SUPERVISING DEPT.:   E&D – PT – Bench Testing

MANAGING DEPT.:   E&D – PT – Bench Testing

1

STANDARD USE CRITERIA

This Standard is aimed at checking the resistance of the tested component to the electrostatic discharges that can be generated by people touching the same component or conductive parts (for instance a metal surface) with which it is in contact.

This standard is to be used in the Product and Process Validation phase of the concerned electronic system.

Change	Date	Description	
-	04/12/93	Edition 1 – New	(LR)
-	Apr. 95	Edition 2 – Drawn up according to Technical Memory Procedure; this Standard cancels and replaces paragraph 7 of Standard 7.Z0890.	(LR)
-	04/27/04	Edition 3 – Changed names of Supervisor (former was Durando) and Manager (former was Dotto). Cancelled paragraph "Test execution timings".	(SS)
-	08/08/07	Edition 4 – Completely revised.	(SS)

Edition 4 Ch. -- Code PEL

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Component Type:

Supplier:

Job:

Drawing Number:

Last Change:

2

REFERENCED STANDARDS

7-G0030   Calculation of test piece significance (PGE)

9.90110   Electric and electronic devices for vehicles. (CEL)

ISO 10605   Road vehicles — Test methods for electrical disturbances from electrostatic discharge.

3

TEST EQUIPMENT

3.1
ESD Generator

The electrostatic discharge generator must meet the following technical requirements:

Output voltage for contact discharges	Adjustable at least between 2-8 kV
Output voltage for discharges in air	Adjustable between 2-25 kV
Accuracy of output voltage	≤5%
Polarity	Positive and negative
Rising time of short-circuit current for contact discharges (10% to 90%)	0.7 – 1.0 ns
Discharge time (100%-10%)	At least 5 s
Capacitive values	150 pF or 330 pF
Discharge resistance	330 Ω or 2000 Ω

Table 1

The ESD generator termination, for both discharges in air and contact discharges, must have shapes and dimensions shown in help 1.

The ESD generator must be able to generate at least 10 discharges with no decay in the discharge wave shape, whose trend and significant parameters are indicated in help 2.

3.2
Ground and coupling surfaces

The coupling surface (located on the wood table on which DUT and what necessary for the test execution are positioned) and the ground surface (located below the wood table) must be made of metal material, with minimum thickness of 0.25 mm.

The coupling surface must extend of at least o.1 m on each side beyond the area occupied by the DUT and by the connection cables. The dimensions must be a least of 1.6 m x 0.8 m. The height of the coupling surface against the ground one must range between 0.7m and 1.0 m. The ground surface must have at least the same dimensions of the coupling one.

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Job:

Component Type:

Drawing Number:

Supplier:

Last Change:

3.3
Insulating supports

If used, the insulating supports, on which DUT and wiring shall be located, must be made of non-hygroscopic material and have a relative permittivity between 1 and 5 (e.g. polyethylene).

The dimensions of these supports must be:

- For the wring supports: height of 50 ± 5 mm and extension at least for 20 mm on each side from the test setup.
- For the DUT support: height of 2-3 mm and extension at least for 20 mm on each side from the test setup. It must ensure the insulation from ESD discharge up to 25 kV.

3.4
Possible dissipating material

It must have a surface higher than the DUT and a resistivity ranging between 10^7 and 10^9 Ω per m^2.

3.5
Battery

12 V and $\geq$ 40Ah

Note: *The above mentioned devices can be replaced by others, provided that they are equivalent or better as regards features, accuracy and repeatability.*

Date:..

Exemption: NO [ ]   YES [ ]

Test Engineer:...

Signature...

