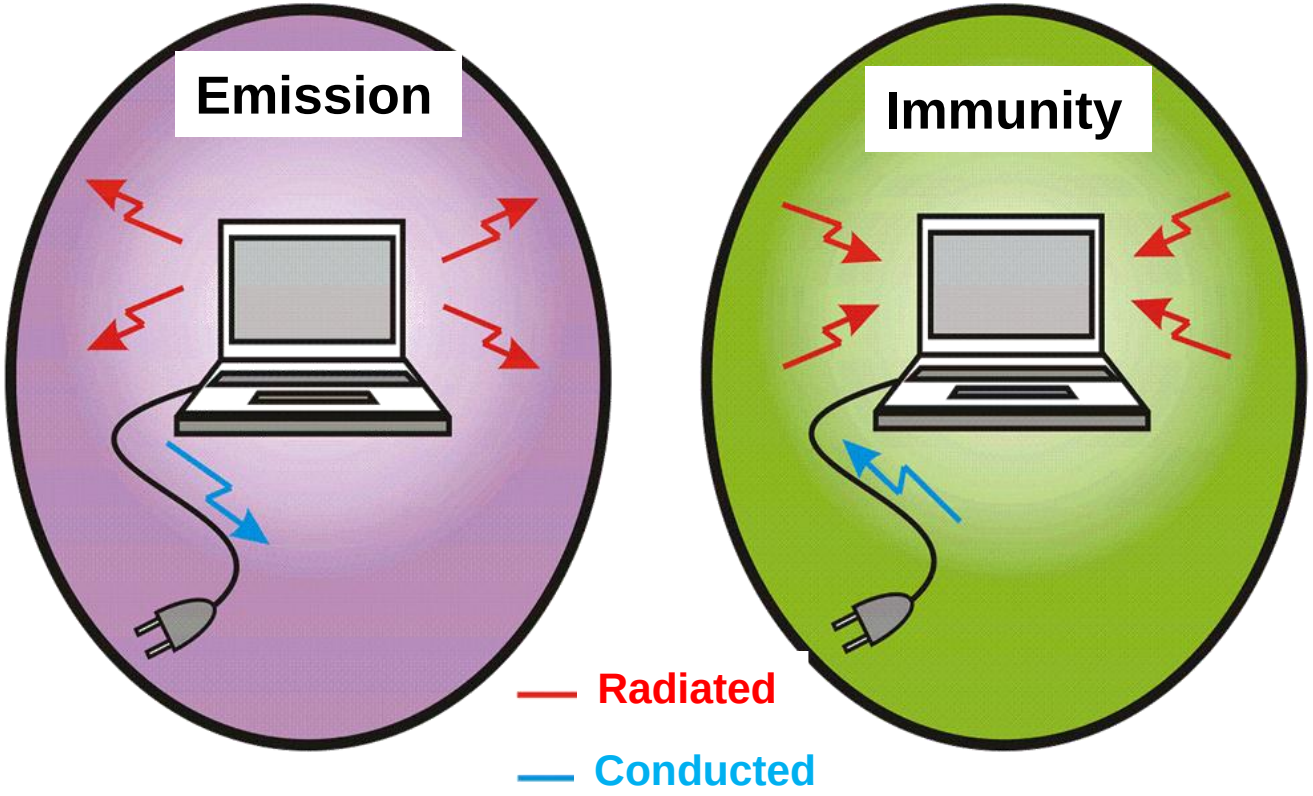
Training Course on Conformity and Interoperability on Type Approval testing for Mobile Terminals, Homologation Procedures and Market Surveillance, Tunis-Tunisia, from 20 to 24 April 2015

Speed up your compliance

EMC standards

Tunis (Tunisia), 20-24 April 2015

Types of EMC measures



Immunity tests

The purpose of immunity tests is to subject a product to a controlled stress that represents the likely range which is mostly dedicated by practical aspects and experience of real-world problems.

Immunity tests

1 – transient phenomena

Performance Criteria for Immunity Tests

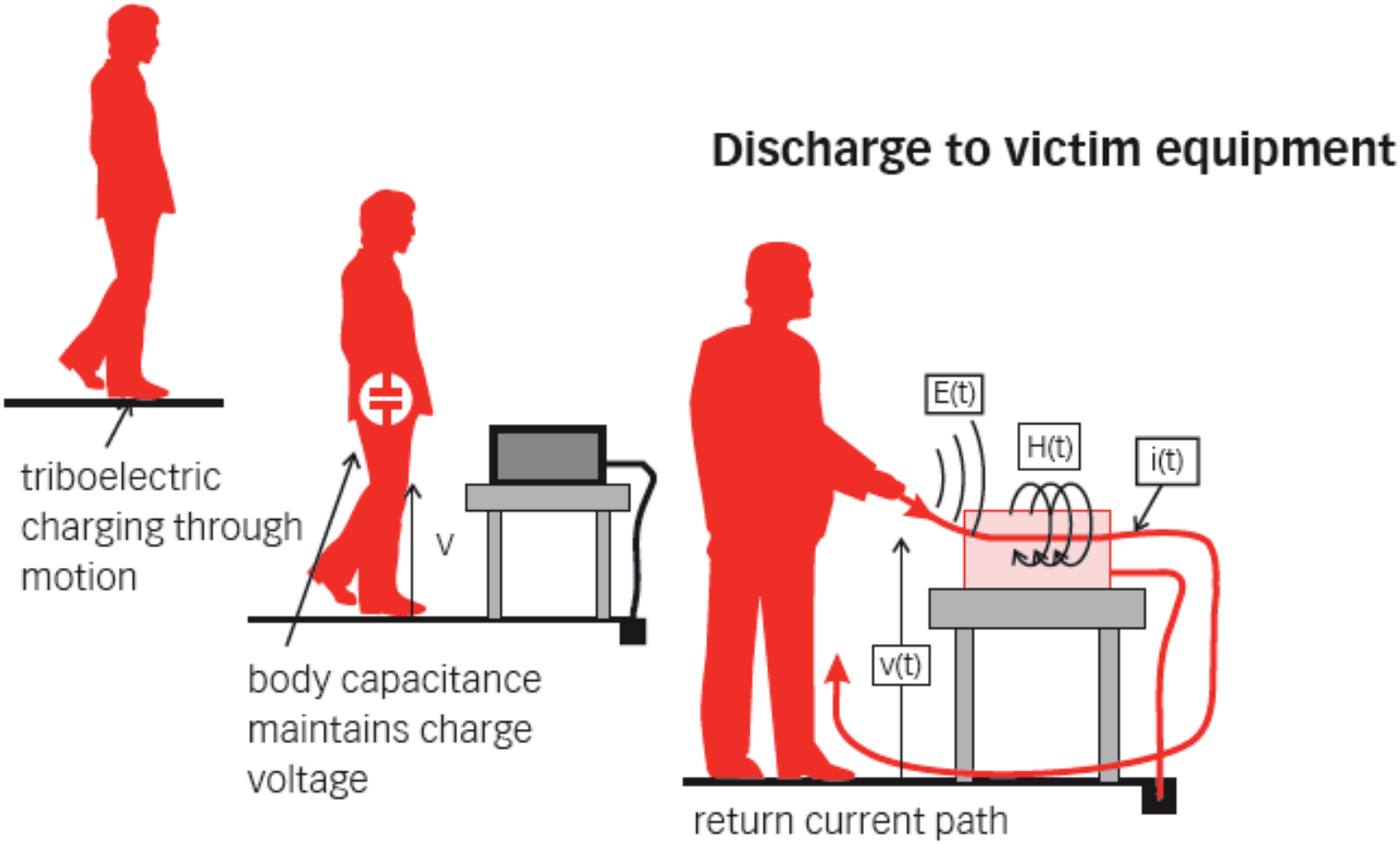
Results of immunity tests are classified into four categories:

- 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

Electrostatic Discharge
ESD – IEC 61000-4-2

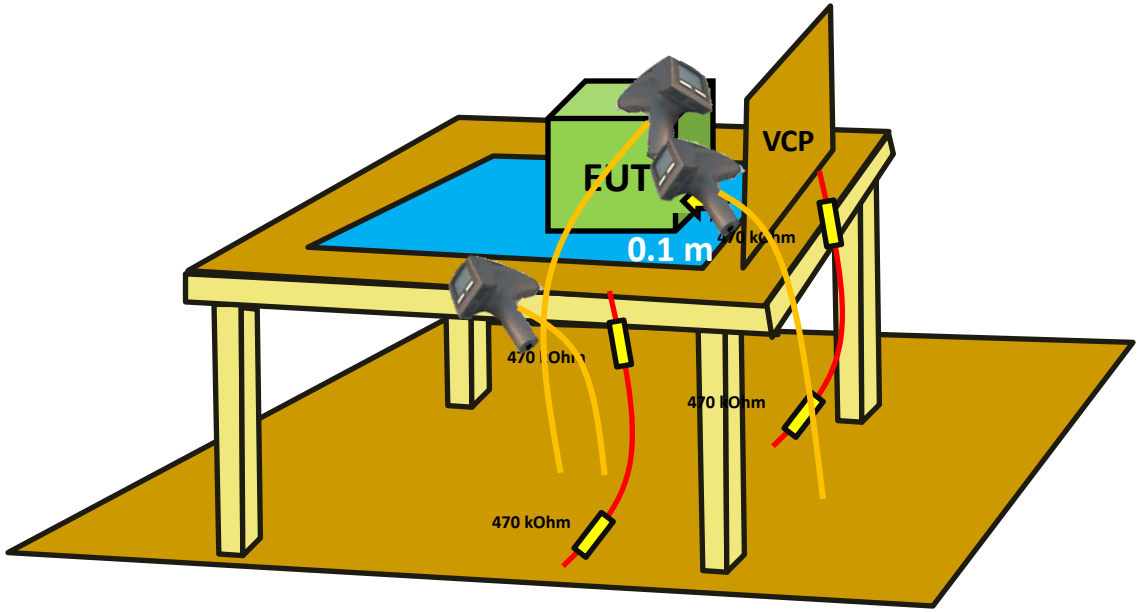


Electrostatic discharge (IEC 61000-4-2)

- 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 kΩ loads

ESD generator

ESD Test setup

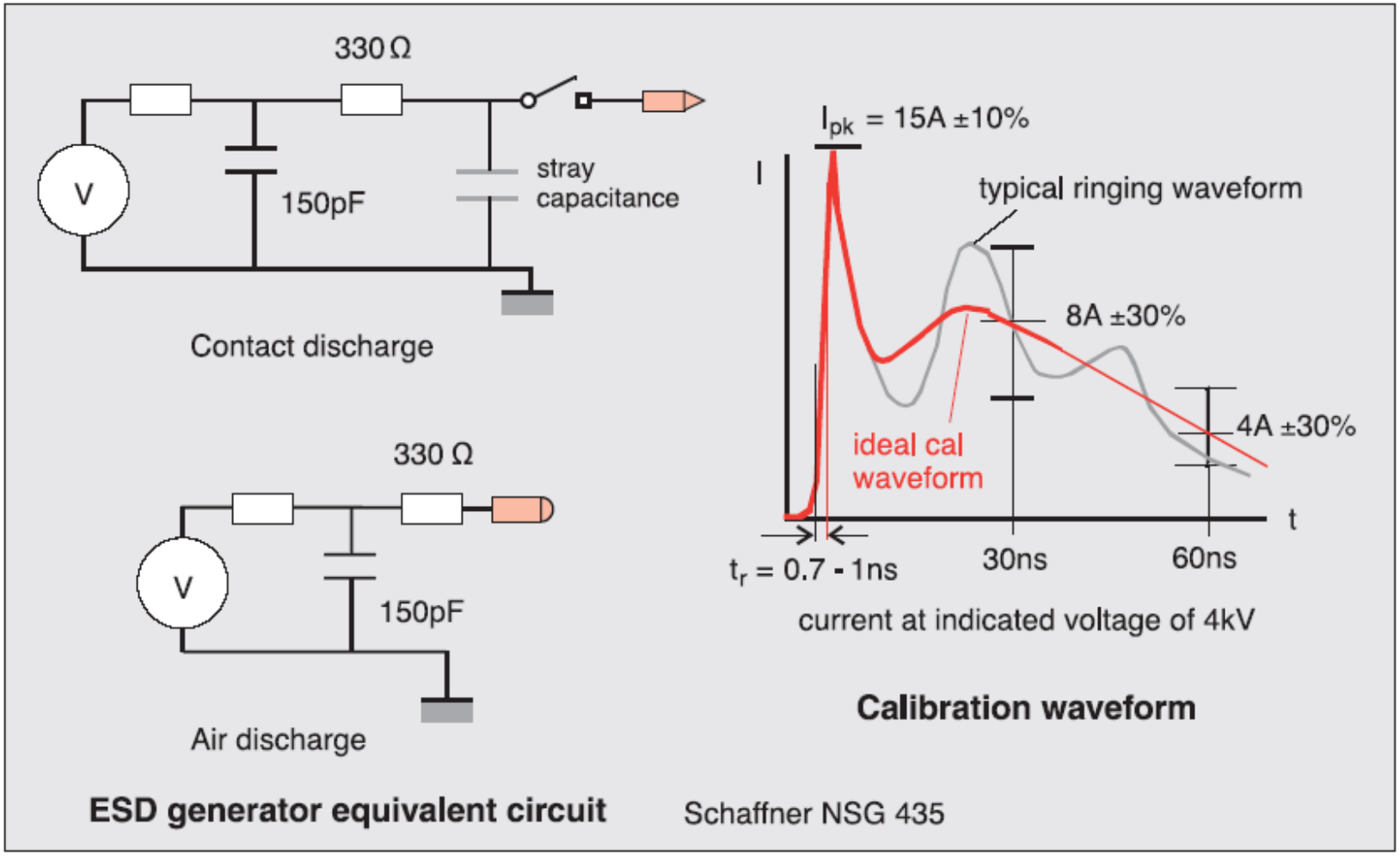


Conducting surface

Dielectrical material

Isolating surface

ESD Waveform



Test levels

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.

Performance Criteria for Immunity Tests

Results of immunity tests are classified into four categories:

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- Performance Criteria B – 'Temporary degradation which is self-recoverable'
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- Performance Criteria D – 'Loss of function which is not recoverable'

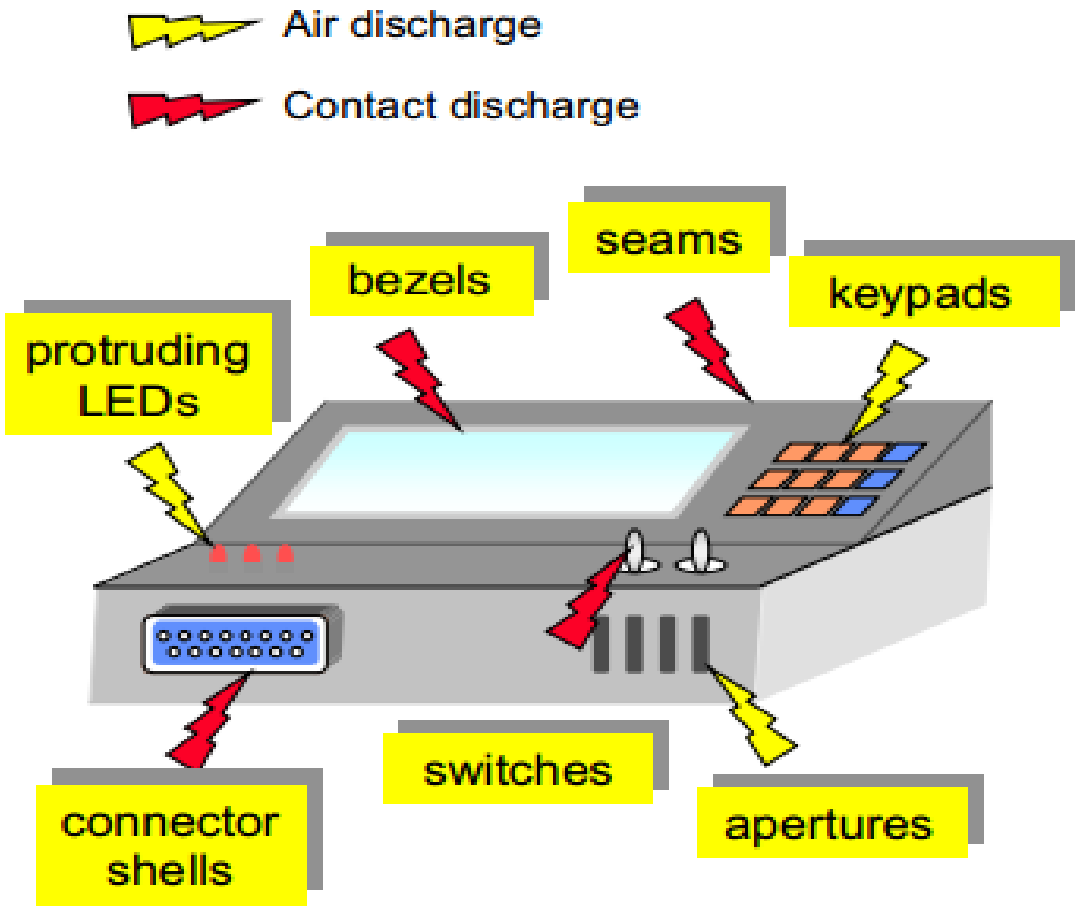
Standards calls

Standard	Scope	ESD	EFT-burst	Surge
IEC/EN 61000-6-1: 2001	Residential, commercial & light industrial generic	4 kV contact, 8 kV air to IEC/EN 61000-4-2	1 kV AC power, 0.5 kV DC power > 10 m, signal and functional earth > 3 m to IEC/EN 61000-4-4	1 kV L-L, 2 kV L-E on AC power input; 0.5 kV L-L & L-E DC power > 10 m, to IEC/EN 61000-4-5
IEC/EN 61000-6-2: 2005	Industrial generic	4 kV contact, 8 kV air to IEC/EN 61000-4-2	2 kV AC power, DC power > 3 m, 1 kV signal and functional earth > 3 m to IEC/EN 61000-4-4	1 kV L-L, 2 kV L-E on AC power; 0.5 kV L-L & L-E DC power connected to a distribution network; 1 kV L-E signal > 30 m, to IEC/EN 61000-4-5
EN 55014-2: 1997 + A1: 2001	Household appliances etc.	4 kV contact, 8 kV air to IEC/EN 61000-4-2	1 kV AC power, 0.5 kV DC power, signal and control > 3 m to IEC/EN 61000-4-4	1 kV L-L, 2 kV L-E on AC mains, to IEC/EN 61000-4-5
EN 55020: 2002	Broadcast receivers etc.	4 kV contact, 8 kV air to IEC/EN 61000-4-2	1 kV AC power to IEC/EN 61000-4-4	Not required
EN 55024: 1998	Information technology equip-ment	4 kV contact, 8 kV air to IEC/EN 61000-4-2	1 kV AC power, 0.5 kV DC power, signal and telecom > 3 m to IEC/EN 61000-4-4	1 kV L-L, 2 kV L-E on AC mains, 0.5 kV L-E on DC power with outdoor cables, to IEC/EN 61000-4-5; 1.5 kV 10/700 µs on signal/telecom ports with outdoor cables, to ITU-T K recs.

Discharge Application

- 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 insolating 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

Choice of discharge points



- 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).

Execution of the test

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.

Contact/air discharge

- 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

ESD design

Design to avoid ESD problems includes:

- choose circuit configurations that are unresponsive to short transients
- lay out the PCB to minimise induced voltages at critical

  nodes
- prevent unavoidable discharge transients from coupling

  into circuits and cables
- design enclosures as far as possible to prevent discharges from occurring

EFT

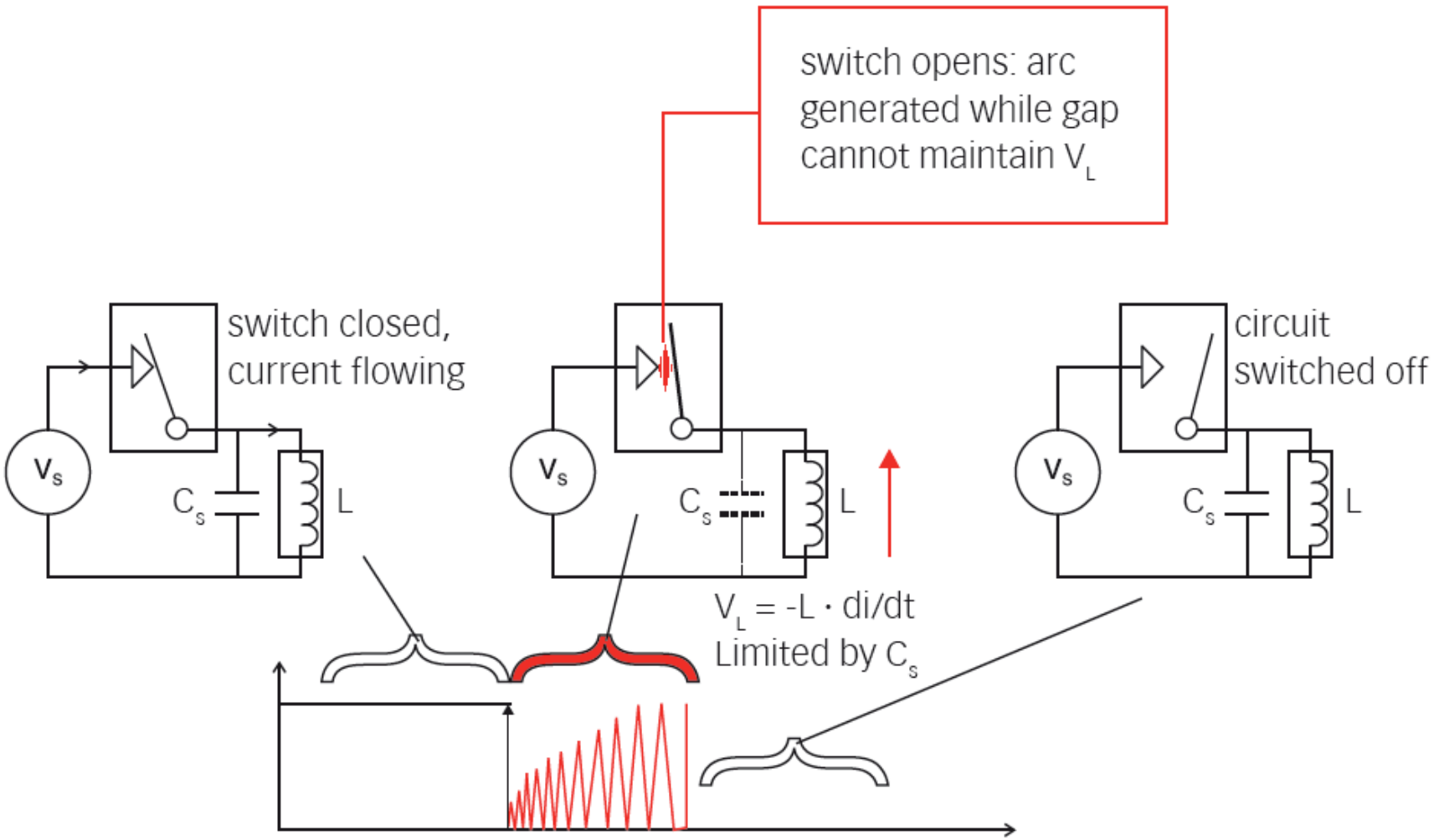
IEC 61000-4-4

The EFT phenomenum

- When a circuit is switched off, the current fl owing through the switch is interrupted more or less instantaneously.
- At the moment of switching there is an infinite di/dt.
- All circuits have some stray inductance associated with the wiring; some types of load, such as motors or solenoids, have considerably more inductance in the load itself.
- The voltage developed across an inductance L by a changing current i is :

