

How to Modify a 4-Channel TPS7H4001QEVM-CVAL Into a 3-Channel EVM

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ABSTRACT

This document outlines the procedures required to convert a TSP7H4001QEVM-CVAL, a 4-channel quadrature phase buck converter evaluation module shown in [Figure 1](#), into a 3-channel buck converter EVM.

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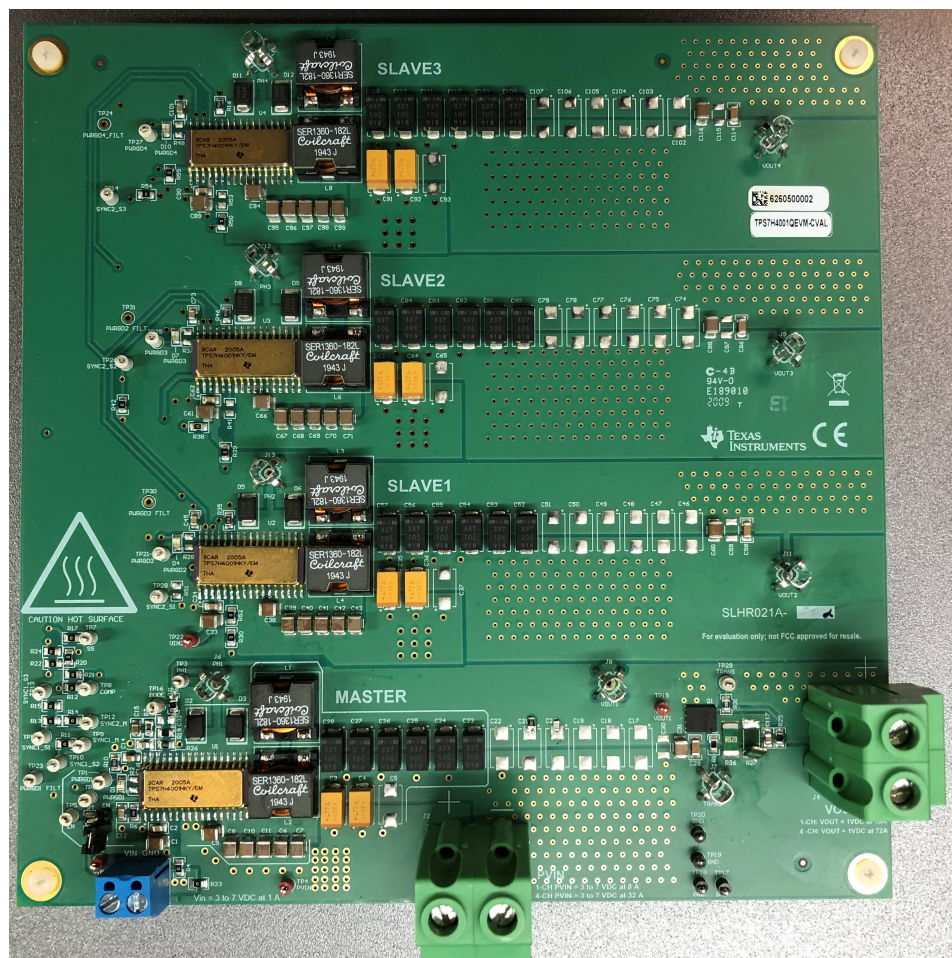
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1 Introduction

The TPS7H4001-SP is a radiation-hardness-assured, 7-V, 18-A synchronous buck converter. Operation of the device is demonstrated on the [TPS7H4001EVM-CVAL Evaluation Module User's Guide](#), which contains a single buck converter capable of supplying 18-A of load current. A key feature of the TPS7H4001-SP is that it supports parallel operation easily allowing four buck converters to operate in quadrature phase and deliver up to 72-A of load current to a tightly regulated line. Parallel operation is demonstrated on the [TPS7H4001QEVM-CVAL Evaluation Module User's Guide](#).

As different applications call for unique load current requirements even within a single system, users may want to evaluate these different applications with the same hardware, avoiding multiple hardware purchases. This document provides instructions on how to do just that; specifically, listing the modifications required on the 4-Channel EVM in order to realize a 3-channel design. Note, this application report is part of a series of reports showing how to convert 4-channel to 1-channel, 4-channel to 2-channel, and 4-channel to 3-channel designs. Please refer to other documents if 1-channel or 2-channel designs are desired.

