

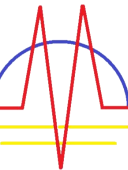
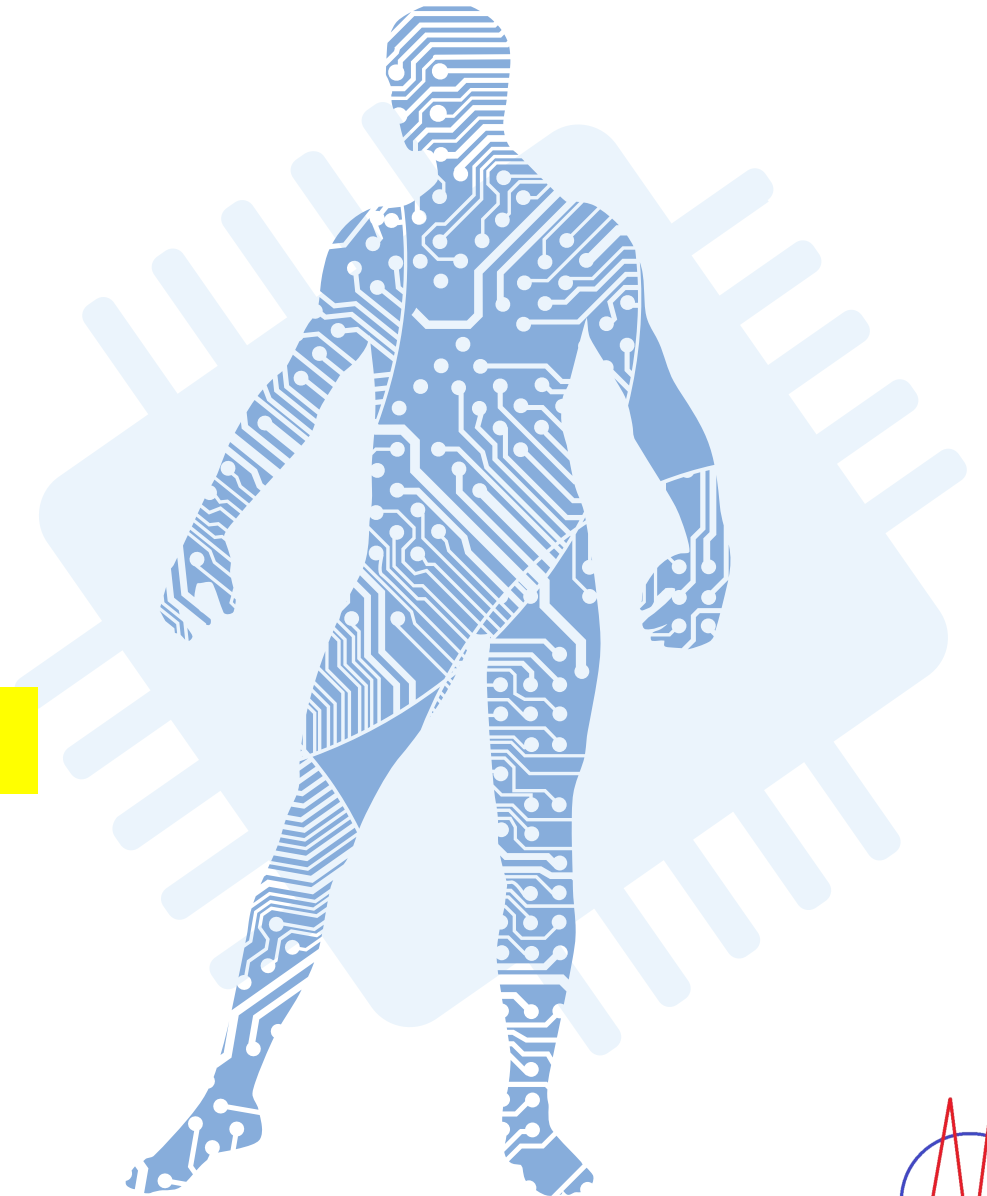
# EMC AND EMI

(part 1/6)

Introduction

# Content

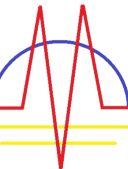
- 01 What is EMC & EMI**
- 02 Sources of EMI**
- 03 Type of EMC and EMI tests**
- 04 Standerds of EMI/EMC**



# 01. What is EMC AND EMI ?

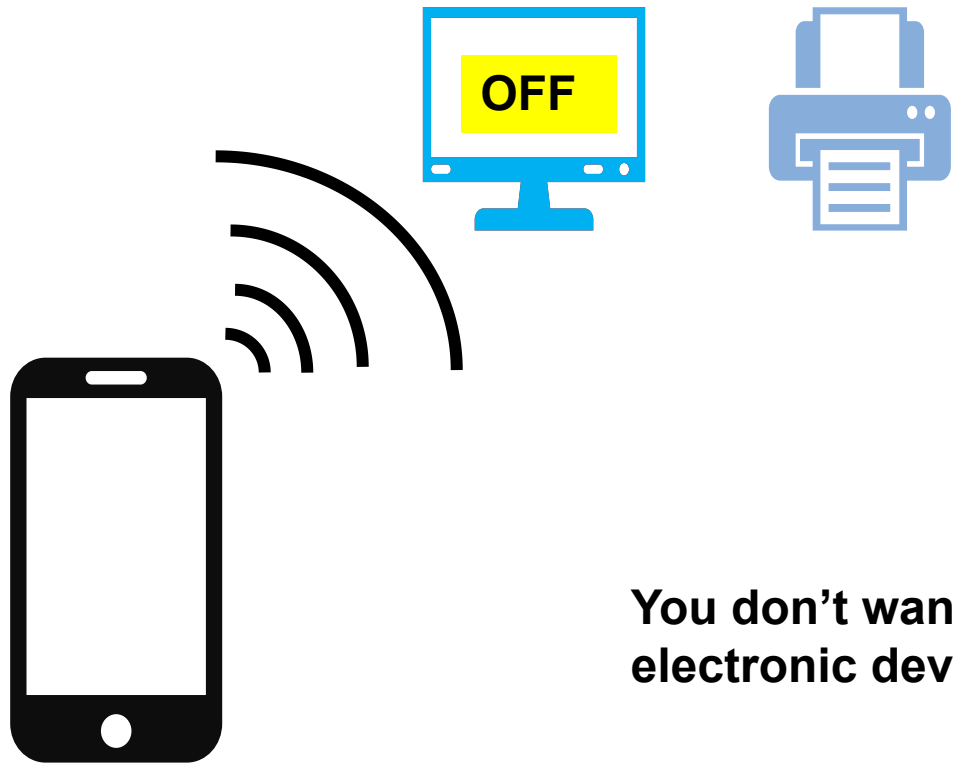
**EMC: Electromagnetic Compatibility**

**EMI: Electromagnetic Interference**

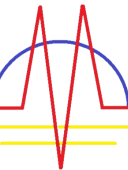
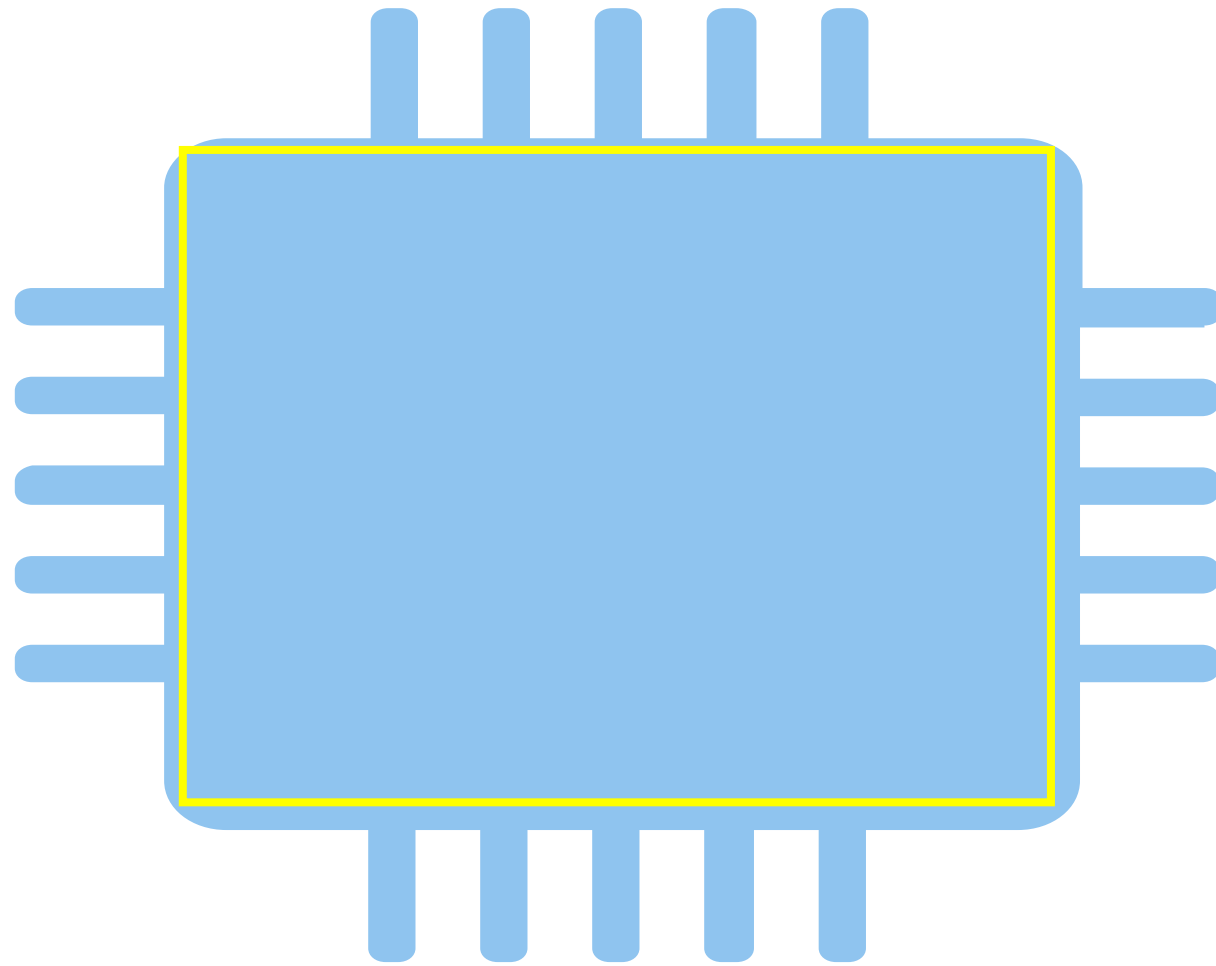