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]   Job:
Component Type: Drawing Number:
Supplier: Last Change:

4

TEST PIECE DESCRIPTION

4.1
Control unit

SYSTEM:	
ABBREVIATIONS:	
SUPPLIER:	
DRAWING NO.:	
CONTROL UNIT ID. No.:	
DESTINATION:	
BUILD LEVEL:	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]

4.2
Wiring

TYPE:	
SUPPLIER:	
DRAWING NO.:	
BUILD LEVEL:	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]

4.3
Sensors and actuators

TYPE:	
SUPPLIER:	
DRAWING NO.:	
BUILD LEVEL:	A [ ]
	B [ ]
	C [ ]
	D [ ]
	E [ ]

Date:...

Test Engineer:...   Signature...

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]
Component Type:
Supplier:

Job:
Drawing Number:
Last Change:

5

TEST COMPONENT SIGNIFICANCE

<table>
<tr><td colspan="6">COMPONENT WEIGHT AND THEIR FEATURES FOR SIGNIFICANCE EVALUATION</td></tr>
<tr><th>Component type</th><th>Signif. % value (A)</th><th>Weight (B)</th><th>Component affecting the test significance</th><th>Significant features</th><th>Min. build level</th></tr>
<tr><td>Active</td><td></td><td>0,5</td><td>Control unit</td><td>printed circuit box if of metal release software</td><td>B</td></tr>
<tr><td>Active</td><td></td><td>0,2</td><td>Wiring</td><td>cable length and section</td><td>C</td></tr>
<tr><td>Active</td><td></td><td>0,3</td><td>Sensors and actuators</td><td>impedances</td><td>C</td></tr>
</table>

Test piece significance (%) = Σ (A x B) =

Note: *for each component, evaluate the significance percentage on three different steps, according to standard 7-G0030, indicating values in column A.*

Date:..

Test Engineer:..   Signature..

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Component Type:

Supplier:

Job:

Drawing Number:

Last Change:

6

TEST PREPARATION

6.1

Get all technical documentation (drawings, specifications, etc.), which is necessary for the test execution.

[ ]

6.2

Identify the system being tested and fill in the tables of module "Test piece description".

[ ]

6.3

Calibration

The calibration of the ESD discharge generator must be carried out according to the needs or how required by the generator manufacturer but at least once a year.

The calibration shall be carried out only for the generator for contact discharges, for the physical discharge is repeatable and deterministic.

Therefore, the calibration results for the contact discharge will ensure the system performances also for the discharges in air.

6.3.1

Calibrate the wave shape of the discharge current as described in Standard ISO 10605 Annex A.

[ ]

Note: The calibration measures shall indicate also the following environmental parameters:

- *temperature;*
- *relative humidity;*
- *barometric pressure and/or altitude.*

6.3.2

Check that the calibration results comply with the data shown in Table 2 of help 2.

[ ]

Date:..

Exemption: NO [ ]   YES [ ]

Test Engineer:..

Signature..

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Job:

Component Type:

Drawing Number:

Supplier:

Last Change:

7

TEST EXECUTION

The environmental temperature during the test must be kept equal to 25 ± 10°C, the relative humidity must range between 20% and 60% and atmospheric pressure between 680 mbar and 1060 mbar. Other possible values shall be specified in the test report.

7.1
Immunity to ESD with component not fed

The test consists in applying the discharges directly to the DUT in order to reproduce the effect of the human discharge that can occur when handling the component for maintenance, assembling and storage. The test plan must specify the points (including pins and surfaces of DUT) of application of ESDs with capacity of 150pF and resistance of 2 k Ω.

7.1.1

Carry out the following test setup, in case making use of a dissipating material   Test Op.   [   ]
between DUT and coupling surface.

Figure A

LEGEND

1 DUT

2 ESD generator with capacity of 150 pF and resistance of 2000 Ω

3 ESD generator power supply unit

4 Wood table

5 Coupling surface

6 Ground point

7 Ground connection

8 Dissipating material (if necessary)

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]   Job:

Component Type: Drawing Number:

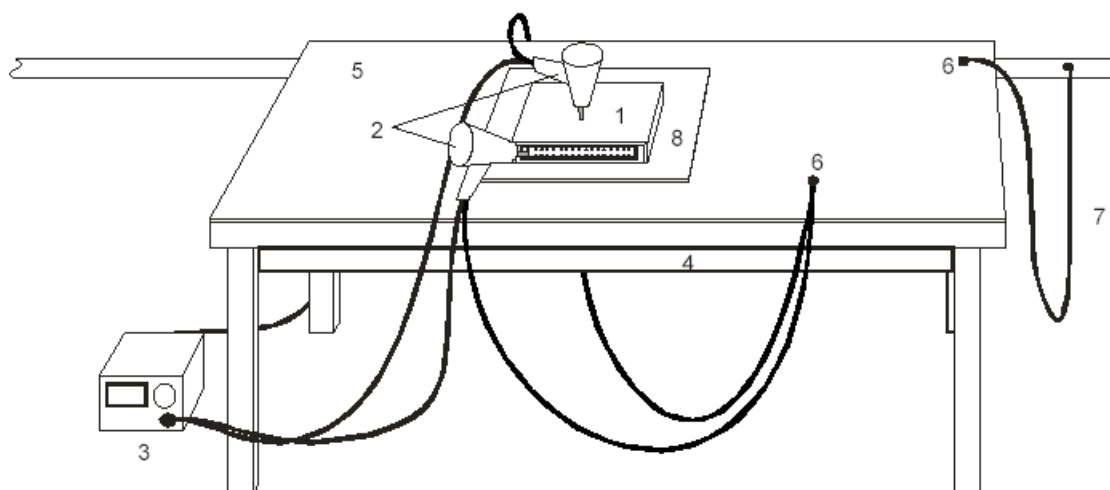Supplier: Last Change:

7.1.2

With DUT connected neither to power supply nor to any peripheral and making use of every test level defined in Proc. Spec. 9.90110, apply 5 discharges with positive polarity and 5 discharges with negative polarity directed to every point defined in the test plan, with interval at least of 1 s after every discharge and considering what indicated below:

Engineer   [ ]

On the surfaces, apply contact discharges and/or discharges in air according to what defined in help 3.

On the contrary, apply only contact discharges to pins.

To apply the contact discharges:

- on pins for which the direct access of the simulator is not possible, use can be made of a cable with section ranging between 0.5 mm² and 2mm² and maximum length of 25 mm to be connected appropriately to the tested pin on which the discharge has to be applied.
- Keep the discharge generator tip perpendicular to the DUT surface, when possible, and anyway with an angle not lower than 45°.
- Put the generator tip in contact with the application point and, then, apply the discharge.

For the discharges in air:

- charge the generator electrode up to the test voltage and then, approaching the electrode tip to the DUT, make the discharge go off.
- The speed of the generator tip toward the DUT must range between 0.1 – 0.5 m/s, and anyway as fast as possible without damaging the DUT and/or the generator.

7.1.3

For every test point, write the discharge results in the related table of module "Data processing".

Engineer   [ ]

7.1.4

Submit the DUT to a functional test according to what defined in the test plan checking that neither variations of the characteristics nor permanent damages occur.

Engineer   [ ]

Date:...   Exemption: NO [ ]   YES [ ]

Test Operator:...

Test Engineer:..   Signature..

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Job:

Component Type:

Drawing Number:

Supplier:

Last Change:

7.2

Immunity to ESD with component fed

The test consists in applying the ESDs to the device and its I/O peripherals (**direct** discharges) and to conductive surfaces immediately close to it (**indirect** discharges) in order to reproduce the effects of the human discharge that can occur in case of contact with these parts during the normal use of the DUT on the vehicle.

If DUT peripherals reachable directly by the user are not available for the test, the ESD shall be applied to the connecting pin between wiring and peripheral.

The application points of the ESDs shall be specified in the test plan.

7.2.1

Put the DUT on the coupling surface (the use of the insulating support shall be defined according to the installation on vehicle).

Test Op.   [ ]

7.2.2

Put the electronic components, which on the vehicle are connected to the body, so that they are connected directly to the coupling surface, in compliance with the minimum distance of 0.2 m between them and the minimum distance of 0.1 m of the components from the edge of the coupling surface.

