

# TIC12400-Q1 and TIC10024-Q1 ISO-10605 ESD Test Report

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## ABSTRACT

This test report summarizes the ISO-10605 ESD test results for the TIC12400-Q1 and TIC10024-Q1 with different external components that can be added for improved ESD performance. Detailed board and test setup information are also described in this report. The results are the same for both devices.

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## 1 Introduction

The TIC12400-Q1 is an advanced *Multiple Switch Detection Interface* (MSDI) designed to detect external switches status in an automotive system. The TIC12400-Q1 and TIC10024-Q1 support up to 24 switch inputs, with 10 inputs configurable to monitor switches connected to either ground or battery. Both devices include a comparator to monitor digital switches independently of the MCU. The TIC12400-Q1 also features an integrated 10-bit ADC to monitor multi-position analog switches. The detection result is communicated to the MCU through the SPI interface.

Refer to [TIC12400-Q1 24-Input Multiple Switch Detection Interface \(MSDI\) With Integrated ADC and Adjustable Wetting Current for Automotive Systems](#) or [TIC10024-Q1 24-Input Multiple Switch Detection Interface \(MSDI\) Device With Adjustable Wetting Current for Automotive Systems](#) for more parametric and feature information of the device.

## 2 Test Setup

Figure 1 and Figure 2 show the schematic of the ISO-10605 test board. INx\_A is shorted to INx for the ISO-10605 for the first 10 input channels (IN0 - IN9).

