User's Guide
SLVUBG5–June 2018

Generic ESD Evaluation Module User's Guide

This User's Guide describes the characteristics, operation, and use of the Generic ESDEVM evaluation module (EVM). This EVM includes footprints for almost all of TI's ESD portfolio to be able to test either the signal integrity or DC characteristics. Since this board is for generic evaluation of the ESD parts, it does not come with any devices soldered down. Devices can be sampled by going to ti.com/esd, clicking on the product folder of the device and ordering samples.

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Trademarks

1 Introduction

Texas Instrument's ESDEVM evaluation module allows the evaluation of most of TI's ESD portfolio. The board comes with all traditional ESD footprints in order to be able to test any number of devices. Devices that need to be tested can be soldered onto their respect footprint and then tested. For the typical high speed ESD devices, an impedance controlled layout is implemented to be able to take the S-parameter and de-embed the board trace. For the non-high speed ESD diodes, footprints with traces going to test points are provided to easily run DC tests such as breakdown voltage, holding voltage, leakage, etc. The board layout also makes it easy to connect any of the device's pins to either power (V_{CC}) or ground by shorting the signal pin to which every the signal is. This board allows the testing of all of these typical ESD diode footprints:

- DPY (0402)
- DPL (0201)
- DQA
- DBV
- DCK

- DPK
- DRY
- DRB
- DQD
- RVZ
- DPW

More information about TI's packages

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 generates IEC61000-4-2 compliance ESD waveforms shown in Figure 1 with adjustable ranges shown in Table 1 and Table 2.

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

Table 1. 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 2. 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

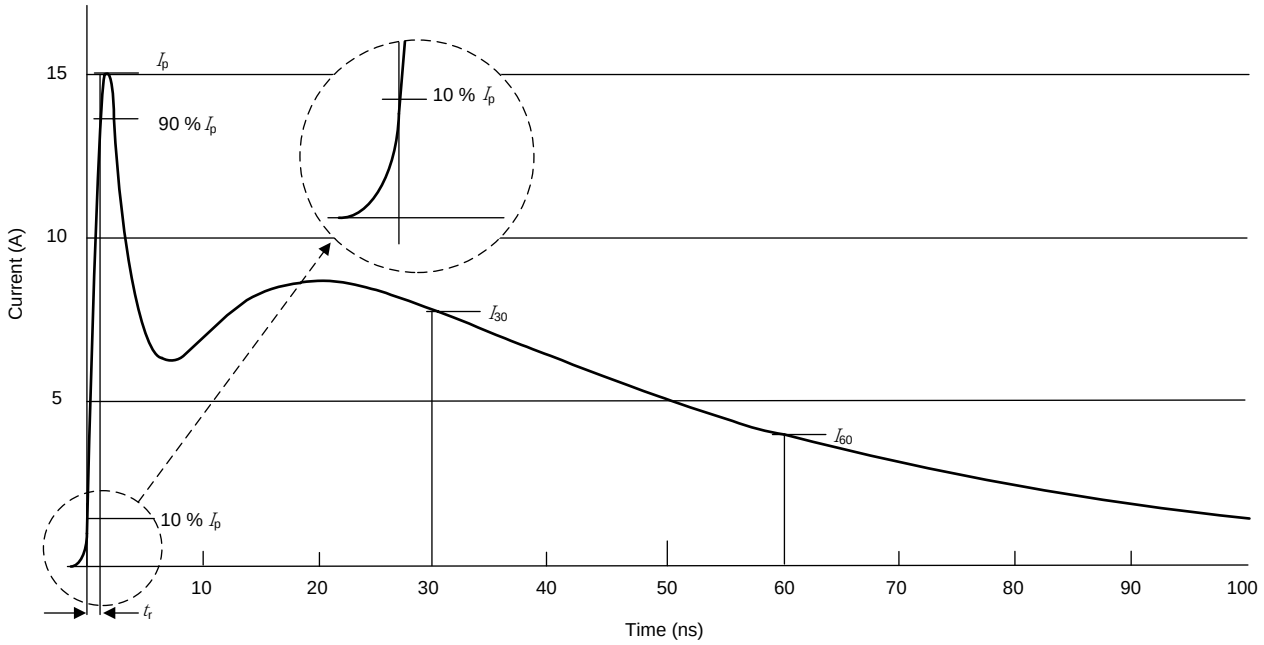

Figure 1. Ideal Contact Discharge Waveform of the Output Current of the ESD Simulator at 4 kV

