TPD2E1B06DRLEVM

This user's guide describes the characteristics, operation, and use of the TPD2E1B06DRLEVM evaluation module (EVM). This EVM includes 7 TPD2E1B06DRL's in various configurations for testing. Five TPD2E1B06DRL's are configured for IEC61000-4-2 compliance testing, one TPD2E1B06DRL is configured for 4-port s-parameter analysis, and one is configured for throughput on USB 2.0 Type A connectors for throughput analysis. Additionally, two of the TPD2E1B06DRL's for ESD testing also allow the capture of clamping waveforms 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 TPD2E1B06DRL evaluation module helps designers evaluate the operation and performance of the TPD2E1B06DRL device. The TPD2E1B06DRL is a dual channel ESD protection device in a small DRL package which offers IEC61000-4-2 Level 4 compliant ESD protection. The 1 pF line capacitance is suitable for a wide range of applications. The TPD2E1B06DRL is characterized for operation over an ambient air temperature range of -40°C to 125°C.

The EVM contains seven TPD2E1B06DRL's. A single TPD2E1B06DRL (U1) is configured with two USB2.0 Type A female connectors (J5 & J6) for capturing Eye Diagrams. The data lines are connected to TPD2E1B06DRL's IO protection pins. A single TPD2E1B06DRL (U2) is configured with 4 SMA (J1 – J4) connectors to allow 4-port analysis with a vector network analyzer. Five TPD2E1B06DRL's (U3 – U7) are configured with test points for striking ESD to the protection pins, two of those (U5 & U6) also have SMB (J7 & J8) connectors for capturing clamping waveforms with an oscilloscope during ESD test. 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	TPD2E1B06DRL	USB 2.0 Eye Diagram
U2	TPD2E1B06DRL	S-parameters
U3 – U7	TPD2E1B06DRL	IEC61000-4-2 ESD Tests
U5 & U6	TPD2E1B06DRL	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 8kV, 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

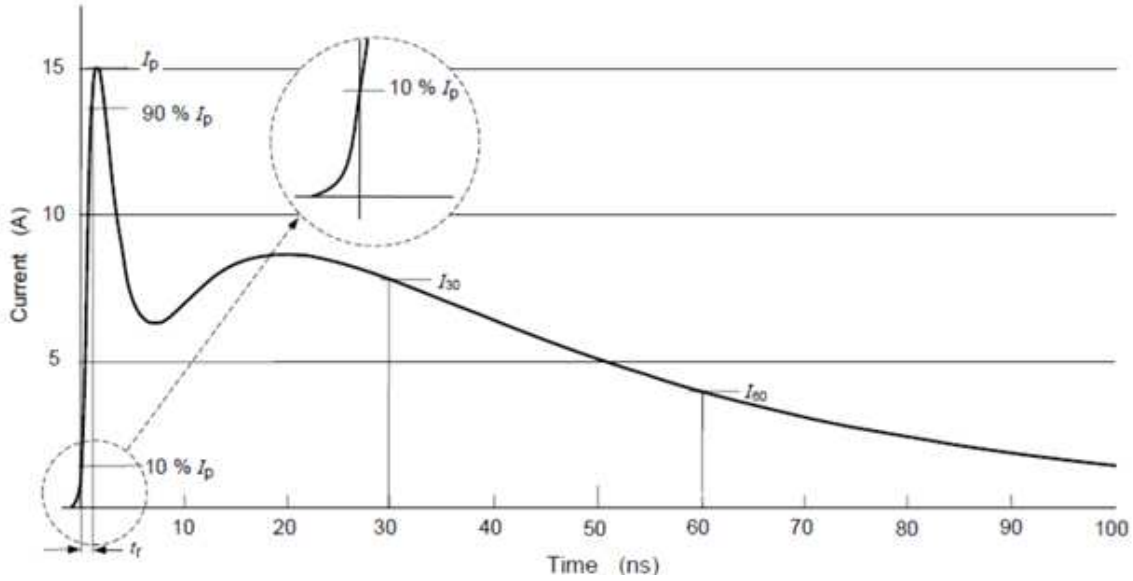

Figure 1. Ideal Contact Discharge Waveform of the Output Current of the ESD Simulator at 4 kV

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 TPD2E1B06DRL (U1) is configured with two USB2.0 Type A female 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

TPD2E1B06DRL (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

TPD2E1B06DRL (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.

