emtest MILMEGA TESEQ

CONDUCTED RF EQUIPMENT POWER AMPLIFIERS



IEC 61000-4-2 ESD Ed.2.0 2008
Immunity to the discharge of electrostatic electricity

Accelonix EMC workshop 17-9-2019

Accelonix keeping you ahead.

Electrostatic Discharge (ESD)

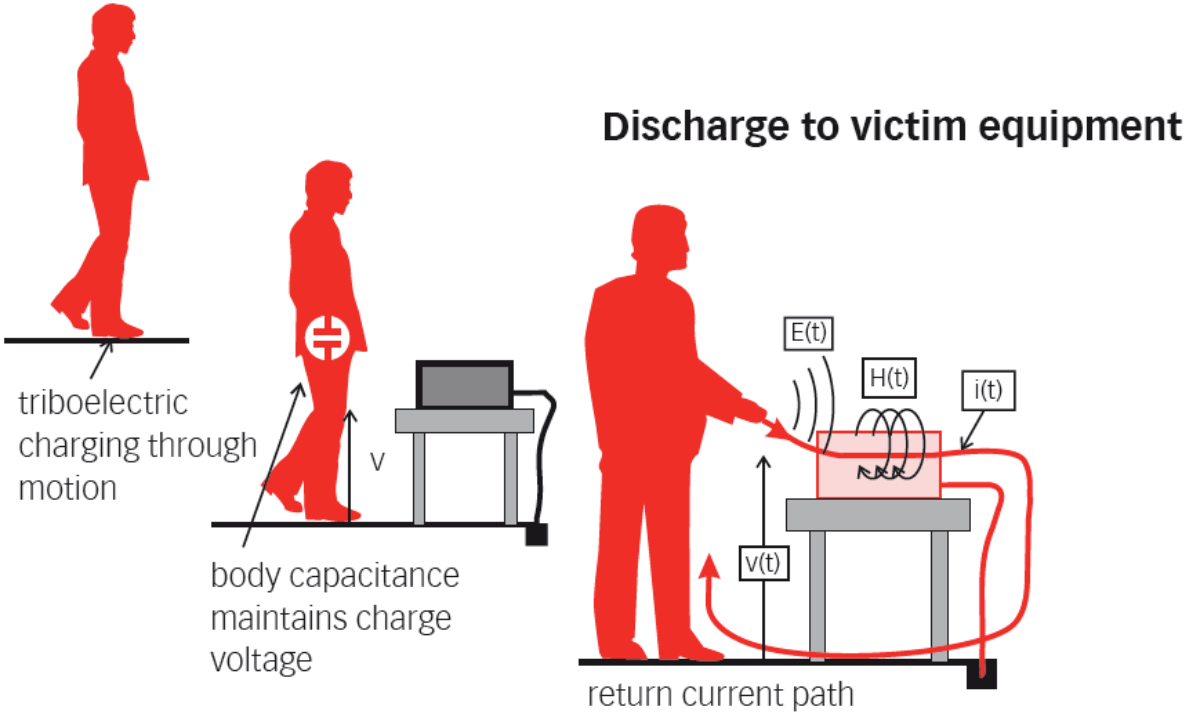
- ESD is the most common EMC test performed.
  ESD is a good starting point.

- The setup is not complex and is very economical

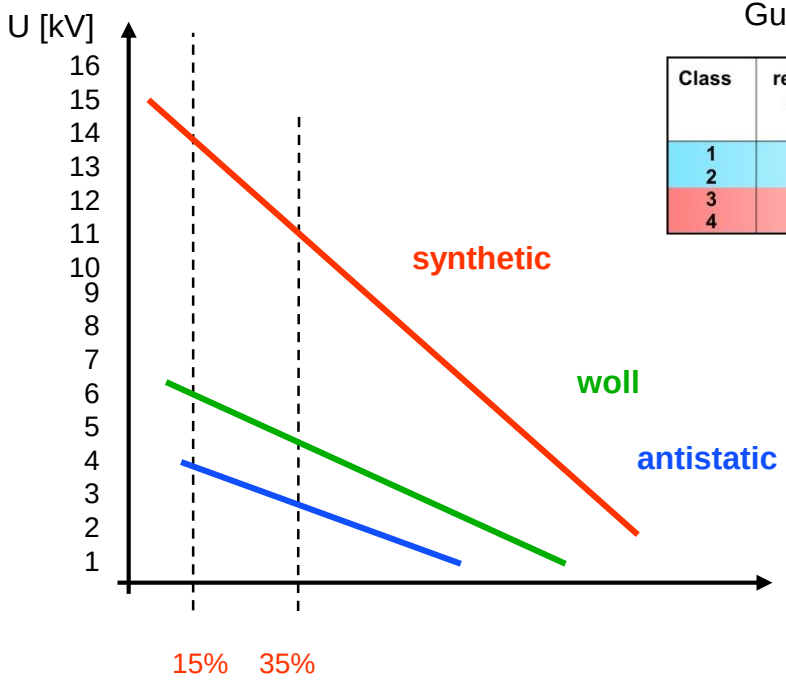
- The application of the actual standards gives good results.
  A product tested according the ESD standards will have a high immunity to the ESD in the „real world“

Note: The methodology and the levels defined by the standards exceed the conditions met in the „real world“

(Electrostatic Discharge (ESD)



Electrostatic voltages



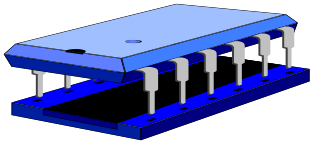
Guideline for the selection of the test levels

