Flat Clamp TVS Evaluation Module—Adaptor Boards

This user's guide describes the characteristics, operation, and use of the TVSxx0x Precision Surge Protection Diode Adaptor Board Evaluation Module (EVM). The TVSxx0x family of devices are precision clamps that keep ultra-low and flat clamping voltages during transient overvoltage events like surge for both bidirectional and unidirectional signals. These adaptor boards place the small DRV package size of the TVSxx00 device and the small DRB package size of the TVSxx01 device into a larger footprint that is designed to fit into industry standard SMA and SMB package types and allow users to test performance in their own systems. This user's guide includes setup instructions, schematic diagrams, a bill of materials, and printed-circuit board layout drawings for the EVM.

Contents

List of Figures

List of Tables

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1 Introduction

Texas Instrument's TVSxx0x evaluation module helps designers evaluate the operation and performance of the TVSxx0x family of devices. The TVSxx0x family is a precision clamp that keeps ultra-low and flat clamping voltage during transient overvoltage events like surge. With TI's precision surge technology, the TVSxx0x's clamping voltage barely changes up to its maximum surge current. The TVSxx0x also responds fast to the surge to limit overshoot voltage during clamping. Used in the system, its superior voltage suppression performance ensures a safe environment for downstream protected circuits.

2 Board Setup

The Flat Clamp Adaptor Board EVM is designed to allow the user to evaluate the protection performance of the TVSxx0x in their own system without having to make any changes to their existing schematic or layout. The EVM serves as an adaptor board to allow the small size of the QFN chip to be placed pin for pin in the industry standard SMA and SMB surge protector footprints. Users can easily replace their existing surge solution chip with the TVS3300 EVM to evaluate the component.

This EVM kit contains 36 adapter boards with 6 boards for each of the TVSxx0x voltage levels. 3 adapter boards per voltage level are in unidirectional configuration and 3 adapter boards per voltage level are in bidirectional configuration. Based on their system, the user must use the unidirectional configuration if the signal on the protected line stays above 0 V. Otherwise, it is recommended to use the bidirectional configuration, which can protect the system if the signal contains both positive and negative voltages.

The unidirectional adapter boards are all 105mil x 200mil (2.6mm x 5mm) and the bidirectional adapter boards are 145mil by 200mil (3.7mm x 5mm). The solderable pad underneath each adapter board is 85mil x 55mil for the unidirectional and 145mil x 50mil for the bidirectional. This can be seen in the figures below.

