

Aspects of Behavior Regarding Certain Electronic Equipment Subject to Electrostatic Discharge

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Abstract - Electrical discharge due to human operators may cause disturbances with very fast variation reaching the sensitive equipment by conduction and radiation and can affect and even destroy them. Therefore, between a human, possible to load electrostatic voltages of 10-15kV ordinal, and an electronic device (computer, laptop, memory stick, etc.), system connected to the grounding, an electrostatic discharge can occur as a result of electric charging (electrification) the person wearing clothes made of synthetic fibers, due to friction with the air. This paper proposes a study of the transient arrangement produced by human electrostatic discharge and the disruptive or destructive effects that may occur. Experimental tests have been performed to determine the degree of immunity to electrostatic discharge (ESD) into the air and through direct contact, in accordance with the regulations in force, in the specialized laboratory of ICMET Craiova, subjecting a memory stick and a wireless Internet connection stick to electrostatic discharge. The results obtained revealed the individualized behavior for each device tested.

Keywords: *electromagnetic compatibility, electrostatic discharge, immunity to a disturbance, contact discharge, air discharge.*

I. INTRODUCTION

Industrial development, especially in the light industry, widely producing synthetic fibers and clothes made of synthetic fibers and semiconductor manufacturing industry has led to the importance of electrostatic discharge studies and analyses.

Electrical discharge, due to human operators, may cause disturbances with very fast variation reaching the sensitive equipment by conduction and radiation that can affect and even destroy them.

Therefore, between a human, possible to load electrostatic voltages of 10-15kV ordinal, and an electronic device (computer, laptop, memory stick, etc.), system connected to the grounding, an electrostatic discharge can occur as a result of electric charging (electrification) the person wearing clothes made of synthetic fibers, due to friction with the air.

This paper proposes a study of the transient arrangement produced by human electrostatic discharge and the disruptive or destructive effects that may occur.

Experimental tests have been performed to determine the degree of immunity to electrostatic discharge (ESD) into the air and through direct contact, in accordance with

the regulations in force, in the specialized laboratory of ICMET Craiova, subjecting a memory stick type ADATA of 8GB and a wireless Internet connection stick to electrostatic discharge. The results obtained revealed the individualized behavior for each device tested.

II. THEORETICAL NOTIONS RELATED TO ELECTROSTATIC DISCHARGES

Electrostatic discharges shall be recorded between broadband disturbance sources.

Electrostatic discharges arising from the accumulation of electrical charge with a certain polarity in the separation of the two areas that previously have been in contact and one of the two environments is isolating [1].

Electrostatic discharge are classified between non-functional sources of electromagnetic interference along with other sources such as: automotive ignition installations, welding equipment, electronic converters, etc. [2]

The development of electronics, microelectronics and generally of IT equipment and the production of synthetic fibers and clothes made of synthetic fibers has led to increasing emphasis on studying and analyzing the effects of disturbing or destructive effects of electrostatic discharges produced by humans.

Electrostatic discharges from humans are important in terms of electromagnetic compatibility.

Depending on the clothes worn by a human operator, humidity environment, etc. a person can be charged with a voltage up to 30 kV, which can produce large amounts of undesirable electrostatic discharge (disturbing or destructive) on electronic equipment. In general, a person walking on a carpet can be charged with a voltage up to 15 kV.

In the case of electrostatic discharge from the point of view of electromagnetic compatibility and determining the level of immunity, the essential problem is the fact that these discharges are very fast and under the form of impulses measured in nanoseconds.

Disturbing phenomena produced by electrostatic discharges are produced by discharge currents under the form of impulses and by time-varying magnetic fields [2]

III. GENERAL ASPECTS OF ESD TESTS

The tests on immunity to electrostatic discharge can be performed in specialized laboratories and on-site (on-site operation).

The tests are done in accordance with the specified standard IEC 61000-4-2 [3].

For ESD testing a high voltage source is required, an energy accumulator and discharge electrode. In general, the discharge electrode is mounted in a device called test gun that can move towards the object tested (EUT) starting from a certain distance until spark discharges occur, known as air discharge. In case the test gun comes into contact with metal parts of the EUT, discharge occurs through direct contact.

In Table I [3] we have presented immunity levels and the tensions the equipment must be tested at.

TABLE I.
TEST LEVELS

Contact discharge		Air discharge	
Level	Test voltage kV	Level	Test voltage kV
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15
x	special	x	special

The contact discharge is the preferred test method and the second method by air discharge shall be used where contact discharge method cannot be applied.

It is important to achieve with the equipment used, through the laboratory simulation of electrostatic discharge, the ideal wave shape of the discharge current through direct contact.

This waveform is shown in figure 1 [2,3].