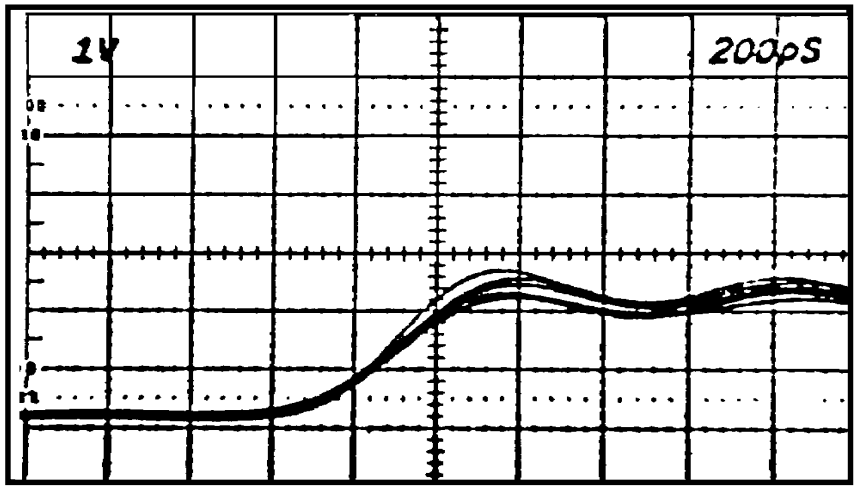
Class	rel humidity al low as %	Antistatic material	Synthetic material	max. voltage [kV]
1	35	x		2
2	10	x		4
3	50		x	8
4	10		x	15

Means of Generation	10-25% RH	65-90% RH
Walking across carpet	35'000 V	1'500 V
Walking across vinyl tile	12'000 V	250 V
Worker at bench	6'000 V	100 V
Poly bag picked up from bench	20'000 V	1'200 V
Chair with urethane foam	18‘000 V	1'500 V

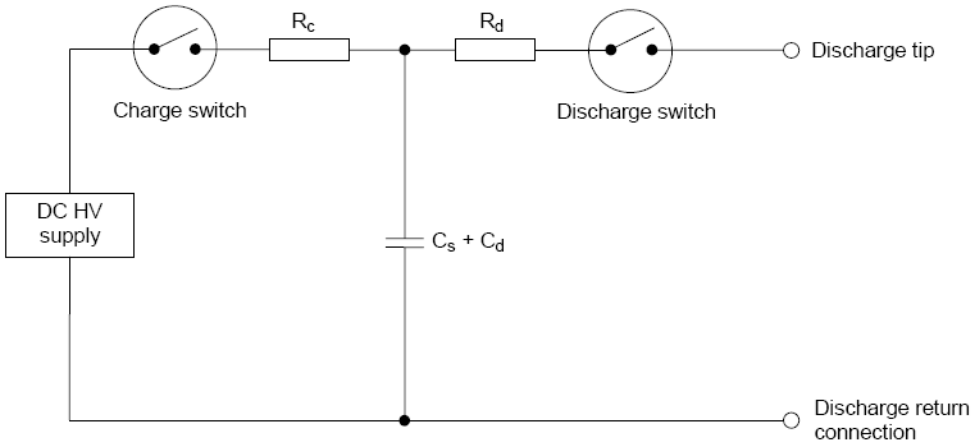
Body discharge of human being

- Discharging by a metallic tool





Simplified diagram of ESD-Simulators



NOTE 1 C_d is a distributed capacitance which exists between the generator and its surroundings.

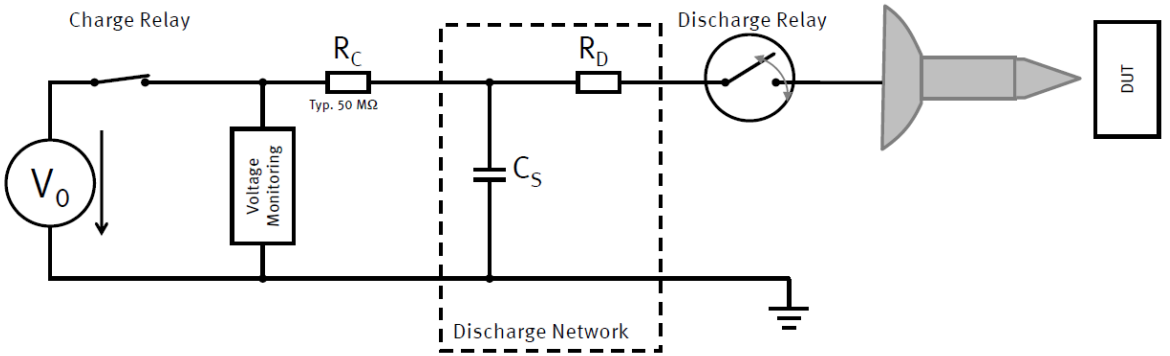
NOTE 2 $C_d + C_s$ has a typical value of 150 pF.

NOTE 3 R_d has a typical value of 330 Ω.