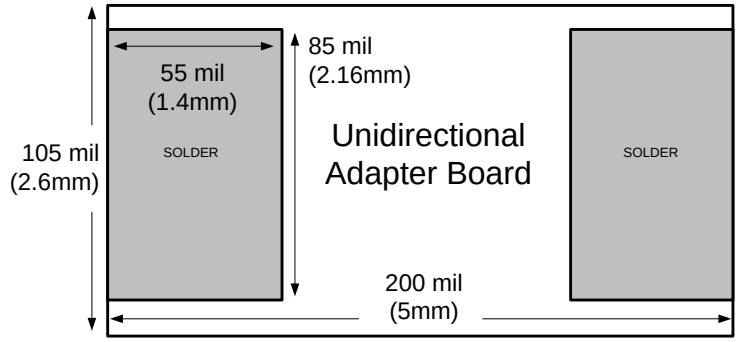

Figure 1. Unidirectional Adapter Board

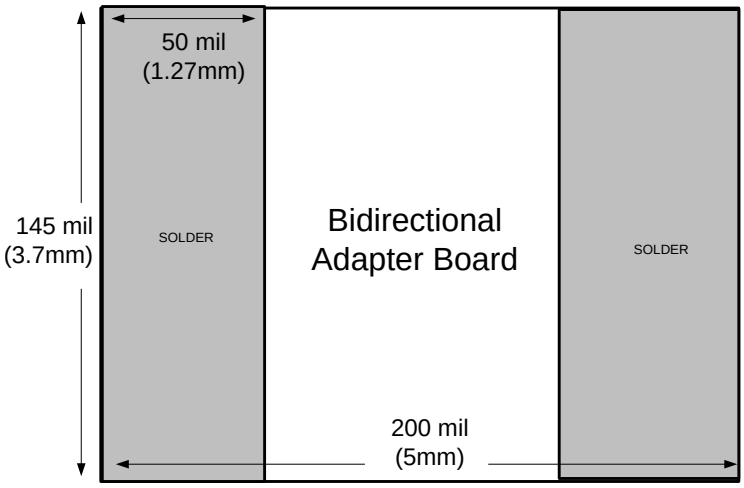

Figure 2. Bidirectional Adapter Board

To install the EVM, remove the existing surge protection solution, cut out the adapter board needed for your applications and place the adaptor board in the existing footprint. If there is no existing surge protection solution in the system, the EVM can still be tested by soldering the bottom plates of the adaptor board over the protected line and a ground plane. In the unidirectional configuration, pin 1 of the adapter board must be installed pointing towards ground, pin 1 can be seen by the silkscreen bar on one side of the unidirectional adaptor boards. In the bidirectional configuration either pin can be connected to ground or input signal. Each adapter board has solder pads on the bottom extending to the edge allowing the board to be soldered down.

2.1 Surge Testing

The adaptor provides an easy way to test the TVSxx0x surge protection as defined in IEC 61000-4-5. Evaluate the TVSxx0x surge protection by exposing the protected line to a surge event. The event must be created by a combinational waveform generator (CWG) in series with a 40-Ω coupling resistor as shown in Figure 3. Test at different surge current levels and observe that the voltage on the line is clamped to a safe level for the protected system. After the surge event, post-test the system to ensure that no damage or shift in leakage currents occurred.

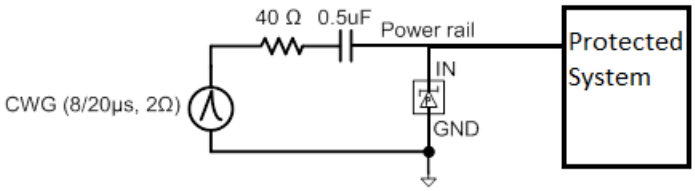

Figure 3. Surge Test Setup Unidirectional Configuration

The waveform in Figure 4 shows the response of the TVSxx0x Unidirectional adaptor board to a 30-A surge waveform created by a similar setup as in Figure 3. Despite the 35 A of current over a IEC 61000-4-5 surge waveform, the TVS3300 holds the voltage on the line to a maximum of 37 V, robustly protecting the downstream components.

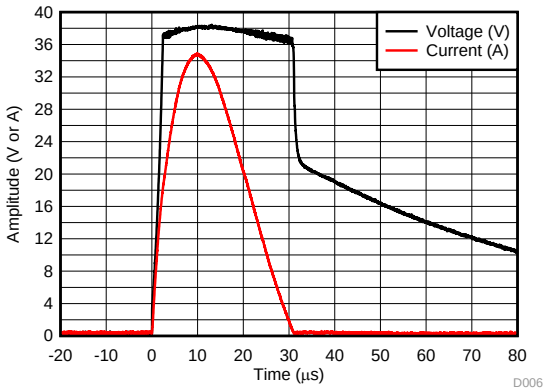

Figure 4. TVS3300 35-A Surge Clamping Waveforms

This is just one of the 6 different voltage level devices on the adapter board with all of them having superior clamping for their node.

2.2 ESD Testing

The TVSxx0x devices also provides ESD protection above ±8-kV contact and ±15-kV air gap according to the IEC 61000-4-2 standard. After installing the adaptor board into the system, evaluate the ESD protection provided by the TVSxx0x by using an ESD simulator to create an ESD event on your protected line. For specific information on ESD testing procedures, see the application report, *IEC 61000-4-x Tests for TI's Protection Devices*.

