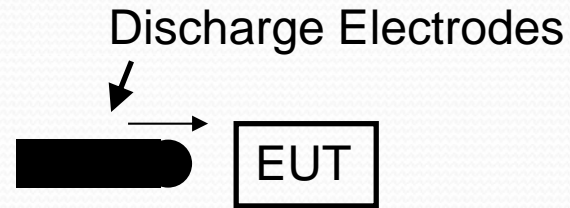


ESD Tests

- Direct Application:

- Air Discharge (**sparks**)



- Contact Discharge



1.5	Electrostatic discharge	Contact discharge	± 4 (charge voltage)	kV	IEC 61000-4-2
		Air discharge	± 8 (charge voltage)	kV	

.....different electrostatic potential in proximity or through direct contact.

ESD Generators



Some models can generate air- or contact discharge up to 30kV. With different combination of R-C value for other applications...



Fast Transient/Burst

Electrical Fast Transients caused a spark in air or other gas - When a circuit is switched off, the current flowing is interrupted; large di/dt is generated.

Arcing between the contacts; first at a low voltage and high frequency; later at a higher voltage and lower frequency.

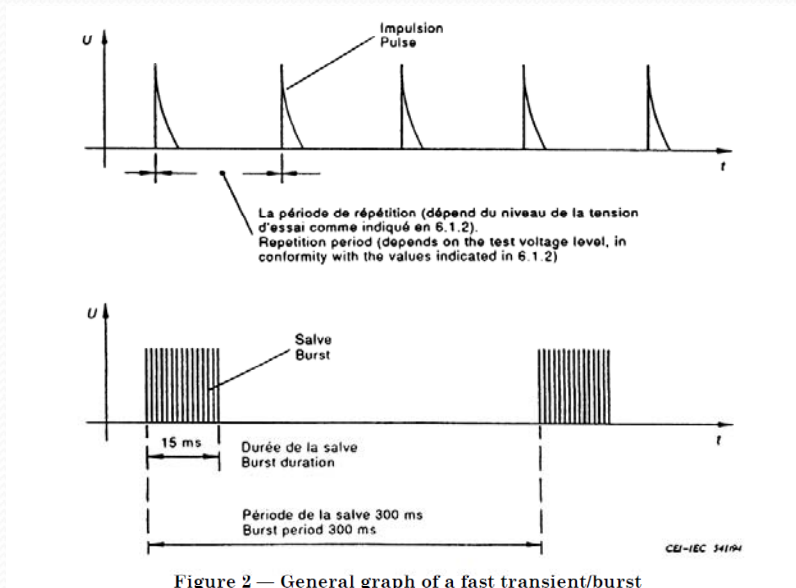
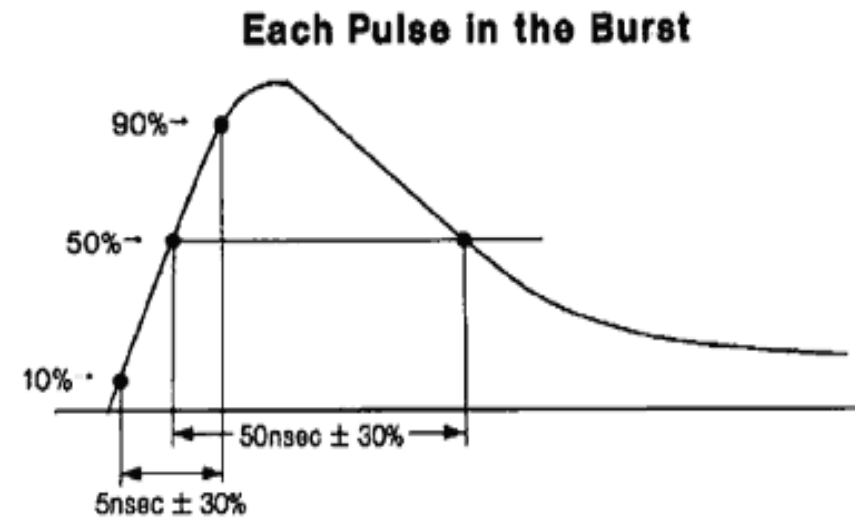


Figure 2 — General graph of a fast transient/burst

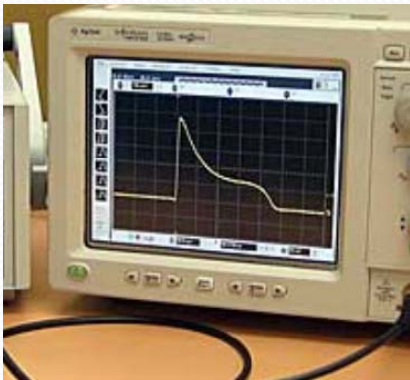
STANDARD EFT WAVEFORM



Electrical Fast Transient

Electrical Fast Transients caused a spark in air or other gas - When a circuit is switched off, the current flowing is interrupted; large di/dt is generated.

Arcing between the contacts; first at a low voltage and high frequency; later at a higher voltage and lower frequency.