# 01.What is EMC

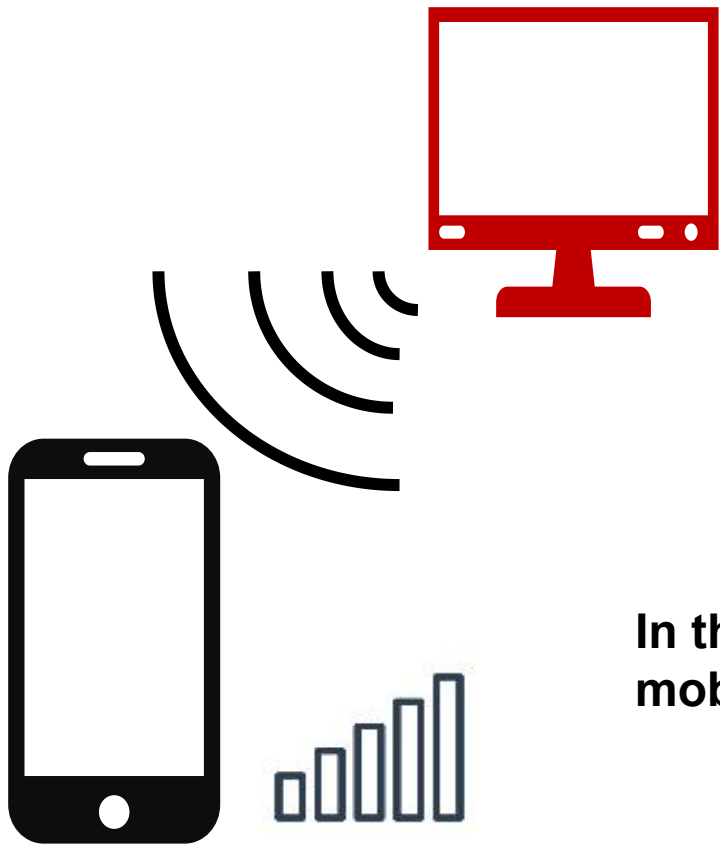
For example:



**You don't want your mobile phone to inter-phase with TV or other electronic devices function.**

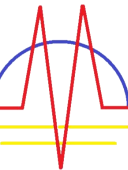


# 01.What is EMC



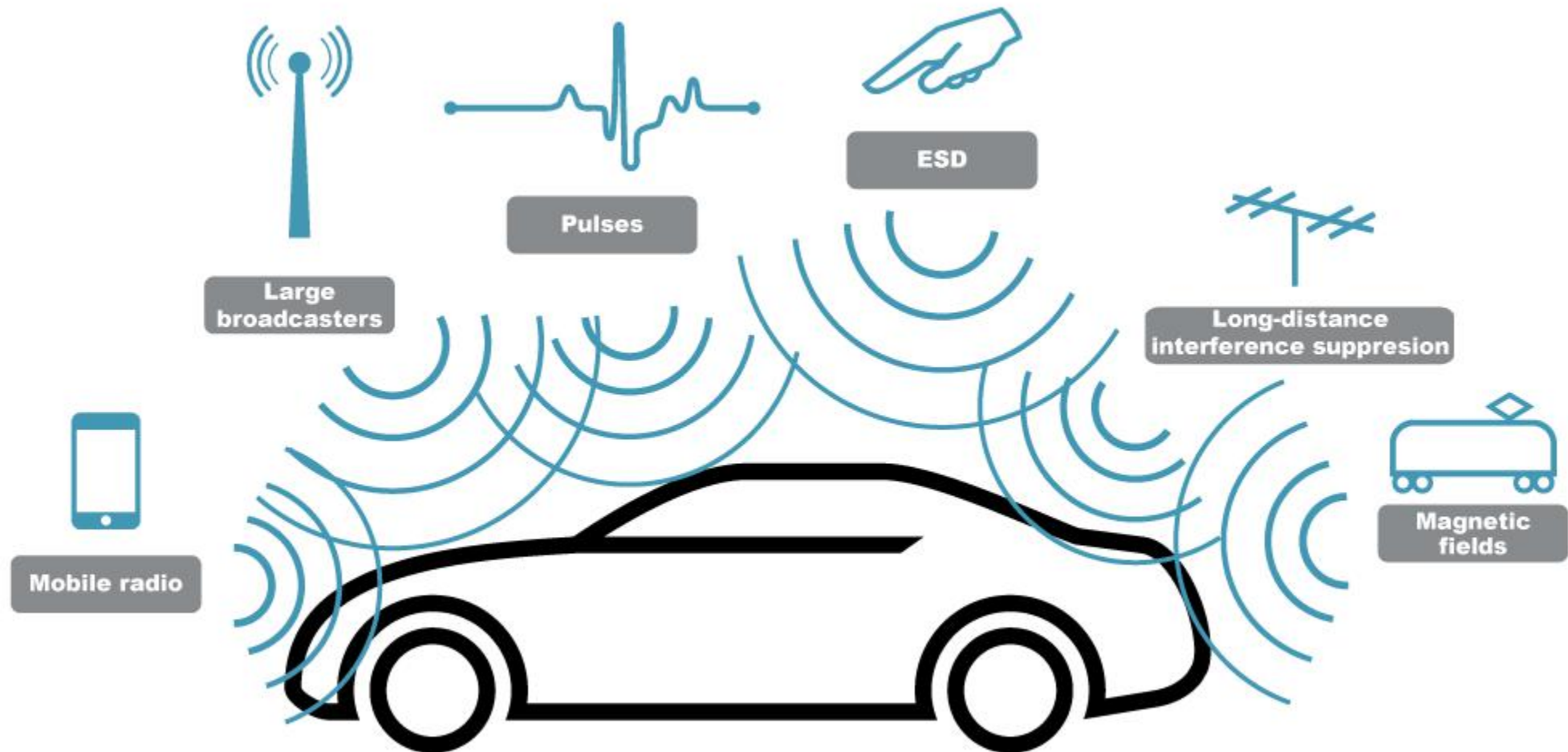
**Describes How well your device can function in its environment without causing any unwanted effects to surrounding equipments.**

**In the same way ,because TV or other device radiation your mobile phone should not malfunction.**



# EMC

## EMC: Electromagnetic Compatibility

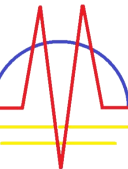


## 02.What is EMI

This is an electronic emission that interferes with components ,RF system , and electronics device.

EMI can be the result of man made or natural occurrences.

**So EMI is a result of electric or magnetic fields acting on the device causing it to malfunction.**

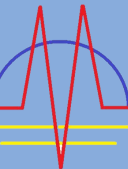


## Another Example

**Why the Aeroplane crew say to switch off the mobile phone and laptops?**

**Because the radiation emitted by your mobile phone or laptop will disturb the aeroplane s high frequency operating communication network Equipment's.**

**While landing or takeoff the aeroplane will send signal to radar ,that signal will be interrupted because of your noise generated by your mobile phone.**





F-WWOW/AJ-DM

F-WWOW/AJ-DM



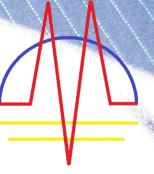
Left side control panel featuring a keyboard and various function buttons for engine and system management.

