EVM User's Guide: TPS7H1302EVM-CVAL

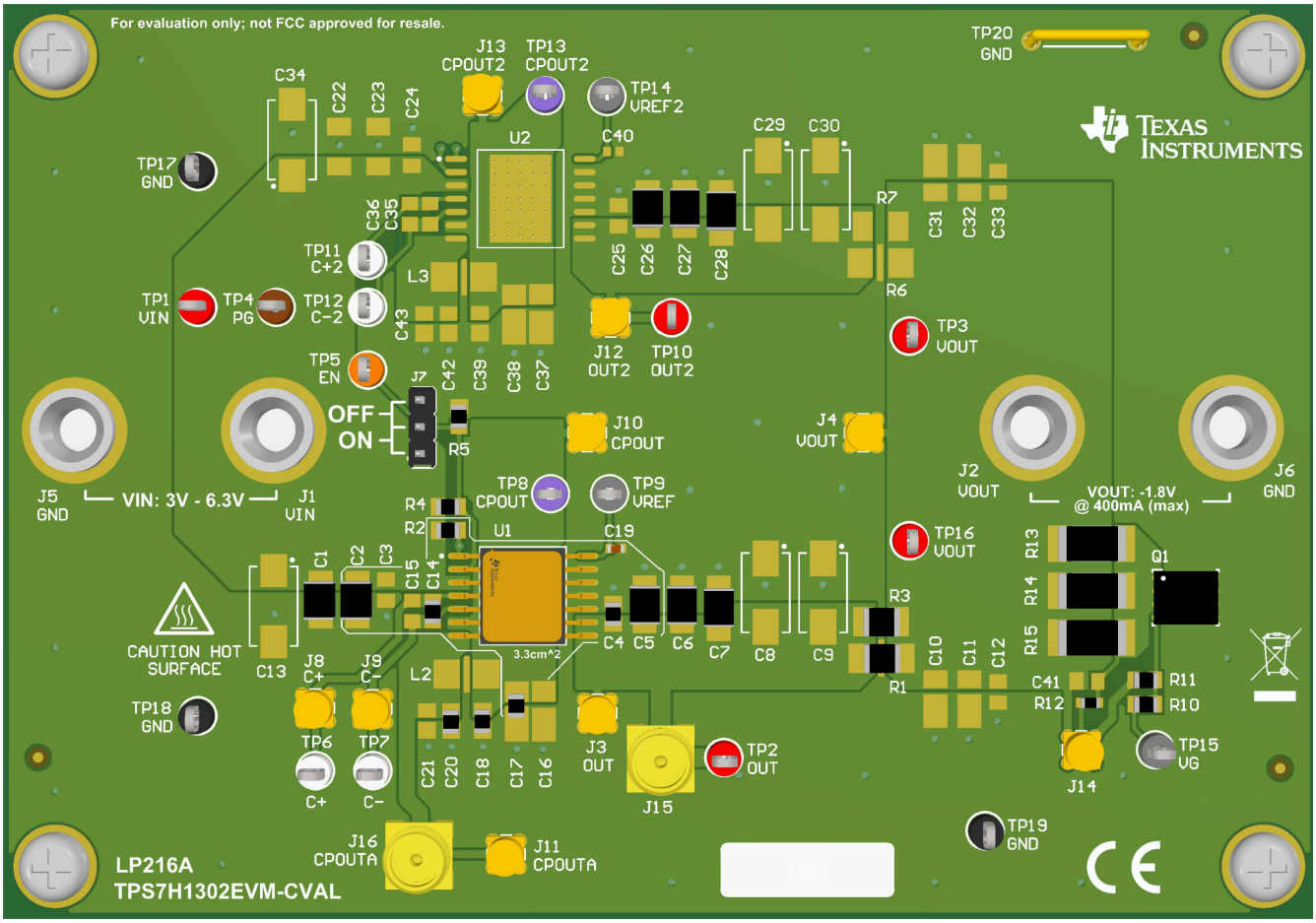
TPS7H1302-SP Evaluation Module

Description

The TPS7H1302EVM-CVAL demonstrates the operation of a single TPS7H1302-SP Switched Capacitor Voltage Inverter with Integrated Low Dropout Regulator (ceramic package). The board provides footprints that can be populated with additional components to allow for testing of customized configurations.

Features

- Flexible configuration options, including capability to configure parallel devices
- On-board load transient circuitry



1 Evaluation Module Overview

1.1 Introduction

The TPS7H1302EVM-CVAL is the Evaluation Module (EVM) for the ceramic package option of the TPS7H1302 and provides a platform to electrically evaluate its features. This user's guide provides details about the EVM, including the configuration, schematics, and BOM. The EVM is designed to provide flexibility to configure the device as desired, through footprints for external components and an additional IC footprint for parallel configurations. By default, the device on the EVM is configured as shown in TPS7H1302EVM-CVAL Default Configuration and Default EVM Schematic. To set up the device in a different configuration, please refer to the TPS7H1302 data sheet to calculate the values of the passives around the device that needs to be changed.

1.2 Kit Contents

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

1.3 Specification

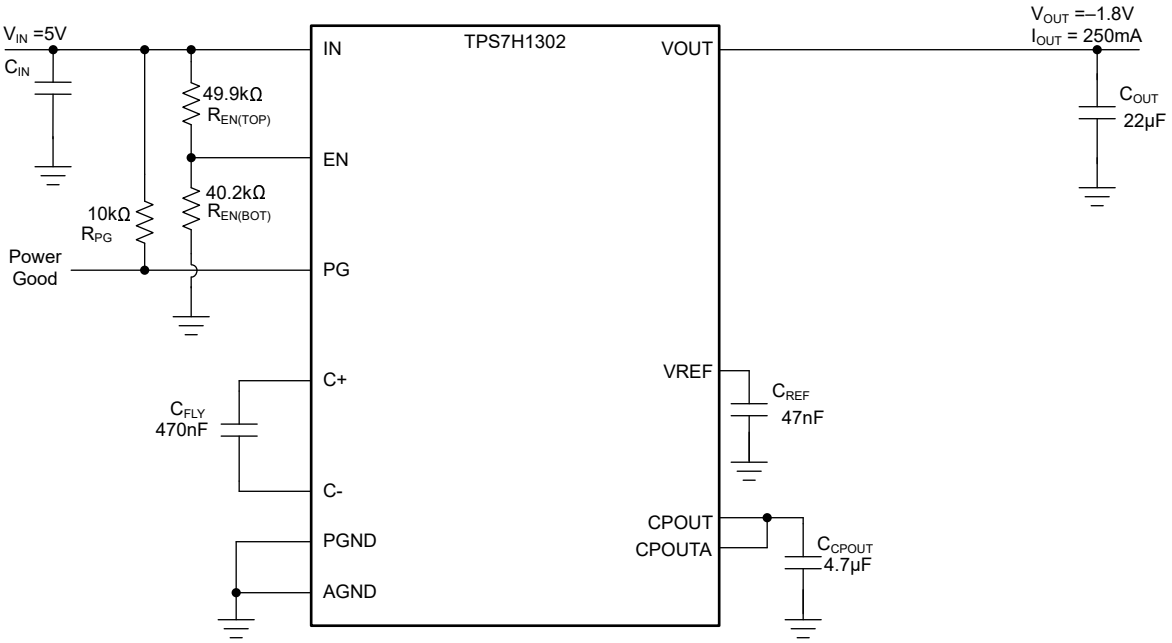


Table 1-1. Default EVM Configuration

Specification	Value	Description
Input Voltage VIN	5V	Falls within the recommended device input voltage range of 3V to 6.3V.
Output Voltage VOUT	-1.8V	Fixed output
Load current IOUT	250mA	Within the max output current rating of 400mA per device.
Enable Voltage	3.89V	VIN value that brings EN above the turn-on threshold. Set by: R4 = 54.9kΩ R5 = 10kΩ
Disable Voltage	3.25V	VIN value that brings EN below the turn-off threshold. Set by: R4 = 54.9kΩ R5 = 10kΩ
Switching Frequency fsw	1MHz	Fixed switching frequency of the internal switch cap array.

1.4 Device Information

The TPS7H1302 is a low-noise regulated switched-capacitor voltage inverter with an integrated low dropout regulator with an input voltage range of 3V to 6.3V, the TPS7H1302 is capable of providing an output current of 400mA with a fixed -1.8V output. The TPS7H1302 uses an internal switching frequency of 1MHz.

