

第八章

静电放电试验规范 ESD test procedures

应当对EUT施加直接和间接放电试验。直接放电是直接对EUT放电。间接放电模拟临近的EUT的导电物体放电，并且通过一个中介金属来传导，例如HCP和VCP。

Testing shall consist of direct and indirect application of discharges to the EUT. Direct discharges are applied directly to the EUT. Indirect discharges simulate discharges that occur to other conductive objects in the vicinity of the EUT and are applied through an intervening metal, such as an HCP or VCP.

试验应当使EUT受到模拟的人体放电。放电点应当选择在用户正常使用产品时易接触的地方。见8.5，“如何选择放电点”。

The test shall subject the EUT to simulated discharges from humans. Discharges shall be applied to areas that are accessible by operating personnel during normal operation. See clause 8.5, Selection of test points.

8.1 实验室测试条件 Laboratory test conditions

实验室ESD试验的目的是：同时模拟ESD发生的水平和类型。但是不能完全等同于实际放电。

The intent of ESD testing in the laboratory is to simulate both the level and type of ESD occurrences that are experienced by the product in the field in a manner that is representative of, but not necessarily identical to, actual ESD.

为了使环境因素对试验结果的影响最小化。试验应当在条款规定的条件下进行。

In order to minimise the effect of environmental parameters on the test results, ESD testing should be carried out under the conditions defined in this clause.

8.1.1 环境条件 Climatic conditions

除非负责通用产品标准的委员会另有规定，实验室的环境条件应当在制造商允许的产品使用条件下测试。

Unless otherwise specified by the committee responsible for the generic or product standard, the climatic conditions in the laboratory shall be within any limits specified for the operation of the EUT and the test equipment by their respective manufacturers.

试验不应在湿度很高的条件下进行，高湿有可能会使水汽凝结在EUT上。

Tests shall not be performed if the relative humidity is so high as to cause condensation on the EUT or the test equipment.

为了保证试验结果的重复性，ESD试验应在如下条件下进行：

- (1) 温度：15~35°C (59~98°F)
- (2) 相对湿度：30%~60%
- (3) 大气压：68-106 kPa

To ensure reproducibility of the test results, ESD testing should be performed under the following climatic conditions:

- a) Temperature: 15-35°C(59-98°F)
- b) Relative humidity: 30% to 60%
- c) Atmospheric pressure: 68-106 kPa

注释：

1. 标准的条件是跟据海平面（101.3kPa和15°C）定义的。106kPa的海拔是-383米，68kPa的海拔是+3236米。国际上对于1kPa的转换是0.145 lbs/in²或0.2953汞柱（美国的标准大气压）和10毫巴（气压单位，多用毫巴，1毫巴等于0.75毫米水银柱的压力）。

2. 试验可以在推荐的环境条件以外进行。但是试验结果可能会因为现对湿度的升高和温度的波动被严重影响。万一出现争论，首先应当在C等级和50%RH的海平面进行再次试验。
3. 试验时实际的环境条件应当在试验报告中记录。海拔可以用来代替大气压。因为天气的因素，大气压在海拔不变地情况下仅有±3%的偏差。如果要记录大气压。必须注意你记录地是真的大气压，而不是大气压转换成地海拔高度。
4. 在给定距离上电极之间的空气击穿电压和大气压力大致成正比，和绝对温度成反比。因此，当通过空气击穿，测试EUT时。ESD测试的电压应当变至设备规格书中和测试环境中所描述的水平。对于同一间隙距离，典型的海平面空气击穿电压大约比3000m高40%。 Failure to change the test voltage to account for pressure variation will create site-to-site immunity variations in the EUT air breakdown values.
5. A correction of the test voltage shall only be applied to air discharge testing if a dielectric barrier is tested. The correction may lead to incorrect results if the failure mechanism is related to the energy of the current of the ESD discharge.