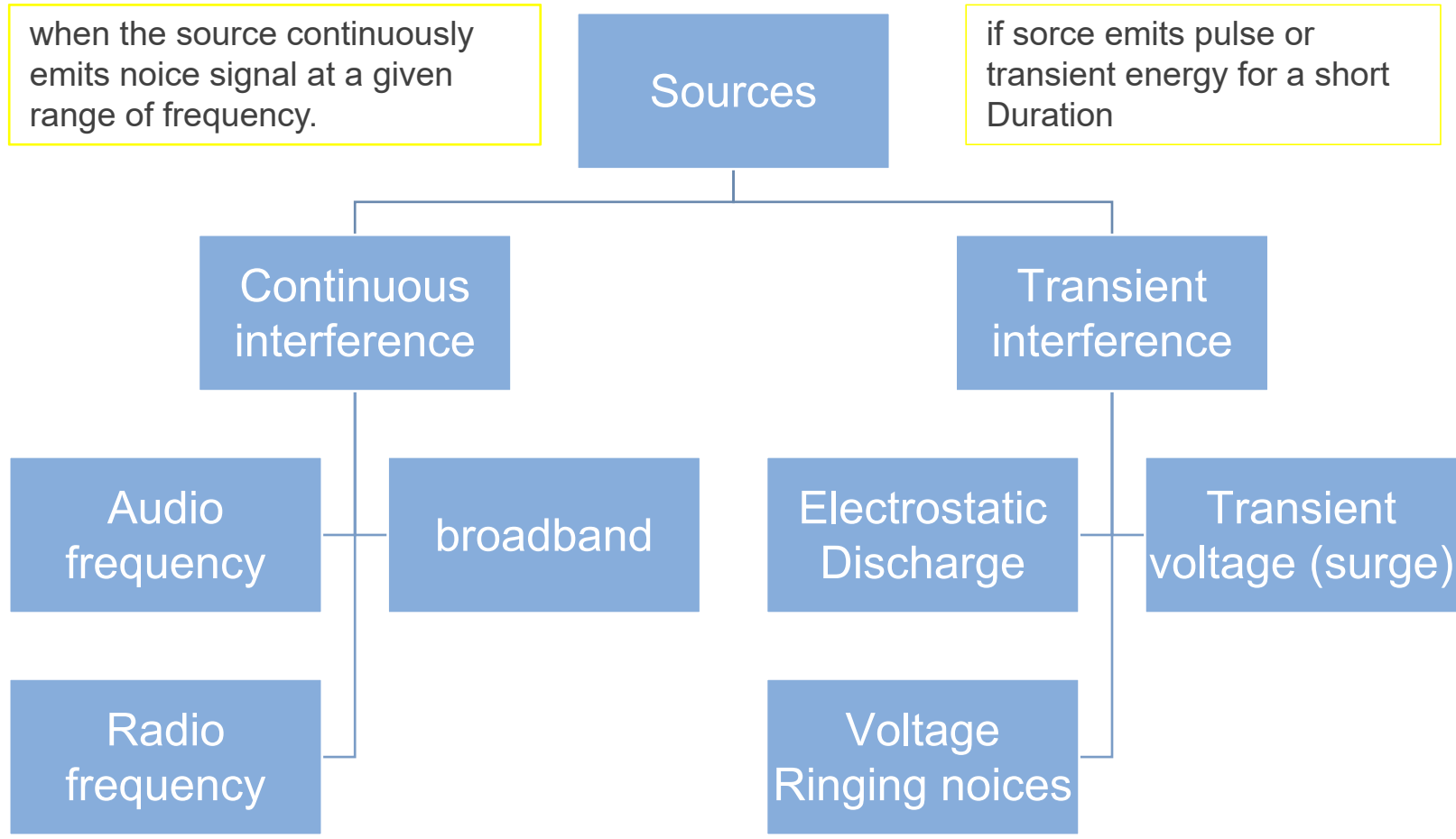
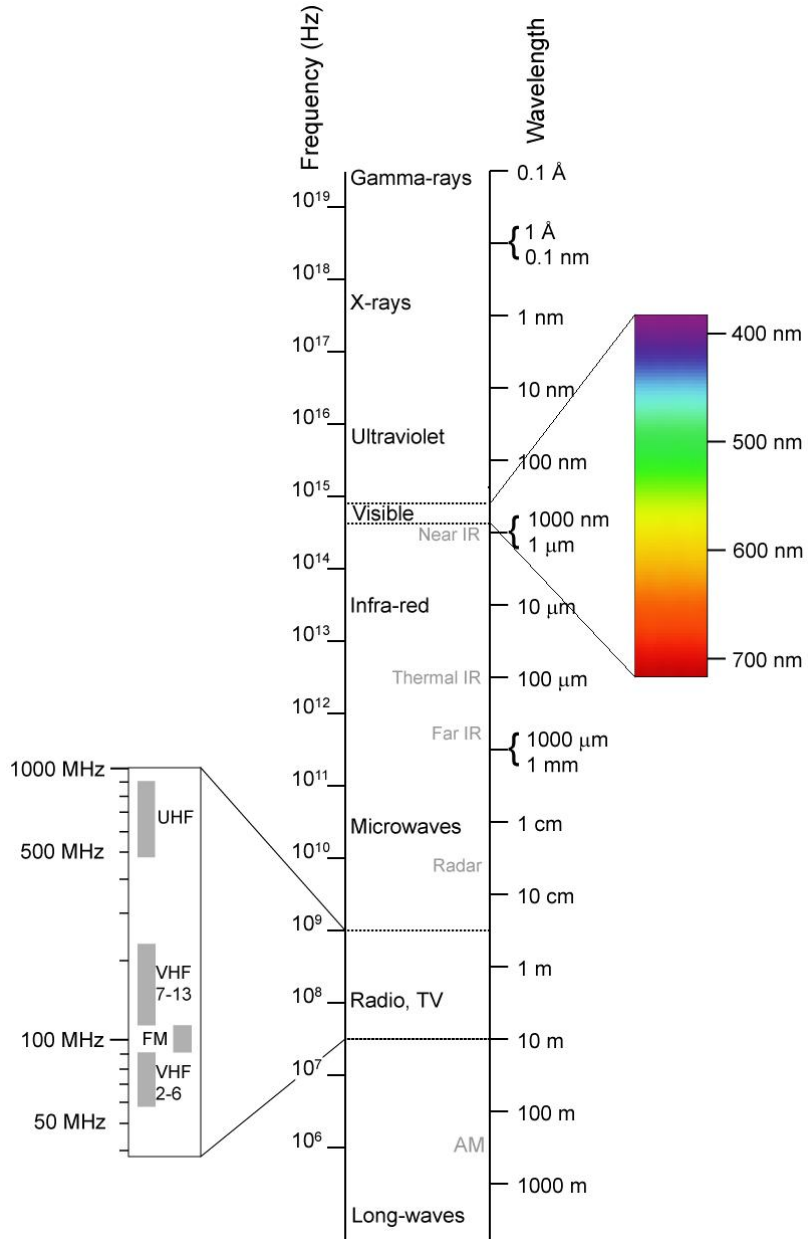


Central control panel featuring a keyboard, four engine levers, and various function buttons.

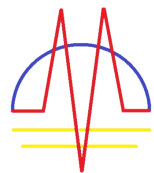
Right side control panel featuring a keyboard and various function buttons.

Bottom control panel featuring a keyboard, engine levers, and various function buttons.





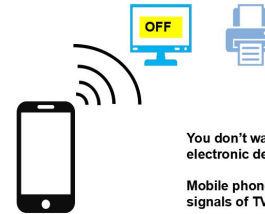
# Sources of EMI.



# Now we know what is EMC and what is EMI.

## 01. What is EMC

For example:



Describes How well your device can function in its environment without causing any unwanted effects to surrounding equipments.

You don't want your mobile phone to interfere with TV or other electronic devices function.

Mobile phone signal should not disturb the TV function and signals of TV.

## 02. What is EMI

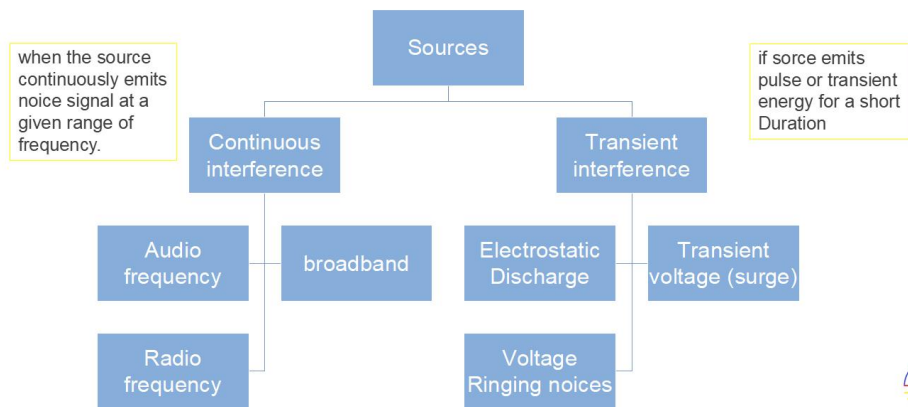
This is an electronic emission that interferes with components, RF system, and electronics device.

EMI can be the result of man made or natural occurrences.

So EMI is a result of electric or magnetic fields acting on the device causing it to malfunction.

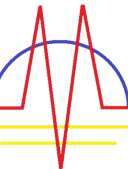


## Sources of EMI



Now we will see how many ways are there by which our device will be affected.

ie., we test our device in different EMI coupling methods.

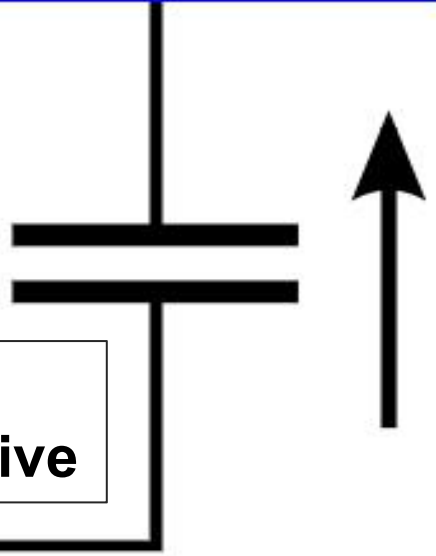
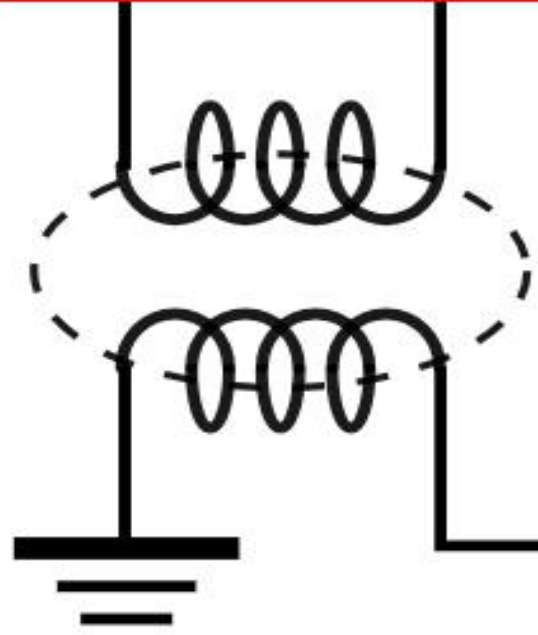


**Radiative**

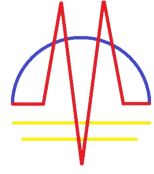
If the noise signal is transmitted in air that is called Radiative