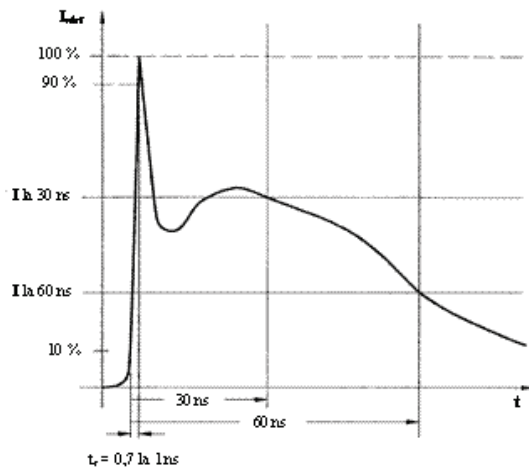


Fig.1 Ideal wave shape of the discharge current

Also, it is important to analyze the results on EST immunity, represented by knowing the environmental conditions in which the tests were performed, namely [3]:

- ambient temperature 15-30 °C;
- relative humidity 30-60%
- atmospheric pressure 860 – 1.060 mbar.

The test result shall be classified in terms of loss of function or degradation of performance of the equipment under test (EUT), as follows [3]:

- a) normal performance within limits specified by the manufacturer;
- b) temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention;
- c) temporary loss of function or degradation of performance, the correction of which requires operator intervention;
- d) loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.

IV. EXPERIMENTAL DETERMINATIONS ON ESTABLISHING THE DEGREE OF IMMUNITY TO ESD

This article has proposed to present the ESD test results for a memory stick (fig. 2 a) and an Internet connection stick (fig. 2 b) in order to establish the degree of immunity



a)



b)

Fig.2 Article proposed to the ESD test

We selected these devices because they can be directly connected to a computing equipment (computer, laptop) and may be subject to human nature ESD (electrostatically charged human operator)

A. Equipment used

The tests were conducted in the specialized laboratory of ICMET Craiova.

The high voltage generator is an electrostatic discharge simulator for immunity tests by air and contact discharges (25 kV), ESD30C (EM Test) (fig. 3.a) equipped with test gun (fig. 3.b).

The ESD30C/ (EM test) is a mains supply powered ESD simulator that generates ESD up to 25 kV in both air discharge and contact discharge mode [8].



a)



b)

Fig.3 Equipment used

The test gun is equipped with two interchangeable tips for air discharge and for direct contact discharge (fig. 4). The two tips are made in accordance with the requirements specified in international standards.



a)



b)

Fig.4 The accessory for test gun

a) top for testing by contact discharge; b) top for testing by air discharge

The tests were conducted at an ambient temperature of 25.5 ° C and a humidity of 54.5%, sizes falling in the range of values provided in [3].

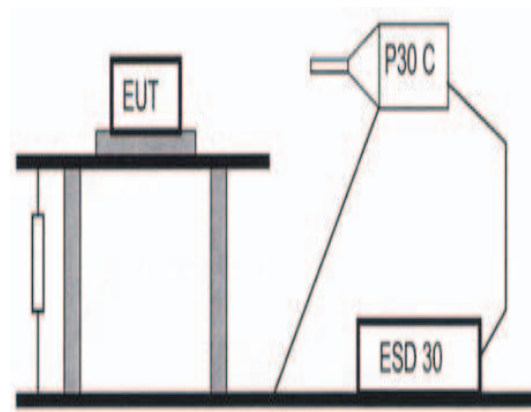


Fig.5 Experimental assembly which is performed in laboratory for the ESD tests [6]

Before carrying out the tests, we carried out a verification of waveform signal produced by the equipment used on a calibration ESD resistance (EM Test) of 2 Ω for a test voltage of 2kV(fig.6).

The result obtained is shown in fig. 7 and is within the limits imposed by [3] and presented in Table II, being similar to the waveforms obtained in similar experimental conditions and found in specialized literature [4].



Fig.6 Calibration ESD resistance (EM Test) of 2 Ω

TABLE II.
CONTACT DISCHARGE CURRENT WAVEFORM PARAMETERS

Level	Indicated voltage [kV]	First peak current of discharge ±15% [A]	Rise time t_r (± 25%) [ns]	Current (± 30 %) at 30 ns [A]	Current (± 30 %) at 60 ns [A]
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 current at 30 ns and 60 ns is the instant when the current first reaches 10% of the 1st peak of discharge current