2 Hardware

2.1 Power Requirements

The TPS7H1302EVM-CVAL requires a single positive power rail (VIN).

- 3V ≤ VIN ≤ 6.3V

2.2 Jumper Information

Designator	Function	
J1	VIN	Positive voltage power input for VIN
J5	GND	
J2	VOUT	Negative voltage power output for VOUT
J6	GND	
J7	EN	Jumper to tie EN to VIN or GND for simple enable/disable.

2.3 Test Points

Designator	Function	
TP1	VIN	Test point for VIN.
TP2	OUT	Test Point for OUT of the main device.
TP10	OUT2	Test Point for OUT of the secondary device.
TP3	VOUT	Test point for shared VOUT of both main and secondary devices.
TP4	PG	Test point for the shared PG signals of both the main and secondary device.
TP5	EN	Test point for the shared EN signal of both the main and secondary devices.
TP6	C+	Test point for the positive terminal of the flying capacitor of the main device.
J8		MMXC connector for the positive terminal of the flying capacitor of the main device.
TP11	C+2	Test point for the positive terminal of the flying capacitor of the secondary device.
TP7	C-	Test point for the negative terminal of the flying capacitor for the main device.
J9		MMCX connector for the negative terminal of the flying capacitor for the main device.
TP12	C-2	Test point for the negative terminal of the flying capacitor of the secondary device.
TP8	CPOUT	Test point for CPOUT of the main device.
J10		MMCX test point for CPOUT of the main device.
TP13	CPOUT2	Test point for CPOUT of the secondary device.
J13		MMCX test point for CPOUT of the secondary device.
J11	CPOUTA	MMCX test point for CPOUTA of the main device.
J16		SMA connector for CPOUTA of the main device.
TP9	VREF	Test point for VREF of the main device.
TP14	VREF2	Test point for VREF of the secondary device.
TP17, TP18, TP19, TP20	GND	Test points for GND.
TP15	VG	Test point used for control of the gate signal used in the load transient circuitry.
TP16	VOUT	

Designator	Function	
J14	TRANS	MMCX connector for sensing the load demanded by the load transient circuitry.

2.4 Best Practices

- Calculate the expected VDroop and VDropout requirements for the expected load when selecting VIN and VOUT.
- Verify proper orientation of components on the negative rails (such as tantalum capacitors).
- Determine VIN ripple requirements when selecting input capacitance.
- Be aware of areas of the board that can heat up during operation.

CAUTION

Hot surface. Contact can cause burns. Do Not Touch!

3 Implementation Results

Waveforms are shown below for the following behaviors:

1. Startup
2. Shutdown
3. Charge pump operation

3.1 Startup

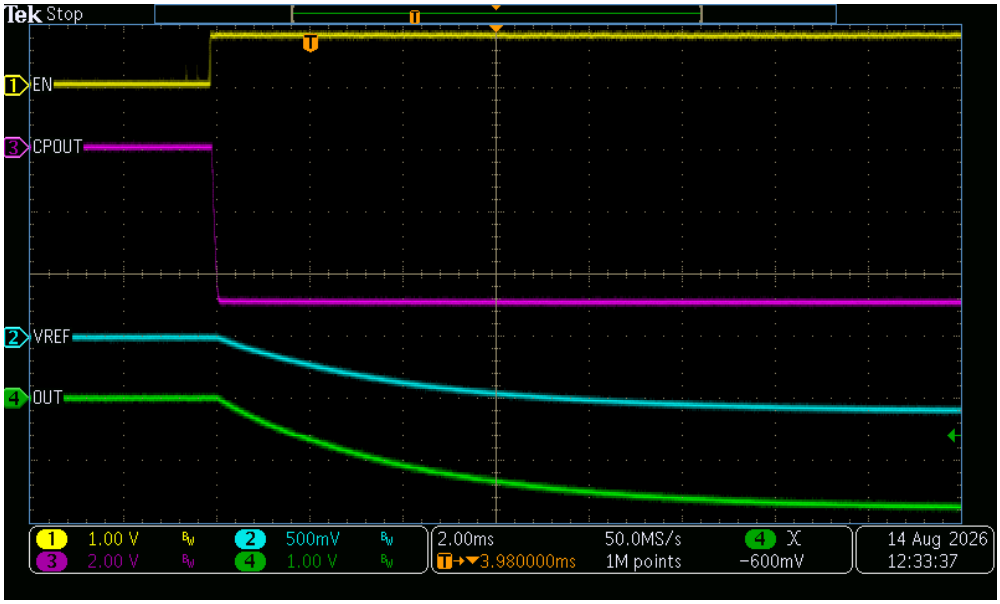


Figure 3-1. EN Independently Driven HIGH

EN follows rising VIN. CPOUT turns on when EN passes the turn-on threshold, then continues to follow VIN as VIN rises further. VOUT turns on once the magnitude of CPOUT has reached ≅60-80% of the magnitude of VIN and the charge pump has exited frequency foldback mode.

