

## **TPD8S300 Evaluation Module**

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This user's guide describes the characteristics, operation, and use of the TPD8S300 evaluation module (EVM). This EVM is a TPD8S300 integrated chip set into a USB Type-C passthrough board to allow the user to test the operation of the TPD8S300 overvoltage protection and ESD protection in their own system. This user's guide includes setup instructions, schematic diagrams, a bill of materials, and printed-circuit board layout drawings for the EVM.

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## 1 Introduction

Texas Instrument's TPD8S300 evaluation module helps designers evaluate the operation and performance of the TPD8S300 device. The TPD8S300 is a single-chip solution for protection of the USB Type-C configuration channel (CC), sideband use channel (SBU), and  $D_{\pm}$  data lines. The device provides Short-to-VBUS Over Voltage Protection up to 22 V for CC1, CC2, SBU1, and SBU2 pins to prevent damage caused by a faulty connector or mechanical twist shorting pins. The TPD8S300 also provides 8-channels of IEC 61000-4-2 ESD protection for CC1, CC2, SBU1, SBU2,  $D_{\pm}$  (Top Side), and  $D_{\pm}$  (Bottom Side) pins of the USB Type-C connector.

## 2 Board Setup

The pass-through EVM allows the user to ensure that the TPD8S300 will not impede typical operation of their USB port while also allowing the user to test the TPD8S300 protection during an overvoltage or ESD event.

To test the TPD8S300 EVM, plug the male ("system side", J1) connector on the EVM into a USB Type-C female port and plug a typical USB Type-C cable or peripheral into the EVM's female connector ("connector side", J2). The TPD8S300 is intended to be placed very close to the port in a typical system, so this setup will closely simulate a designed in TPD8S300. When plugged in, the user can ensure that the TPD8S300 will not impede standard USB operation.

The  $0\ \Omega$  resistors R2 and R3 allow the user to determine whether the TPD8S300 dead battery resistors are active. By default, the resistors will short the CC1 and CC2 pins to the RPD\_G1 and RPD\_G2 pins and enable the dead battery resistor function, allowing the TPD8S300 to serve as either a UFP or a DFP port. To simulate a use case where the TPD8S300 will not function as a UFP, turn off the dead battery functionality by manually removing these resistors.

The EVM requires 3.3 V between the Vpwr (TP1) and Ground (TP3) pins to power up the TPD8S300. If the system supports USB charging from a dead battery condition, it is recommended that the EVM be powered from the protected USB Controller to show that the dead battery functionality works properly. The EVM includes a 0.1  $\mu\text{F}$  (C2) capacitor to ground on the Vbias pin of the TPD8S300, a 100-k $\Omega$  (R1) resistor to Vpwr on the  $\overline{\text{FLT}}$  pin, and a 1- $\mu\text{F}$  (C1) capacitor to ground on the Vpwr pin. These are recommended for proper operation of the TPD8S300 in all applications.

### 2.1 Overvoltage Protection Testing

The EVM is designed to allow the user to ensure that the TPD8S300 can protect their system from overvoltage events. By shorting either a CC line or SBU line to a high voltage on the connector side of the EVM, the user can confirm that the TPD8S300 will protect their system. The short can be created by applying 20 V to one of the protected lines on a USB Type-C breakout board plugged into J2 or by using a custom board that discharges 20 V over a capacitor when plugged in. When the TPD8S300 sees a voltage over the overvoltage threshold on a protected line it will isolate all four CC and SBU lines within 100 ns to protect the system. Use an oscilloscope to measure the voltage on both the system side and the connector side of the EVM to view the clamped voltage that the protected system is seeing.

The waveform in [Figure 1](#), where channel one is the system side of the TPD8S300EVM and channel two is the connector side, was taken when CC1 from a TPD8S300EVM in DFP mode in series with a TPD8S300EVM was shorted to a 24-V Vbus line. The event was created by a plugging in a one foot cable to a custom USB Type-C board that simulates a faulty peripheral, pulling Vbus to 24 V and discharging the voltage to the CC line over a capacitor. Measuring the voltage over the TPD8S300EVM shows the device clamping the overvoltage event to a maximum voltage of 7.5 V and completely isolating the controller within 60 ns.