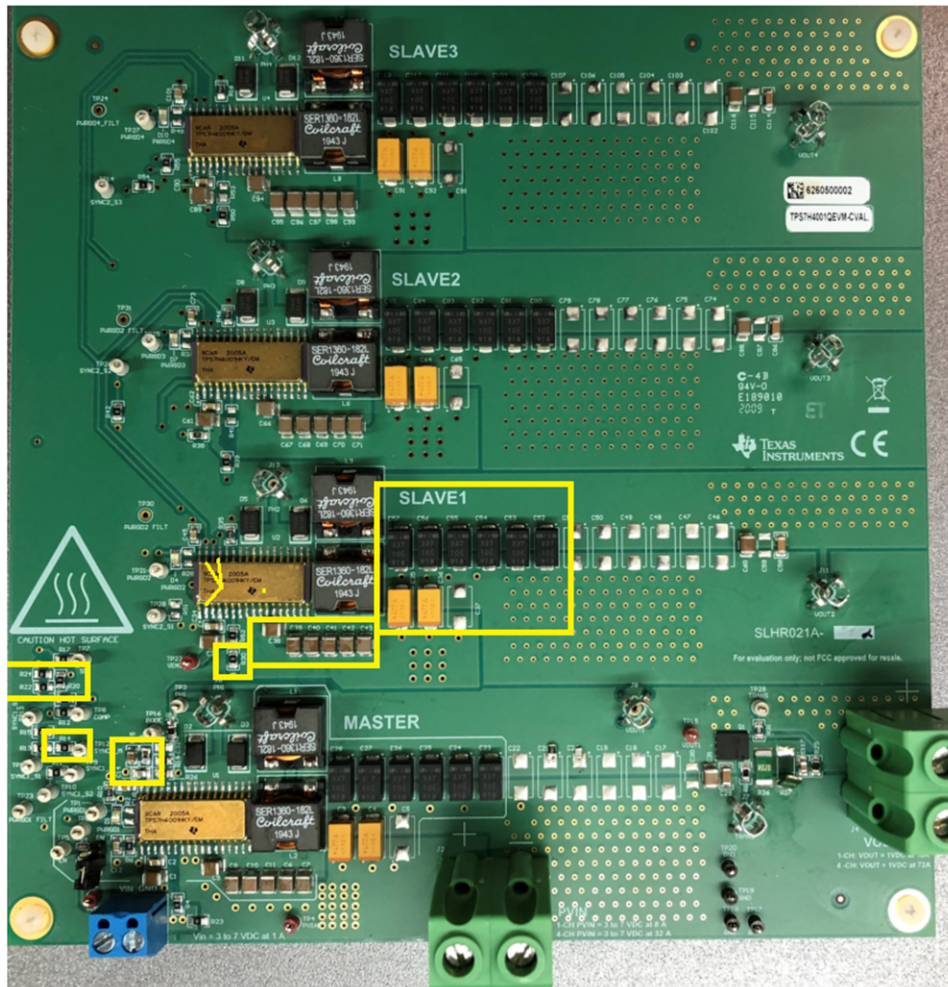
Figure 1. TPS7H4001QEVM-CVAL



2 BOM Modifications Required

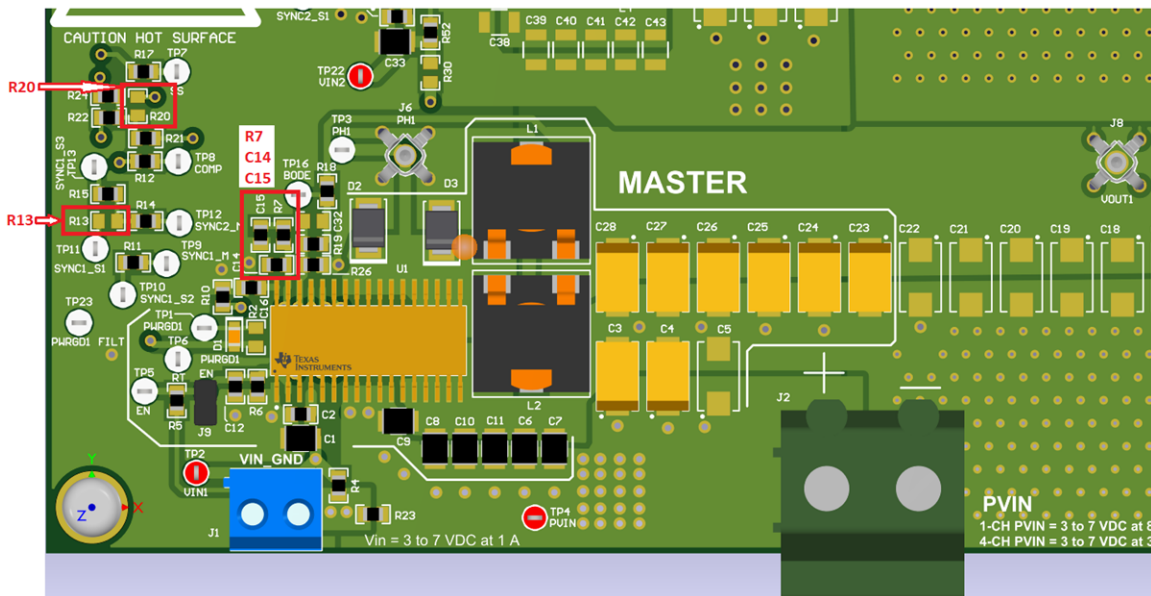
The following steps must be taken to ensure proper operation of a 3-channel buck converter on a populated 4-channel EVM (TPS7H4001QEVM-CVAL). An overview of where changes are required is shown in [Figure 2](#) while a summary of all changes is provided in [Table 1](#).