NOTES

1. Standard conditions are defined as sea level (101,3 kPa and 15°C). Then 106 kPa is -383 m and 68 kPa is +3236 m altitude. International conversion for 1 kPa is 0,145 lbs/in² or 0.2953 in Hg (typical reported atmospheric pressure measurement in the USA) and 10 mbar.
2. Tests can be performed outside the recommended climatic conditions. However, the results may be significantly affected with increased RH and variations in temperature. In case of **dispute**, testing at 21 degrees C and 50% relative humidity at sea level takes precedence.
3. The actual environmental conditions existing during the test should be recorded in the test report. Instead of the atmospheric pressure, the altitude can be noted. Due to weather systems, the barometric pressure at a constant altitude changes only by typically +/- 3 %. If the barometric pressure is recorded, care must be taken that it is the true barometric pressure and not the barometric pressure converted to sea level.
4. Air breakdown voltage at a fixed distance between electrodes is approximately proportional to atmospheric pressure and inversely proportional to absolute (K) temperature. Therefore, when testing EUTs for air breakdown (external or internal with either test method), the ESD test voltage level should be changed to reflect the test equipment specification and the environmental test conditions. Typically, air breakdown voltage at sea level will be about 40% higher than at 3000 m for the same gap distance. Failure to change the test voltage to account for pressure variation will create site-to-site immunity variations in the EUT air breakdown values. A correction of the test voltage shall only be applied to air discharge testing if a dielectric barrier is tested. The correction may lead to incorrect results if the failure mechanism is related to the energy of the current of the ESD discharge.

8.1.2 电磁条件 Electromagnetic conditions

试验环境的电磁条件应当不影响测试结果。

The ambient electromagnetic conditions should be such as not to influence the results of this test.

8.2 EUT安装 EUT set-up

8.2.1 EUT软件和/或操作模式 EUT software and/or mode of operation

为EUT选择可以在任何正常模式下使用的软件。

Choose test software for the EUT that will exercise all modes of normal operation.

因为EUT本身的复杂性，如果选择所有的EUT的操作模式进行测试，需要大量的时间和金钱。对于某些特殊的模式和容易暴露于ESD且非常敏感的部位应当测试。在选择EUT的操作模式时，需要良好的工程判断力。试验报告中应述及操作模式和选择他们的原因。

Where it is cost prohibitive to exercise all normal modes of operation because of EUT complexity, specific modes

expected or known to exhibit the most susceptibility should be exercised. Good engineering judgement shall be used in selecting the operating modes to be tested. The modes exercised and the rationale for their selection shall be documented in the test report.

如果设备操作系统的复杂性降低，用于评估所有操作模式的可能性就随之增大。

As the complexity of the machine operating system decreases, the probability of evaluating all or most modes of operation increases.

8.2.2 辅助设备 Auxiliary equipment

如果EUT需要和辅助设备连接以模拟真实的情况，辅助设备同样需要用和EUT一样的电压水平测试。如果不能实现，I/O电缆可以用过滤器或铁氧体环状线安装地距AE很近。

If the EUT needs to interface with auxiliary equipment (AE) to operate in a realistic way, this auxiliary equipment shall have proven to be immune at an equal or greater level than aimed for the EUT. If this is not the case, the I/O cables can be fitted with filters or ferrite toroids very close to the AE; see Annex D.

8.3 放电模式 Discharge Modes

可以通过两种方式对EUT实施放电，接触放电和空气放电。对可导电表面施加接触放电。对绝缘表面施加空气放电。对于不能施加接触放电的表面，须施加空气放电。以绝缘表面为例，导电表面被绝缘物质所覆盖或者在焊缝之下。这时接触放电头不能触及，只能以接触放电头对EUT施加间接放电。见附录C“空气和接触放电模式的对比”

Discharges can be applied to the EUT by two discharge modes: contact and air. Conductive surfaces are to be tested using contact mode discharges. Non-conductive surfaces are to be tested using air discharges. Air discharges shall be applied to those parts of the EUT to which it is not possible to apply contact discharges. Examples are non-conductive surfaces, conductive parts or surfaces covered by insulating material or behind seams or slots and places where it is not physically possible to position the contact discharge tip. Indirect discharge testing shall be performed using contact mode discharges only. See Annex C for guidance on air versus contact discharge modes.

在接触放电模式，ESD发生器放电电极的尖部先接触EUT，然后按下按钮施加放电。在空气放电模式，放电电极先被充电至测试电压，随后立即向EUT靠近，通过电弧对EUT放电，以期击穿测试点和放电电极之间的绝缘体。见8.4.4.2条

In contact discharge mode, the tip of the ESD generator's discharge electrode is brought in contact with the EUT before the discharge switch is actuated to apply the discharge. In air discharge mode, the discharge electrode is charged to the test voltage and then brought rapidly to the EUT, applying the discharge through an arc that happens when the tip approaches close enough to the EUT to break down the dielectric between the tip and test point. See also clause 8.4.4.2.