Test Op.   [ ]

7.2.3

Put the electronic components, which on the vehicle are insulated from the body, on an insulating support having the characteristics defined in paragraph "Test equipment".

Test Op.   [ ]

7.2.4

Connect the power supply terminals of DUTs and other electronic components to battery (see. Figures B and C).
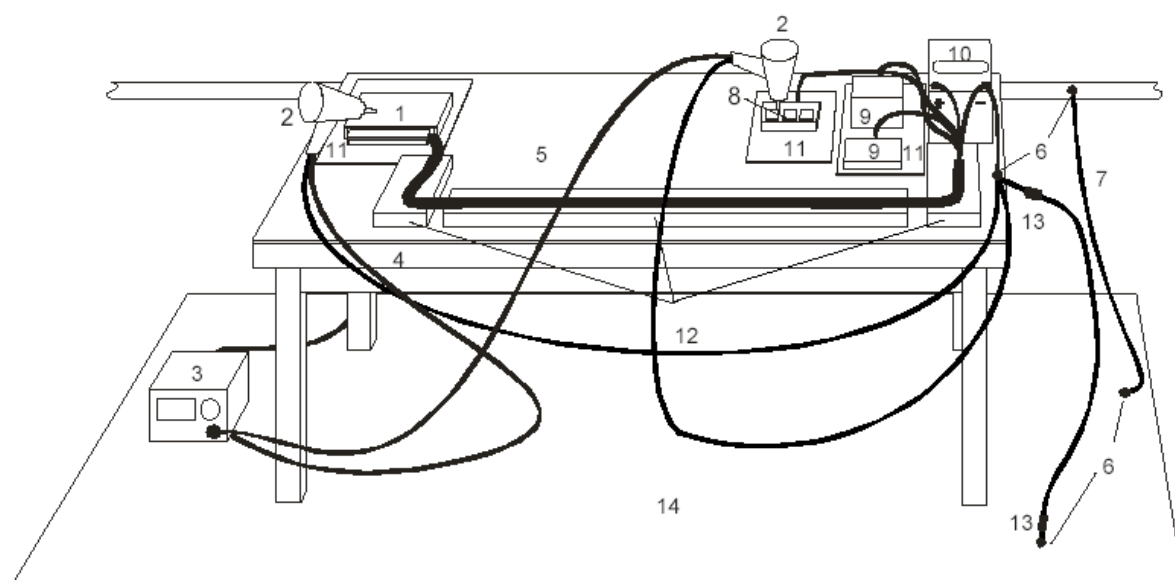
Test Op.   [ ]

Figure B – Setup for DIRECT ESDs

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]   Job:

Component Type: Drawing Number:

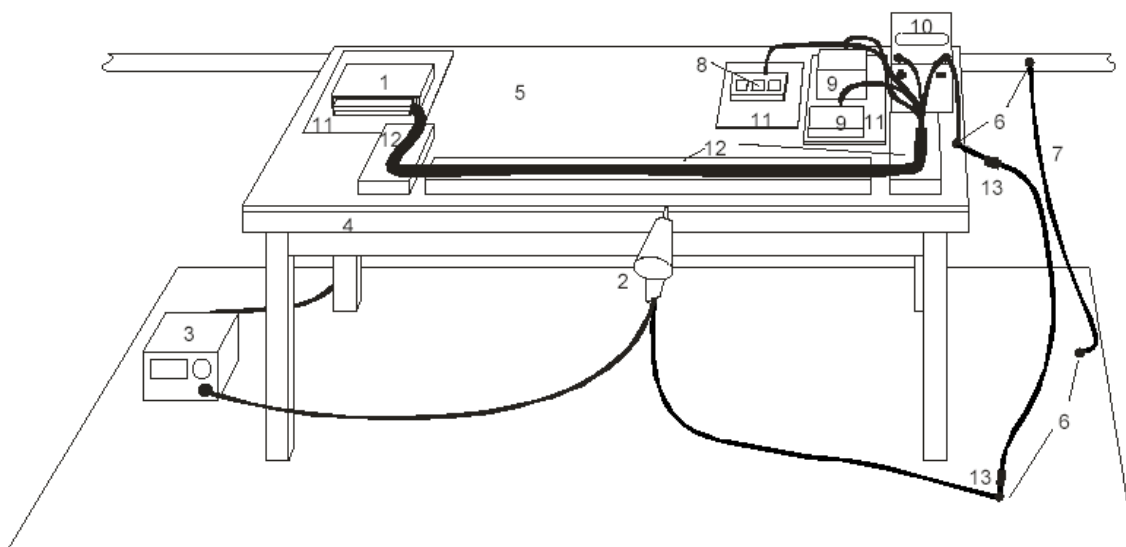Supplier: Last Change:

Figure C – Setup for INDIRECT ESDs

LEGEND

1 DUT

2 ESD generator with capacity of 150 pF or 330 pF in function of the location of DUT on vehicle, according to what required by Proc. Spec. 9.90110 and resistance of 2000 Ω

3 ESD generator power supply unit

4 Wood table

5 Coupling surface

6 Ground point

7 Ground connection

8 DUT peripherals accessible on vehicle

9 Other peripherals

10 Battery

11 -12 Insulating supports (if required)

13 470kΩ resistances

14 Ground surface (not compulsory)

7.2.5

Connect the DUT peripherals (sensors, actuators, switches, etc.) to all the other I/O pins.   Test Op.   [ ]

7.2.6

Collect the connection cables between DUT, battery and peripherals in a bunch whose length shall range between 1.50 m and 2.50 m.   Test Op.   [ ]

7.2.7

Put the cable bunch parallel to the coupling surface edge at a distance at least equal to 0.1 m and place it on an insulating support having the characteristics defined in paragraph "Test equipment".   Test Op.   [ ]

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Job:

Component Type:

Drawing Number:

Supplier:

Last Change:

7.2.8

Connect the ground cable of the ESD generator to the coupling surface and to the ground surface, if any, as shown in figures B and C, then place it at least at 0.2 m from DUT and from every I/O cable while applying the ESDs.

Test Op.   [ ]

7.2.9

In the test plan, define the operative conditions in which the DUT has to be set during the test.

Engineer   [ ]

7.2.10

For every test point, for every level defined in Proc. Spec. 9.90110, apply 5 **direct** contact and/or in-air discharges, according to what define in help 3 with both positive and negative polarity with an interval at least of 1 s after every discharge and considering what indicated below:

Engineer   [ ]

For the contact discharges:

- keep the discharge generator tip perpendicular to the DUT surface, when possible, and anyway with an angle not lower than 45°.
- Put the generator tip in contact with the application point and, then, apply the discharge.

For the discharges in air:

- charge the generator electrode up to the test voltage and then, approaching the electrode tip to the DUT, make the discharge go off.
- The speed of the generator tip toward the DUT must range between 0.1 – 0.5 m/s, and anyway as fast as possible without damaging the DUT and/or the generator.

7.2.11

When applying every series of ESDs, check that the behavior of the DUT complies with what required by Proc. Spec. 9.90110 according to its ESD classification.

Engineer   [ ]

7.2.12

For every test point, write the results in the related table of module "Data processing".

Engineer   [ ]

7.2.13

At the end of every series of ESDs, check that the behavior of the DUT complies with what required by Proc. Spec. 9.90110 according to its ESD classification.

Engineer   [ ]

7.2.14

To every test point defined in the test plan, for every level defined in Proc. Spec. 9.90110, apply 50 **indirect** contact discharges both with positive and negative polarity, with intervals at least of 50 ms after every discharge and considering what indicated below:

Engineer   [ ]

- the ESD generator tip must be on the same plane of the coupling surface (NOTE: no ESD must be applied on the coupling surface).
- Put the generator tip in contact with the edge of the coupling surface and, then, apply the discharge.