Figure 2. Overview Of Required Modifications



1. Modifications near MASTER DUT U1 ([Figure 3](#) and [Figure 7](#))
 - a. Isolate VSENSE feedback pin 32 of SLAVE1 by removing 0-ohm jumper R20.
 - b. Isolate SYNC2 pin 6 of SLAVE1 device by removing 0-ohm jumper R13.
 - c. Replace compensation circuit at R7, C14, C15 near DUT U1:
 - i. R7=3.0kohms
 - ii. C15=27nF
 - iii. C14=240pF

Figure 3. Modifications near MASTER DUT U1



2. Modifications near SLAVE1 DUT U2 (Figure 4 and Figure 8)
 - a. Isolate VIN pin 4 of Slave 1 DUT U2 by removing 0-ohm jumper R30
 - b. Remove input capacitors of Slave 1 DUT U2 by completely removing, or lifting one terminal of each capacitor as shown in Figure 5. (C35, C36, C38, C39, C40, C41, C42, C43)
 - c. Remove output capacitors of Slave 1 DUT U2 by completely removing, or lifting one terminal of each capacitor so as to remove from circuit as shown in Figure 5. (C52, C53, C54, C55, C56, C57, C58, C60)
 - d. Using a solder iron and tweezers, carefully lift the following pins off the PCB as shown in Figure 6 (note only pins 31 and 33 are shown in graphic)
 - i. Enable pin (EN pin2)
 - ii. Soft start pin (SS/TR pin31)
 - iii. COMP pin (COMP pin 33)