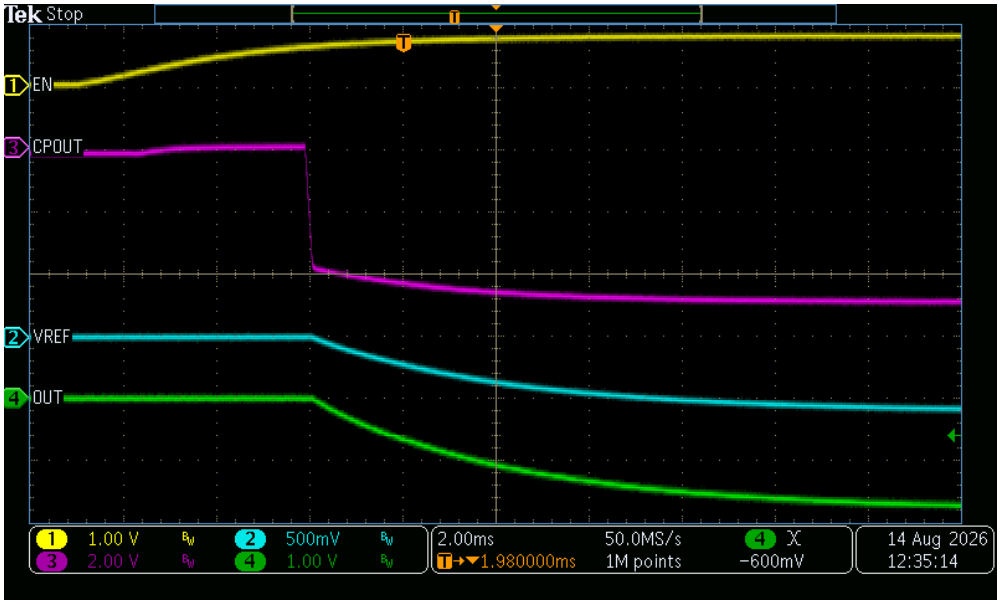


Figure 3-2. EN Tied to Rising VIN via Resistor Divider

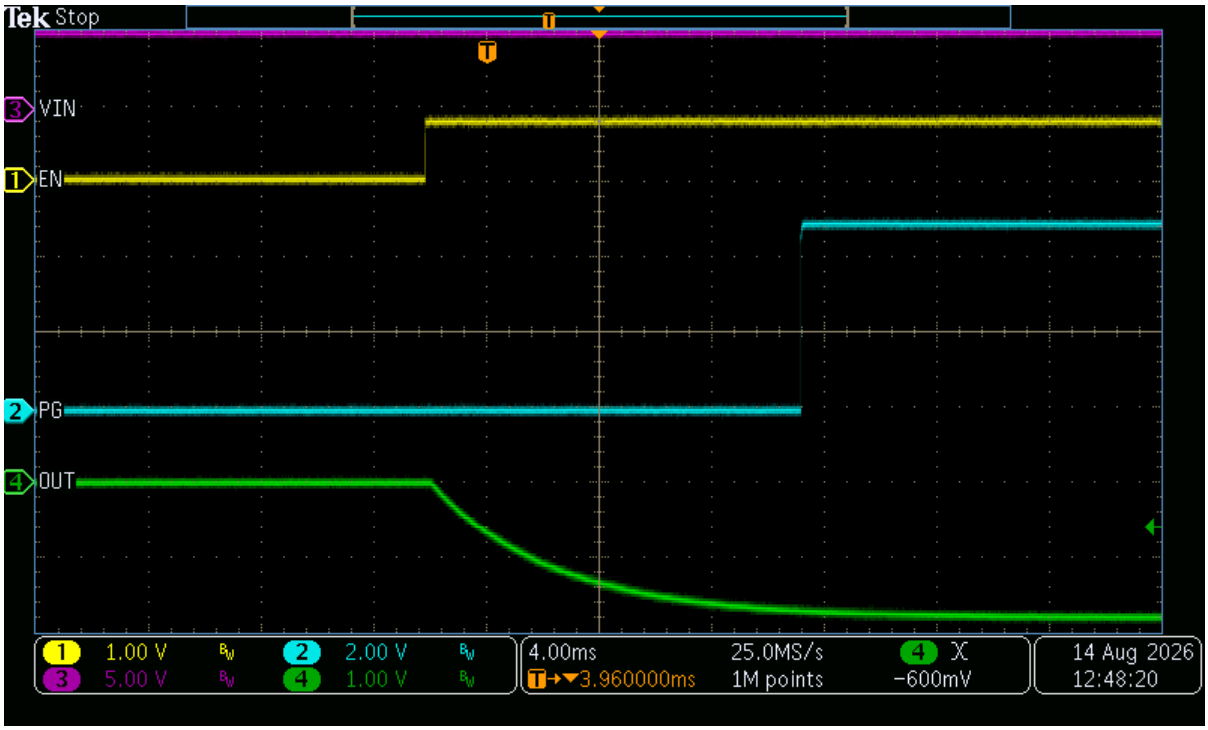


Figure 3-3. Power Good Assert - EN Independently Driven HIGH

Because VIN is rising in this waveform, the PG output can be observed briefly in an undefined state while VIN is below VIN_MIN_PG (0.8V nominal).

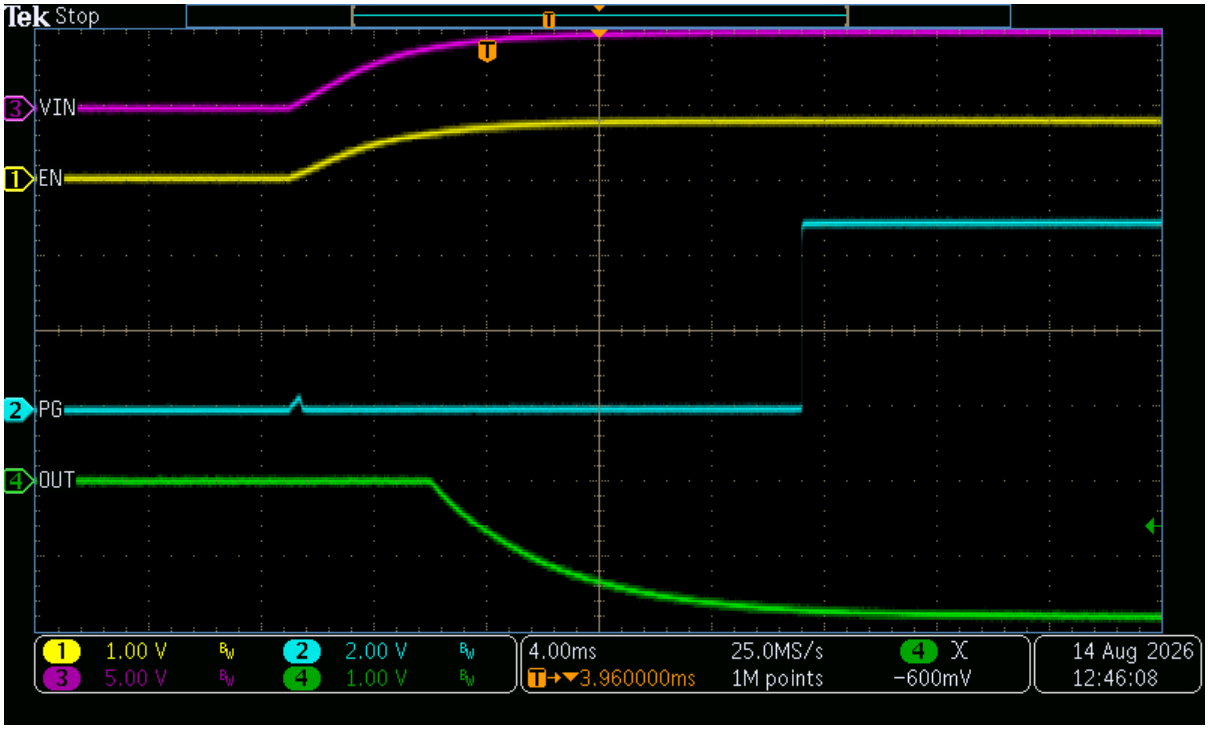


Figure 3-4. Power Good Assert - EN Tied to Rising VIN via Resistor Divider

3.2 Shutdown

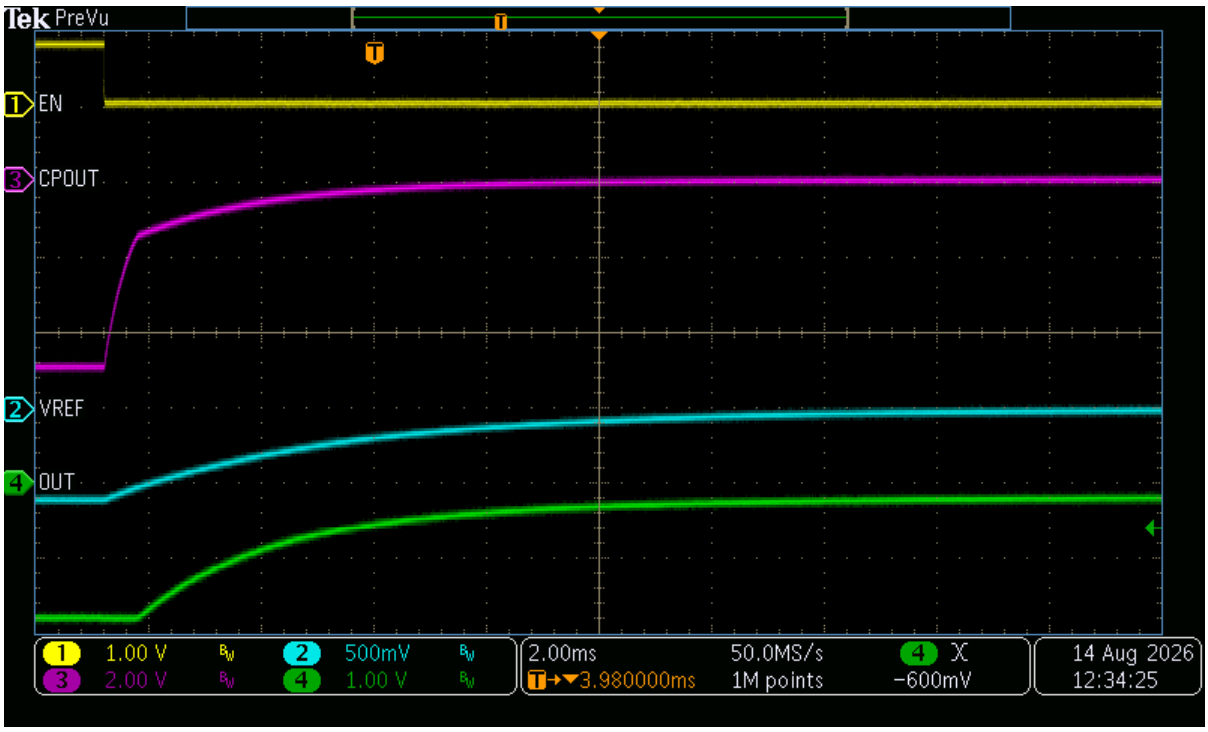


Figure 3-5. EN Independently Driven LOW

CPOUT and EN follow the falling VIN voltage until EN reaches the turn-off threshold and disables CPOUT and VOUT.

