TPD2E2U06-Q1EVM

This user's guide describes the characteristics, operation, and use of the TPD2E2U06-Q1EVM evaluation module (EVM). This EVM includes 7 TPD2E2U06-Q1's in various configurations for testing. Five TPD2E2U06-Q1's are configured for IEC61000-4-2 compliance testing, one TPD2E2U06-Q1 is configured for 4-port s-parameter analysis, and one is configured for throughput with USB 2.0 Type A connectors. Additionally, one of the TPD2E2U06-Q1's for ESD testing also allows the capture of a clamping waveform during an ESD event. This user's guide includes setup instructions, schematic diagrams, a bill of materials, and printed-circuit board layout drawings for the evaluation module.

1 Introduction

Texas Instrument's TPD2E2U06-Q1 evaluation module helps designers evaluate the operation and performance of the TPD2E2U06-Q1 device. The TPD2E2U06-Q1 is a dual channel ESD protection device in a small DBZ package which offers IEC61000-4-2 Level 4 compliant ESD protection. The 1.5 pF line capacitance is suitable for a wide range of applications. The TPD2E2U06-Q1 is characterized for operation over an ambient air temperature range of -40°C to 125°C.

The EVM contains seven TPD2E2U06-Q1's. A single TPD2E2U06-Q1 (U1) is configured with two USB2.0 Type A female connectors (J5 & J6) for capturing Eye Diagrams. The data lines are connected to TPD2E2U06-Q1's IO protection pins. A single TPD2E2U06-Q1 (U2) is configured with 4 SMA (J1 – J4) connectors to allow 4-port analysis with a vector network analyzer. Five TPD2E2U06-Q1's (U3 – U7) are configured with test points for striking ESD to the protection pins, one of those (U6) also has an SMB (J7) connector for capturing clamping waveforms with an oscilloscope during an ESD strike. Caution must be taken when capturing clamping waveforms during an ESD event so as not to damage the oscilloscope. A proper procedure is outlined below in Section 3.4.

Table 1. EVM Configuration

Reference Designator	TI Part Number	Configuration
U1	TPD2E2U06-Q1	USB 2.0 Eye Diagram
U2	TPD2E2U06-Q1	S-parameters
U3 – U7	TPD2E2U06-Q1	IEC61000-4-2 ESD Tests
U6	TPD2E2U06-Q1	ESD Clamping waveforms

2 DEFINITIONS

Contact Discharge — a method of testing in which the electrode of the ESD simulator is held in contact with the device-under-test (DUT).

Air Discharge — a method of testing in which the charged electrode of the ESD simulator approaches the DUT, and a spark to the DUT actuates the discharge.

ESD simulator — a device that outputs IEC61000-4-2 compliance ESD waveforms shown in Figure 1 with adjustable ranges shown in Table 2 and Table 3.

IEC61000-4-2 has 4 classes of protection levels. Classes 1 – 4 are shown in Table 2. Stress tests should be incrementally tested to level 4 as shown in Table 3 until the point of failure. If the DUT does not fail at 8 kV, testing can continue in 2 kV increments until failure.

Table 2. IEC61000-4-2 Test Levels

Contact Discharge		Air Discharge	
Class	Test Voltage [± kV]	Class	Test Voltage [± kV]
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15

Table 3. Waveform Parameters in Contact Discharge Mode

Stress Level Step	Simulator Voltage [kV]	Ipeak ±15% [A]	Rise Time ±25% [nS]	Current at 30ns ±30% [A]	Current at 60ns ±30% [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

