

High Performance Synchronous Buck EVM Using the TPS51125

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1 Introduction

The TPS51125 is a cost effective, dual-synchronous buck controller targeted for notebook system power supply solutions. It provides 5-V and 3.3-V LDOs and requires few external components. The 270-kHz VCLK output can be used to drive an external charge pump, generating gate drive voltage for the load switches without reducing the main converter's efficiency. The TPS51125 supports high-efficiency, fast transient response and provides a combined power-good signal. Out-of-Audio™ mode light-load operation enables low acoustic noise at much higher efficiency than conventional forced PWM operation. Adaptive on-time D-CAP™ control provides convenient and efficient operation. The part operates with supply input voltages ranging from 5.5 V to 28 V and supports output voltages from 2 V to 5.5 V.

TPS51125EVM evaluation module is a high efficiency, dual synchronous buck converter providing 5 V at 8 A and 3.3 V at 8 A from 8-V to 25-V input.

2 Performance Specification Summary

Table 1 gives the EVM performance specifications and qualifications.

Table 1. Performance Specification Summary

SPECIFICATION		TEST CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input voltage range	Voltage applied to VBAT	8		25	V
CHANNEL1						
V_{OUT}	Output voltage			5		V
f	Operating frequency	$V_{TONSEL} = V_{VREF}$, $V_{VIN} = 12\text{ V}$, $I_{OUT} = 6\text{ A}$		245		kHz
I_{OUT}	Output current	$8\text{ V} \leq V_{VIN} \leq 25\text{ V}$	8			A
I_{OC}	Overcurrent limit	$V_{VIN} = 12\text{ V}$		10		
CHANNEL2						
V_{OUT}	Output voltage			3.3		V
f	Operating frequency	$V_{TONSEL} = V_{VREF}$, $V_{VIN} = 12\text{ V}$, $I_{OUT} = 6\text{ A}$		305		kHz
I_{OUT}	Output current	$8\text{ V} \leq V_{VIN} \leq 25\text{ V}$	8			A
I_{OC}	Overcurrent limit	$V_{VIN} = 12\text{ V}$		10		

