Application Note

ISO 10605 Road Vehicles Test Methods for Electrical Disturbances from Electrostatic Discharge

ABSTRACT

ISO 10605 (Road vehicles − Test methods for electrical disturbances from electrostatic discharge) is the international standard used to test immunity compliance of electronic components in automotive applications. The standard partly stemmed from IEC 61000-4-2 and simulates the discharge of a human body inside or outside a vehicle. This application notes provides an overview of the ISO 10605, comparing it to the IEC-61000-4-2 standard, and providing a brief guide for selecting parts and interpreting data.

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Trademarks

1 ISO 10605 Overview

ISO 10605 (Road vehicles − Test methods for electrical disturbances from electrostatic discharge) is the international standard that defines the test methods to test ESD immunity electronic components used in automotive applications. It specifically covers the following scenarios:

- ESD in assembly
- ESD caused by service staff
- ESD caused by passengers

2 ISO 10605 ESD Waveforms and Test Parameters

Texas Instruments (TI) uses industry standard ESD test generators calibrated to the ISO 10605 test waveforms to conduct testing. ISO 10605 is partly based on IEC 61000-4-2, a standard that covers system level ESD immunity; however, it has several key differences specific to automotive applications. Unlike IEC 61000-4-2, ISO 10605 does not define specific upper limit of stress voltage. However, the test voltages are generally in the range of 2 kV to 15 kV for direct contact discharge, and 15 kV to 25 kV for air gap. Some automotive manufacturers have their own specifications, and some parts can have specifications as high as 30-kV contact, 30-kV air gap discharge. The generator is set to meet the parameters shown in Table 2-1.

Table 2-1. ISO 10605 Generator Parameters

Parameter	Characteristic
Output voltage (contact discharge)	2 kV to 15 kV (or as defined by test plan)
Output voltage (air gap discharge)	2 kV to 25 kV (or as defined by test plan)
Output voltage accuracy	≤ 5%
Output polarity	Positive and negative
Rise time of short circuit current in contact discharge mode (10% to 90%)	0.7 ns to 1.0 ns
Interval time	Minimum 1 s
Holding time	≥ 5 s
Capacitances	150 pF or 330 pF
Discharge resistances	330 Ω or 2000 Ω

ISO 10605 testing uses two different resistors, 2000 Ω and 330 Ω, to simulate different types of ESD events. The 2-kΩ resistor represents a human body discharging directly through the skin, while the 330-Ω resistor simulates a human body discharging through a metallic object. The test is also done at two different capacitances: 150 pF and 330 pF. These values represent a human body outside and inside the vehicle respectively. The 330-pF and 330-Ω test is the highest energy or current of any of the ISO 10605 test parameters, and thus is the most widely used test standard.

Figure 2-1 is an example of the ISO 10605 Discharge Equivalent Circuit.

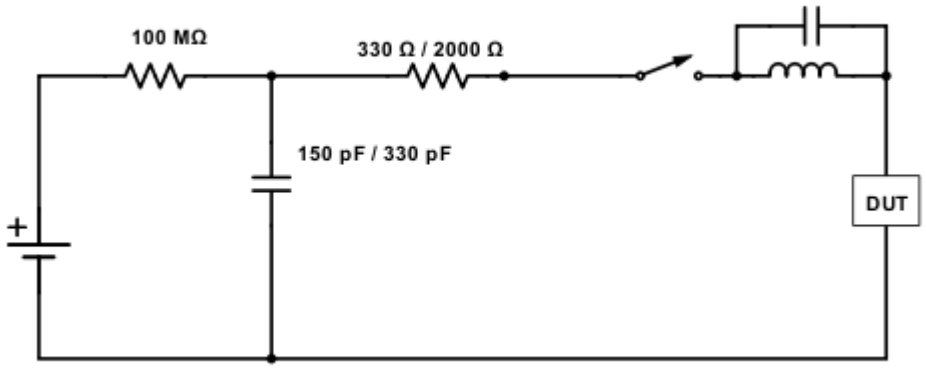

Figure 2-1. ISO 10605 Equivalent Circuit

The circuit starts off with the switch open, and charges the 150-pF, 330-pF capacitor. Then the discharge is represented by the closing of the switch, which causes the capacitor to discharge across the DUT. The resistor represents the resistance of the gun, and the inductor and capacitor represent the L-C parasitics.

Table 2-2 summarizes the similarities and differences between ISO 10605 and IEC 61000-4-2 test parameters. The 150-pF and 330-Ω test is roughly equivalent to the IEC 61000-4-2 test.