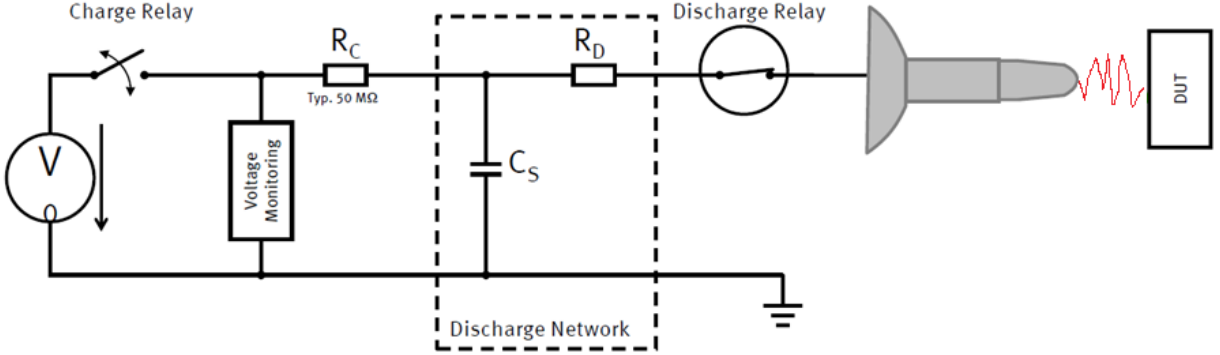
Figure 1 – Simplified diagram of the ESD generator

Modes of discharges

Contact Discharge



Air Discharge



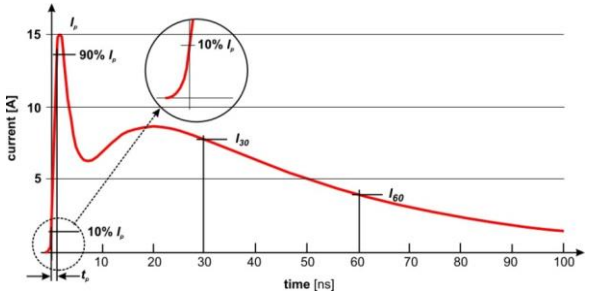
Test Levels

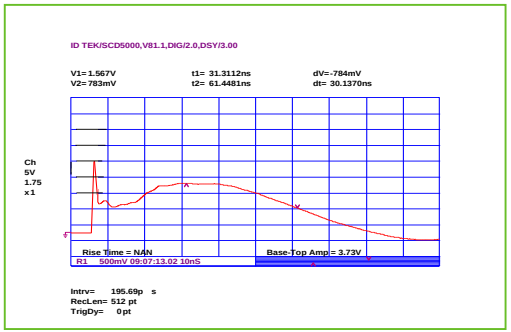
- For air discharge all test levels up to requirement have to be tested.
- For contact discharge only the specified test levels have to be tested (however, we recommend to continue testing as for air discharge).
- Maximum 1 discharge per second
- min. 10 discharges with stronger polarity

Level	Air discharge	Contact discharge
1	2 kV	2 kV
2	4 kV	4 kV
3	8 kV	6 kV
4	15 kV	8 kV

Specification contact discharges :

- According to EN 61000-4-2:2009





Level	Indicated voltage [kV]	First peak current of discharge [A] (± 15%)	Rise time t_r with discharge switch [ns] (± 25%)	Current at 30ns [A] (± 30%)	Current at 60ns [A] (± 30%)
1	2	7.5	0.8	4	2
2	4	15	0.8	8	4
3	6	22.5	0.8	12	6
4	8	30	0.8	16	8

The reference point for measuring the time for the current at 30ns and 60ns is the instant when the current reaches 10% of the 1st peak of the discharge current.

NOTE: The rise time t_r is the interval between 10% and 90% value of the 1st peak current.

ESD waveform verification

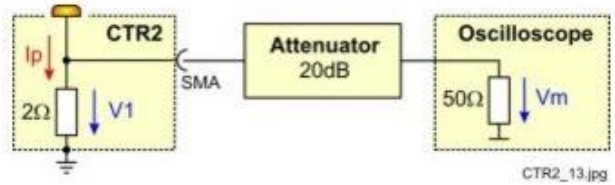
Tools needed
- DSO with a bandwidth of at least 2GHz
- Faraday cage
- Pellegrini target

At voltage levels +/- 2kV, +/- 4kV, +/- 6kV, +/- 8kV :

Four parameters need to be measured at each voltage level:
- Initial peak current
- Rise time between 10% and 90% of the initial peak
- Current value at 30ns
- Current value at 60ns

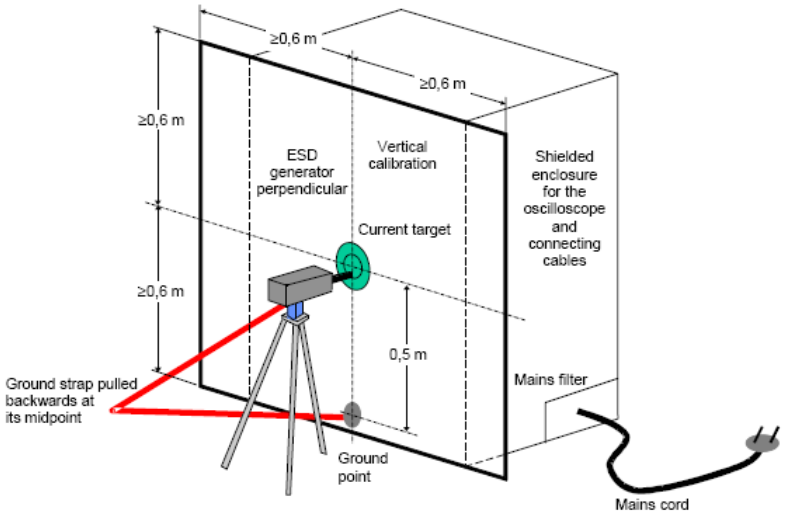
The time domain for the initial peak and rise time measurement is recommended to be set to 1ns/Div.
For the current measurement at 30nS and 60ns a setting of 10ns/Div is recommended as being appropriate

ESD waveform verification



For example:
A discharge current of 7.5A will give a voltage reading of 1.5V on the DSO

Set-up for calibration of ESD pulses



NOTE 1 The generator should be installed on a tripod or equivalent non metal low loss support.