3 Schematic

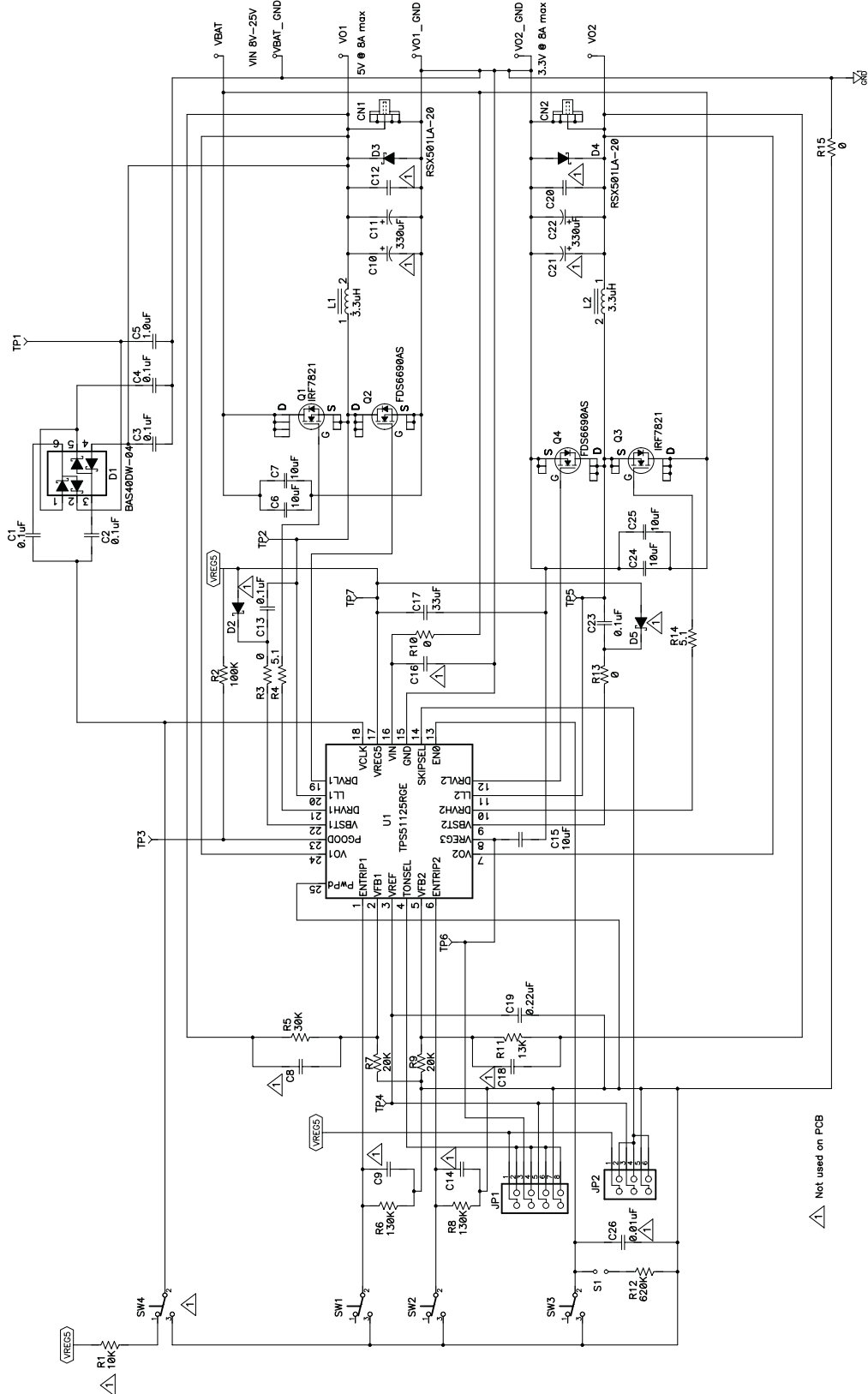


Figure 1. TPS51125-EVM Schematic Diagram

4 Test Setup and Results

4.1 Test Setup

Connect test equipment and TPS51125EVM board as shown in Figure 2.

