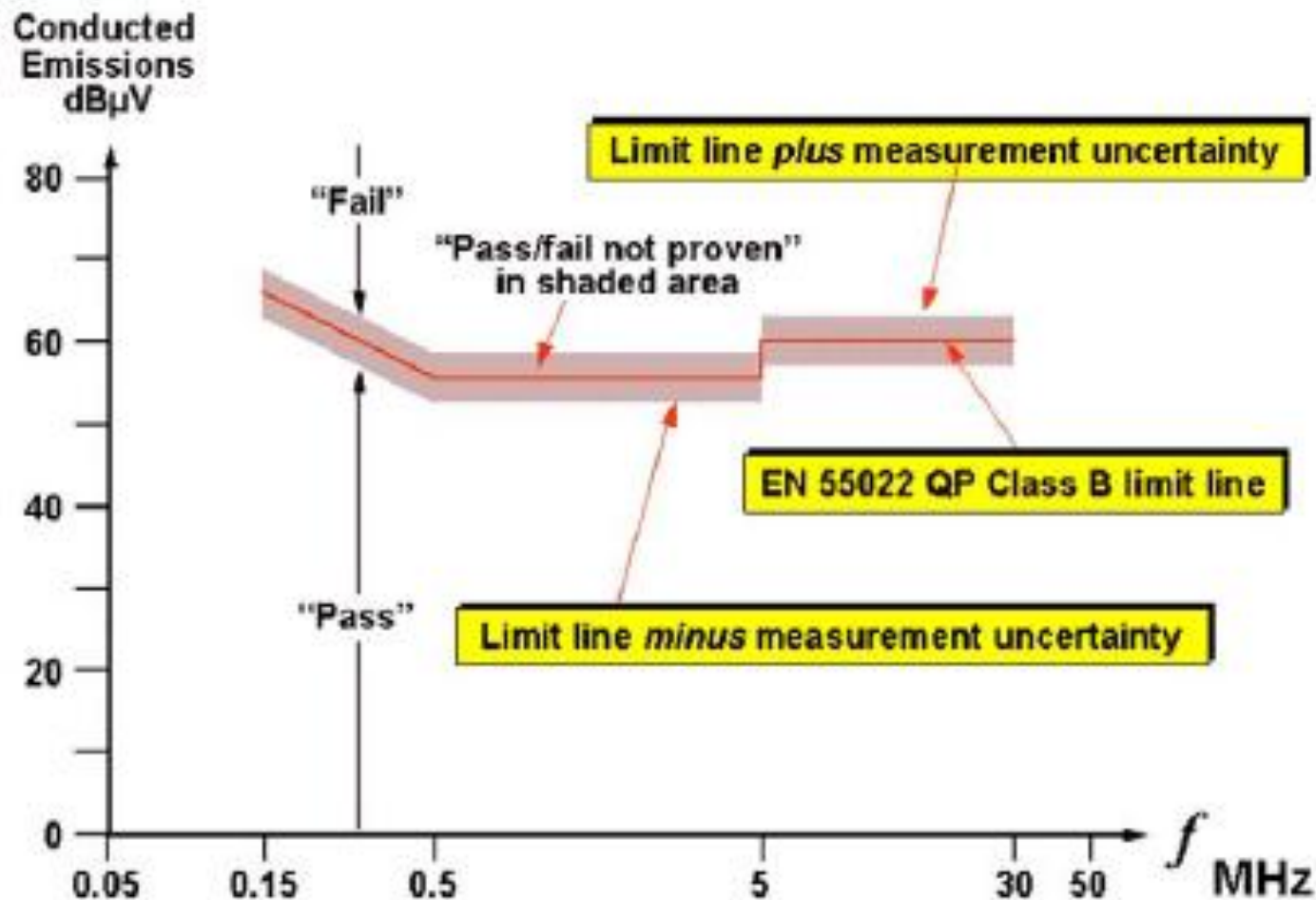
Measurement of conducted electromagnetic disturbances must be made:

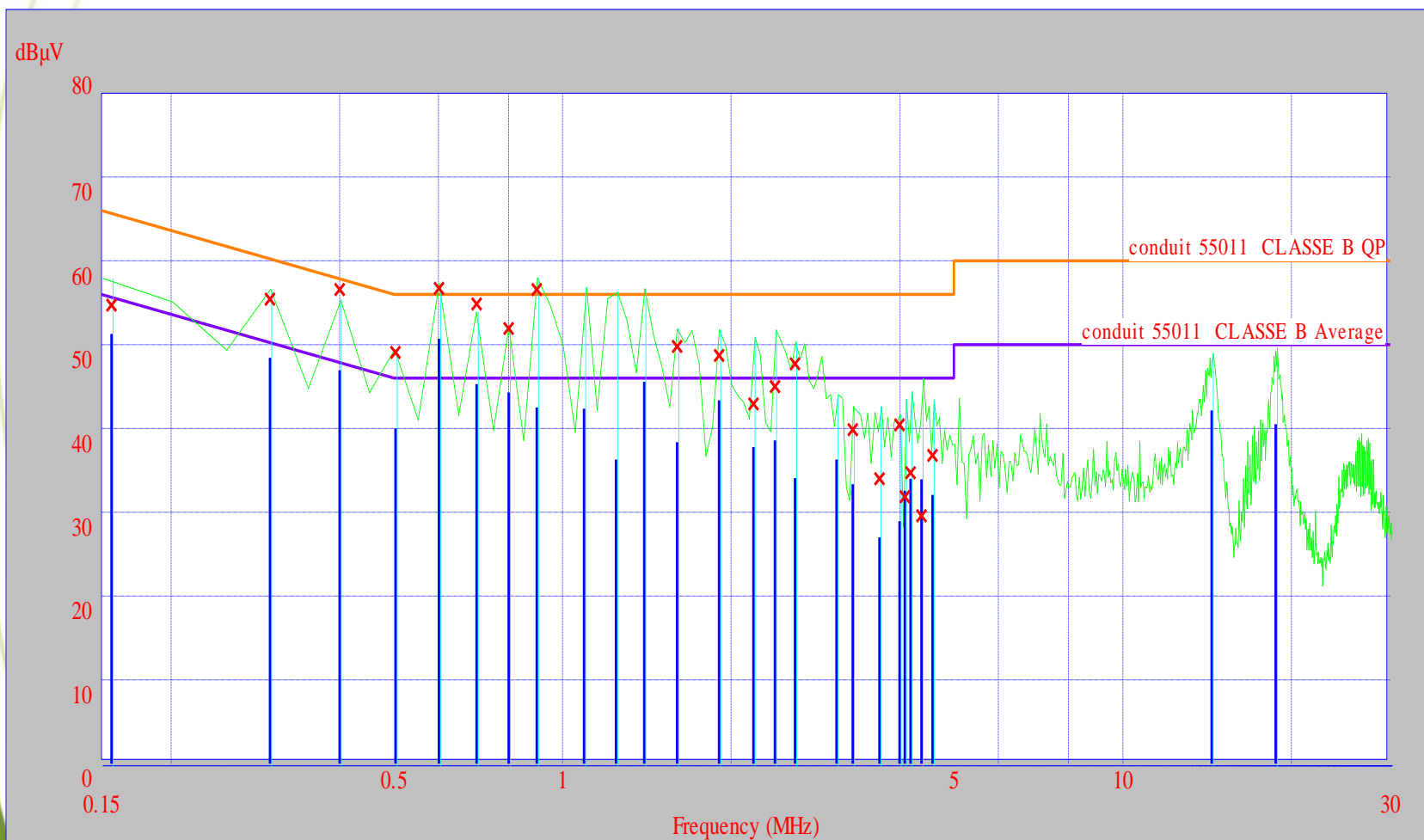
- by means of a measuring receiver
- with a peak detector
- in the frequency range 9 kHz to 30 MHz.