$$V = -L \cdot di/dt$$

The EFT phenomenum



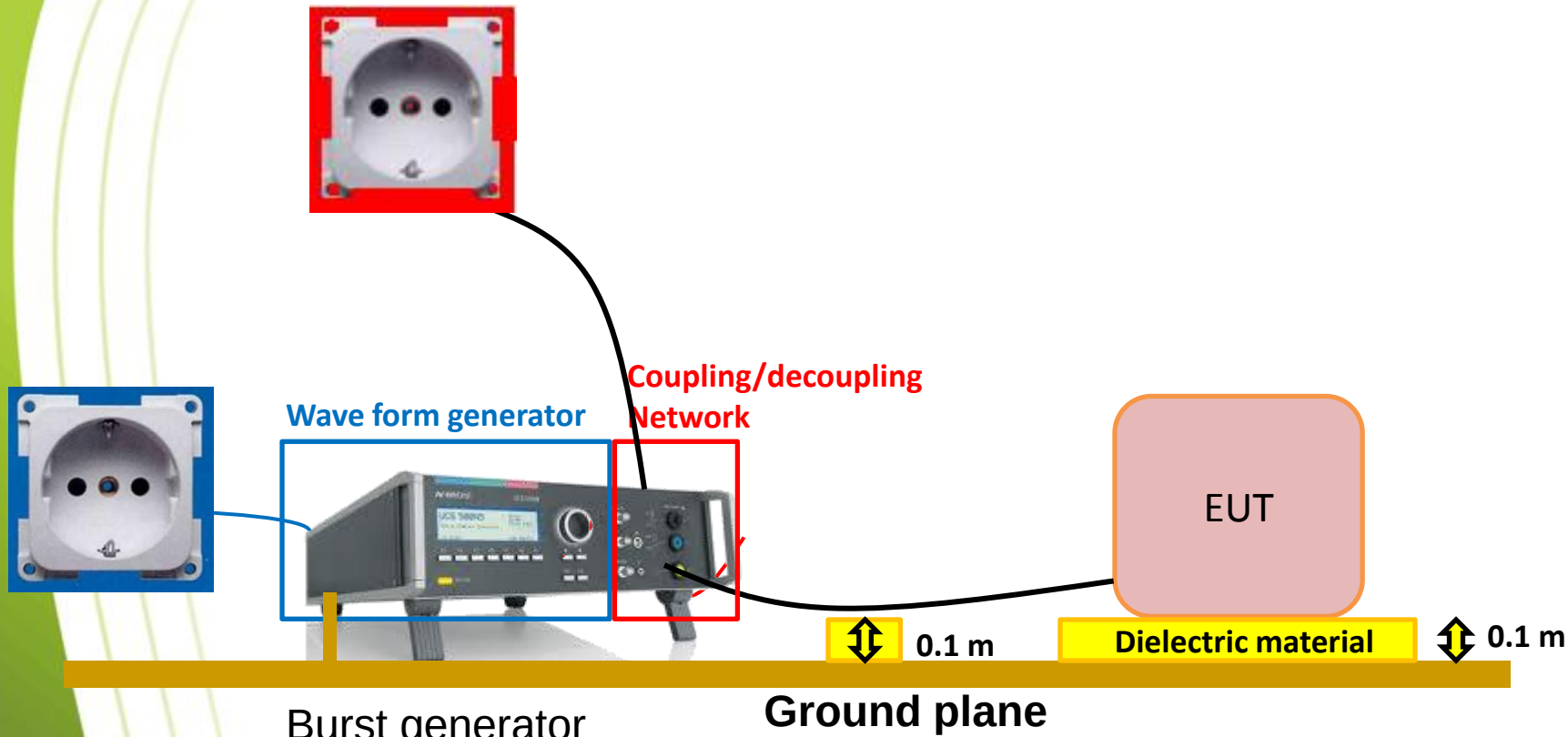
Electrical fast transients IEC 61000-4-4

- 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

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



Test levels

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.

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IEC/EN 61000-6-2: 2005	Industrial generic	4 kV contact, 8 kV air to IEC/EN 61000-4-2	2 kV AC power, DC power > 3 m, 1 kV signal and functional earth > 3 m to IEC/EN 61000-4-4	1 kV L-L, 2 kV L-E on AC power; 0.5 kV L-L & L-E DC power connected to a distribution network; 1 kV L-E signal > 30 m, to IEC/EN 61000-4-5
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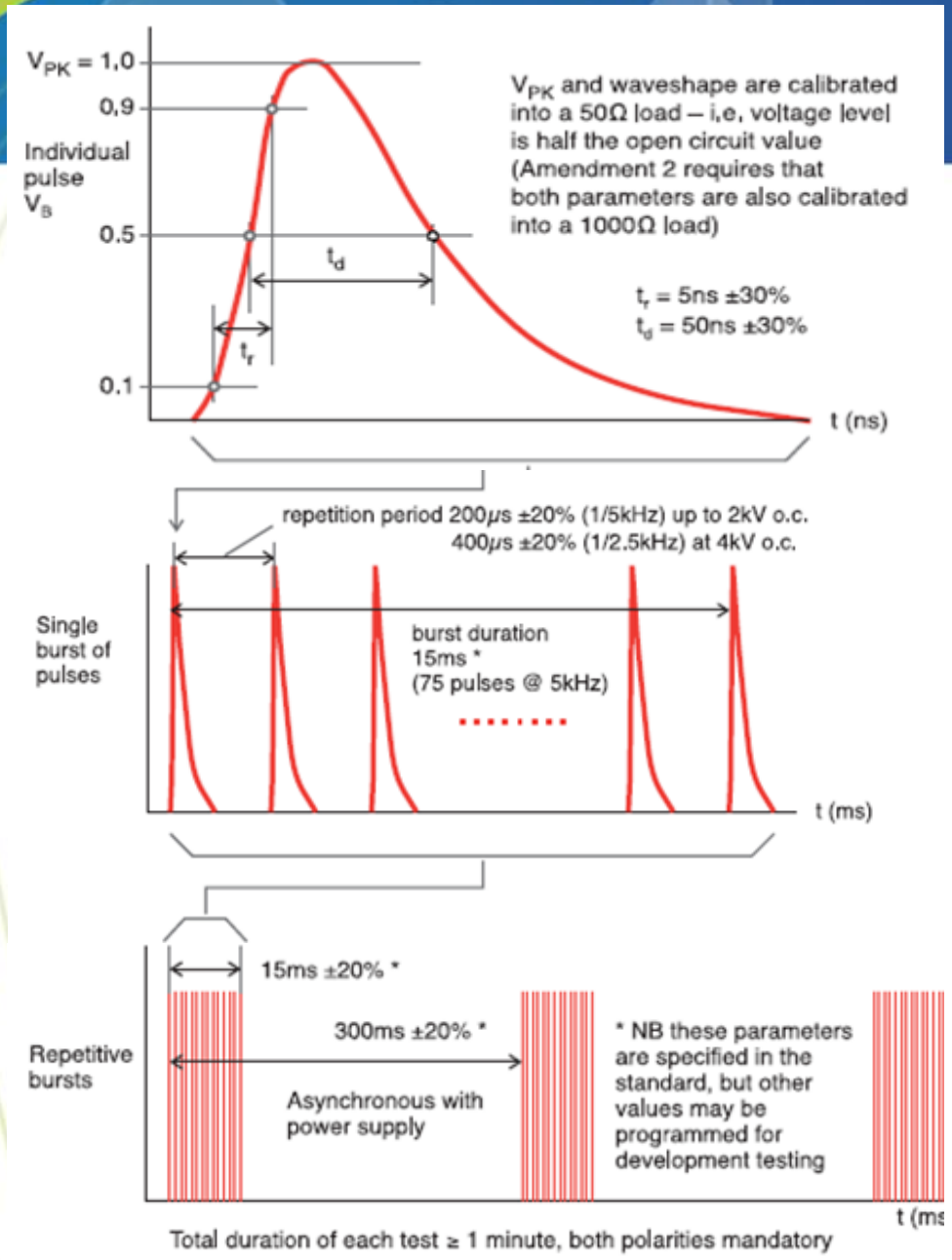


EFT wave form

EFT Application

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

Test setup

- 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.

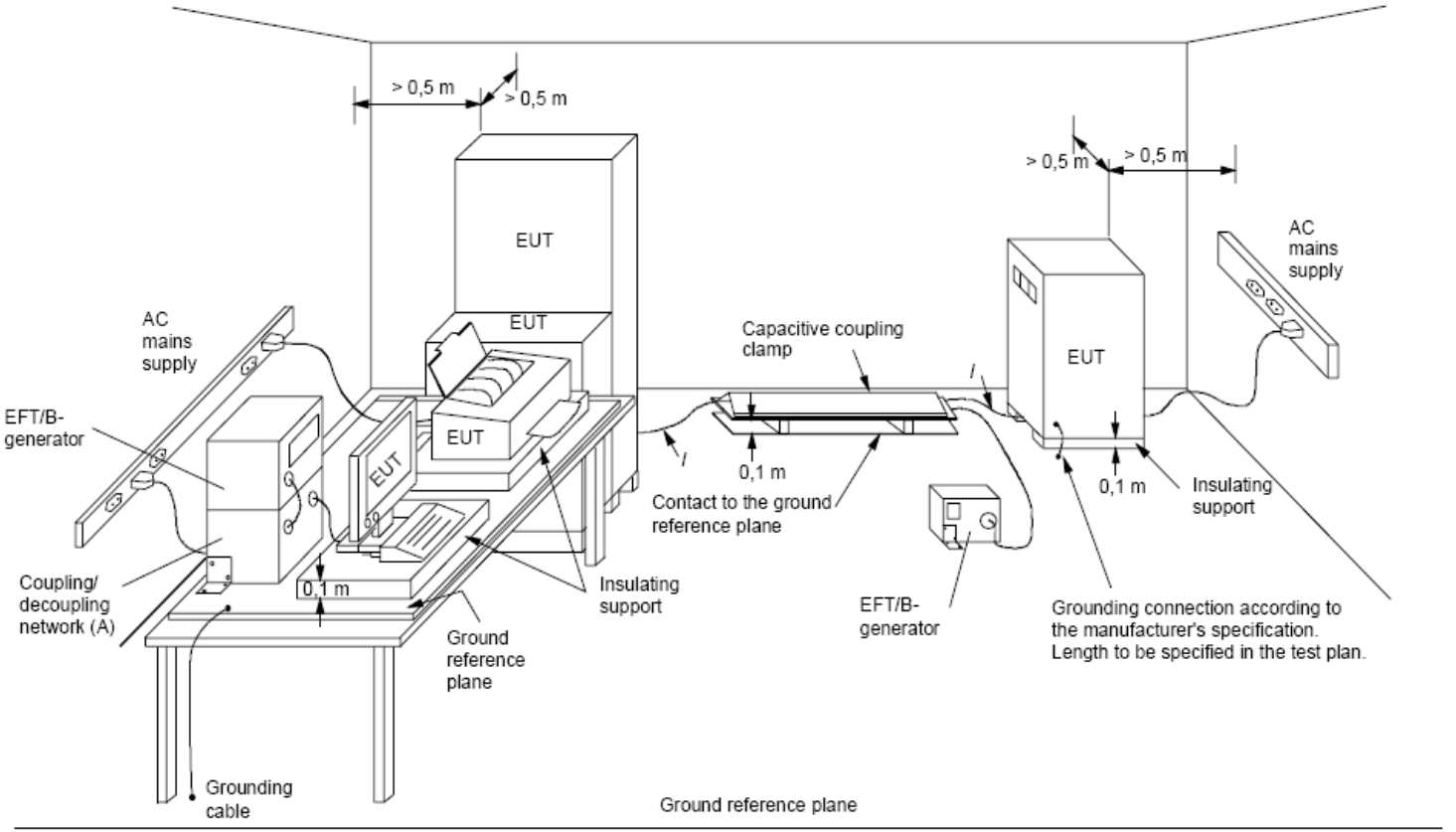
Test setup

- 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.

Test procedure

- 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.

Test setup



IEC 901/04

Key

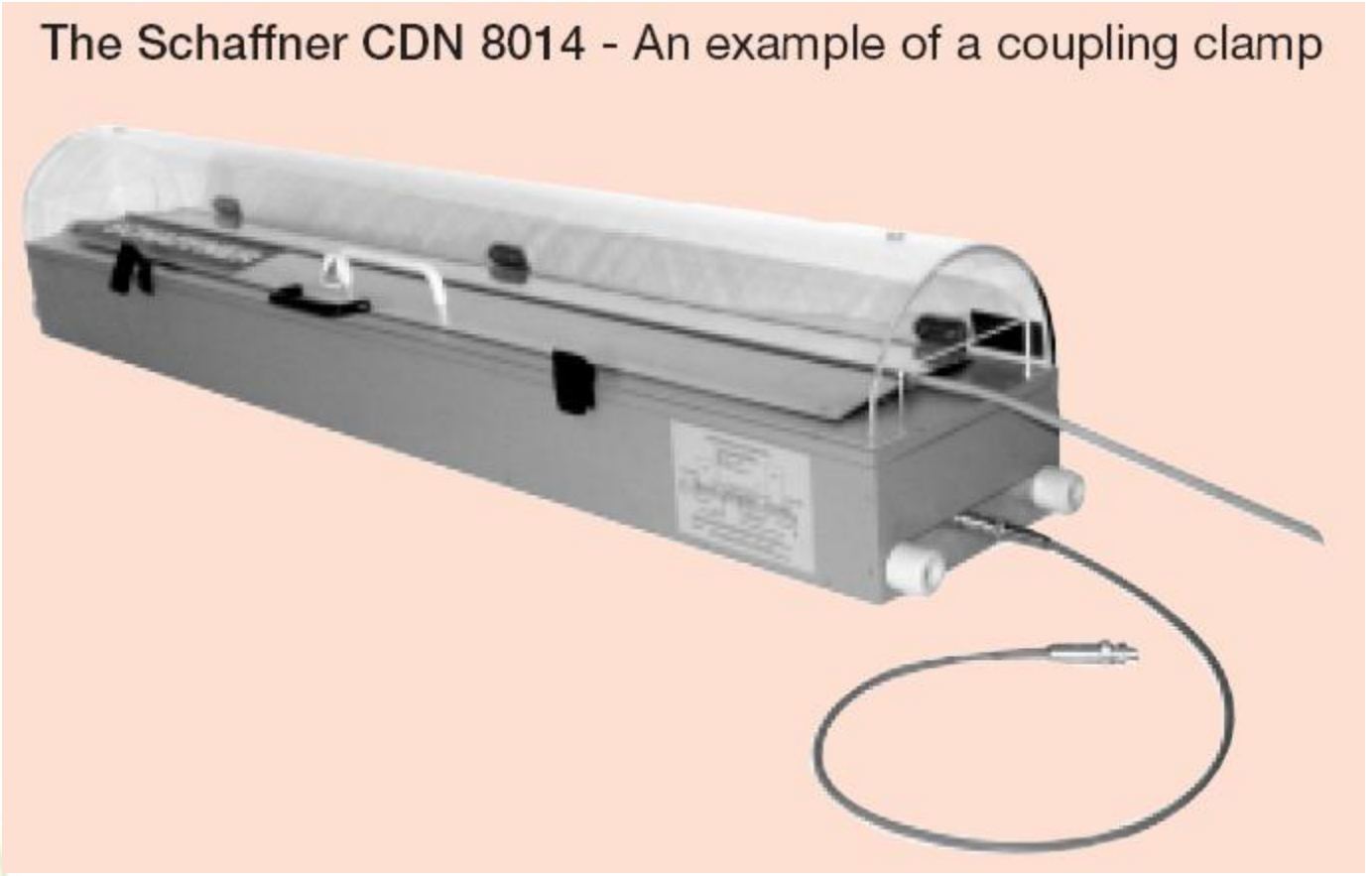
l length between clamp and the EUT to be tested (should be 0,5 m ± 0,05 m)

(A) location for supply line coupling

(B) location for signal lines coupling

Capacitive coupling clamp

The Schaffner CDN 8014 - An example of a coupling clamp

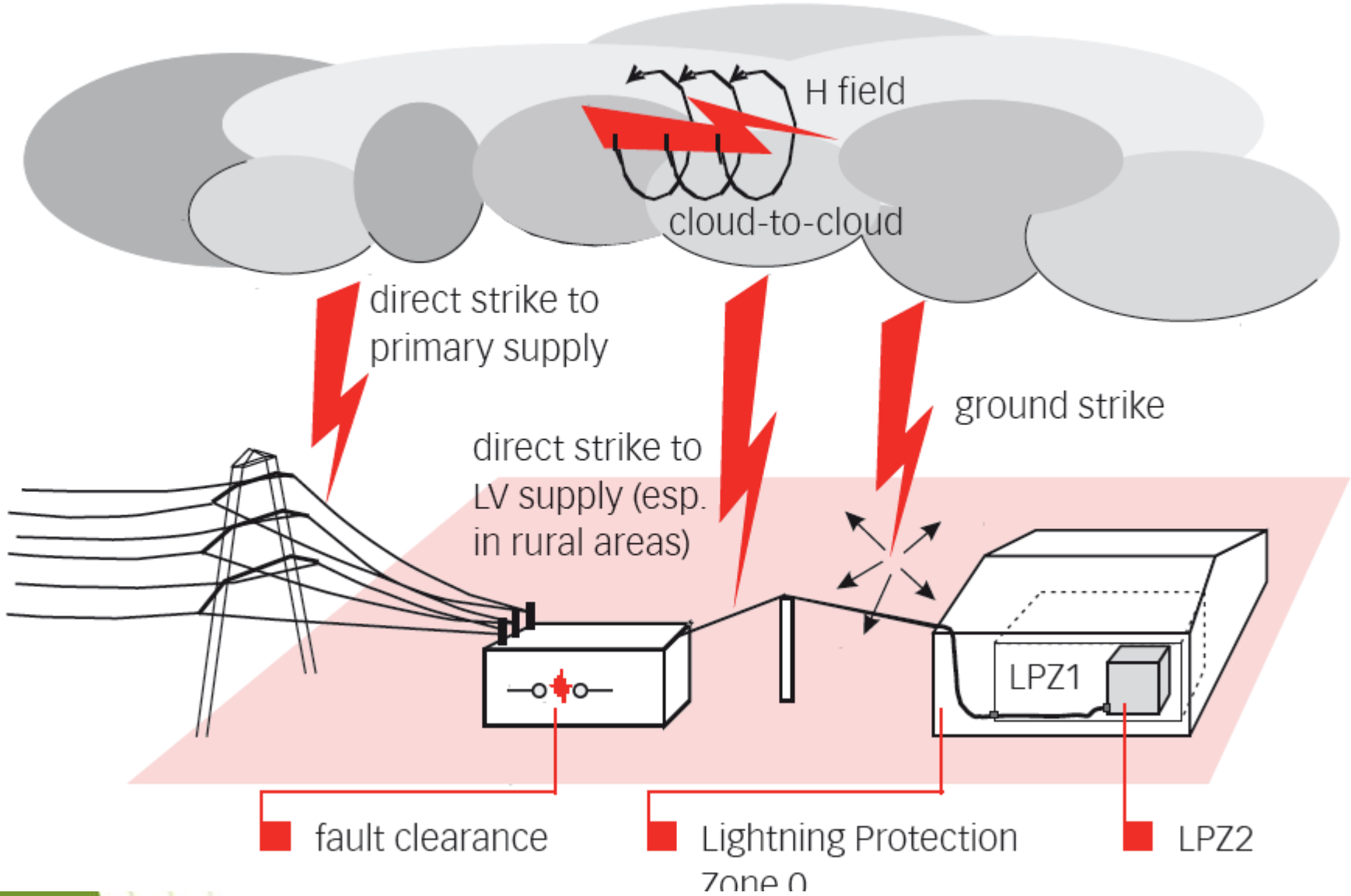


Link to the standard IEC 61000-4-4

Surge

IEC 61000-4-5

The surge phenomenum



Surge effects

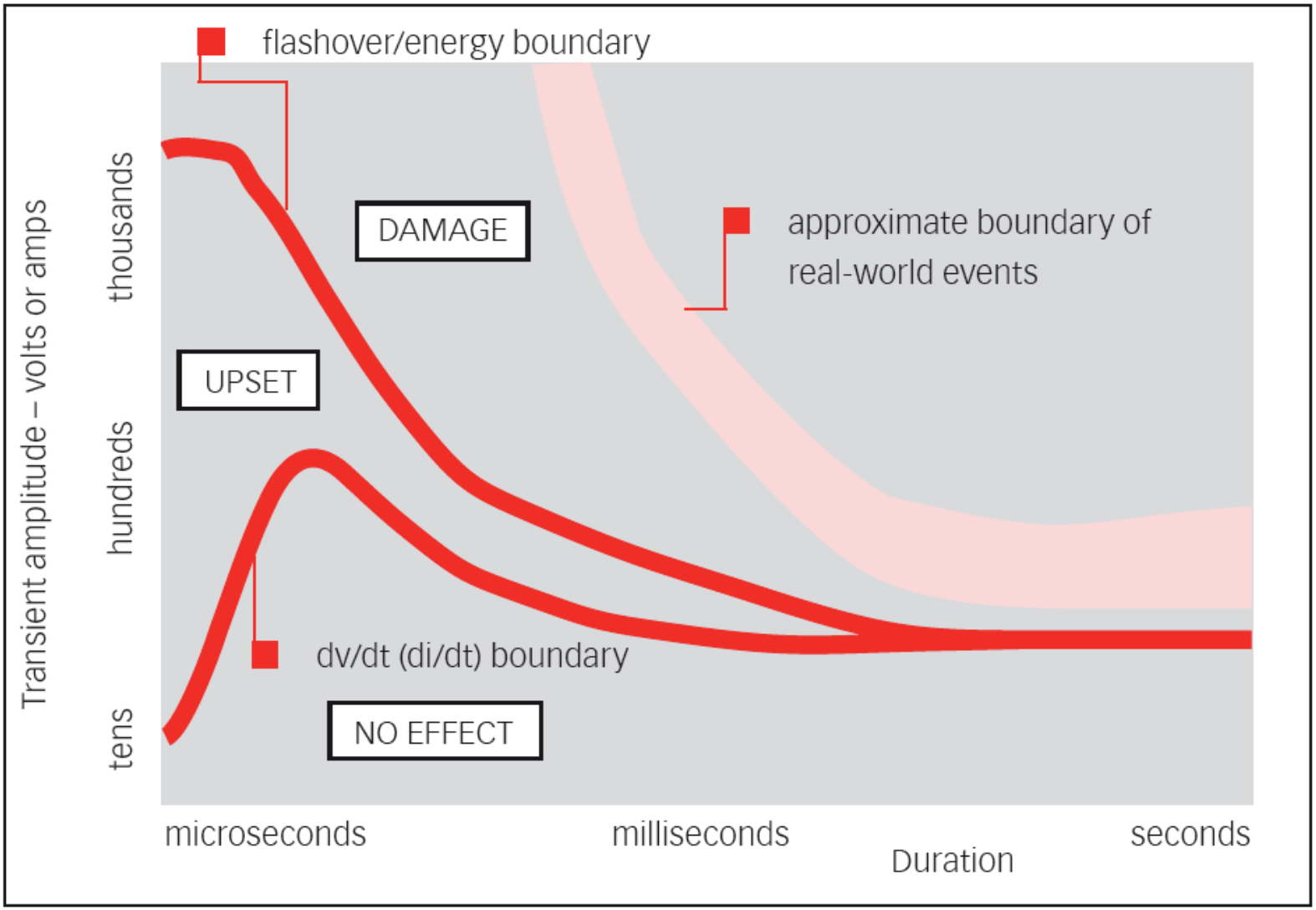
- Surges impinging on electronic equipment may cause