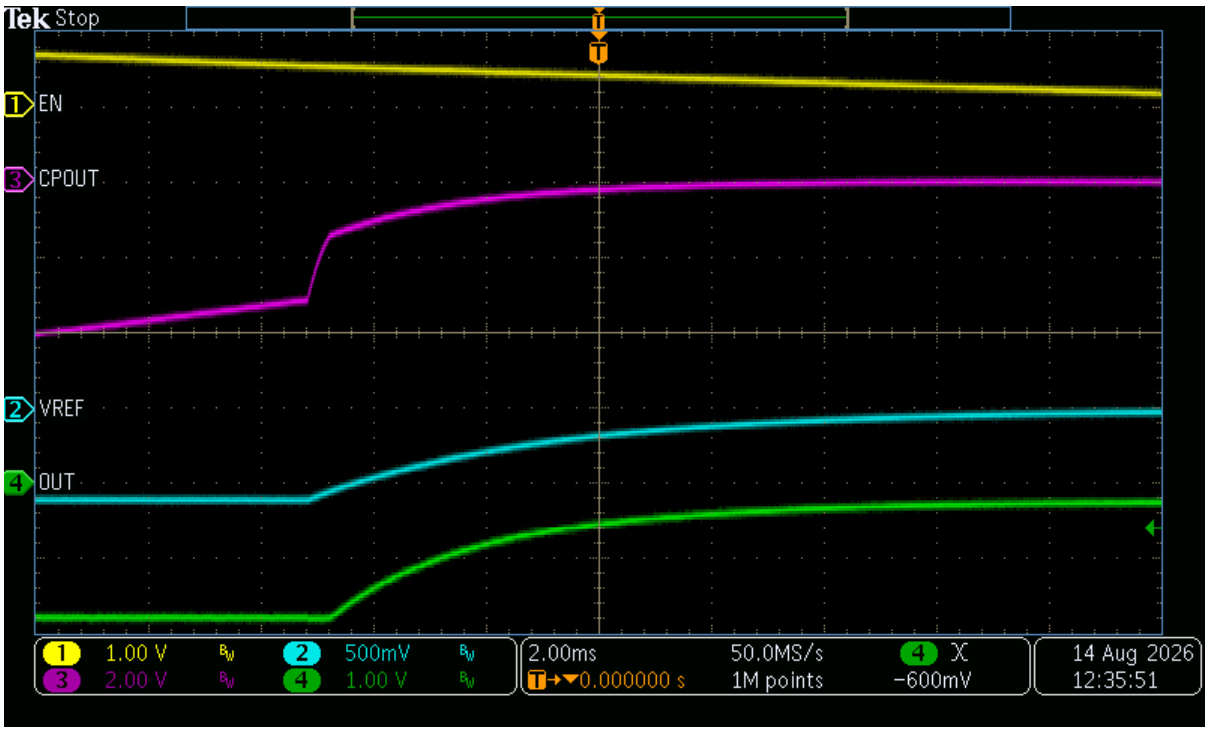


Figure 3-6. EN Tied to Falling VIN via Resistor Divider

Figure 3-7. Power Good De-assert - EN Independently Driven LOW

PG is pulled up to VIN and follows VIN until VIN is low enough for EN to reach the turn-off threshold. Because VIN is falling in this waveform, the PG output can be observed briefly in an undefined state while VIN is below VIN_MIN_PG (0.8V nominal).

Figure 3-8. Power Good De-assert - EN Tied to Falling VIN via Resistor Divider

3.3 Charge Pump Operation

C+ and C- show the charge pump at the foldback switching frequency during the startup charging of CPOUT, before entering the nominal 1MHz switching frequency.

Figure 3-9. Startup

The current demanded by the charge pump produces a ripple on VIN. Bulk capacitor and bypass capacitor selection can aid mitigation of this ripple if needed, such as in cases where VIN is a shared rail.