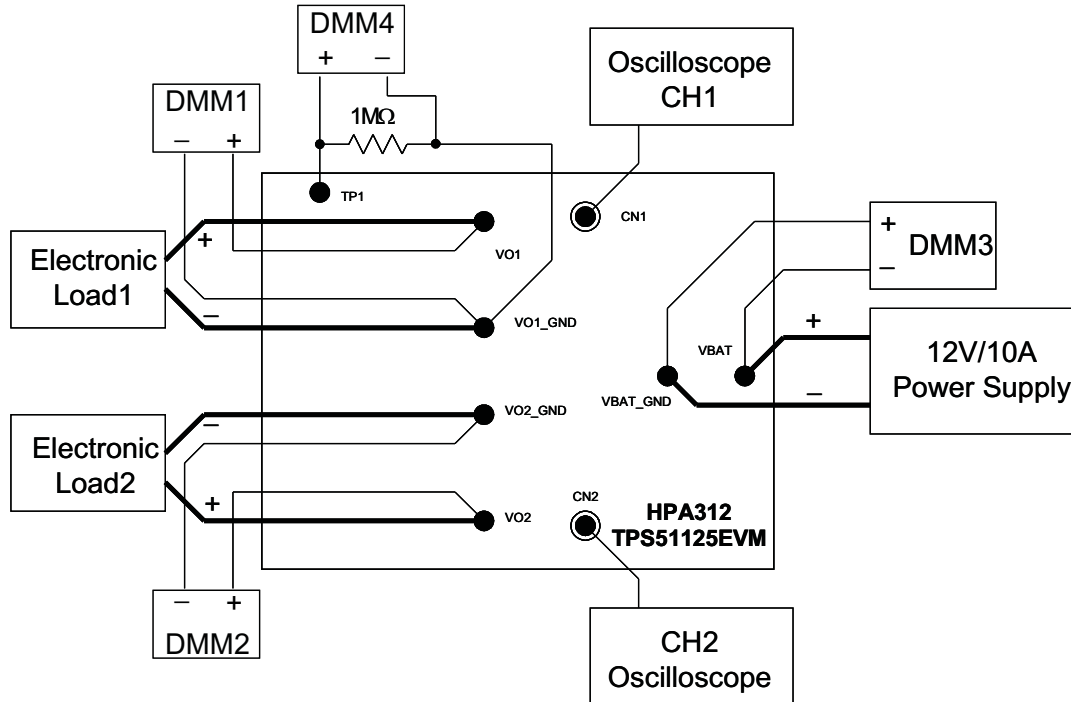


Figure 2. Equipment Setup for TPS51125EVM board

4.2 Test Procedure

1. Ensure the switches SW1 (ENTRIP1), SW2 (ENTRIP2) and SW3 (EN0) are in "OFF" position.
2. Ensure the shunt jumper for JP1 is set 5-pin to 6-pin (Med1), and shunt jumper for JP2 is set 3-pin to 4-pin (Auto-skip).
3. Apply appropriate VBAT voltage to VBAT and VBAT_GND terminals.
4. Turn on SW3 (EN0), and both VREG5 (5V-LDO) and VREG3 (3.3V-LDO) start up.
5. When SW3 stays on, VREF (2V-REF) enables.
6. When SW3 stays on and turn on SW1 (ENTRIP1), CH1-output starts up.
7. When SW3 stays on and turn on SW2 (ENTRIP2), CH2-output starts up.