  hardware damage and complete failure, or in lesser cases, operational upset.
- Below some level dependent on equipment design, no

  effect is observed.
- Above this level, a surge may cause the operation of the

  equipment to change state

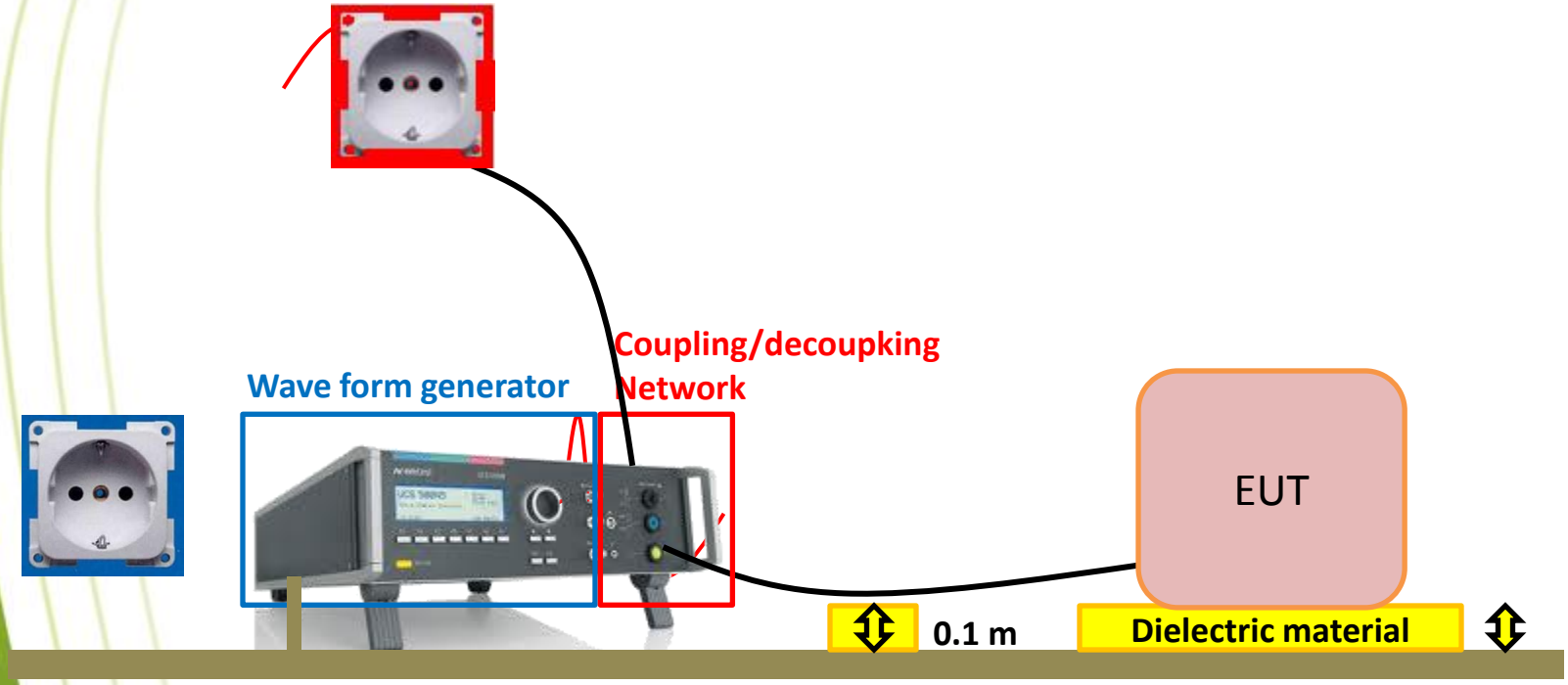
surge parameters vs equipments effects



Surge tests (IEC 61000-4-5)

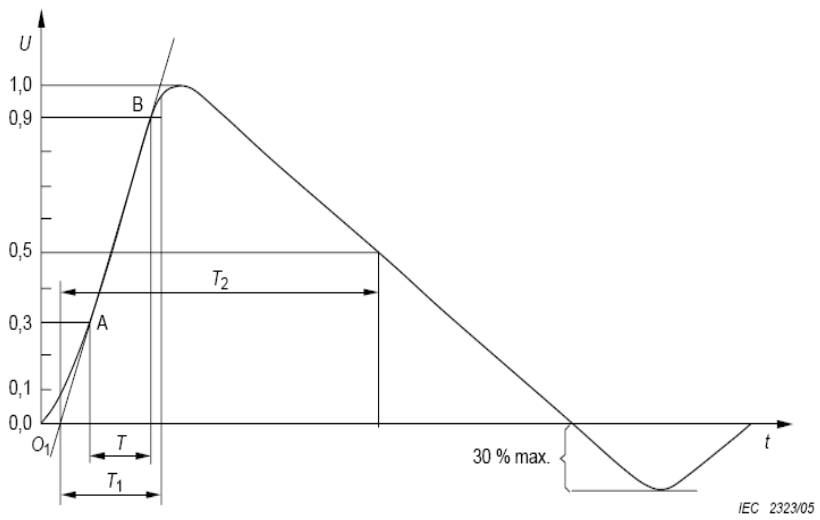
- Purpose of test:
  - ✓ Evaluation the immunity of a device across shock waves caused by transient voltages induced by the residual or lightning impulse
- Materials needed:
  - ✓ Surge wave generator (1.2 / 50 microseconds),
  - ✓ Decoupling/coupling network (internal or external)
  - ✓ Ground plane

Surge immunity – IEC 61000-4-5



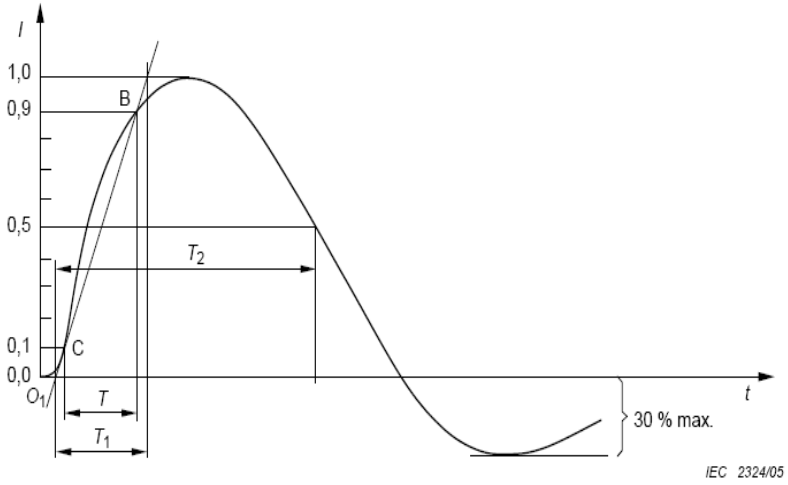
Surge generator
With integrated CDN

Surge Waveform, 1.2/50 µs



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

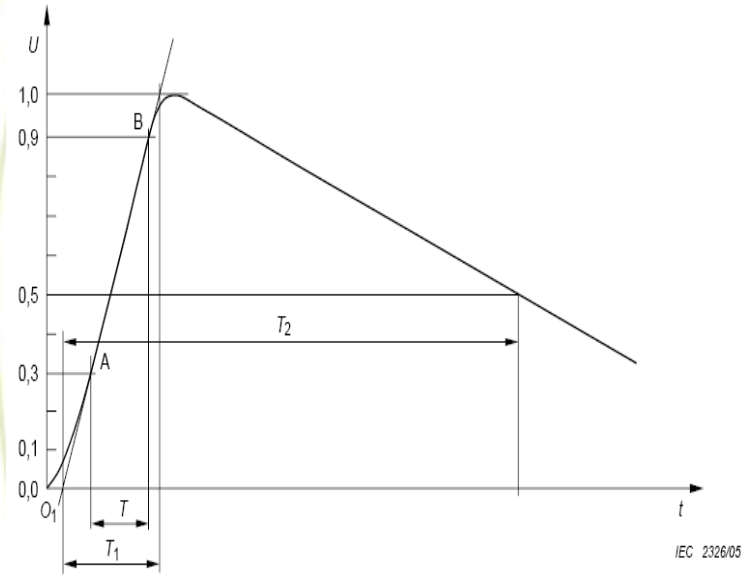
Waveform of **open-circuit voltage (1,2/50 µs)** at the output of the generator with no CDN connected (waveform definition according to IEC 60060-1)



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

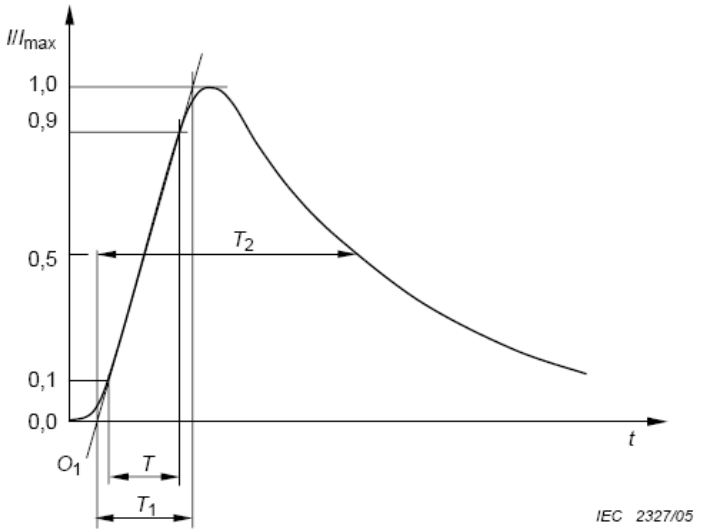
Waveform of **short-circuit current (8/20 µs)** at the output of the generator with no CDN connected (waveform definition according to IEC 60060-1)

Surge Waveform, 10/700 µs



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

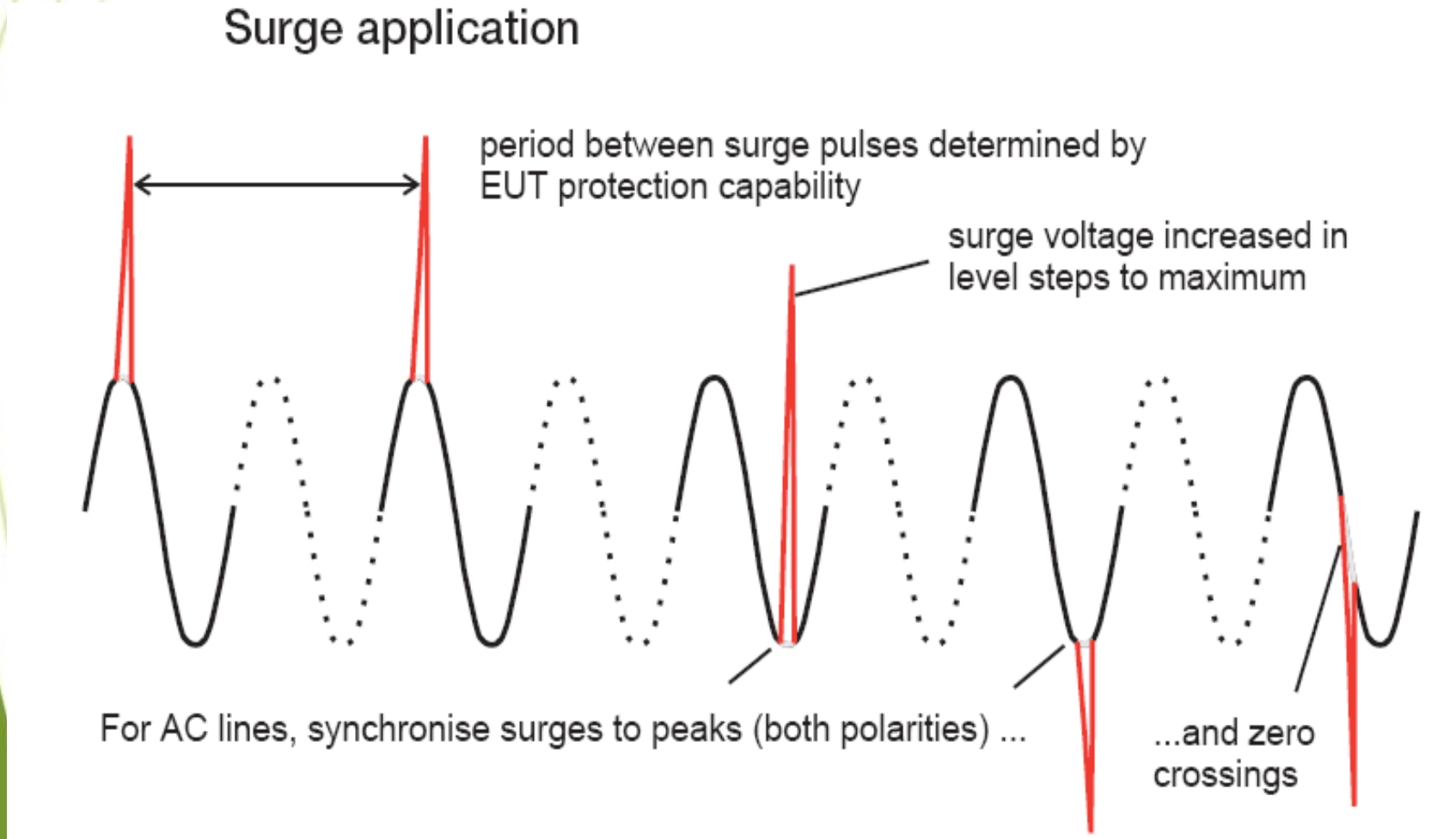
Waveform of **open-circuit voltage (10/700 µs)** (waveform definition according to **ITU-T K series** and IEC 60060-1)



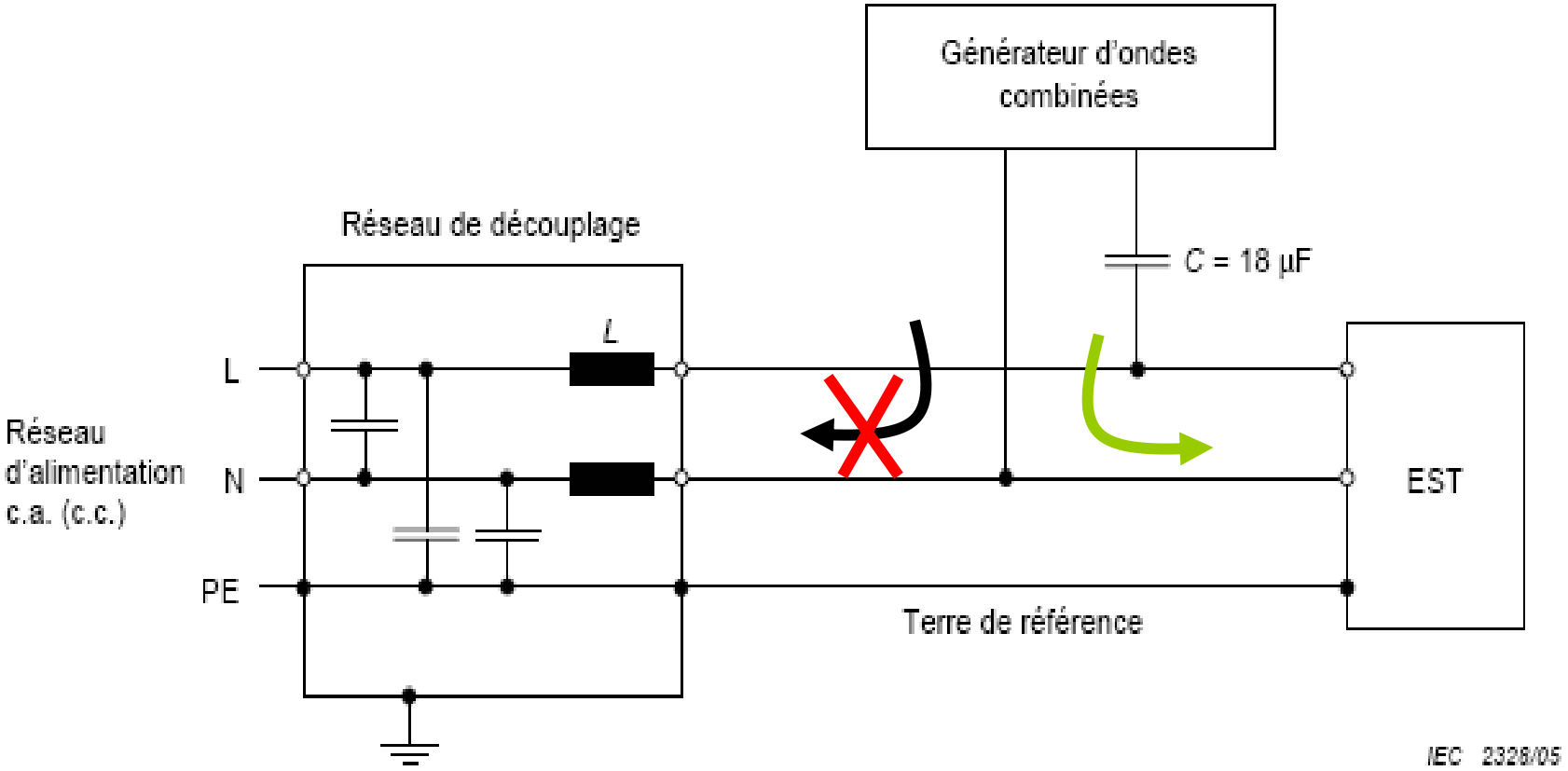
Front time: $T_1 = 1{,}25 \times T = 5\ \mu s \pm 20\ \%$
Time to half-value: $T_2 = 320\ \mu s \pm 20\ \%$.

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

Surge application



Role of CDN


Générateur d'ondes combinées
Réseau de découplage
C = 18 µF
L
L
N
PE
Réseau d'alimentation c.a. (c.c.)
EST
Terre de référence
IEC 2328/05

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- Performance Criteria D – 'Loss of function which is not recoverable'

Test levels

Level	Open-circuit test voltage ±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.	

Standards calls

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IEC/EN 61000-6-2: 2005	Industrial generic	4 kV contact, 8 kV air to IEC/EN 61000-4-2	2 kV AC power, DC power > 3 m, 1 kV signal and functional earth > 3 m to IEC/EN 61000-4-4	1 kV L-L, 2 kV L-E on AC power; 0.5 kV L-L & L-E DC power connected to a distribution network; 1 kV L-E signal > 30 m, to IEC/EN 61000-4-5
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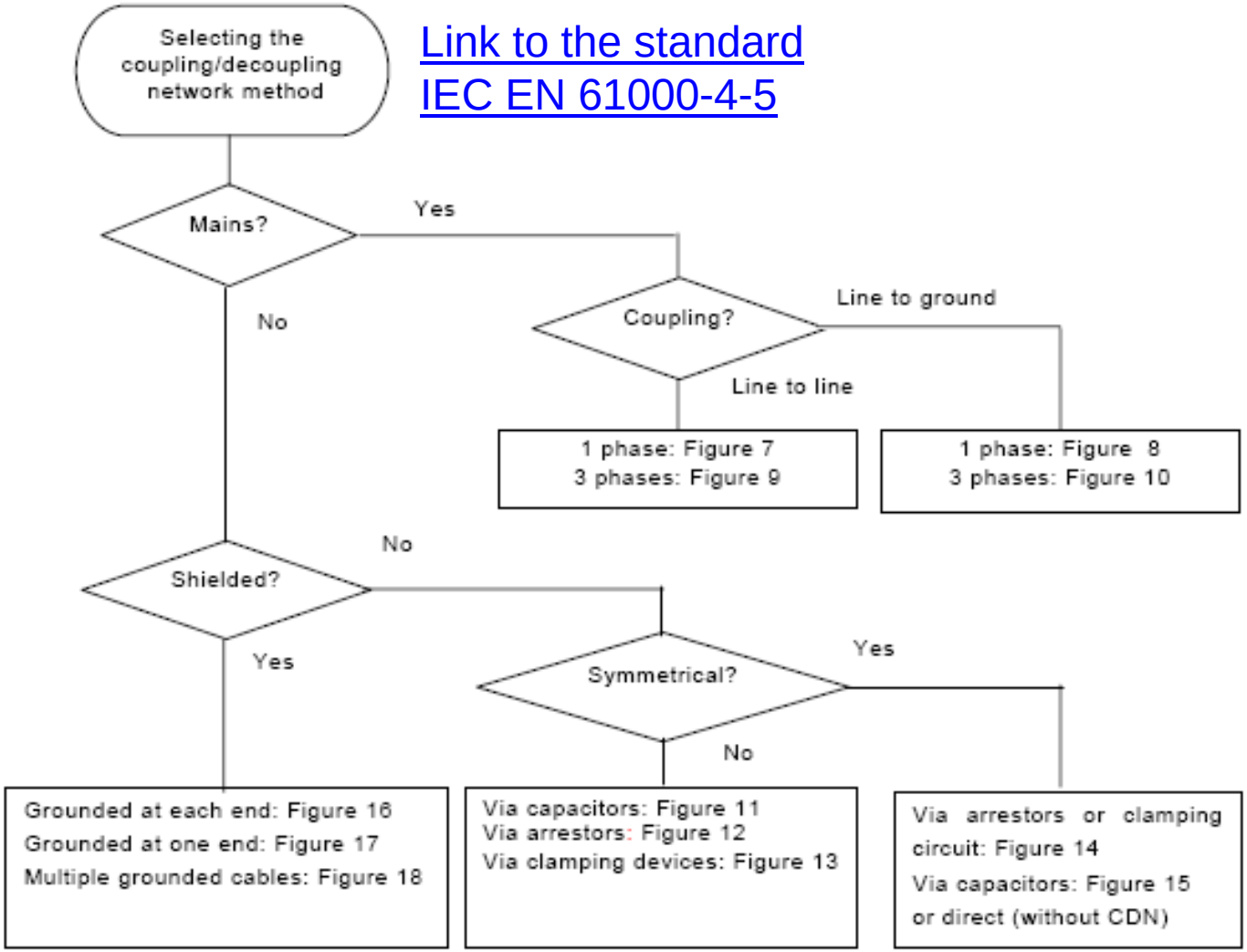
Surge application

- 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

Surge Procedure

- Apply at least five positive and five negative surges at each coupling point
- Wait for at least a minute between applying each surge, to allow time for any protection devices to recover
- For ac mains,
  - Apply the surges line to line (three combinations for 3-phase delta, six for 3-phase star, one for single phase) and line to earth (two combinations for single phase, three for 3-phase delta, four for 3-phase star)
  - Synchronise the surges to the zero crossings and the positive and negative peaks of the mains supply (four phase values), and apply five pulses in each polarity at each phase
- Increase the test voltage in steps up to the specified maximum level, so that all lower test levels are satisfied