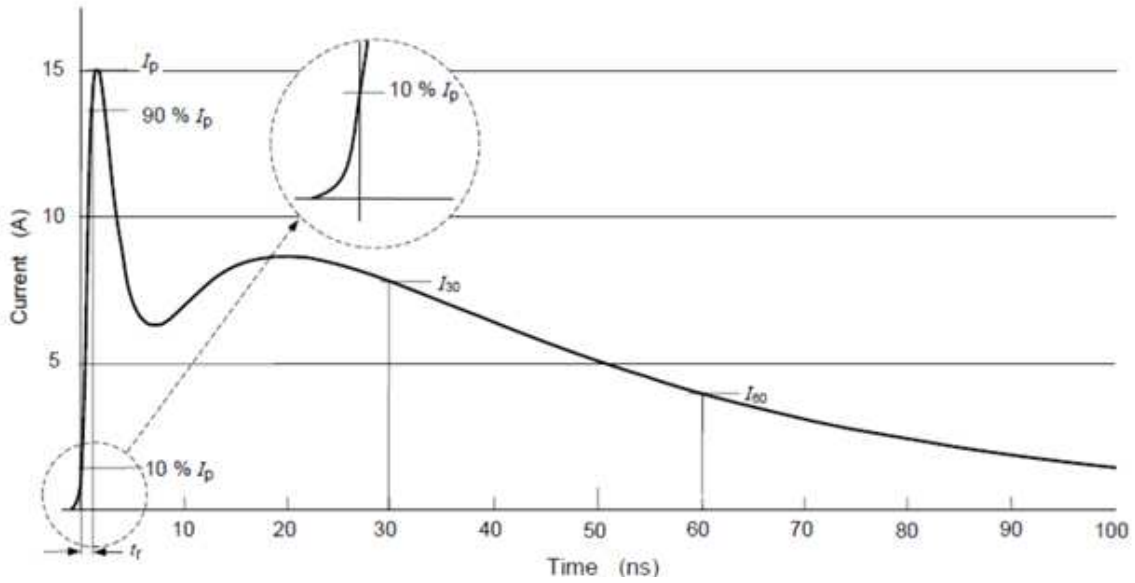

Figure 1. Ideal Contact Discharge Waveform of the Output Current of the ESD Simulator at 4 kV

3 SETUP

This section describes the intended use of the EVM. A generalized outline of the procedure given in IEC-61000-4-2 is described here. IEC-61000-4-2 should be referred to for a more specific testing outline. Basic configurations for collecting S-parameters, Eye Diagrams, and ESD clamping waveforms are outlined as well.

3.1 U1

A single TPD2E2U06-Q1 (U1) is configured with two USB2.0 Type A connectors (J5 & J6) for capturing Eye Diagrams. Using either J5 or J6 as input or output, attach to a USB2.0 compliant Eye Diagram tester setup for the intended application, either transmitter or receiver.

3.2 U2

TPD2E2U06-Q1 (U2) is configured with 4 SMA (J1 – J4) connectors to allow 4-port analysis with a vector network analyzer. Connect Port 1 to J1, Port 2 to J2, Port 3 to J3, and Port 4 to J4. This configuration allows for the following terminology in 4 port analysis:

- S_{11}: Return loss
- S_{21}: Insertion loss
- S_{31}: Near end cross talk
- S_{41}: Far end cross talk

3.3 U3 – U7

TPD2E2U06-Q1 (U3 – U7) can be used for destructive electrostatic discharge (ESD) pass/fail ESD strikes. Specifically, they can be used for both IEC-61000-4-2 air and contact discharge tests. The following procedure ensures proper testing setup and method for both discharge tests. Each IO has a Test Pad (TP1 – TP10) directly connected to it.

3.3.1 Test Method and Set-Up

An example test setup is shown in Figure 2. Details of the testing table and ground planes can be found in the IEC 61000-4-2 test procedure. Ground the EVM using the banana connector labeled GND (J9). Discharge the ESD simulator on any of the Test Points TP1 – TP10. Contact and air-gap discharge are tested using the same simulator with the same discharge waveform. While the simulator is in direct contact with the test point during contact, it is not during air-gap.