8.3 施加放电 Application of the discharge

应当在所有选定的点施加放电，放电时设备应正常运转。然而测试点仅仅限制在正常使用设备时可能被触及的地方。见8.5条

Discharges shall be applied to all selected test points with the equipment operating normally. However, test points are to be limited to those areas that are likely to be contacted during normal operation of the EUT; see clause 8.5.

试验应当包括：对于每一个确定的测试点施加不同极性至少50次接触放电。对于不能施加接触放电的部位（例如被绝缘层覆盖），需要施加至少10次不同极性的空气放电，所有的电压等级都需要测试，包括较低等级的电压。如果在规定等级放电，但是没有电弧产生，那么更低的电压就不再需要测试了（例如在在8KV没有产生电弧，那么2KV和4KV根本就不用测了）

The test shall consist of at least 50 contact discharges of each polarity applied to each defined test point for the test level specified. Those defined test points to which contact discharge cannot be applied (eg, covered by insulating material), shall be tested by applying at least 10 air discharges of each polarity at the defined test level and all lower test levels. Air discharges need not be applied at test levels below the voltage at which arcing does not occur. (For example, if no arc occurs at 8 kV, then air discharges do not need to be applied at 2 and 4 kV.)

8.4.1 测试电压的等级 Test voltage steps

8.4.1.1 接触放电方法 Contact Discharge Method

因为在接触放电时ESD发生器的放电电流和充电电压关系是线性的，所以允许只在最高电压上测试，而不需要在所有的低等级电压上进行测试。见附录C

Because the discharge current of ESD generators in contact mode is linear with respect to the charge voltage, it is permissible to test at only the severity level required for the product and not at all lower voltage levels. See Annex C.

8.4.1.2 空气放电方法 Air Discharge Method

一些产品有对特定的静电电压敏感的特性，不一定只是表现在较高的电压等级上。因为这个原因以及在空气放电时充电电压和放电电流是非线性关系，所以在空气放电时，必须从低压到高压进行测试。在没有其它的要求的情况下，应按“表一”中给出的顺序测试。

Some products have the tendency to exhibit susceptibility responses when exposed to specific ESD voltages, but not necessarily at higher voltage levels. Because of this and the nonlinear relationship between charge voltage and discharge current in the air discharge method, test points subjected to air discharges must be tested at lower test levels up to the severity level required for the EUT. In the absence of other requirements, the test levels given in Table 1 should be used. 例如，一个EUT需要按“水平3”（8KV的空气放电方法）来测试。那么需要在2KV、4KV、8KV三个等级下测试，除非在2KV和4KV时根本没有电弧出现。

For example, an EUT required to meet test level 3 (8 kV for air discharge method of testing) shall be tested at 2 kV, 4 kV and 8 kV, unless discharges do not occur at the lower levels.

注释：如果在等级较低的电压上没有发生放电，那么我们认为产品在低电压上合格。

NOTE: When no discharges (can) take place at these lower test levels, the product is deemed to comply with the requirement to test at the lower levels.

8.4.2 ESD事件的时间间隔 Time between ESD events

连续的单次放电之间的时间间隔应当尽可能的长，以期判定EUT是否完成了错误恢复和重试的循环。每一次的放电应当被单独考虑，因此允许的时间间隔应当确保故障不是因为连续放电导致的，而是因为独立的ESD事件，并且在在放电间隔期间，应当导走充在EUT上的静电。

The time interval between successive single discharges should be as long as necessary to determine whether the EUT has completed an error recovery or retry cycle. Every discharge should be considered individually; therefore, time needs to be allowed between discharges to ensure that a failure is not due to sequencing, but due to the individual ESD event and that any charge imparted on the EUT is allowed to dissipate.

我们推荐连续的单次放电之间的时间间隔为1秒钟。如果假定更高的频率不会影响到试验结果，我们允许提高放电频次以缩短试验的时间，例如可以将频次升至20次/秒。在7.1.4条中详述了如何去除EUT上静电的方法，对于自动重复测试的最慢限制为最长间隔10s

The time interval between successive single discharges is recommended to be 1 s. Faster repetition rates, e.g. up to 20 discharges/s, are allowed to make the test time shorter, provided the faster rate does not influence test results. By using the EUT charge removing measures as described in clause 7.1.4, a maximum time of 10 s should be used as slowest limit

considering automated repetitive testing.