Choice of coupling devices



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

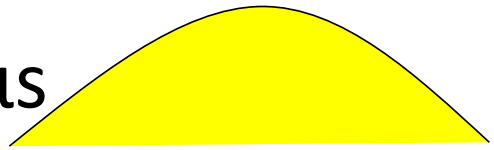
Comparision between transient tests

Comparision of transient standards

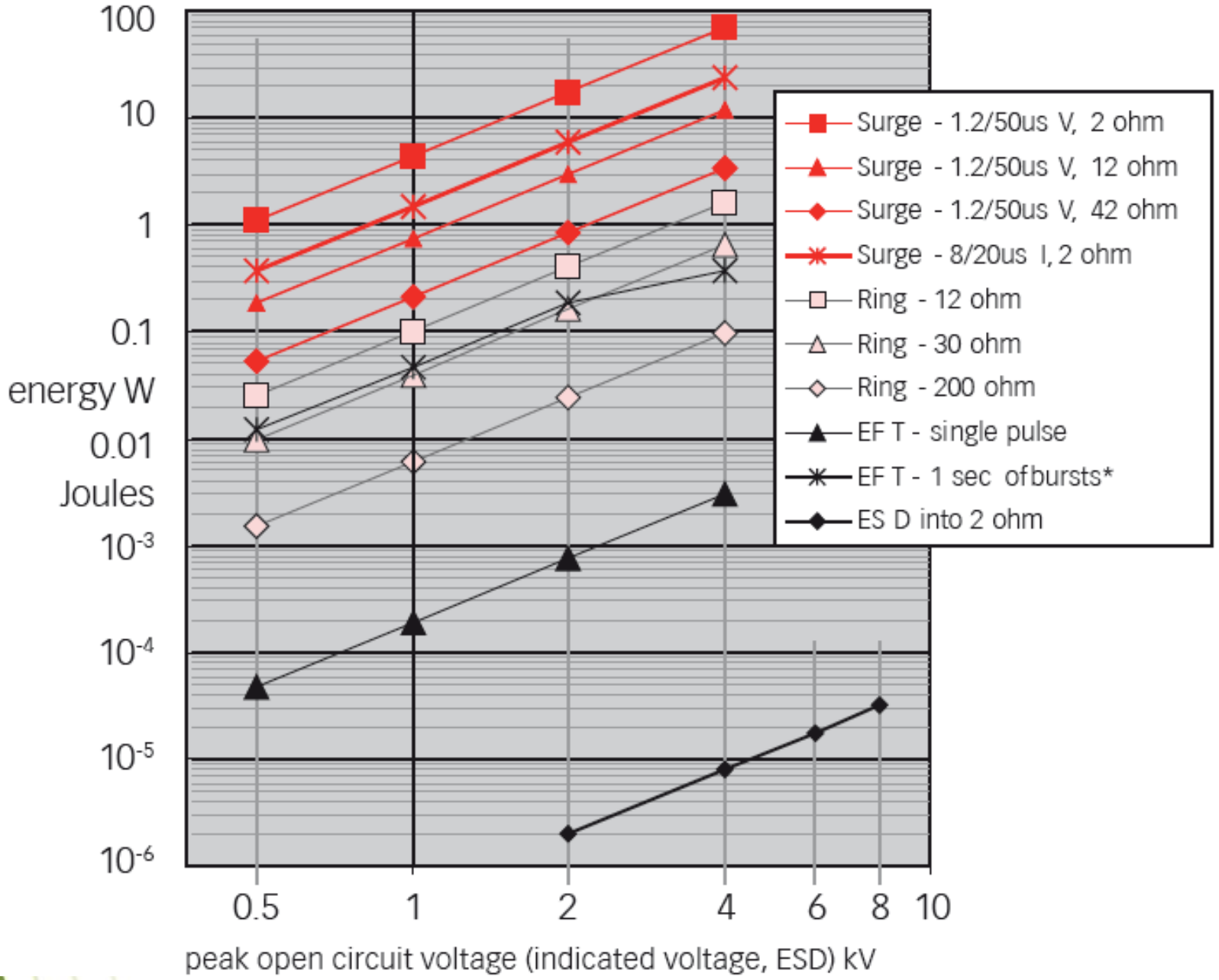
- The “energy measure” of a given waveform can be described by

$$W = \frac{1}{R} \cdot \int_0^T \left(\frac{V(t)}{2} \right)^2 dt \qquad W = R \cdot \int_0^T \left(\frac{I(t)}{2} \right)^2 dt$$

- ESD : waveform magnitude in ns
- EFT : waveform magnitude in ns
- Surge : waveform magnitude in µs



Surge test is more energetic than ESD and EFT

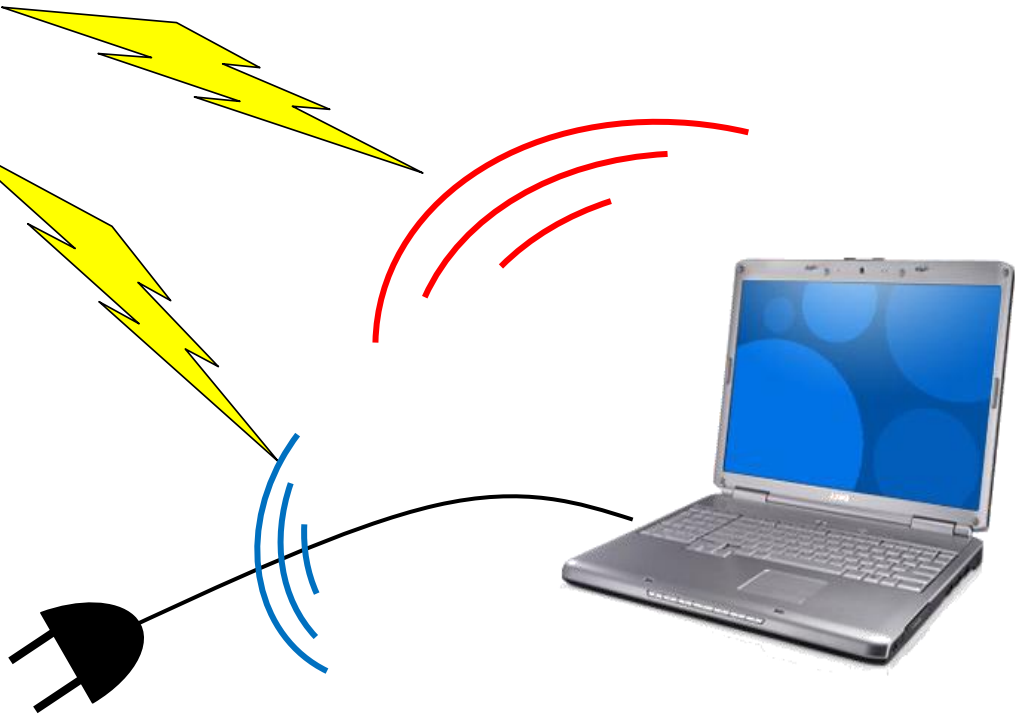

100
10
1
0.1
energy W
0.01
Joules
10-3
10-4
10-5
10-6
0.5
1
2
4
6
8
10
peak open circuit voltage (indicated voltage, ESD) kV
Surge - 1.2/50us V, 2 ohm
Surge - 1.2/50us V, 12 ohm
Surge - 1.2/50us V, 42 ohm
Surge - 8/20us I, 2 ohm
Ring - 12 ohm
Ring - 30 ohm
Ring - 200 ohm
EF T - single pulse
EF T - 1 sec ofbursts*
ES D into 2 ohm

Immunity tests

2 – LF and RF phenomena

RF coupling phenomenum

RF emetters



Radiated immunity

IEC 61000-4-3

Radiated immunity (IEC 61000-4-3)

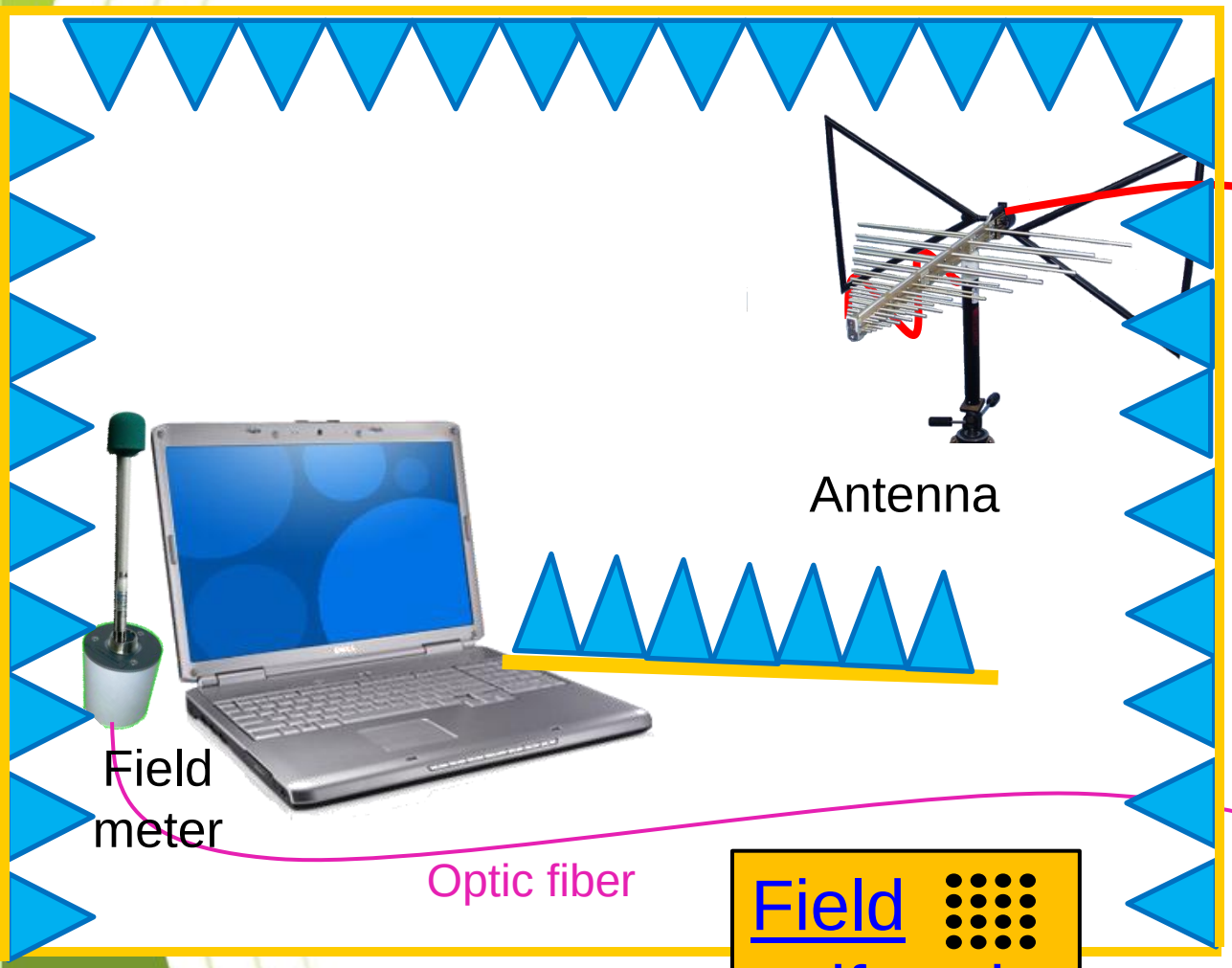
- Test purpose

  Evaluate the performance of a device submitted to radiated RF field

- Needed instruments:
  - ✓ RF generator
  - ✓ Power amplifier
  - ✓ Directional coupler
  - ✓ Power meter
  - ✓ Antenna(s)
  - ✓ Field-meter

Radiated immunity – IEC 61000-4-3

Overview



Power amplifier

Generator

GPIB

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'

Equipments

- *Anechoic chamber: of a size adequate to maintain a uniform field of sufficient dimensions* with respect to the equipment under test (EUT). Additional absorbers may be used to damp reflections in chambers which are not fully lined.
- *RF signal generator(s) capable of covering the frequency band of interest and of being* amplitude modulated by a 1 kHz sine wave with a modulation depth of 80%.
- *Power amplifiers: to amplify signal (unmodulated and modulated) and provide antenna* drive to the necessary field level.

Equipments

- *Field generating antennas: biconical, log periodic, horn or any other linearly* polarized antenna system capable of

  satisfying frequency requirements.
- *An isotropic field sensor with adequate immunity of any*

  head amplifier and optoelectronics to the field strength to be measured, and a fibre optic link to the indicator outside the chamber.
- *Associated equipment to record the power levels*

  necessary for the required field strength and to control the generation of that level for testing.

Frequency range

- The tests are normally performed without gaps in the

  frequency range 80 MHz to 1 000 MHz.

- Test levels related to the protection against RF emissions

  from digital radio telephones and other RF emitting devices

  - The tests are normally performed in the frequency ranges

    800 MHz to 960 MHz and 1,4 GHz to 6,0 GHz.

Calibration of field

- The purpose of field calibration is to ensure that the uniformity of the field over the test sample is sufficient to ensure the validity of the test results.
- IEC 61000-4-3 uses the concept of a uniform field area, which is a hypothetical vertical plane of the field in which variations are acceptably small.
- A database for setting the required field strength for the immunity test is obtained.
- The field calibration is valid for all EUTs whose individual faces (including any cabling) can be fully covered by the UFA.

Calibration of field

- A full field calibration process should be carried out

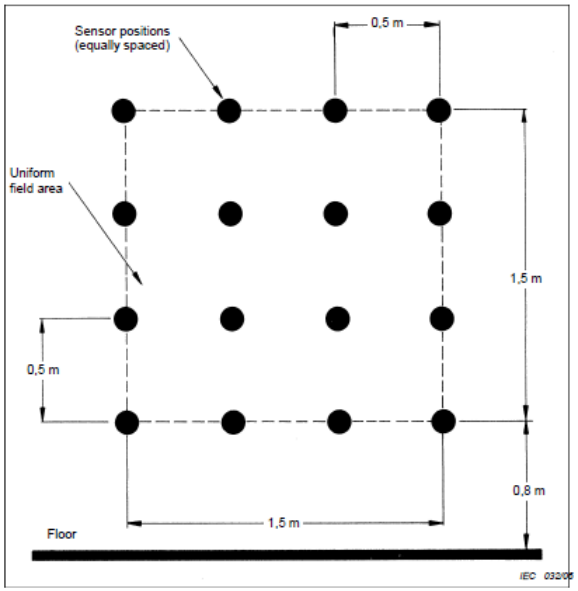
  annually and when changes have been made in the enclosure configuration.

- The UFA is subdivided into a grid with a grid spacing of 0,5 m (example an 1,5 m × 1,5 m UFA).

- At each frequency, a field is considered unif orm if its magnitude measured at

  the grid points is within 0/+6 dB

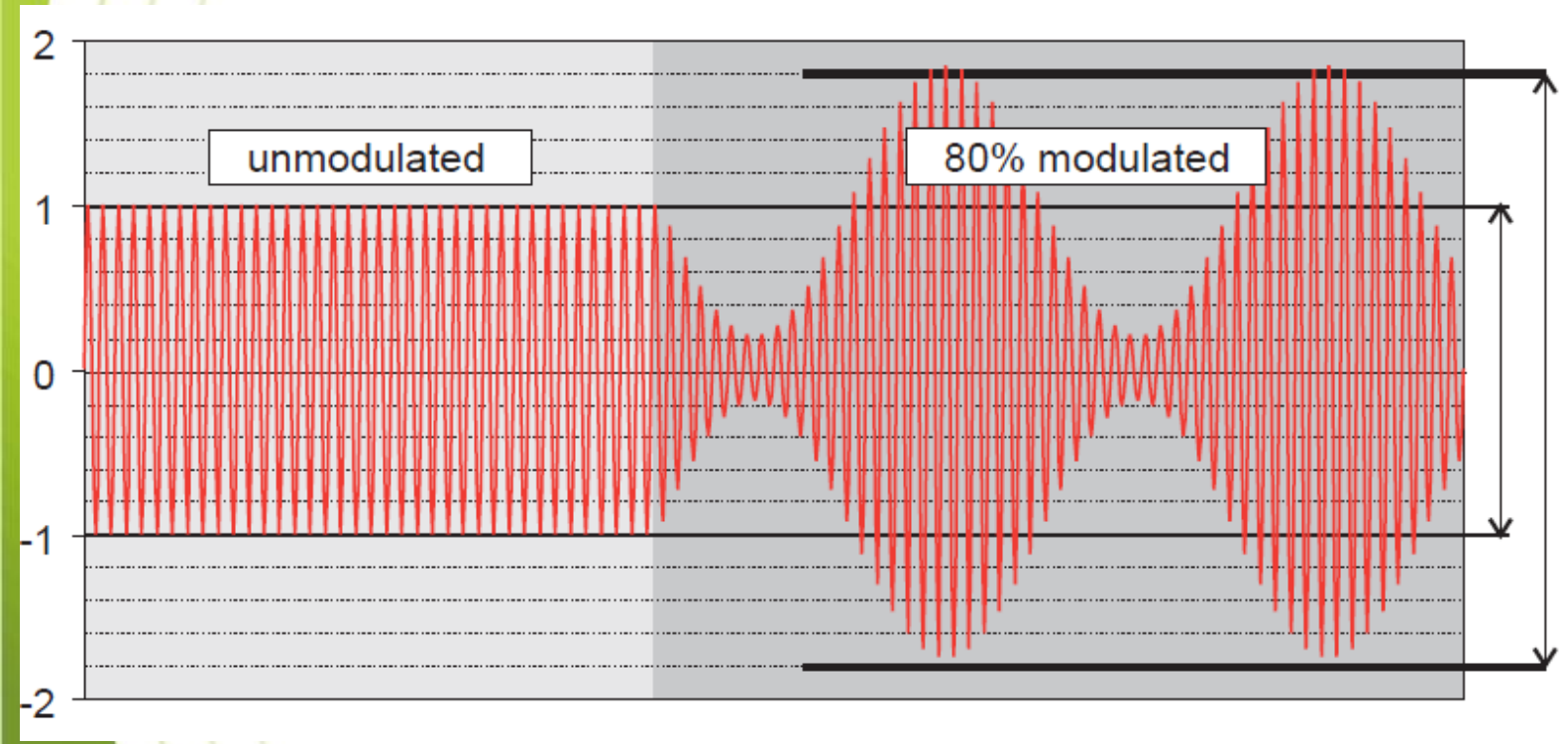
  of the nominal value for not less than 75 % of all grid points



Calibration of field

- Calibration is 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 they can scale the power down.

AM modulation



Considerations for equipments choice

- Select an antenna to use.
  - Frequency range
  - Power handling
  - Beam width & gain
- Select the correct amplifier
  - Use calculated power to select the correct amplifier
  - Needs to be selected at the 1dB compression point
  - Calculate power requirements
- Antenna data: based on measured data or gain
  - Calculate out all loses between amplifier and antenna
  - Cables, directional coupler and connectors
  - Intended test distance (1 to 3 meters)

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'

Test levels

Level	Test field strength V/m
1	1
2	3
3	10
4	30
x	Special
NOTE x is an open test level and the associated field strength may be any value. This level may be given in the product standard.	

Standards calls

EN	EN 61000-6-1: 2001	EN 61000-6-2: 2001	EN 301 489-1: v1.4.1	EN 55014-2: 1997 + A1	EN 55020: 2002 + A1 + A2	EN 55024: 1998 + A1 + A2
Related IEC	IEC 61000-6-1	IEC 61000-6-2	-	CISPR 14-2	CISPR 20	CISPR 24
Scope	Residential, commercial, light industry generic	Industrial generic	Radio comms equipment: common requirements	Household appliances, electric tools and similar	Broadcast receivers and associated equipment	Information technology equipment
Test	Requirements					
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Conducted RF	3 V rms 80% AM 0.15-80 MHz to EN 61000-4-6 on AC power and functional earth ports, and all signal, control and DC power ports > 3m	10 V rms 80% AM 0.15-80 MHz to ENV 50141, except 47-68 MHz where level is 3 V rms: all ports except signal lines < 3 m	3 V rms 80% AM 0.15-80 MHz to EN 61000-4-6 on AC power, and signal, telecomm, control and DC power ports > 3 m, with exclusion band, disregarding narrowband responses	3 V rms 80% AM 0.15-80 MHz to EN 61000-4-6 on AC power ports, 1 V rms on DC and signal ports > 3 m, category IV; extending to 230 MHz for cats. II and III	RF common mode 126 dBmV emf 26-30 MHz, antenna terminal; induced voltages at mains and audio terminals, 0.15-150 MHz 80% AM up to 130 dBmV emf	3 V rms 80% AM 0.15-80 MHz to EN 61000-4-6 on power and all signal cable ports > 3 m, extra spot frequency functional test for TTE
LF magnetic field	3 A/m to EN 61000-4-8, susceptible devices only	30 A/m to EN 61000-4-8, susceptible devices only	Not applicable	Not applicable	Not applicable	1 A/m to EN 61000-4-8, susceptible devices only

Field strength

- The resultant field is computed as folows:

$$e = \frac{\sqrt{30p}}{d}$$

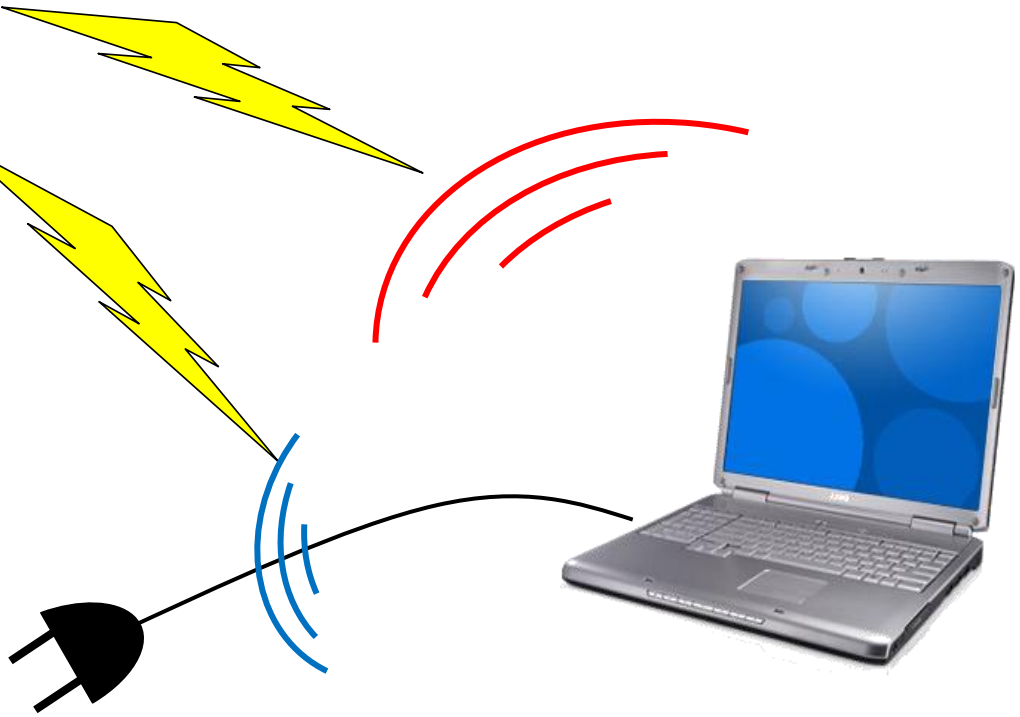
  - p is the radiated power
  - d is the distance between the antenna and the field mesure