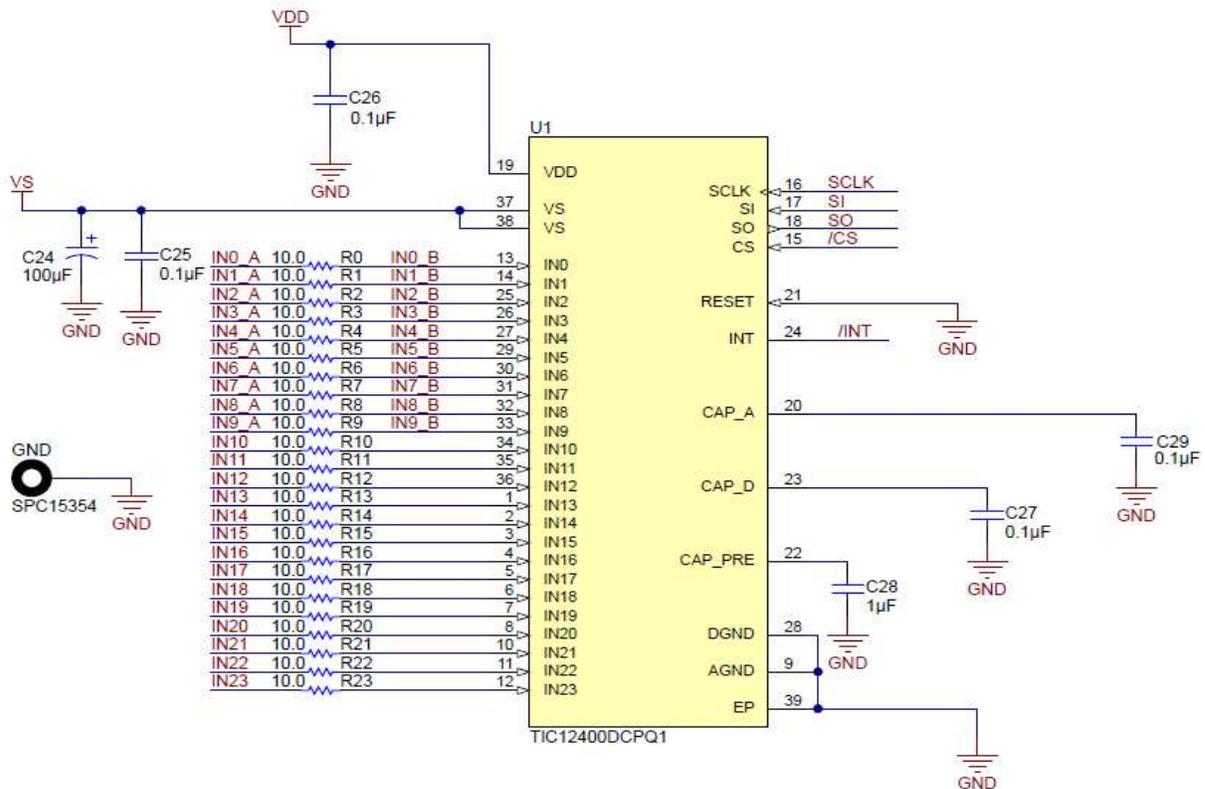


Figure 1. TIC12400-Q1 and TIC10024-Q1 Test Board Schematic Part 1

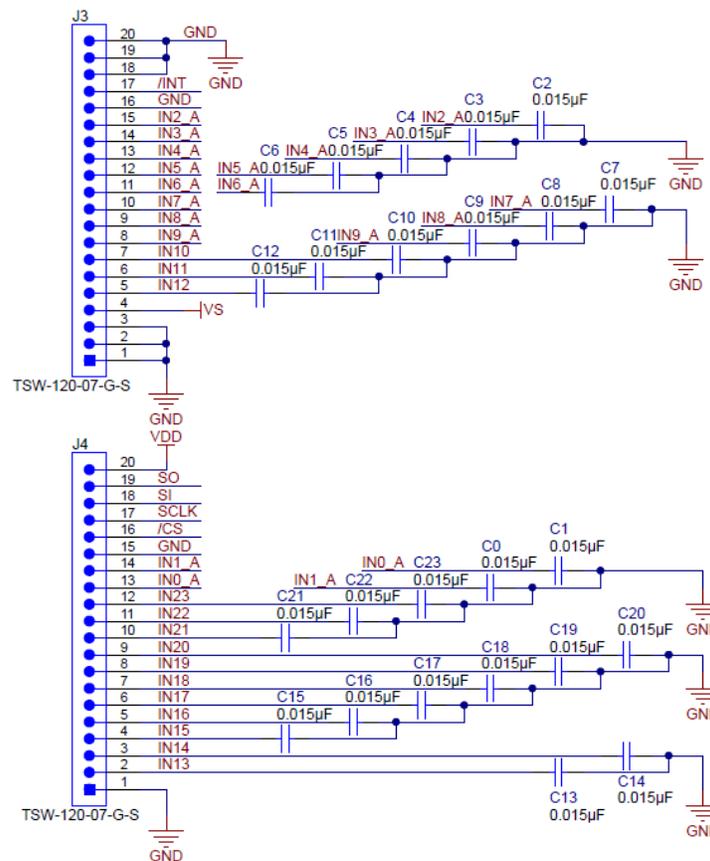


Figure 2. TIC12400-Q1 and TIC10024-Q1 Test Board Schematic Part 1

Each input has an input resistor (R0-R23) and capacitor (C0-C23) and the [Results](#) section of this document show the results for different R and C combinations. The setup utilizes a motherboard and daughter card setup