注释：

1. 高放电速率有利于这些希望做复合ESD试验的人，他们希望加快试验的进度。然而当EUT通过了试验
2. 所有50次放电可以按顺序依次施加，完成后我们可以验证是否EUT仍然良好，
3. 一次连续的放电可施加50次接触放电。

NOTES

1. Higher repetition rates are advantageous to those who want to perform multiple trials ESD testing in order to expedite the test time. However, when the EUT passes the test at the level with the lower repetition rate, the EUT is considered to comply.
2. Where it is possible for the application of the discharges to be synchronous with the EUT operation cycle, consideration should be given to vary the discharge repetition frequency randomly.
3. All 50 contact discharges can be applied in a single sequence. After this sequence, it can be verified whether the EUT operating as intended, as it is irrelevant for the test whether an error after the first or the last discharge.

8.4.3 ESD发生器在操作时的位置 Orientation of ESD generator

对于直接放电，ESD发生器的放电头部应当垂直于EUT或HCP的表面（如果EUT很小，见附录D）。对于耦合板的放电（就是间接放电），施加放电时，放电头应和VCP以及HCP处于同一平面，但是不用在HCP或VCP地两面都放电，只要对着边缘放电即可。

For direct discharges to the EUT, the ESD generator's discharge tip is held perpendicular to the surface of the EUT or HCP when a small EUT is considered, see annex D. For discharges to coupling planes (i.e., indirect discharges), the discharge tip is in the same plane as the HCP or VCP while making contact with the plane's edge. No discharges are made to either side of the flat surfaces of the HCP and/or VCP.

8.4.4 对EUT的直接放电 Direct application of discharge to the EUT

8.4.4.1 接触放电的电极连接 Electrode connections for contact discharge method

对于接触放电，施加放电前，放电电极的头部必须先接触EUT上的导电表面。

In the case of direct contact discharges, the tip of the discharge electrode must touch a conducting point on the EUT before the discharge switch is actuated.

如果导电基体上有涂层，要使用以下流程：1) 如果制造商没有声明涂层是绝缘的，那么我们需要用放电枪的“尖头”刺穿涂层对导电基体放电。2) 如果制造商声明涂层是绝缘的，那么我们使用空气地方方法进行放电，并禁止使用接触放电方法。

Where painted surfaces cover a conducting substrate, the following procedure is used. If the coating is not declared to be an insulating coating by the equipment manufacturer, then the pointed tip of the ESD generator penetrates the coating so as to make contact with the conducting substrate. If the coating is declared to be an insulating coating, then the surface is tested as an insulating surface using the air discharge method and no electrical contact shall be made with the conducting substrate.

8.4.4.2 空气放电的靠近速度 Speed of approach for air discharge method

如果导电基体上有涂层，要使用以下流程测试：1) 如果制造商没有声明涂层是绝缘的，对于空气放电来说，放电电极靠近EUT的速度对于“上升时间”和“注入电流的幅度”是一个关键要素。任何测试，靠近速度应该在0.1~0.5m/s之间。在实际操作时，在避免机械损坏静电枪头和EUT的情况下，靠近EUT的速度应尽量地快。静电枪在靠近EUT的过程中如果发生电弧，不应停止靠近，应当继续靠近直到接触EUT表面。

The speed of approach of the discharge electrode is a critical factor in the rise time and amplitude of the injected current during an air discharge. The speed of approach should be between 0,1 - 0,5 m/s for any test. Because the approach speed is not trivial to measure, in practice the ESD generator should approach the EUT as quickly as possible without causing damage to the EUT or ESD generator. The ESD generator should not be stopped when the arc occurs, but rather should be followed through until the electrode touches the surface. **8.4.5 HCP和VCP在“间接放电”时的使用**

Indirect application of the discharge using the HCP or VCP

通过“泄漏电线”连接GRP的HCP和VCP的接触放电，模拟了在临近EUT的物体上的放电。“泄漏电线”用来防止：电荷累积在耦合板上。见6.6条。

Discharges to objects placed or installed near the EUT are simulated by applying contact discharges of the ESD generator to the HCP or VCP that is connected to the GRP via a bleeder wire. The bleeder wire prevents a charge build-up on the coupling plane, see clause 6.6.

