EVM User's Guide: TPS7H2201EVM

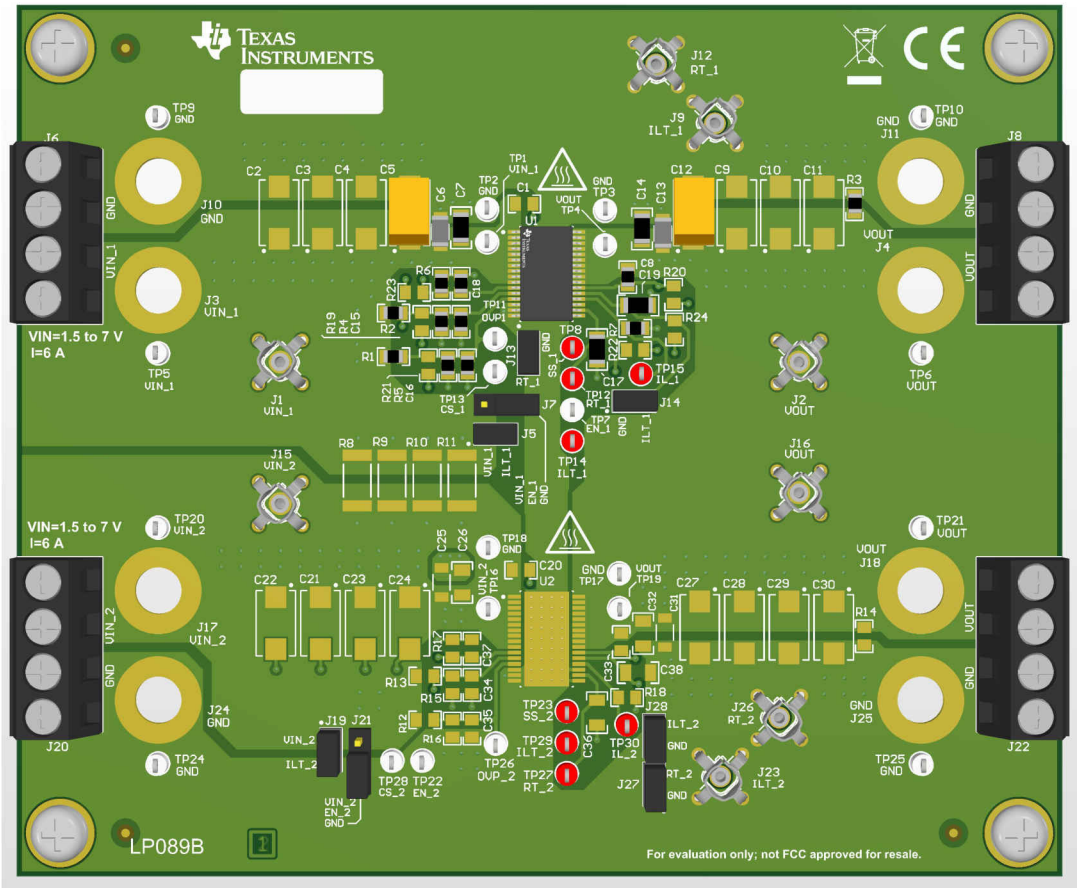
TPS7H2201EVM Evaluation Module (EVM)

Description

The TPS7H2201EVM demonstrates the operation of a single TPS7H2201 eFuse (Radiation Tolerant/ Hardened Plastic). The board provides footprints that can be populated with additional components to allow for testing of customized configurations, such as parallel or redundant eFuses.

Features

- Flexible configuration options, including single- and parallel-device circuits
- Customizable soft start, current limit, current limit timers, enable threshold, undervoltage threshold, and capacitance.



The EVM is populated for a single-device configuration. The footprints on the bottom half of the board can be populated if a parallel-device configuration is desired.

TPS7H2201EVM Board

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1 Evaluation Module Overview

1.1 Introduction

The TPS7H2201EVM is the Evaluation Module (EVM) for the plastic package option of the TPS7H2201 and provides a platform to electrically evaluate the features. This user's guide provides details about the EVM, the configuration, schematics, and BOM.

The EVM is designed to be used across the entire input voltage and output current range of the TPS7H2201 while providing flexibility in configuring the device under different conditions. By default, the device in the EVM is configured as shown in TPS7H2201EVM Default Configuration. To configure the device in a different configuration, please refer to the TPS7H2201 data sheet (SLVSDO0) to calculate the values of the passives around the device that need to be changed.

1.2 Kit Contents

- EVM board (1)
- EVM Kit User's Guide (1)

1.3 Specification

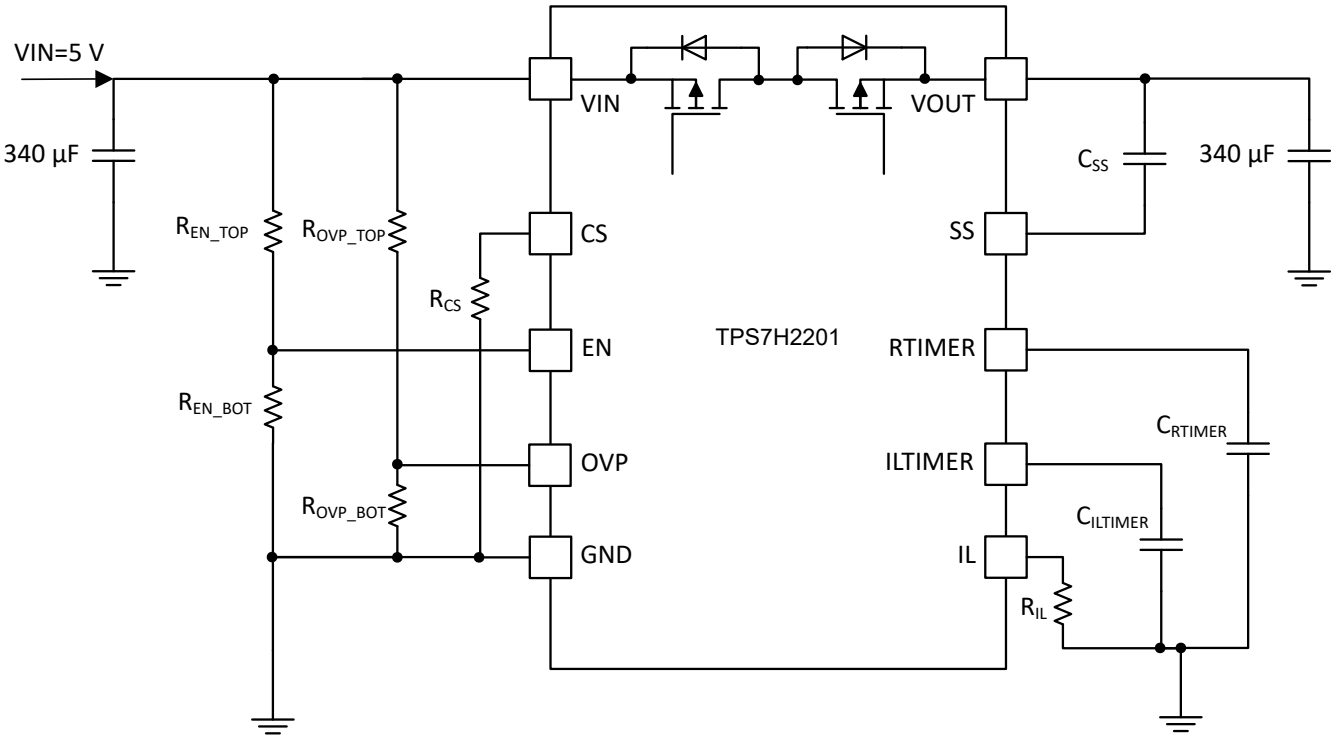


Figure 1-1. Typical Application Schematic

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Table 1-1. TPS7H2201EVM Default Configuration

Specification	Value	Description
Input Voltage VIN	5 V	Falls within the recommended device input voltage range of 1.5 V to 7 V.
Output Current I_{OUT}	0 to 6 A	Does not exceed maximum device continuous switch current of 6 A per device.
EN Turn-on Voltage VIN_{EN_RISE}	4.7 V	Typical EN turn-on and turn-off values. Set by: R2 (R_{TOP_EN}) = 100 kΩ R4 (R_{BOT_EN}) = 14.9 kΩ
EN Turn-off Voltage VIN_{EN_FALL}	3.9 V	
OVP Enter Voltage VIN_{OVP_RISE}	5.7 V	Typical OVP enter and exit values. Set by: R1 (R_{TOP_OVP}) = 100 kΩ R5 (R_{BOT_OVP}) = 11.1 kΩ
OVP Exit Voltage VIN_{OVP_FALL}	5.5 V	
Soft Start Time t_{SS}	approximately 9 ms	Typical time to go from 10% to 90% of the final voltage. Set by: C8 (C_{SS}) = 0.12 uF
Current Limit I_L	8.5 A	Typical current limit. Set by: R7 (R_{IL}) = 5.76 kΩ
Current Limit Timer $t_{ILTIMER}$	1 ms	Typical time spent in current limiting mode. Set by: C19 ($C_{ILTIMER}$) = 2000 pF
Reset Timer t_{RTIMER}	1 ms	Typical time device is disabled before retrying. Set by: C17 ($C_{ILTIMER}$) = 2000 pF