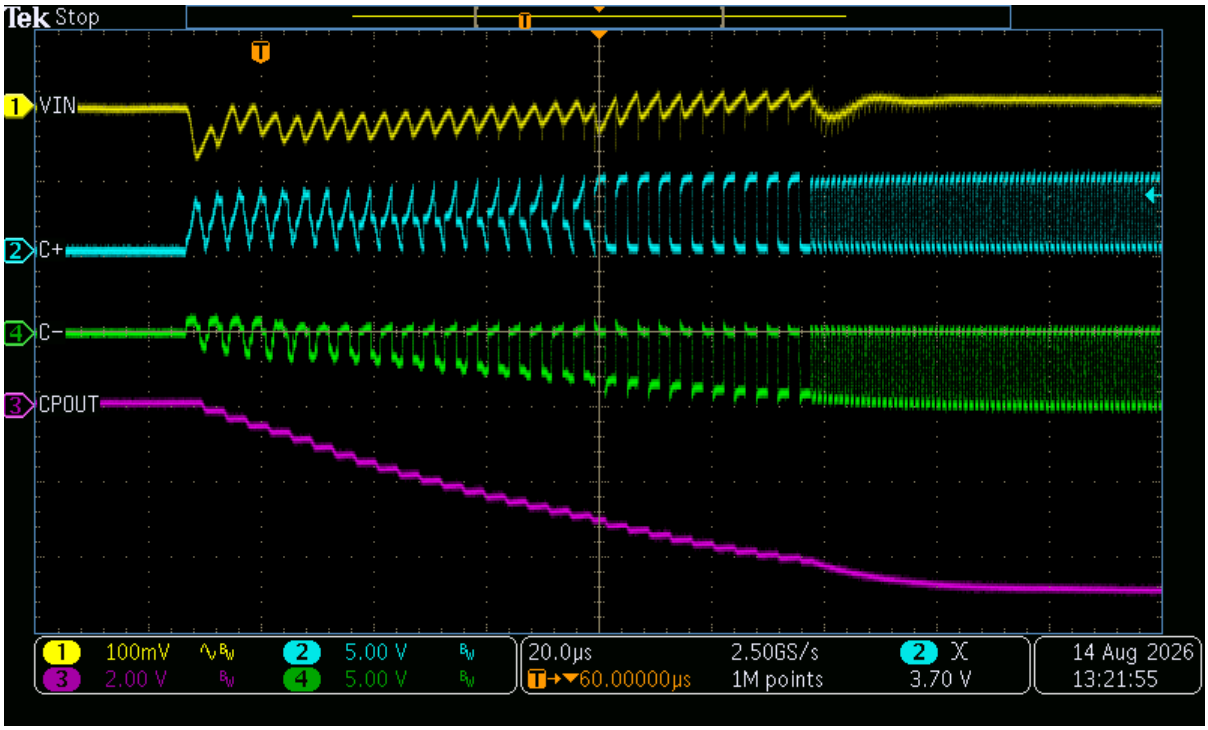


Figure 3-10. VIN Ripple

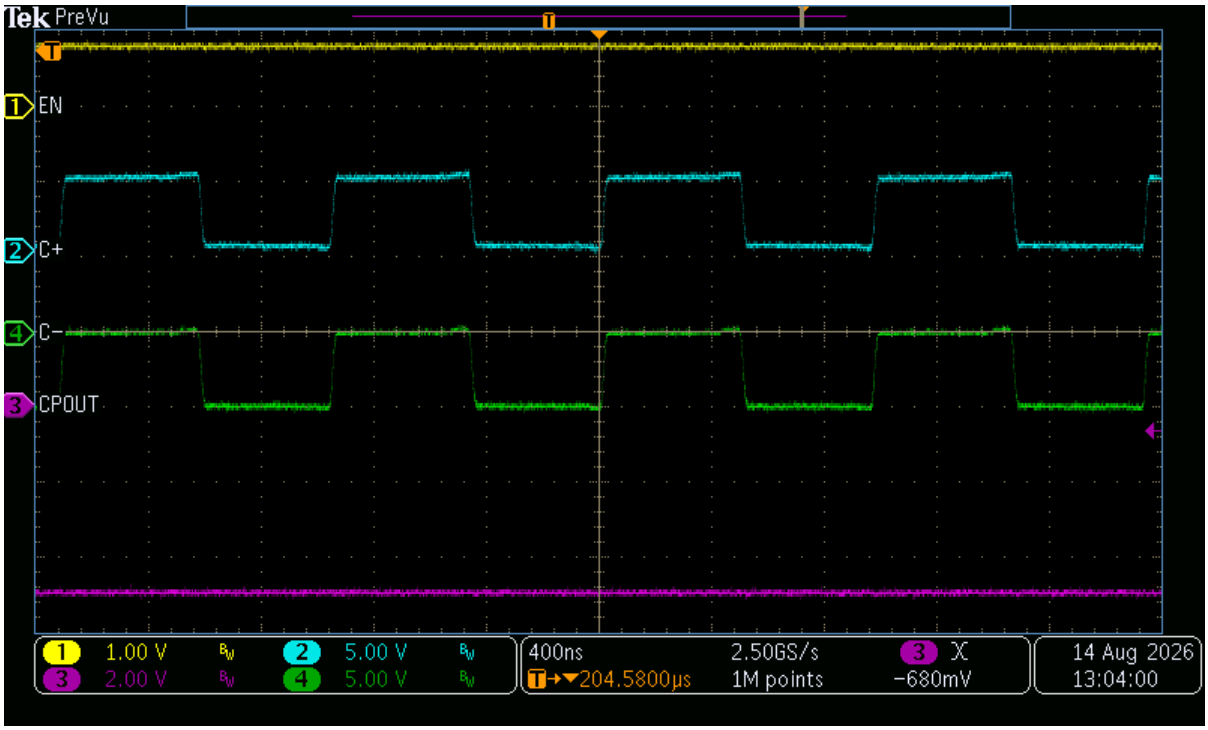


Figure 3-11. Steady-state

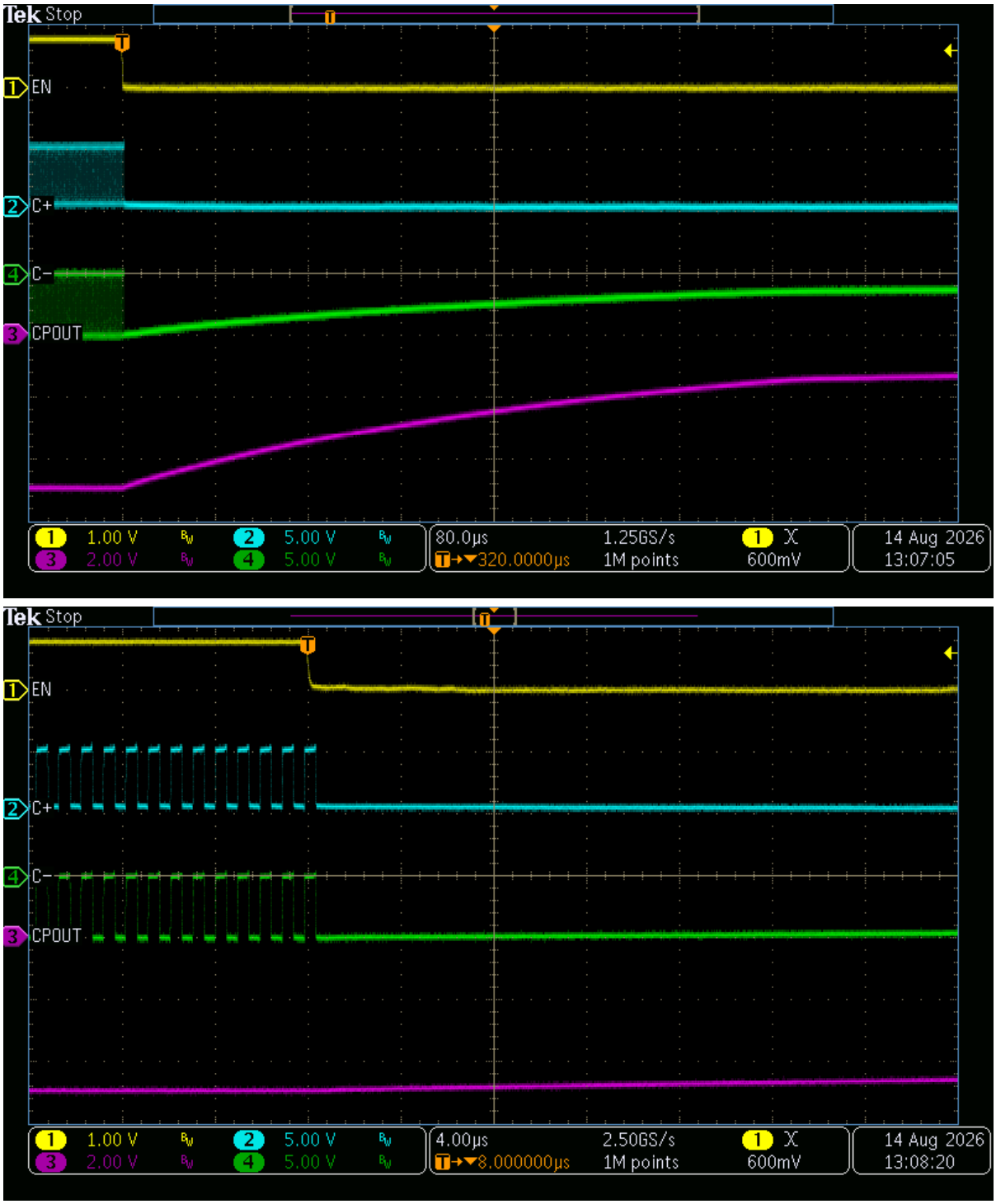


Figure 3-12. Shutdown

4 Hardware Design Files

4.1 Schematics

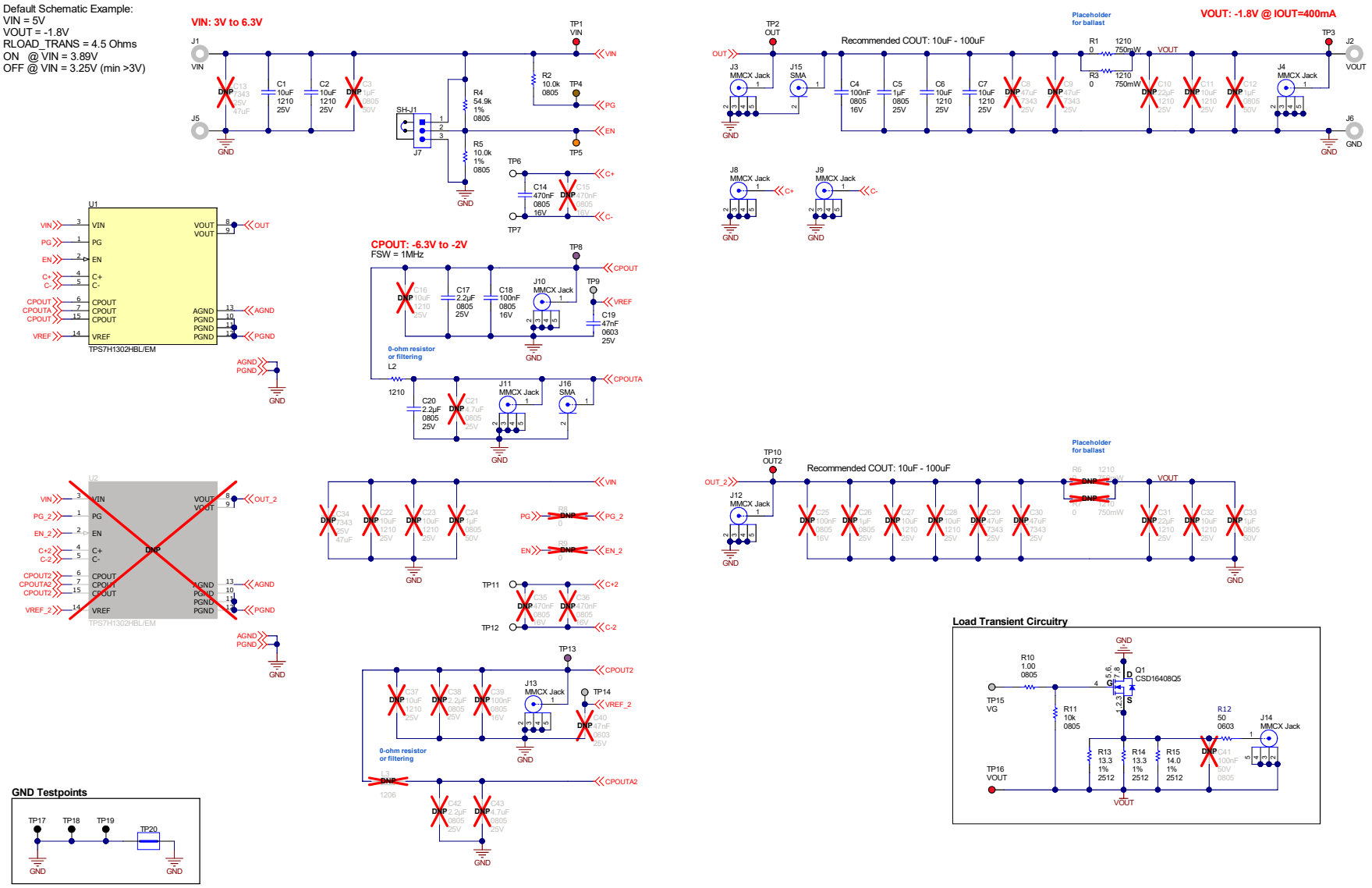


Figure 4-1. Default EVM Schematic

The schematic below shows an example of how the TPS7H1302 can be configured for a parallel-device design.