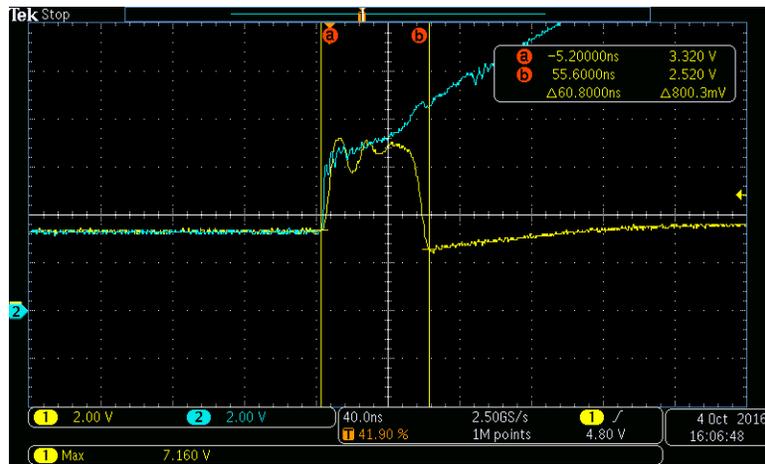


Figure 1. CC1 Line Short to 20-V Waveform

## 2.2 ESD Testing

Figure 2 shows the TPD8S300EVM. The EVM has four ESD test points, one on each CC and SBU line, that allow the user to use an ESD simulator in either contact or air-gap test mode to measure the ESD protection provided by the TPD8S300. Probe points one and two correspond to the SBU2 and SBU1 lines respectively. Probe points four and five correspond to the CC1 and CC2 lines respectively. To measure the ESD response on the D± lines use an ESD simulator on the respective points on a break-out board plugged into J2. Refer to the application report, [IEC 61000-4-x Tests for TI's Protection Devices](#) for specifics on proper ESD testing methods.