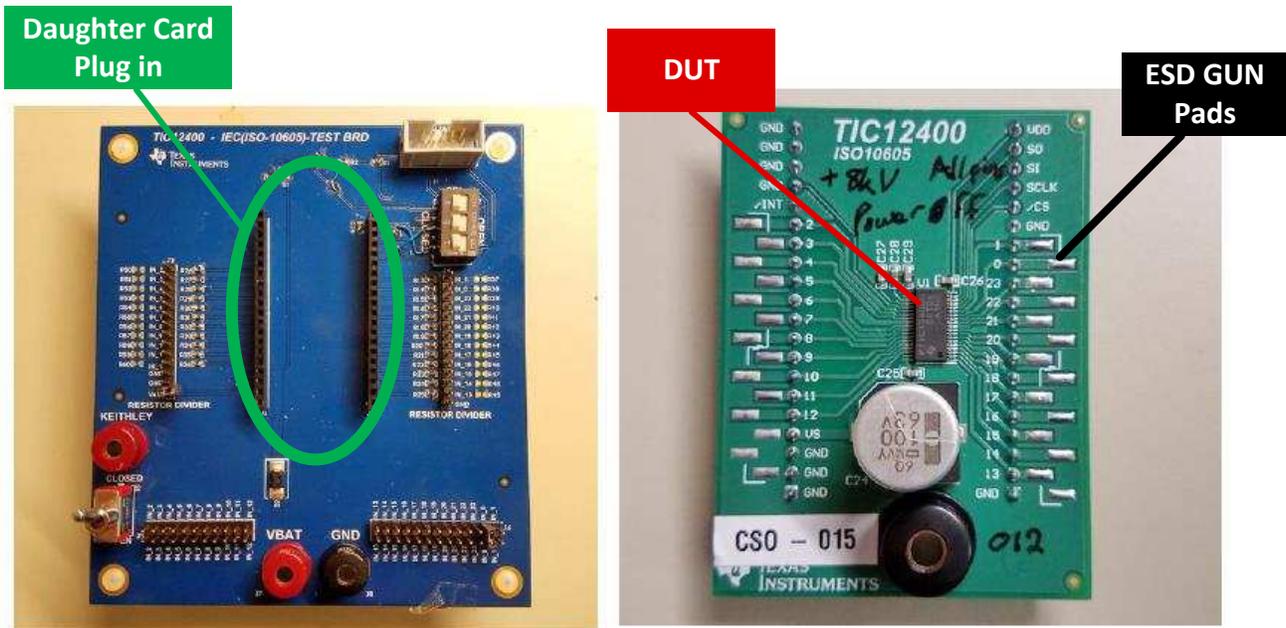


Figure 3. Motherboard and Daughter Card

The daughter card (with DUT soldered down) is plugged into the motherboard during ESD strikes. Daughter cards with different capacitor and resistor values are used to check ESD performance of the DUT.

Parasitics are minimized in the ESD board design, including:

- Shortest traces possible
- Flooded vias to improve grounding
- Soldered down units to reduce parasitic impact from sockets

Figure 4 shows the ESD Gun and DUT equivalent circuit and Figure 5 shows the general lab setup.

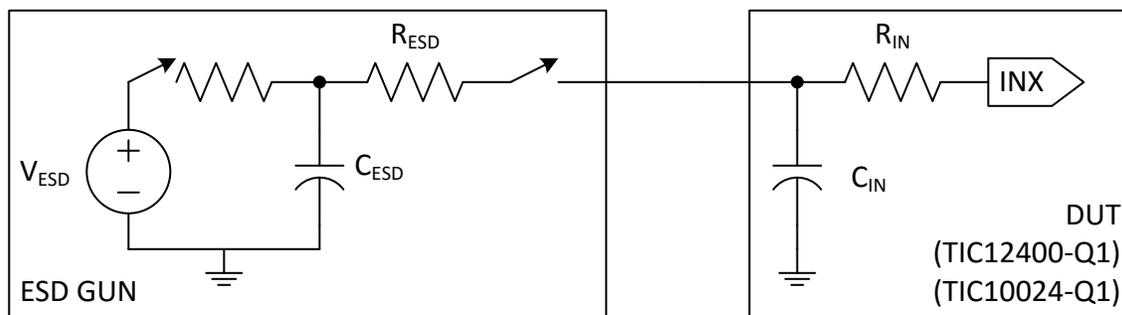
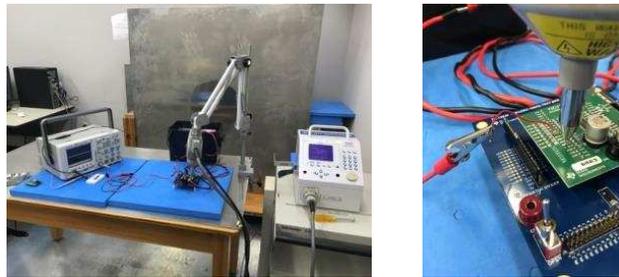
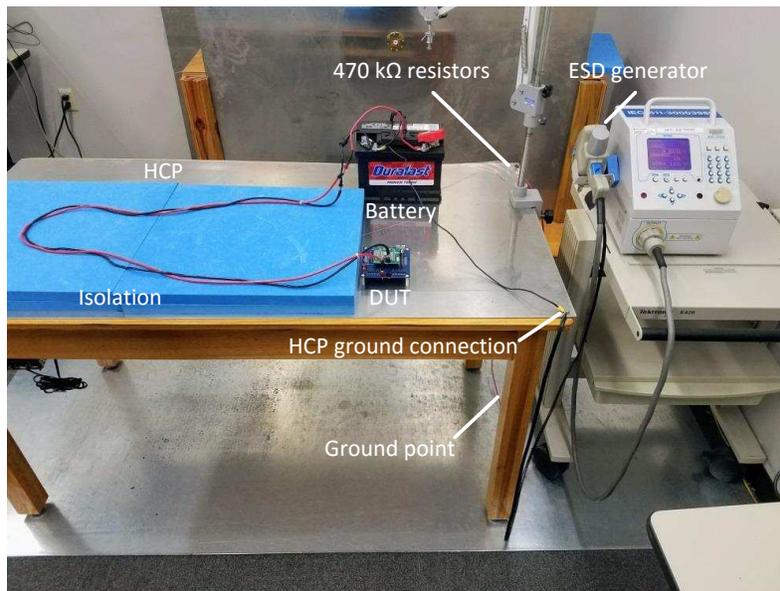