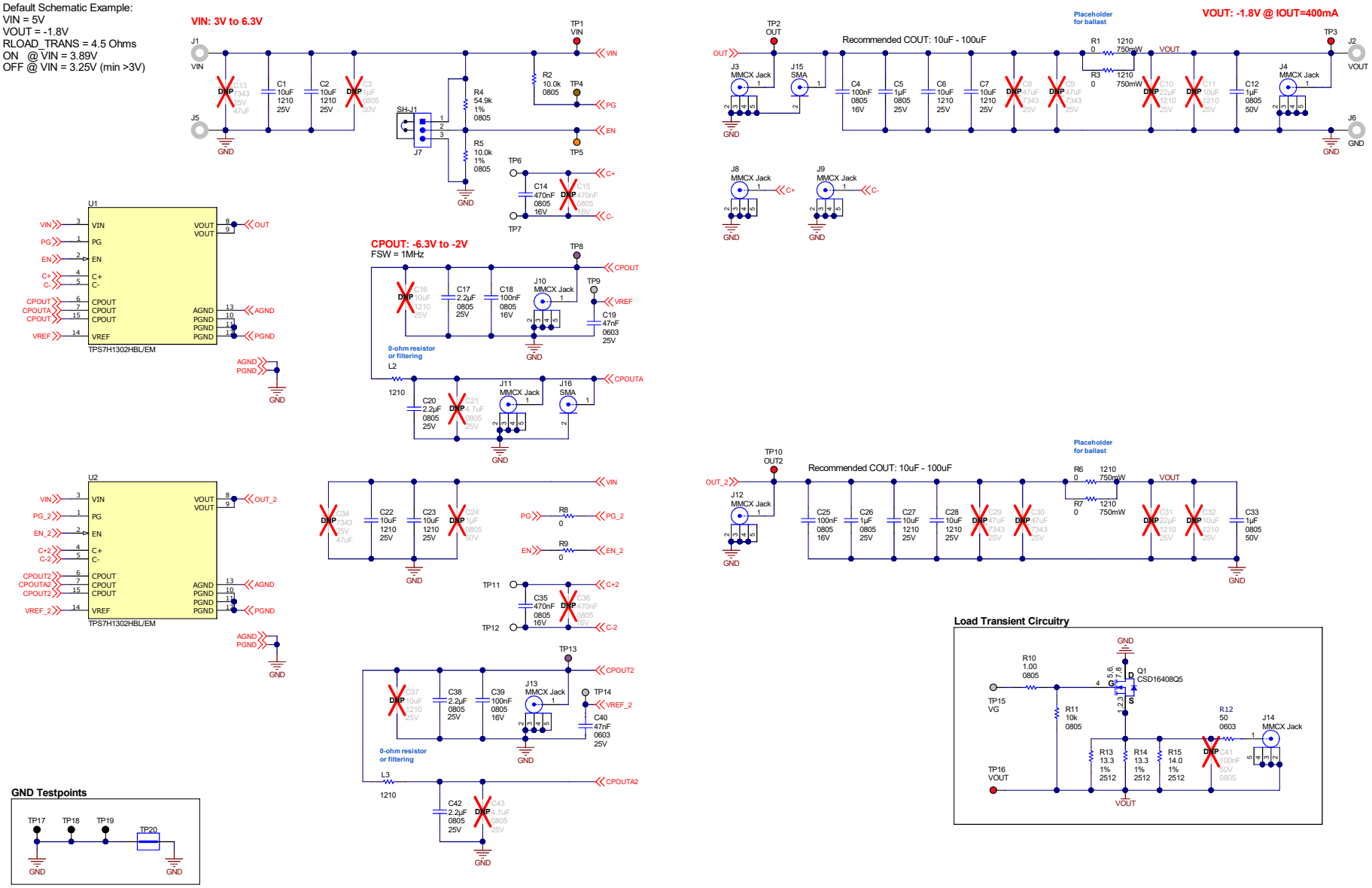


Figure 4-2. Example Schematic: Parallel TPS7H1302-SP

4.2 PCB Layouts

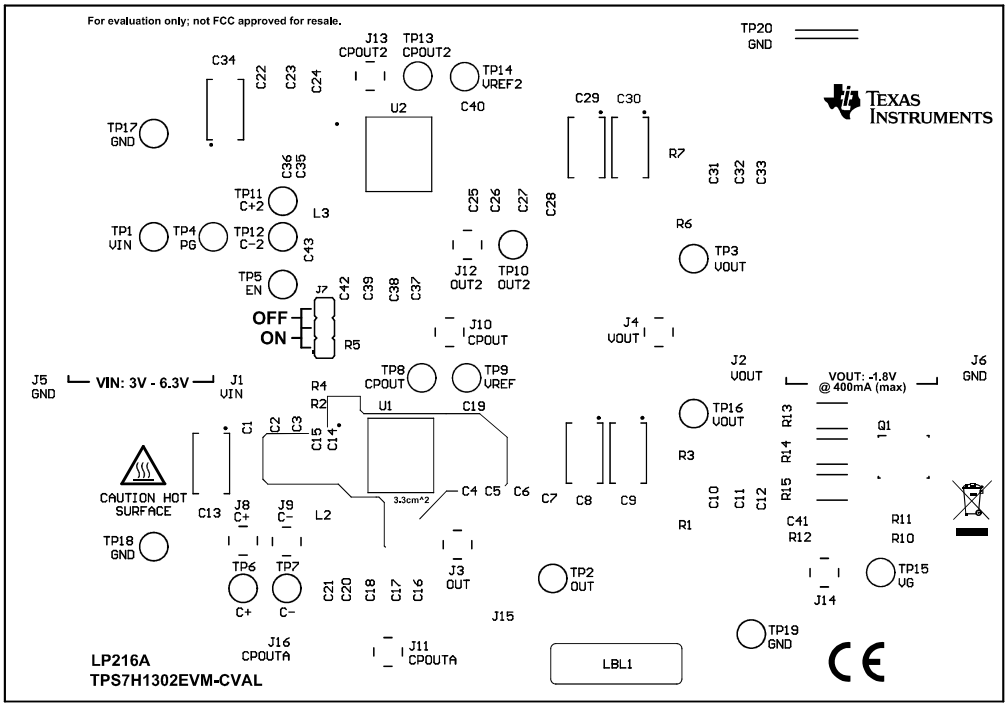


Figure 4-3. Top Silkscreen

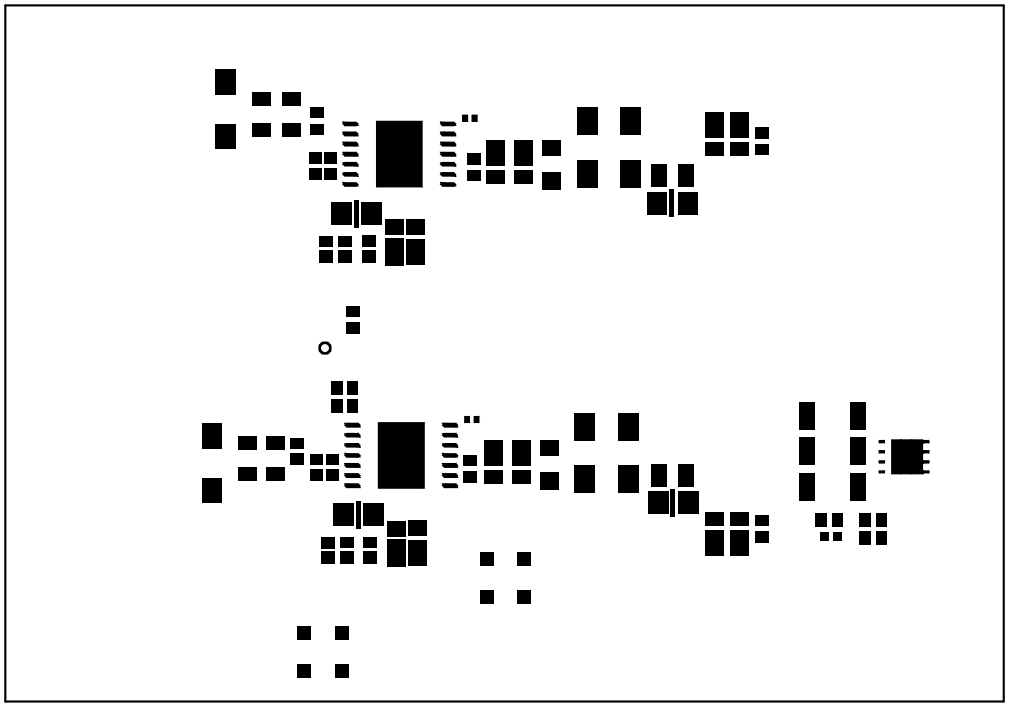


Figure 4-4. Top Solder Mask

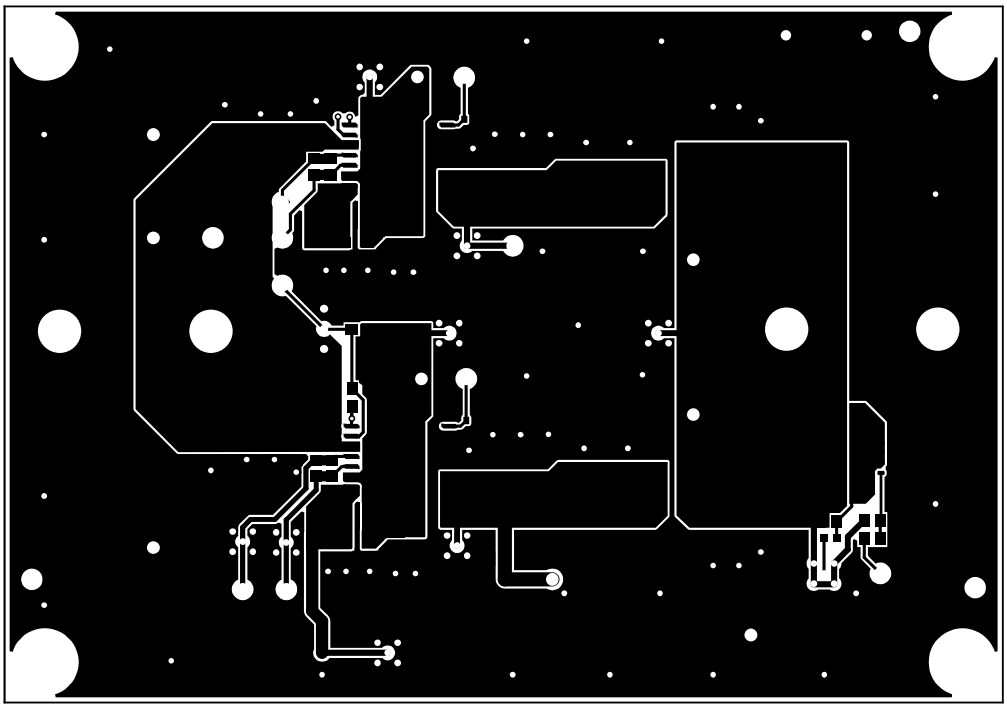


Figure 4-5. Top Layer

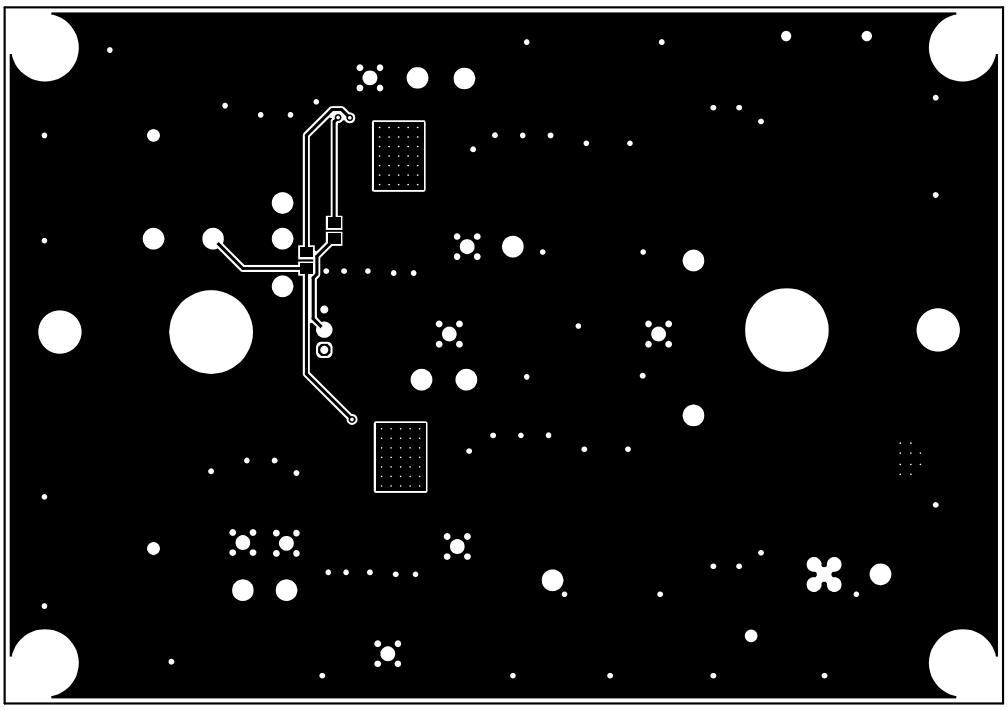


Figure 4-6. Bottom Layer

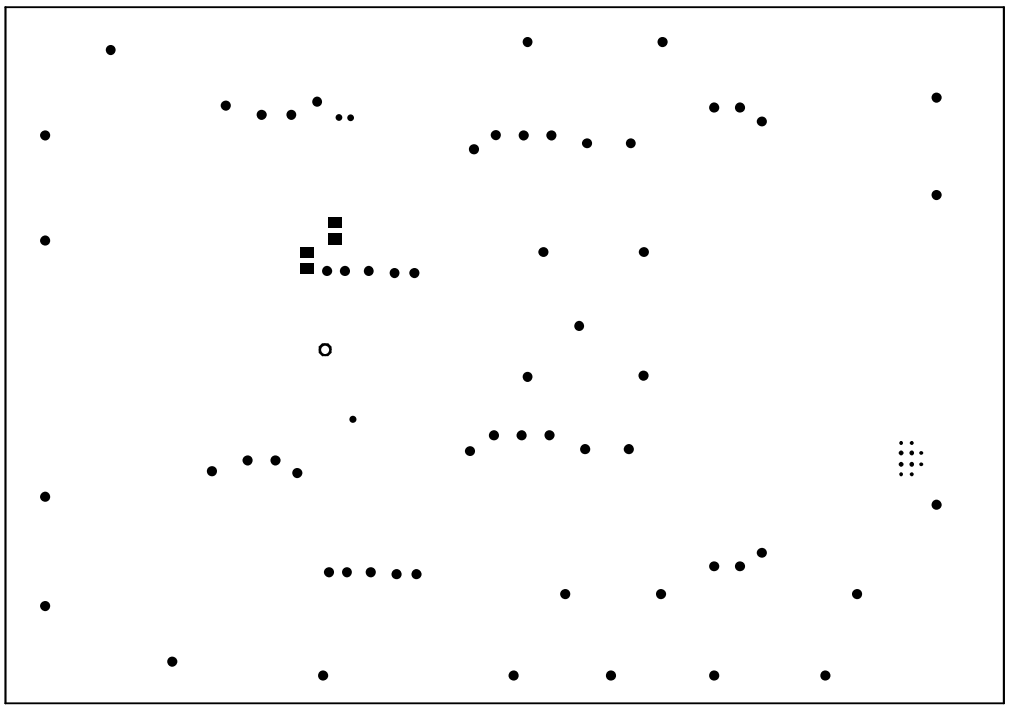


Figure 4-7. Bottom Solder Mask

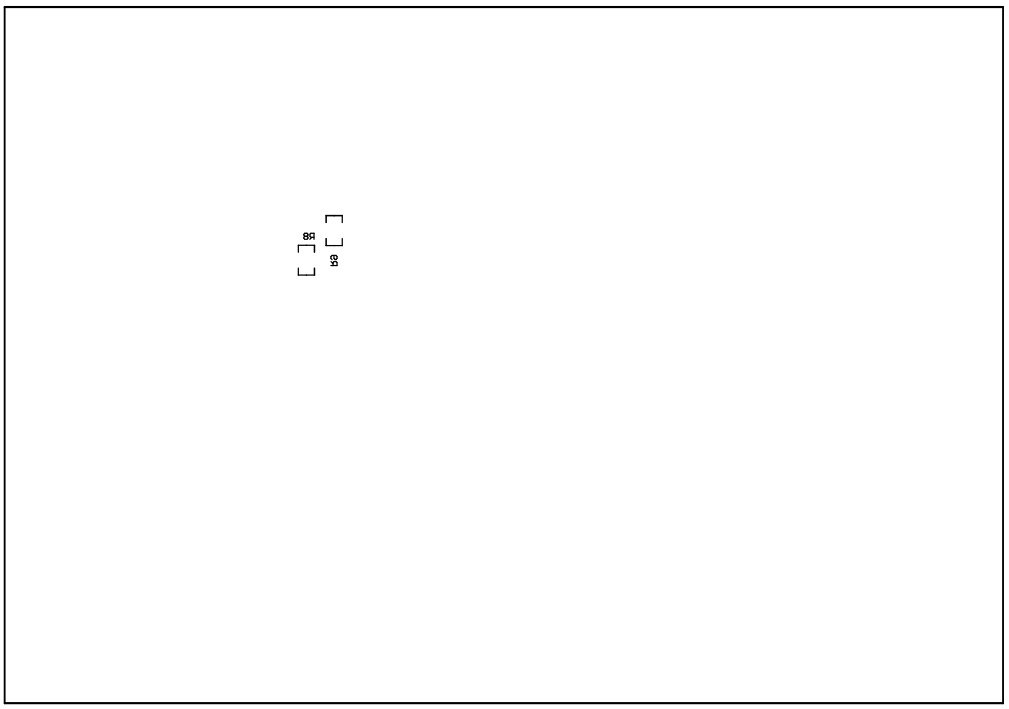
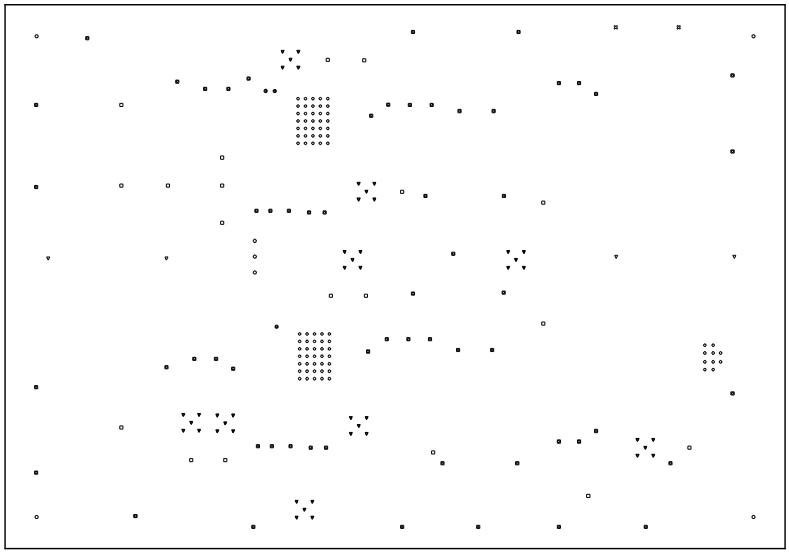


Figure 4-8. Bottom Silkscreen



Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
◇	80	7.87mil (0.200mm)	PTH	Round	Top Layer - Bottom Layer	
◎	3	18.00mil (0.457mm)	PTH	Round	Top Layer - Bottom Layer	
◘	60	28.00mil (0.711mm)	PTH	Round	Top Layer - Bottom Layer	
▼	45	33.07mil (0.840mm)	PTH	Round	Top Layer - Bottom Layer	
✪	3	40.16mil (1.020mm)	PTH	Round	Top Layer - Bottom Layer	+/-1.97mil
⊠	2	51.18mil (1.300mm)	PTH	Round	Top Layer - Bottom Layer	
□	19	63.00mil (1.600mm)	PTH	Round	Top Layer - Bottom Layer	
○	4	125.98mil (3.200mm)	PTH	Round	Top Layer - Bottom Layer	
▽	4	214.57mil (5.450mm)	PTH	Round	Top Layer - Bottom Layer	
	220 Total					

Figure 4-9. Drill Drawing

4.3 Bill of Materials (BOM)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2, C6, C7	4	10uF	CAP, CERM, 10uF, 25V, +/- 10%, X7R, 1210	1210	12103C106KAT2A	AVX
C4, C18	2	0.1uF	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, 0805	0805	C0805C104K4RACTU	Kemet