Figure 5 shows all the adapter boards that come in one evaluation module.

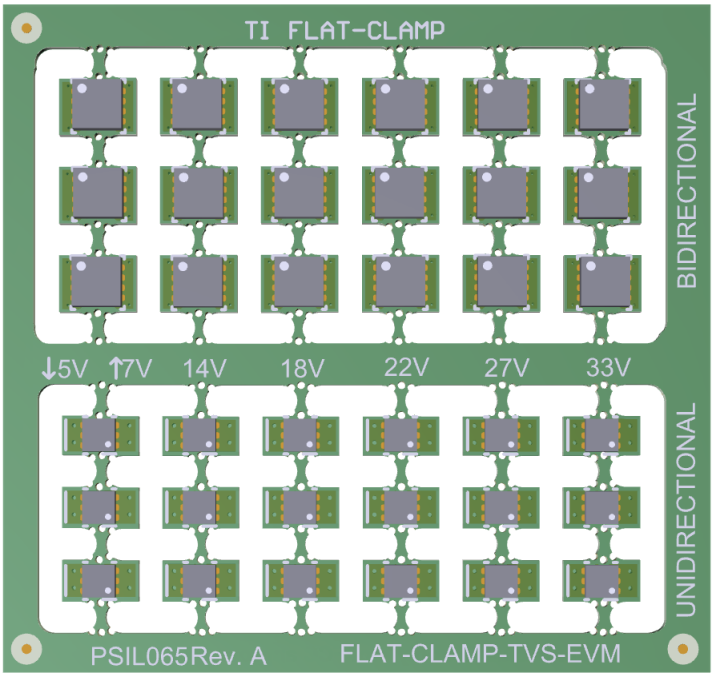

Figure 5. FLAT-CLAMP-TVS-EVM Board

3 Schematic

Figure 6 through Figure 12 display the EVM schematics with each voltage node.