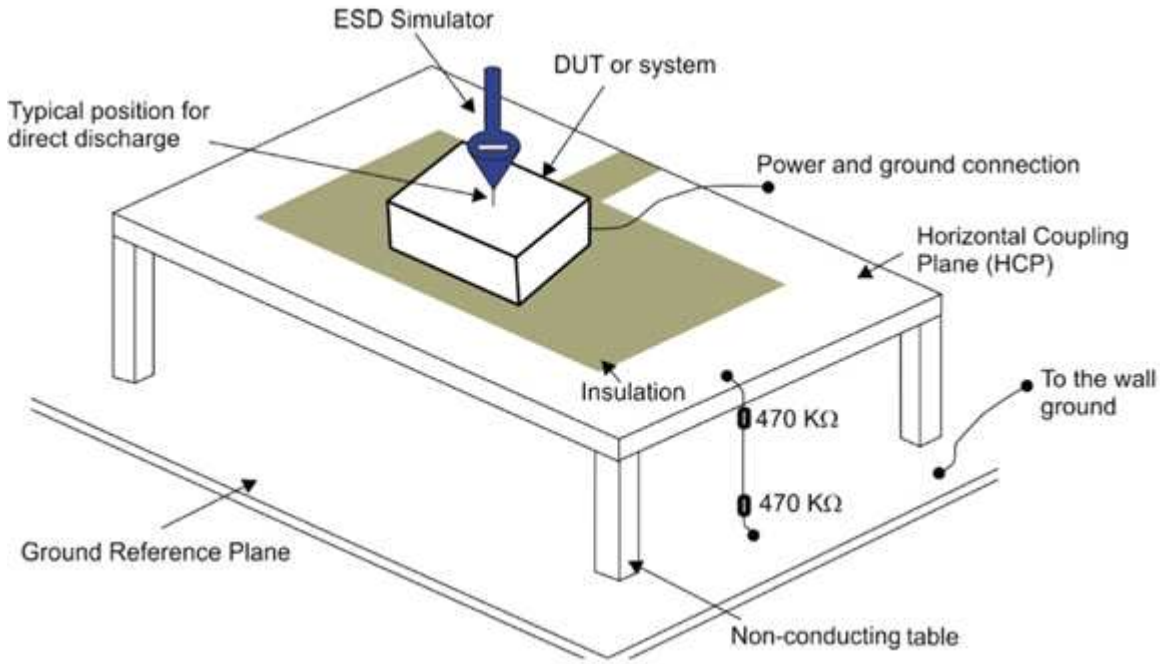

Figure 2. System Level ESD Test Setup

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 U5 & U6

Two TPD2E1B06DRL's (U5 & U6) also have SMB (J7 & J8) connectors 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 50Ω attenuators and 0 Ω resistors (already installed {R1 & R2}).
  - 1 10X 50Ω attenuator and 150 Ω resistors (to be installed at R1 & R2).
- 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 U5:

1. Using two 10X attenuators:
   - 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 20V.
   - Following Section 3.3.1, strike contact ESD to TP5.
2. Using one 10X attenuator:
   - Install 150 Ω resistors in R1 and R2.
   - 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 20V.
   - Following Section 3.3.1, strike contact ESD to TP5.

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

The same procedure above can be applied to U6 by striking ESD on TP8 and connecting the 50Ω shielded SMB cable to J8.

The voltage levels of the ESD applied to TP5 & TP8 should not exceed +/- 8 kV while capturing clamping waveforms.

4 BOARD LAYOUT

This section provides the TPD2E1B06DRLEVM board layout. TPD2E1B06DRLEVM is a 4-layer board of FR-4 at 0.062” thickness. Layers 2 and 3 are ground planes and not shown here.