接触放电应当施加在VCP的垂直边。VCP应放置在距EUT表面0.1m远的地方。对于又大又宽的EUT，VCP的中心应当和EUT的中心基本对齐，如果EUT比VCP高0.5m，对于EUT敏感电路的位置，应当在不同的高度和不同的位置对EUT施加间接放电。一般应对EUT的四个垂直于水平面的面放电。

Contact discharges shall be applied to the centre of one vertical edge of the VCP while the VCP is positioned parallel to and 0.1 m from the EUT surface and/or cables connected thereto. With a tall or broad EUT, the VCP shall have its centre at the centre of the EUT. If the height of the EUT is greater than 0.5 m, consideration should be given to applying indirect discharges with the VCP at different heights and positions corresponding to the location of the sensitive circuitry of the EUT. Discharges using the VCP should be made to all four sides of all equipment.

对于HCP间接接触放电应当施加在EUT的每个中心位置（前、后、左、右）。EUT应当距HCP的边缘0.1m。可能的话，可以在HCP上移动EUT的每个面来测试。

With indirect contact discharges to the HCP the discharges shall be applied to each centre position (front, back and sides) of the EUT on the HCP. The EUT shall be kept at 0.1 m from the edge of the HCP. It may be necessary to move the EUT on the HCP for each face tested.

8.5 测试点的选择 Selection of test points

应对操作者可以接触的EUT部位和VCP的垂直边放电。例如：键盘区域和其他人机界面装置，如开关，把手，按钮等。

The discharges shall be applied to the EUT at operator accessible points and to the vertical edge of the VCP. Examples of operator accessible points include any point in the control or keyboard area and any other point of human-machine communication devices such as switches, knobs, and buttons.

注释：对于普通产品，如果安装时已经考虑了ESD的防护，如有一个静电罩，或者接了地，那么本标准不要求对接口的PIN角进行放电。

NOTE: If the normal product installation will always have a protective ESD cover or cable connected, then the application of electrostatic discharges to open connector pins is not required by this standard.

以下情况，要对EUT的如下点和表面进行放电，

1. 正常使用产品各项功能时可以接触到的部位。
2. 试验报告中列出的测试点；
3. 如果制造商认为用户在正常使用过程中不可能触及的点或面应当从测试中排除。

The discharges shall be applied only to those points and surfaces of the EUT, which are accessible to persons during normal use of the intended functions. All points tested shall be listed in the test report. All other points and surfaces, which the manufacturer does not consider to be normally accessible by an operator when the EUT is in normal use, shall be excluded from the test.

如下的部分应当排除在外：

- 1) 仅在对设备进行维护时才可能触及的地方。对于此种情况，产品附带的文档应该告知消除静电的方法。
- 2) 仅在对设备进行维修时才可能触及的地方。这种很少接触的地方的例子有：更换电池时对电池的接触，电话中的自动应答机磁带。
- 3) 有些点或面在设备安装之后，当你将设备安装好之后就不再有可能摸到。例如：设备靠墙的部分。
- 4) 对于有“接口保护金属罩”的同轴和多pin角的接口，仅对金属罩施加接触放电。
- 5) 对于接口或者可接触部分，为了实现特殊的功能，一般他们对ESD都非常敏感。如果制造商提供了ESD警世标致，就不再测试。例如为了测试，接收和其他通信功能的实现使用的射频输入接口。

The following exclusions apply:

- 1) Those points and surfaces which are only accessible under maintenance. In this case, special ESD mitigation procedures shall be given in the accompanying documentation
- 2) Those points and surfaces which are only accessible under service by the (end-)user. Examples of these rarely accessed points are: battery contacts while changing batteries, a cassette in a telephone answering machine, etc.
- 3) Those points and surfaces of equipment which are no longer accessible after installation or to which the instructions for use prohibit access, e.g. the bottom and/or wall-side of an equipment or areas behind fitted connectors.
- 4) The contacts of coaxial and multi-pin connectors which are provided with a metallic connector shell. In this case, contact discharges shall only be applied to the metallic shell of that connector.
- 5) Those contacts of connectors or other accessible parts that are ESD sensitive because of functional reasons and are provided with an ESD warning label, e.g. RF inputs from measurement, receiving or other communication functions.