Figure 4. Modifications near SLAVE1 DUT U2

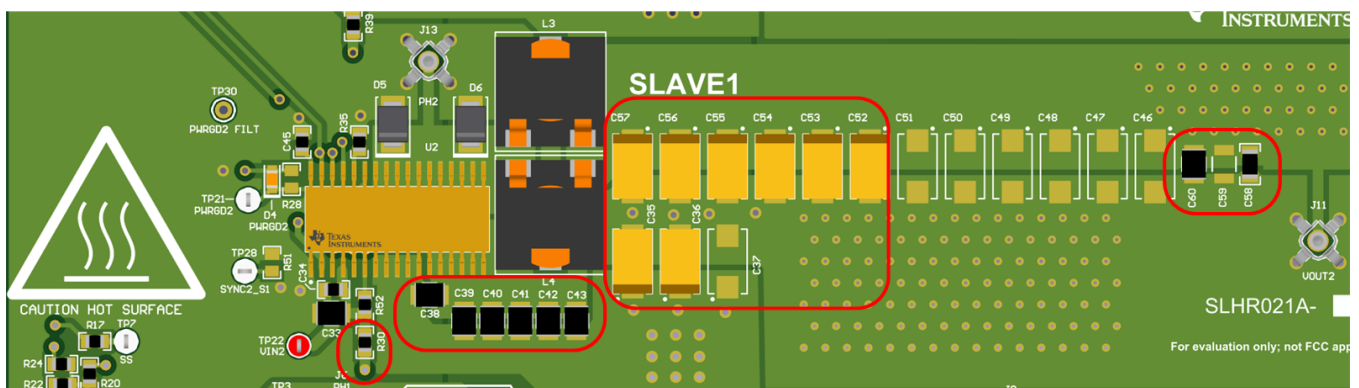


Figure 5. Open Circuit Input/Output Capacitors

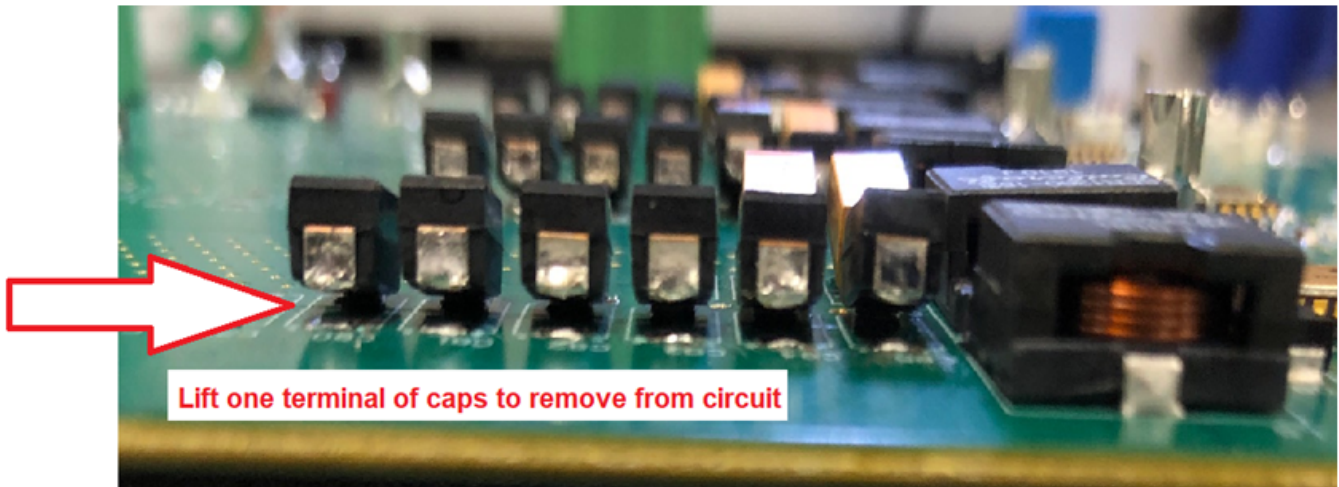


Figure 6. Lift Pins 2, 31, 33 from PCB



Table 1. Summary of BOM Changes

Position on PCB	Component Designator	Action
MASTER DUT U1	R13, R20	DNI
	R7	Replace with 3.0kohms
	C14	Replace with 240pF
	C15	Replace with 27nF
SLAVE1 DUT U2	R30	DNI
	C35, C36, C38, C39, C40, C41, C42, C43	DNI
	C52, C53, C54, C55, C56, C57, C58, C60	DNI
	U2 pin 2 (EN)	Lift off of PCB
	U2 pin 31 (SS/TR)	Lift off of PCB
	U2 pin 33 (COMP)	Lift off of PCB