3 S-Parameter Analysis

The top half of the ESDEVM allows signal analysis of ESD diodes. SMA connectors J9 and J10, allow the S-parameter to be taken by vector network analyzer for the DPY (0402), DPL (0201) packages. Also, J16 and J17 can be used to calibrate out the board parasitics to get a more accurate frequency response for the device connected. In order to get results for a particular device only one footprint should be populated at a time. Also for the 4 channel DQA package SMA connectors are provided.

3.1 DQA 4-Port Analysis

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

- S_{11}: Return Loss
- S_{31}: Insertion Loss
- S_{21}: Near End Cross Talk
- S_{41}: Far End Cross Talk

4 Lower Speed Device Testing

The lower portion of the board contains footprints for ESD devices that typically are not placed on high speed signal lines. Therefore the best way to test these devices is to access their pins directly to do DC characteristics on them or to strike the individual pins to see what the device can survive. Each pin of each device goes out to the middle of a three test point row. In the row of test points, the outside most hole is connected to the ground plane of the board. The inside most test point is connected to the VCC plane of the board. This provides ease to be able to connect any setup of an ESD diode to its correct functionality. Most ESD diodes will have one or two pins that are ground for the device which with this layout can easily be shorted to ground by shorting the two test points together. In the same vain the ESD diodes with V_{CC} pins can be connected to the correct pin as well.

If it is desired to do ESD testing on the ESD diodes, make sure that the power pins are connected correctly and use the method below to strike the device. After striking if there is a significant change in the leakage, it is safe to assume the device is broken.

4.1 ESD Tests

TI's ESD portfolio of devices provide robust protection during an ESD event. In order to see the passing level of the device the set up below should be used. It is important to note that due to the parasitics of the EVM, the IEC waveform is slightly different than during validation of the device potentially lending to different results.

4.1.1 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. 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.

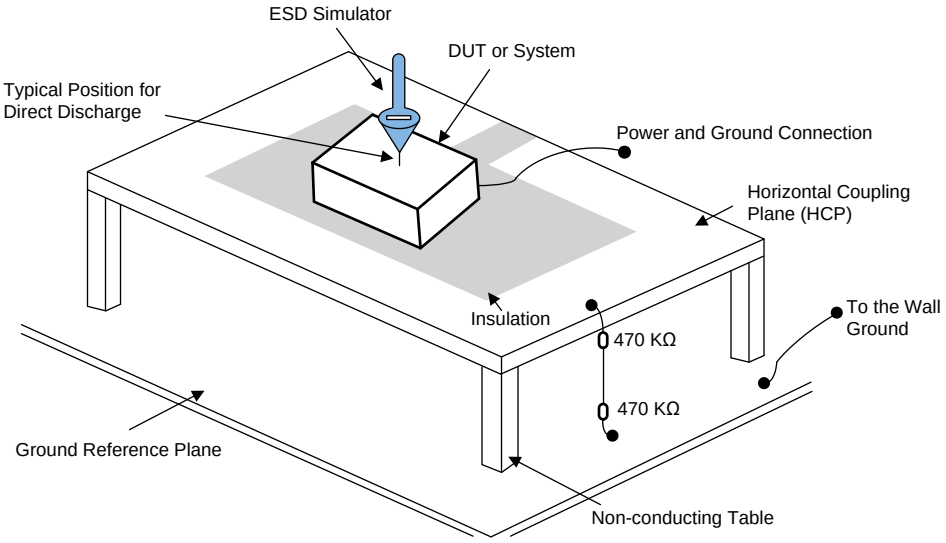

Figure 2. System Level ESD Test Setup

4.1.2 Evaluation of Test Results

After ESD testing, perform IV curve testing to see if device has broken or not.

5 Board Layout

This section provides the ESDEVM board layout. ESD224EVM is a 4-layer board of 370HR at 0.062” thickness. Layers 2 and 3 are simple ground planes and not shown here.