基本原理：许多“连接端口”设计用来处理高频信号（模拟或者数字信号），因此不能提供足够的过电压保护装置。例如模拟信号，滤波器是一个解决办法。“过压保护二极管”所带来的“杂散电容”，对于EUT的工作频率可能有帮助。

Rationale: Many connector ports are designed to handle high frequency information, either analogue or digital, and therefore cannot be provided with sufficient overvoltage protection devices. In the case of analogue signals, band-pass filters may be a solution. Overvoltage protecting diodes have too much stray capacitance to be useful at the frequencies where the EUT is designed to operate.

非导电表面的接触。比如：塑料件，接口和正常情况下会操作的普通功能，应当只施加空气放电。注意空气放电使用圆形放电头。

Contacts within a non-conductive, e.g. plastic, connector and which are accessible to persons during normal use of the intended functions shall be tested by the air-discharge test only. This test has to be carried out by using the rounded tip finger on the ESD generator.

表格 5 – 需要考虑的测试点

情况	接口	覆盖材料	施加空气放电	施加接触放电
1	金属的	无	--	屏蔽
2	金属的	绝缘的		屏蔽
3	金属的	金属的	--	覆盖并屏蔽
4	绝缘的	无		--
5	绝缘的	绝缘的		--
6	绝缘的	金属的	--	覆盖

Case	Connector	Covr material	Air discharge to:	Contact discharge to:
1	Metallic	None	--	Shell
2	Metallic	Insulated		Shell when accessible
3	Metallic	Metallic	--	Shell and cover
4	Insulated	None		--
5	Insulated	Insulated		--
6	Insulated	Metallic	--	Cover

应当对EUT系统中的所有设备和外围设备施加放电。未接地的导电表面应当根据需要的测试水平进行测试。

Discharges should be applied to all equipment and peripherals that form the EUT system. Ungrounded conductive surfaces should be tested for subsequent breakdowns at the desired test levels.

对于预先选定的测试点的数量没有限定。但是，对于可以直接施加直接接触放电的测试点就不再需要空气放电了。对于只有在设备维护时才能触及任何点都不必施加放电，除非制造商和用户达成了某种测试协议。

No restriction is placed on the number of pre-selected points to be tested. However, air discharge to the test points which allow direct contact ESD testing is not a requirement. The application of discharges to any point of the equipment that is accessible only during maintenance is not required unless agreed upon by the manufacturer and the user.

8.6] “逐步增加”法则 Escalation Strategy

经验表明，ESD试验过程中发现的偶然故障很难再被复现。为了能够对此给出合格还是不合格的判断，我们建议以下的法则：

Experience has shown that during ESD testing, occasionally errors occur which can hardly be reproduced. To allow the user a pass/fail judgment the following strategy is suggested:

如果在特定测试等级和特定测试点发现某故障，试验员又认为它是一个偶然事件（注释：试验员可以认为任何故障都是偶然事件），那么他可以根据如下的程序来重复试验。

If an error occurs at a particular test level at a particular test point and the operator expects this to be a random event (note: the operator may declare any error as a "random" event), the operator may repeat the test at this point according to the following procedure.

如果在50次放电中，有不少于1次的故障发生（在给定测试等级和测试点），可以认为由于“静电事件导致了”故障（即不合格）。

If more than 1 error occurs in the first 50 discharges, the EUT fails the test at that test point and test level. The error is considered to be caused by an ESD event

如果仅有1次故障发生，而且试验员怀疑这仍是一个随机事件。那么需要再进行100次新的放电，如果在这100次中没有发现故障，那么认为试验合格，如果有超过1次的故障发生，那么不合格，如果恰巧仅有1次故障发生，那么还需要在进行下一轮放电来判断。

If 1 error occurs in the first 50 discharges and the operator suspects this to be a random event, a second test is run at that test point applying 100 new discharges. If no errors occur in this set of 100 discharges, the EUT passes the test at that test point. If more than one error occurs in this set of 100 discharges, the EUT fails the test. If exactly 1 error occurs in this set of 100 discharges, a third test is performed.

第三轮放电需要施加200次放电，如果没有发现故障，那么合格；如果有大于等于1次的故障发生，则不合格。

The third test is to apply 200 new discharges at that test point. If no errors occur in this set of 200 discharges, the EUT passes the test at that test point. If 1 or more errors occur in this set of 200 discharges, the EUT fails the test.

Annex D

(Informative)

Test Set-up Guidance

D.1 Guidance

To ensure better reproducibility of the test results, the following considerations should be made. The influence of these measures may be EUT dependent. It is for this reason that this

information is not incorporated into the normative part of the standard.