Conducted immunity

IEC 61000-4-6

RF coupling phenomenum

RF emetters



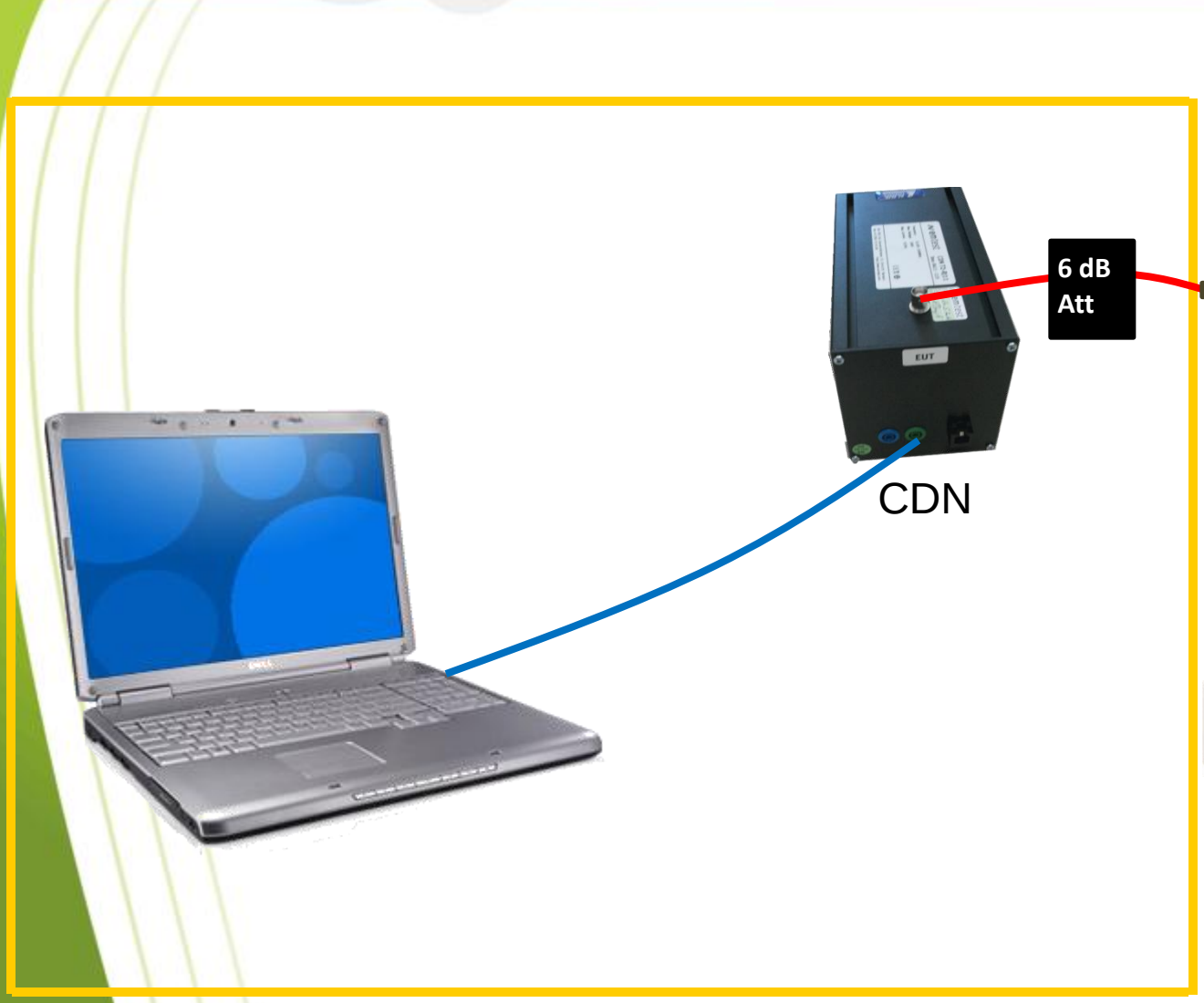
Radiated immunity (IEC 61000-4-3)

- Test purpose

  Evaluate the performance of a device submitted to conducted electromagnetic field

- Needed instruments:
  - ✓ RF generator
  - ✓ Power amplifier
  - ✓ Directional coupler
  - ✓ Dual power meter
  - ✓ Coupling device (CDN, EM clamp, Current clamp, …)
  - ✓ 6 dB attenuator

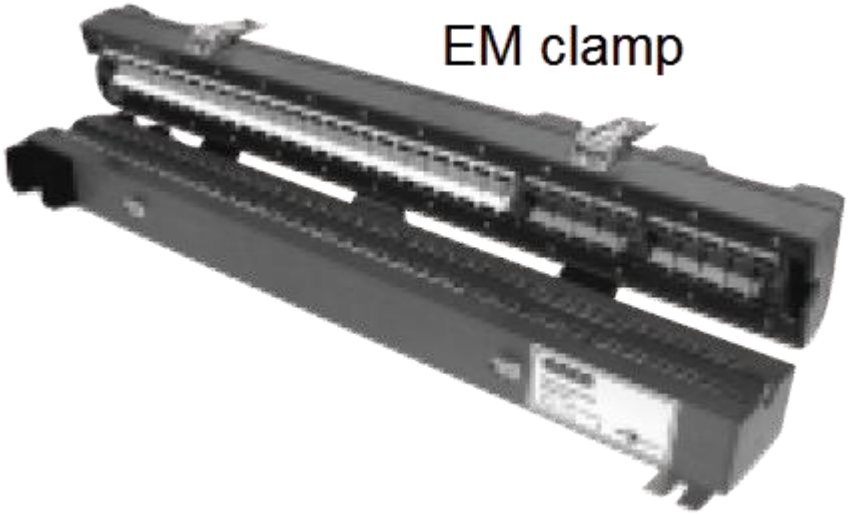
Conducted immunity – IEC 61000-4-6

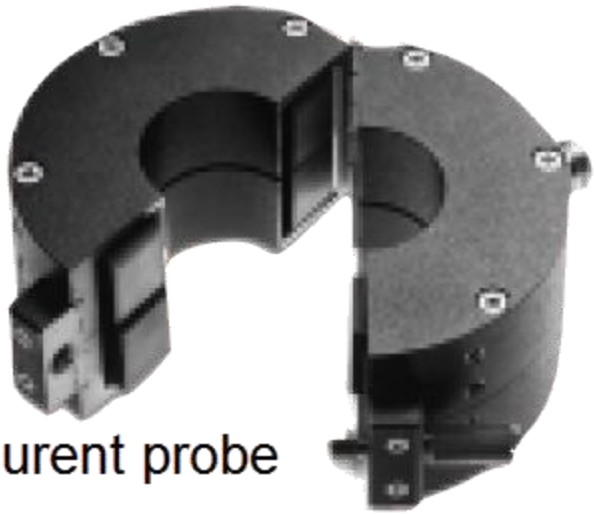


Coupling devices

CDN

EM clamp



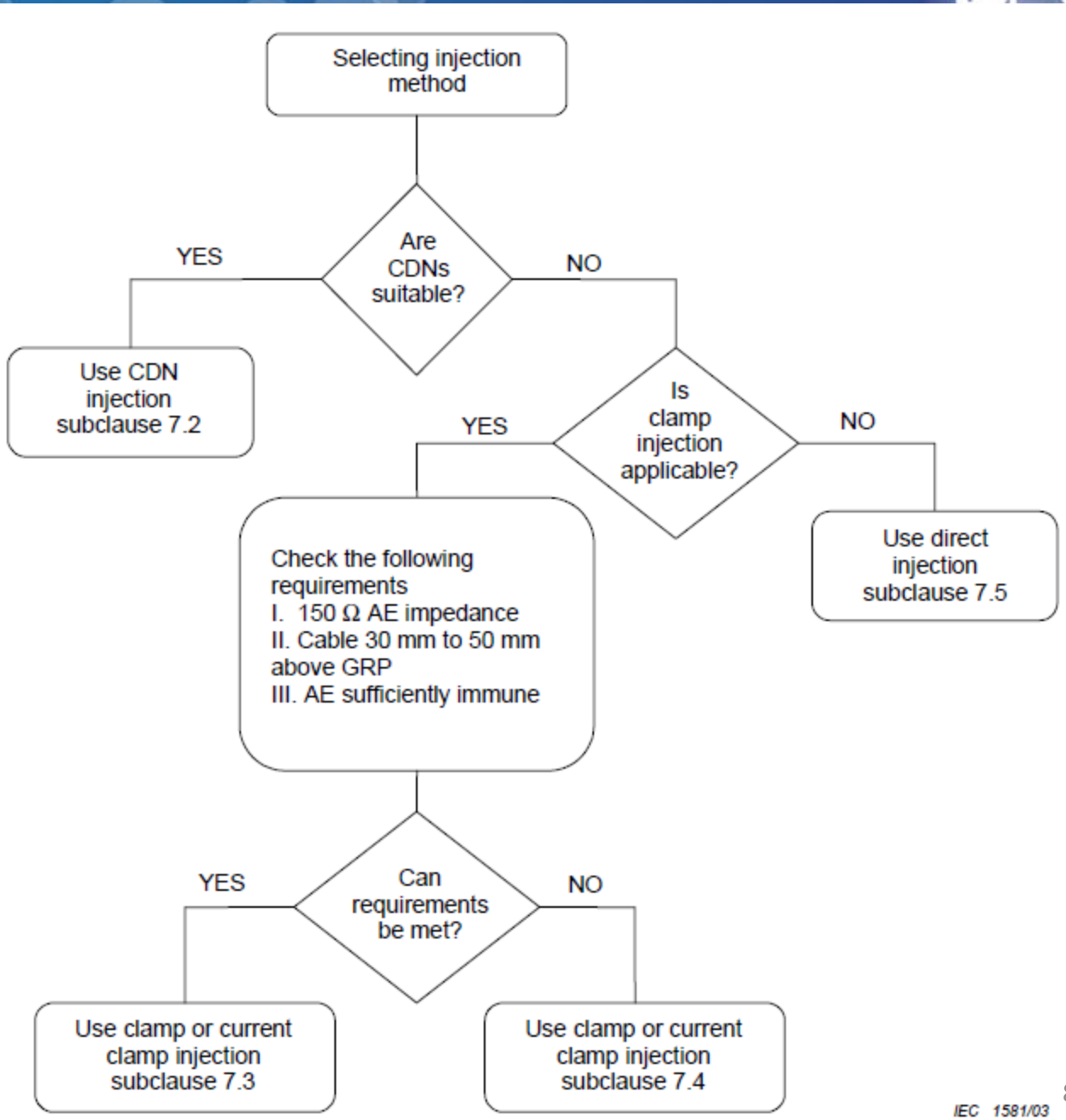


Curent probe

Coupling devices

- Coupling and decoupling devices shall be used for appropriate coupling of the disturbing signal to the various cables connected to the EUT and for preventing applied
  test signals from affecting other devices, equipment and
  systems that are not under test.
- The coupling and decoupling devices can be combined
  into one box (a coupling/ decoupling network, CDN) or can consist of several parts.
- The preferred coupling and decoupling devices are the CDNs, for reasons of test reproducibility and protection of
  the AE.
- However, if they are not suitable or available, other
  injection methods can be used.

Rules for selecting the injection method



Types of CDNs

Typ	*Interconnected lines*
M1, M2, M3, M4, M5, M2+M3	Unscreened supply (mains)
AF2, AF4, AF6, AF8	Unscreened nonbalanced lines
S1, S2, S9, S25	Screened lines
T2, T4, T8	Unscreened balanced lines
RJ11, RJ45	Unscreened data lines
RJ11/S, RJ45/S, USB	Screened data lines

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'

Typical test levels

Table 1 – Test levels

Frequency range 150 kHz – 80 MHz		
Level	Voltage level (e.m.f.)	
	U_0 dB(μV)	U_0 V
1	120	1
2	130	3
3	140	10
X [a]	Special	

[a] X is an open level.

Standards calls

EN	EN 61000-6-1: 2001	EN 61000-6-2: 2001	EN 301 489-1: v1.4.1	EN 55014-2: 1997 + A1	EN 55020: 2002 + A1 + A2	EN 55024: 1998 + A1 + A2
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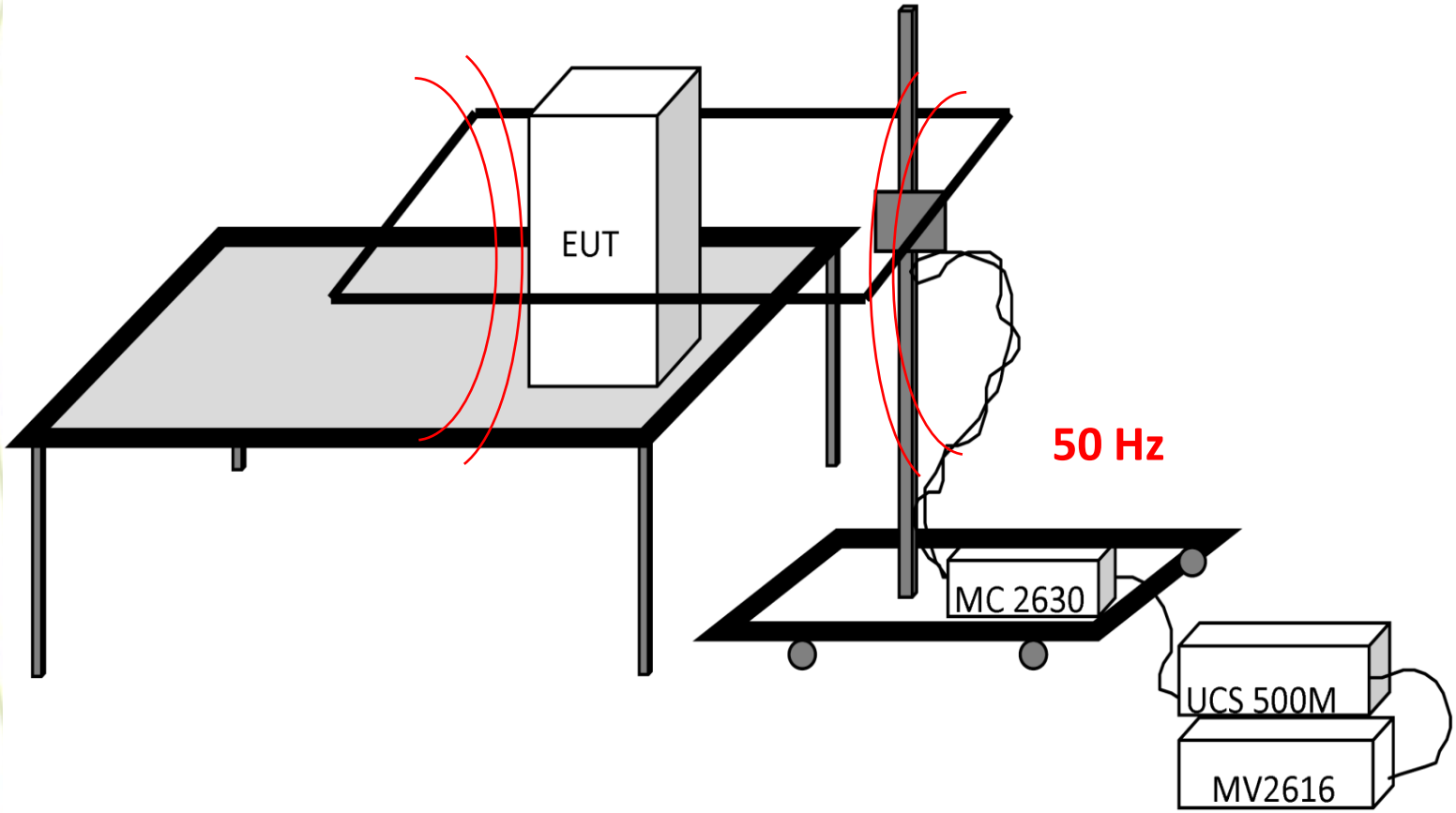
Calibrating the injected level

- substitution method
- The power required to give this same stress level is repeated in the actual test.
- For the 150 ohms systems, the required power : vstress/6 or Vstress - 15.6 dB (resistive divider)
- For the 50 ohms systems, the required power : Vstress/2 or Vstress - 6 dB (open circuit)

Immunity to magnetic fields

IEC 61000-4-8

Magnetic field immunity – IEC 61000-4-8



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Standards calls

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

Voltage dips and short interruptions – IEC 61000-4-11

Power fail generator

EUT

Variac

Performance Criteria for Immunity Tests

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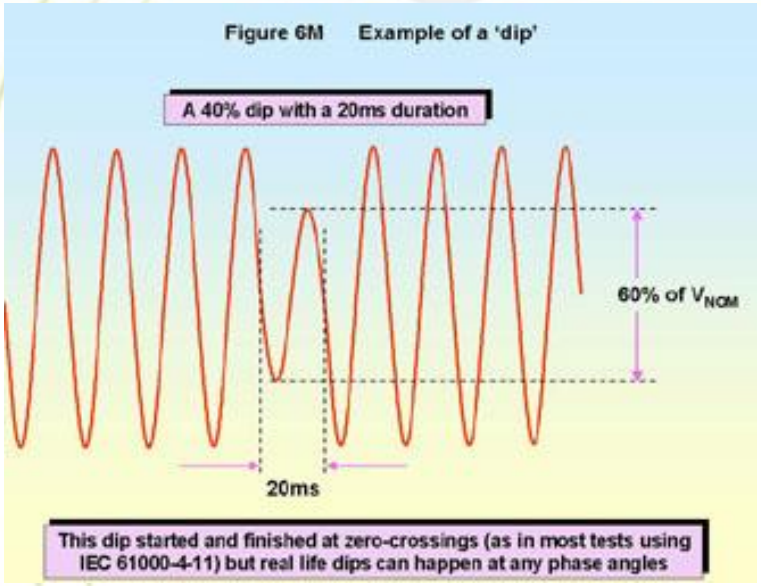
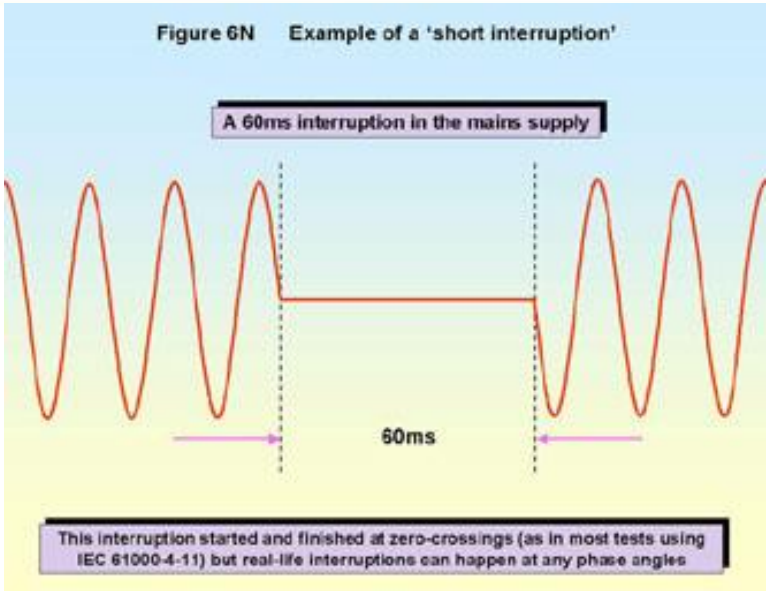
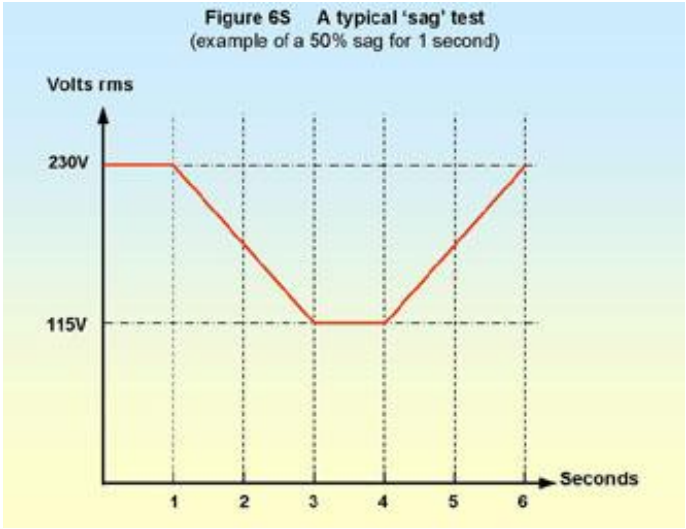
Voltage dips and short interruptions – EN 61000-4-11 Overview







Emission tests

Emission

CISPR 22 / EN 55022

ITE functionnality

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

Equipements Classes (1)

- **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.

Equipements Classes(2)

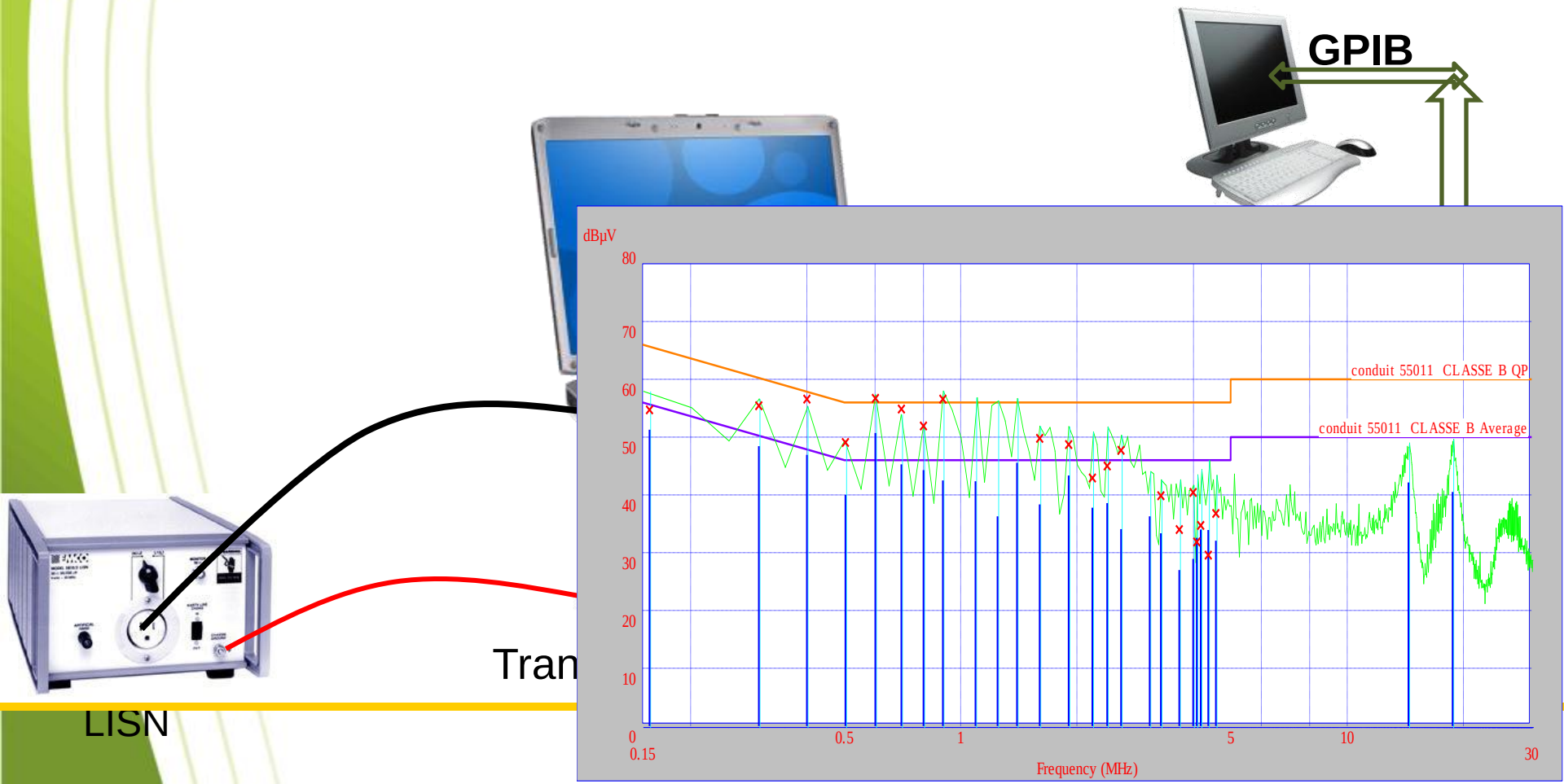
- **Class A consists of all other ATI complying with the limits of disturbance of class A but not those of class B.**
- **Can be used in commercial or industrial environment.**