3 Schematic Changes

Figure 7. Master DUT U1 Modifications
MASTER (POL1) at U1

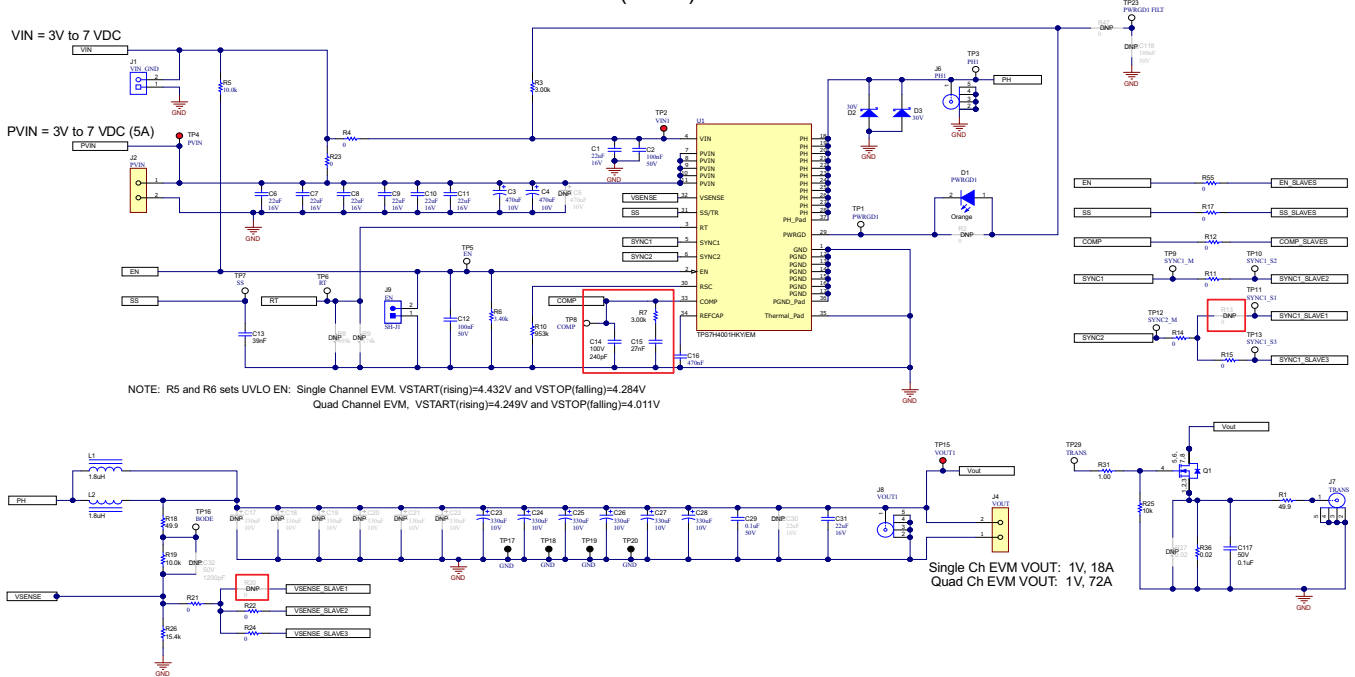


Figure 8. SLAVE1 DUT U2 Modifications