1.4 Device Information

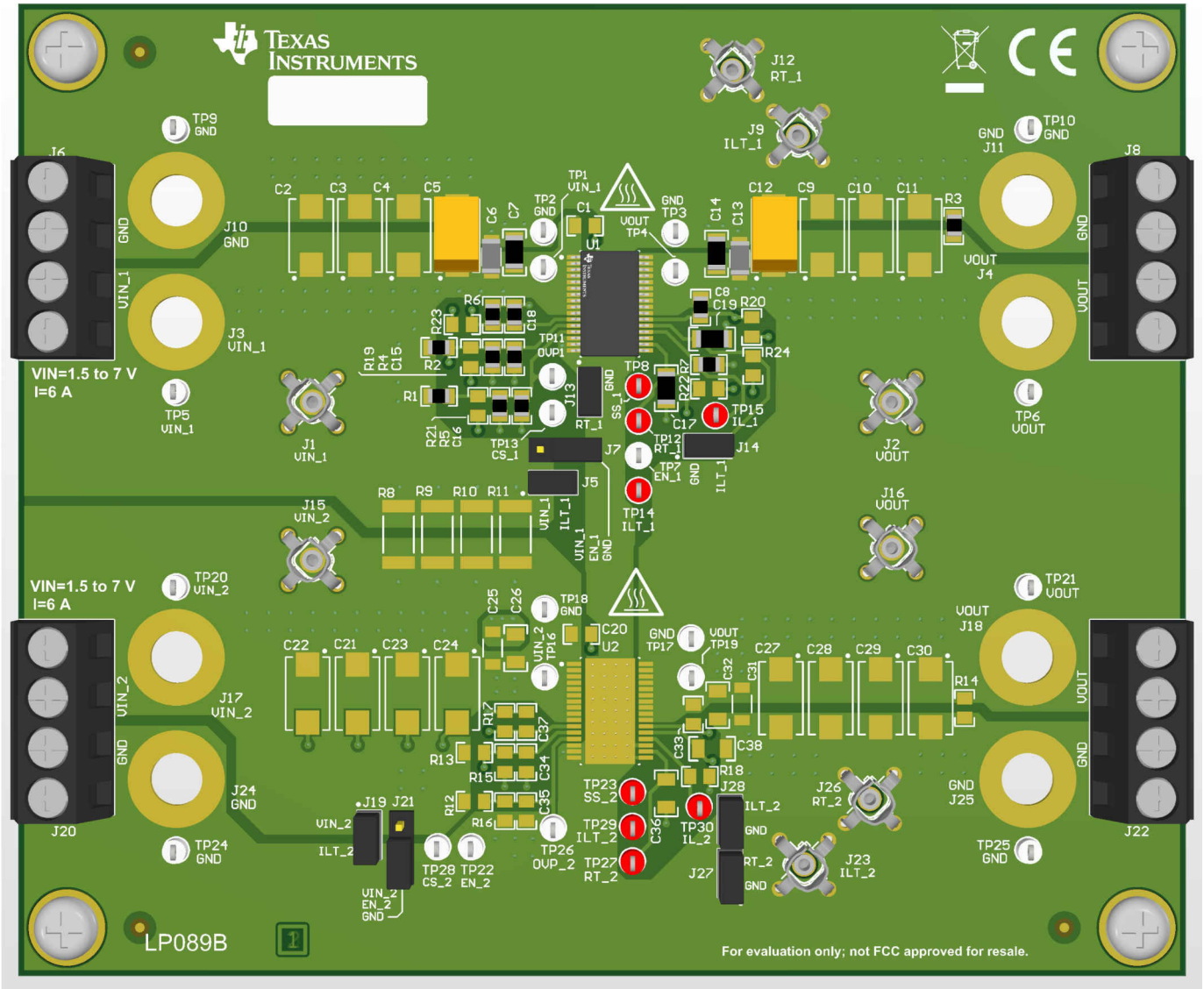
The TPS7H2201 is a single channel, 6-A eFuse with a programmable slew rate for applications that require specific rise-time as well as programmable current limit for protection purposes. In addition, the TPS7H2201 features a reverse current protection capability for redundancy applications as well as programmable fault timers. The device contains a P-channel MOSFET that can operate over an input voltage range of 1.5 V to 7 V and can support a maximum continuous current of 6 A. The device is controlled by an on and off input (EN), which is capable of interfacing directly with low-voltage control signals.

- Data sheet: TPS7H2201-SP and TPS7H2201-SEP Radiation Hardened 1.5-V to 7-V, 6-A eFuse

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2 Hardware

2.1 EVM Connectors and Test Points



TPS7H2201EVM

Table 2-1. Summary of Connectors and Test Points

Reference Designator	Function	
J3, J6 (pins 3& 4)	VIN1	Input Voltage and Current for U1
J6 (pins 1 & 2), J8	GND	
J17, J20 (pins 1& 2)	VIN2	Input Voltage and Current for U2
J20 (pins 3& 4), J24	GND	
J4, J8 (pins 1& 2), J18, J22 (pins 3&4)	VOUT	Output Voltage and Current for Board
J8 (pins 3& 4), J11, J22 (pins 1&2), J25	GND	

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Table 2-1. Summary of Connectors and Test Points (continued)

Reference Designator	Function	
J1, TP1, TP5	VIN1	Test Point
J15, TP16, TP20	VIN2	
J2, J16, TP4, TP6, TP19, TP21	VOUT	
TP2, TP3, TP9, TP10, TP17, TP18, TP24, TP25	GND	
TP7	EN1	
TP22	EN2	
TP11	OVP1	
TP26	OVP2	
TP13	CS1	
TP28	CS2	
TP8	SS1	
TP23	SS2	
TP15	IL1	
TP30	IL2	
J9, TP14	ILTIMER1	
J23, TP29	ILTIMER2	
J12, TP12	RTIMER1	
J26, TP27	RTIMER2	
J7	VIN1 - EN1 - GND	Shunt for mode selection
J21	VIN2 - EN2 - GND	
J5	VIN1 - ILTIMER1	
J14	ILTIMER 1 - GND	
J19	VIN2 - ILTIMER2	
J28	ILTIMER2 - GND	
J13	RTIMER1 - GND	
J27	RTIMER2 - GND	

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2.1.1 Alternate EVM Configurations

The default EVM configuration has a single device and the external components populated, however, an additional device can be populated. This allows testing for two different dual-device applications:

1. Redundant - Each device has a different VIN source but a common VOUT. The common VOUT is already implemented on the EVM through a shared plane. In this configuration, each device has a separate external components.
2. Parallel - Each device has the same VIN source as well as a common VOUT. To connect the VIN for both devices, populate the 4 parallel size 2512, 1-W, 0-Ω resistors (R8, R9, R10 and R11). The EN, OVP, CS, SS, RTIMER and ILTIMER pin nodes of the devices must sepalso be connected by populating 0-Ω resistors (R19, R21, R23, R20, R22 and R24 respectively). The external components for U2, except for the IL pin, are also typically removed for parallel operation.