Conducted emissions
CISPR22/EN 55022

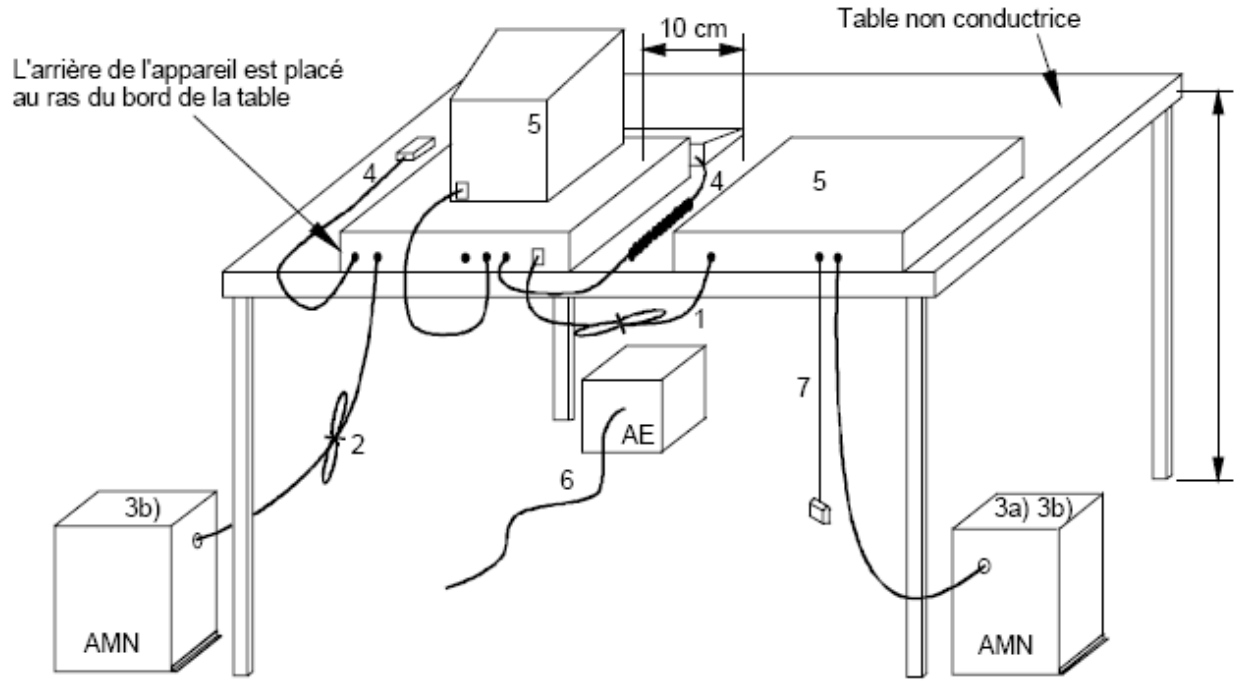
Required equipments

- 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



Conducted emission test setup



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

Conducted emissions

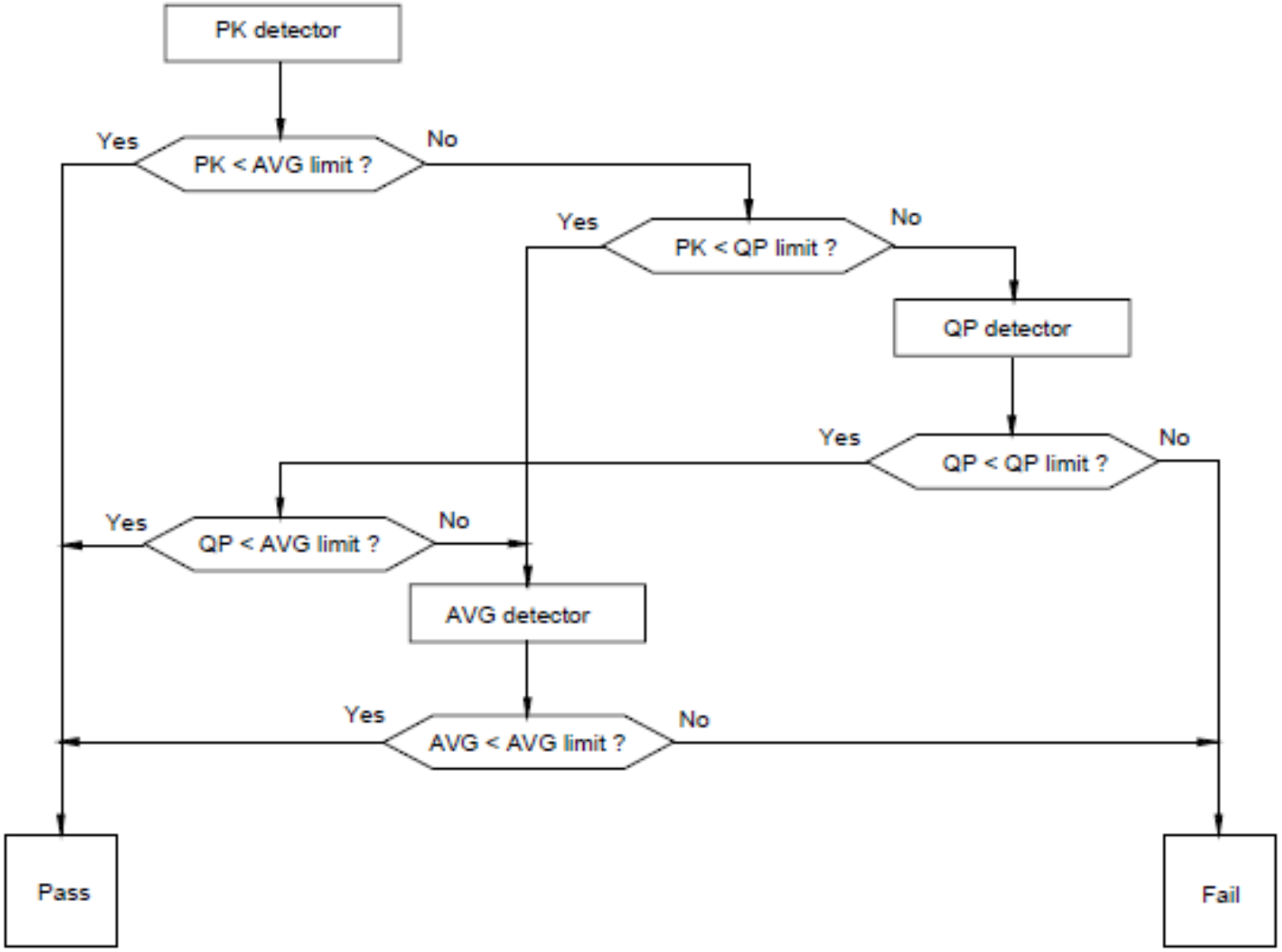
Measurement of conducted electromagnetic disturbances must be made:

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

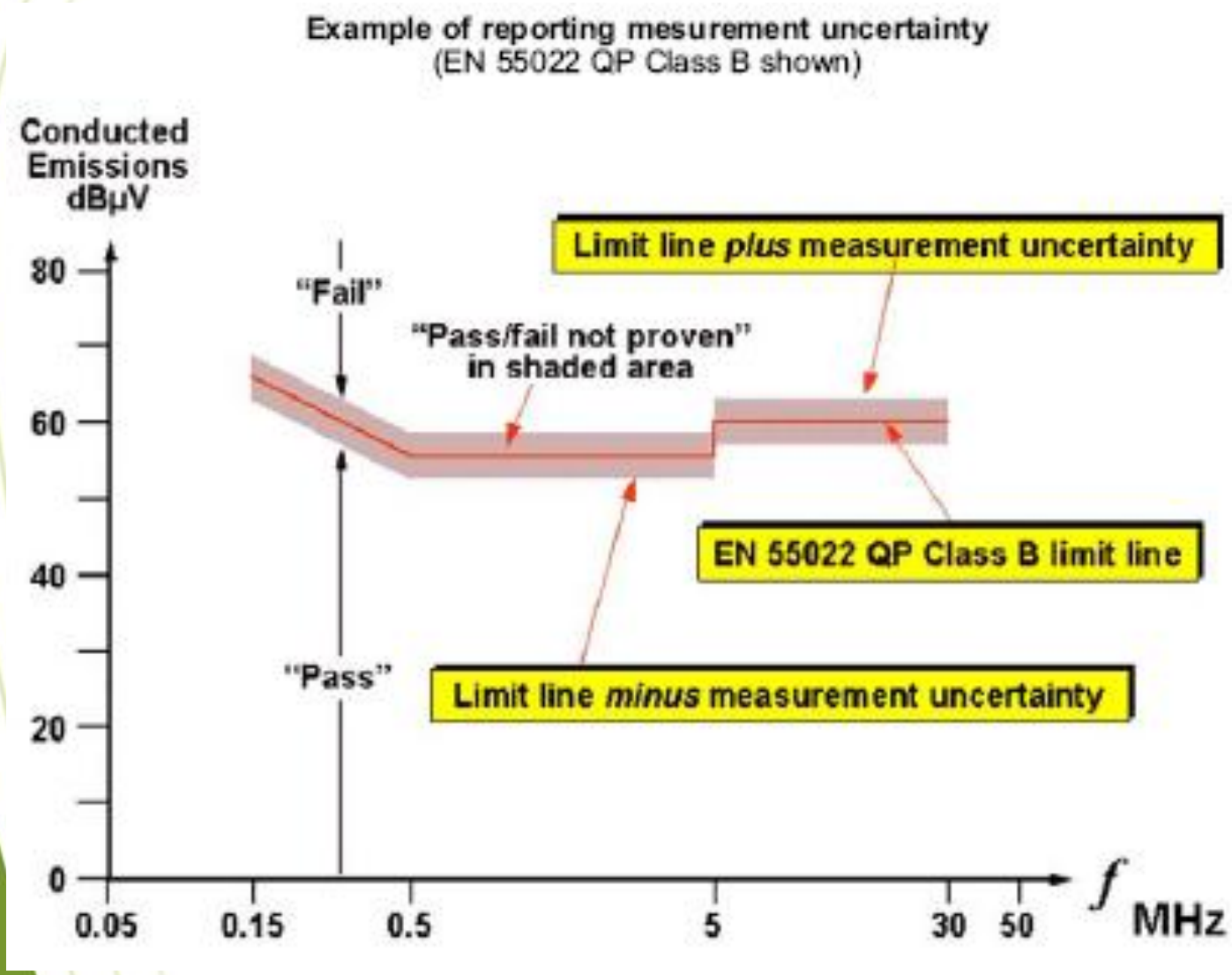
Conducted limits

- 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

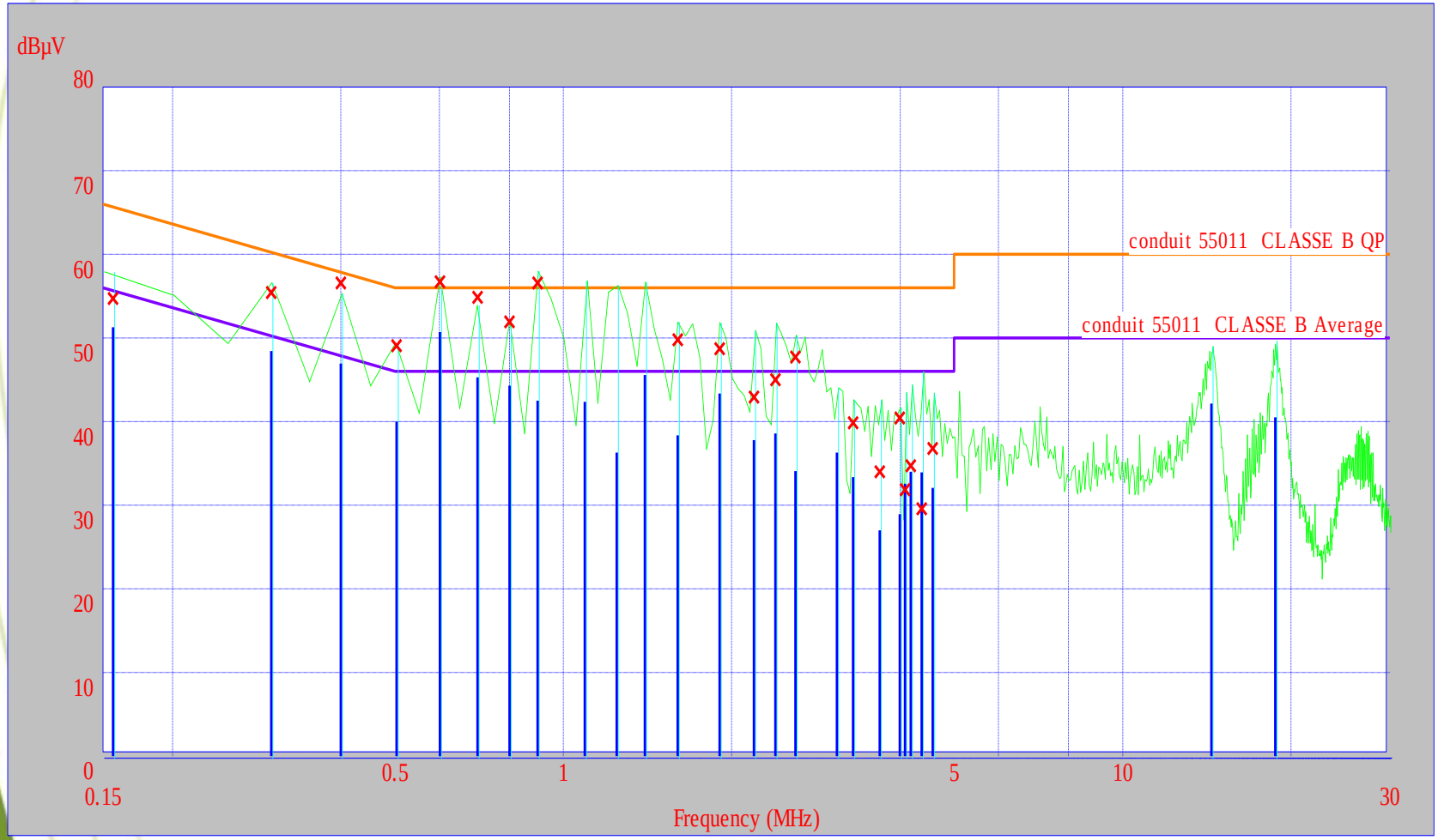
Decision tree



Emissison thresholds



Measure


dBµV
80
70
60
50
40
30
20
10
0
0.15
0.5
1
5
10
30
Frequency (MHz)
conduit 55011 CLASSE B QP
conduit 55011 CLASSE B Average

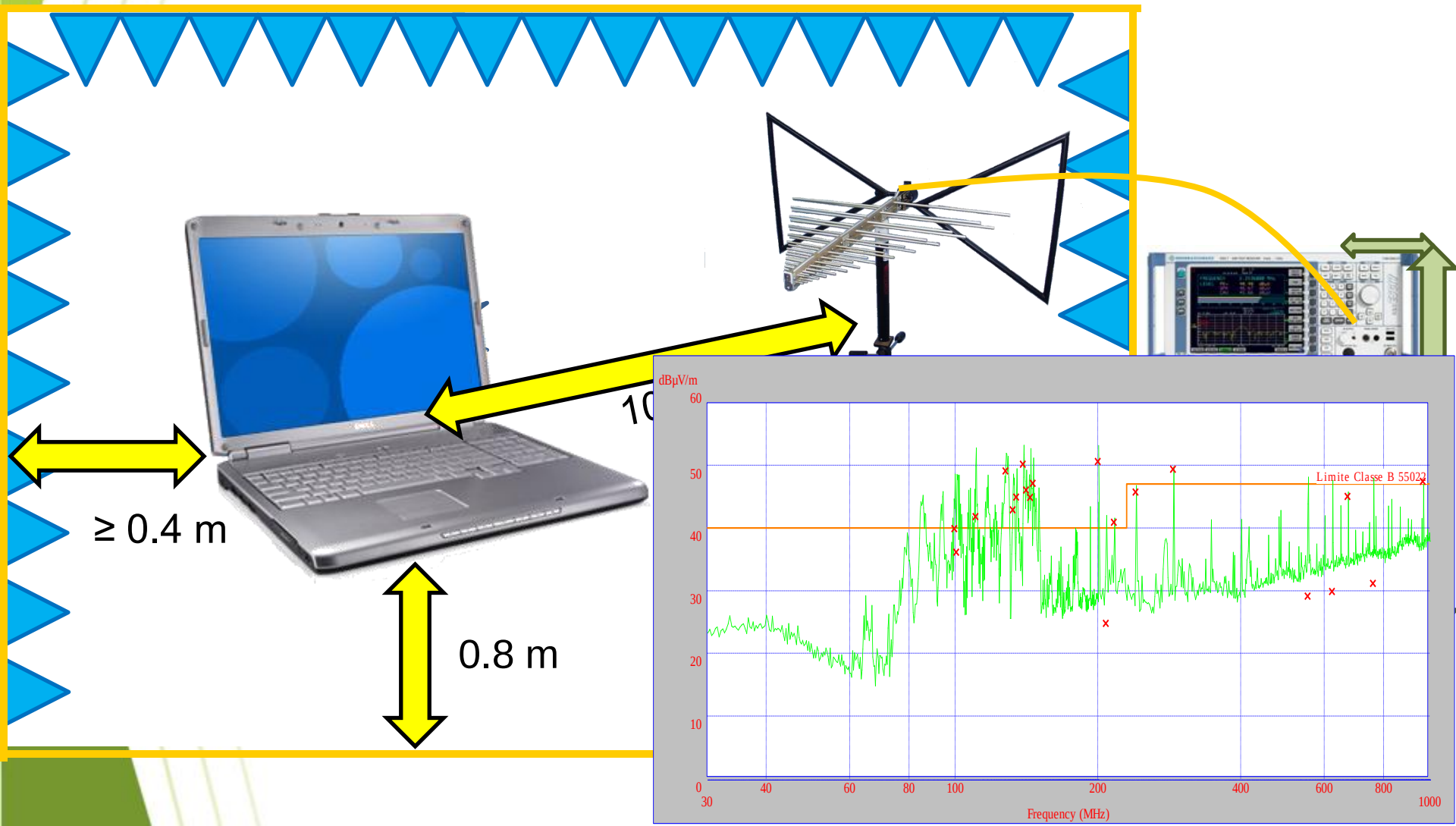
Radiated emissions

CISPR22/EN 55022

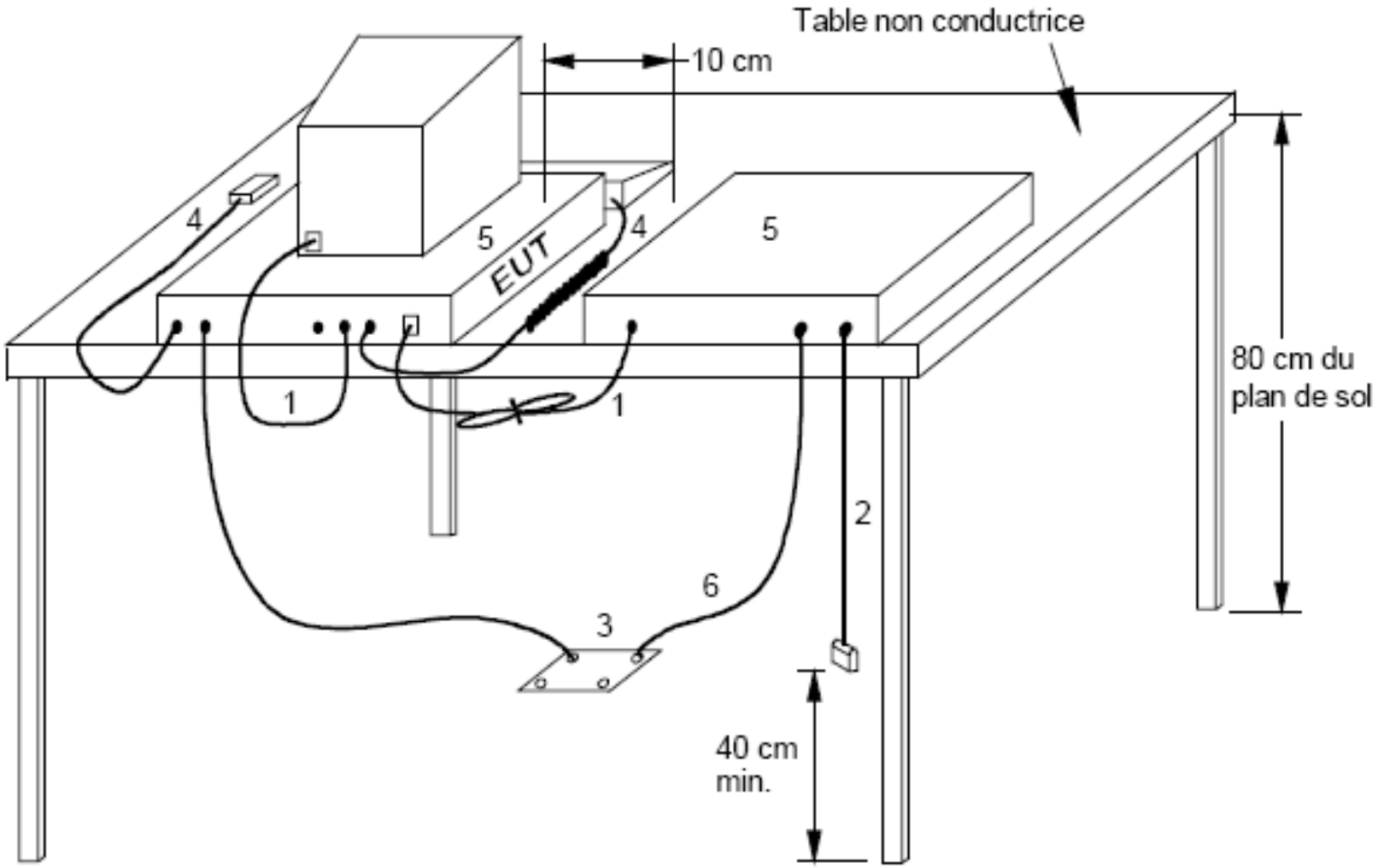
Required equipments

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

Radiated emission - CISPR22/EN 55022



Test setup for radiated emission



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

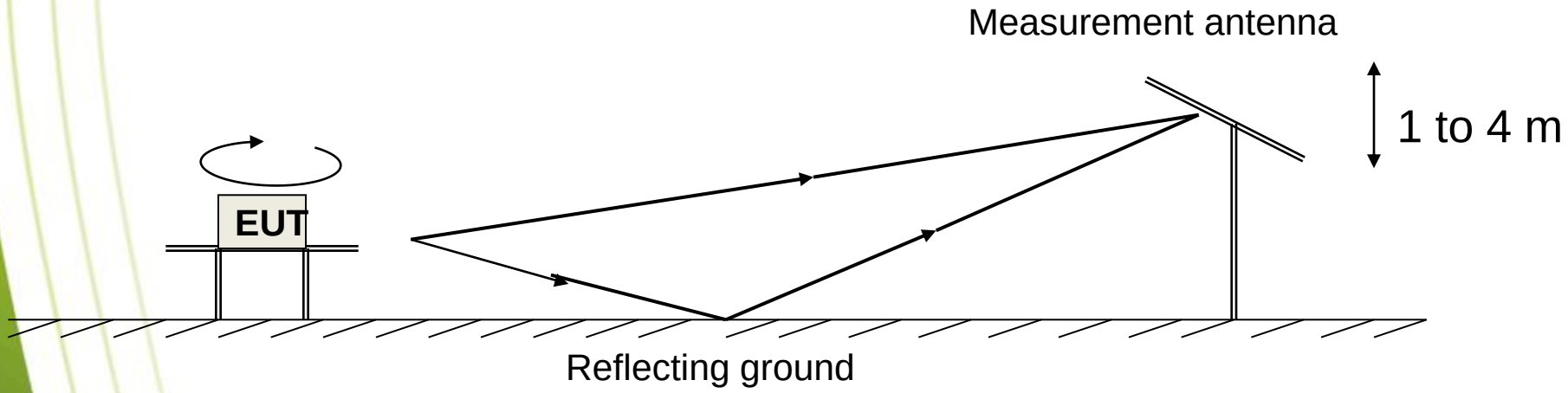
  range 30 MHz to 1 GHz or 6 GHz.