Figure 4. ESD Gun and DUT Equivalent Circuit

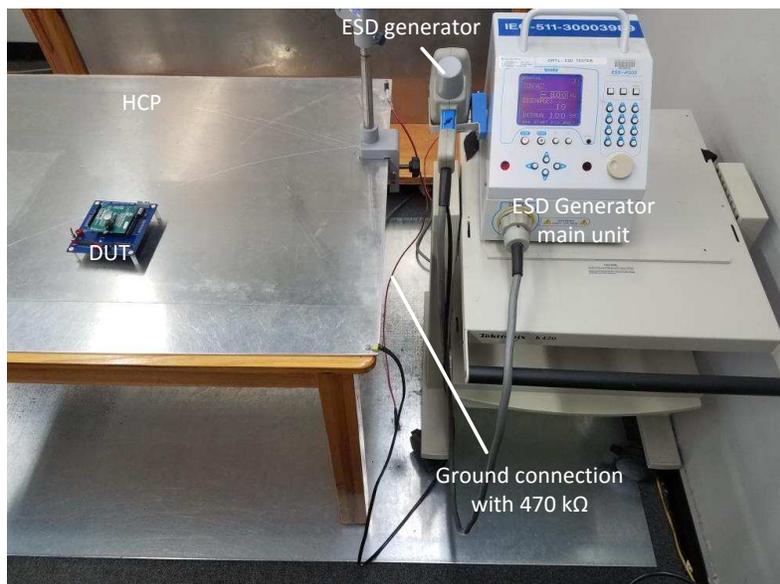


**Figure 5. LAB Setup With Motherboard and Daughterboard**

Figure 6 and Figure 7 show the powered-up and unpowered setups, respectively.



**Figure 6. Powered-up Setup**



**Figure 7. Unpowered Setup**

### 3 Test Procedure

A 12-V car battery is used to power up the device. The ISO-10605 test board is situated on a motherboard, which provides communication to the PC via USB connector pre- and post-test. The motherboard also provides the ISO-10605 test board physical isolation from the horizontal coupling plane (HCP). A 1-M $\Omega$  bleeder resistor is connected between the striking point and board ground to facilitate quicker discharge between each ESD discharge event in accordance with the ISO-10605 standard.

The DUT is subjected to ESD stress at the INx pins according to ISO-10605 ESD standard.

During the test the motherboard provides power to the daughter card and allows SPI communication to the PC. Every switch input is checked pre- and post-test for wetting current accuracy. Standoffs are used to isolate the board from the ground plane. The DUT was stressed with different  $R_{IN}$  and  $C_{IN}$  values.

The follow procedure was performed on each unit tested with each  $R_{IN}$  and  $C_{IN}$  combination as denoted in the [Results](#) section.