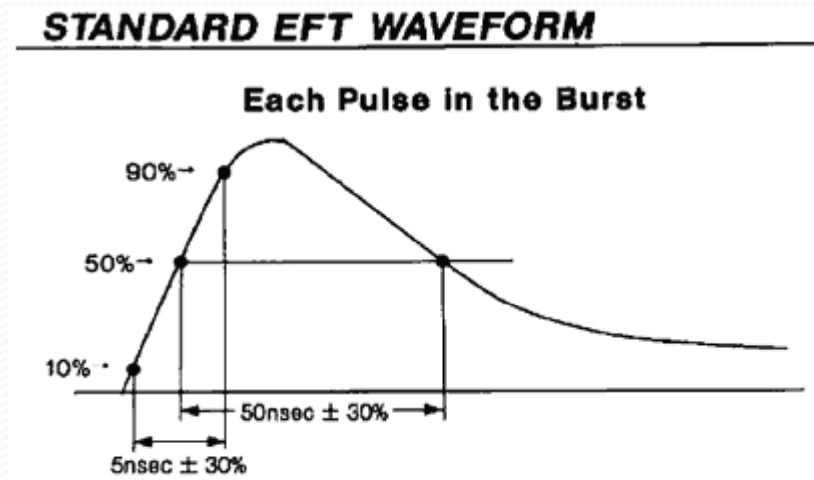
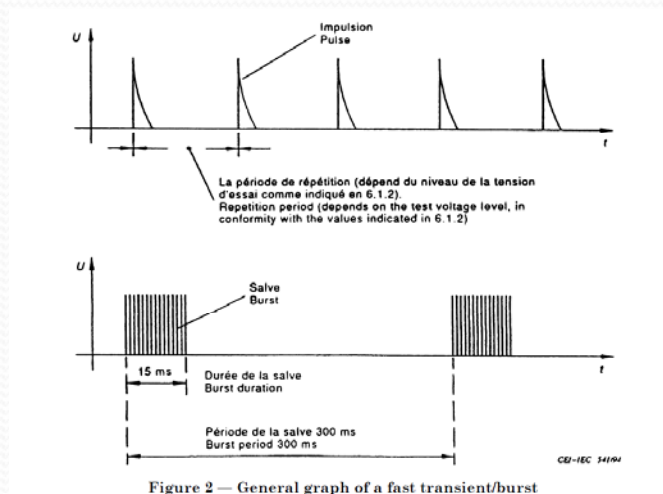
IEC 61000-4-4 Electromagnetic Compatibility (EMC) - Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.

Fast Transient/Burst

Electrical Fast Transients caused a spark in air or other gas - When a circuit is switched off, the current flowing is interrupted; large di/dt is generated.

Arcing between the contacts; first at a low voltage and high frequency; later at a higher voltage and lower frequency.

Coupling of the EFT into electronic products occurs when power cables handling high currents are run in close proximity to power, data, and/or I/O cables.



Surge

- Sudden rises in voltage and/or current to a connected load; standard household equipment can be damaged by surges of 500 volts or greater....
- Indoors, caused by major equipment, such as your air conditioner switching on and off.
- Outdoors, they can be caused by incidents involving electric lines, power equipment failures. Lightning in seasonal storms.



Electromagnetic Compatibility (EMC) — Part 4-5:
Testing and measurement techniques — Surge
immunity test

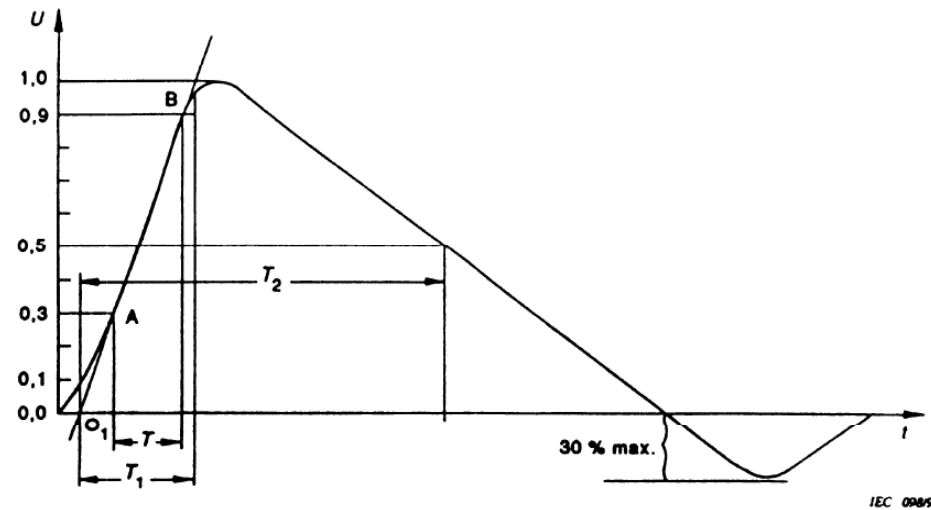
5 Test levels

The preferential range of test levels is given in Table 1.

Table 1 — Test levels

Level	Open-circuit test voltage $\pm 10\%$ 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.