4.3 Start-Up Performance

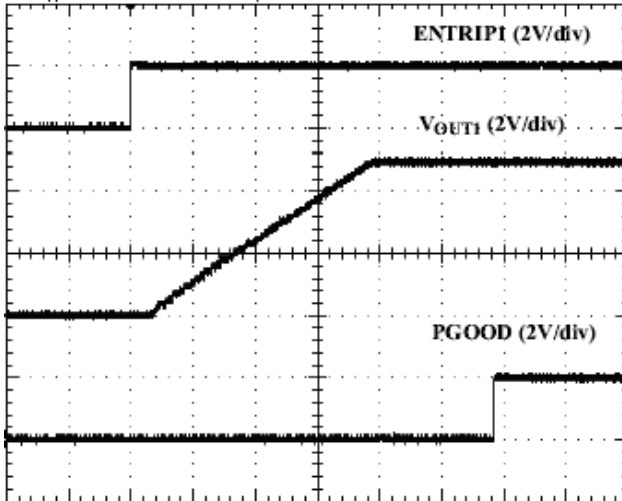


Figure 3. 5-V Startup Waveforms

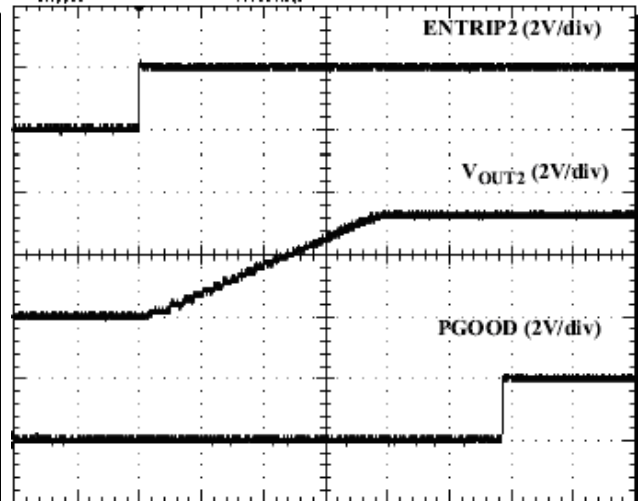


Figure 4. 3.3-V Startup Waveforms

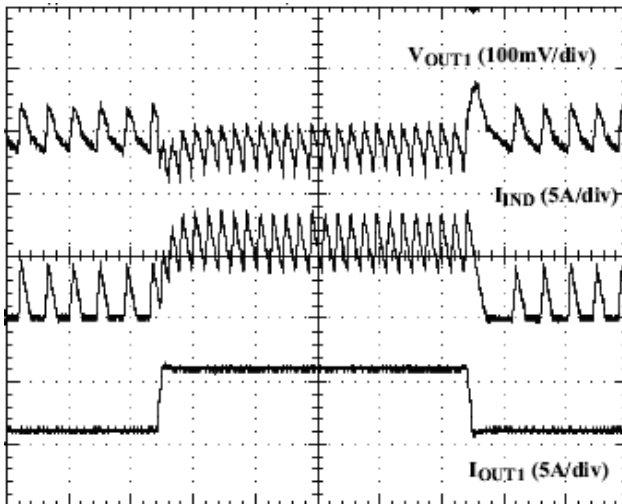


Figure 5. 5-V Load Transient Response

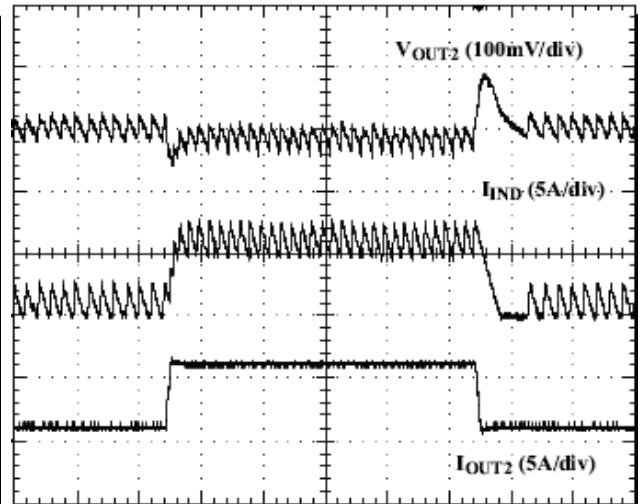


Figure 6. 3.3-V Load Transient Response

5 Configuration

This EVM can be set at a configuration of the user's choice. Please refer to the following specific configuration setting sections

5.1 Switching Frequency Selection

The switching frequency can be set by the TONSEL pin using JP1 on the EVM. The default setting is 245 kHz for CH1 and 305 kHz for CH2.

Table 2. Switching Frequency Selection

TONSEL CONNECTION	SWITCHING FREQUENCY (kHz)	
	CH1	CH2
GND (SLOW)	200	250
VREF (MED1)	245	305
VREG3 (MED2)	300	375
VREG5 (FAST)	365	460

5.2 Operation Mode Selection

Operation mode can be set by the SKIPSEL pin using JP2 on the EVM. The default setting on the EVM is auto-skip mode.

Table 3. Operation Mode Selection

SKIPSEL CONNECTION	OPERATION MODE
GND	PWM only
VREF	Auto skip
VREG5	Out-of-Audio™

5.3 VCLK ON/OFF Selection

The VCLK drive for the charge-pump can be disabled by pulling down EN0 with 620 kΩ of resistance using S1 on the EVM.

Table 4. VLCK Control

END CONNECTION	VCLK
OPEN	ENABLED
Pull down to GND with 620 kΩ	DISABLED

6 Physical Layouts

This section provides the board layout and assembly drawings for the EVM, that include the top layer ([Figure 7](#)), the bottom layer ([Figure 8](#)), and inner layer views ([Figure 9](#) and [Figure 10](#)) of the EVM.