C5	1	1uF	CAP, CERM, 1uF, 25V, +/- 10%, X7R, 0805	0805	C0805C105K3RACTU	Kemet
C14	1	0.47uF	CAP, CERM, 0.47uF, 16V, +/- 5%, X7R, 0805	0805	0805YC474JAT2A	AVX
C17, C20	2	2.2uF	CAP, CERM, 2.2uF, 25V, +/- 10%, X7R, 0805	0805	C0805C225K3RAC	Kemet
C19	1	47nF	CAP, CERM, 0.047uF, 25V, +/- 10%, X7R, 0603	0603	C0603C473K3RAC7867	Kemet
H1, H2, H3, H4	4		Machine Screw, Round, #4-40x 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, J5, J6	4		Standard Banana Jack, Uninsulated, 5.5mm	Keystone_575-4	575-4	Keystone
J3, J4, J8, J9, J10, J11, J12, J13, J14	9		MMCX JACK, 50 Ohm, Gold, TH	MMCX JACK, Gold, TH	0734151471	Molex
J7	1		Header, 2.54mm, 3x1, Tin, TH	Header, 2.54mm, 3x1, Tin, TH	22284030	Molex
J15, J16	2		Connector, SMA Jack, Vertical, Gold, SMD	SMA	142-0711-201	Cinch Connectivity
L2, R1, R3	3	0 Ohm	RES, 0, 1%, 0.75W, AEC-Q200 Grade 0, 1210	1210	CRCW12100000Z0EAHP	Vishay-Dale
Q1	1		MOSFET, N-CH, 25V, 113A, DQH0008A (VSON-CLIP-8)	DQH0008A	CSD16408Q5	Texas Instruments
R2, R5	2	10k	RES, 10.0k, 1%, 0.125W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R4	1	54.9k	RES, 54.9k, 1%, 0.125W, AEC-Q200 Grade 0, 0805	0805	CRCW080554K9FKEA	Vishay-Dale
R10	1	1	RES, 1.00, 1%, 0.125W, 0805	0805	RC0805FR-071RL	Yageo America
R11	1	10k	RES, 10k, 5%, 0.125W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0JNEA	Vishay-Dale
R12	1	50	50 Ohms ±0.1% 0.1W, 0603 (1608 Metric) Thin Film	0603	RT0603BRE0750RL	Yageo