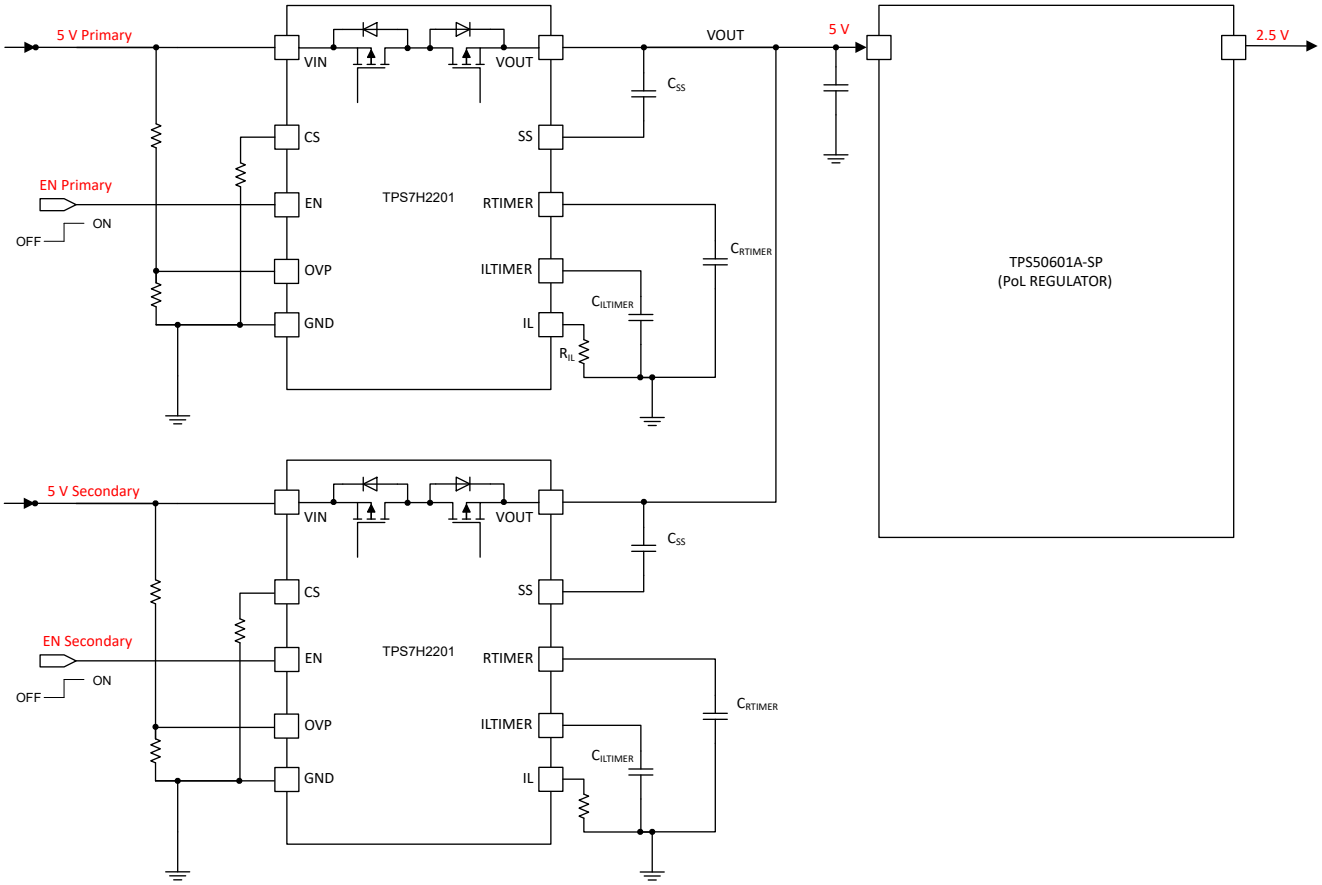


Figure 2-1. Redundant Configuration Example

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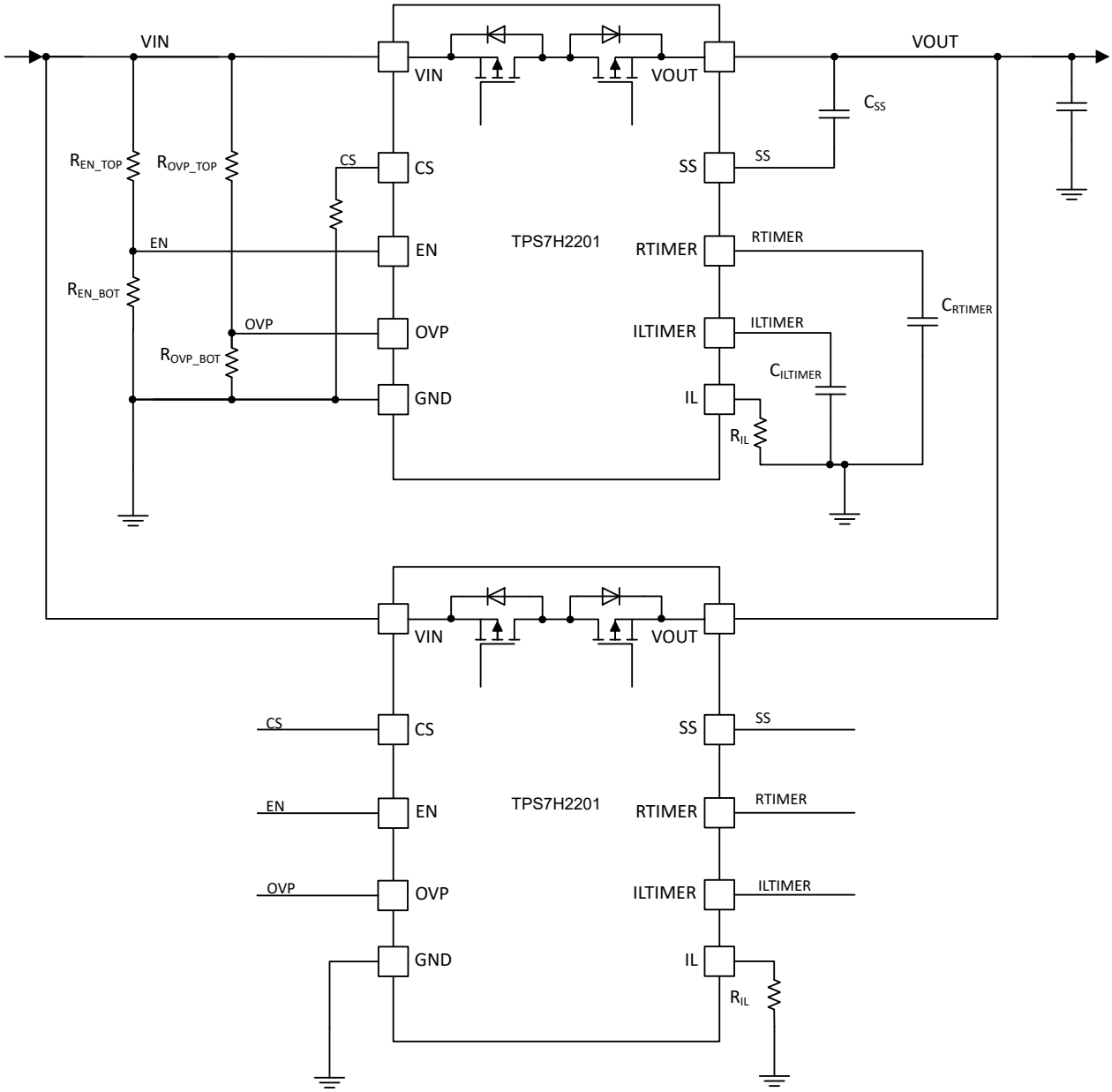


Figure 2-2. Parallel Configuration Example

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3 Implementation Results

3.1 Default Configuration Results

All tests were performed using the default configuration shown in Table 1-1.

CAUTION

Under extreme fault conditions (a constant GND short on the output for example), if the device is configured for current limit and retry mode, then the amount of power dissipates is large. If left unchecked, then this on-off behavior can cause the board to heat up quickly.