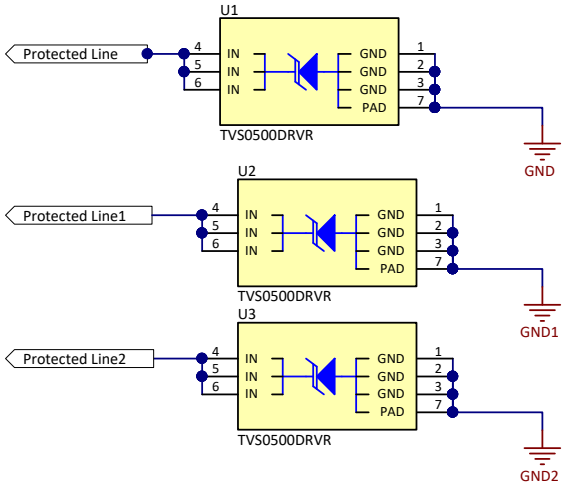

Figure 6. TVS0500 Schematic

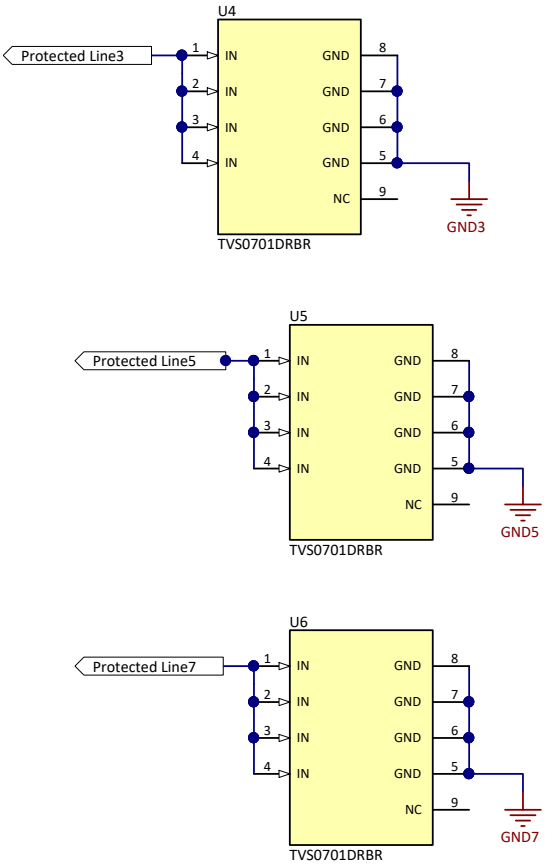

Figure 7. TVS0701 Schematic