Table 2-2. Test Parameters of ISO 10605 vs IEC 61000-4-2

Standards	ISO 10605		IEC 61000-4-2	
Parameter	Contact	Air Gap	Contact	Air Gap
Output voltage	2-15 kV	2-25 kV	2-8 kV	2-15 kV
Interval time	Minimum 1 s		Minimum 1 s	
Network capacitance	150 pF, 330 pF		150 pF	
Network resistance	330 Ω, 2000 Ω		330 Ω	
Number of discharge pulses	Minimum 3		Minimum 10	
ESD generator ground reference	Battery Ground		Earth	
Test conditions	Unpowererd, Powered with Battery		Powered	

Figure 2-2 and Figure 2-3 show the different waveforms at their respective capacitance and resistance levels. Figure 2-2 through Figure 2-5 are example waveforms of 5-kV contact discharges, and help illustrate the variation in energy dissipation related to the resistance and capacitance values. Figure 2-4 and Figure 2-5 show the waveforms of 5-kV contact discharges under ideal conditions. The noise seen in Figure 2-2 and Figure 2-3 could be attributed to a variety of factors, such as L-C parasitics or noise from the generator or discharge gun.

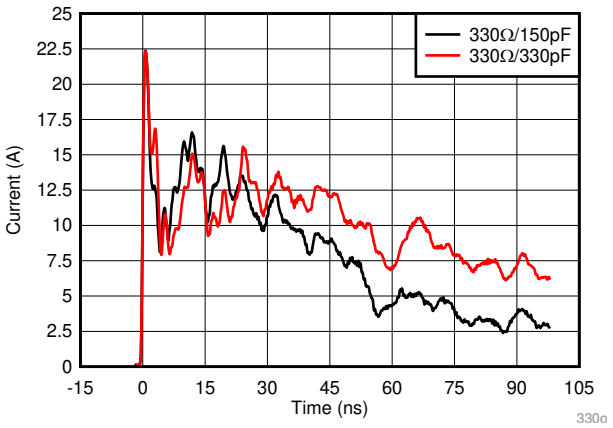

Figure 2-2. 330-Ω, 5-kV Contact Discharge

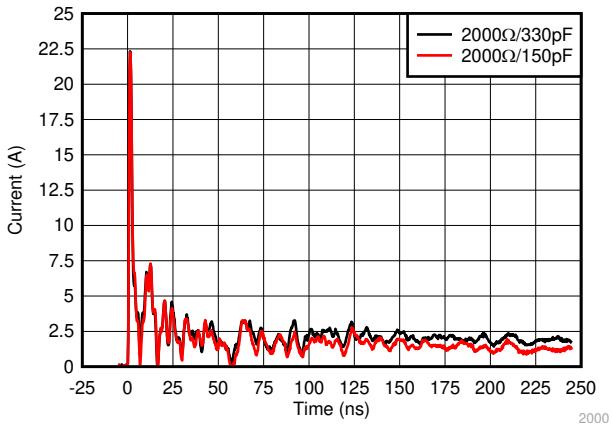

Figure 2-3. 2000-Ω, 5-kV Contact Discharge

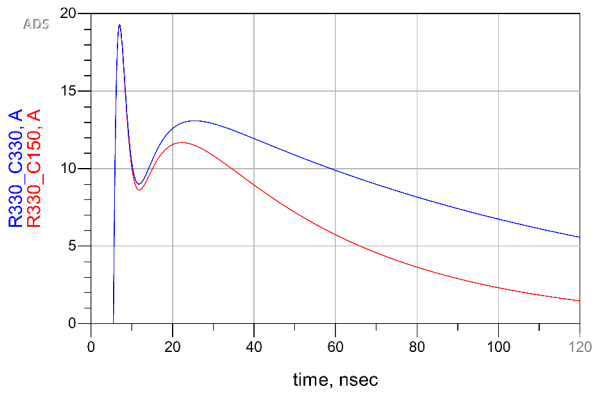

Figure 2-4. 330-Ω, 5-kV Contact Discharge Ideal Current Waveform

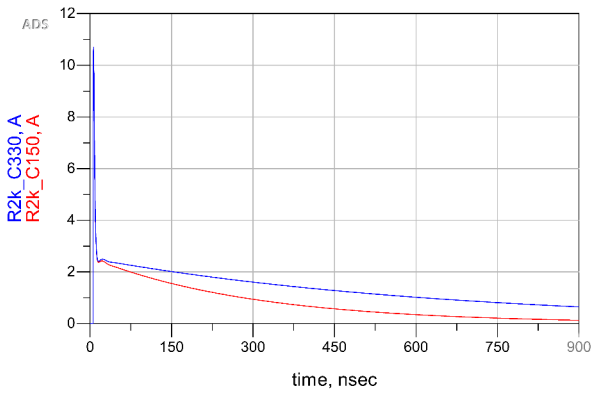

Figure 2-5. 2000-Ω, 5-kV Contact Discharge Ideal Current Waveform

As illustrated in Figure 2-2 through Figure 2-5, the 330-pF discharge (simulating a body inside the vehicle) has more energy than the 150-pF discharge (simulating a body outside the vehicle). This is because the higher capacitance dissipates over a longer period of time. The 330-Ω discharge also dissipates more energy than the 2000-Ω discharge due to its lower resistance. Because of this, the 330-Ω and 330-pF discharge has the highest energy of any of the tests, which is shown by having the largest area under its curve below.