为保证较好的试验再现性，必须作以下考虑。EUT可能决定这些测量的影响

D.2 Cable layout

Cables that are connected to the EUT during the ESD test should be positioned 30 mm above

the GRP or HCP to establish a transmission line with characteristic impedance of approximately 150 Ω . This characteristic impedance of the transmission-line will last until twice the propagation delay of the cable over metal plane, typically 3,3 ns/m in free space (C_0

= 3.108 m/s). Considering the rise time of the discharge wave shape (0,7 – 1 ns rise time with

a decay time of about 3 times the rise time results in 4 ns total discharge time) physical lengths of 0,7 m (2 times 0,7. 3,3 ns/m) will be sufficient to satisfy this requirement.

Meeting this cable geometry for all cables connected to the EUT during the test will enhance

reproducibility of test results.

D.3 Cable termination

When the geometrical requirements of D2 for the cable layout are met, the cable currents resulting from the initial discharge will be stabilised. However, additional test set-up measures

may be needed to stabilise effects from the bulk current that arrives after the initial discharge.

These effects may be stabilised by terminating cables dropped from the HCP to the GRP at the point where each cable reaches the GRP. A short circuit to the GRP or termination with a

coupling/decoupling network (CDN) according to IEC 61000-4-6, representing a common mode impedance of 150Ω , may be used for this purpose.

NOTE: The common-mode termination will only affect EUTs that are sensitive to the bulk discharge current rather than the initial discharge current.

In case the CDNs are not used, all cables connected to the EUT could be short-circuited to the GRP from the high-frequency point of view. In this case, the length of all cables should be

at least 1,5 m (= sum of cable length on the table plus the table height). For the purpose of common-mode termination CLC-filters should be used rather than LCL-filter types.

Although

the length of the cable(s) does NOT account for proper characteristic transmission-line impedance at 30 ns (2 times 1,5. 3,3 ns/m = 10 ns), measurements have proven that with table-top equipment this way of termination is the most suitable alternative.

NOTE: When the cables are left open (in common-mode) at the end, reflections, i.e. resonances, will occur on the

cables that may affect the EUT adversely. This condition should be avoided.

In case loaded CDNs are used, both with table-top as with floor standing equipment, the length of the cables connected becomes irrelevant as the transmission-line impedance established geometrically will be terminated resistively. Under this common-mode terminated

condition, the CDNs can be located close to the EUT.

D.4 ESD generator orientation

As defined in the main part of the document, the ESD generator shall be held perpendicular to

the (large) EUT and/or GRP or HCP that is near to the ESD generator as the waveshape characteristics of the ESD generator are specified accordingly during calibration. Putting the

ESD generator under a small angle (< 70 degrees, figure D1) to the EUT, HCP and/or GRP at

close distance will influence the stray capacitance between the ESD generator and its environment substantially. Accordingly the waveshape and initial peak current will be affected.

D.4.1 Testing small table-top equipment.

The test set-up will be as defined in clause 7.1.1. However, when applying the direct discharge to a small EUT (maximum dimension 0,2 m), the EUT can be put at maximum in 6

orthogonal orientations with respect to the HCP. The EUT shall be positioned at least 0,1 m

from the edge of the HCP. To ensure that the ESD generator will deliver the correct discharge

current waveshape to the EUT, the ESD generator's discharge electrode has to remain perpendicular to the surface of the HCP under all test conditions.

It is never allowed to put the ESD generator's discharge electrode in parallel to the HCP at close distance and move the EUT towards the tip such that a discharge can take place to the

EUT.

For EUT with dimensions over 0,15 m, it will depend on the size of the ESD generator whether it can be held perpendicular to the surface of the EUT. In case the ESD generator cannot be held away from the HCP by at least 0,1 m, the orientation of the ESD generator shall remain perpendicular to the HCP surface during the test.

$\varphi < 200$ when height above HCP

is less than 0,1m

$> 0,1$ m

$> 0,1$ m

HCP Insulation material, $d = 0,03$ m

L, W, HEUT $\leq 0,2$ m

Cable(s)

$\geq 0,6$ m $\geq 0,1$ m

Edge of HCP

0,03 m

Figure D.1 - ESD generator orientations when testing small products

The accessible point(s) of the EUT can only be touched under certain EUT orientations only.

No test should be carried to these accessible points when they cannot be reached without fulfilling the requirements as indicated above.

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