- The EUT shall respect the limits of Tables 1 and 2 which include limits on the **mean** value and limits on **quasi-peak** value
- A receiver is used to average value detection and a quasi-peak detector



Example of reporting measurement uncertainty
(EN 55022 QP Class B shown)







Radiated emissions

CISPR22/EN 55022



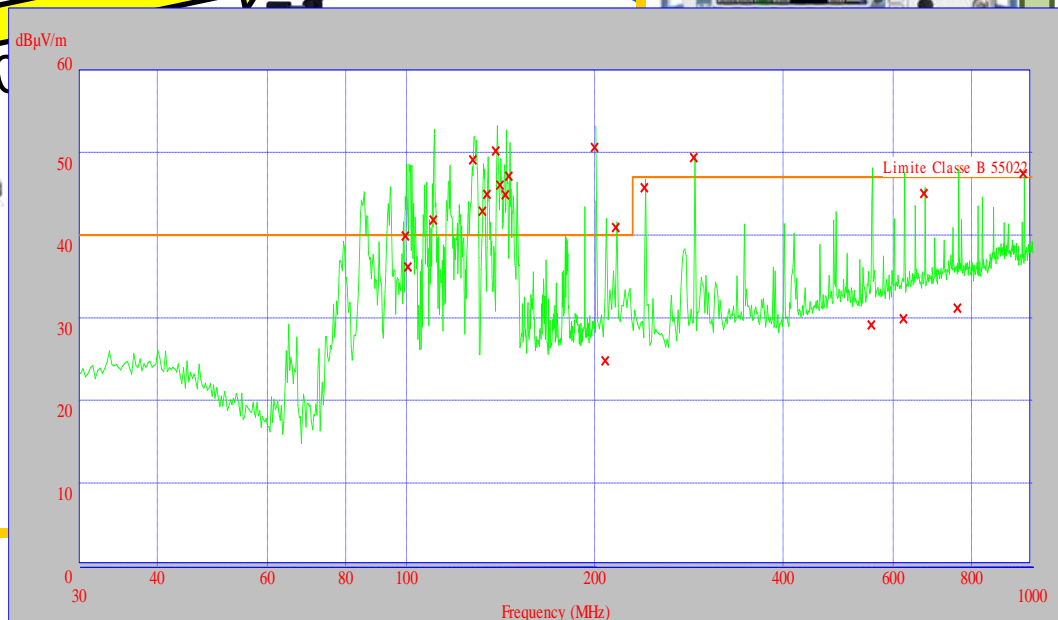
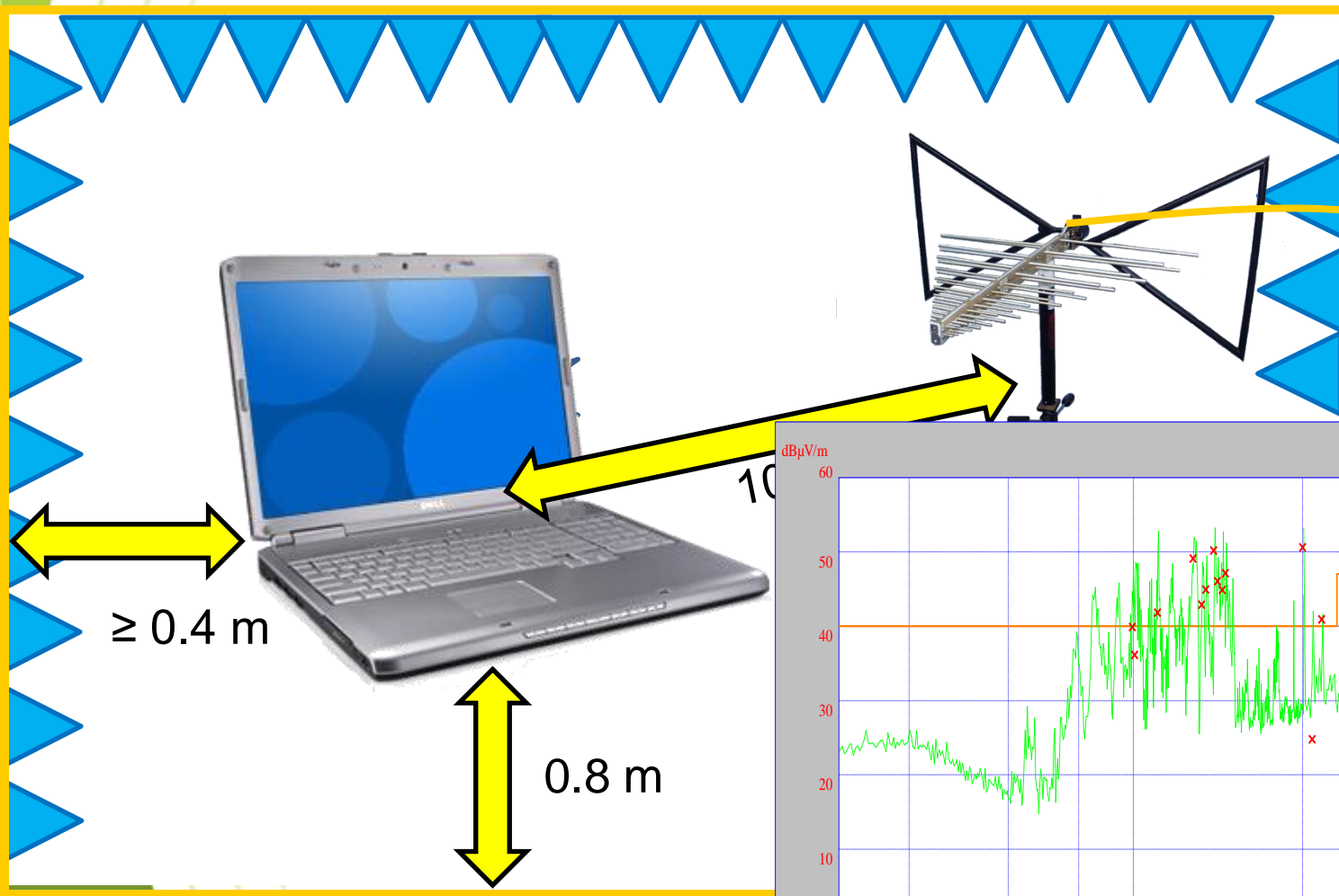
Required equipments