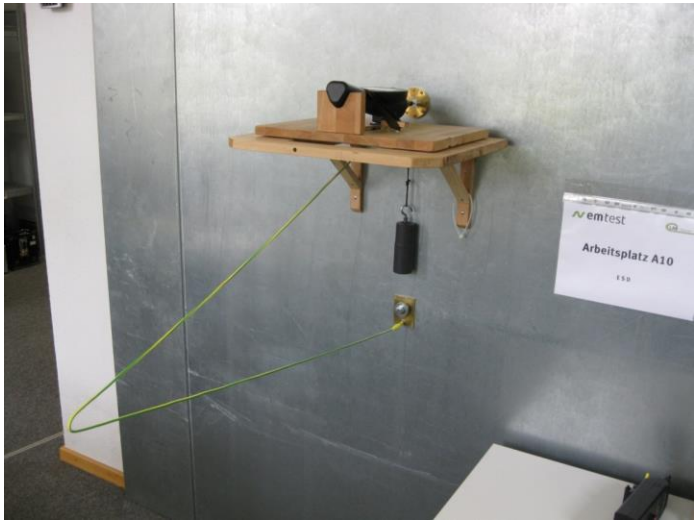
NOTE 2 The generator should be powered in the same way as it will be used during test.

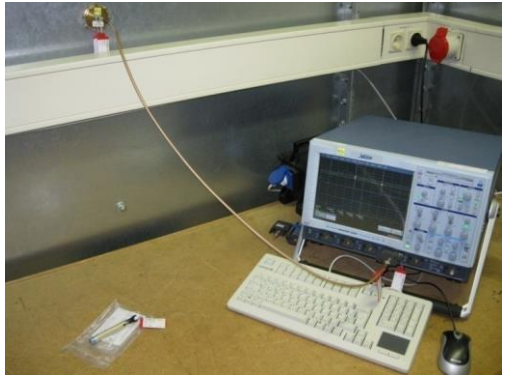
NOTE 3 A reversed setup compared to Figure B.5 can also be used.

Pellegrini target

TECHNICAL DATA	
Measuring Resistor	2ohm ±5%
Design	As per IEC 61000-4-2, Ed.2:2008 and EN 61000-4-2:2009
Output	Coaxial SMA Connector
Attenuator	An additional attenuator must be connected to the output of the CTR 2 depending on the input capability of the oscilloscope.
Insertion loss	±0.5dB up to 1 GHz and ±1.2dB up to 4GHz This must always be measured as a "Target-Attenuator-Cable" chain. The target itself must not be measured.
ESD test voltage	±30kV
Dimensions	70mm (diameter) x 30mm
Weight	Approx. 400g

Set-up for the calibration of ESD pulses



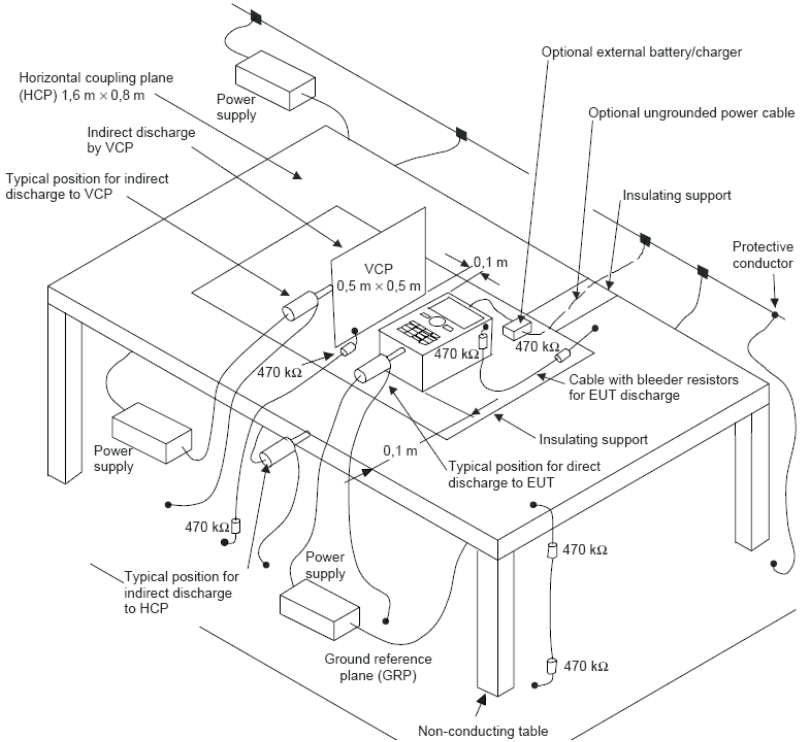


Please observe that the ground return cable shall be pulled backwards at its mid point to form a large loop.
This is of high importance as the ground return cable may heavily influence the ESD pulses, especially at the measuring point at 30ns and 60ns.
If this fact is not properly observed you may see oscillations on the scope disturbing the pulse characteristic