Programmable Fault Timers

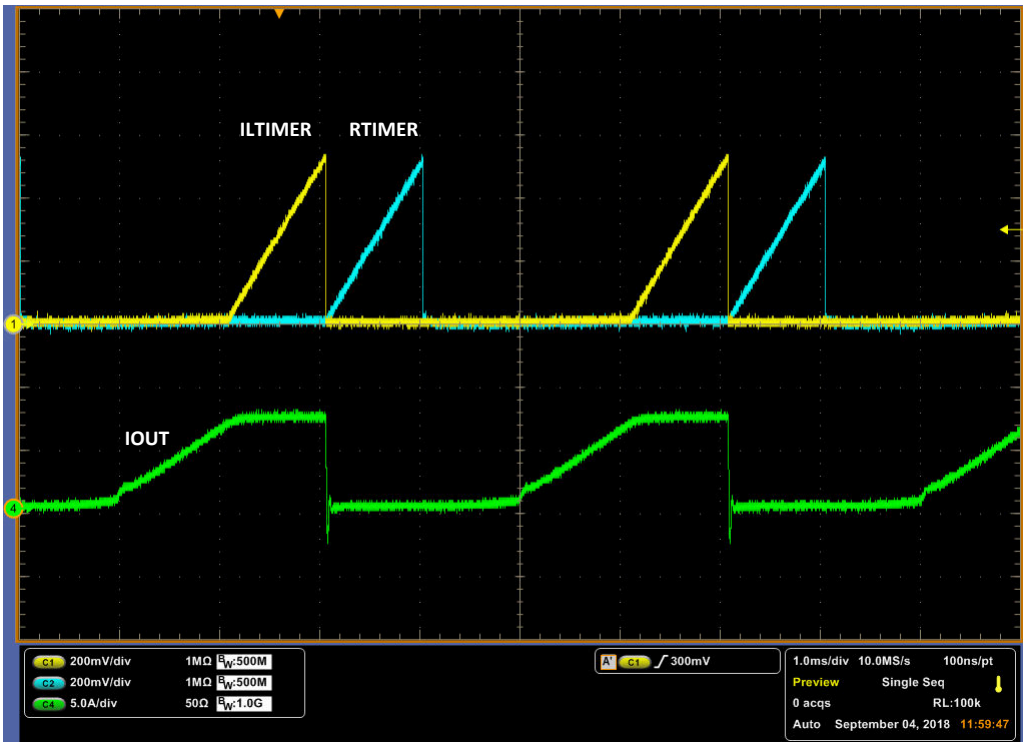


Figure 3-1. ILTIMER and RTIMER Waveforms for IL=7.5 A

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Power Up and Power Down

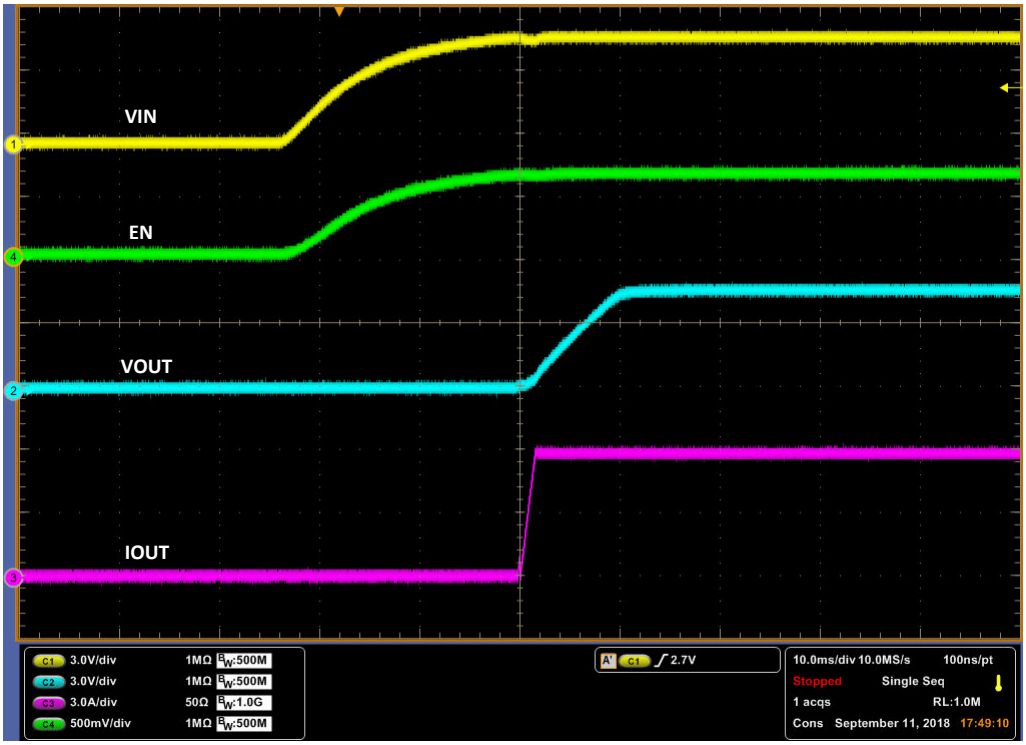


Figure 3-2. Power-up

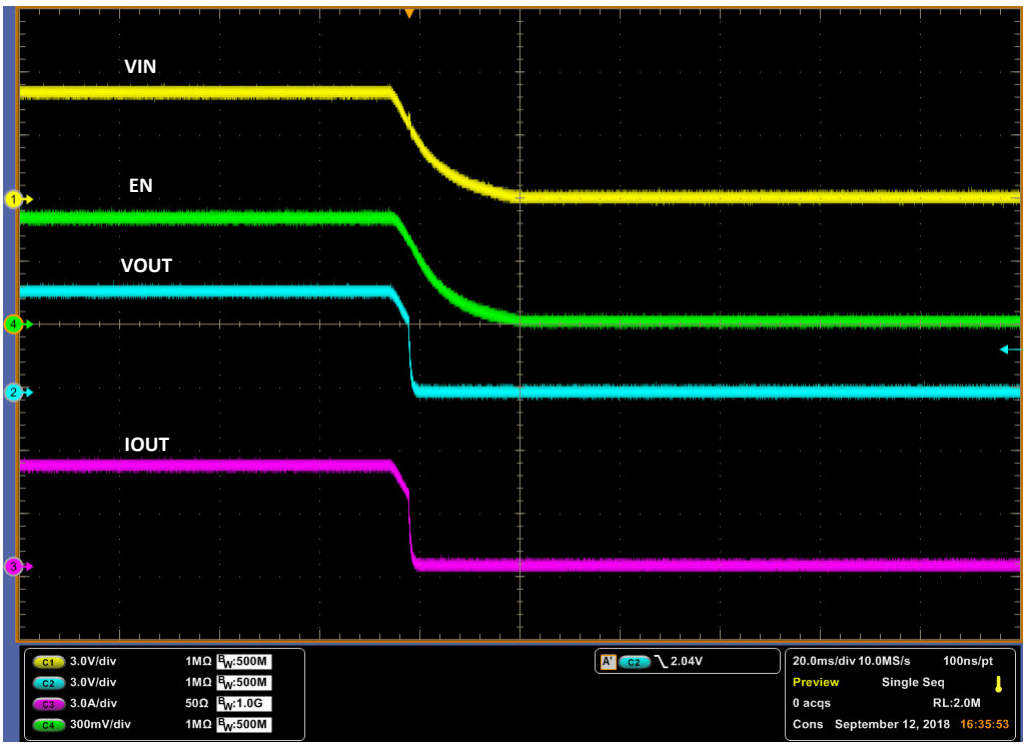


Figure 3-3. Power-down

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Overvoltage Protection

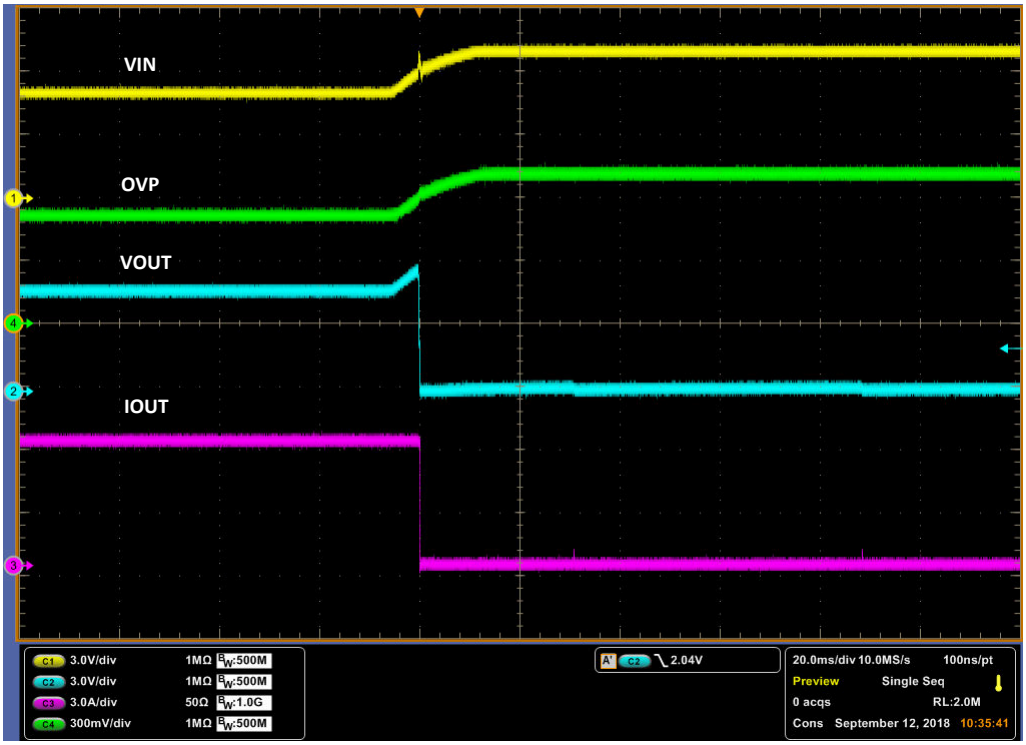


Figure 3-4. OVP Assertion at VIN = 6 V

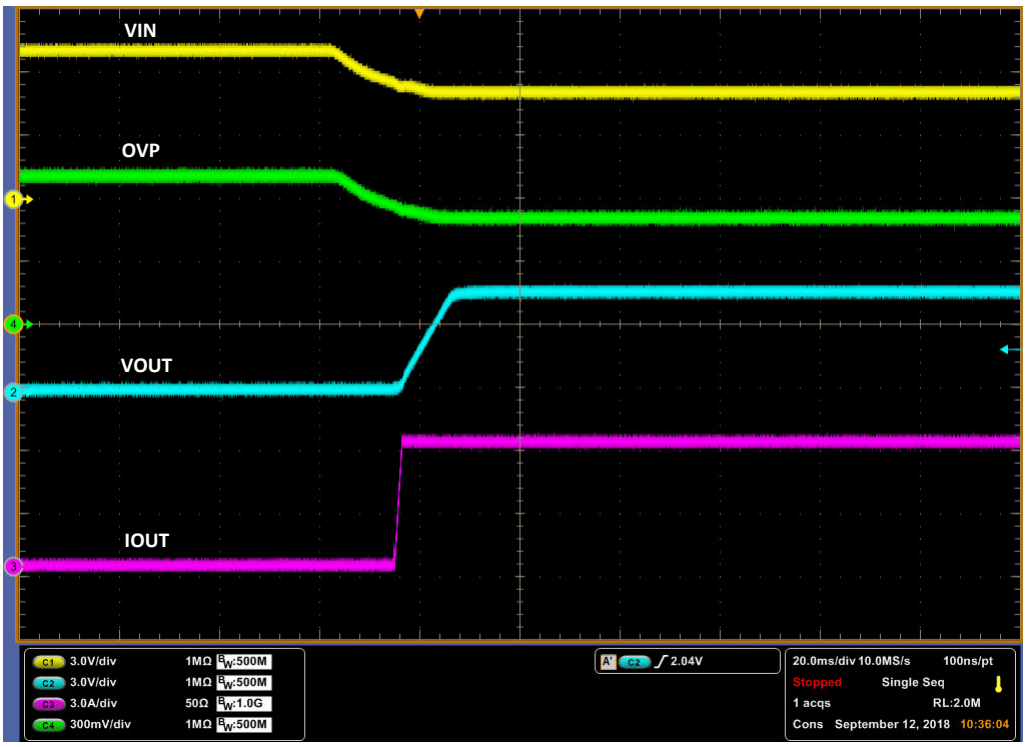


Figure 3-5. OVP Deassertion by Returning VIN = 5 V

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4 Hardware Design Files

4.1 Schematic

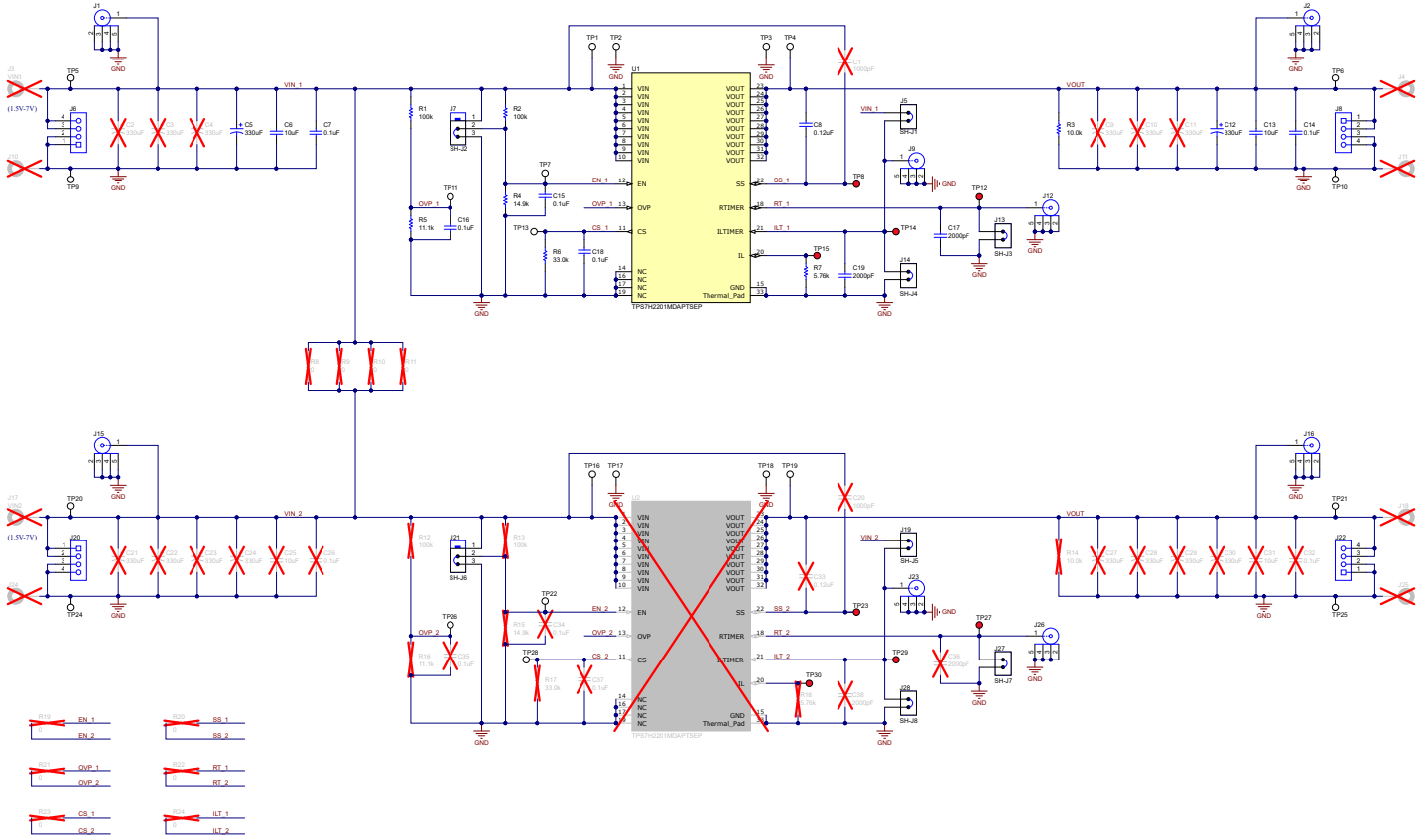


Figure 4-1. TPS7H2201EVM Default Schematic