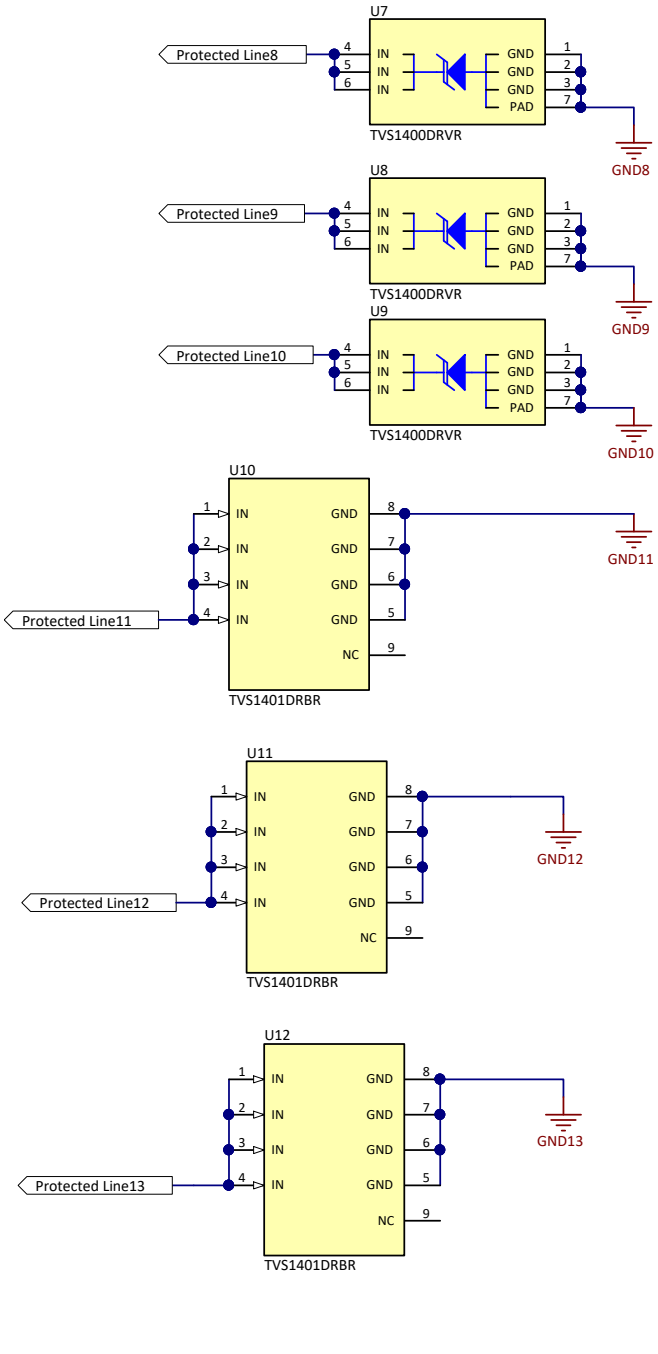

Figure 8. TVS140X Schematic

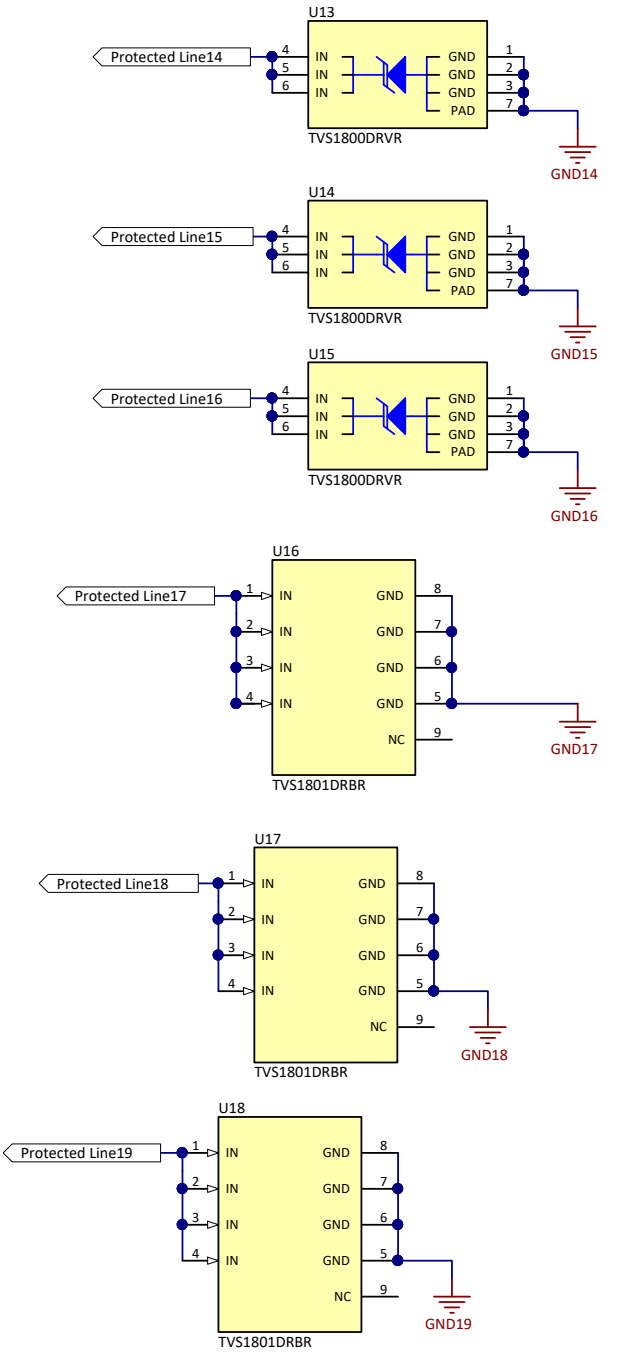

Figure 9. TVS180X Schematic