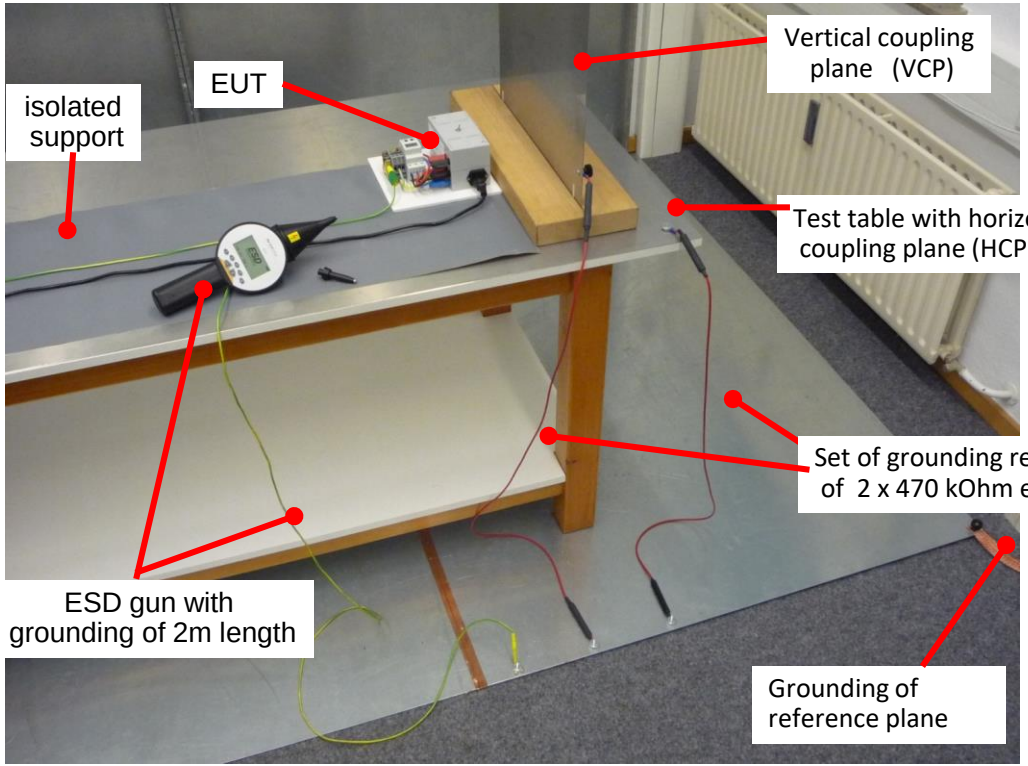
Summary of the essential changes from previous Ed.1.0

- Amendment limit deviations for the waveform of the current pulse:
  - first discharge current peak +/-15%
  - rise time: 0.8ns +/-25%
- For calibration each single pulse must meet the waveform specification.
- Distance test set-up to walls or other metallic parts: >0.8m
- Ground return line can be connected on the metallic wall of the laboratory, if this is extensively connected with the reference ground surface.
- 2m ground return line is not allowed to hold in the hand.
- Figures were changed, also the VCP has been included at floor-standing devices
- The use of an air ionizer is not allowed.
- At contact discharge it is not a must to test each test level individually up to the demanded level, this only applies to air discharge.