An example schematic is also provided below, which shows the EVM configured for parallel operation.

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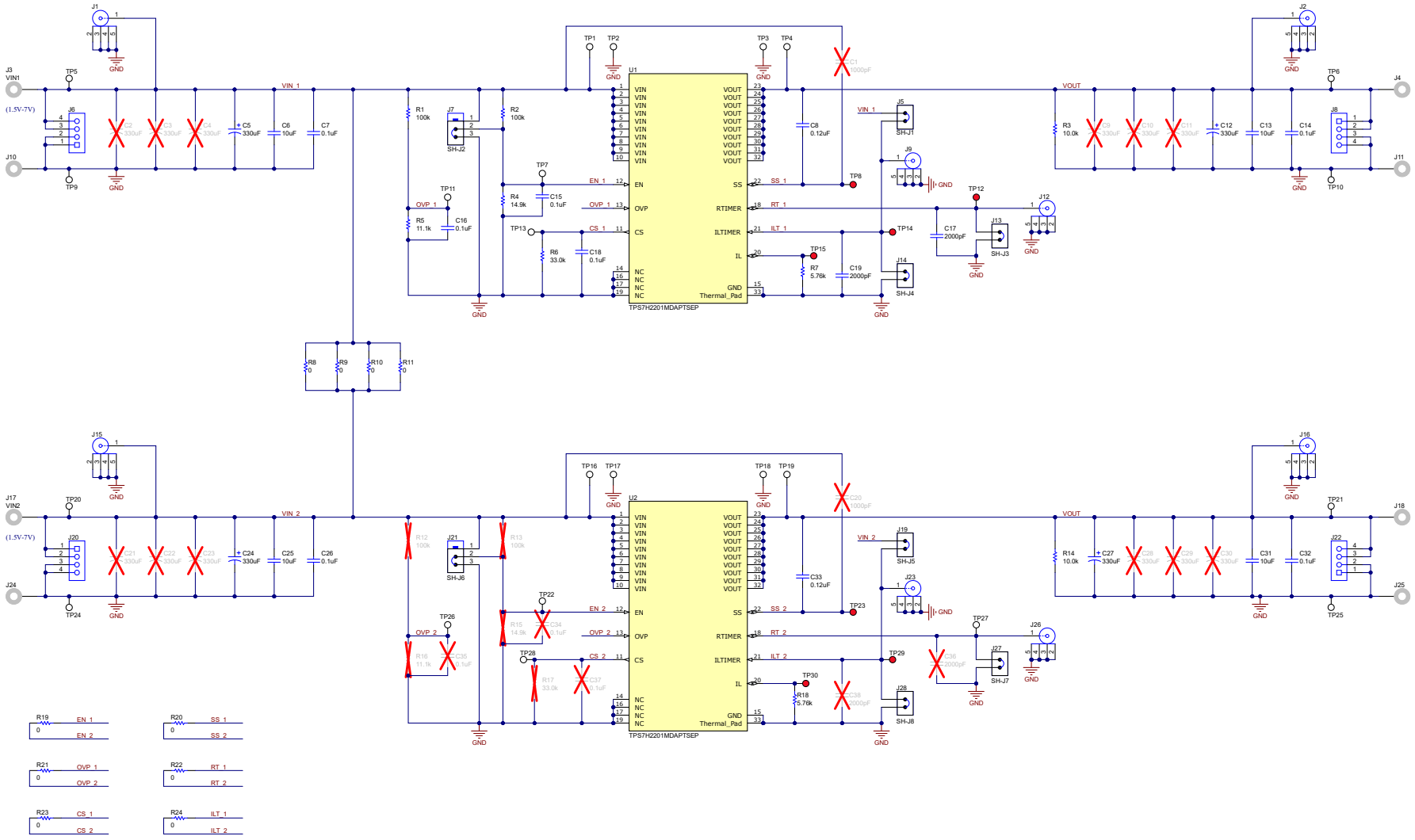


Figure 4-2. Example: TPS7H2201EVM Parallel Schematic

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4.2 PCB Layouts

The EVM layout flows from left (VIN) to right (VOUT) with the input and output capacitors placed as close as possible to the TPS7H2201. Vias under the TPS7H2201 allow a thermal path from the top layer all the way to the bottom layer. The EVM does not populate all the input and output capacitors for the TPS7H2201 but has footprints that allow additional capacitors to be populated. While this provides flexibility to the customer for electrical evaluation, it does not reflect the best optimized area for the TPS7H2201 in a real application.

