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Implementation of CISPR 14-2 Standards on Electrostatic Discharge (ESD) Immunity Test for Household Appliances Induction Cooker

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Abstract: Electromagnetic compatibility testing (EMC) is one of the important aspects to guarantee the quality of household appliance products induction cooker. One of the test clauses is electrostatic discharge (ESD). The purpose of this paper describes the application of the CISPR 14-2 standard on the ESD test and its suitability for household appliances induction cookers. The test is performed only on the air discharge method and to see the performance change, the power consumption measurement before and after discharge is applied. The test results show a decrease in measured power consumption by 3.5%. In ESD test, the air discharge is applied at some point specified that is power button, hot pot button, display and heatsink. The test results showed no degradation of performance or failure of function of induction cooker.

Keywords: Electromagnetic compatibility; electrostatic discharge; CISPR 14-2 standard; induction cooker.

1. Introduction

1.1. Background

Household appliances are so many kinds and uses so it is in demand among housewives now. In fact, for people who have or planning new houses, household appliances become a necessity for him. As technology evolves, many household appliances today are equipped with inverter technology which may generate disturbances in the frequency range within 9-150 kHz [1] related to the frequency switching used such as washing machine with washing mode, rinse and dryer simultaneously in one tube, inverter technology on conditioning room (AC) and refrigerator, blender, microwave up to induction cooker. Now cooking food is an important phenomenon in everyday life because it requires a large amount of energy source. Modern devices such as induction cookers become another alternative for the use of coal, wood, gas, etc. According to Pradip, et al (2010) the most significant advantage in the use of induction cookers is high efficiency thereby reducing consumption and electricity costs [2].

With the still high purchasing of the people, making more and more kinds of equipment is in every house. On the other hand, the electrical and electronic product often (unexpectedly) produce radio-frequency (RF) energy resulting in electromagnetic interference to the surrounding equipment as well as the equipment itself [3]. Therefore the aspect of electromagnetic

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compatibility (EMC) of household appliances becomes an important thing to do. One way to find out the electromagnetic compatibility of a household appliance product is through electromagnetic susceptibility/immunity testing (EMS). One important test in Electromagnetic Susceptibility is electrostatic discharge testing (ESD).

1.2. Purpose

The purpose of this paper is to describe the application of the CISPR 14-2 [4] standard on electrostatic discharge (ESD) tests and their suitability for household appliances induction cookers. The paper is limited only to the method of air discharge that is the method of giving pulse disturbance by not directly touching the surface of the induction cooker or non-contact method. The results of this study will be useful in the development of EMC household appliance induction cooker testing methods, improving the quality of equipment products by providing recommendation to the manufacturers, increasing the competitiveness of products for the improvement of the nation's economy.

2. Basic theory

Electrostatic discharge or usually called ESD is an electric current transfer from one object to another object. The current movement is caused by contact and separation. Some electronic components that are sensitive to ESD are electronic component made of semiconductor materials such as transistors, diodes, Integrated circuit and others. Movement current has a very small value when compared with dynamic current such as electric current in general, thus the current movement is difficult to be perceived but this current movement greatly affects the performance of electronic components that have high sensitivity to current noise, so that it can cause electrical hazard [5]. This current movement creates energy, this phenomenon can be explained by conduction, induction and triboelectricity theory on electrostatic [6].

Conduction and induction in electrostatic are the basic concepts in understanding the displacement or movement of charge in ESD [7], the same also related to the triboelectricity theory that explains the charge interaction when two objects are in contact with one another. This charge will leave the object so that the abandoned object is more negative, while the targeted object is more positive with the existing of this charge movement. This effect depends on the area of contact and the material of the object. For electronic equipment testing against electrostatic discharge (ESD), an ESD simulator (ESD gun) with a special output called human body model (HBM) was used as seen in Figure 1. This model consists of resistors and capacitors coupled series. The capacitor is charged with high voltage from an external source and then discharges through the resistor to the input terminal.