Test set-up for table top devices according IEC 61000-4-2



Test set-up ESD according to EN61000-4-2

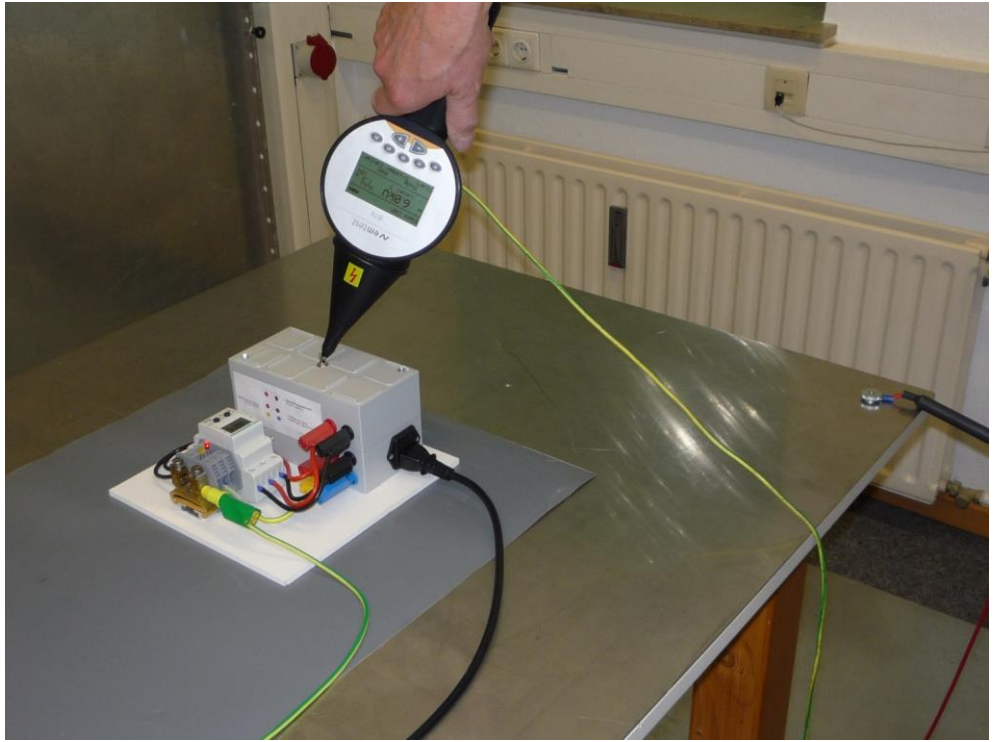


Reference ground plane

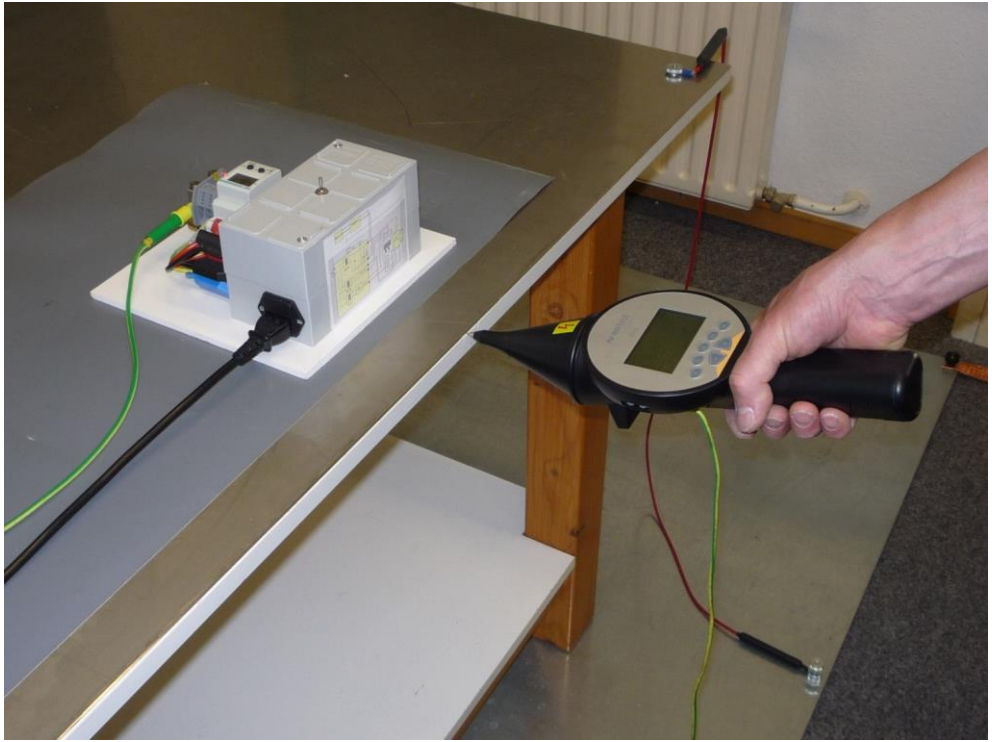
Test set-up and test execution

- The horizontal coupling plane (HCP) must have a size of (1.6 ±0,2)m x (0.8 ±0,2)m.
- The HCP is 0.8m above the ground plane (GRP) on an non-metallic table and is connected via 2 x 470 kΩ to the GRP.
- The ground plane (GRP) shall project beyond the EUT or the dimensions of the HCP by at least 0.5m and shall be connected to the protective grounding system.
- The HCP shall project beyond the EUT including connection lines by at least 10 cm to all sides.
- The EUT table has to provide a distance of >0.8m to any other conducting structures.
- The EUT and cables shall be isolated from the coupling plane by an insulating support (0,5 ±0,05)mm thick.
- The grounding ratio of the EUT shall be according to the real ratio, i.e. if the EUT is additionally grounded in practice, then this has to be considered as well in the test set-up. Attention, but not at HCP!
- The return cable of the test gun or discharge circuit respectively has to be connected with the GRP and has to be leaded in a distance of ≥0.2m to the EUT and its lines while discharging.
- The tester is not allowed to hold the return cable in the hand.
- The test gun is kept in a 90° angle to the discharge point. If this is not possible, it has to be stated into the test report.