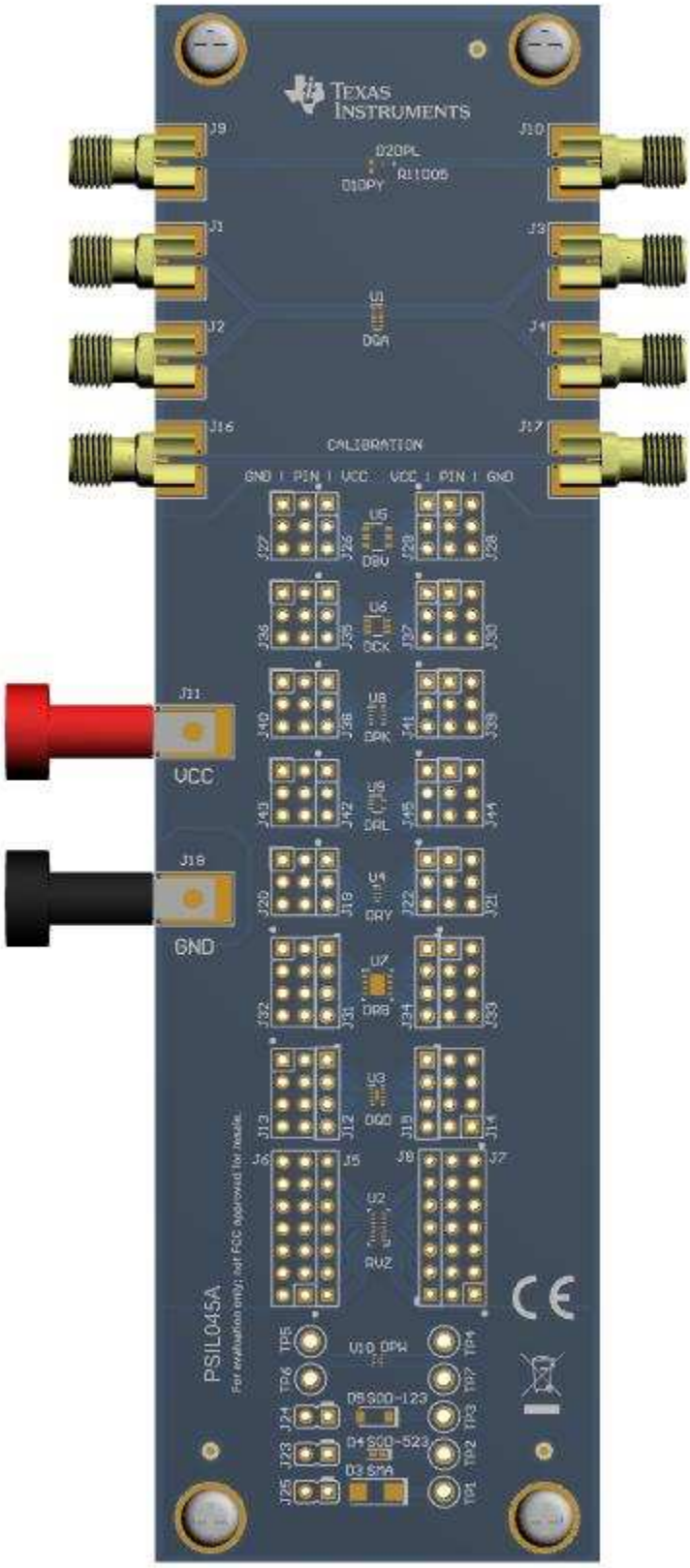

Figure 3. 3D Board Image

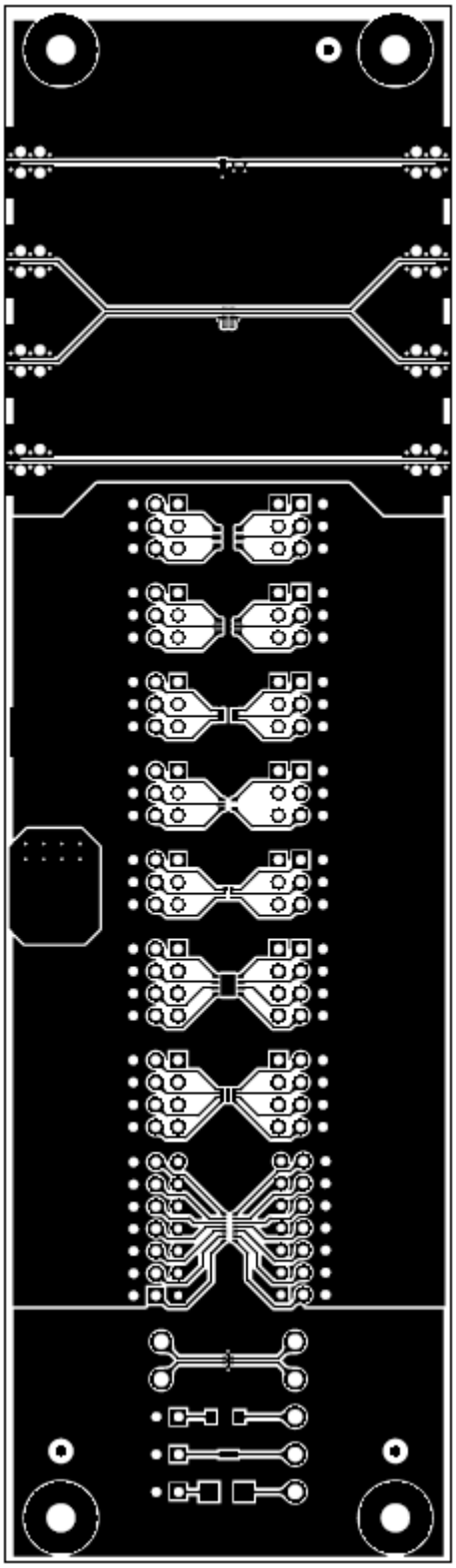

Figure 4. ESDEVM Top Layer

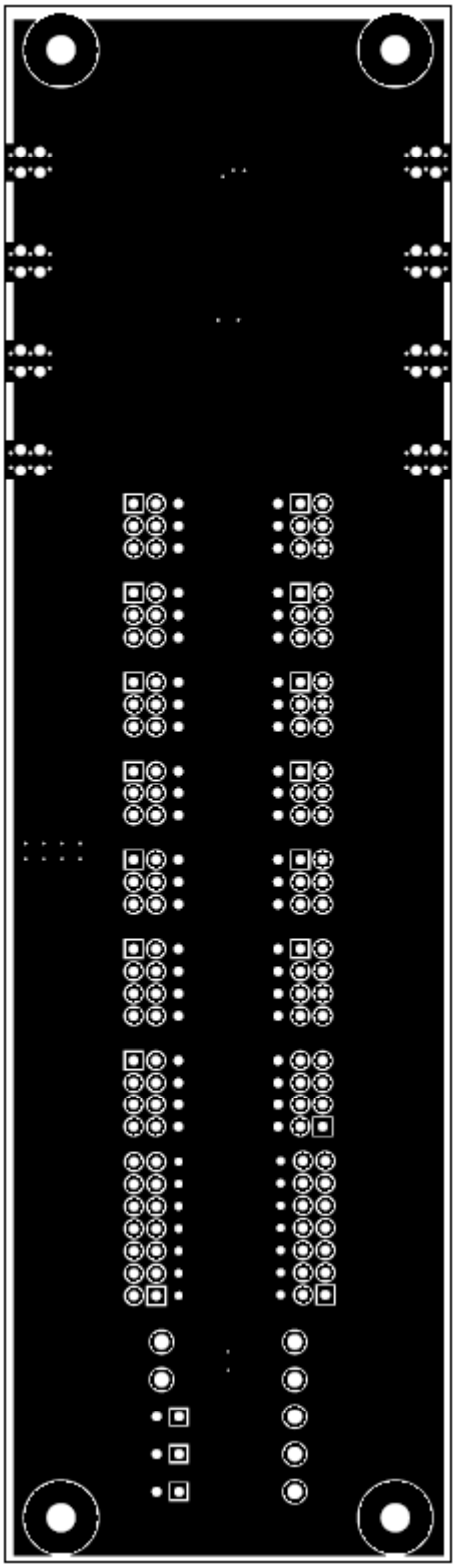

Figure 5. ESDEVM Bottom Layer

6 Schematics and Bill of Materials

6.1 Schematics

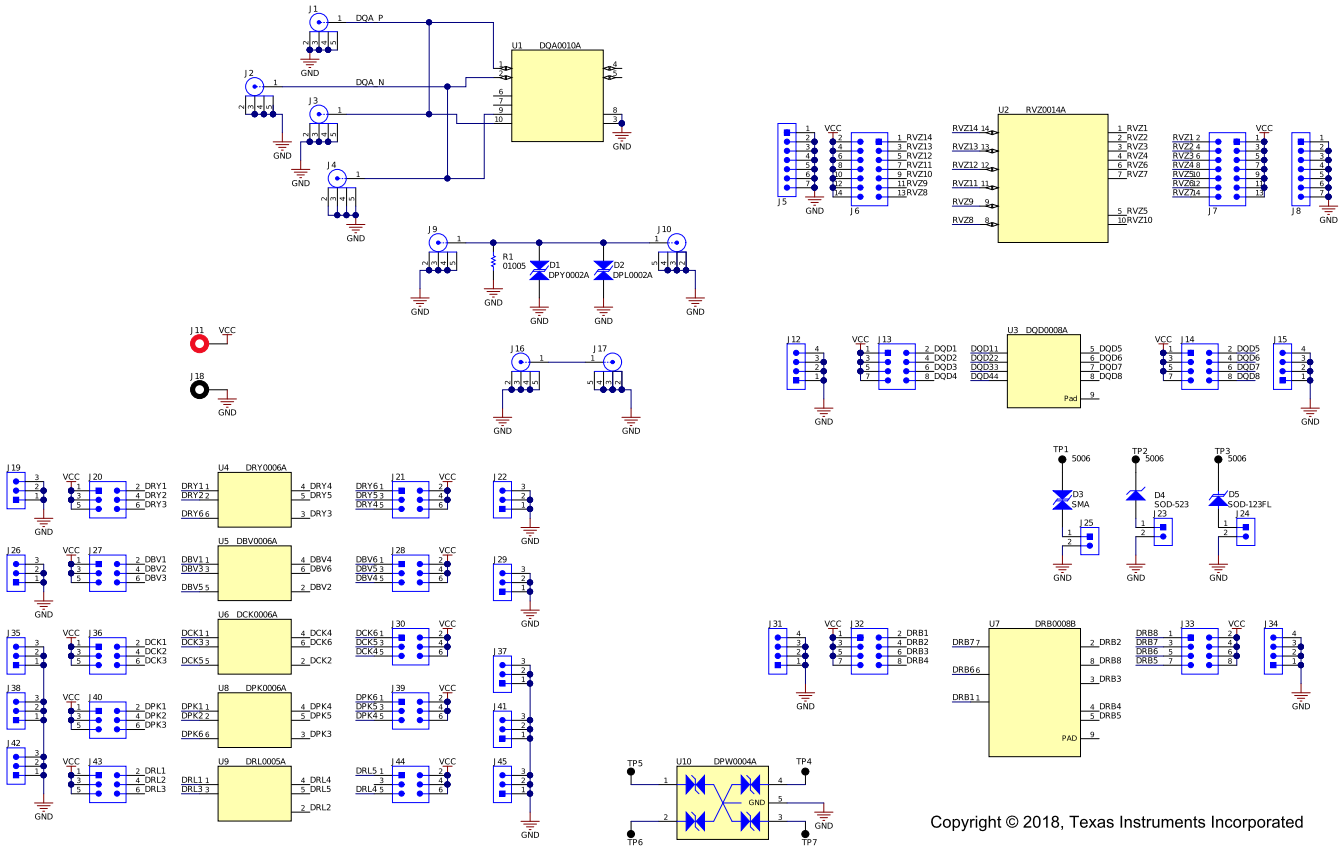

Figure 6. ESDEVM Schematic

Table 3. Bill of Materials

Count	Reference Designator	Description	Part Number	Manufacturer
8	J1, J2, J3, J4, J9, J10, J16, J17	Connector, End launch SMA 50 ohm, TH	142-0761-881	Cinch Connectivity
1	J11	Standard Banana Jack, Insulated, Red	6091	Keystone
1	J18	Standard Banana Jack, Insulated, Black	6092	Keystone
0	D1	1-Channel ESD Protection Diode for USB Type-C and Thunderbolt 3, DPY0002A (X1SON-2)	DPY0002A	Texas Instruments
0	D2	1-Channel ESD Protection Diode for USB Type-C and Thunderbolt 3, DPL0002A (X2SON-2)	DPL0002A	Texas Instruments
0	D3	Diode, TVS, Bi, 33 V, SMA	SMA	
0	D4	Diode, Zener, 5.1 V, 300 mW, SOD-523	SOD-523	
