ESD224 Evaluation Module User's Guide

This user's guide describes the characteristics, operation, and use of the ESD224EVM evaluation module (EVM). This EVM includes four ESD224's, two to test the characteristics of the ESD224 and two in HDMI pass-through mode. One ESD224 is used to measure bandwidth, one ESD224 is used to measure the clamping voltage during an IEC61000-4-2 ESD strike and two ESD224's are configured to pass-through HDMI 2.0 signals using an HDMI Type A female and male header. This user's guide includes setup instructions, schematic diagrams, a bill of materials, and a printed-circuit board layout drawing of the EVM.

Trademarks

1 Introduction

Texas Instrument's ESD224 evaluation module helps designers evaluate the operation and performance of the ESD224 device. The ESD224 is a quad-channel ESD protection device in a small DQA package which offers IEC61000-4-2 Level 4 compliant ESD protection. The 0.5-pF line capacitance is suitable for high speed applications. The ESD224 is characterized for operation over an ambient air temperature range of –40°C to 125°C.

The EVM contains four ESD224's, two for electrical characterization of the device and two sitting on the TMDS Data and Clock Lines with an HDMI female header on one side and a HDMI male header on the other. The HDMI 2.0 pass-through portion of the board can be snapped off to be used by itself. This allows the EVM to be connected to an HDMI port via a HDMI cable and pass HDMI 2.0 signals through. The other portion of the board allows the device to be characterized.

Table 1. EVM Configuration

Reference Designator	TI Part Number	Configuration
U1	ESD224	S-Parameters
U2	ESD224	ESD Clamping waveforms
U3 – U4	ESD224	HDMI 2.0 Pass-Through

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 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

Table 2. IEC61000-4-2 Test Levels (continued)

Contact Discharge		Air Discharge	
Class	Test Voltage [± kV]	Class	Test Voltage [± kV]
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

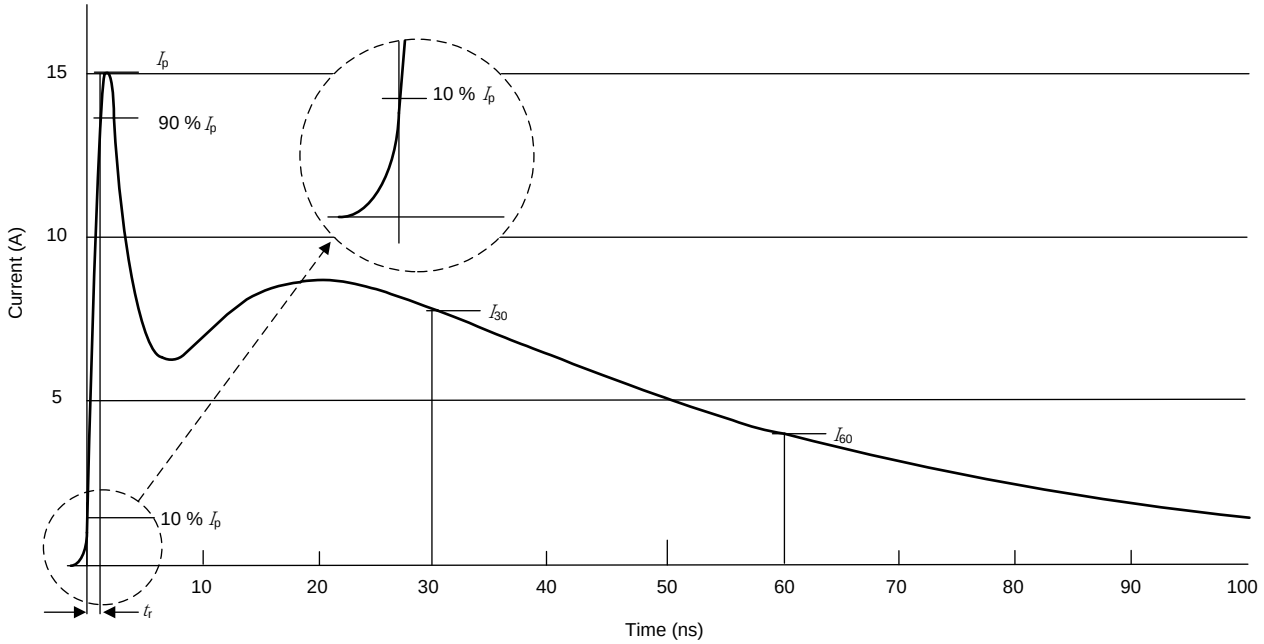

Figure 1. Ideal Contact Discharge Waveform of the Output Current of the ESD Simulator at 4 kV

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 - S-Parameters 4-Port Measurement

ESD224 (U1) 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

3.2 U2 - ESD Clamping waveforms

One ESD224 (U2) also has two SMB (J5, J6) 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

3.2.1 ESD Tests

The ESD224 device provides an ultra-low clamping voltage during an ESD event. The pass-through capabilities of this board allow it to be connected to a system and then do the system level ESD testing.