- A receiving antenna, associated with a measuring receiver, is placed at a specific distance from the EUT (test equipment)

Radiated EM field measure

- 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

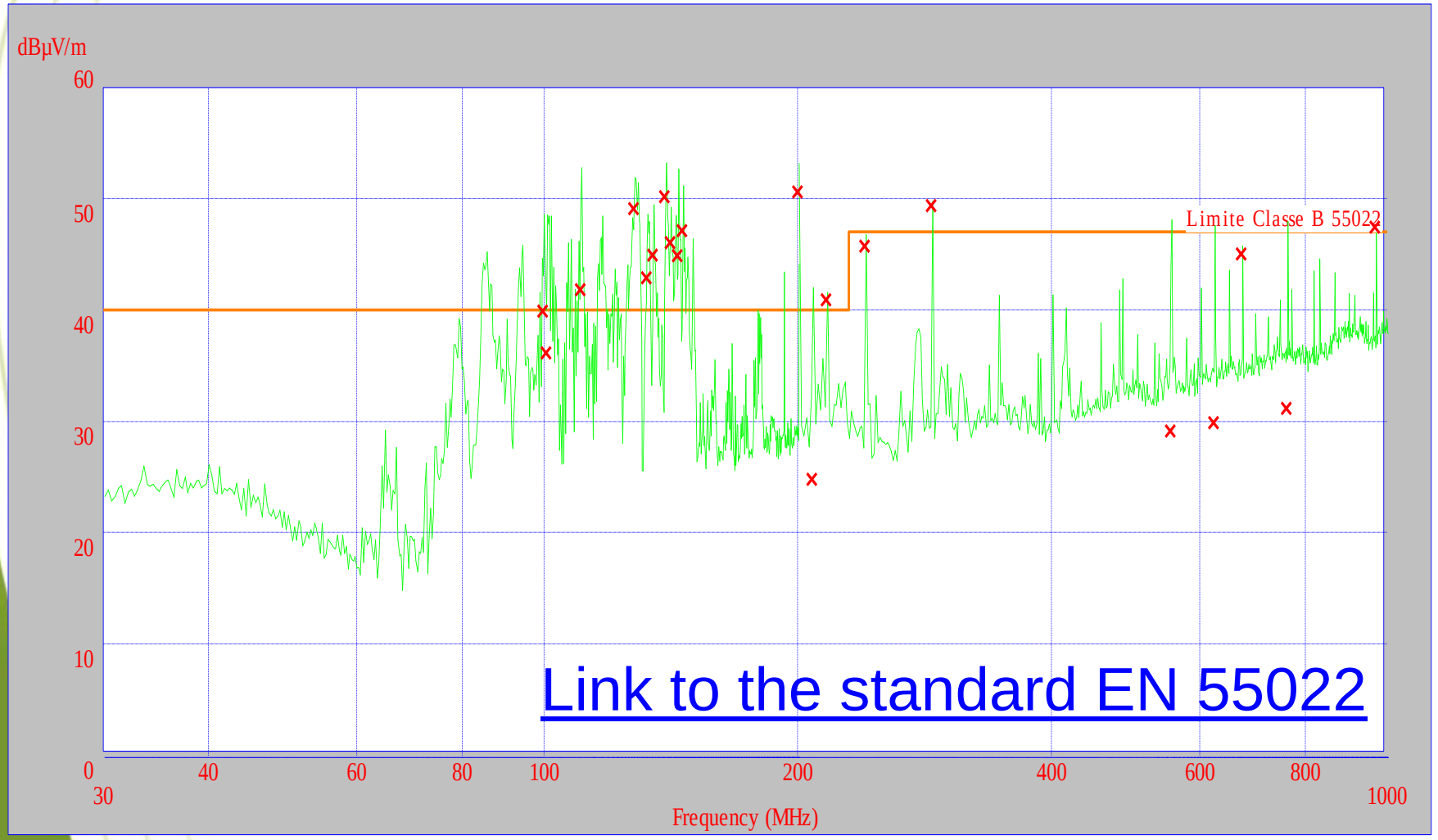
Radiated field measurement



Open area test site

Site de mesure en espace libre

Measure


dBµV/m
60
50
40
30
20
10
0
30
40
60
80
100
200
400
600
800
1000
Frequency (MHz)
Limite Classe B 55022
Link to the standard EN 55022

Harmonics emission

IEC 61000-3-2

Harmonics emission

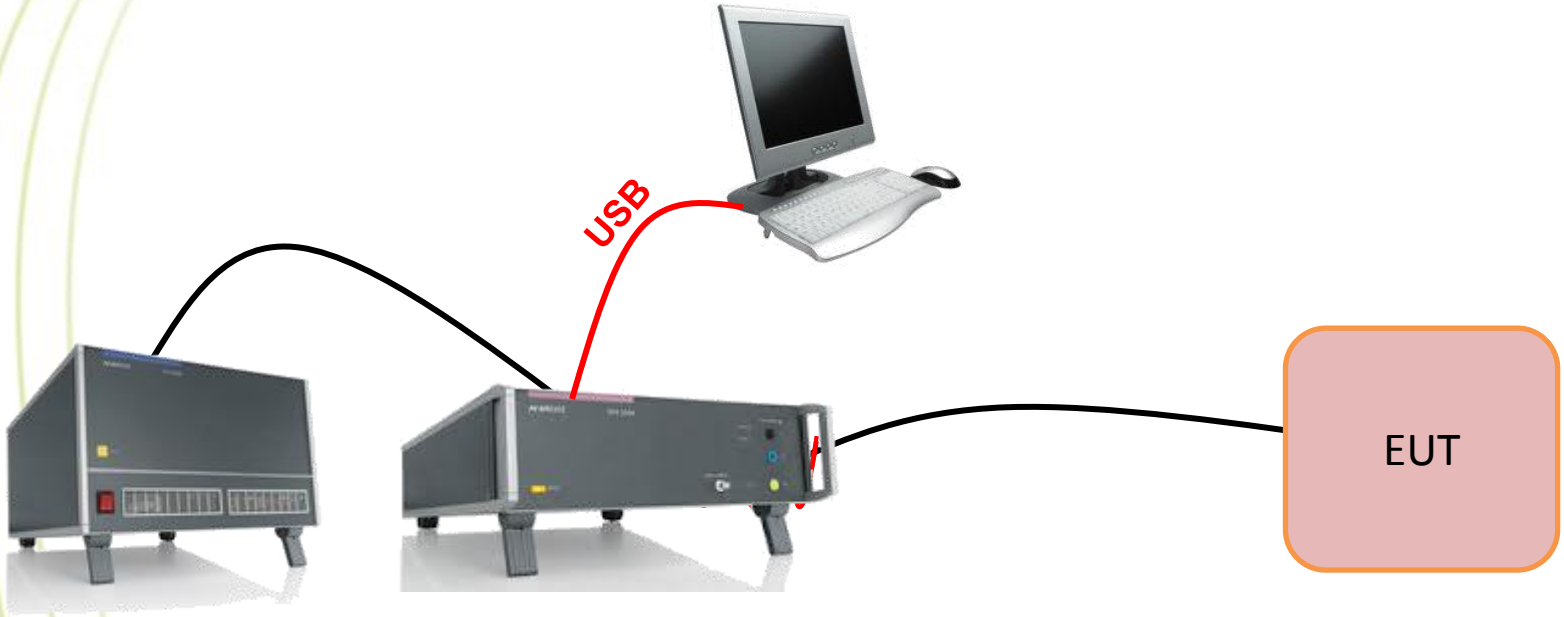
Causes

- They are generated by devices that consume non-sinusoidal current, such as fluorescent lighting or power supplies (equipment components nonlinear diodes, thyristors ...)

Effects

- Heating cables (neutral wire three-phase)
- Premature aging of electronic components

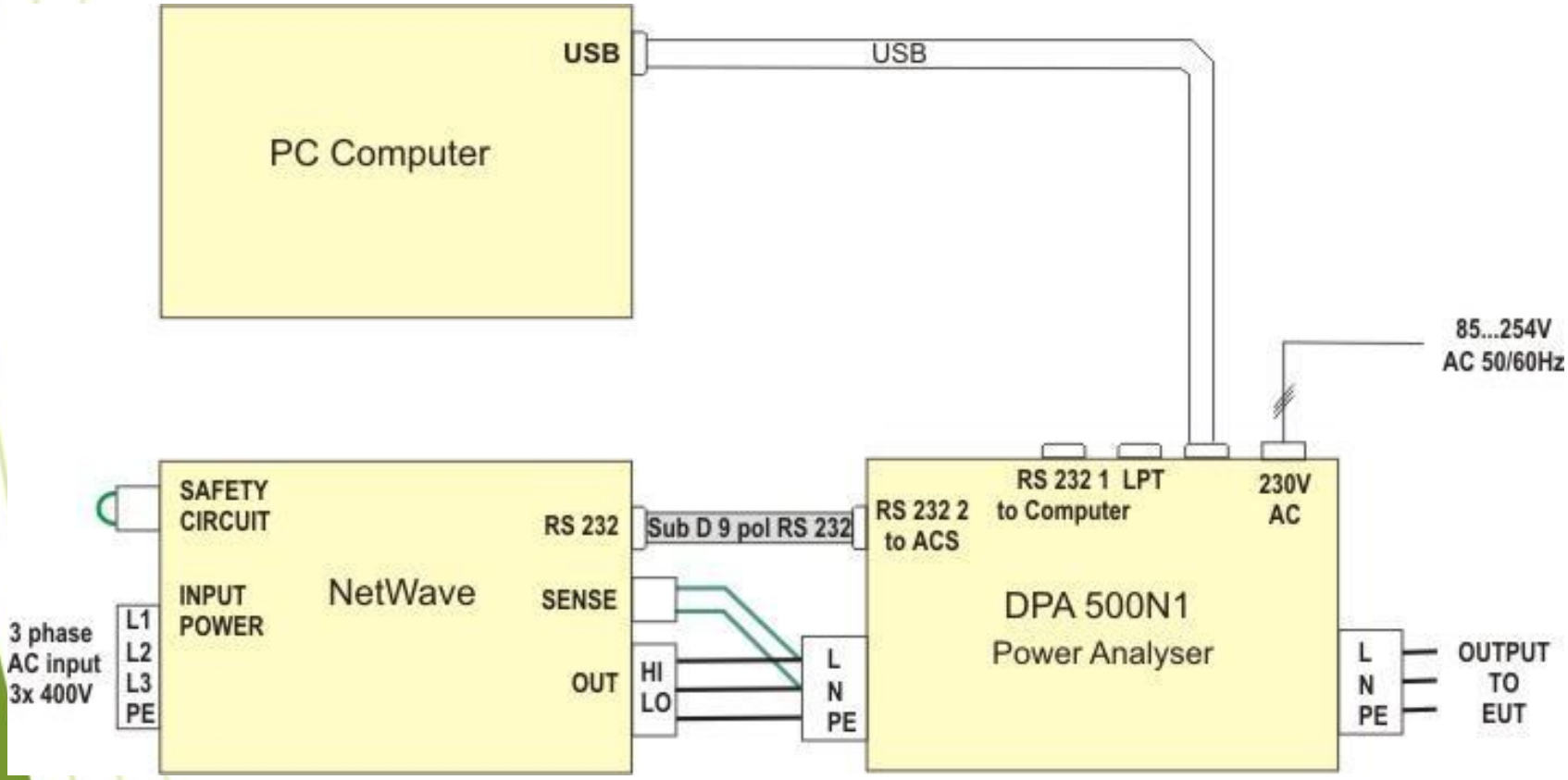
Harmonics emission – IEC 61000-3-2



Stable source

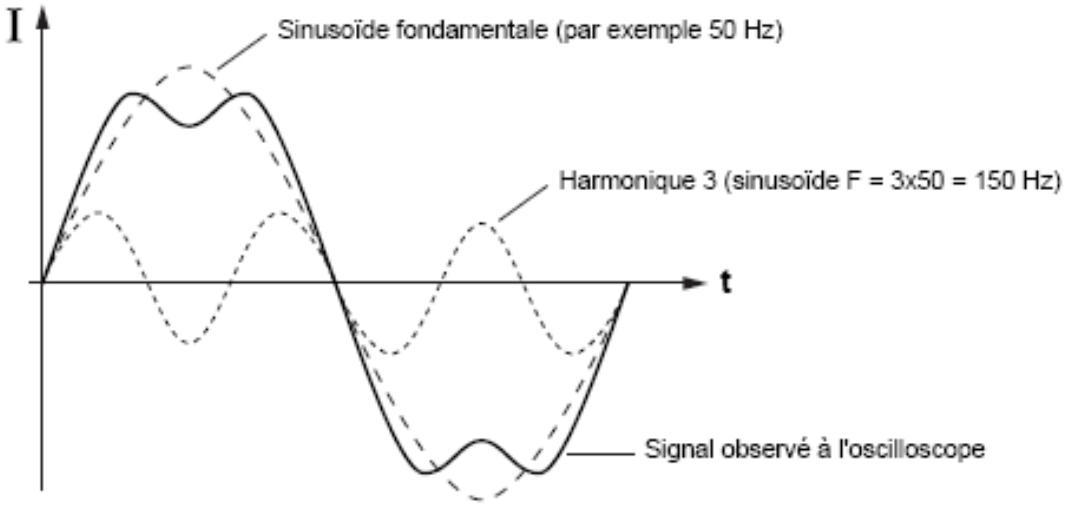
Harmonics analyser

DPA connection

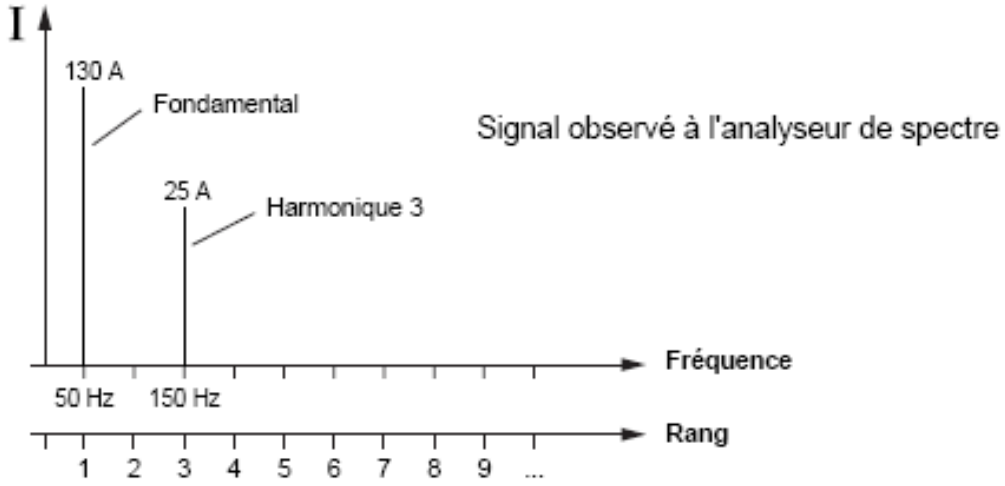


Spectral effects

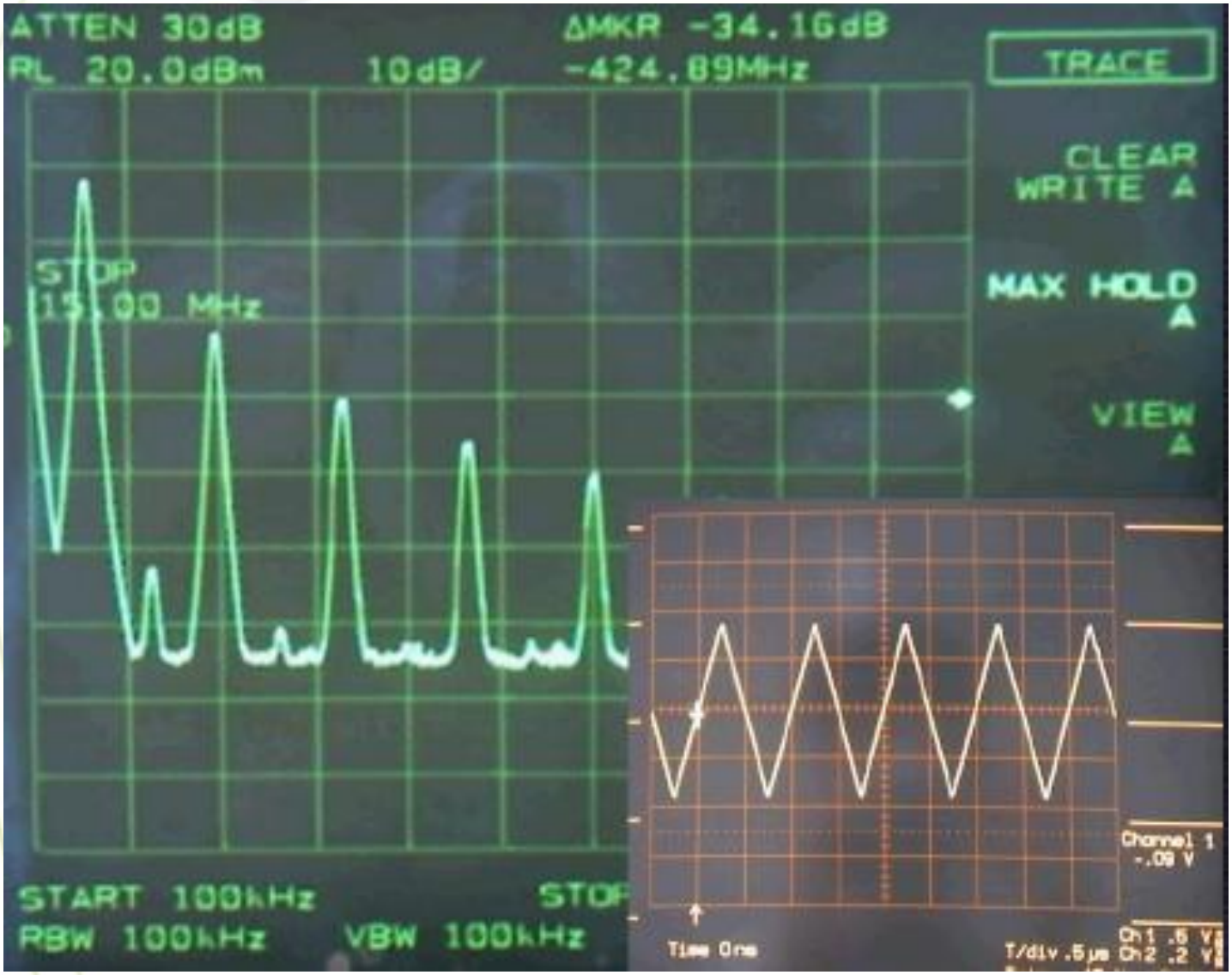
Temporal



Spectral



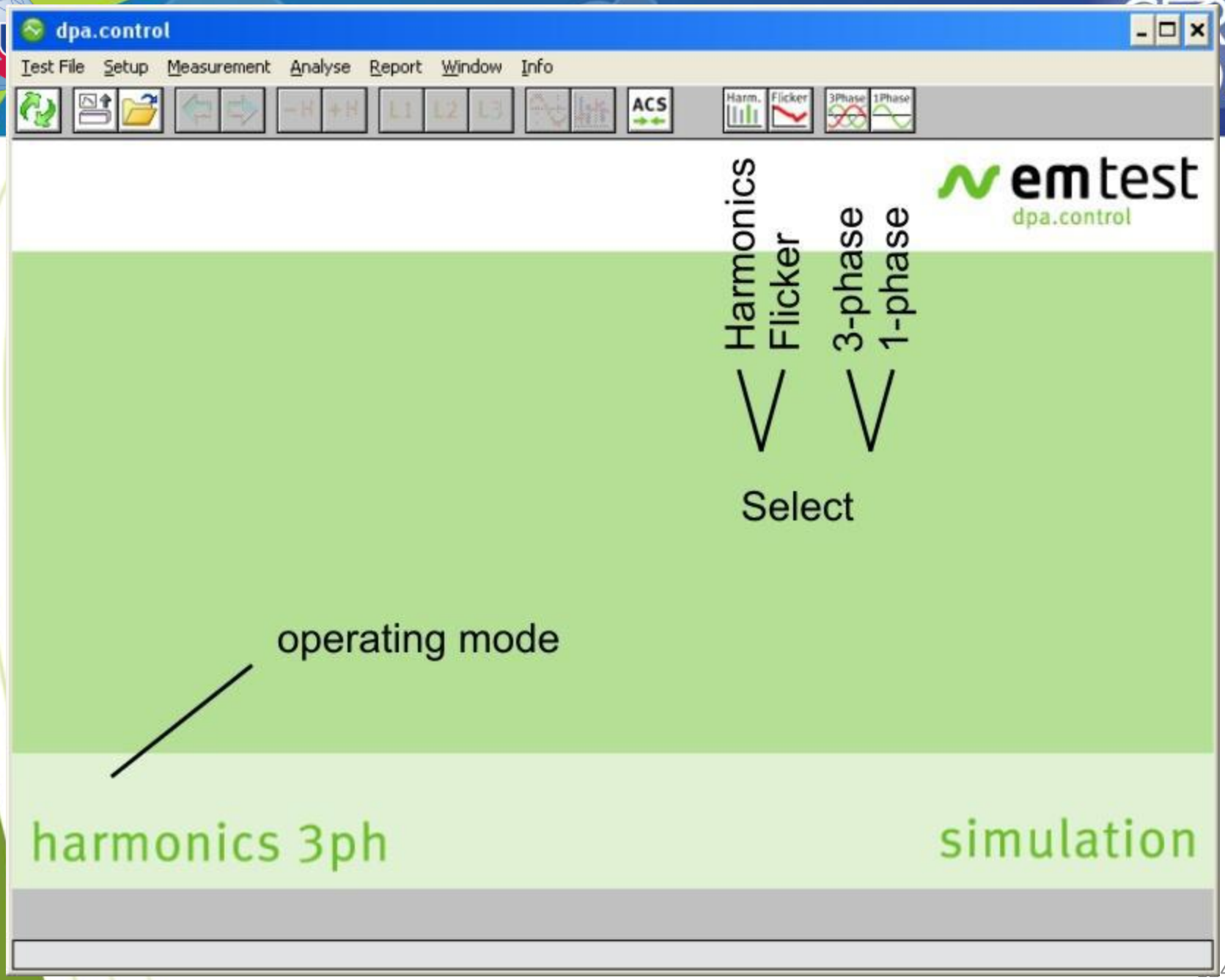
Time vs frequency representation



Test classes

There are 4 different classes in the EN 61000-3-2 that have different limit values:

- Class A: Balanced 3-phase equipment, household appliances excluding equipment identified as class D, tools, excluding portable tools, dimmers for incandescent lamps, audio equipment, and all other equipment, except that stated in one of the following classes.
- Class B: Portable tools, arc welding equipment which is not professional equipment
- Class C: Lighting equipment.
- Class D: PC, PC monitors, radio, or TV receivers. Input power $P \leq 600$ W.


dpa.control
Test File
Setup
Measurement
Analyse
Report
Window
Info
ACS
Harm.
Flicker
3Phase
1Phase
emtest
dpa.control
Harmonics
Flicker
3-phase
1-phase
Select
operating mode
harmonics 3ph
simulation

Test procedure

1. Select the correct test observation period (Table 6.1) of the EUT (min. 10s)
2. Enter the following data (only Class C and D), if available