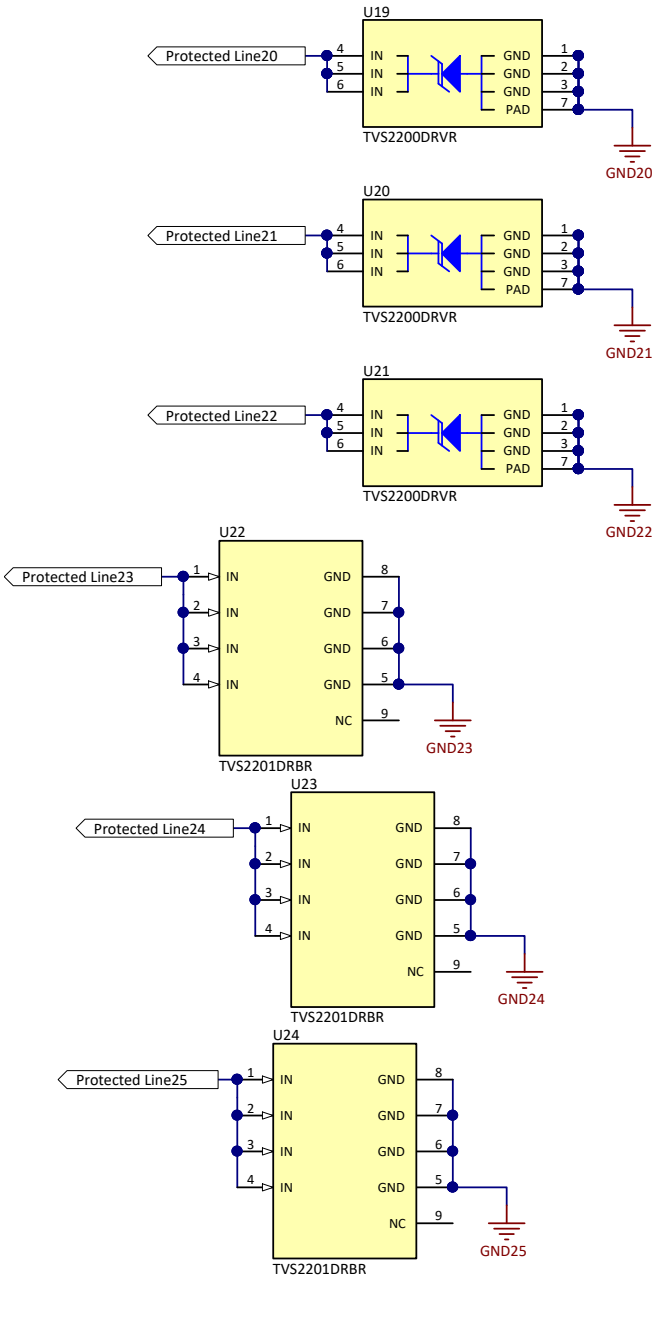

Figure 10. TVS220X Schematic

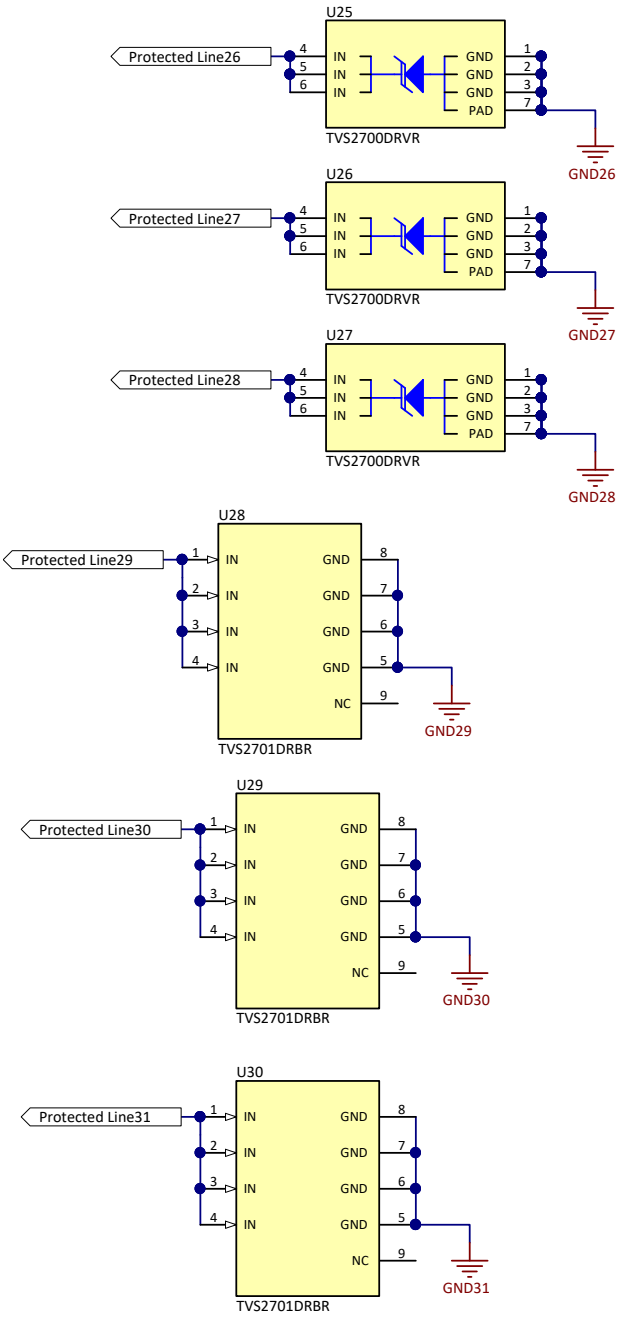

Figure 11. TVS270X Schematic