- Receiving antennas
- EMI receiver or spectrum analyser
- EMI software

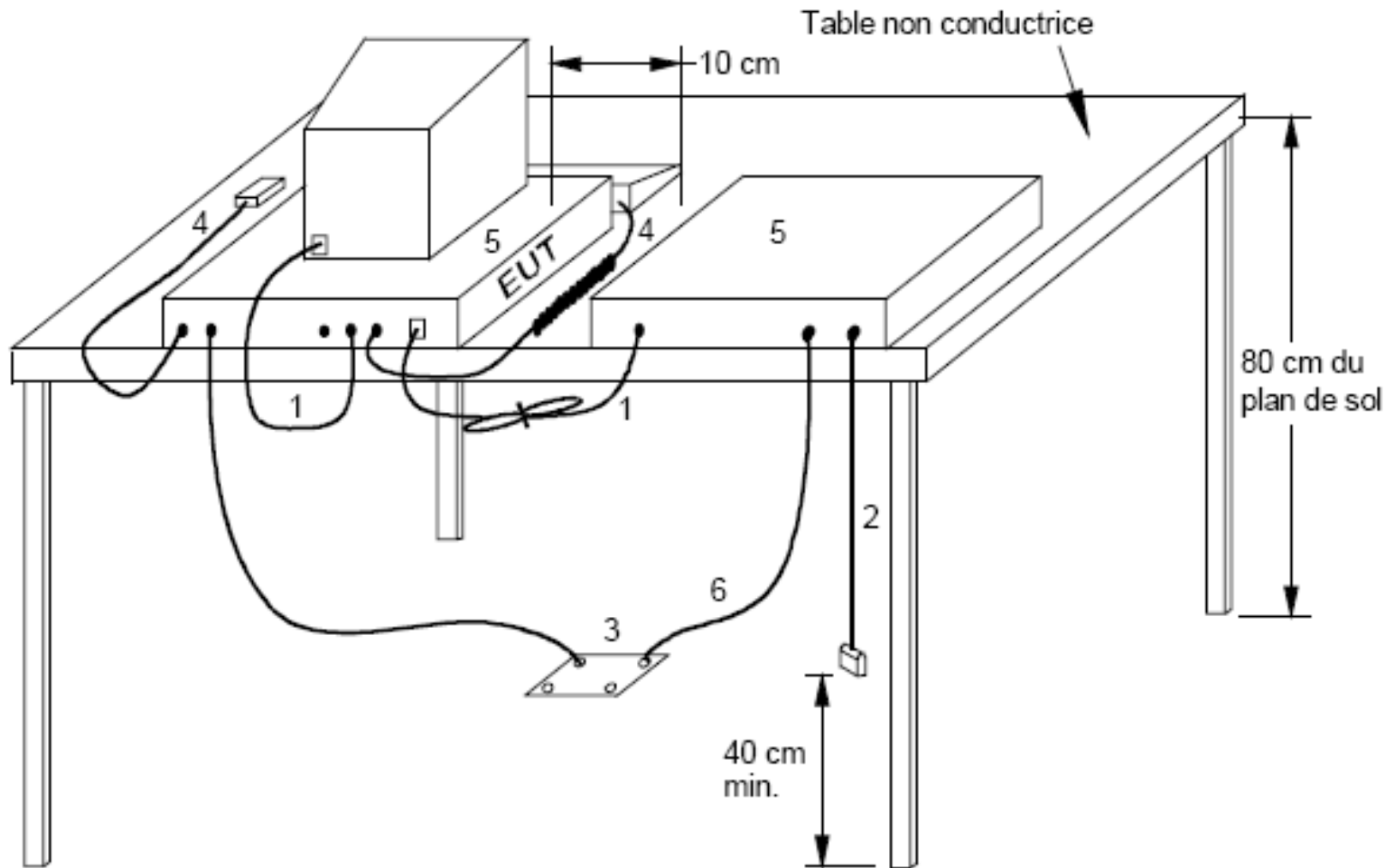


Radiated emission - CISPR22/EN 55022





Test setup for radiated emission

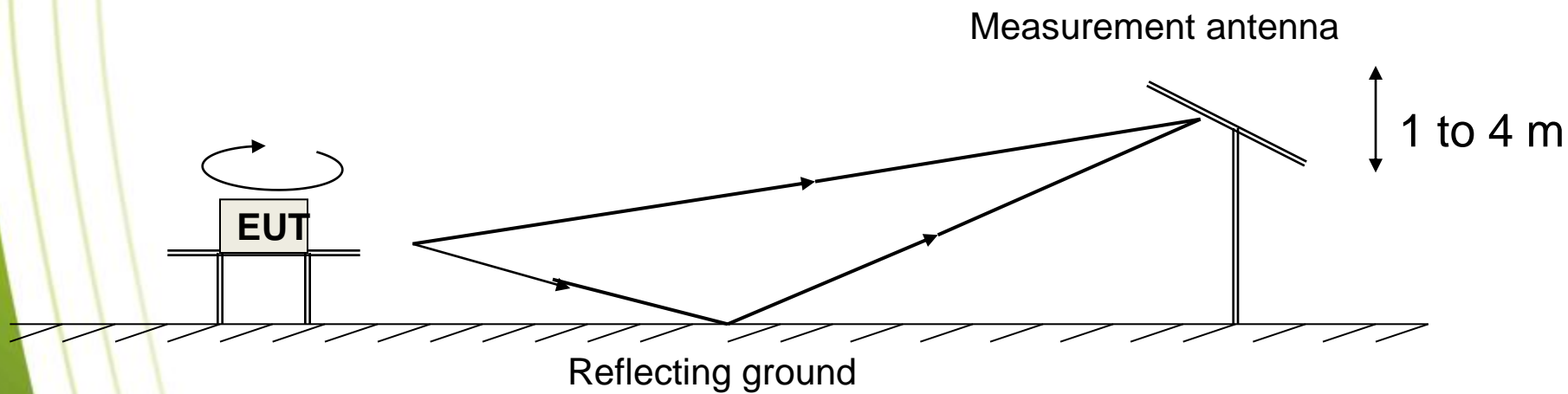


- The measurement of radiated electromagnetic disturbances must be performed by means of a measuring receiver equipped with a quasi-peak detector in the frequency range 30 MHz to 1 GHz or 6 GHz.
- A receiving antenna, associated with a measuring receiver, is placed at a specific distance from the EUT (test equipment)

- Peak measure to determine the most perturbing condition
- Determining antenna polarisation that most generate disturbances
- For every frequency :
 - ✓ Determine the antenna hight that captures the maximum measured level
 - ✓ Determine the angle that generated the maximum of disturbances