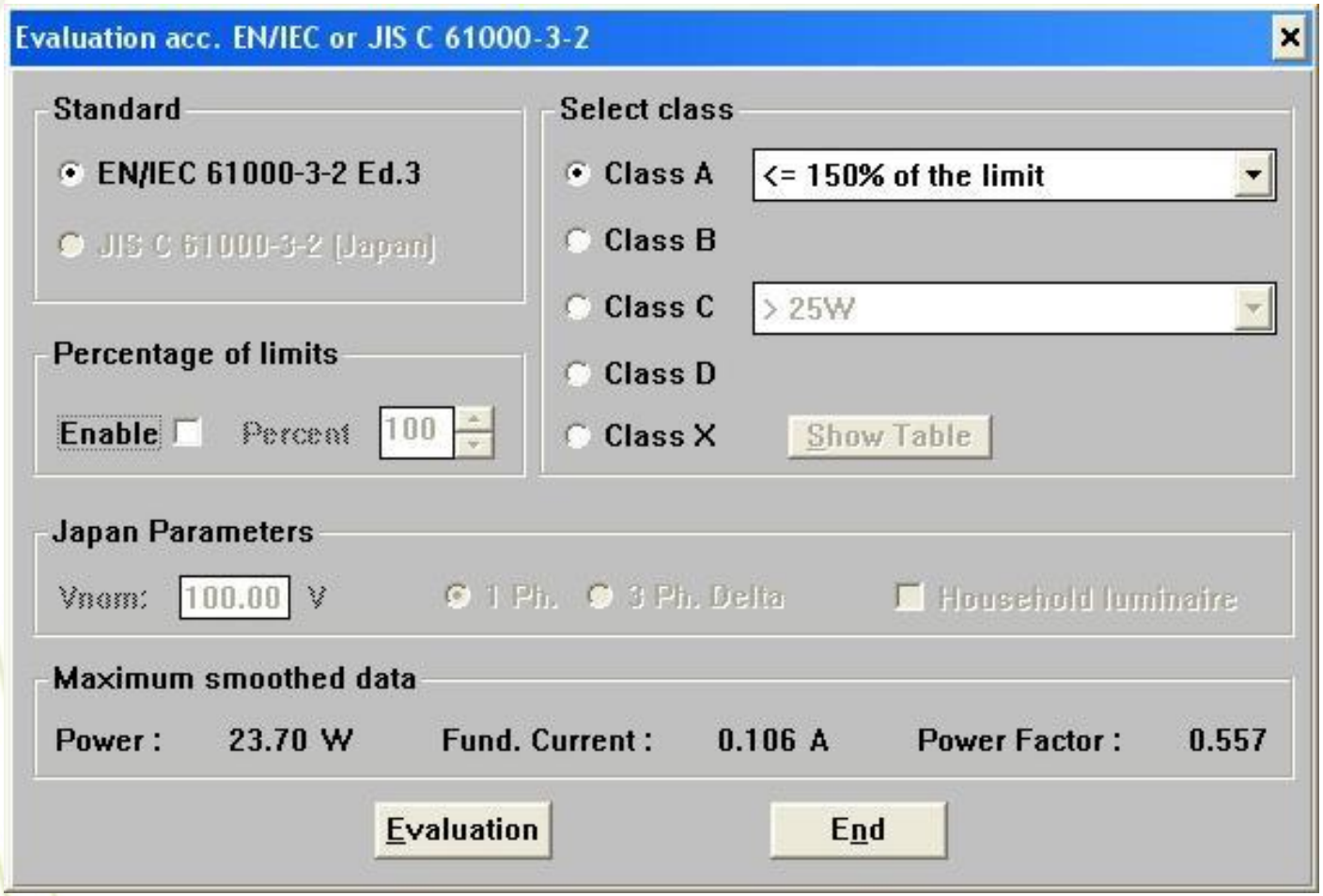
   Class D : Max. Power or Class C : Maximum Fund. current and Max Power Factor

1. Start the measuring
2. Upload the data to the computer
3. Select the Class A...D
4. Start the evaluation
5. Print the report

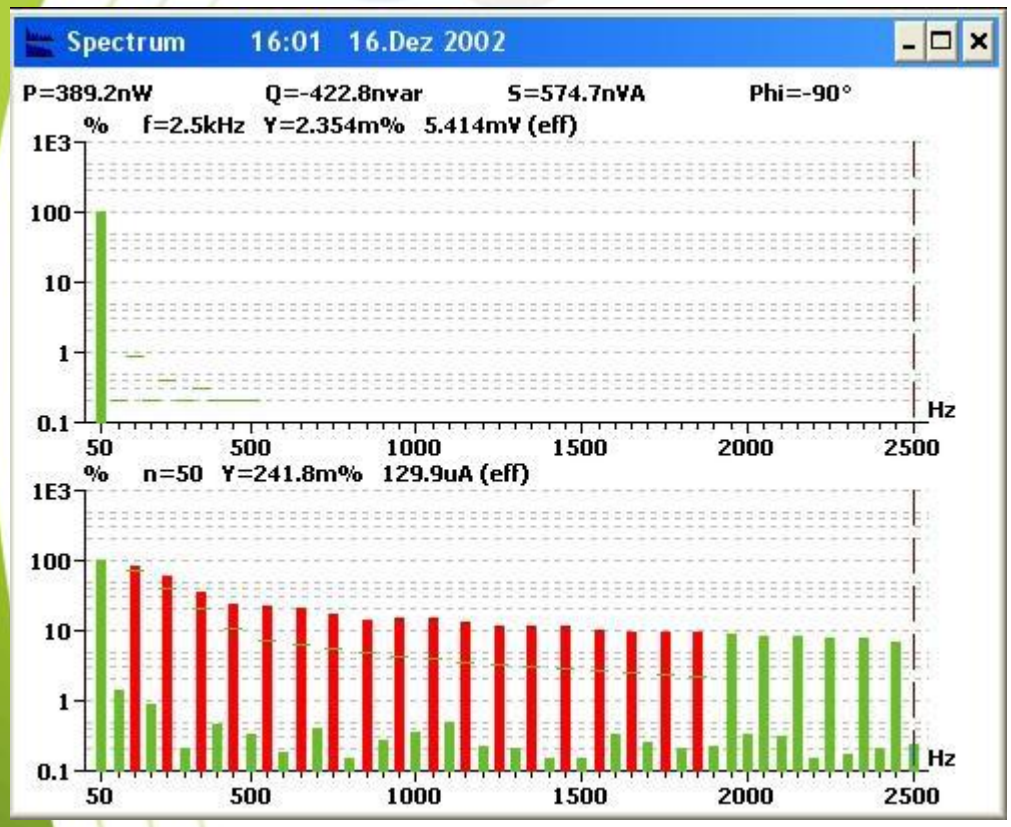
Data flow

- The DPA measures simultaneeusly on all 2 or 6 input channels, carries out the Fourier transformation in real time
- stores all data on the internal hard disk.
- When measuring fluctuations the system generates approx. 1 Mbyte data per minute on the hard disk. The upload of a 2.5 minute measurement needs less than 20 seconds. An internal timer in the DPA stops automatically the measurement.
- The data are ready for upload on the internal hard disk.
- The DPA will overwrite the measurement by starting the next measurement.

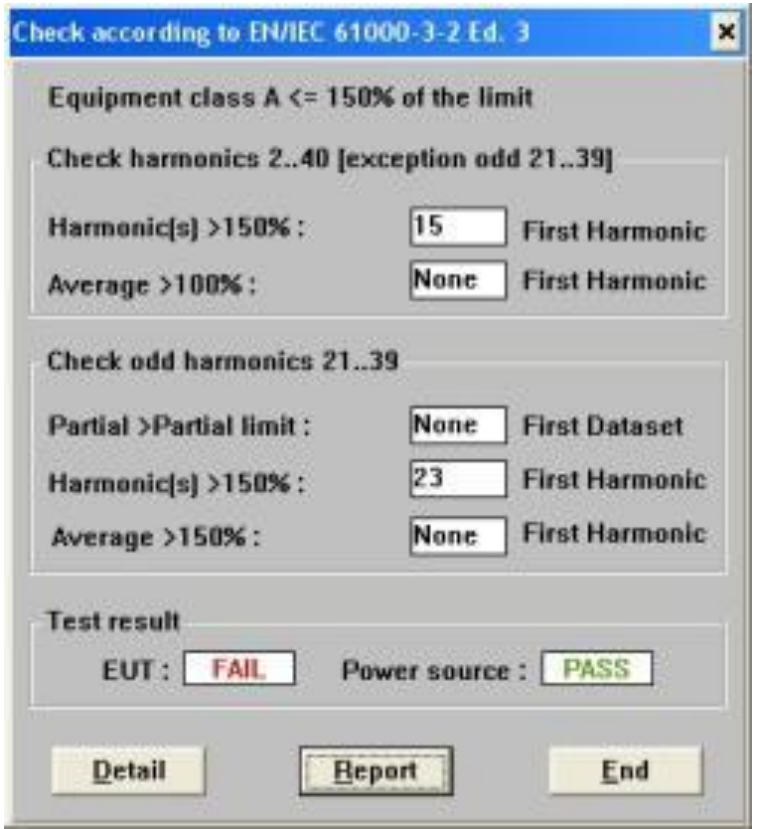
Test parameters



Test result



Limit values are indicated and harmonics exceeding the specified limit are
marked in red colour.



Flickers emission

IEC 61000-3-3

Flicker

- Flicker standards are imposed to limit voltage variations

  caused by loads connected to the supply network that

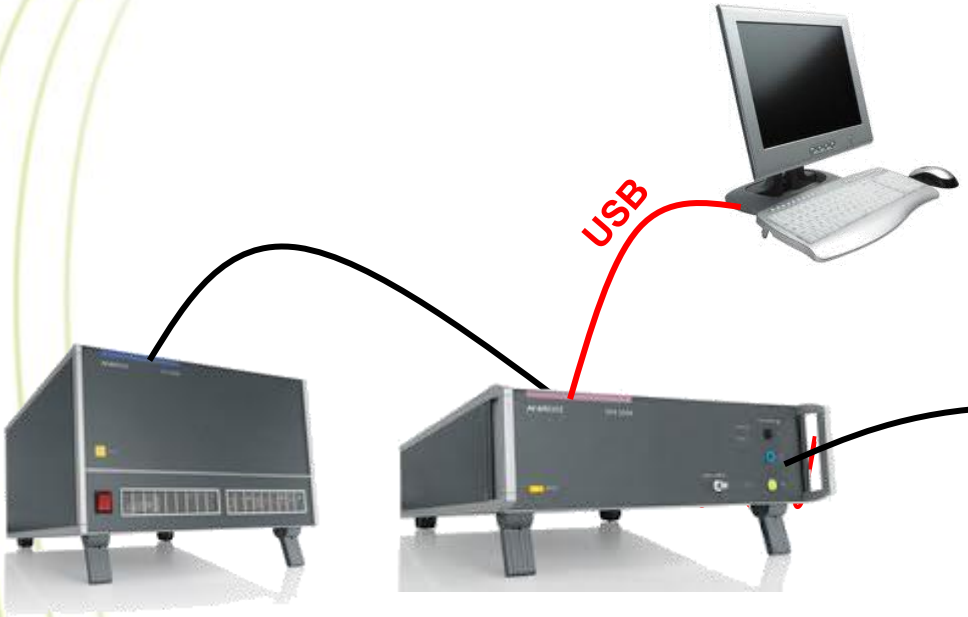
  would cause lights connected at the same circuit to flicker.

- For device single phase up to 16A the standard

  EN IEC 61000-3-3 sets the limits for voltage fluctuation

  caused by electrical apparatus.

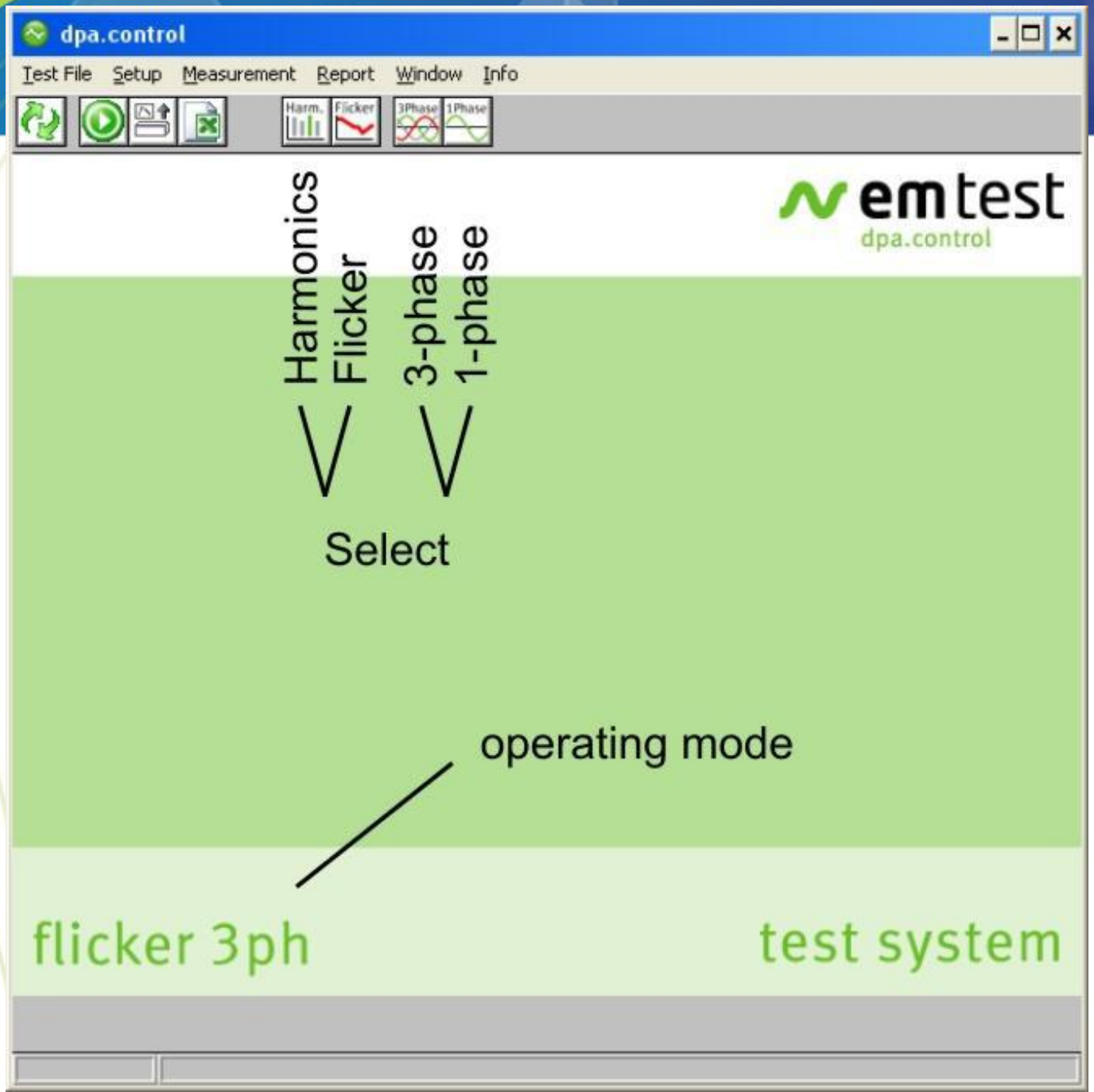
Flickers emission – IEC 61000-3-3



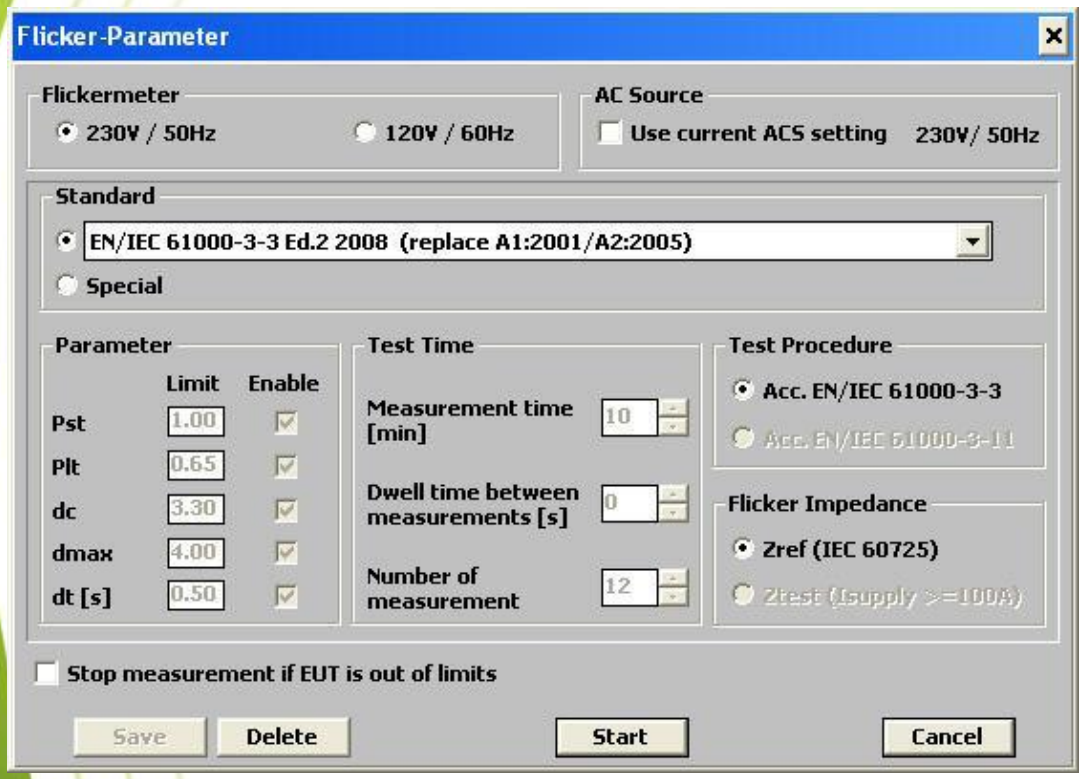
EUT

Stable source

Flickers analyser


dpa.control
Test File
Setup
Measurement
Report
Window
Info
Harm.
Flicker
3Phase
1Phase
emtest
dpa.control
Harmonics
Flicker
3-phase
1-phase
Select
operating mode
flicker 3ph
test system

Flickers test



The flicker analysis is based on a standards library including the basic standards but also, and even more important, product-specific Requirements such as hair dryers and vacuum cleaners.

The actual flicker values are continously displayed. A test can be stopped once a limit is exceeded. This could, in case, safe valuable test time.

Flickers parameters

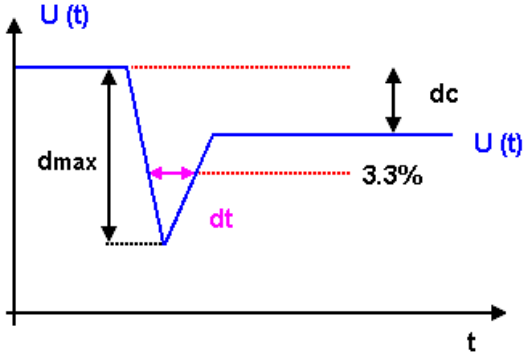
After the flicker measurement the values of dc, dmax, dt are displayed on the screen.

- dc : Relative continuous voltage variation (must be smaller than 3.3%) The dc value is a % value relative to the nominal AC

  voltage of 230V AC.
- dmax: Max. relative voltage variation (must be smaller than 4% or 6.7%). The dmax value is a % value relative to the nominal AC

  voltage of 230V AC.
- dt: Time with v 3%. During max. 500ms the

  voltage is allow 3.3% limit.



Limits

- The limits shall be applicable to voltage fluctuations and

  flicker at the supply terminals of the equipment under test:
- The following limits apply:
  - the value of *Pst shall not be greater than 1,0;*
  - the value of *Plt shall not be greater than 0,65;*
  - the value of *d(t) during a voltage change shall not exceed 3,3 % for more than 500 ms;*
  - the relative steady-state voltage change, *dc, shall not exceed 3,3 %;*

Limits

- the maximum relative voltage change *dmax, shall not exceed*

  a) 4 % without additional conditions;

  b) 6 % for equipment which is:

  - switched manually, or
  - switched automatically more frequently than twice per day

  c) 7 % for equipment which is

  - attended whilst in use
  - switched on automatically, or is intended to be switched on manually, no more than twice per day, and also has either a delayed restart

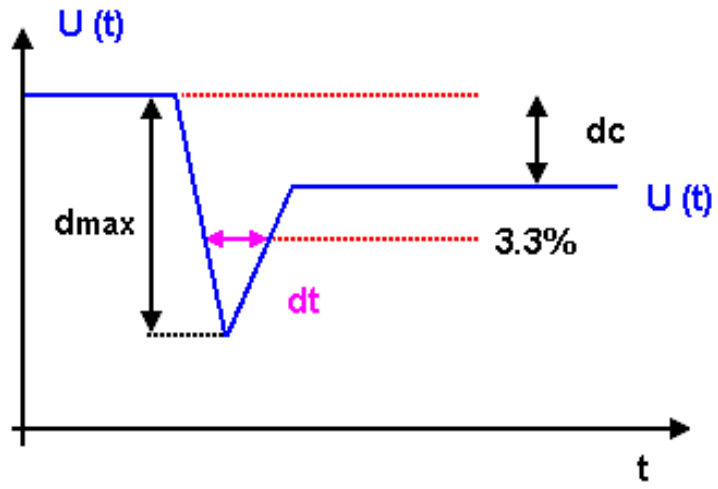
Test results

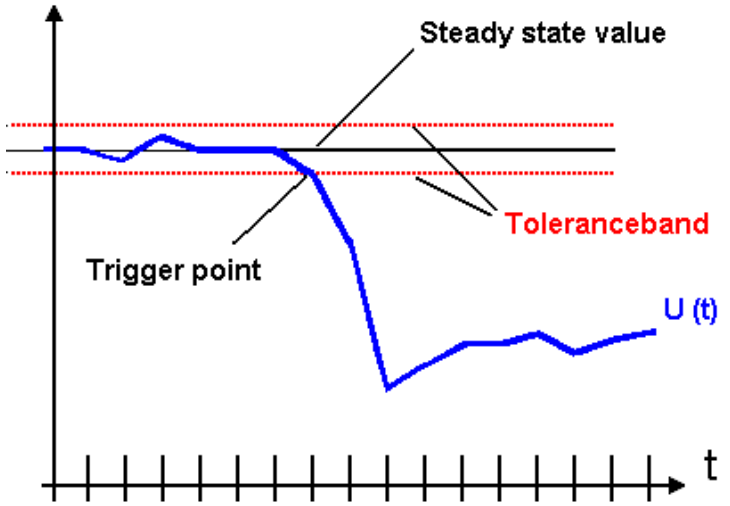
Result flicker measurement (maximum value)

Measurement time: 10 min Number of measurement: 12

	L1	L2	L3	Limit	Result
Pst	0.758	0.758	0.758	1.00	PASS
Plt	0.498	0.498	0.498	0.65	PASS
dc [%]	2.986	2.986	2.985	3.00	PASS
dmax [%]	5.121	5.126	5.126	4.00	FAIL
dt [s]	0.030	0.030	0.030	0.20	PASS

Detail Report End





Example of a product standard

EN 55024

Example of a generic standard

EN 61000-6-1

Example of a test report

Link

Training Course on Conformity and Interoperability on Type Approval testing for Mobile Terminals, Homologation Procedures and Market Surveillance, Tunis-Tunisia, from 20 to 24 April 2015

Speed up your compliance

EMC standards

Tunis (Tunisia), 20-24 April 2015