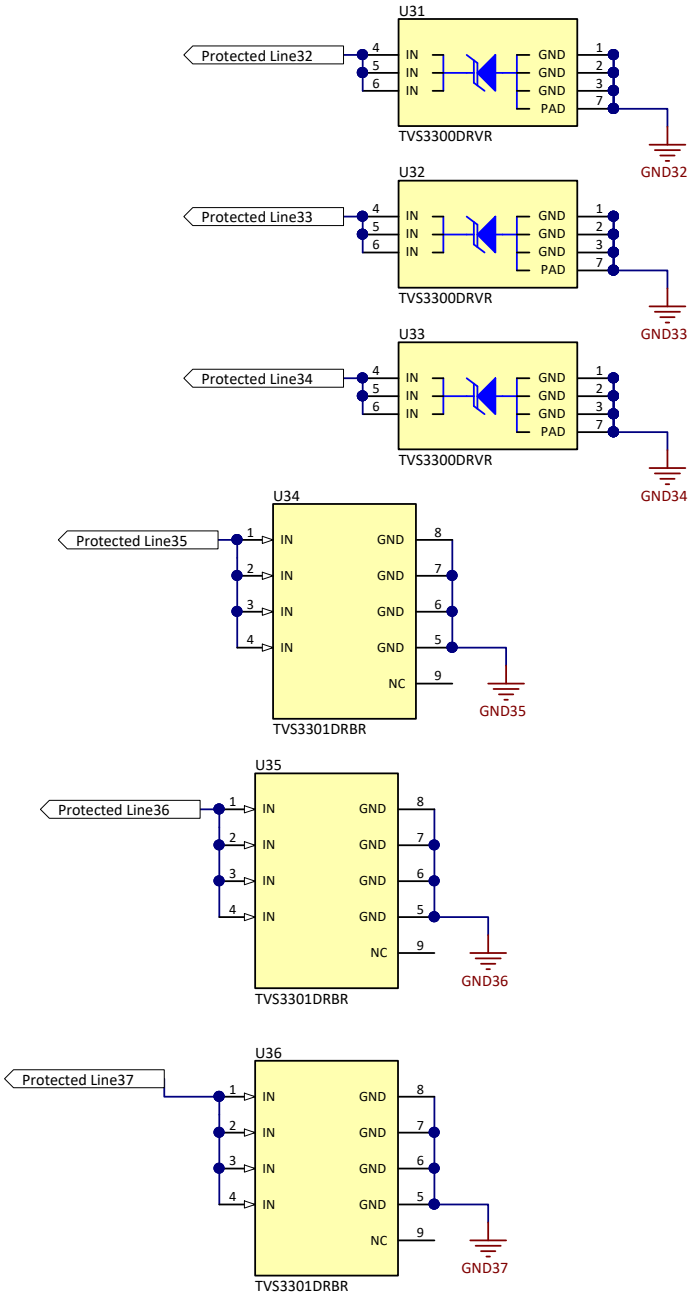

Figure 12. TVS330X Schematic

4 Layout

Figure 13 and Figure 14 illustrate the PCB layout images.