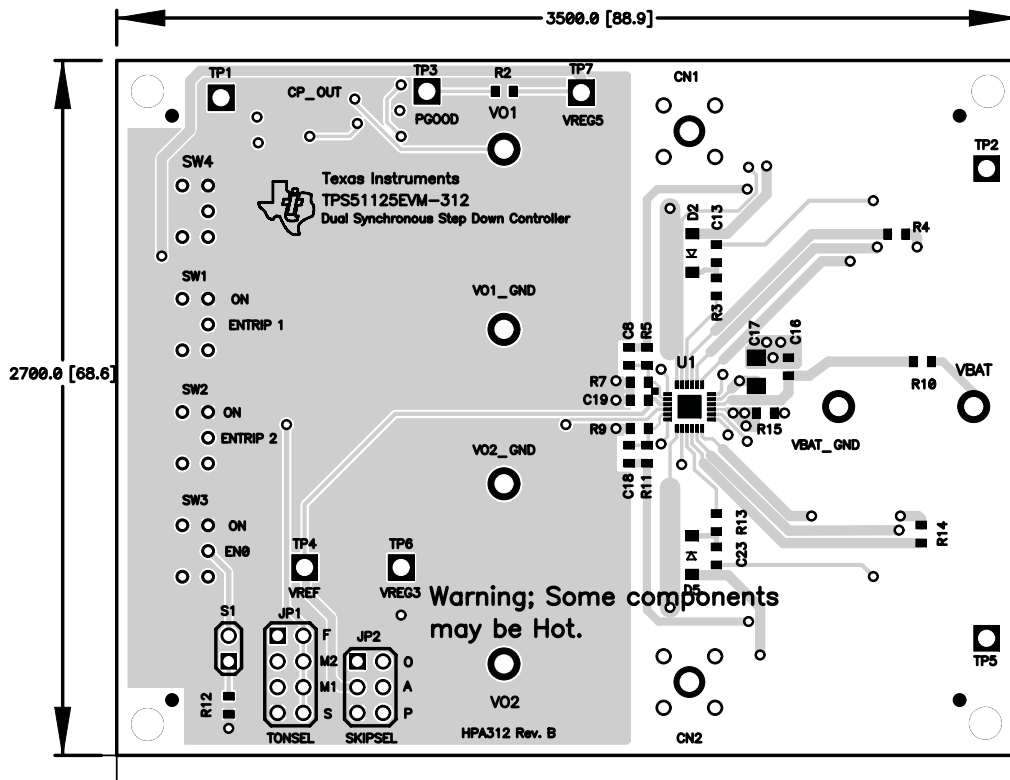


Figure 7. Top Layer Routing

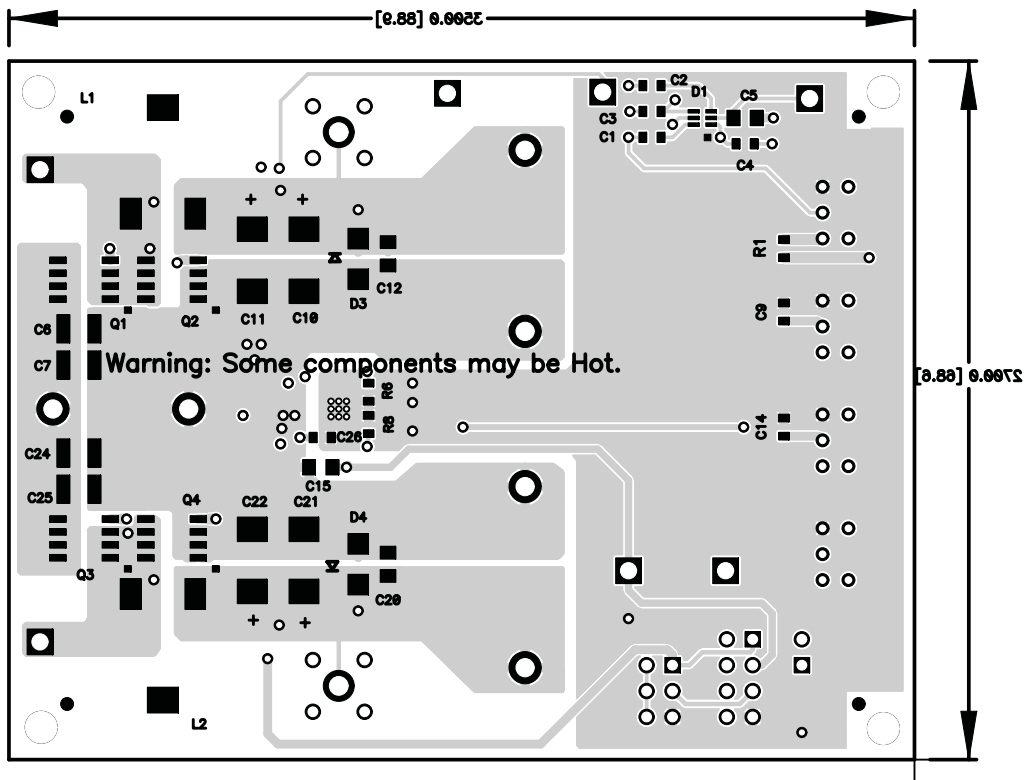


Figure 8. Bottom Layer Routing

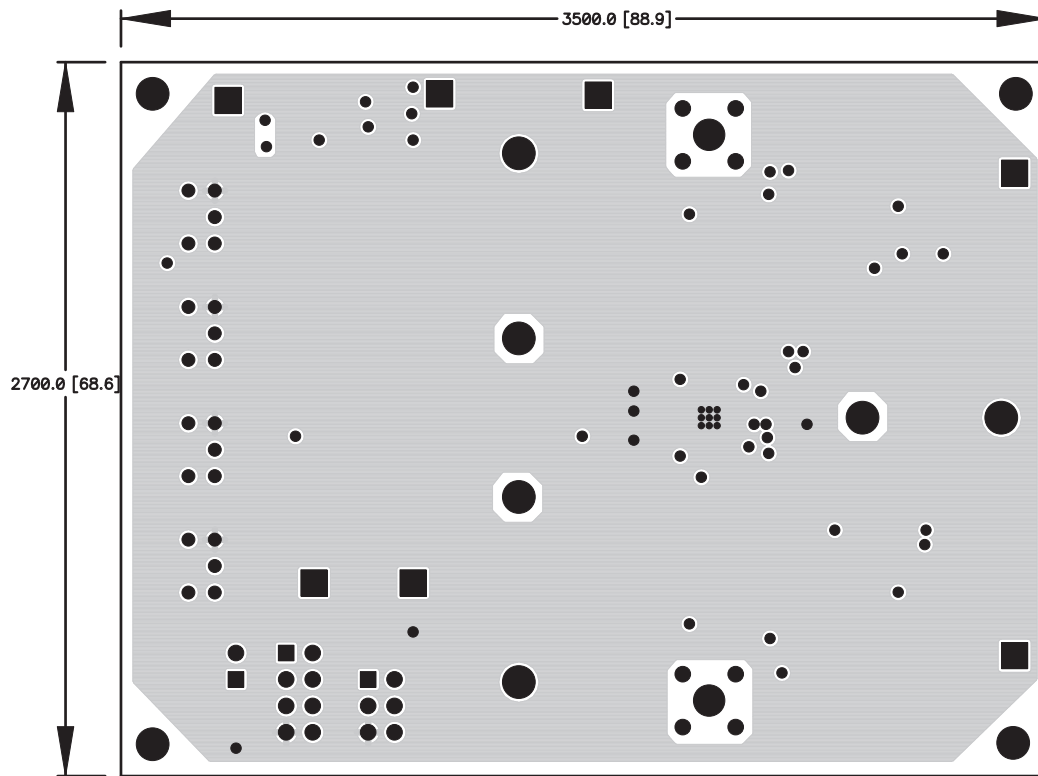


Figure 9. Inner Layer 1

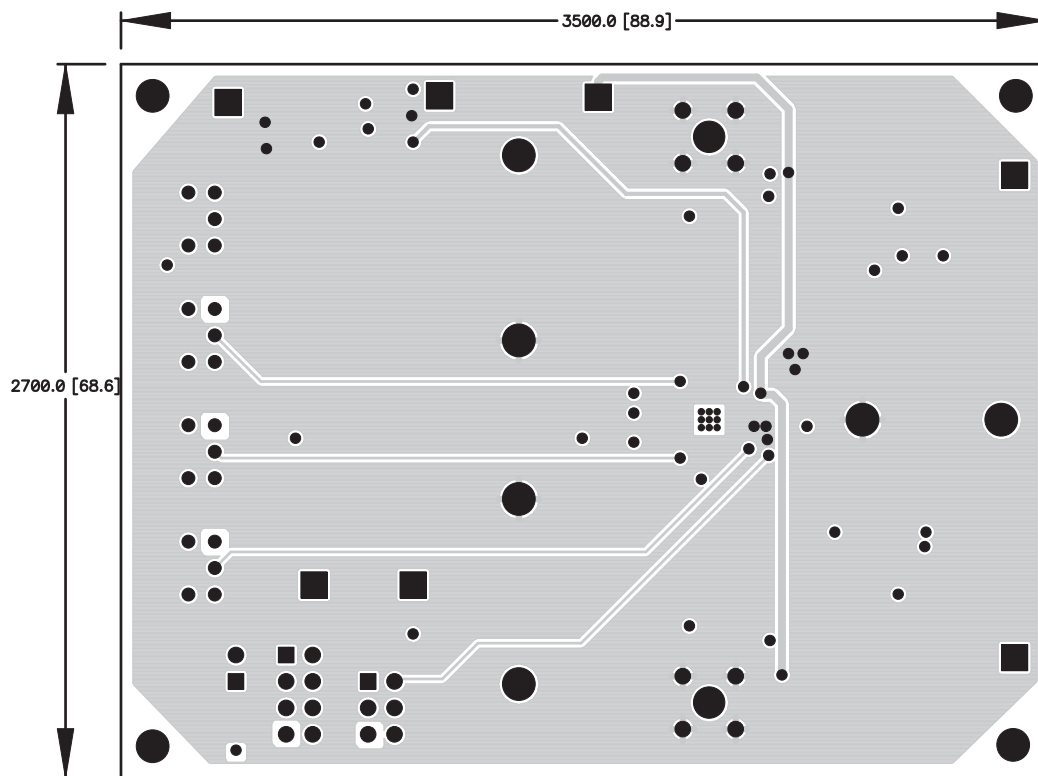


Figure 10. Inner Layer 2

7 List of Materials

Table 5. TPS51125 List of Materials

RERERENCE DESIGNATOR	QTY	DESCRIPTION	SIZE	MFR	PART NUMBER
C1, C2, C3, C4, C13, C23	6	Capacitor, Ceramic, 100 nF, 50 V, X5R, 10%	0603	muRata	GRM188B31H104K
C5	1	Capacitor, Ceramic, 1 μF, 25 V, X5R, 10%	0805	TDK	C2012X5R1E105K
C6, C7, C24, C25	4	Capacitor, Ceramic, 10 μF, 25 V, BJ, M	1210	Taiyo Yuden	TMK325BJ106MM
C8, C9, C14, C16, C18, C26	0	Capacitor	0603	Any	Any
C10, C21	0	Capacitor	7343 (D)	Any	Any
C11, C22	2	Capacitor, POS, 330 μF, 6.3 V, 25 mΩ, 20%	7343 (D)	SANYO	6TPE330ML
C12, C20	0	Capacitor	0805	Any	Any
C15	1	Capacitor, Ceramic, 10 μF, 6.3 V, X5R, 10%	0805	TDK	C2012X5R0J106K
C17	1	Capacitor, Ceramic, 33 μF, 6.3 V, X5R, 20%	1206	TDK	C3216JB0J336M