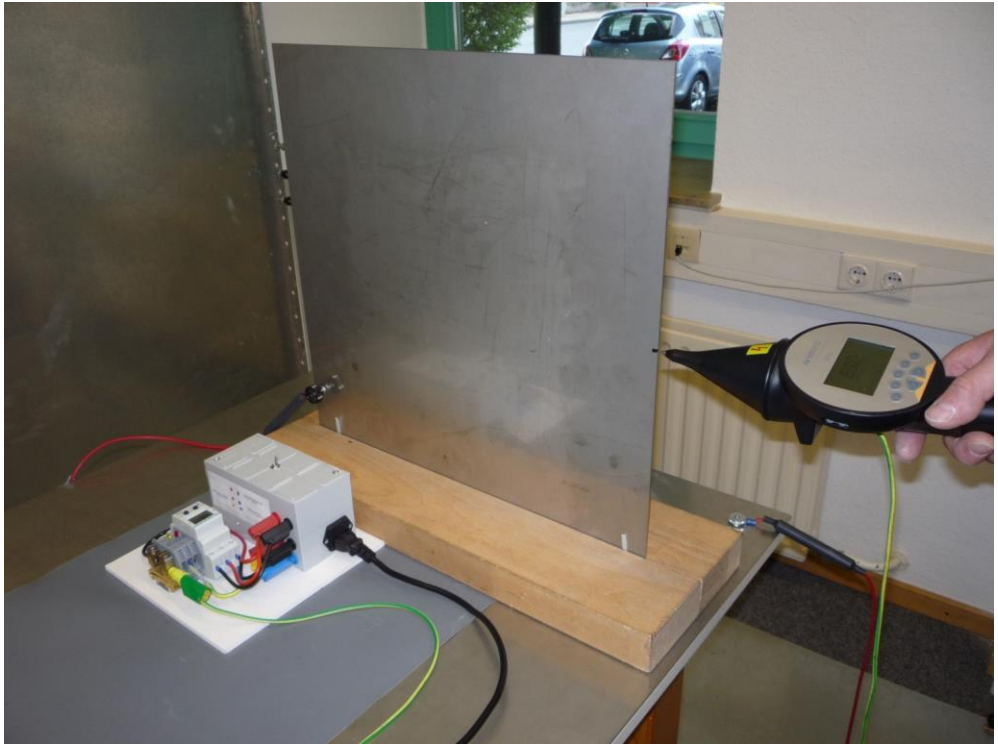
Direct discharge as contact discharge



Indirect discharge on HCP

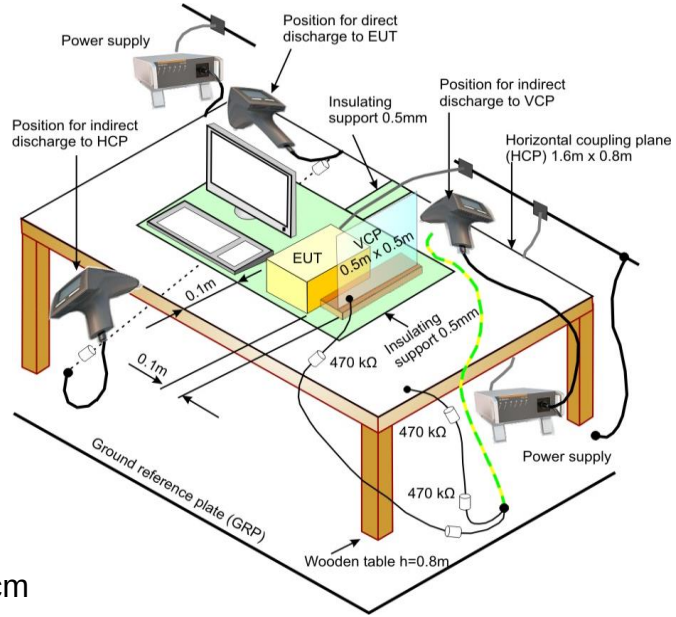


Indirect discharge on VCP



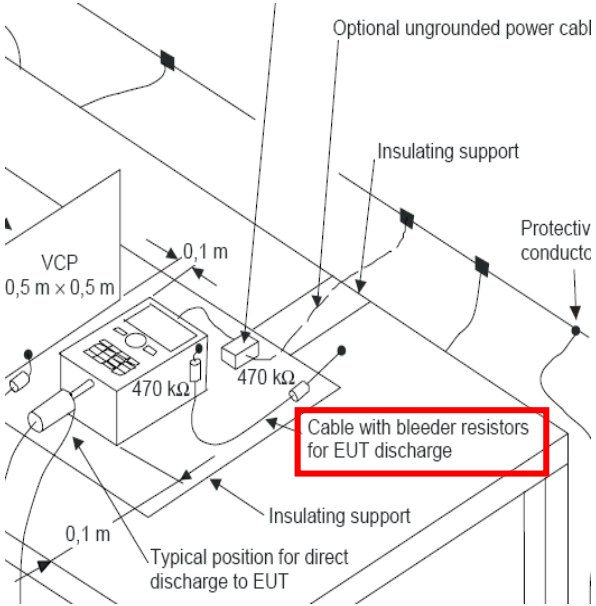
Test points according to EN 61000-4-2

- Direct discharge
  - All accessible points (touchable by user)
  - Housing: edges, angles, surfaces, slots, indicator parts
  - Operating parts: switches, buttons, plugs, etc.
  - Interfaces with metallic housing: only contact discharge on plug housing
  - Interfaces with isolated housing: only air discharge on plug housing
  - In certain cases product standards can request the discharge on pins
- Indirect discharge
  - Edge of vertical coupling plane, VCP with 10 cm distance to each EUT side.
  - Edge of horizontal coupling plane, EUT with each side with 10 cm distance to the discharge point.