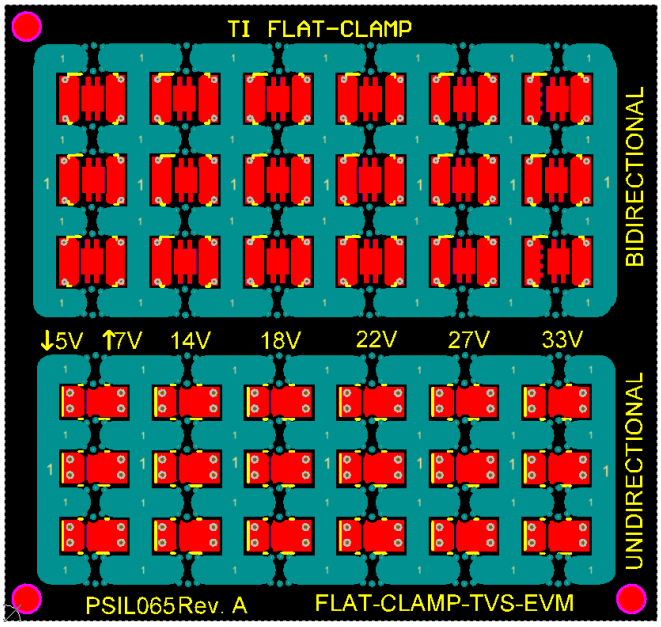

Figure 13. Evaluation Module Top Layer

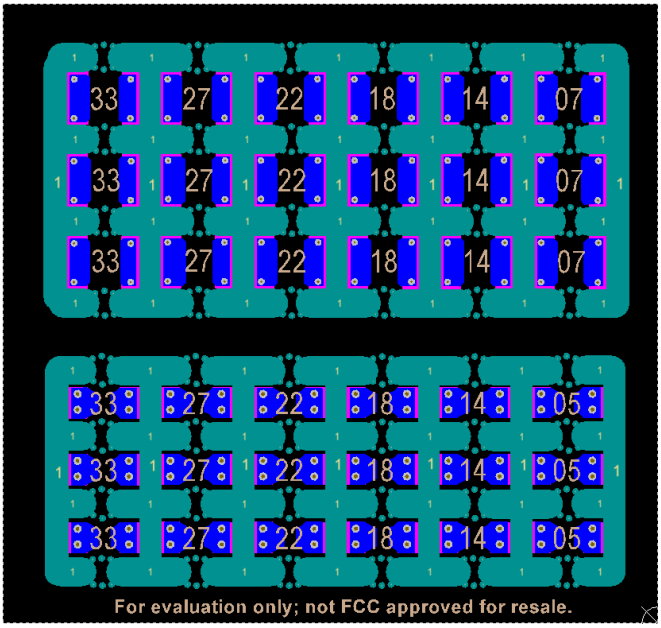

Figure 14. Evaluation Module Bottom Layer

5 Bill of Materials

Table 1. Evaluation Module Bill of Materials

Designator	QtY	Value	Description	Package Reference	Part Number	Manufacturer
U1,U2,U3,U4,U5,U6,U7,U8,U9	9	5 V	5-V Precision Surge Protection Clamp	DRV	TVS0500DRV	Texas Instruments
U10,U11,U12,U13,U14,U15,U16,U17,U18	9	14 V	14-V Precision Surge Protection Clamp	DRV	TVS1400DRV	Texas Instruments
U19,U20,U21,U22,U23,U24,U25,U26,U27,	9	18 V	18-V Precision Surge Protection Clamp	DRV	TVS1800DRV	Texas Instruments
U28,U29,U30,U31,U32,U33,U34,U35,U36	9	22 V	22-V Precision Surge Protection Clamp	DRV	TVS2200DRV	Texas Instruments
U37,U38,U39,U40,U41,U42,U43,U44,U45	9	27 V	27-V Precision Surge Protection Clamp	DRV	TVS2700DRV	Texas Instruments
U46,U47,U48,U49,U50,U51,U52,U53,U54	9	33 V	33-V Precision Surge Protection Clamp	DRV	TVS3300DRV	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.

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.

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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.

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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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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.

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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.

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4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

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