3.2.1.1 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.

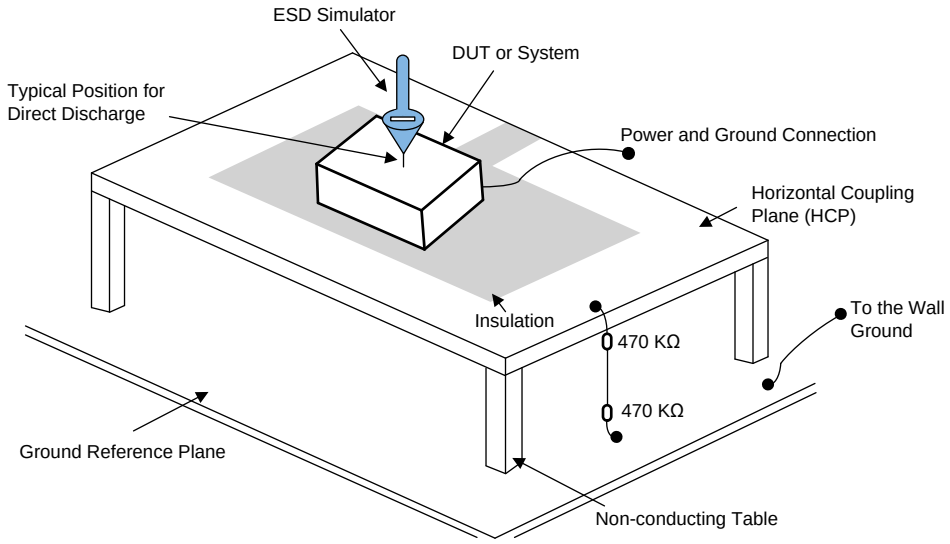

Figure 2. System Level ESD Test Setup

3.2.1.2 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.
- 1 10X 50Ω attenuator and one 150 Ω resistor (the resistor is already factory installed at R1 and R2).
- 50 Ω shielded SMB cables.

Procedure

In order to protect the oscilloscope, attenuation of the measured signal is required. Here is the procedure for testing channel 1 of U2:

1. Using one 10X attenuator:
   - Attach two 10X attenuator to the oscilloscope.
   - Attach the 50 Ω shielded SMB cable between J5 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 IEC 61000-4-2, strike contact ESD to TP1.

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 TP1 should not exceed +/– 8 kV when capturing clamping waveforms.

If the clamping waveform for channel two is desired, follow the same procedure except connecting the oscilloscope to J6 and striking TP3.

For best performance of this test, connect the IC, that the ESD224 is suppose to be protecting, to TP2 or TP4 and then strike and see the waveform. This will show the clamping waveform when another device is connected because the ESD224 limits the current seen by this IC during an ESD event.

3.2.1.3 Evaluation of Test Results

After ESD testing, perform normal operation testing to see if device has broken or not.

3.3 U3 and U4 - HDMI

At the top of the EVM there are two HDMI connectors, a male and a female. Two ESD224's (U3 and U4) are placed between those connectors, on the TMDS data and TMDS clock lines, to provide ESD protection for any devices connected downstream of the board. This board can be connected into a system to pass HDMI 2.0 content, from an HDMI source to a display for example, in order to verify HDMI 2.0 compliance. However, due to the losses from the male and the female HDMI connectors, it is not recommended to use this EVM board to run the standard HDMI 2.0 compliance tests. This EVM board is intended for functional and ESD testing only. For running HDMI 2.0 compliance tests, it is recommended to place ESD224s directly on the system board built specifically for such a purpose. Please note that this EVM board was attached to the TPD158RGZEVM to run HDMI 2.0 compliance tests and the results confirmed the HDMI 2.0 compliance with margin.

4 Board Layout

This section provides the ESD224EVM board layout. ESD224EVM is a 2-layer board of FR-408HR at 0.062” thickness. Layers 2, 3, and 4 are simple ground planes and not shown here.