The following images show the TPS7H2201EVM board layers.

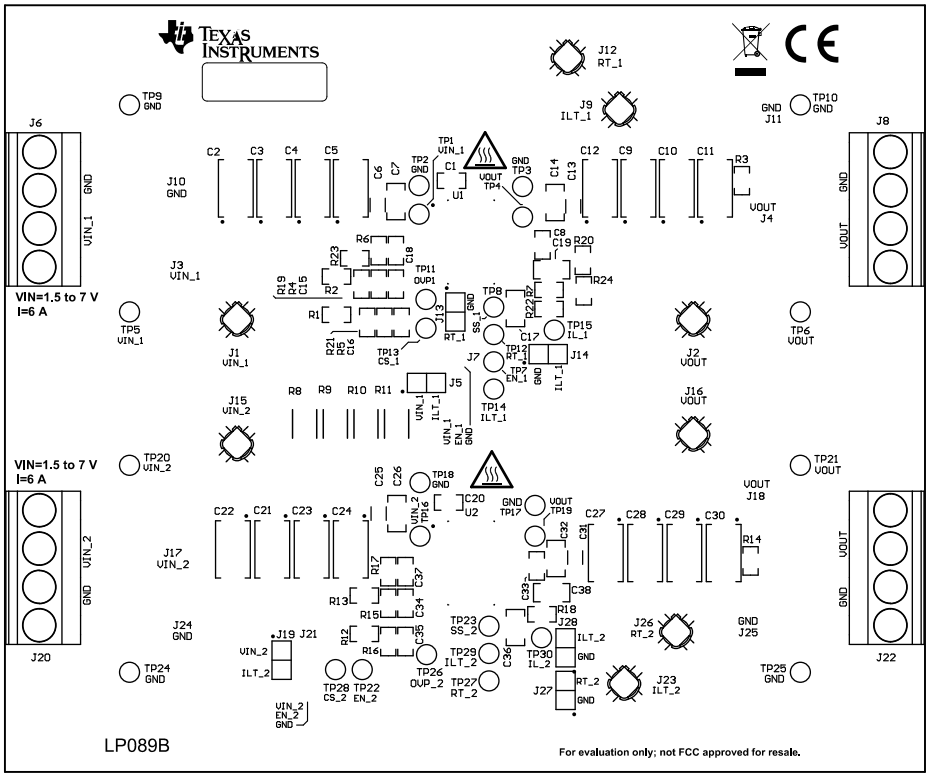


Figure 4-3. Top Overlay

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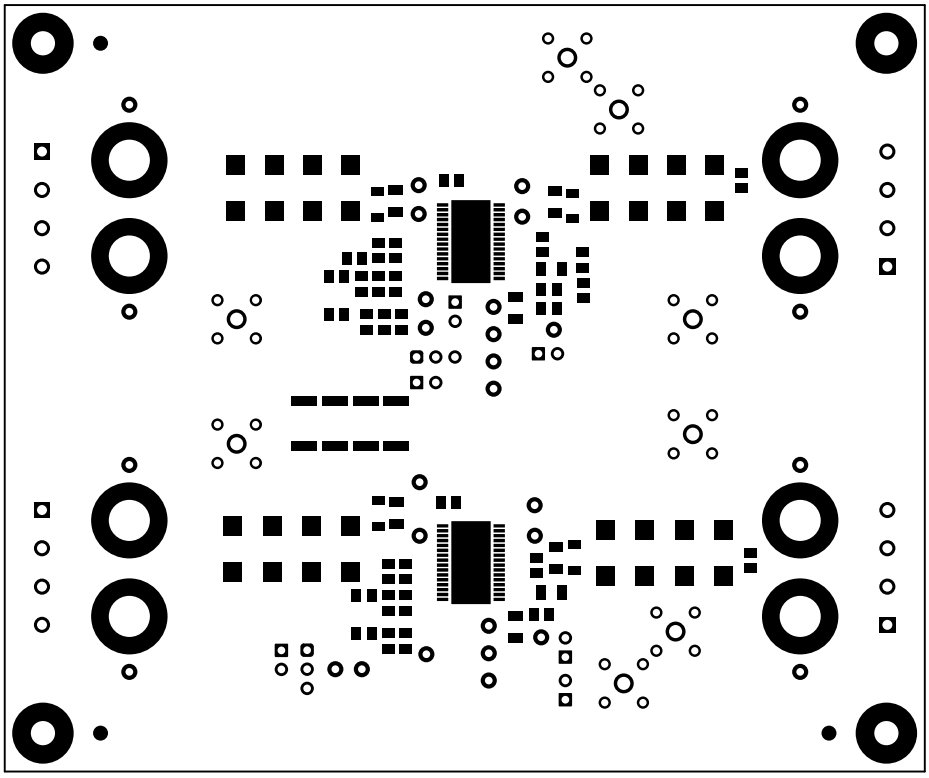


Figure 4-4. Top Solder Mask

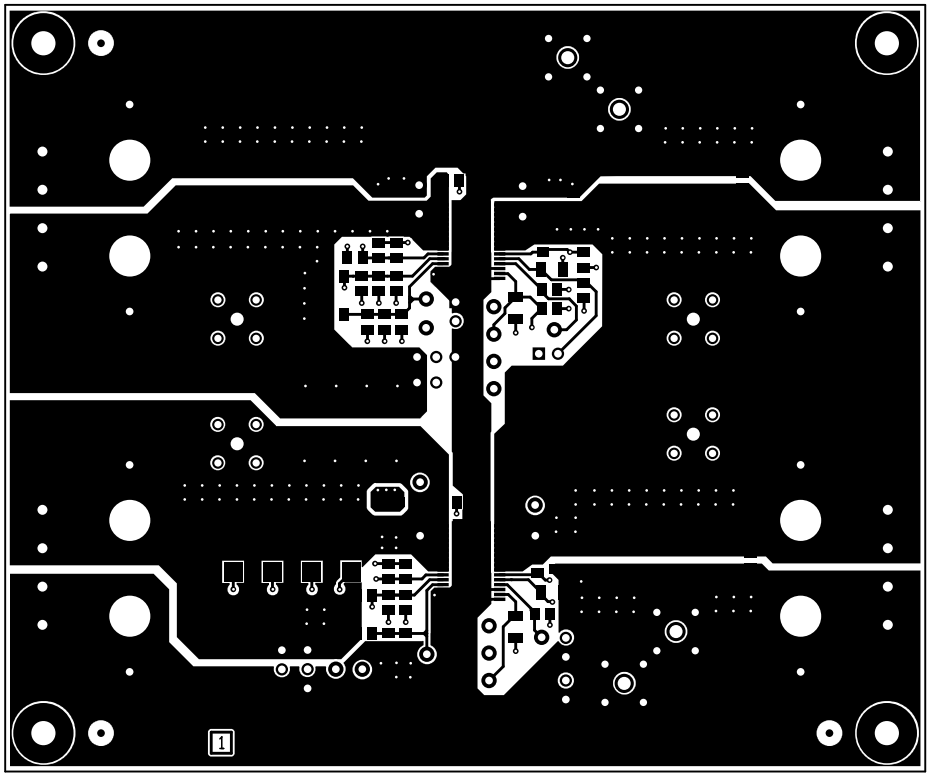


Figure 4-5. Layer 1 (Top)