If the noise signal is transmitted through wires that is called conductive



**Conductive**

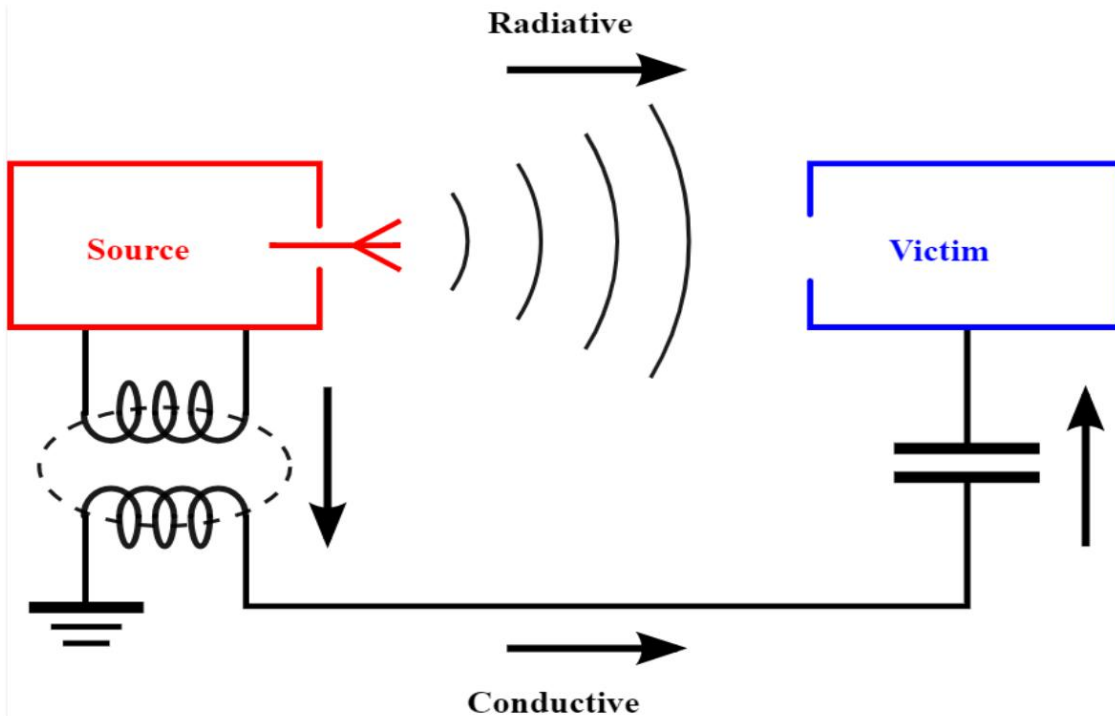


# Tests performed on device to know EMC/EMI

First we conduct a test to know how much noise is generated from our Device(victim)

- 1) **Conducted Emission test.**
- 2) **Radiation Emission test**

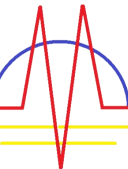
This two test will show how much noise is emitted by air and through wires.



Next we conduct two more test to know the immunity of our Device(victim).

- 3) **Immunity to Conduction Emission**
- 4) **Immunity to Radiation Emission**

This two test will explain how much level our device can withstand the noise signal.



# They are four test that we perform on Device.

1) Conducted Emission test.

2) Radiation Emission test

3) Immunity to Conduction Emission

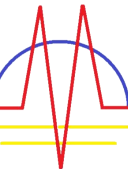
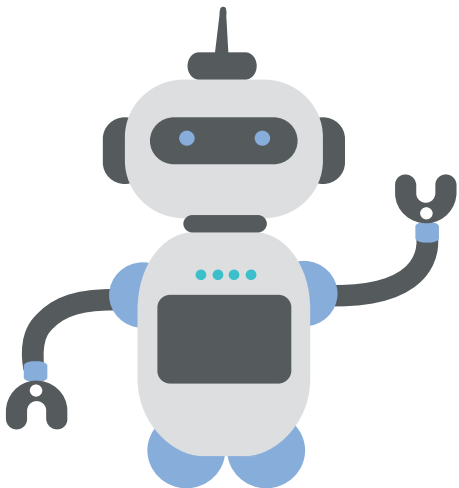
4) Immunity to Radiation Emission

Surge Immunity

Transient immunity

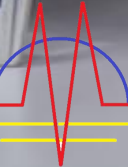
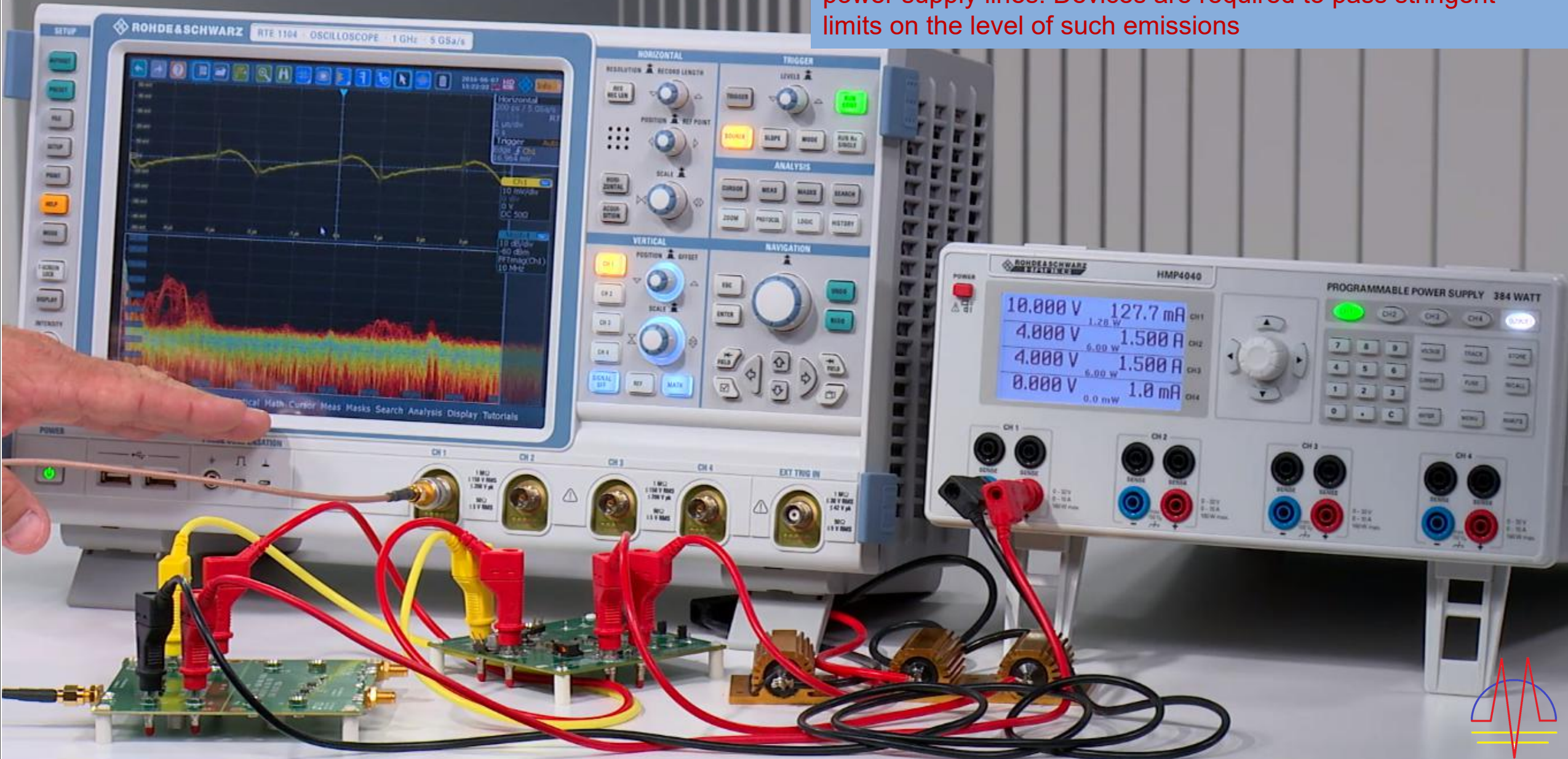
ESD immunity test

High frequency noise  
Immunity test



# 1) Conducted Emission test.

Conducted emissions are electromagnetic disturbances caused by a device and conducted out by interconnects such as the power supply lines. Devices are required to pass stringent limits on the level of such emissions

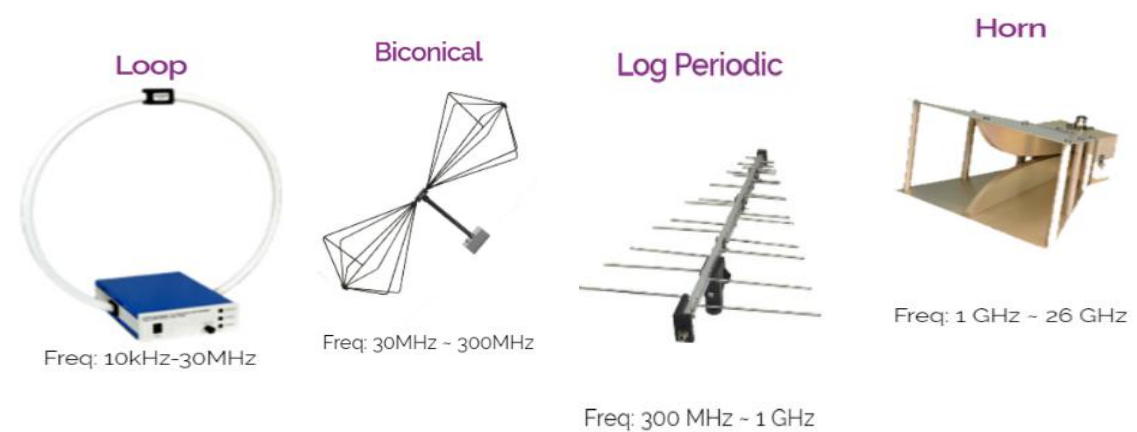


# 2) Radiation Emission test



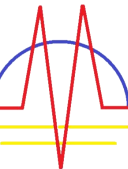
Radiated emissions testing involves measuring the electromagnetic field strength of the emissions that are unintentionally generated by your product.