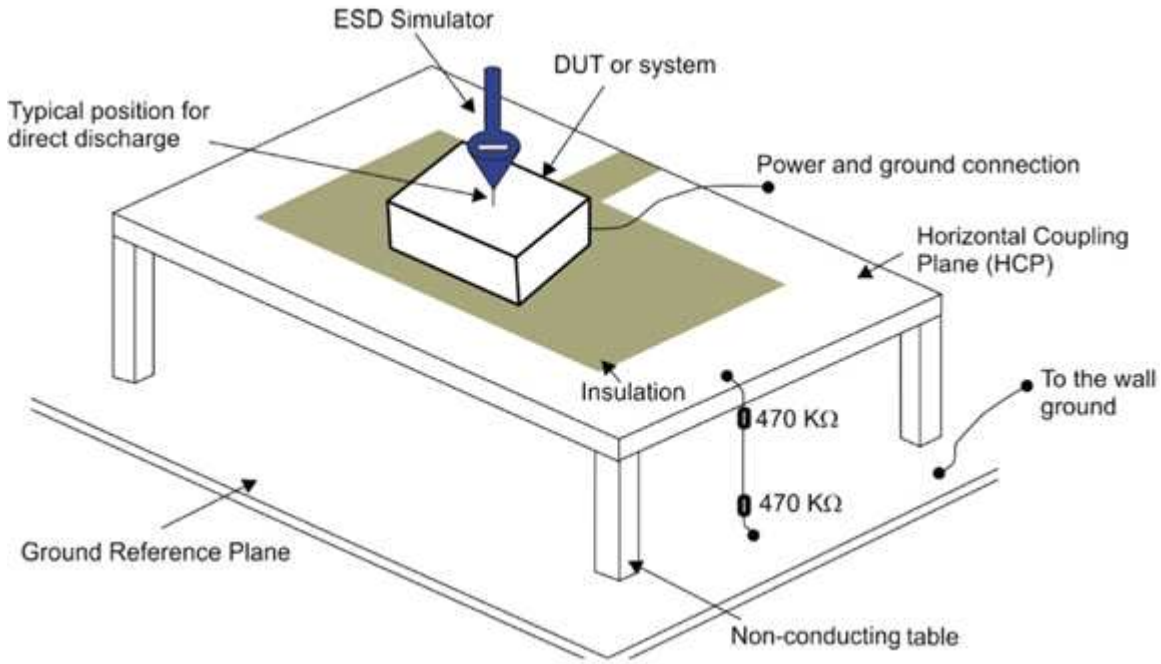

Figure 2. System Level ESD Test Setup

3.3.2 Evaluation of Test Results

Connect the tested device on the EVM to a curve tracer both before and after ESD testing. After each incremental level, if the IV curve of the ESD protection diode shifts ±0.1V, or leakage current increases by a factor of ten, then the device is permanently damaged by ESD.

3.4 U6

A TPD2E2U06-Q1 (U6) also has an SMB (J7) connector for capturing clamping waveforms with an oscilloscope during an ESD strike. Caution must be taken when capturing clamping waveforms during an ESD event so as not to damage the oscilloscope.

3.4.1 Oscilloscope setup

Without a proper procedure, capturing ESD clamping waveforms exposes the oscilloscope to potential voltages higher than the rating of the equipment. Proper methodology can mitigate any risk in this operation.

Recommended equipment:

- Minimum of 1GHz bandwidth oscilloscope.
- Either of the following:
  - 2 10X 50 Ω attenuators and a 0 Ω resistor (to be installed at R1).
  - 1 10X 50 Ω attenuator and a 150 Ω resistor (already installed at R1).
- 50 Ω shielded SMB cable.

Procedure

In order to protect the oscilloscope, attenuation of the measured signal is required. Here are two possible procedures for testing U6:

1. Using two 10X attenuators:
   - Install a 0 Ω resistor in R1.
   - Attach two 10X attenuators to the oscilloscope channel being used.
   - Attach the 50 Ω shielded SMB cable between J7 and the attenuator.
   - Set the scope attenuation factor to 100X.
   - Set the oscilloscope to trigger on a positive edge for (+) ESD and a negative edge for (–) ESD strikes. The magnitude should be set to 20 V.
   - Following Section 3.3.1, strike contact ESD to TP8.
2. Using one 10X attenuator:
   - Attach one 10X attenuator to the oscilloscope.
   - Attach the 50 Ω shielded SMB cable between J7 and the attenuator.
   - Set the scope attenuation factor to 40X.
   - Set the oscilloscope to trigger on a positive edge for (+) ESD and a negative edge for (–) ESD strikes. The magnitude should be set to 20 V.
   - Following Section 3.3.1, strike contact ESD to TP8.