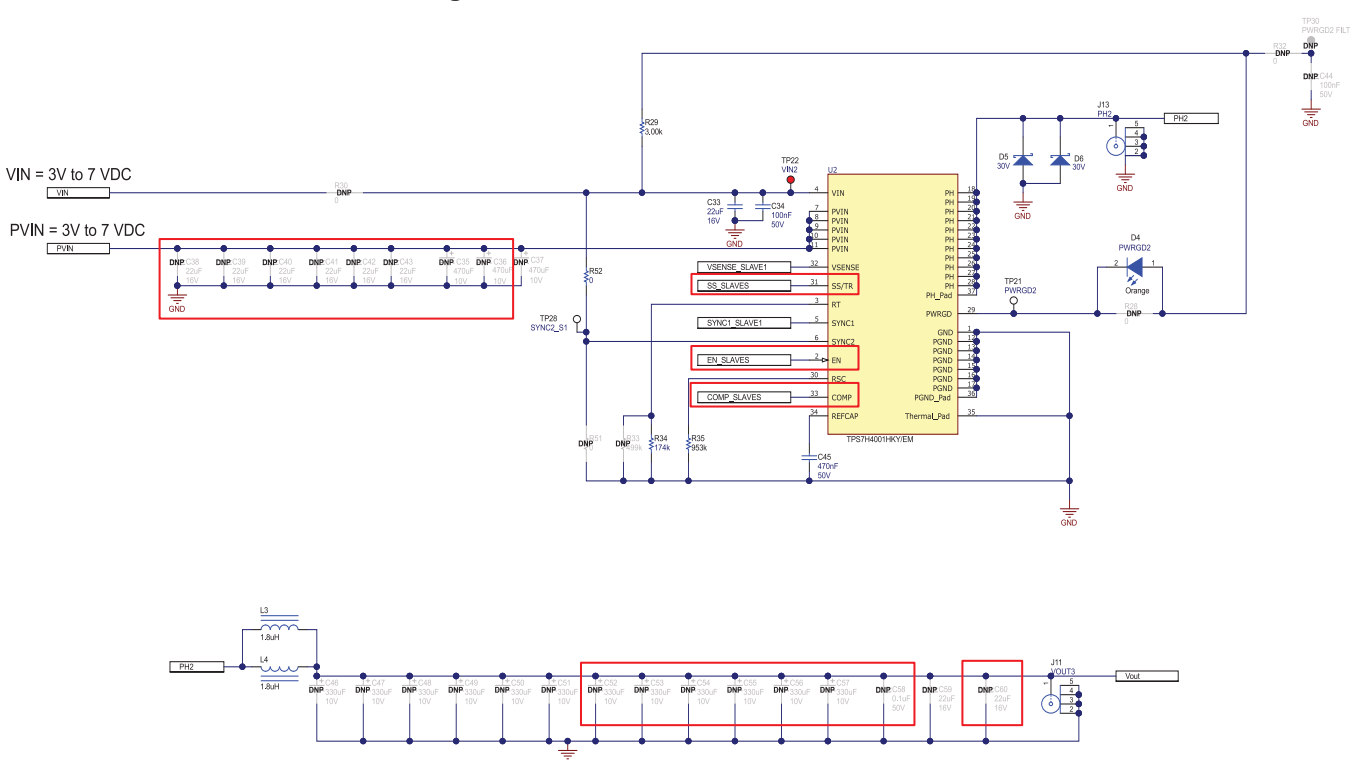


Figure 9. SLAVE2 DUT U3 Modifications

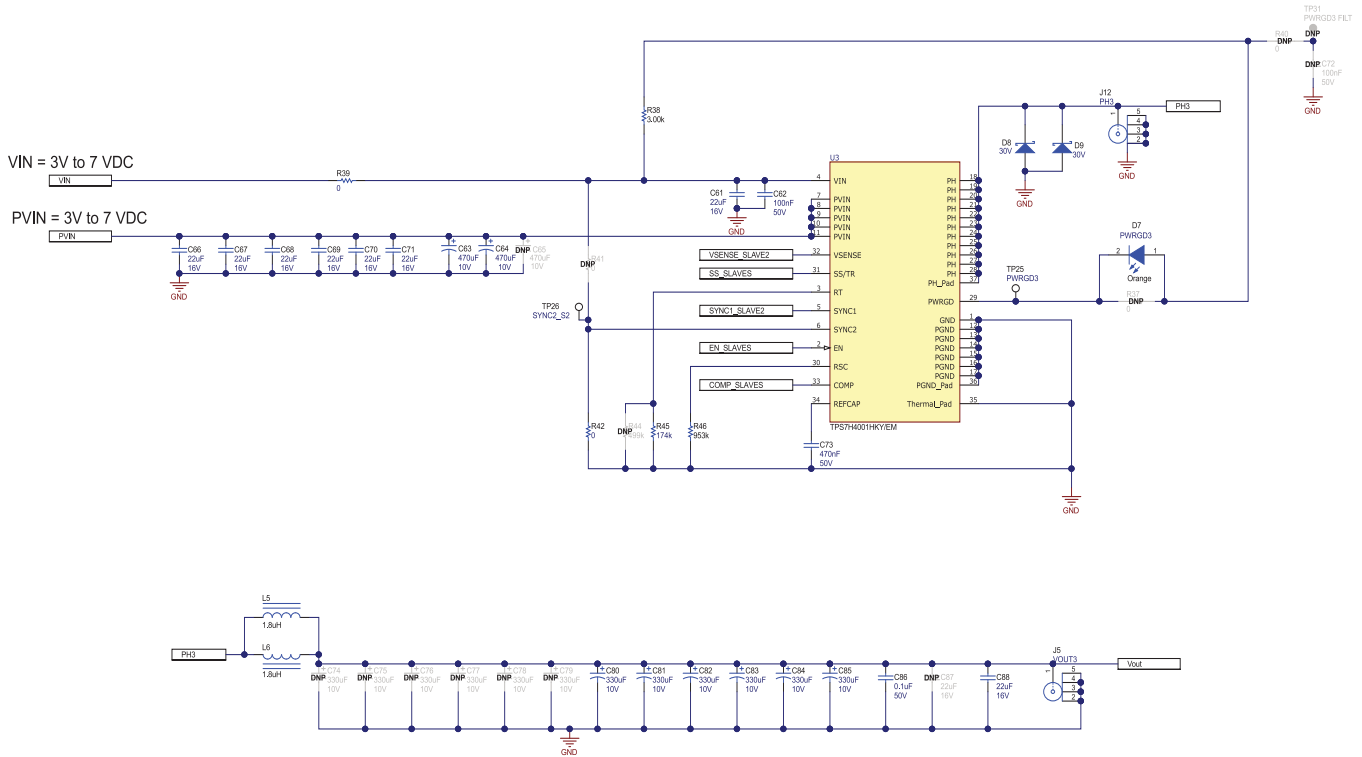
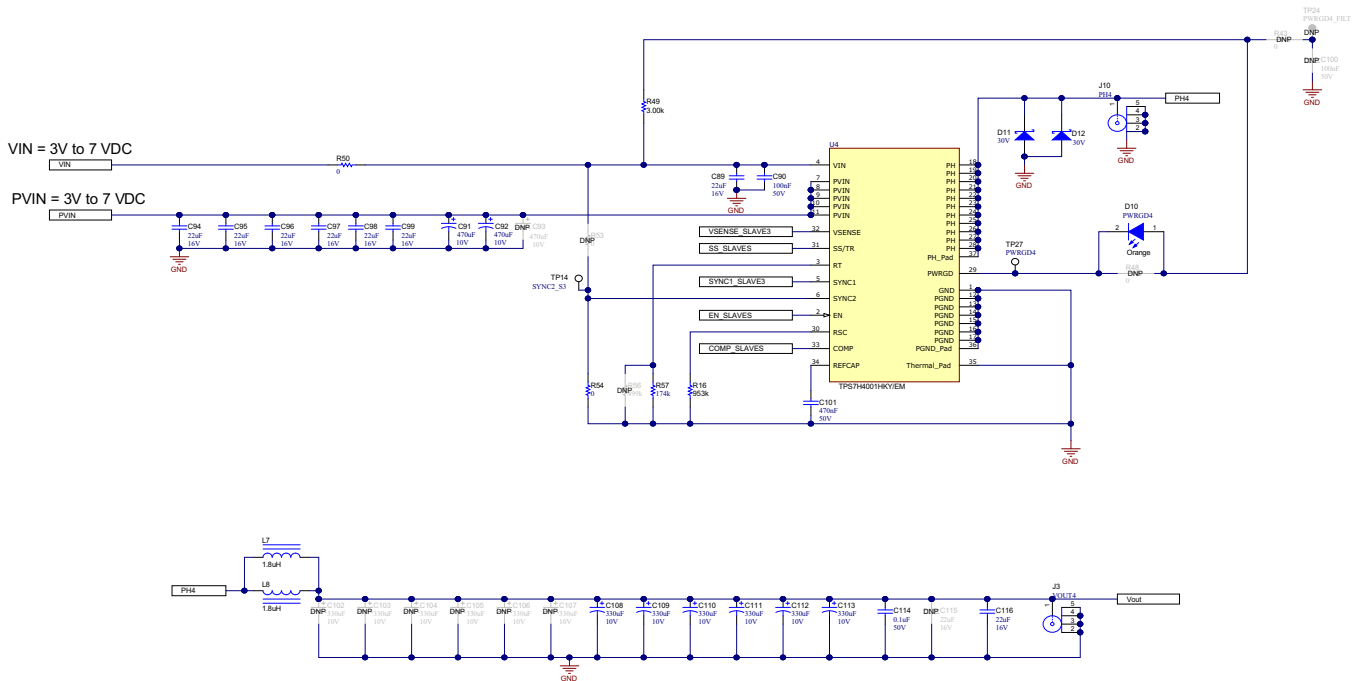