Fig.8 Issues during tests

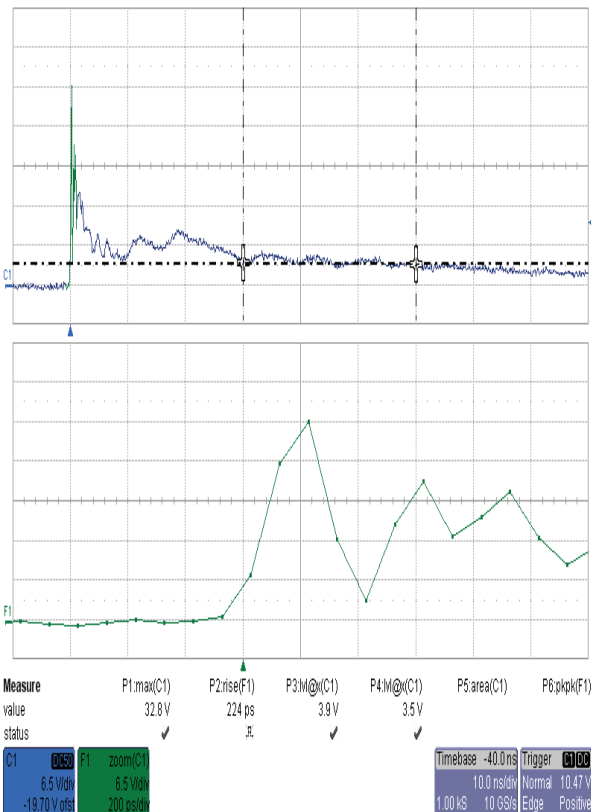


Fig. 7. Waveforms obtained experimental.

B. Results of the experimental tests

The test points were selected so that the requirements IEC 61000-4-2 and thus can be considered:

- points on metallic sections of a cabinet which are electrically isolated from ground;
- any point in the control or keyboard area and any other point of man-machine communication, such as switches, knobs, buttons, indicators, LEDs, slots and other operator-accessible areas.

The ESD shall be applied only to those points and surfaces of the EUT which are accessible to persons during normal use [3]:

- those points and surfaces which are only accessible under maintenance;

- those points and surfaces which are only accessible under service by the (end-) user (for example : battery contacts while changing batteries, a cassette in a telephone answering machine etc.);
- in the case of the contacts of coaxial and multi-pin connectors which are provided with a metallic connector shell, the test point (contact discharges) shall only be applied to the metallic shell of the connectors;
- those points and surface of equipment which are no longer accessible after fixed installation or after following the instructions for use;
- contacts within a non- conductive connector and which are accessible shall be tested by the air- discharge test only. In this case is used the rounded tip finger on the ESD generator.

The test results obtained by the two electronic devices are shown in Table III for the Internet connection stick and in Table IV for the memory stick.

“Good” means behavior so that the EUT behaved normal performance within limits specified by the manufacturer.

C. Analysis of the results obtained

By analyzing the results presented in Table III and Table IV, we can conclude that the wireless Internet connection stick tested behaved well for each ESD level, for both air and direct contact discharge. After testing with 15 kV voltage air discharge, we observed the occurrence of discharges in the form of light luminescent effluvia.

Regarding the memory stick type ADATA 8GB, we observed that for an ESD voltage of 2kV, 4 kV and 8 kV it behaved well, as there were no operational problems. At the ESD air discharge tests, at a voltage of 15 kV, we observed perturbations in operation, namely after charging with positive polarity, a blockage occurred in operation and after charging with negative polarity, a reset occurred in operation.

It is important to remember is that electrostatic discharges did not lead to destroying the equipment tested.

V. CONCLUSIONS

The development of light industry for the large scale manufacture of synthetic fibers and clothes made of synthetic fibers correlated with the technological advances in IT (computers, laptop, mobile phones and other electronic devices, etc.) has led to an increased importance of studying electrostatic discharges and immunity tests of electronic equipment on ESD.

Therefore, between a human, possible to load electrostatic voltages of 10-15kV ordinal, and an electronic device (computer, laptop, memory stick, etc.), system connected to the grounding, an electrostatic discharge can occur as a result of electric charging (electrification) the person wearing clothes made of synthetic fibers, due to friction with the air.

ESD can cause distortions in the operation of various electronic equipment or even their destruction.

ESD tests can be performed in specialized laboratories certified for this purpose, or on site.

In this paper, we subjected to ESD a memory stick and a wireless internet connection stick.

The tests were conducted with special equipment (power source, test gun) found at ICMET Craiova and in normal environmental conditions.

By analyzing the test results determining the degree of ESD immunity of the equipment tested, we observed that the wireless Internet connection stick behaved well, as there were no problems in operation and in the case of the memory stick, we reported loss in performance at a voltage of 15kV, namely blockage of operation after testing with positive polarity and a resetting of its operation after testing with negative polarity.

Following these tests, as a conclusion, it is worth noting that the electrostatic discharges did not lead to the destruction of the equipment tested, as they behaved well in this regard.

The results of these experimental tests have highlighted the importance and necessity of establishing ESD immunity of electronic equipment which may be subjected, incidentally, to human-type ESD.

TABLE III.
TEST RESULTS FOR INTERNET CONNECTION STICK

Contact discharge			Air discharge		
Level	Test voltage kV	Performance	Level	Test voltage kV	Performance
1	2	good	1	2	good
2	4	good	2	4	good
3	6	good	3	8	good
4	8	good	4	15	good – small glow discharge

TABLE IV.
TEST RESULTS FOR MEMORY STICK

Contact discharge			Air discharge		
Level	Test voltage kV	Performance	Level	Test voltage kV	Performance
1	2	good	1	2	good
2	4	good	2	4	good
3	6	good	3	8	good
4	8	good	4	15	a) positive electrode- temporary loss of function (the correction of which requires operator intervention) b) negative electrode – temporary loss of function (reset the system)

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