Emissions are inherent to the switching voltages and currents within any digital circuit, the only question is: how large are the emissions and do they comply with the emissions limits?

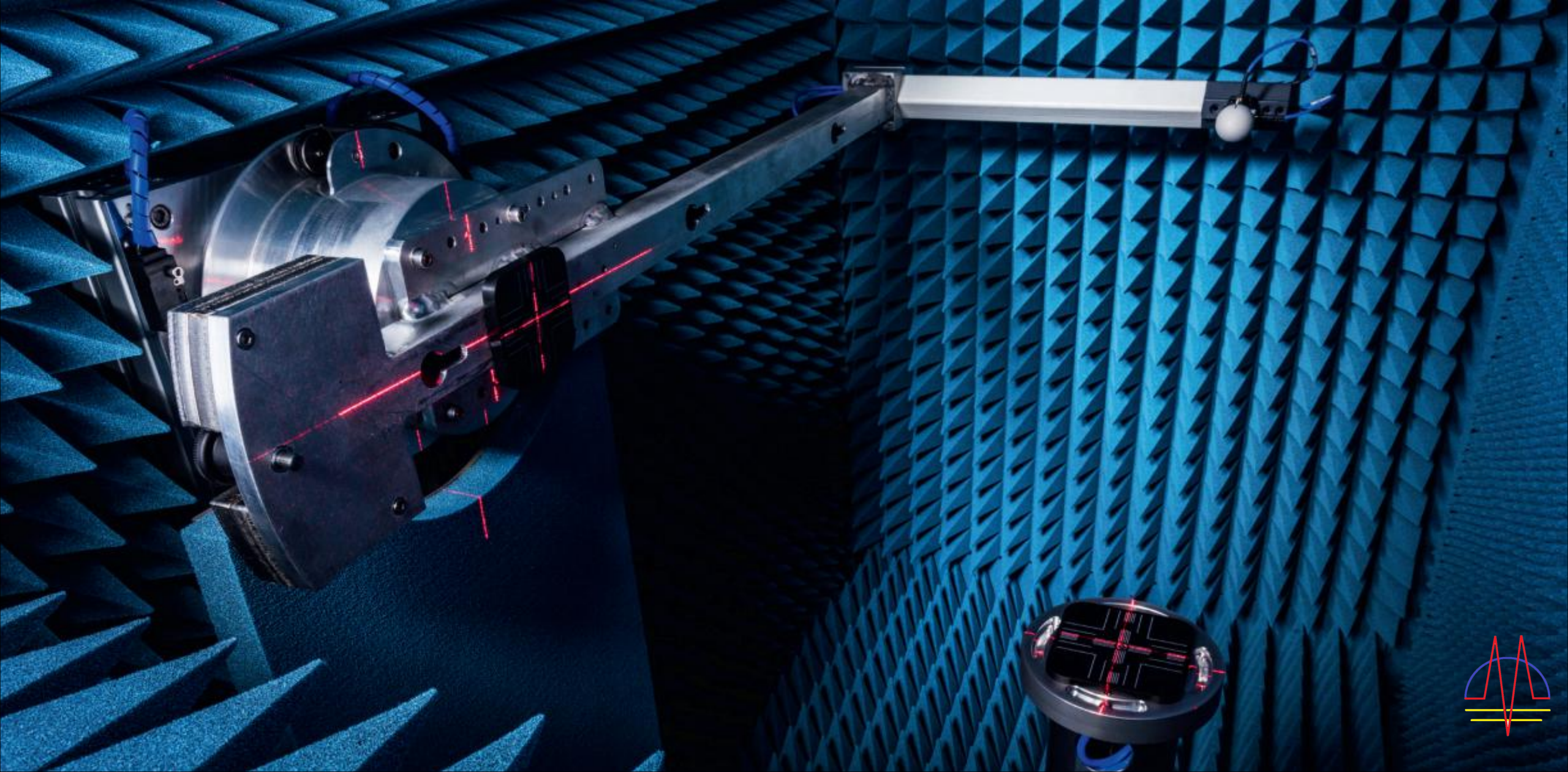


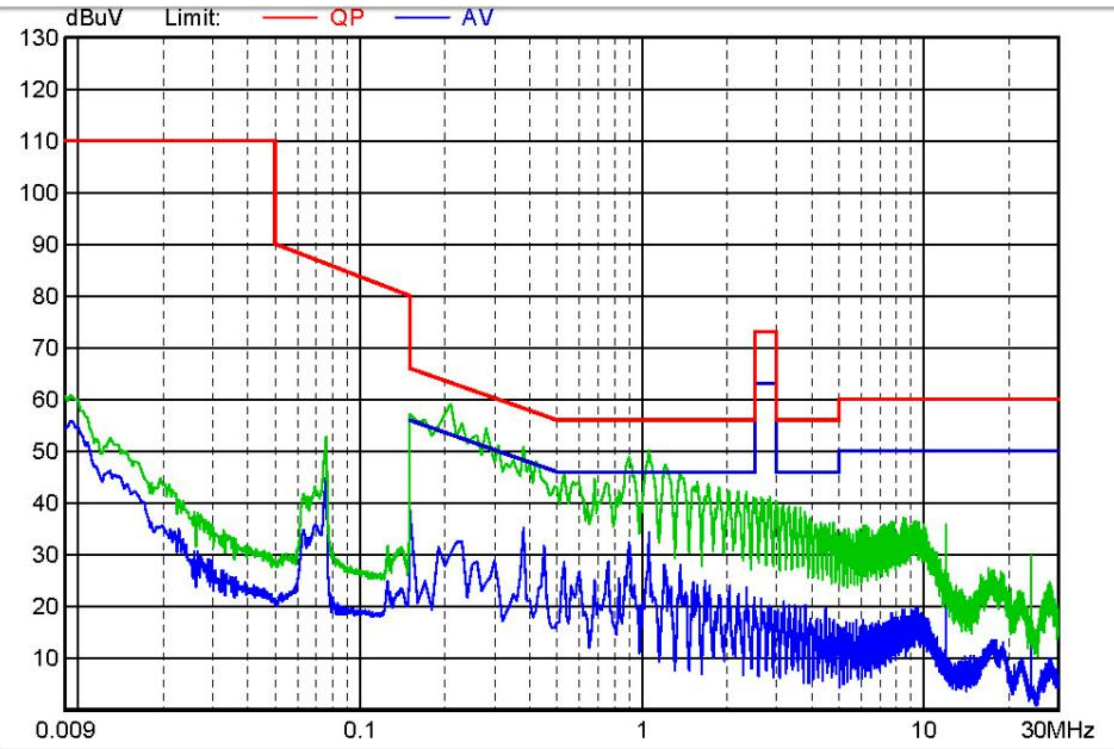
Radiation emission test is concern about how much your product is emitting radiation in terms of RF energy.

So how do EMC test labs measure radiated emissions?

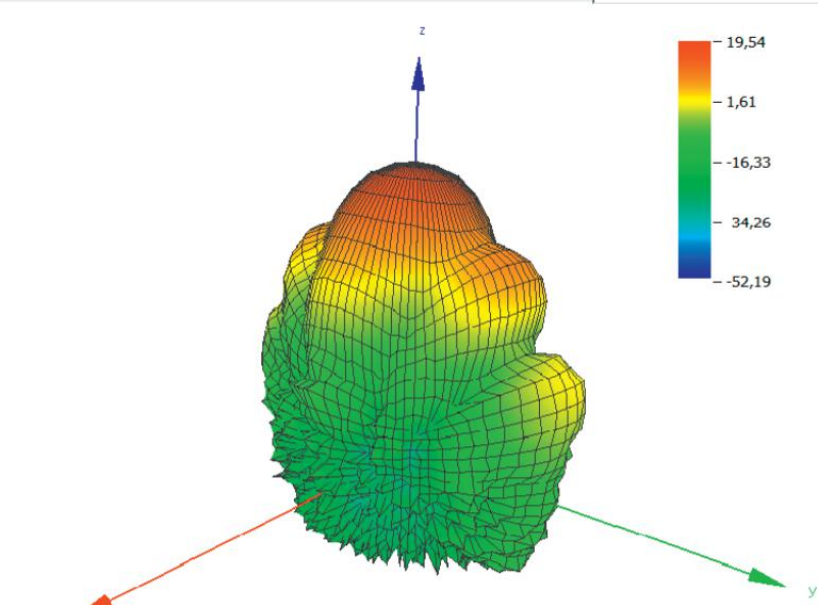


## 2) Radiation Emission test

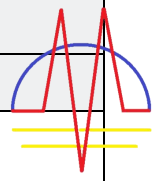




RP\_29700.000000\_tot  
TRP = 0.66 dBm



Application	Standards (Examples) EMI
<b>Industrial and Household Products</b> (commercial)	CISPR 11/EN 55011
	CISPR 14-1/EN 55014-1
	ANSI-C 63.4
	FCC 15, 18
<b>Information Technology</b> (commercial)	CISPR 22/EN 55022
	ANSI-C 63.4
	FCC 15, 18
<b>Medical Devices</b> (commercial)	EN 60601-1-2
	CISPR 11/EN 55011
<b>Wireless Devices</b> (commercial)	ETSI EN 301489-x
	3GPP TS 51.010
	ETSI EN 301908-1
	ETSI EN 300328-1
	FCC part 15
<b>Automotive</b>	2004/104/EC CISPR 12, SAEJ 551/2 CISPR 25, SAEJ 1113/41
	MIL-STD 461E, CE101, CE102, CE106, RE101, RE102, RE103
<b>Military / Avionics</b>	RTCA/DO-160
	VG95370-95377
	DEF-STAN 49-41
	GAM-EG 13
<b>Consumer Products Radio/TV Receivers</b> (commercial)	CISPR 13/EN 55013



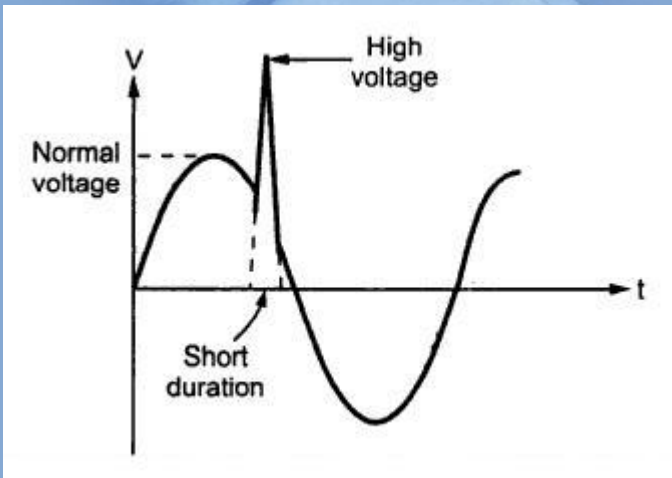
# 3) Immunity to Conduction Emission

This test will explain how much level our device can withstand the noise signal that comes from conducting wires or conducting paths.