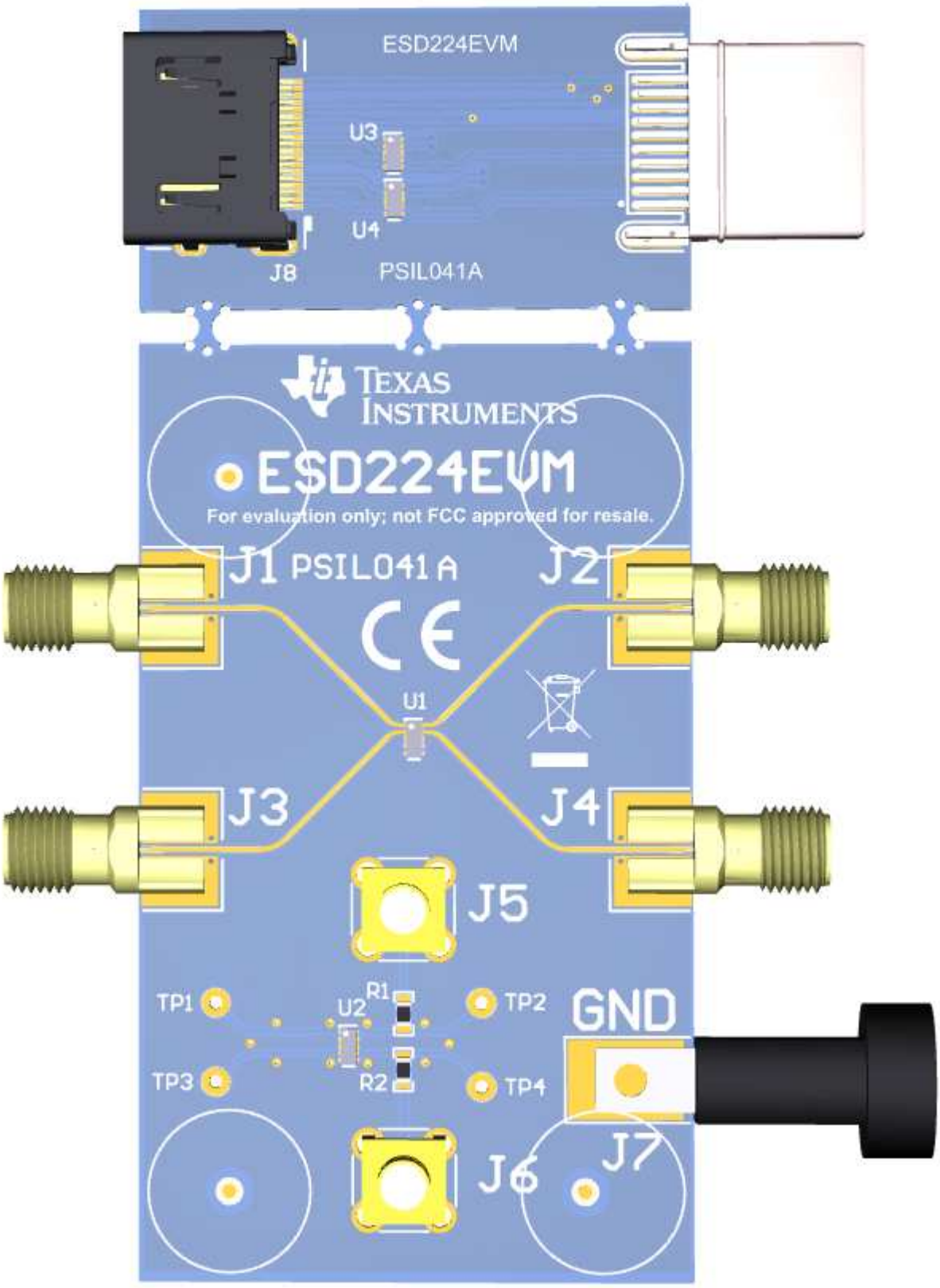

Figure 3. 3D Board Image

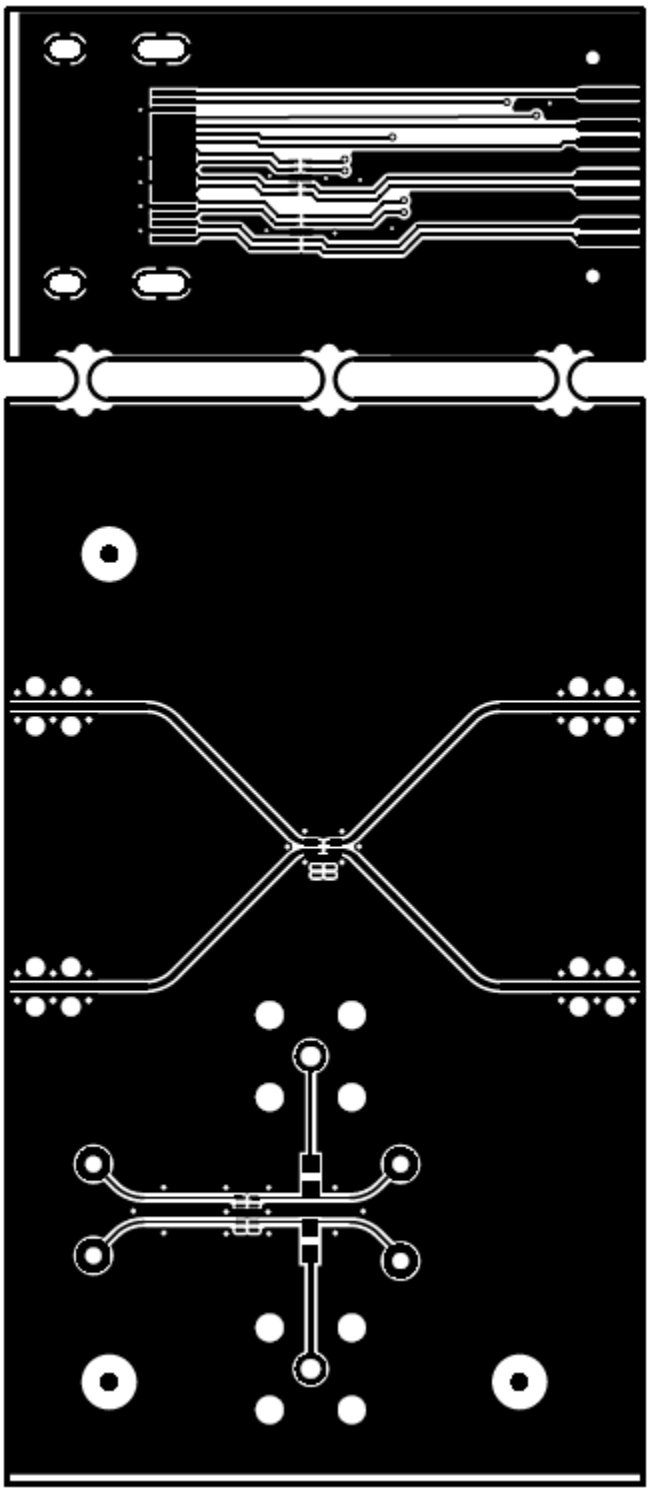

Figure 4. ESD224EVM Top Layer

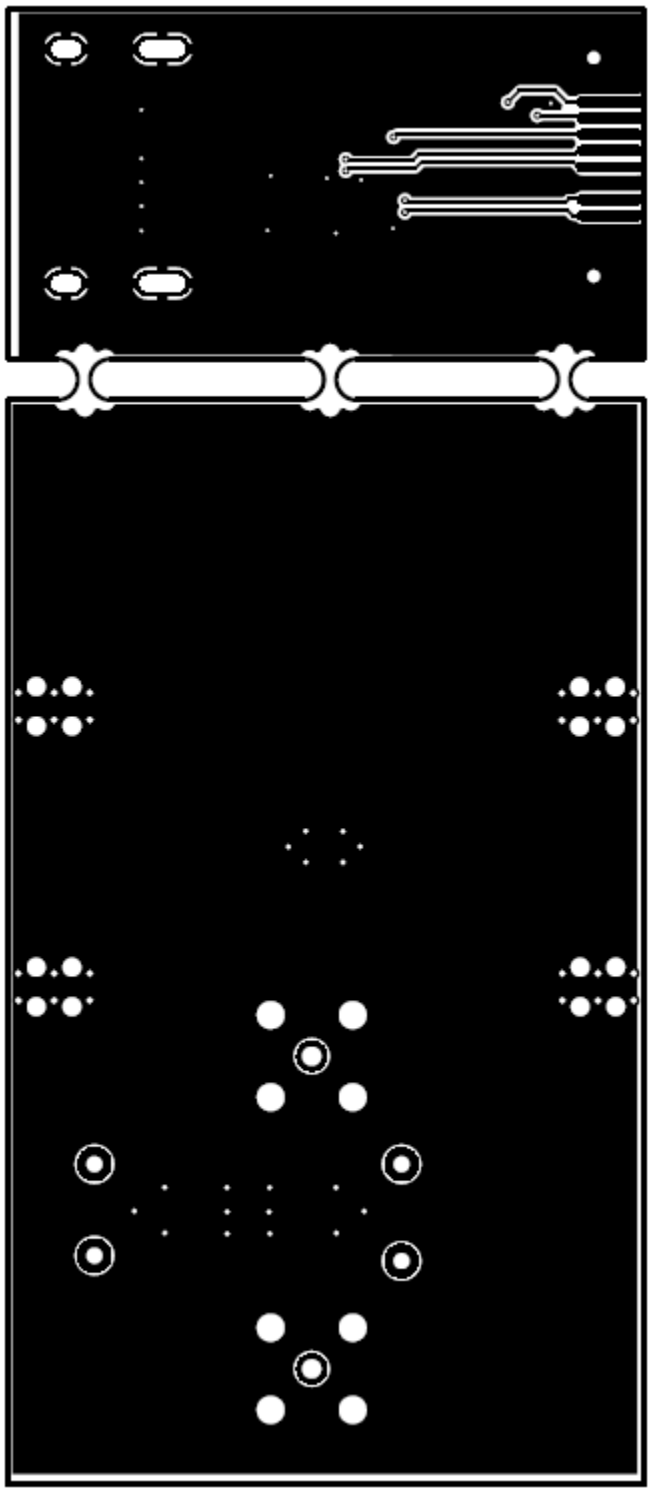

Figure 5. ESD224EVM Bottom Layer

5 Schematics and Bill of Materials

5.1 Schematics

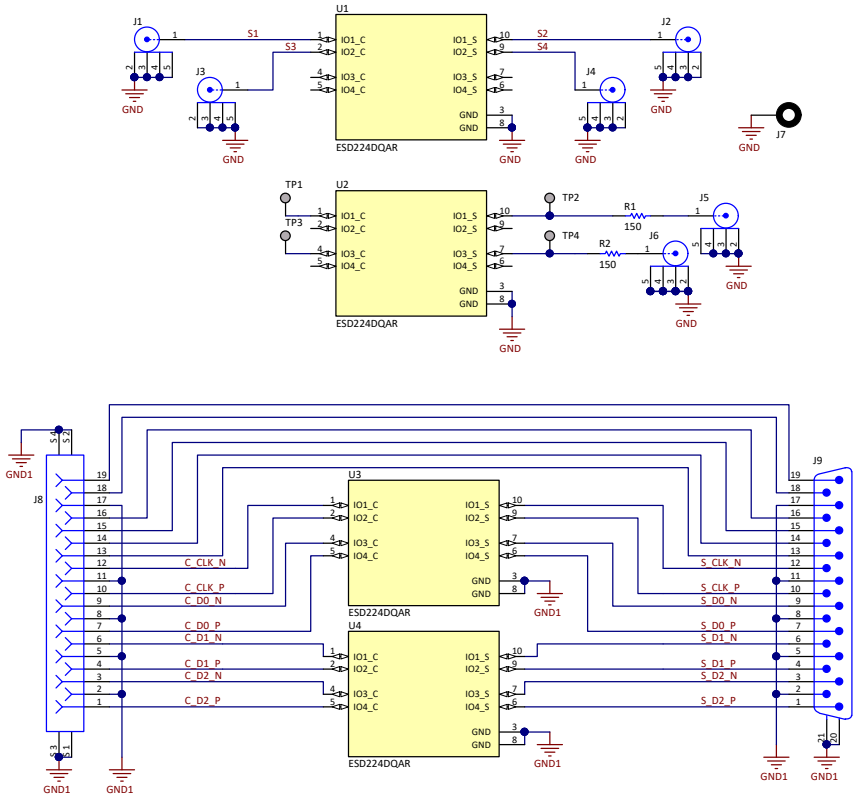

Figure 6. ESD224EVM Schematic

Table 4. Bill of Materials

Count	RefDes	Description	Part Number	MFR
4	U1,U2,U3,U4	IC, 4-channel ESD solution	ESD224	TI
4	J1, J2, J3, J4	Connector, End Launch SMA 50 Ohm, TH	142-0761-881	Cinch Connectivity
2	J5, J6	Connector, SMB, Vertical RCP 0-4GHz, 50Ohm, TH	47151-0001	Cinch Connectivity
1	J7	Standard Banana Jack, Insulated, Black	6092	Keystone
1	J8	Receptacle, HDMI, 0.5mm, 19 Pos, R/A, Gold, SMT	47151-0001	Molex
1	J9	HDMI Type A Plug, 1 mm, Black, TH	HDA-M-CN01	Bosscon
2	R1, R2	Resistor, 150, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW0603150RFKEA	Vishay-Dale

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      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.

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      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.

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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.*

3.2 *Canada*

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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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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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