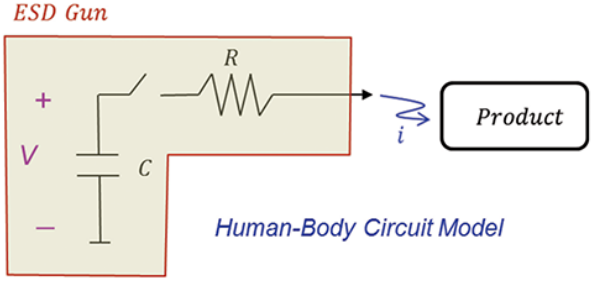

Figure. 1. Equivalent circuit for ESD gun with output.

Electrostatic discharge (ESD) is a severe source of interference in electronic products and can produce damage or upset failures [8]. Generally, ESD on electronic products might occur when the device itself becomes charged by triboelectrification and approaches another conducting object. Other types of ESD occur when a human, charged by triboelectrification, touches the electronic product.

3. Methodology

3.1. Equipment under test (EUT)

In this study used an induction cooker CIC 996 with serial number CIC00316B00018837 which is included in the portable stove with manual operation type. Maximum power consumption of the EUT is 1000 watts, cooking surface of glass material and has a single burner.

3.2. Test equipment

BEST EMC is an ESD generator with measurement capacity up to 16.5 kV with step 100 V. The noise is applied to EUT by ESD gun connected to BEST EMC. Supply voltage 220 V, 50 Hz is used to provide voltage to the EUT. To protect against electric shock and suppress the noise from the mains is used isolation transformer.

Power Hitester HIOKI 3193-10 with a maximum power input of 150 VA and a power output of 1.2 W - 150 kW is used to measure the EUT power consumption before and after it is tested. Temperature and humidity to determine the environmental conditions of the test site are recorded and displayed by the thermohygrometer.

3.3. Consumption power measurement

The purpose of this measurement is simply to know the power consumed by EUT before and after ESD test. Power Hitester is used to display the output voltage and current from the EUT by connecting the power cable EUT to the Power Hitester input. Measurements executed after warming up ± 15 minutes with the condition of cooking water 1.5 Liter. From voltage (V) and current (I) obtained then can be calculated power consumed (P) by EUT that is by formula:

$$P = V \, x \, I \tag{1}$$

3.4. Electrostatic discharge test

The electrostatic discharge (ESD) immunity testing for electric/electronics equipment or devices is prescribed in the international standard IEC 6l000-4-2 [9], which specifies the detail of test equipment specification and actual test methods. Basically, this testing is based on ESD phenomena caused by the touch action of a charged human [10].

In clause 8 standard CISPR 14-2 describes that the test shall be carried out under the conditions specified in CISPR 14-1 [11], so that the test is performed on the voltage and frequency according to the specifications of the EUT which is 220 V and 50 Hz. Cooking mode used is the most power used that is hot pot mode.

Electrostatic discharge test with air discharge mode is applied by using ESD gun with rounded or non-pointed ends. During the test, the gun is positioned at a distance of at least 50 cm from the specified EUT points. Discharge will arise when the gun is triggered and moved closer to the EUT.

The discharges voltage level are 2 kV, 4 kV and 8 kV, generate from the BEST EMC generator. The discharge points are applied to the power button, hot pot button, display, heatsink as shown in Figure 2. in sequence with each point 10 times discharge and with positive and negative polarity.

Figure 2. Discharge point test induction cooker.

4. Result and discussion

4.1. Power consumption measurement

At the beginning before being tested, after the EUT is turned on with hot pot mode for ± 15 minutes then the EUT power cable is immediately connected to the Power Hitester which will display the EUT voltage and current. After the ESD testing is complete, re-measure the EUT voltage and current by using the Power Hitester. The measurement set up can be seen in Figure 3.

Figure 3. Power consumption measurement set up.

From the Table 1 can be seen that the result of power consumption measurement before EUT tested have the voltage value is 209,09 V and current value equal to 4,447 A, so the power consumption is 0,9298 kW. While the power consumption measurement after EUT tested obtained voltage and current values of 207.52 V and 4.323 A, so that the power consumption is 0.8971 kW. There was a decrease power consumption of 0.0327 kW. From the data and based on the criteria in Annex A of the standard CISPR 14-2, there was a degradation of performance of the EUT which the power consumption decrease, but do not exceed 10% of the initial power or before the EUT tested. Based on the conformity to the CISPR 14-2 standard then the EUT belongs to Category A.