Figure 10. SLAVE3 DUT U4 Modifications
SLAVE3 (POL4) at U4



4 Bill of Materials (BOM) of Modified EVM
Table 2. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		SLHR021	Any
C1, C6, C7, C8, C9, C10, C11, C31, C33, C61, C66, C67, C68, C69, C70, C71, C88, C89, C94, C95, C96, C97, C98, C99, C116	25	22uF	CAP, CERM, 22 uF, 16 V, +/- 10%, X7R, 1210	1210	C3225X7R1C226K250AC C	TDK
C2, C12, C34, C62, C90	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 0805	0805	08055C104JAT2A	AVX
C3, C4, C63, C64, C91, C92	6	470uF	CAP, TA, 470 uF, 10 V, +/- 10%, 0.023 ohm, SMD	7343-43	TPME477K010R0023	AVX
C13	1	0.039uF	CAP, CERM, 0.039 uF, 50 V, +/- 10%, X7R, 0805	0805	08055C393KAT2A	AVX
C14	1	240pF	CAP, CERM, 240 pF, 100 V, +/- 5%, C0G/NP0, 0805	0805	GRM2165C2A241JA01D	MuRata
C15	1	0.027uF	CAP, CERM, 0.027 uF, 50 V, +/- 10%, X7R, 0805	0805	08055C273KAT2A	AVX
C16, C45, C73, C101	4	0.47uF	CAP, CERM, 0.47 uF, 50 V, +/- 10%, X7R, 0805	0805	C2012X7R1H474K125AB	TDK
C23, C24, C25, C26, C27, C28, C80, C81, C82, C83, C84, C85, C108, C109, C110, C111, C112, C113	18	330uF	CAP, Tantalum Polymer, 330 uF, 10 V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C29, C86, C114	3	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 1206	1206	C1206C104J5RACTU	Kemet
C117	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0805	0805	C0805C104K5RACTU	Kemet
D1, D4, D7, D10	4	Orange	LED, Orange, SMD	LED_0805	LTST-C170KFKT	Lite-On
D2, D3, D5, D6, D8, D9, D11, D12	8	30V	Diode, Schottky, 30 V, 2 A, SMB	SMB	B230-13-F	Diodes Inc.
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	1		Terminal Block, 5.08 mm, 2x1, Brass, TH	2x1 5.08 mm Terminal Block	ED120/2DS	On-Shore Technology
J2, J4	2		Fixed Terminal Blocks MKDSP 10 HV/ 2-10	HDR2	1929517	Phoenix contact
J3, J5, J6, J7, J8, J10, J11, J12, J13	9		Compact Probe Tip Circuit Board Test Points, TH, 25 per	TH Scope Probe	131-5031-00	Tektronix