Since IEC 61000-4-2 has a lower capacitance of 150 pF and 330 Ω, ISO 10605 at 330 pF and 330 Ω has a longer period of energy dissipation. Because of this, the stress on the device and change in temperature in ISO 10605 is significantly higher than IEC 61000-4-2, making it a more intensive test.

3 ISO 10605 Bench Setup

The TI ESD test bench set up complies with the ISO 10605 standards as shown in Figure 3-1. The Device under Test (DUT) is placed on a horizontal coupling plane (HCP). Two 470-kΩ resistors in series connect the HCP to the ground reference plane (GRP), and all devices are placed on a non-conductive table. Unlike IEC 61000-4-2, ISO 10605 is supposed to simulate the discharge of a device into a vehicle, so the generator (referred to as ESD simulator in Figure 3-1) is grounded to the table (upper HCP) instead of the earth. That is because the table is supposed to act as an independent body isolated from the earth. The illustration in Figure 3-1 gives a basic overview of the rest of the setup. Note the grounding of the simulator to the table (HCP) instead of the floor.

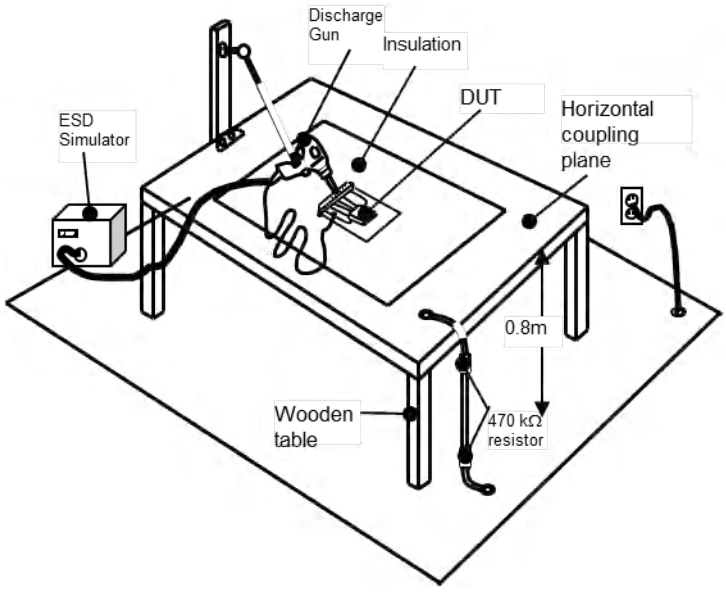

Figure 3-1. ISO 10605 Basic Table Setup

4 How to Interpret Test Data and Choose the Correct Protection

Since the 330 pF, 330-Ω test has the highest energy and current of the ISO 10605 standard, this is the most common test performed on automotive qualified parts in TI's ESD Portfolio. All of TI's automotive qualified parts have the suffix Q1. Automotive qualified parts need to indicate the 330-pF and 330-Ω discharge level in the Features and Specifications sections of TI's data sheets. If the part is used in an automotive application, make sure the product data sheet for its ISO 10605 rating.

Table 4-1 includes various TI parts with their ISO 10605 and IEC 61000-4-2 ratings:

Table 4-1. ESD Ratings

Part #	ISO 10605 (330 pF / 330 Ω)		IEC 61000-4-2	
	Contact	Air Gap	Contact	Air Gap
TPD4E02B04-Q1	±10 kV	±10 kV	±12 kV	±15 kV
TPD1E10B06-Q1	±8 kV	±15 kV	±30 kV	±30 kV
TPD1E10B09-Q1	±8 kV	±15 kV	±20 kV	±20 kV
TPD2E2U06-Q1	±20 kV	±25 kV	±25 kV	±30 kV
TPD1E01B04-Q1	±12.5 kV	±15 kV	±15 kV	±17 kV
ESD2CAN24-Q1	±30 kV	±30 kV	±30 kV	±30 kV

Also, it needs to be considered what application the device is going on. Different applications require different aspects to work in the system beyond the ISO 10605 rating. To make a full device selection see the System-Level ESD/EMI Protection Guide.

5 Conclusions

Testing and verifying transient immunity is a vital component in ensuring the reliability of modern electronic components, and ISO 10605 provides the guidelines for automotive ESD testing.

While ISO 10605 standard is similar to the IEC 61000-4-2 standard, it has several key differences:

1. The generator is grounded to the table instead of the floor to simulate the isolated environment of a vehicle.
2. The test is performed at different resistance values to simulate the discharge of a body directly and through a metal object. It is also performed at different capacitances to simulate a discharge both inside and outside the vehicle.

While there are a variety of other differences, ISO 10605 is quite similar to IEC 61000-4-2, and it is the industry standard for ESD protection devices in automotive applications.

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (October 2021) to Revision B (August 2022)	Page
• Added *ESD2CAN24-Q1* to the ESD Ratings table	5

Changes from Revision * (July 2018) to Revision A (October 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document	1
• Added *TPD1E01B04-Q1* device to this document	1
• Updated capacitor values regarding the device being inside versus outside a vehicle	2

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