01

## Surge Immunity

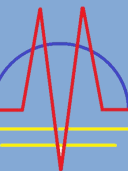
The basics of the test are to subject the system to voltage spikes on top of the nominal voltage input to the system.



These spikes are representative of voltage fluctuations that occur from causes such as large motor drives, nearby lightning strikes, etc. These high voltage deviations can cause a variety of issues when applied to a system not designed to handle them.

This is tested according IEC61000-4-5 and IEC61000-4-9.

It can be widely meet the testing requirement against the lighting surge of electronic products.



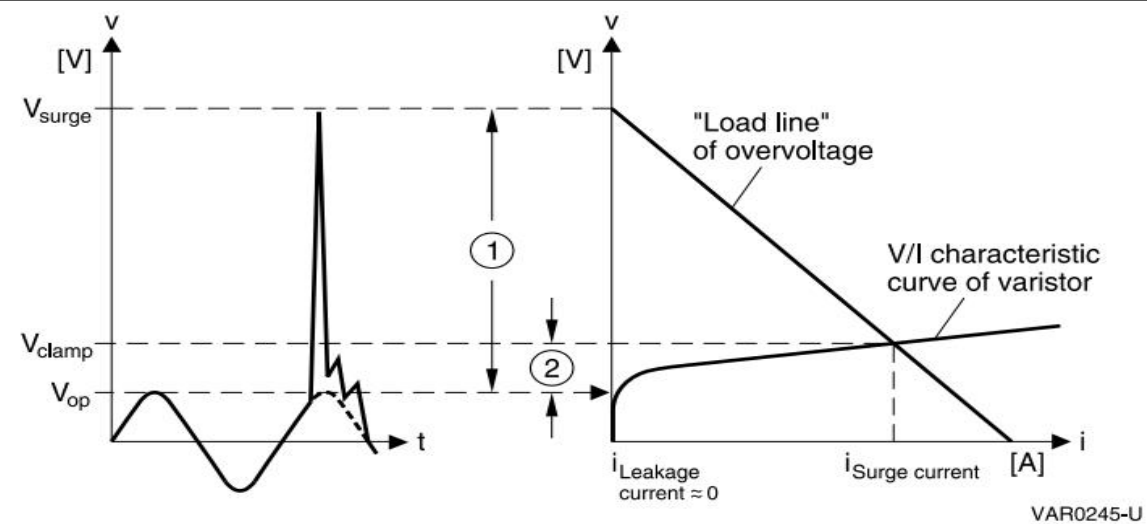
# MULTIFUNCTIONAL TRANSIENT SIMULATOR FOR RENEWABLE ENERGY



## FOR TESTS ACCORDING TO ...

- > ANSI/IEEE C62.41
- > ECE-R10
- > EN 61000-4-11
- > EN 61000-4-29
- > EN 61000-4-4
- > EN 61000-4-5
- > EN 61000-4-8
- > EN 61000-4-9
- > EN 61000-6-1
- > EN 61000-6-2
- > EN 61543
- > IEC 60255-22-5
- > IEC 61000-4-11
- > IEC 61000-4-29
- > IEC 61000-4-4
- > IEC 61000-4-5
- > IEC 61000-4-8
- > IEC 61000-4-9
- > IEC 61008-1
- > IEC 61009-1
- > IEC 61326

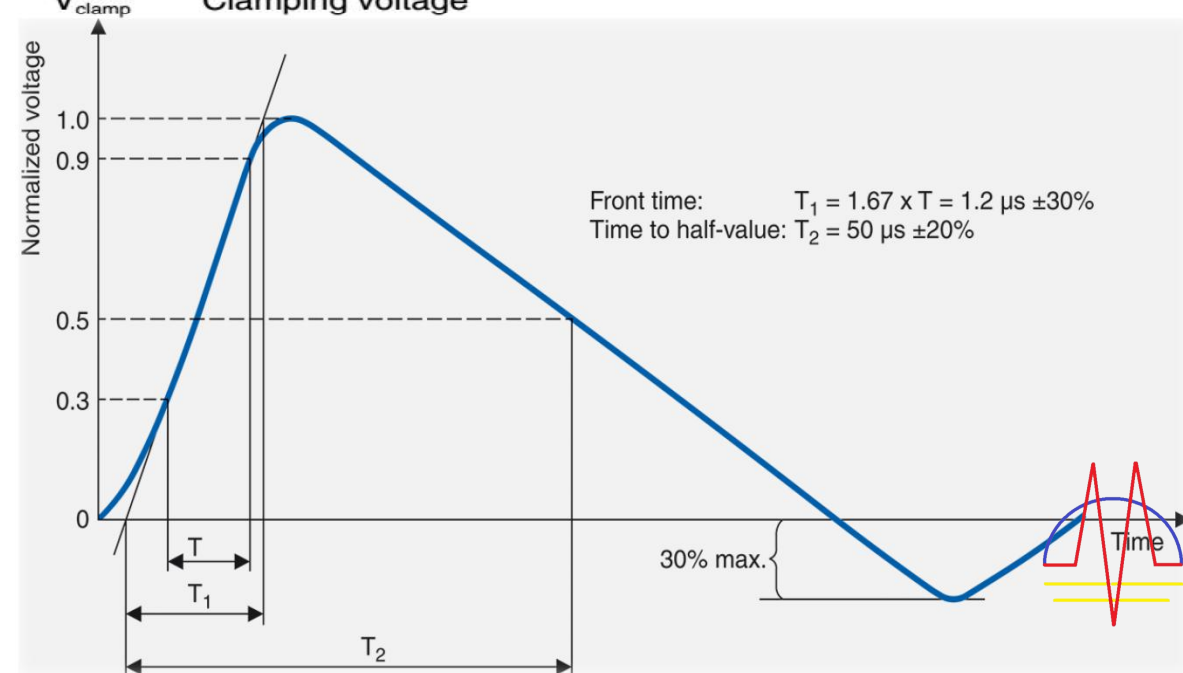
"8 x 20us" means a transient that rises in 8us and decays to a 50% value in 20us



**Figure 3** Principle of overvoltage protection by varistors

The overvoltage ① is clamped to ② by a varistor.

- $V_{op}$  Operating voltage
- $V_{surge}$  Superimposed surge voltage
- $V_{clamp}$  Clamping voltage



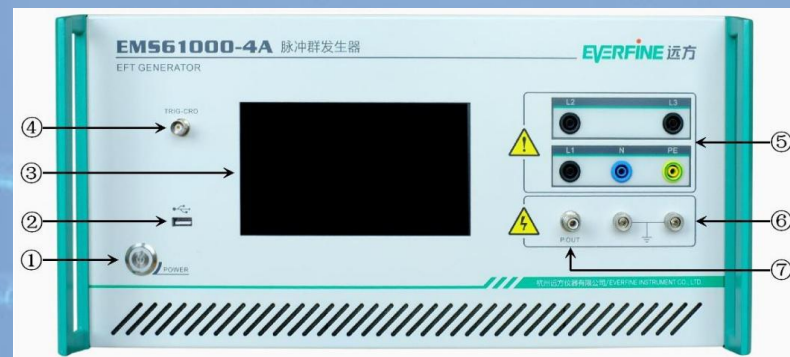
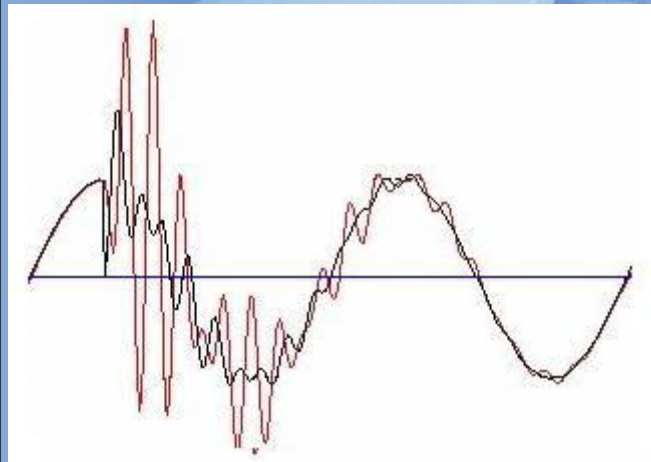
# Transient immunity

Voltage Transients pulse will be raised in very short time, and has high pulse repetition rate.

(This may be up to 1MHz high frequency)

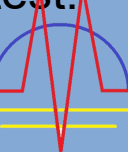
Transient voltages – temporary unwanted spikes or blips of voltage in an electrical circuit -- can come from any number of sources either inside or outside of an industrial plant.

Adjacent loads turning on or off, power factor correction capacitor banks or even distant weather can generate transient voltages on distribution systems. These transients, which vary in amplitude and frequency, can erode or cause insulation breakdown in motor windings



This is tested according IEC61000-4-4

Also this test is named as Electrical intelligent Transient (EFT) immunity test.