0	D5	Diode, TVS, Uni, 36 V, 58.1 Vc, SOD-123FL	SOD-123FL	

Table 3. Bill of Materials (continued)

0	J5, J8	Header, 100mil, 7x1, TH	800-10-007-10-001000	Mill-Max
0	J6, J7	Header, 100mil, 7x2, Tin, TH	PEC07DAAN	Sullins Connector Solutions
0	J12, J15, J31, J34	Header, 100mil, 4x1, Tin, TH	PEC04SAAN	Sullins Connector Solutions
0	J13, J14, J32, J33	Header, 100mil, 4x2, Tin, TH	PEC04DAAN	Sullins Connector Solutions
0	J19, J22, J26, J29, J35, J37, J38, J41, J42, J45	Header, 100mil, 3x1, Tin, TH	PEC03SAAN	Sullins Connector Solutions
0	J20, J21, J27, J28, J30, J36, J39, J40, J43, J44	Header, 100mil, 3x2, Tin, TH	PEC03DAAN	Sullins Connector Solutions
0	J23, J24, J25	Header, 2.54 mm, 2x1, Gold, TH	GBC02SAAN	Sullins Connector Solutions
0	R1	RES, 0, 5%, 0.03 W, 01005	01005	
0	TP1, TP2, TP3, TP4, TP5, TP6, TP7	Test Point, Compact, Black, TH	5006	Keystone
0	U1	4-Channel ESD Protection Diode for USB Type-C and HDMI 2.0, DQA0010A (USON-10)	DQA	Texas Instruments