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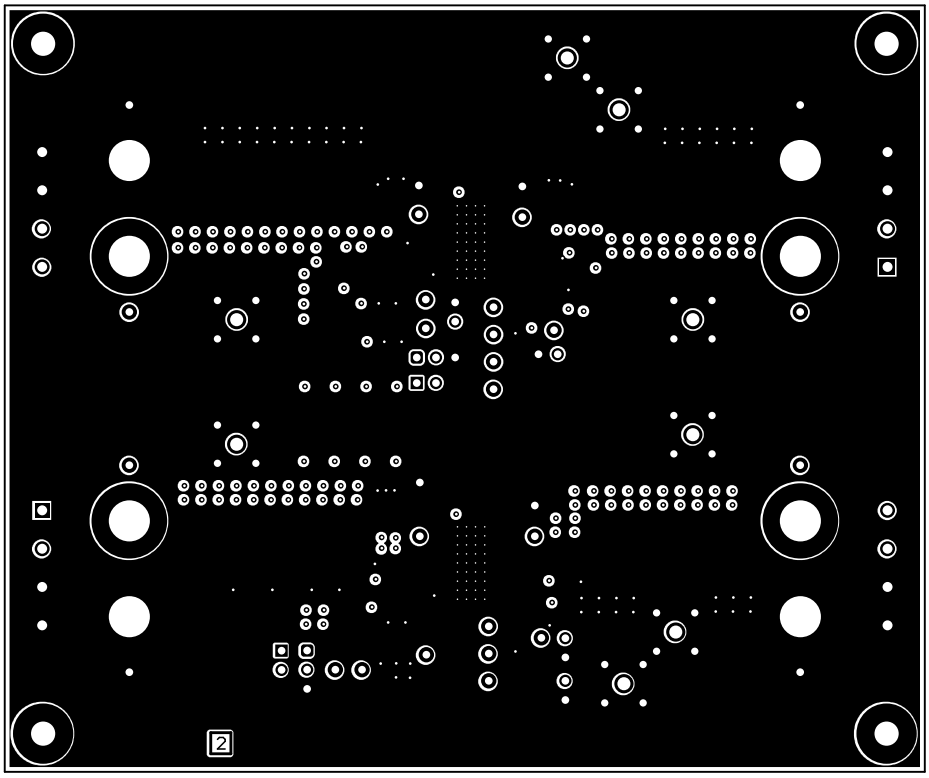


Figure 4-6. Layer 2

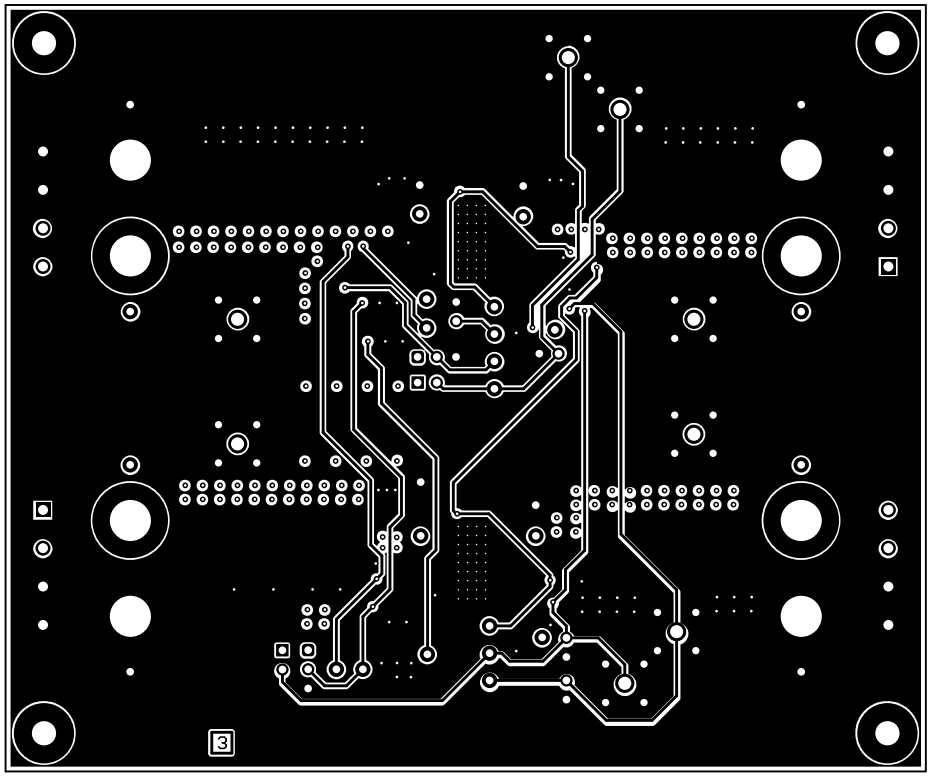


Figure 4-7. Layer 3

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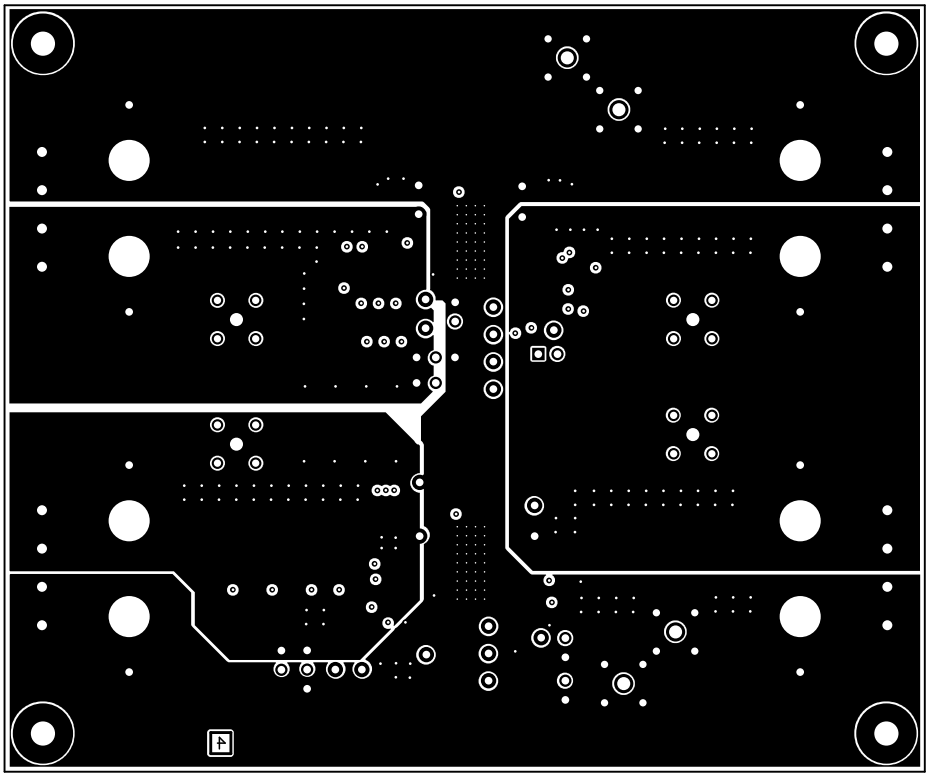


Figure 4-8. Layer 4 (Bottom)