Recommended settings for the time axis is 20 ns/div and for the voltage axis is 10 V division.

The voltage levels of the ESD applied to TP8 should not exceed ± 8 kV while capturing clamping waveforms.

4 Board Layout

This section provides the TPD2E2U06-Q1EVM board layout. TPD2E2U06-Q1EVM is a 4-layer board of FR-4 at 0.062” thickness. Layers 2, 3 and 4 are identical.

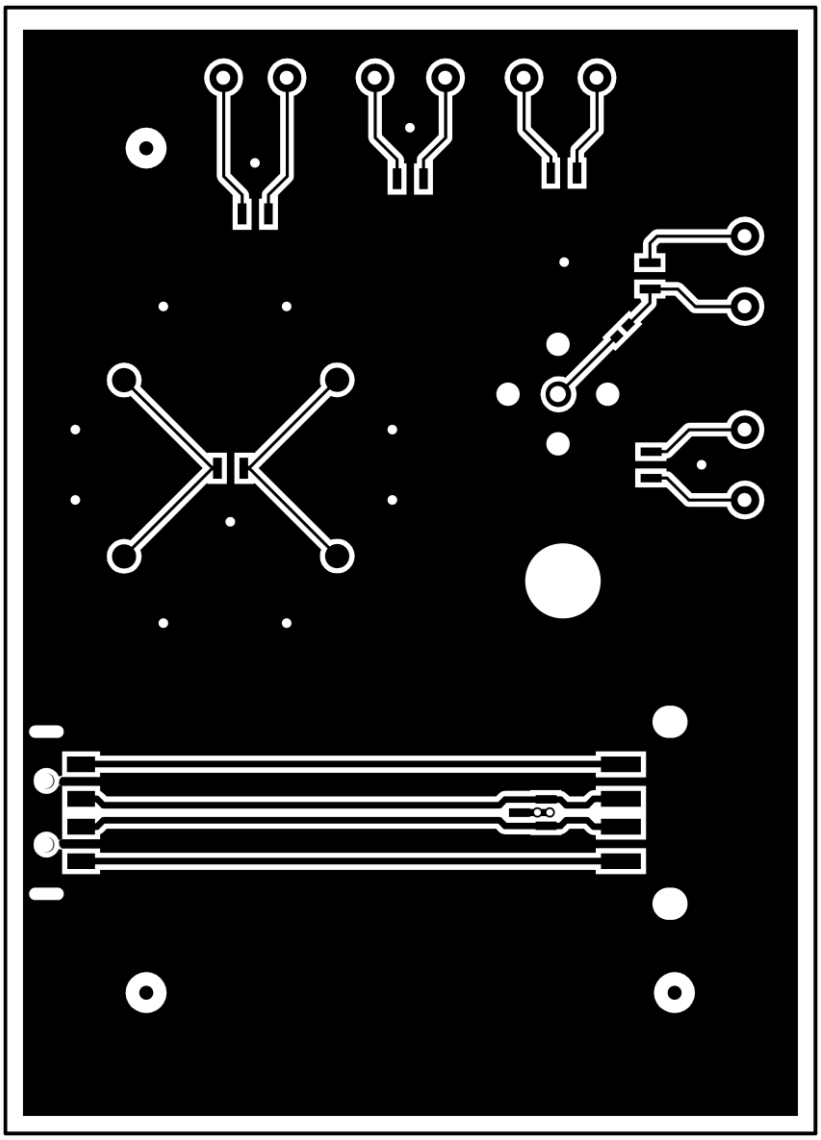

Figure 3. TPD2E2U06-Q1EVM Top Layer