Table 1. Result of power consumption measurement.

Before	V (V_{RMS})	I (A_{RMS})	P (kW)
	209.09	4.447	0.9298
After	V (V_{RMS})	I (A_{RMS})	P (kW)
	207.52	4.323	0.8971

4.2. Electrostatic discharge Test

Setup of ESD test can be done by setting the EUT on non-conductive table as high as 80 cm and with a distance of 80 cm to the wall as shown in Figure 4. EUT and accompanying wires should be isolated with insulation material with a thickness of 0.5 ± 0.05 mm and is grounded to ground reference plane (GRP) via ground cable with 470 kΩ resistor. The return cable from the ESD gun must be grounded to the GRP. Measurement and conformity results are shown in Table 2.

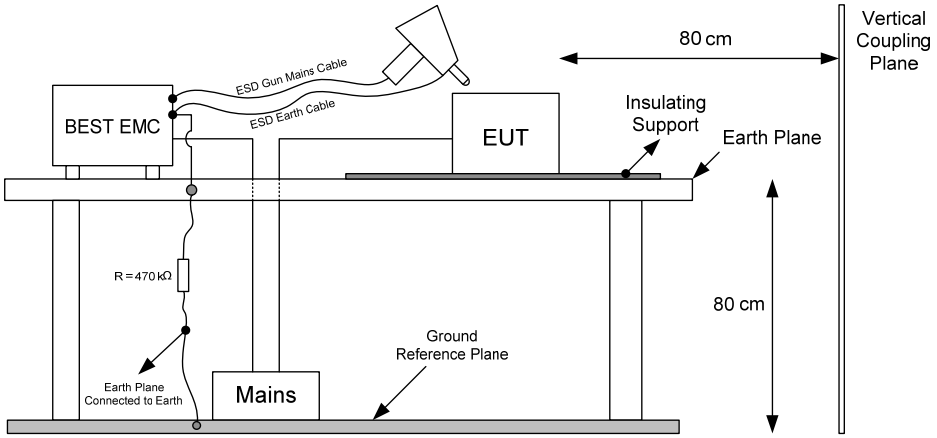

Figure 4. ESD test set up.

From ESD test results it is seen that all discharges given to specified points do not result in EUT having performance degradation or failure of function. This happens probably the interference does not enter the electronic system inside the EUT and or possibly the direct disruption to the GRP through the EUT ground system. Compliance refers to IEC 61000-4-2 where the results of conformity indicate the classification of EUT test results falling into category A. Compliance refers to IEC 61000-4-2 where the classification of EUT test results falls into Category A.

Table 2. ESD test result.

Discharge point	Number of discharge	2 kV		4 kV		8 kV	
		Polarity					
		+	-	+	-	+	-
Power button	10	A	A	A	A	A	A
Hot pot button	10	A	A	A	A	A	A
Display	10	A	A	A	A	A	A
Heatsink	10	A	A	A	A	A	A

5. Conclusion

The power consumption measurement results show that the measured power before and after tested has decreased by 0.0327 kW or 3.5% of initial power. This may be because the heat induced by the induction cooker comes solely from the coil that produces an electromagnetic field. The electromagnetic field generated will absorb the inductive reactive power so that it will reduce the power factor [12].

Based on CISPR 14-2 standard, the induction cooker that used is included in category II equipment. The minimum requirement of compliance to electrostatic discharge test for category II

- IV of household appliances is B which is temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the EUT recovers its normal performance, without operator intervention.

ESD test results show that the EUT when receiving disturbance does not occur degradation of performance or failure of function. The EUT are still working normally when the discharge voltage of 2 kV, 4 kV and 8 kV is subjected to test points i.e. power button, hot pot button, display and heatsink with positive and negative polarity. Referring to the CISPR 14-2 standard requirements, electrostatic discharge test results obtained by criterion A at all points.

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