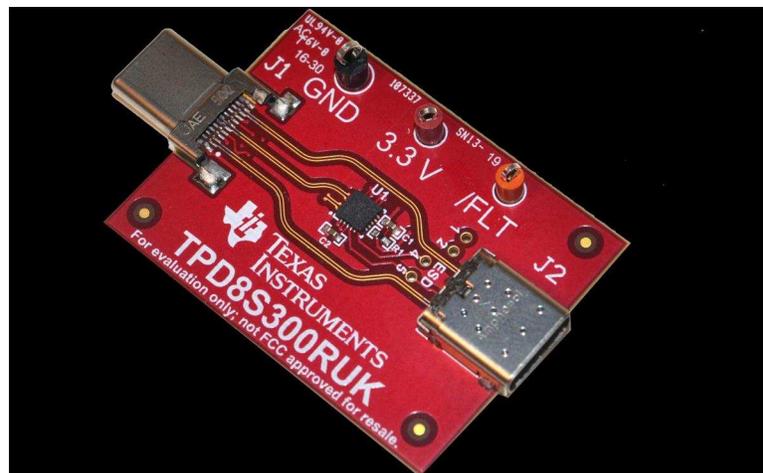


Figure 2. TPD8S300EVM

### 3 Schematic

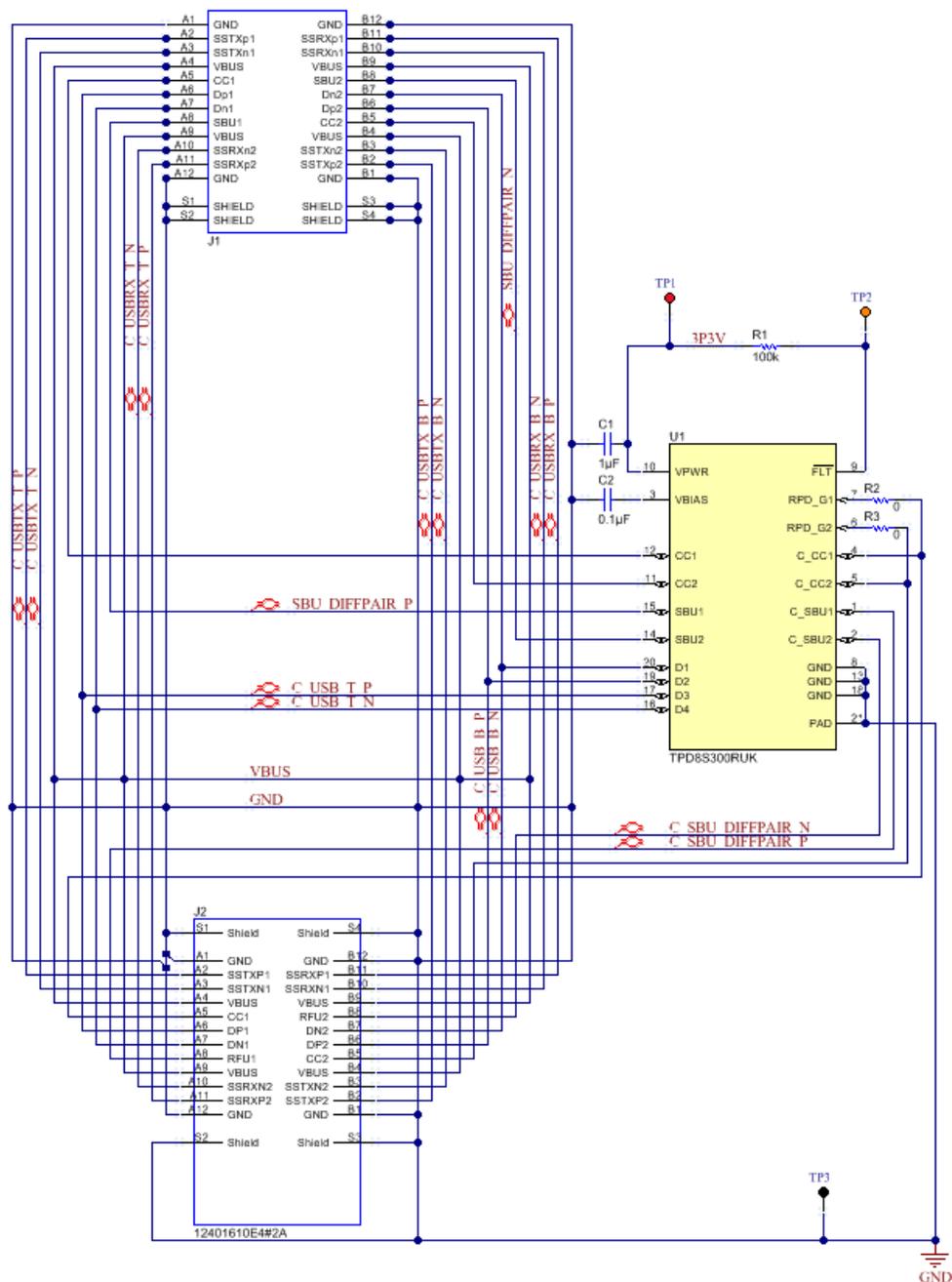


Figure 3. TPD8S300EVM Schematic

## 4 Board Layout

This section provides the TPD8S300EVM board layout. The TPD8S300 is an 8-layer board of FR-4 at 0.032" thickness.