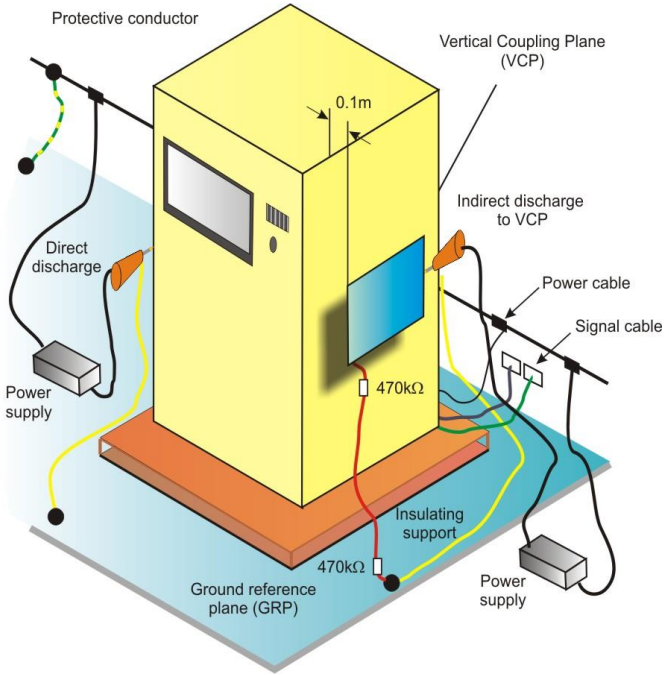
Test procedure for ungrounded devices

- **Problem**:
  - A prior loaded test point cannot discharge itself completely.
- **Consequences**:
  - Cascading of test voltage (over-tested)
  - Too low discharge current (under-tested)
  - Non-reproducible behavior of EUT
- **Remedy**:
  - Removing load before next discharge:
  - Fixing an discharge connection (2 x 470kΩ) on supply point (see figure right hand)
  - Discharging manually with carbon fiber brush in line with discharge connection (2 x 470kΩ)
  - Increasing time between discharges!?!
  - According to the new standard it is not allowed to use an ionisator

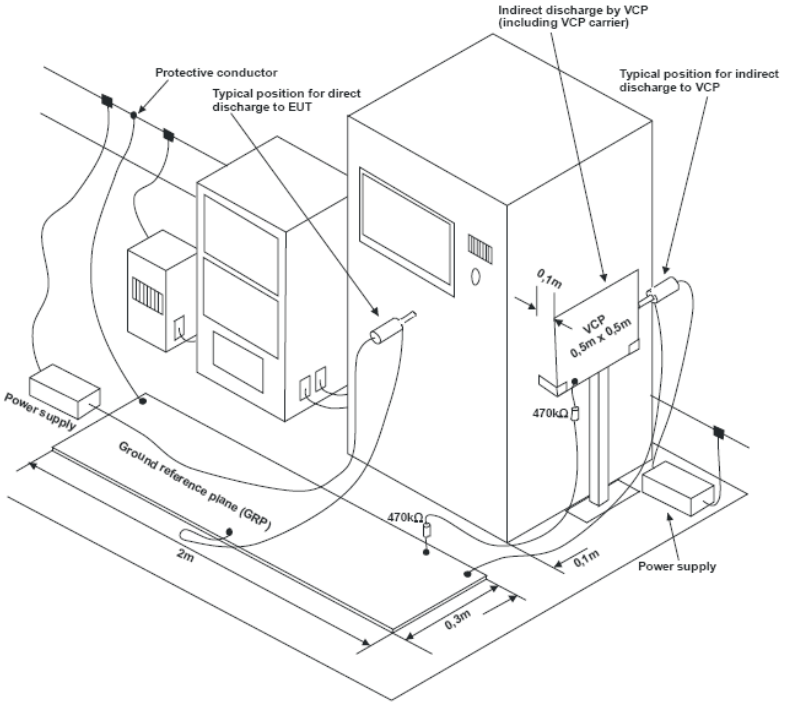


[3]

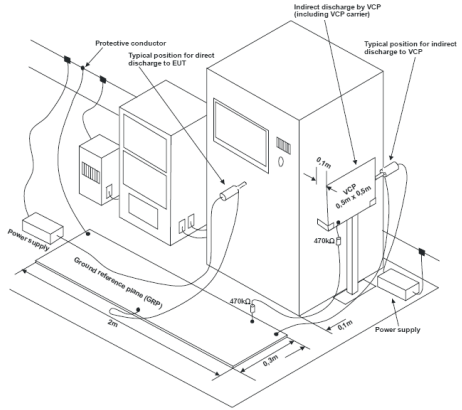
Test set-up for ungrounded floor standing devices



Test set-up for floor-standing devices, post installation



Test set-up for floor-standing devices, post installation



For informative testing:

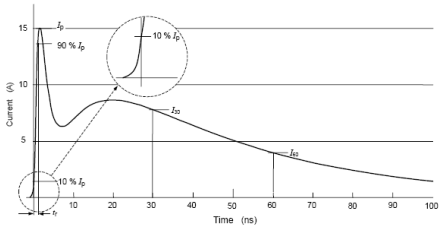
If you want to strengthen the ESD noise current, connect the reference ground plane or the Ground return line direct to the EUT housing. Depending on the ground point, certain coupling paths could be simulated.

Summary electrostatic discharge ESD

- Interference source:
  - Static charging by load separation due to friction of badly conductive materials. When approaching variably charged elements the interfering charge exchange happens.

- Parameter:
  - Sporadic, pulse-shaped, high-energy, high-frequency, broadband disturbancies arise as single pulses
  - Standard: Rise times in ns range with amplitudes of 2kV, 4kV, 6kV, 8kV, 12kV, 15kV, 20kV, 25kV.
  - Practise: Amplitudes of several 10kV.

- Impact:
  - Impact of signal in data processing fields (Logic error and its consequences).
  - Impact of analogue signals and controls.
  - Destruction of semiconductors.



ESD Simulators

Current ESD simulators from the AMETEK CTS product lines

emtest

dito

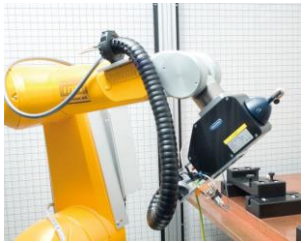
NX30 NX30.1

TESEQ

NSG 435

NSG 437

NSG 438



NSG 439

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RF EQUIPMENT

POWER AMPLIFIERS

Thank you!

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