Table 2. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
J9	1		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Würth Elektronik
L1, L2, L3, L4, L5, L6, L7, L8	8	1.8uH	Inductor, Shielded E Core, Ferrite, 1.8 µH, 13 A, 0.0026 ohm, AEC-Q200 Grade 3, SMD	SER1360	SER1360-182KLB	Coilcraft
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.20 inch	THT-14-423-10	Brady
Q1	1	25 V	MOSFET, N-CH, 25 V, 113 A, DQH0008A (VSON-CLIP-8)	DQH0008A	CSD16408Q5	Texas Instruments
R1, R18	2	49.9	RES, 49.9, 0.1%, 0.125 W, 0805	0805	RT0805BRD0749R9L	Yageo America
R3, R7, R29, R38, R49	5	3.00k	RES, 3.00 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF3001V	Panasonic
R4, R11, R12, R14, R15, R17, R21, R22, R23, R24, R39, R42, R50, R52, R54, R55	16	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08050000Z0EA	Vishay-Dale
R5, R19	2	10.0k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0FKEA	Vishay-Dale
R6	1	3.40k	RES, 3.40 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08053K40FKEA	Vishay-Dale
R10, R16, R35, R46	4	953k	RES, 953 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW0805953KFKEA	Vishay-Dale
R25	1	10k	RES, 10 k, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510K0JNEA	Vishay-Dale
R26	1	15.4k	RES, 15.4 k, 0.1%, 0.125 W, 0805	0805	RG2012P-1542-B-T5	Susumu Co Ltd
R31	1	1.00	RES, 1.00, 1%, 0.125 W, 0805	0805	RC0805FR-071RL	Yageo America
R34, R45, R57	3	174k	RES, 174 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF1743V	Panasonic
R36	1	0.02	RES, 0.02, 1%, 1 W, AEC-Q200 Grade 0, 2512	2512	LRMAM2512-R02FT4	TT Electronics/IRC
SH-J1	1	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP1, TP3, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP16, TP21, TP23, TP25, TP26, TP27, TP28, TP29	20		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
TP2, TP4, TP15, TP22	4		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone
TP17, TP18, TP19, TP20	4		Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone

Table 2. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U1, U2, U3, U4	4		Radiation Hardened 3-V to 7-V Input, 18-A Synchronous Buck Converter	CDFP34		Texas Instruments
C5, C35, C36, C37, C65, C93	0	470uF	CAP, TA, 470 uF, 10 V, +/- 10%, 0.023 ohm, SMD	7343-43	TPME477K010R0023	AVK
C17, C18, C19, C20, C21, C22, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C74, C75, C76, C77, C78, C79, C102, C103, C104, C105, C106, C107	0	330uF	CAP, Tantalum Polymer, 330 uF, 10 V, +/- 20%, 0.006 ohm, 7343-43 SMD	7343-43	T530X337M010ATE006	Kemet
C30, C38, C39, C40, C41, C42, C43, C59, C60, C87, C115	0	22uf	CAP, CERM, 22 uF, 16 V, +/- 10%, X7R, 1210	1210	C3225X7R1C226K250AC	TDK
C32	0	1200pf	CAP, CERM, 1200 pF, 50 V, +/- 10%, X7R, 0805	0805	08055C122KAT2A	AVX
C44, C72, C100, C118	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 0805	0805	08055C104JAT2A	AVX
C58	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 1206	01206	C1206C104J5RACTU	Kemet
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R2, R13, R20, R28, R30, R32, R37, R40, R41, R43, R47, R48, R51, R53	0	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08050000Z0EA	Vishay-Dale
R8, R33, R44, R56	0	499k	RES, 499 k, 0.1%, 0.125 W, 0805	0805	RG2012P-4993-B-T5	Susumu Co Ltd
R9	0	174k	RES, 174 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF1743V	Panasonic
R27	0	0.02	RES, 0.02, 1%, 1 W, AEC-Q200 Grade 0, 2512	2512	LRMAM2512-R02FT4	TT Electronics/IRC
TP24, TP30, TP31	0		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone

5 Summary

Implementing the EVM modifications described in this document will allow users of a 4-channel TPS7H4001QEVM-CVAL evaluation module to realize three channel operation.

6 References

- Texas Instruments, [TPS7H4001-SP Radiation-Hardness-Assured 3-V to 7-V Input 18-A Synchronous Buck Converter Data Sheet](#)
- Texas Instruments, [TPS7H4001EVM-CVAL Evaluation Module User's Guide](#)
- Texas Instruments, [TPS7H4001QEVM-CVAL Evaluation Module User's Guide](#)
- Texas Instruments, [How to Modify a 4-Channel TPS7H4001QEVM-CVAL Into a 1-Channel EVM](#)
- Texas Instruments, [How to Modify a 4-Channel TPS7H4001QEVM-CVAL Into a 2-Channel EVM](#)

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