C19	1	Capacitor, Ceramic, 220 nF, 50 V, X5R, 10%	0603	muRata	GRM188B31C224K
CN1, CN2	2	Adaptor, 3.5-mm probe clip (or 131-5031-00)	0.2	Tektronix	131-4244-00
D1	1	Diode, Schottky Barrier Array, 40 mA, 40 V	SOT363	Diodes	BAS40DW-04
D2, D5	0	Diode, Schottky, 0.5 A, 30 V	SOD123	Any	Any
D3, D4	2	Diode, Schottky, 3 A, 20 V	SMA	Rohm	RSX501LA-20 or RSX501L-20
JP1	1	Header, 2x4-pin, 100 mil spacing (36-pin strip)	0.20 × 0.40 in	Sullins	PTC36DAAN
JP2	1	Header, 2x3-pin, 100 mil spacing (36-pin strip)	0.20 × 0.30 in	Sullins	PTC36DAAN
L1, L2	2	Inductor, high-current, 7.3 mΩ, 14 A, SMT	0.425 × 0.45 in	Toko	FDA1055-3R3M
Q1, Q3	2	MOSFET, N-channel, 30 V, 11 A, 9.1 mΩ	SO8	IR	IRF7821
Q2, Q4	2	MOSFET, N-channel, 30 V, 11 A, 12.5 mΩ	SO8	Fairchild	FDS6690AS
R1	0	Resistor	0603	Any	Any
R2	1	Resistor, Chip, 100 kΩ, 1/16W, 1%	0603	Std	Std
R3, R10, R13, R15	4	Resistor, Chip, 0 Ω, 1/16 W, 1%	0603	Std	Std
R4, R14	2	Resistor, Chip, 5.1 Ω, 1/16W, 1%	0603	Std	Std
R5	1	Resistor, Chip, 30 kΩ, 1/16W, 1%	0603	Std	Std