R13, R14	2	13.3	RES, 13.3, 1%, 1W, AEC-Q200 Grade 0, 2512	2512	CRCW251213R3FKEG	Vishay-Dale
R15	1	14	RES, 14.0, 1%, 1W, AEC-Q200 Grade 0, 2512	2512	CRCW251214R0FKEG	Vishay-Dale
SH-J1	1		CONN JUMPER S2 (1x 2) Position Shunt Connector Black Open Top 0.100" (2.54mm) Gold SHORTING .100"	JUMPER	QPC02SXGN-RC	Sullins

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP2, TP3, TP10, TP16	5		Test Point, Multipurpose, Red, TH	Multipurpose Testpoint	5010	Keystone
TP4	1		Test Point, Multipurpose, Brown, TH	Multipurpose Testpoint	5125	Keystone
TP5	1		Test Point, Multipurpose, Orange, TH	Multipurpose Testpoint	5013	Keystone
TP6, TP7, TP11, TP12	4		Test Point, Multipurpose, White, TH	Multipurpose Testpoint	5012	Keystone
TP8, TP13	2		Test Point, Multipurpose, Purple, TH	Multipurpose Testpoint	5129	Keystone
TP9, TP14, TP15	3		Test Point, Multipurpose, Grey, TH	Multipurpose Testpoint	5128	Keystone
TP17, TP18, TP19	3		Test Point, Multipurpose, Black, TH	Multipurpose Testpoint	5011	Keystone
TP20	1		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
U1	1		TPS7H1302HBL/EM	CFP14	TPS7H1302HBL/EM	Texas Instruments

5 Compliance Information

5.1 Compliance and Certifications

- Texas Instruments, TPS7H1302EVM-CVAL EU RoHS Declaration of Conformity (DoC)

6 Additional Information

6.1 Trademarks

All trademarks are the property of their respective owners.

7 Related Documentation

- Texas Instruments, Standard Terms for Evaluation Modules

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