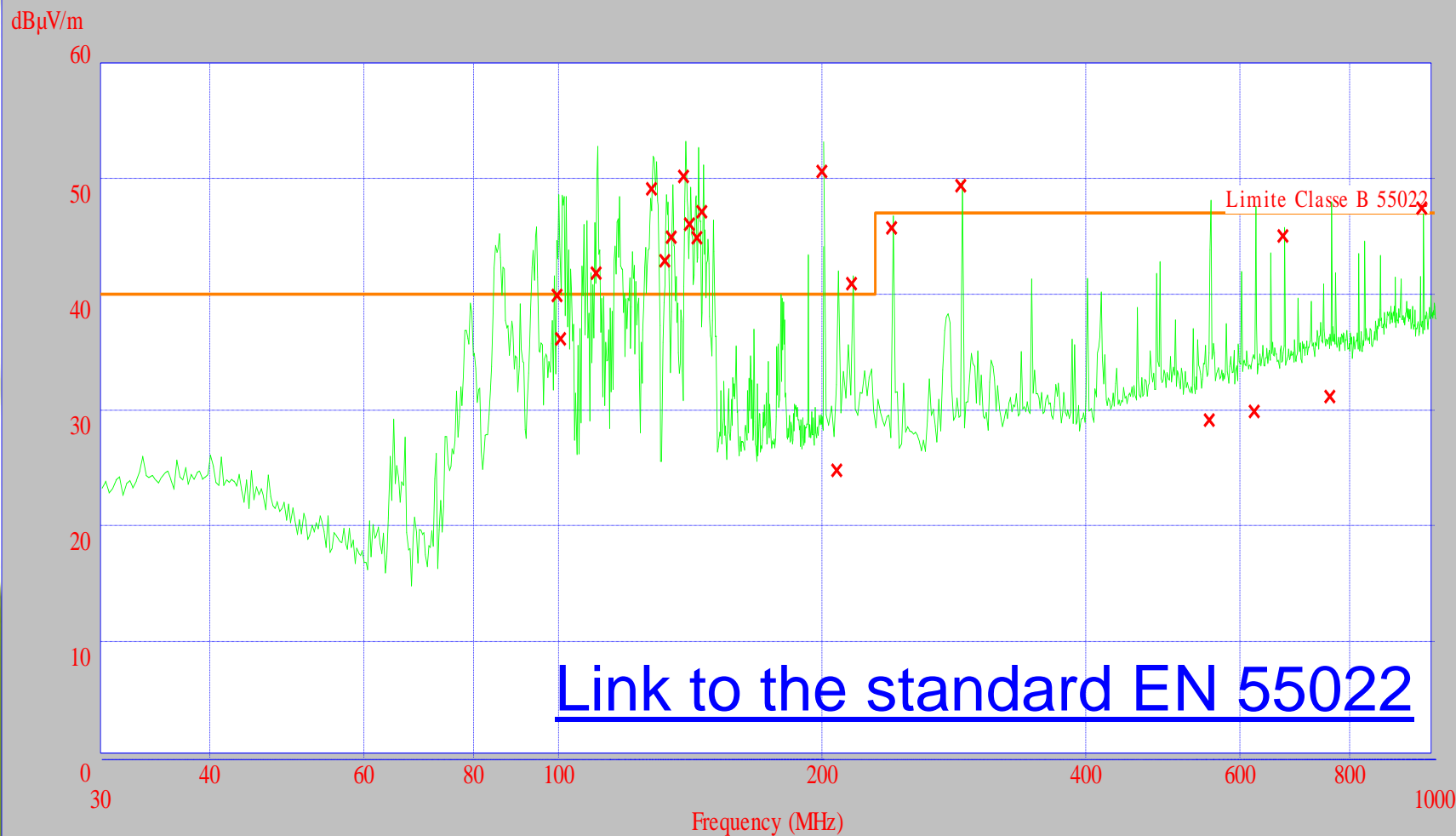
Radiated field measurement



Open area test site



Site de mesure en espace libre





Harmonics emission

IEC 61000-3-2



Harmonics emission – IEC 61000-3-2



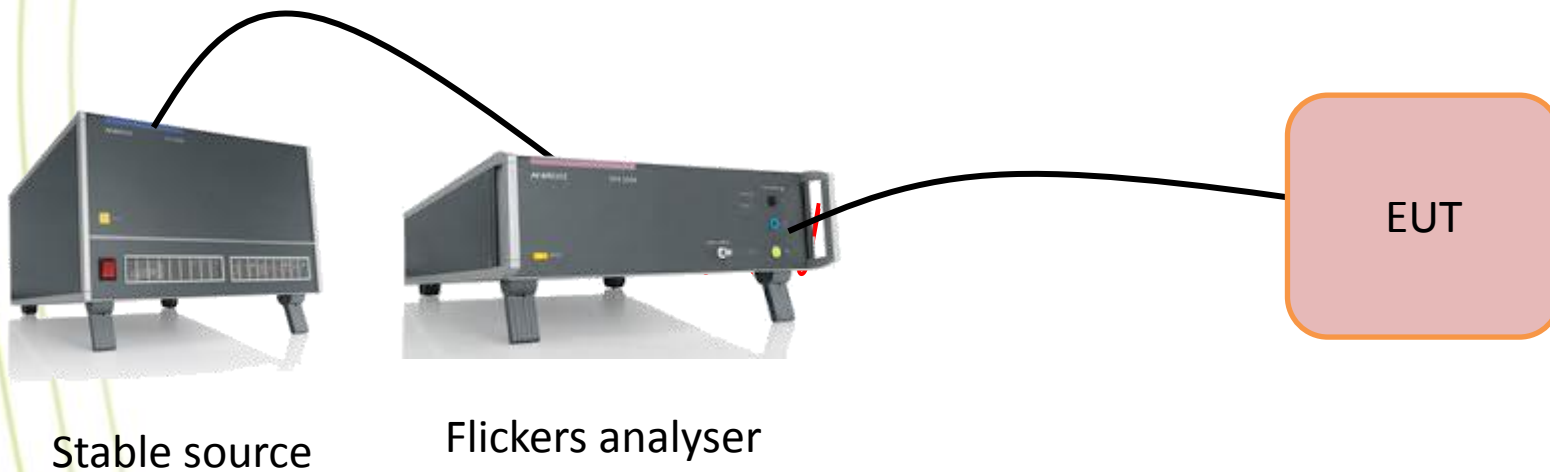
Stable source

Harmonics analyser

EUT



Flickers emission IEC 61000-3-2



Example of a product standard

[EN 55024](#)

Example of a generic standard

[EN 61000-6-1](#)

Example of a test report

[Link](#)



ITU Training on Conformance and Interoperability
for ARB and AFR Regions
CERT, 23-27 June 2014



Speed up your compliance

EMC standards

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