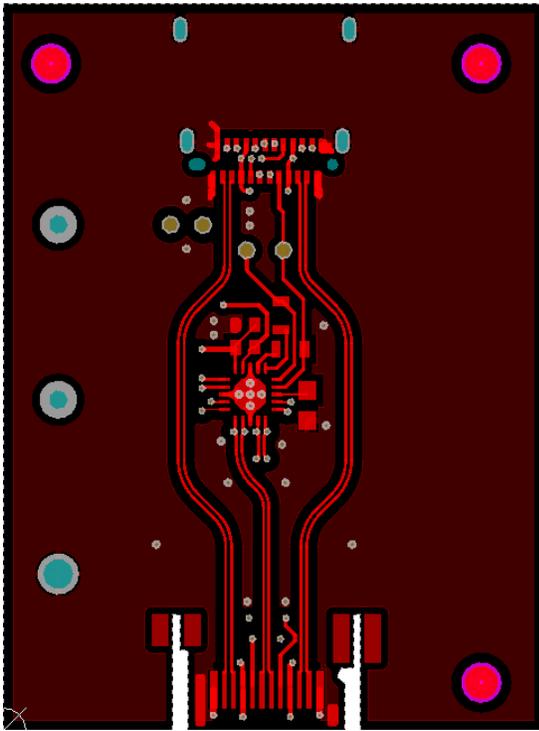


Figure 4. Top Layer

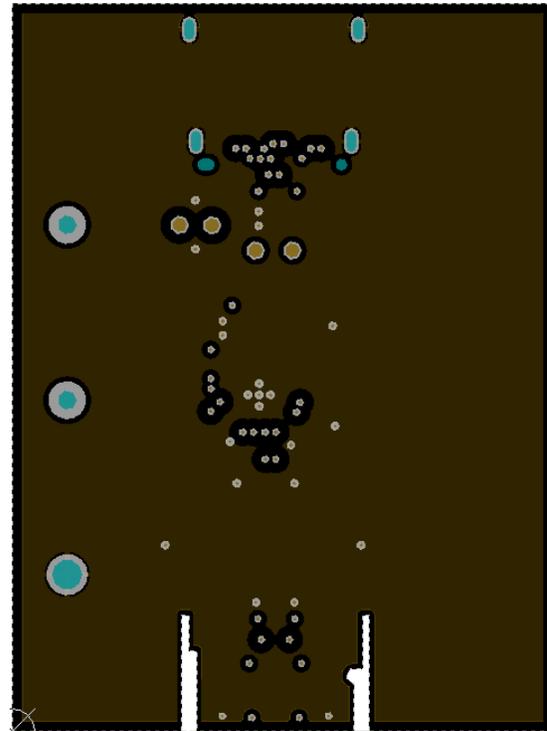


Figure 5. Ground Plane 1

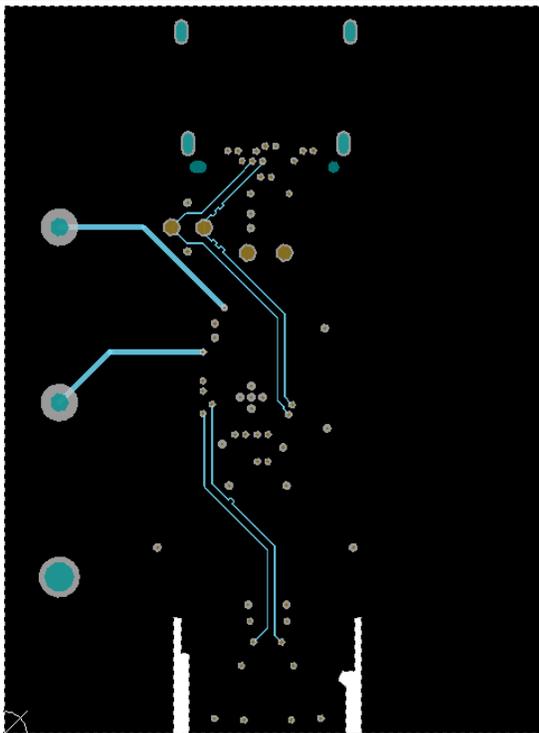


Figure 6. Midlayer 1

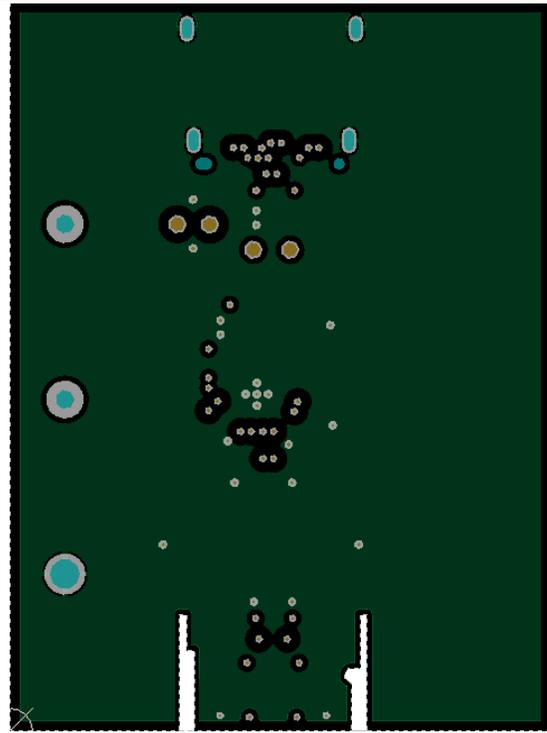


Figure 7. Ground Plane 2

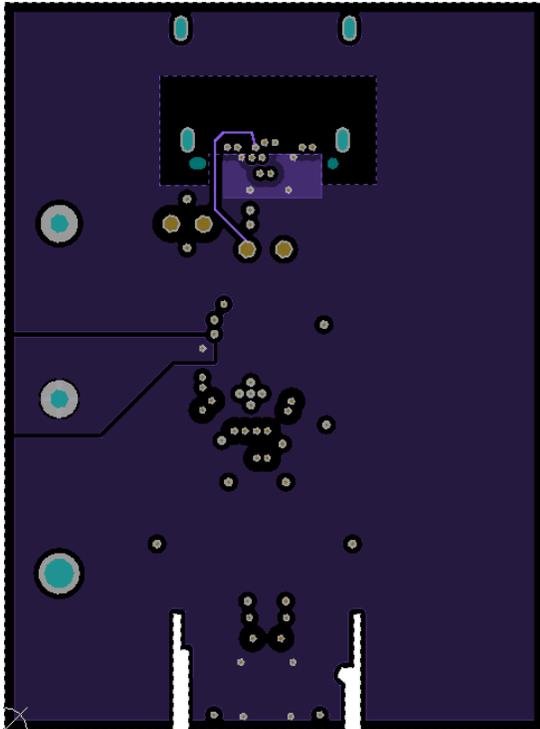


Figure 8. Power Plane 1

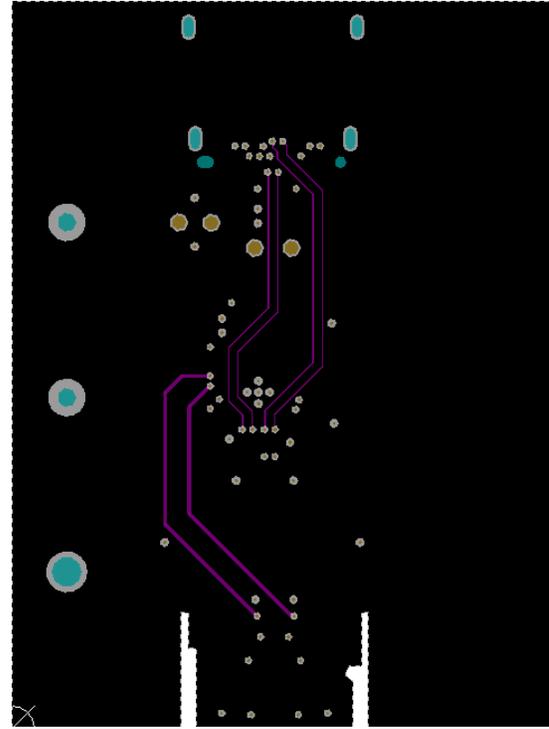


Figure 9. Midlayer 2

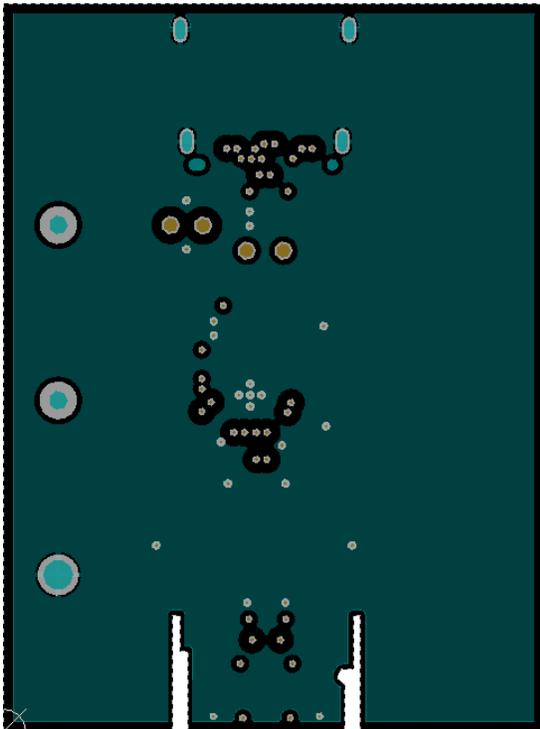


Figure 10. Ground Plane 3

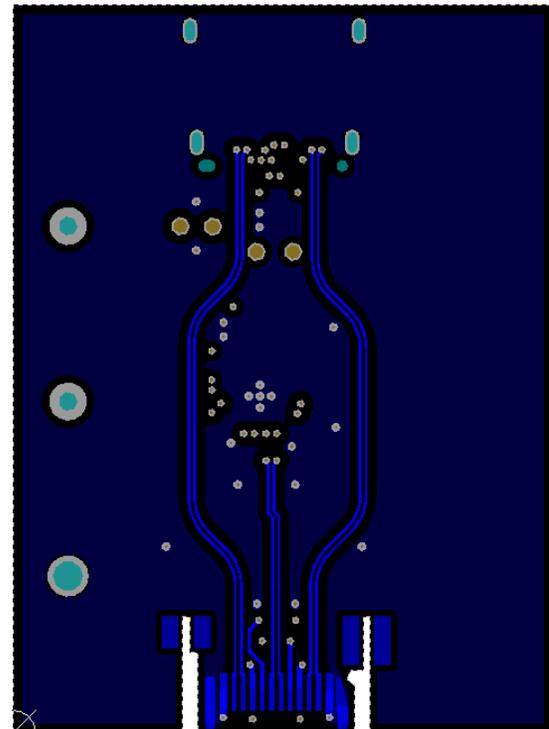


Figure 11. Bottom Layer

## 5 Bill of Materials

**Table 1. Bill of Materials**

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1	1	1 uF	CAP, CERM, 1 uF, 35 V, ±10%, JB, 0402	0402	C1005JB1V105K050BC	TDK
C2	1	0.1 uF	CAP, CERM, 0.1uF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71H104KE02D	MuRata
J1	1		Plug, USB3.1 Type C, 24 V Position, R/A, SMT	Plug, USB3.1 Type C, 24 V Position, R/A, SMT	DX07P024MJ1R1500	JAE Electronics
J2	1		Receptacle, 0.5 mm, USB TYPE C, R/A, SMT	Receptacle, .5mm, USB TYPE C, R/A, SMT	12401610E4#2A	Amphenol Canada
R1	1	100 kΩ	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ104X	Panasonic
R2, R3	2	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
TP1	1		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP2	1		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
TP3	1		Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone
U1	1		USB Type C Interface Protector: Short-to-VBUS Over Voltage and IEC 61000-4-2 ESD Protection, RUK0020b	RUK0020B	TPD8S300RUK	Texas Instruments

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