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
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

<table>
<thead>
<tr>
<th>Contact Discharge</th>
<th>Air Discharge</th>
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<tbody>
<tr>
<td>Class</td>
<td>Test Voltage [± kV]</td>
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<tr>
<td>---</td>
<td>---</td>
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<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
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<td>4</td>
<td>8</td>
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</table>

Table 2. Waveform Parameters in Contact Discharge Mode

<table>
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<tr>
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<td>7.5</td>
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<tr>
<td>3</td>
<td>6</td>
<td>22.5</td>
<td>0.8</td>
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<td>4</td>
<td>8</td>
<td>30</td>
<td>0.8</td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>
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 configuration 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](image)

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 ESDEVDM 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
6 Schematics and Bill of Materials

6.1 Schematics

Figure 6. ESDEVVM Schematic

Table 3. Bill of Materials

<table>
<thead>
<tr>
<th>Count</th>
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<th>Description</th>
<th>Part Number</th>
<th>Manufacturer</th>
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<tr>
<td>8</td>
<td>J1, J2, J3, J4, J9, J10, J16, J17</td>
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<td>142-0761-881</td>
<td>Cinch Connectivity</td>
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<td>Keystone</td>
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<td>Texas Instruments</td>
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<td>DRL</td>
<td>Texas Instruments</td>
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<td>4-Channel ESD Protection With +/-15kV Contact ESD, DPW0004A (X2SON-4)</td>
<td>DPW</td>
<td>Texas Instruments</td>
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STANDARD TERMS FOR EVALUATION MODULES

1. **Delivery:** TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software.

1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2. **Limited Warranty and Related Remedies/Disclaimers:**

2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3. **Regulatory Notices:**

3.1 **United States**

3.1.1 Notice applicable to EVMs not FCC-Approved:

**FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

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

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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.

Concernant les EVMs avec appareils radio:

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.

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.

Concernant les EVMs avec antennes détachables

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.

3.3 Japan

3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/sds/it_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
          http://www.tij.co.jp/sds/it_ja/general/eStore/notice_01.page

3.3.2 Notice for Users of EVMs Considered “Radio Frequency Products” in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan.
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.
【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術基準適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本書製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。

日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿6丁目24番1号
西新宿三井ビル

3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lods/ti_ja/general/eStore/notice_02.page
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lods/ti_ja/general/eStore/notice_02.page

3.4 European Union
3.4.1 For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):
This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 EVM Use Restrictions and Warnings:
4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
4.3 Safety-Related Warnings and Restrictions:
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