R6, R8	2	Resistor, Chip, 130 kΩ, 1/16W, 1%	0603	Std	Std
R7, R9	2	Resistor, Chip, 20 kΩ, 1/16W, 1%	0603	Std	Std
R11	1	Resistor, Chip, 13 kΩ, 1/16W, 1%	0603	Std	Std
R12	1	Resistor, Chip, 620 kΩ, 1/16W, 1%	0603	Std	Std
S1	1	Header, 2-pin, 100 mil spacing, (36-pin strip)	0.2 × 0.2 in	Sullins	PTC36SAAN
SW1, SW2, SW3	3	Switch, ON-ON mini toggle	0.28 × 0.18 in	Nikkai	G-12AP
SW4	0	Switch, ON-ON mini toggle	0.28 × 0.18 in	Any	Any
TP1, TP2, TP3, TP4, TP5, TP6, TP7	7	Test point, yellow, through-hole	0.125 × 0.125 in	Keystone	5014
U1	1	Dual synchronous step-down controller with OOA operation and 100-mA LDO	QFN-24	TI	TPS51125RGE
VBAT, VBAT_GND, VO1, VO1_GND, VO2, VO2_GND	6	Pin, wiring terminal	0.12(D) × 0.4 in	Mill Max	3138-2-00-15-00-00-080
	1	Printed circuit board	3.5 × 2.7 × 0.062 in	Any	TPS51125EVM
	3	Shunt, 2POs, gold	0.100 × 0.200 inch	Molex	15-29-1025
	4	Standoff M/F hex 4-40 nylon	0.625 in	Keystone	4803
	4	Nut hex 4-40 nylon		Building Fasteners	NY HN 440

8 References

TPS51125 Data Sheet, Dual-Synchronous Buck Controller ([SLUS786](#))

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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

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

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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.

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This Class A or B digital apparatus complies with Canadian ICES-003.

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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This device complies with Industry Canada licence-exempt RSS standard(s). 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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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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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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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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