# 4) Immunity to Radiation Emission

This test will explain how much level our device can withstand the noise signal that comes from Air or vacuum.

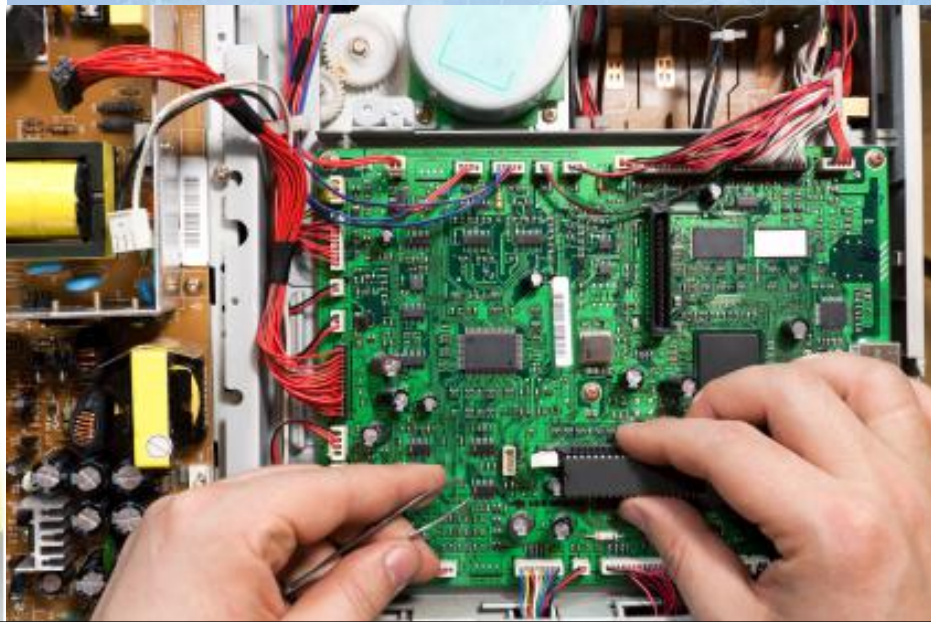
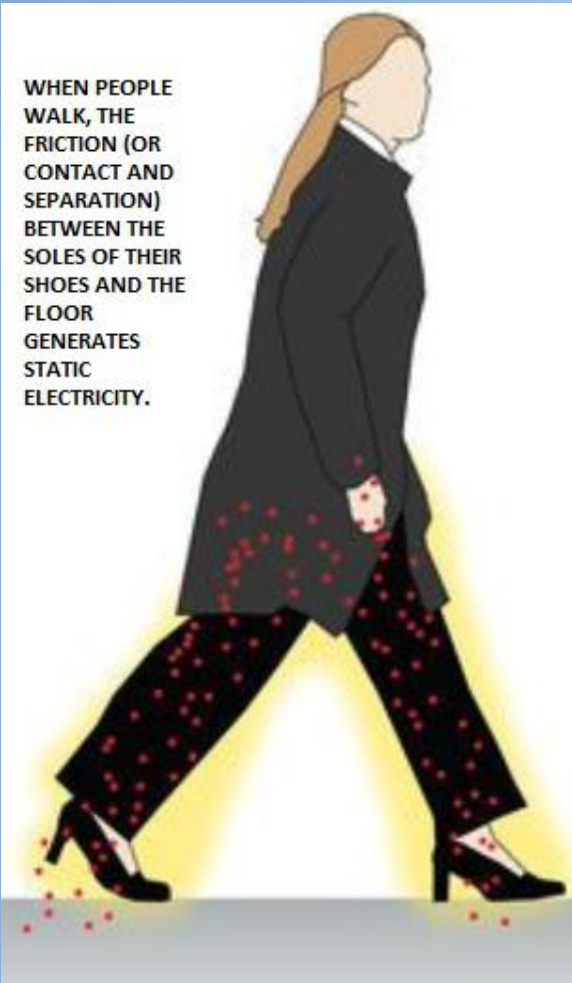
01

## ESD Immunity Test

ESD means Electrostatic discharge

For example ESD, or electrostatic discharge, is an energy transfer between two objects that are differently charged. ESD can short out or cause damage to electronic devices, which is why several electronic manufacturers protect their devices against ESD

WHEN PEOPLE WALK, THE FRICTION (OR CONTACT AND SEPARATION) BETWEEN THE SOLES OF THEIR SHOES AND THE FLOOR GENERATES STATIC ELECTRICITY.



So once after the product designed they apply static voltage up to 3KV on different areas of the product.

In this case your device should not fail to work after testing.

This is tested according IEC61000-4-2, IEC747-1, MIL-STD-883E/F

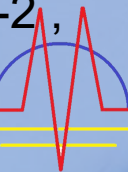
**ATTENTION**

ESD CONTROL AREA



WEAR PROPER  
ELECTROSTATIC GROUNDING  
EQUIPMENT AT ALL TIMES

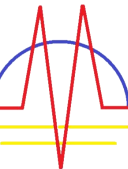
**CAUTION**  
THIS AREA CONTAINS  
SENSITIVE ELECTRONIC DEVICES



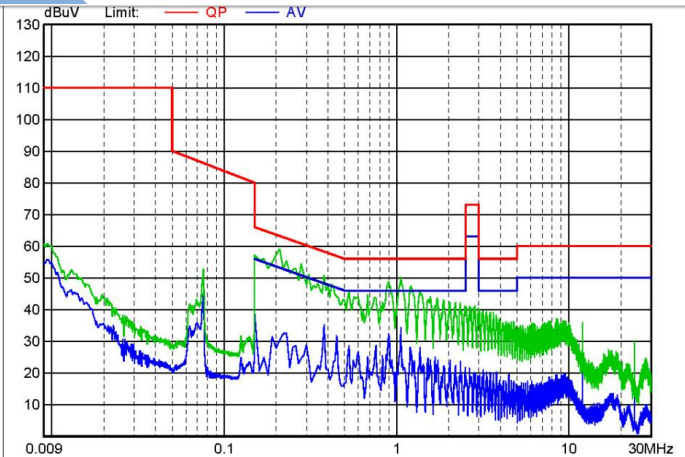


ESD simulator (Electrostatic Discharge Generator or Electrostatic Gun) is in full compliance with IEC 61000-4-2, EN61000-4-2, ISO10605, GB/T17626.2, GB/T17215.301 and GB/T17215.322.

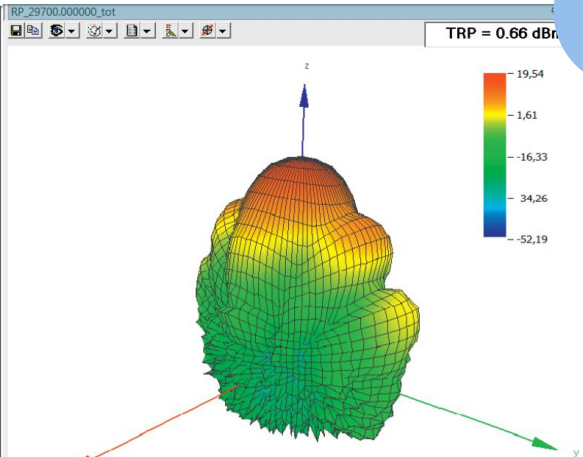
The ESD generator is designed for the assessment of electrical and electronic equipment to withstand ESD performance.



# High frequency noise Immunity test

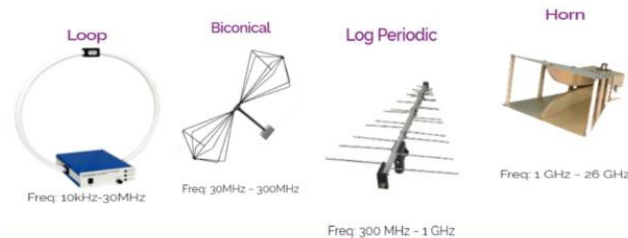


## 2) Radiation Emission test



Radiated emissions testing involves measuring the electromagnetic field strength of the emissions that are unintentionally generated by your product.

Emissions are inherent to the switching voltages and currents within any digital circuit, the only question is: how large are the emissions and do they comply with the emissions limits?



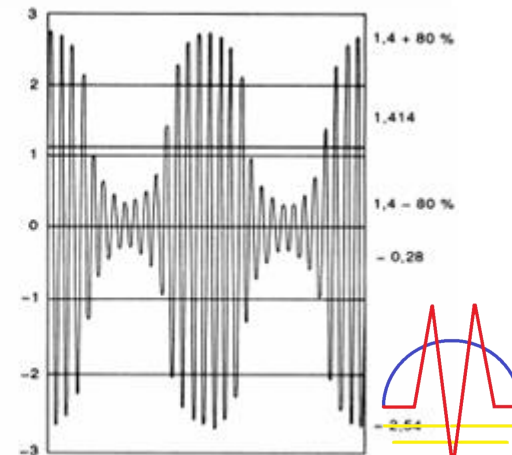
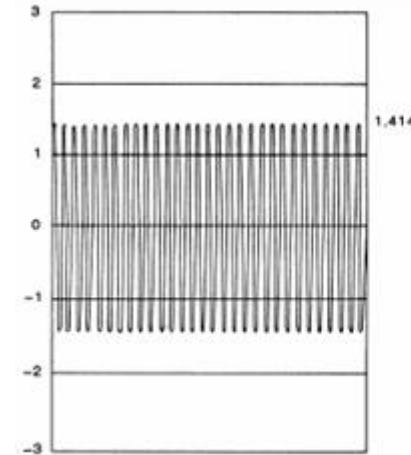
Radiation emission test is concern about how much your product is emitting radiation in terms of RF energy.



The theory behind the radiated immunity test is that your device will encounter many different types of electric field disturbances in normal usage.

Someone might use a cellphone next to it; someone might operate a motor next to it. There are lots of electric field sources that may interact with your device.