1. Full production test for parametric performance check before the units are struck by ESD.
2. Units were then subjected to 10 positive strikes and 10 negative strikes.
3. Full production test for parametric performance. Results were analyzed for any shift or failures of parametrics. A device was considered passing if no shift or failures occurred.

### 4 Results

This section details the results of the testing. All pass results are for Status 3 of the ISO-10605 standard. The different statuses follow:

- Status 1: The function performs as designed, during and after the test.
- Status 2: The function does not perform as designed during the test, but returns automatically to normal operation after the test.
- Status 3: The function does not perform as designed during the test and does not return to normal operation with a simple driver/passenger intervention, such as turning off/on the DUT, or cycling the ignition switch after the disturbance is removed.
- Status 4: The function does not perform as designed during or after the test and cannot be returned to proper operation without more extensive intervention, such as disconnecting and reconnecting the battery or power feed. The function shall not have sustained any permanent damage as a results of the testing.

[Table 1](#) shows different 8-kV results with powered-up and unpowered setups. The ESD discharge resistance and capacitance is shown in row 2. The first column has the DUT input capacitance. If an input resistance is shown, the device passes 8 kV with that resistance at the corresponding  $C_{IN}$ . Increasing the resistance beyond the value in the table will increase the protection. The data in the following tables are recommended values for reference only and performance is only ensured with our test setup. Actual performance may vary on different boards.

**Table 1. 8-kV Test**

8-kV test	DUT Powered-up		DUT Unpowered	
ESD Gun Equivalent Circuit	330 $\Omega$ , 330 pF	2 k $\Omega$ , 330 pF	330 $\Omega$ , 150 pF	2 k $\Omega$ , 150 pF
DUT $C_{IN}$	DUT $R_{IN}$	DUT $R_{IN}$	DUT $R_{IN}$	DUT $R_{IN}$
2.2 nF	Not Supported	Not Supported	PASS 10 $\Omega$	PASS 10 $\Omega$
15 nF	PASS 33 $\Omega$	PASS 33 $\Omega$	PASS 10 $\Omega$	PASS 10 $\Omega$
47 nF	PASS 20 $\Omega$	PASS 20 $\Omega$	PASS 10 $\Omega$	PASS 10 $\Omega$
100 nF	PASS 20 $\Omega$	PASS 20 $\Omega$	PASS 10 $\Omega$	PASS 10 $\Omega$

Table 2 shows different 15-kV results with powered-up and unpowered setups.

**Table 2. 15-kV Test**

15-kV test	DUT Powered-up		DUT Unpowered	
ESD Gun Equivalent Circuit	330 $\Omega$ , 330 pF	2 k $\Omega$ , 330 pF	330 $\Omega$ , 150 pF	2 k $\Omega$ , 150 pF
DUT C <sub>IN</sub>	DUT R <sub>IN</sub>	DUT R <sub>IN</sub>	DUT R <sub>IN</sub>	DUT R <sub>IN</sub>
2.2 nF	Not Supported	Not Supported	Not Supported	Not Supported
15 nF	Not Supported	Not Supported	PASS 20 $\Omega$	PASS 20 $\Omega$
47 nF	Not Supported	Not Supported	Untested	Untested
100 nF	PASS 100 $\Omega$	PASS 100 $\Omega$	Untested	Untested

Table 3 shows different passing and failing ESD results with a fixed ESD Gun equivalent circuit of 330  $\Omega$  and 330 pF and no R<sub>IN</sub> on the DUT. The DUT is powered-up during these tests.

**Table 3. Powered-Up With Fixed ESD Gun Equivalent Circuit**

DUT C <sub>IN</sub> /R <sub>IN</sub>	ISO-10605 Pass Level
	ESD Gun Equivalent Circuit: 330 $\Omega$ , 330 pF
2.2 nF / 0 $\Omega$	$\pm 2$ kV
15 nF / 0 $\Omega$	$\pm 2$ kV
47 nF / 0 $\Omega$	$\pm 4$ kV
68 nF / 0 $\Omega$	$\pm 6$ kV
82 nF / 0 $\Omega$	$\pm 4$ kV
100 nF / 0 $\Omega$	$\pm 4$ kV

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