0	U2	6-Channel Ultra-Low-Capacitance IEC ESD Protection Diodes, RVZ0014A (USON-14)	RVZ	Texas Instruments
0	U3	ESD Array For Portable Space-Saving Applications, 8 Channels, -40 to +85 degC, 8-pin WSON (DQD), Green (RoHS & no Sb/Br)	DQD	Texas Instruments
0	U4	ESD-Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85 degC, 6-pin SON (DRY), Green (RoHS & no Sb/Br)	DRY	Texas Instruments
0	U5	Low-Capacitance + / - 15-kV ESD Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85 degC, 6-pin SOT-23 (DBV), Green (RoHS & no Sb/Br)	DBV	Texas Instruments
0	U6	Low-Capacitance + / - 15-kV ESD Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85 degC, 6-pin SOT70 (DCK), Green (RoHS & no Sb/Br)	DCK	Texas Instruments
0	U7	40-V, 450-mA, Low IQ, Low-Dropout Voltage Regulator with Power Good, DRB0008B (VSON-8)	DRB	Texas Instruments
0	U8	Low-Capacitance + / - 15-kV ESD Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85 degC, 6-pin USON (DPK), Green (RoHS & no Sb/Br)	DPK	Texas Instruments

Table 3. Bill of Materials (continued)

0	U9	Low-Capacitance Array with + / - 15 kV ESD Protection, 4 Channels, -40 to +85 degC, 5-pin SOT (DRL), Green (RoHS & no Sb/Br)	DRL	Texas Instruments
0	U10	4-Channel ESD Protection With +/-15kV Contact ESD, DPW0004A (X2SON-4)	DPW	Texas Instruments

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      3.1.2 *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

      NOTE: 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

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

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(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.

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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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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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