This test is intended to see how well your product performs when it's subjected to an electric field of a specified amplitude (measured in volts/meter) across a range of frequencies.



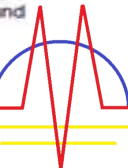
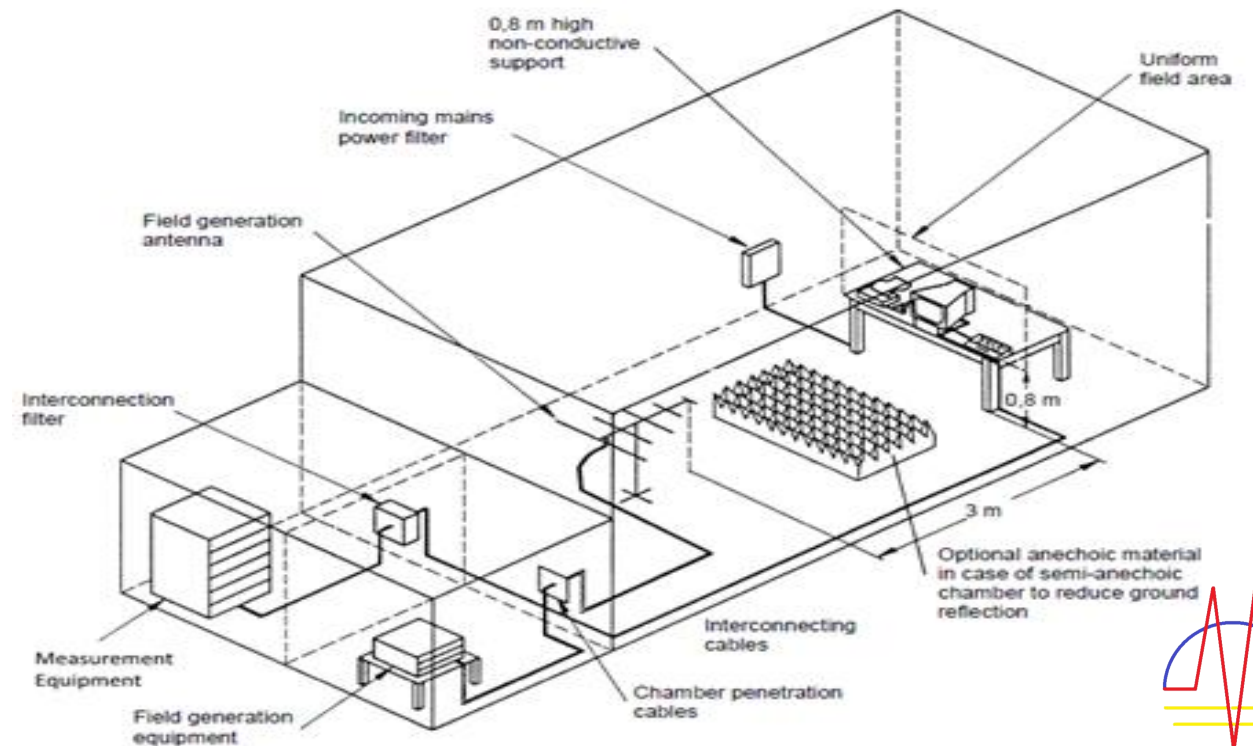
So how do EMC test labs measure radiated emissions?

During this test, your equipment is going to be subjected to a uniform electric field. The test lab has calibrated the field at several points around the test area that your product will sit within.

EMC testing guide - radiated immunity  
The field is generated in this way: A signal generator feeds a modulated sine wave to a broadband RF power amplifier. The output of the amplifier is connected to a transducer (an antenna), which turns the varying conducted voltage into a varying radiated electric field.

The field is usually modulated at 80% with a 1 kHz sine wave. For some standards, the modulation frequency and depth are different.

This is tested according (IEC/EN61000-4-3)



## Other Immunity tests that are performed on devices

**01** Magnetic Field

- IEC/EN61000-4-8

**02** Voltage Dips, Drops & Interruptions

- IEC/EN61000-4-11/-29

**03** Harmonic Current Testing

(IEC61000-3-2)

**04** Voltage Flicker Testing

-IEC61000-3-3



# CISPR standard.

CISPR standards cover product emission and immunity requirements as well as defining test methods and equipment.

CISPR is the acronym of **Comité International Spécial des Perturbations Radio**,<sup>[1]</sup> or the International Special Committee for Radio Protection.

- [CISPR 11](#), Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement.
- [CISPR 12](#), Vehicles, boats and internal combustion engine driven devices - Radio disturbance characteristics - Limits and methods of measurement for the protection of receivers except those installed in the vehicle/boat/device itself or in adjacent vehicles/boats/devices.
- [CISPR 14-1](#), Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission.
- [CISPR 14-2](#), Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 2: Immunity - Product family standard.
- [CISPR 15](#), Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
- [CISPR 16-1](#), Specification for radio disturbance and immunity measurement apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus.
- [CISPR 16-2](#), Specification for radio disturbance and immunity measurement apparatus and methods - Part 2: Methods of measurement of disturbances and immunity
- [CISPR 16-3](#), Specification for radio disturbance and immunity measurement apparatus and methods - Part 3: Reports and recommendations of CISPR
- [CISPR 16-4](#), Part 4-1: Uncertainties, statistics and limit modelling — Uncertainties in standardized EMC tests
- [CISPR 20](#), Sound and television broadcast receivers and associated equipment. Immunity characteristics. Limits and methods of measurement
- [CISPR 24](#), Information technology equipment - Immunity characteristics - Limits and methods of measurement.
- [CISPR 25](#), Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers"
- [CISPR 32](#), Electromagnetic compatibility of multimedia equipment - Emission requirements (replaced CISPR 13 and CISPR 22)
- [CISPR 35](#), Electromagnetic compatibility of multimedia equipment - Immunity requirements (will replace CISPR 20 and CISPR 24)

## European standards concerning unwanted electrical emissions

- [EN 50 081 part1](#) European Generic emission standard, part1: Domestic, commercial and light industry environment, replaced by EN61000-6-3
- [EN 50 081 part2](#) European Generic emission standard, part2: industrial environment, replaced by EN61000-6-4
- [EN 55 011](#) European limits and methods of measurement of radio disturbance characteristics for scientific and medical equipment
- [EN 55 013](#) European limits and methods of measurement of radio disturbance characteristics of broadcast receivers
- [EN 55 014](#) European limits and methods of measurement of radio disturbance characteristics of household appliances and power tools, replaced by EN55014-1, and immunity part is covered by EN55014-2
- [EN 55 015](#) European limits and methods of measurement of radio disturbance characteristics of fluorescent lamps
- [EN 55 022](#) European limits and methods of measurement of radio disturbance characteristics of information technology equipment
- [EN 60 555 part 2 and 3](#) Disturbances of power supply network (part 2) and power fluctuations (part 3) caused by of household appliances and power tools, replaced by EN61000-3-2 and EN61000-3-3
- [EN 13309](#) Construction Machinery - Electromagnetic compatibility of machines with internal electrical power supplies
- [VDE 0875](#) German EMC directive for broadband interference generated by household appliances
- [VDE 0871](#) German EMC directive for broadband and narrowband interference generated by information technology equipment

## European standards concerning immunity to electrical emissions

- [EN 50 082 part1](#) European immunity standard, part1: Domestic, commercial and light industry environment, replaced by EN61000-6-1
- [EN 50 082 part2](#) European immunity standard, part2: industrial environment, replaced by EN61000-6-2
- [EN 50 093](#) European, immunity to short dips in the power supply ([brownouts](#))
- [EN 55 020](#) European, immunity from radio interference of broadcast receivers
- [EN 55 024](#) European immunity requirements for information technology equipment
- [EN 55 101](#) older draft of immunity requirements for information technology equipment, replaced by [EN 55 024](#)
- [EN 50 081 part1](#) European Generic emission standard, part1: Domestic, commercial and light industry environment, replaced by EN61000-6-3
- [EN 50 081 part2](#) European immunity requirements for information technology equipment, replaced by EN61000-6-4

# IEC standards

The [IEC standards](#) on [Electromagnetic compatibility](#) (EMC) are mostly part of the IEC 61000 family. Below are some examples.

- [IEC/TR EN 61000-1-1](#), Electromagnetic compatibility (EMC) - Part 1: General - Section 1: Application and interpretation of fundamental definitions and terms
- [IEC/TR EN 61000-2-1](#), Electromagnetic compatibility (EMC) - Part 2: Environment - Section 1: Description of the environment - Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems
- [IEC/TR EN 61000-2-3](#), Electromagnetic compatibility (EMC) - Part 2: Environment - Section 3: Description of the environment - Radiated and non-network-frequency-related conducted phenomena
- [IEC EN 61000-3-2](#), Electromagnetic compatibility (EMC) - Part 3-2 - Limits - Limits for harmonic current emissions (equipment input current  $\leq 16$  A per phase)
- [IEC EN 61000-3-4](#), Electromagnetic compatibility (EMC) - Part 3-4: Limits - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A
- [IEC/TS EN 61000-3-5](#), Electromagnetic compatibility (EMC) - Part 3: Limits - Section 5: Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16 A
- [IEC EN 61000-4-2](#), Electromagnetic compatibility (EMC)- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
- [IEC EN 61000-4-3](#), Electromagnetic compatibility (EMC)- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
- [IEC EN 61000-4-4](#), Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
- [IEC EN 61000-4-5](#), Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
- [IEC EN 61000-4-6](#), Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
- [IEC EN 61000-4-7](#), Electromagnetic compatibility (EMC) - Part 4-7: Testing and measurement techniques - General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
- [IEC EN 61000-4-8](#), Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test
- [IEC EN 61000-4-9](#), Electromagnetic compatibility (EMC) - Part 4-9: Testing and measurement techniques - Pulse magnetic field immunity test
- [IEC EN 61000-4-11](#), Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests



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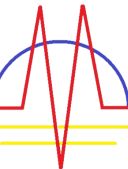
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