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]   Job:

Component Type: Drawing Number:

Supplier: Last Change:

7.2.15

When applying every series of ESDs, check that the behavior of the DUT   Engineer   [ ]
complies with what required by Proc. Spec. 9.90110 according to its ESD
classification.

7.2.16

For every test point, write the results in the related table of module "Data   Engineer   [ ]
processing".

7.2.17

At the end of every series of ESDs, check that the behavior of the DUT complies   Engineer   [ ]
with what required by Proc. Spec. 9.90110 according to its ESD classification.

Date:.. Exemption: NO [ ]   YES [ ]

Test Operator:...

Test Engineer:.. Signature...

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Component Type:

Supplier:

Job:

Drawing Number:

Last Change:

8

DATA PROCESSING

8.1

Immunity to ESD with component not fed

ESD application point:			
Discharge type (in air or contact):			
Discharge characteristics (Capacity and resistance):			
Test level:			
Functionality to be tested:			
Check procedure:			
Discharge no. 1	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 2	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 3	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 4	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 5	Positive polarity:	Result:	
	Negative polarity:	Result:	
Notes:			

Date:...

Test Engineer:..

Exemption: NO [ ]   YES [ ]

Signature...

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]   Job:
Component Type: Drawing Number:
Supplier: Last Change:

8.2
Immunity to ESD with component fed

8.2.1
Direct ESDs

ESD application point:			
Discharge type (in air or contact):			
Discharge characteristics (Capacity and resistance):			
Test level:			
Functionality to be tested:			
Check procedure:			
Discharge no. 1	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 2	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 3	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 4	Positive polarity:	Result:	
	Negative polarity:	Result:	
Discharge no. 5	Positive polarity:	Result:	
	Negative polarity:	Result:	
Notes:			

Date:... Exemption: NO [ ]   YES [ ]

Test Engineer:.. Signature...

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]
Component Type:
Supplier:

Job:
Drawing Number:
Last Change:

8.2.2

Indirect ESDs

ESD application point:	
Discharge characteristics (Capacity and resistance):	
Test level:	
Functionality to be tested:	
Check procedure:	
Positive polarity:	Result (*):
Negative polarity:	Result (*):
Notes:	

(*) at the end of the 50 discharges

Date:..

Test Engineer:...

Exemption: NO [ ]   YES [ ]

Signature..

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]   Job:

Component Type: Drawing Number:

Supplier: Last Change:

9

RECOVERY ACTIVITY OF THE BENCH/VEHICLE/TEST PIECE

9.1

Disconnect the system, the various sensors, actuators, probes and everything not belonging to the system.   Test Op.   [ ]

9.2

Restore the possible connections that have been modified, in order to carry out the tests.   Test Op.   [ ]

9.3

Make the test bench ready for a new test.   Test Op.   [ ]

9.4

File the tested components at least for 10 years so that they can be found easily.   Engineer   [ ]

Note: At the end of the filing period, the components shall be destroyed.

Date:.. Exemption: NO [ ]   YES [ ]

Test Operator:...

Test Engineer:... Signature...

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Job:

Component Type:

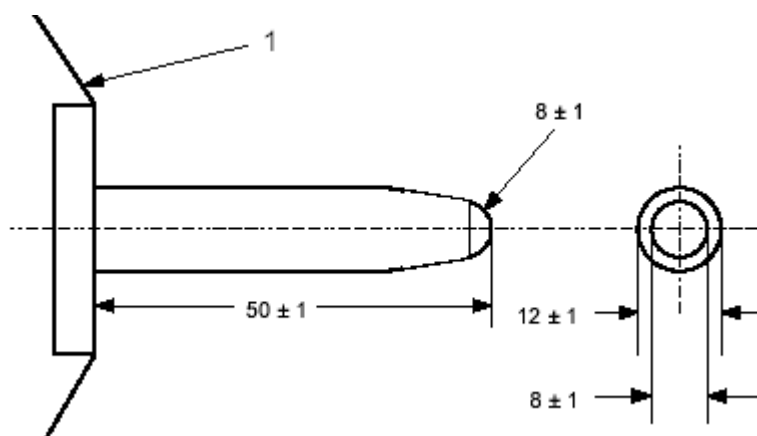Drawing Number:

Supplier:

Last Change:

10

HELP

Help 1

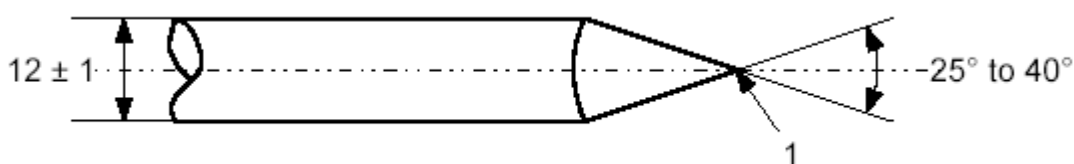### TERMINATION OF E.S.D. SIMULATOR FOR DISCHARGES IN AIR

Dimensions in millimeters

For discharges with voltage higher than 15 kV, an electrode tip with higher diameter is required (e.g. from 20 to 30 mm)

TERMINATION OF E.S.D. SIMULATOR FOR CONTACT DISCHARGES

Dimensions in millimeters

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]   Job:

Component Type: Drawing Number:
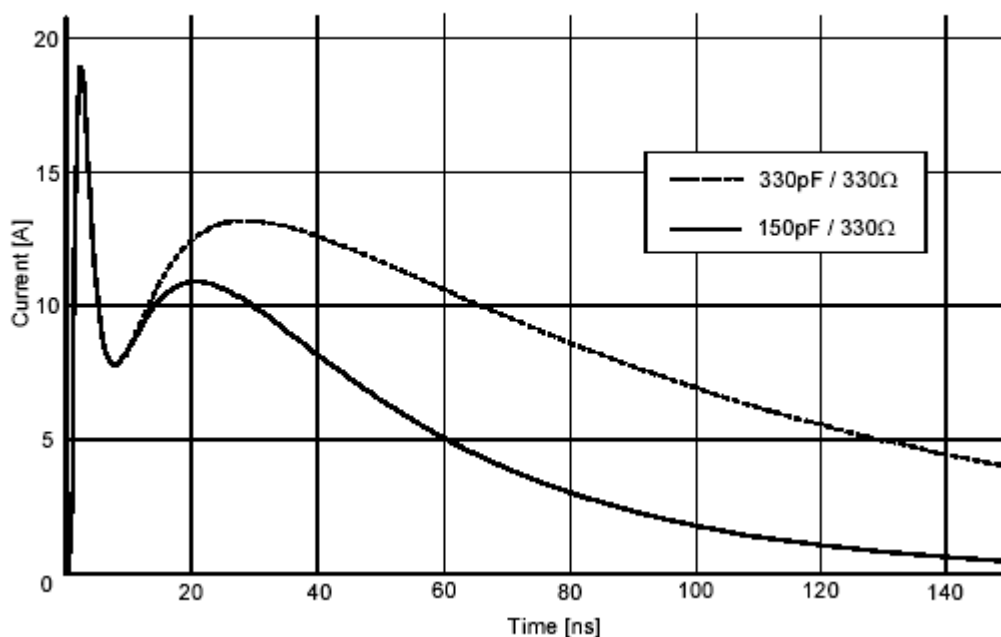
Supplier: Last Change:

Help 2

PARAMETERS OF THE WAVE SHAPE FOR CONTACT DISCHARGES

Typical values R/C	Peak current/kV [A]	Tolerance [%]	Current 1/kV [A]	Tolerance [%]	Current 2/kV [A]	Tolerance [%]
150pF/330Ω	**3.75**	**±10**	2 (@30ns)	**±30**	1 (@60ns)	**±30**
330pF/330Ω	**3.75**	**±10**	2 (@65ns)	**±30**	1 (@130ns)	**±30**
150pF/2000Ω	**3.75**	**-0/+30**	0.275 (@180ns)	**±30**	0.15 (@360ns)	**±50**
330pF/2000Ω	**3.75**	**-0/+30**	0.275 (@400ns)	**±30**	0.15 (@800ns)	**±50**