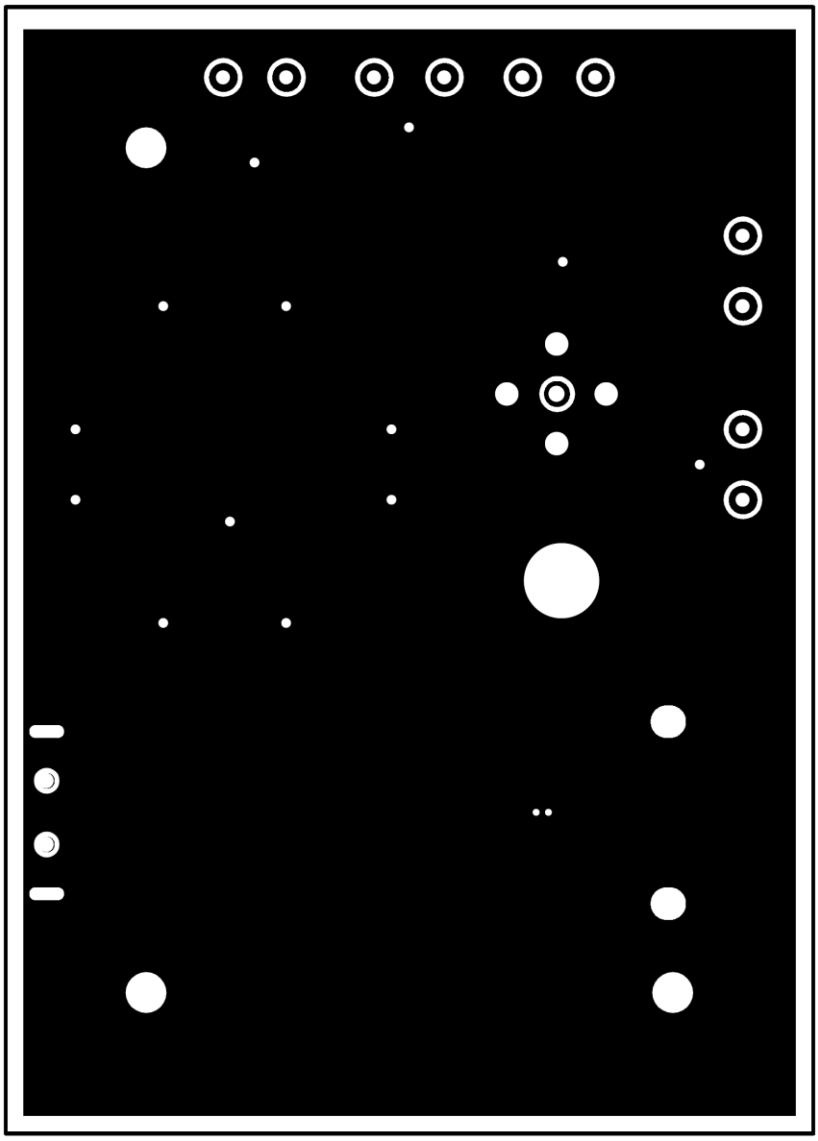

Figure 4. TPD2E2U06-Q1EVM Midlayer 1, Midlayer 2, and Bottom Layers

5 Schematics and Bill Of Materials

5.1 Schematics

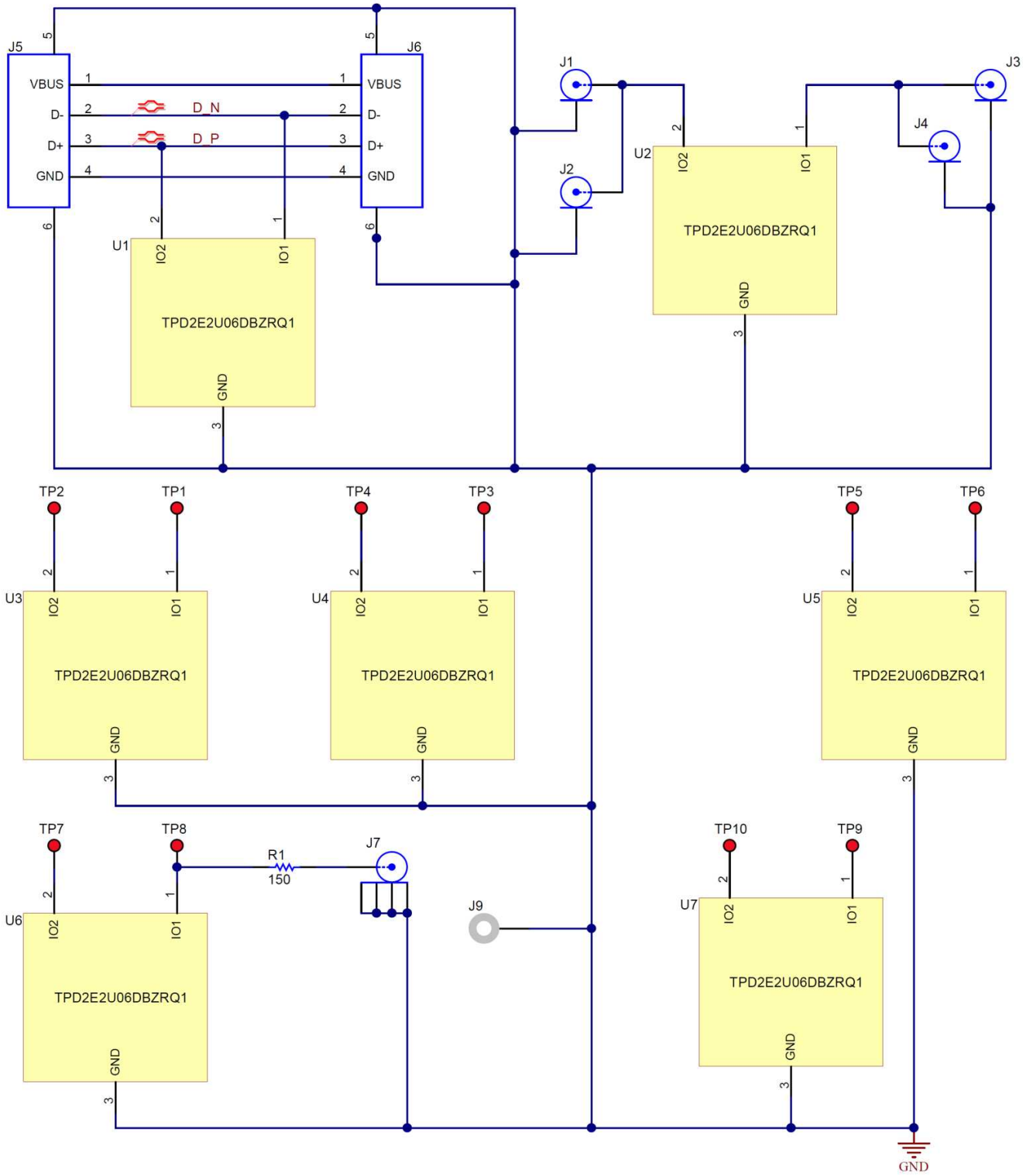

Figure 5. TPD2E2U06-Q1EVM Schematic

Table 4. Bill of Materials

Count	RefDes	Description	Size	Part Number	MFR
7	U1-U7	IC, 2-channel ESD solution	0.063 x 0.048 inch	TPD2E2U06-Q1	TI
4	J1-4	Connector, SMA, Plug SMA Limited Detent SMP-P/PCB	0.25 X 0.375 inch	142-0701-231	Emerson
2	J5-6	Connector, USB,TYPE A Female	0.52 X 0.55 inch	87583-2010BLF	FCI
2	J7	Conn SMB Jack Str 50 Ohm Pcb	0.236 X 0.236 inch	131-3701-261	Molex
1	J9	Standard Banana Jack, Uninsulated, 5.5mm	0.312” diameter	575-4	Keystone
1	R1	RES, 150, 5%, 0.063 W, 0402	0402	CRCW0402150RJNED	Vishay-Dale

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- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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