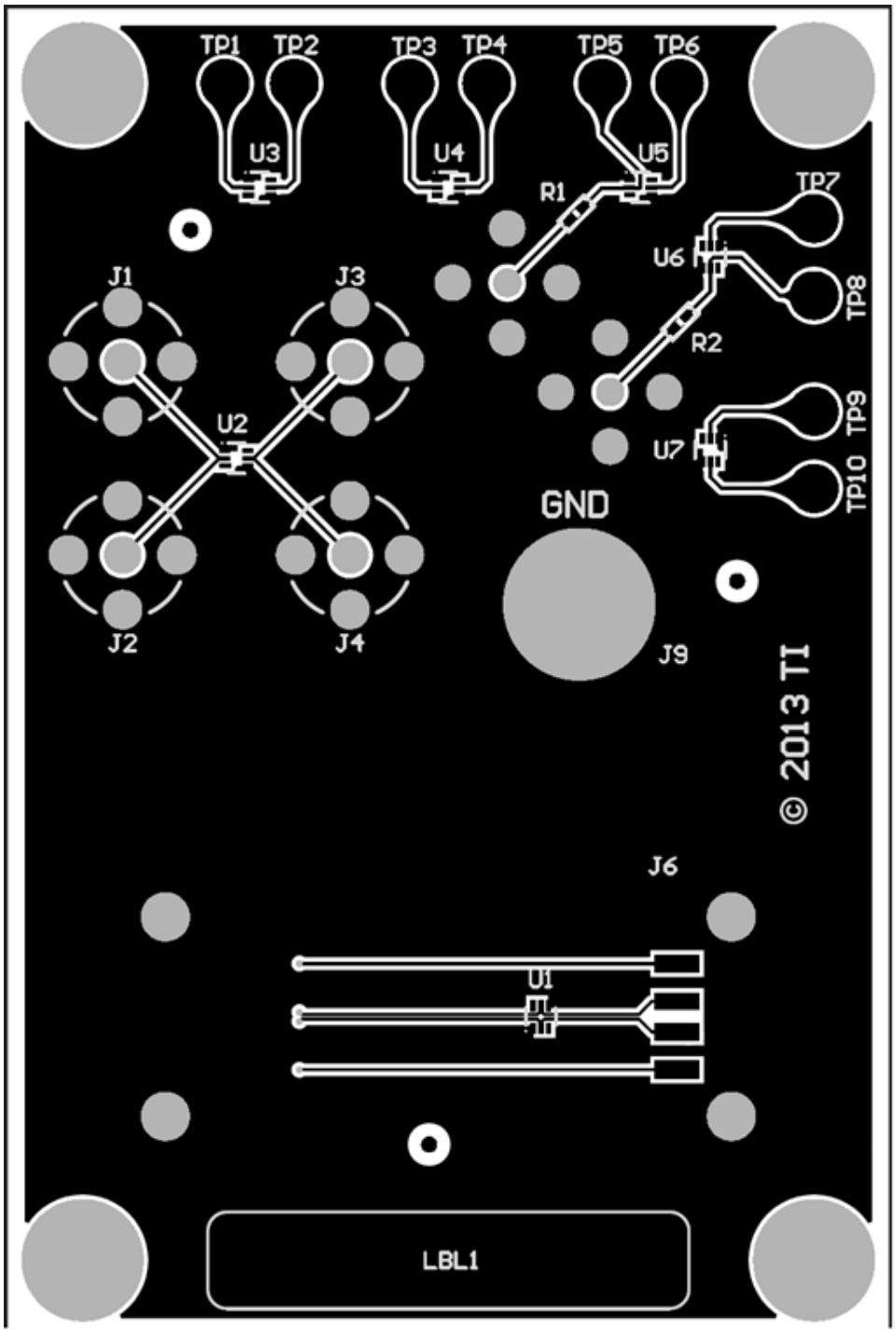

Figure 3. TPD2E1B06DRLEVM Top Layer

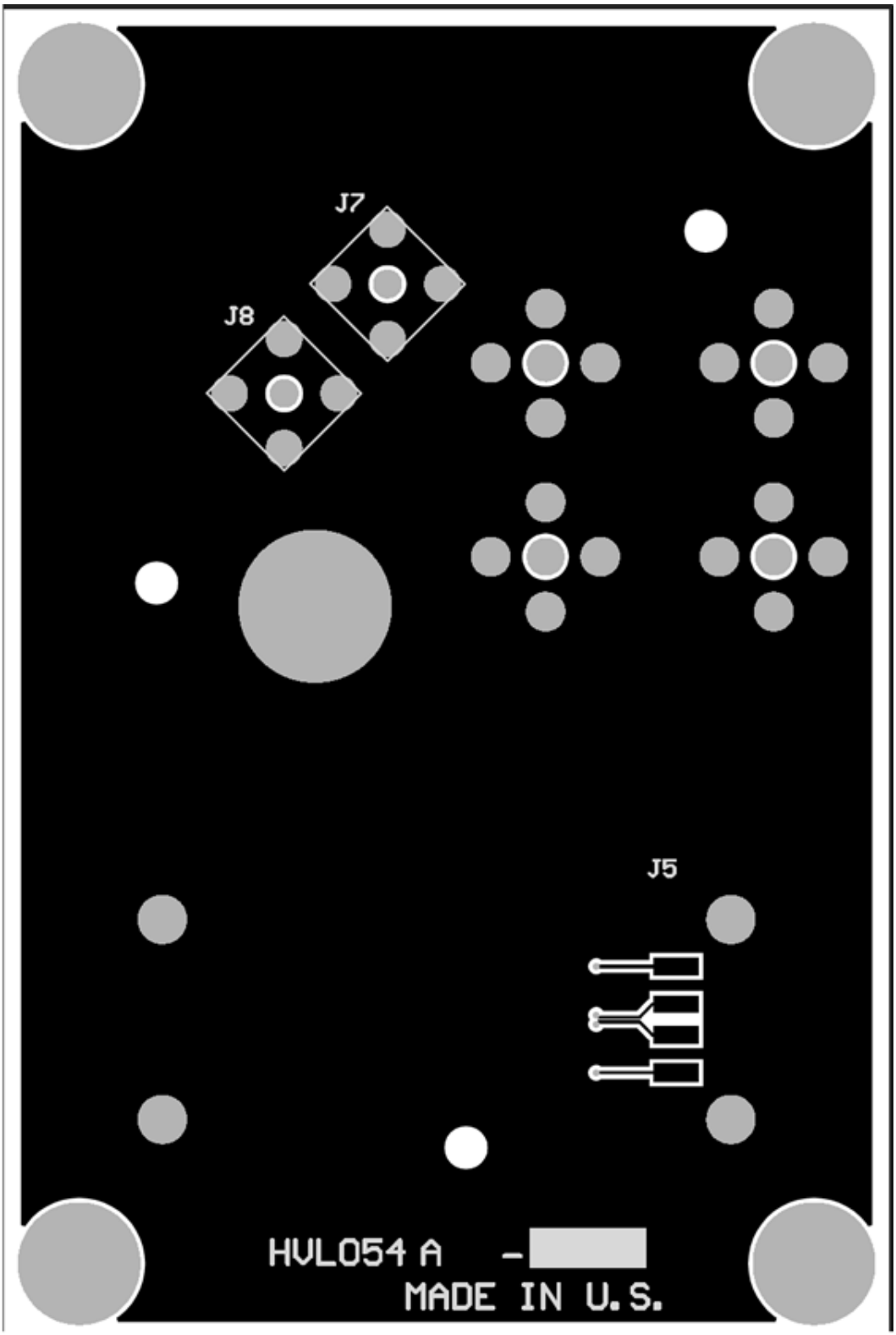

Figure 4. TPD2E1B06DRLEVM Bottom Layer

5 SCHEMATICS AND BILL OF MATERIALS

5.1 Schematics

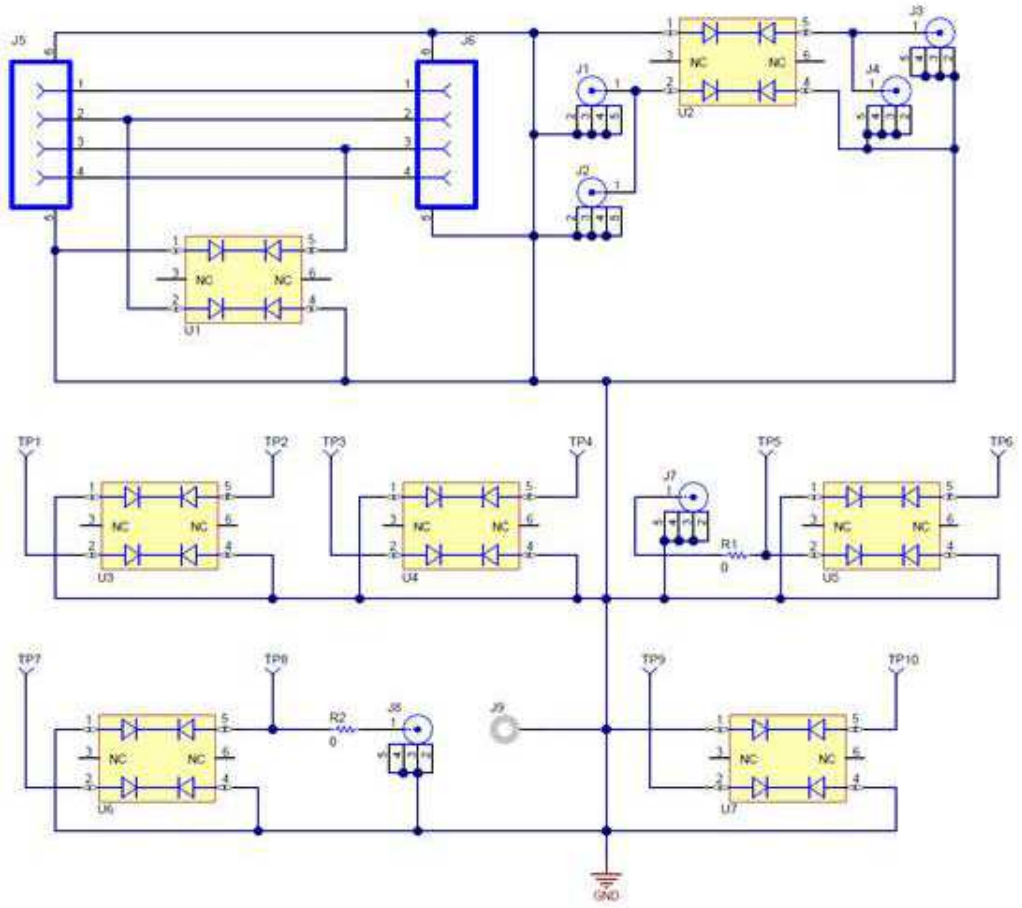

Figure 5. TPD2E1B06DRLEVM Schematic

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	TPD2E1B06DPL	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	J7-8	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

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For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

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- Reorient or relocate the receiving antenna.
- 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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
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