NOTES:

1. The peak levels will be measured with no interpolation

2. The target utilized for measurements must comply with requirements of ISO 10605

3. The times of measurements in ns indicated in the table are derived from the time constant RS (-40% for current 1 and +20% for current 2)

Table 2

Figure 2a: Example of wave shape for contact discharge (for 150 pF/330pF, 330Ω and 5 kV)

Build Level: A[ ] - B[ ] - C[ ] - D[ ] - E[ ]

Component Type:

Supplier:

Job:
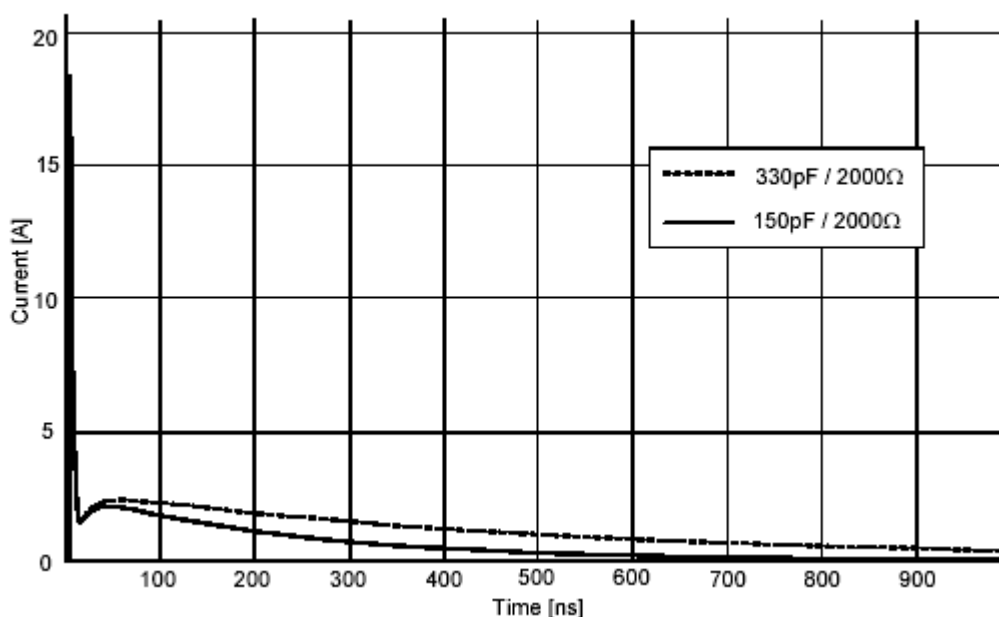
Drawing Number:

Last Change:

Figure 2b: Example of wave shape for contact discharge (for 150 pF/330pF, 2000Ω and 5 kV)

Help 3

Discharges can be applied to DUT in 2 ways: in aria and by contact according to what defined in the following recapitulating table and making use of the appropriate tip as described in help 1.

Surface type	Discharge modality
CONDUCTIVE	Discharge in **air** for discharges higher than 8kV
	Contact discharges for discharges lower than or equal to 8kV
NON-CONDUCTIVE	Discharge in **air**
NOTE: Should the conductive surface of DUT be covered by a layer of conductive paint, apply the contact discharge after making the ESD generator tip penetrate through the same paint until getting to the metal underlay. On the contrary, should paint be insulating, apply discharges in air.	

Table 3

Moreover, contact discharges are subdivided into:

- **Direct** discharges: to be applied on DUT and/or all the peripherals that can be achieved by a user when making use of or handling a device (pins, surfaces, connectors, switches, antennas, display, diagnosis intake, etc.)
- **Indirect** discharges: to be applied on the horizontal edge of the coupling surface