Front time: $T_1 = 1,67 \times T = 1,2 \mu\text{s} \pm 30\%$

Time to half-value: $T_2 = 50 \mu\text{s} \pm 20\%$.

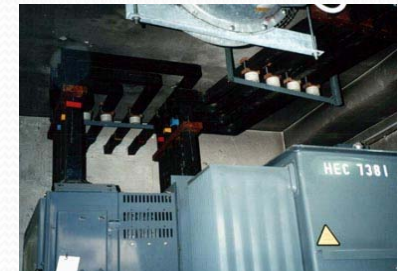
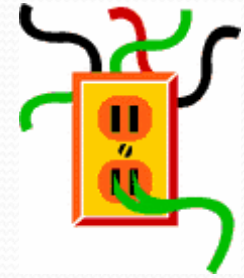
Figure 2 — Waveform of open-circuit voltage (1,2/50 μs)
(waveform definition according to IEC 60-1)

Power frequency magnetic field

Electrical power lines, wiring, transformers and household appliances

...

- Power stations, HV transformer builder, overhead cable, railways system....



Electromagnetic compatibility (EMC) — Part 4-8: Testing and measurement techniques — Power frequency magnetic field immunity test

Table 1 — Test levels for continuous field

Level	Magnetic field strength A/m
1	1
2	3
3	10
4	30
5	100
x ^a	special

^a "x" is an open level. This level can be given in the product specification.

Table 2 — Test levels for short duration: 1 s to 3 s

Level	Magnetic field strength A/m
1	n.a. ^b
2	n.a. ^b
3	n.a. ^b
4	300
5	1 000
x ^a	special

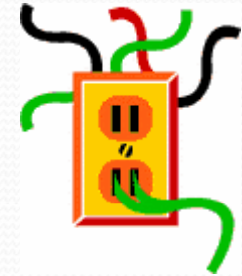
^a "x" is an open level. This level, as well the duration of the test, can be given in the product specification.

^b "n.a." = not applicable

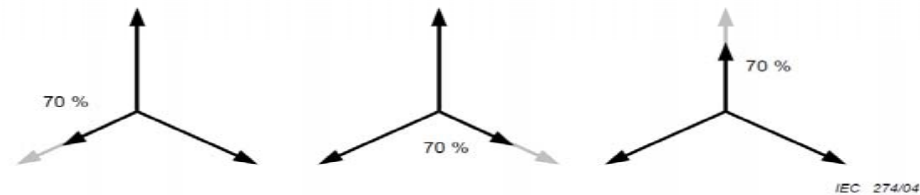
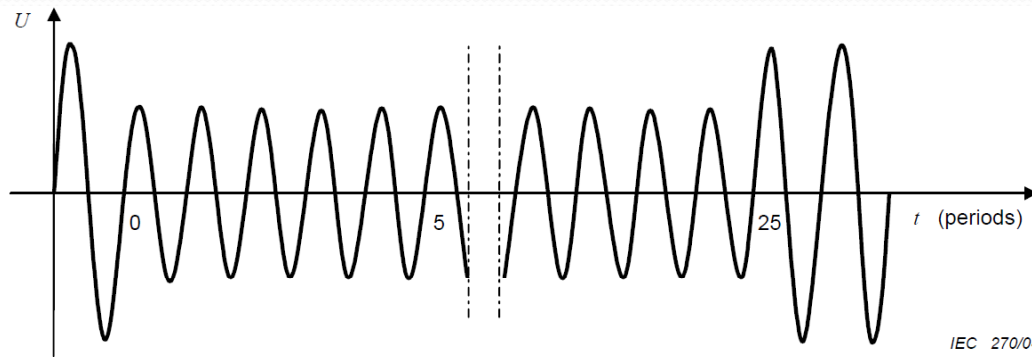
$$\oint_l \overline{H} \cdot d\overline{l} = I \Leftarrow \text{Ampere's law}; \quad H = \frac{I}{2\pi r} \quad 10 = \frac{I}{2\pi \times 1m}$$

Voltage dips, short interruptions and voltage variations

- Electrical equipment can be affected by voltage dips, short interruptions or voltage variations of the power supply caused by faults in the network, in installations or by a sudden large change of load.

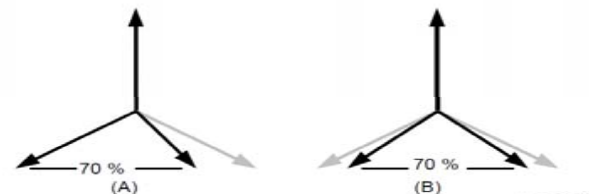


Voltage dips, short interruptions and voltage variations



NOTE Phase-to-neutral testing on three-phase systems is performed one phase at a time.

Figure 4a) – Phase-to-neutral testing on three-phase systems



Immunity Test results

Criterion	Performance
A	Normal performance, specified by manufacturer
B	Temporary loss of function or performance degradation during test. EUT recovers its performance without intervention
C	Temporary loss of function or degradation (requiring intervention)
D	Loss of function or degradation unrecoverable



Summary

- Some concept and fundamentals on EMC.
- RE, RI, CE, DI, ESD, FT & S, H-Field, Voltage Dip.