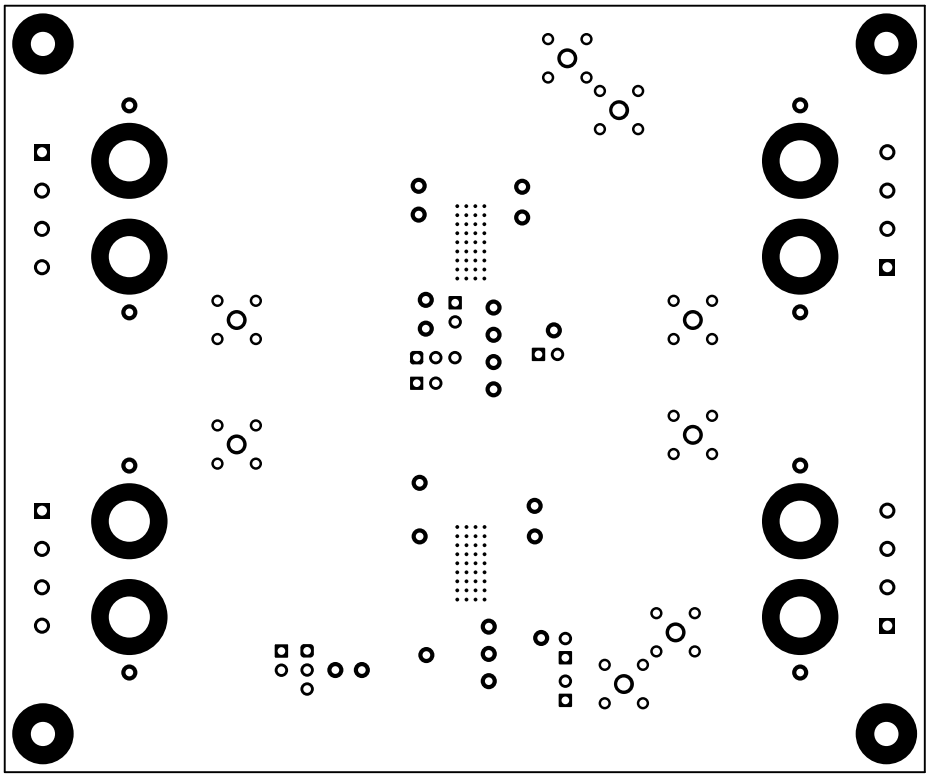


Figure 4-9. Bottom Solder

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4.3 Bill of Materials

Default Configuration BOM

Table 4-1. TPS7H2201EVM Default BOM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C5, C12	2	330uF	CAP, Tantalum Polymer, 330 uF, 10 V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C6, C13	2	10uF	CAP, CERM, 10 uF, 50 V, +/- 10%, X5R, 1206_190	1206_190	CL31A106KBHNNNE	Samsung Electro-Mechanics
C7, C14	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 1206	1206	12065C104JAT2A	AVX
C8	1	0.12uF	CAP, CERM, 0.12 uF, 50 V, +/- 10%, X7R, 0805	805	08055C124KAT2A	AVX
C15, C16, C18	3	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 5%, X7R, 0805	805	08053C104JAZ2A	AVX
C17, C19	2	2000 pF	CAP, CERM, 2000 pF, 50 V,+/- 5%, C0G/NP0, 1206	1206	12065A202JAT2A	AVX
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J9, J12, J15, J16, J23, J26	8		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix
J5, J13, J14, J19, J27, J28	6		Header, 100mil, 2x1, Gold, TH	Header, 100mil, 2x1, TH	HTSW-102-07-G-S	Samtec
J6, J8, J20, J22	4		Terminal Block, 4x1, 5.08mm, TH	4x1 Terminal Block	39544-3004	Molex
J7, J21	2		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1, R2	2	100k	RES, 100 k, 0.1%, 0.125 W, 0805	805	RT0805BRD07100KL	Yageo America
R3	1	10.0k	RES, 10.0 k, 1%, 0.2 W, 0805	805	MCU08050C1002FP500	Vishay/Beyschlag
R4	1	14.9k	RES, 14.9 k, 0.1%, 0.125 W, 0805	805	RT0805BRD0714K9L	Yageo America
R5	1	11.1k	RES, 11.1 k, 0.1%, 0.2 W, 0805	805	PTN0805E1112BST1	Vishay Thin Film
R6	1	33.0k	RES, 33.0 k, 0.1%, 0.125 W, 0805	805	RG2012P-333-B-T5	Susumu Co Ltd
R7	1	5.76k	RES, 5.76 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW08055K76FKEA	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8	8	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions

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Table 4-1. TPS7H2201EVM Default BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP9, TP10, TP11, TP13, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP24, TP25, TP26, TP28	22		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
TP8, TP12, TP14, TP15, TP23, TP27, TP29, TP30	8		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
U1	1		TPS7H2201MDAPTSEP	HTSSOP32	TPS7H2201MDAPTSEP	Texas Instruments
C1, C20	0	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, X7R, 0805	805	C0805C102J5RACTU	Kemet
C2, C3, C4, C9, C10, C11, C21, C22, C23, C24, C27, C28, C29, C30	0	330uF	CAP, Tantalum Polymer, 330 uF, 10 V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C25, C31	0	10uF	CAP, CERM, 10 uF, 50 V, +/- 10%, X5R, 1206_190	1206_190	CL31A106KBHNNNE	Samsung Electro-Mechanics
C26, C32	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 1206	1206	12065C104JAT2A	AVX
C33	0	0.12uF	CAP, CERM, 0.12 uF, 50 V, +/- 10%, X7R, 0805	805	08055C124KAT2A	AVX
C34, C35, C37	0	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 5%, X7R, 0805	805	08053C104JAZ2A	AVX
C36, C38	0	2000 pF	CAP, CERM, 2000 pF, 50 V,+/- 5%, C0G/NP0, 1206	1206	12065A202JAT2A	AVX
J3, J4, J10, J11, J17, J18, J24, J25	0		Standard Banana Jack, Uninsulated, 5.5mm	Keystone_575-4	575-4	Keystone
R8, R9, R10, R11	0	0	RES, 0, 5%, 1 W, 2512	2512	RC6432J000CS	Samsung
R12, R13	0	100k	RES, 100 k, 0.1%, 0.125 W, 0805	805	RT0805BRD07100KL	Yageo America
R14	0	10.0k	RES, 10.0 k, 1%, 0.2 W, 0805	805	MCU08050C1002FP500	Vishay/Beyschlag
R15	0	14.9k	RES, 14.9 k, 0.1%, 0.125 W, 0805	805	RT0805BRD0714K9L	Yageo America
R16	0	11.1k	RES, 11.1 k, 0.1%, 0.2 W, 0805	805	PTN0805E1112BST1	Vishay Thin Film
R17	0	33.0k	RES, 33.0 k, 0.1%, 0.125 W, 0805	805	RG2012P-333-B-T5	Susumu Co Ltd
R18	0	5.76k	RES, 5.76 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW08055K76FKEA	Vishay-Dale
R19, R20, R21, R22, R23, R24	0	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW08050000Z0EA	Vishay-Dale
U2	0		TPS7H2201MDAPTSEP	HTSSOP32	TPS7H2201MDAPTSEP	Texas Instruments

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Parallel Configuration BOM

An example BOM for the EVM configured for parallel operation is provided below.

Table 4-2. Example: TPS7H2201EVM Parallel Configuration BOM

Designator	Qty	Value	Description	PackageReference	PartNumber	Manufacturer
C5, C12, C24, C27	4	330uF	CAP, Tantalum Polymer, 330 uF, 10 V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C6, C13, C25, C31	4	10uF	CAP, CERM, 10 uF, 50 V, +/- 10%, X5R, 1206_190	1206_190	CL31A106KBHNNNE	Samsung Electro-Mechanics
C7, C14, C26, C32	4	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 1206	1206	12065C104JAT2A	AVX
C8, C33	2	0.12uF	CAP, CERM, 0.12 uF, 50 V, +/- 10%, X7R, 0805	805	08055C124KAT2A	AVX
C15, C16, C18	3	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 5%, X7R, 0805	805	08053C104JAZ2A	AVX
C17, C19	2	2000 pF	CAP, CERM, 2000 pF, 50 V,+/- 5%, C0G/NP0, 1206	1206	12065A202JAT2A	AVX
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J9, J12, J15, J16, J23, J26	8		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix
J3, J4, J10, J11, J17, J18, J24, J25	8		Standard Banana Jack, Uninsulated, 5.5mm	Keystone_575-4	575-4	Keystone
J5, J13, J14, J19, J27, J28	6		Header, 100mil, 2x1, Gold, TH	Header, 100mil, 2x1, TH	HTSW-102-07-G-S	Samtec
J6, J8, J20, J22	4		Terminal Block, 4x1, 5.08mm, TH	4x1 Terminal Block	39544-3004	Molex
J7, J21	2		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1, R2	2	100k	RES, 100 k, 0.1%, 0.125 W, 0805	805	RT0805BRD07100KL	Yageo America
R3, R14	2	10.0k	RES, 10.0 k, 1%, 0.2 W, 0805	805	MCU08050C1002FP500	Vishay/Beyschlag
R4	1	14.9k	RES, 14.9 k, 0.1%, 0.125 W, 0805	805	RT0805BRD0714K9L	Yageo America
R5	1	11.1k	RES, 11.1 k, 0.1%, 0.2 W, 0805	805	PTN0805E1112BST1	Vishay Thin Film
R6	1	33.0k	RES, 33.0 k, 0.1%, 0.125 W, 0805	805	RG2012P-333-B-T5	Susumu Co Ltd
R7, R18	2	5.76k	RES, 5.76 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW08055K76FKEA	Vishay-Dale
R8, R9, R10, R11	4	0	RES, 0, 5%, 1 W, 2512	2512	RC6432J000CS	Samsung
R19, R20, R21, R22, R23, R24	6	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW08050000Z0EA	Vishay-Dale

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Table 4-2. Example: TPS7H2201EVM Parallel Configuration BOM (continued)

Designator	Qty	Value	Description	PackageReference	PartNumber	Manufacturer
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8	8	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP9, TP10, TP11, TP13, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP24, TP25, TP26, TP28	22		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
TP8, TP12, TP14, TP15, TP23, TP27, TP29, TP30	8		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
U1, U2	2		TPS7H2201MDAPTSEP	HTSSOP32	TPS7H2201MDAPTSEP	Texas Instruments
C1, C20	0	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, X7R, 0805	805	C0805C102J5RACTU	Kemet
C2, C3, C4, C9, C10, C11, C21, C22, C23, C28, C29, C30	0	330uF	CAP, Tantalum Polymer, 330 uF, 10 V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C34, C35, C37	0	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 5%, X7R, 0805	805	08053C104JAZ2A	AVX
C36, C38	0	2000 pF	CAP, CERM, 2000 pF, 50 V,+/- 5%, C0G/NP0, 1206	1206	12065A202JAT2A	AVX
R12, R13	0	100k	RES, 100 k, 0.1%, 0.125 W, 0805	805	RT0805BRD07100KL	Yageo America
R15	0	14.9k	RES, 14.9 k, 0.1%, 0.125 W, 0805	805	RT0805BRD0714K9L	Yageo America
R16	0	11.1k	RES, 11.1 k, 0.1%, 0.2 W, 0805	805	PTN0805E1112BST1	Vishay Thin Film
R17	0	33.0k	RES, 33.0 k, 0.1%, 0.125 W, 0805	805	RG2012P-333-B-T5	Susumu Co Ltd

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5 Additional Information

Trademarks

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6 Related Documentation

- Texas Instruments, Standard Terms for Evaluation Modules

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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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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/lsds/ti_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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

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.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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