User's Guide
SLUU311A–APRIL 2008–Revised JULY 2012

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	$V_{TONSEL} = V_{VREF}$, $V_{VIN} = 12$ V, $I_{OUT} = 6$ A		245		kHz
I_{OUT}	Output current	8 V ≤ V_{VIN} ≤ 25 V	8			A
I_{OC}	Overcurrent limit	$V_{VIN} = 12$ V		10		
CHANNEL2						
V_{OUT}	Output voltage			3.3		V
f	Operating frequency	$V_{TONSEL} = V_{VREF}$, $V_{VIN} = 12$ V, $I_{OUT} = 6$ A		305		kHz
I_{OUT}	Output current	8 V ≤ V_{VIN} ≤ 25 V	8			A
I_{OC}	Overcurrent limit	$V_{VIN} = 12$ V		10		

3 Schematic

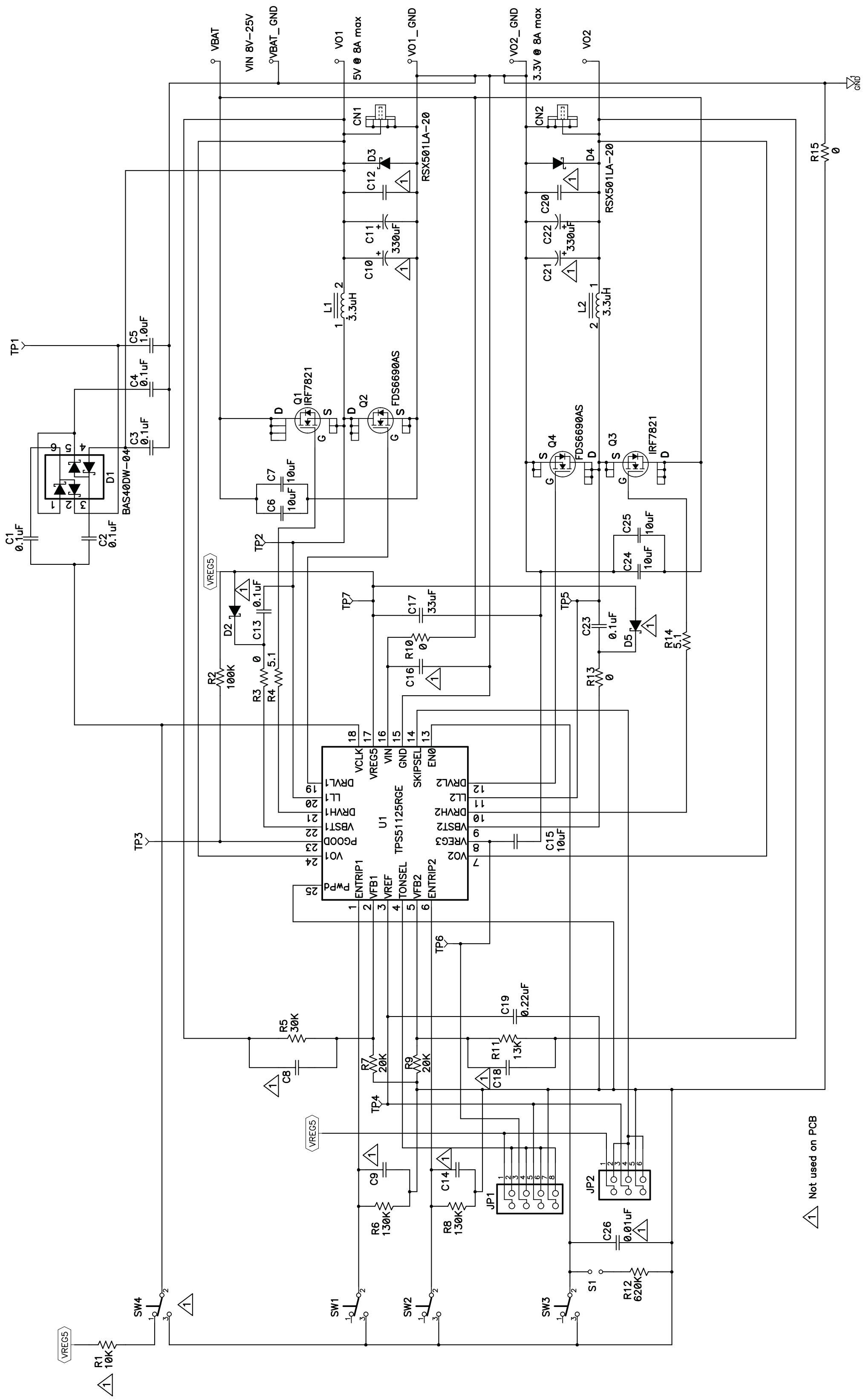

Figure 1. TPS51125-EVM Schematic Diagram

4 Test Setup and Results

4.1 Test Setup

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

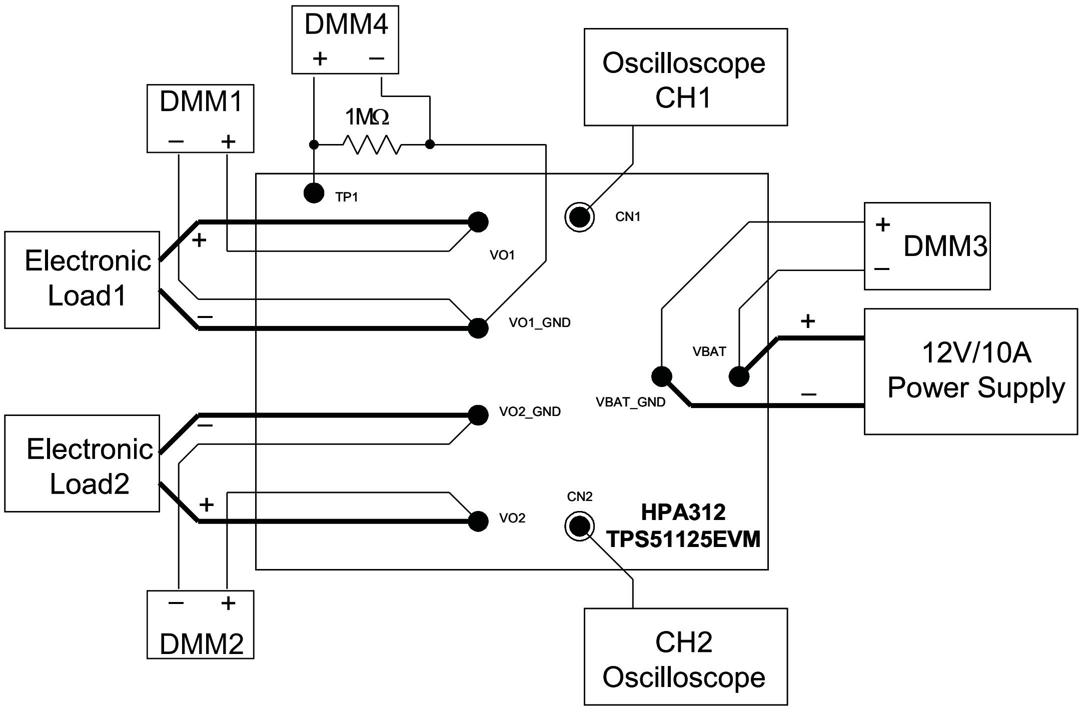

Figure 2. Equipment Setup for TPS51125EVM board

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

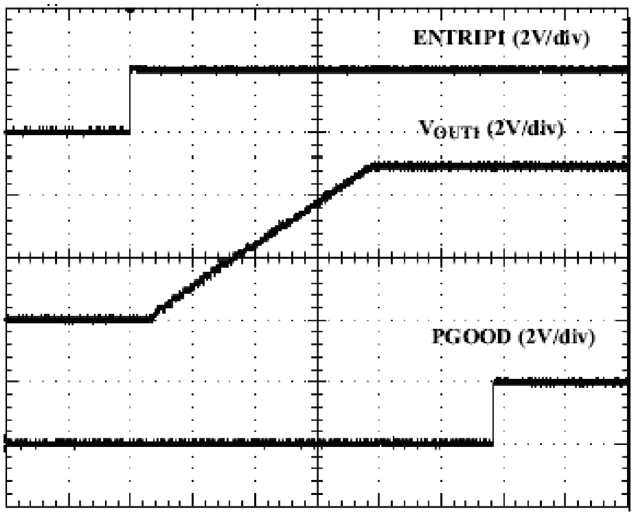

Figure 3. 5-V Startup Waveforms

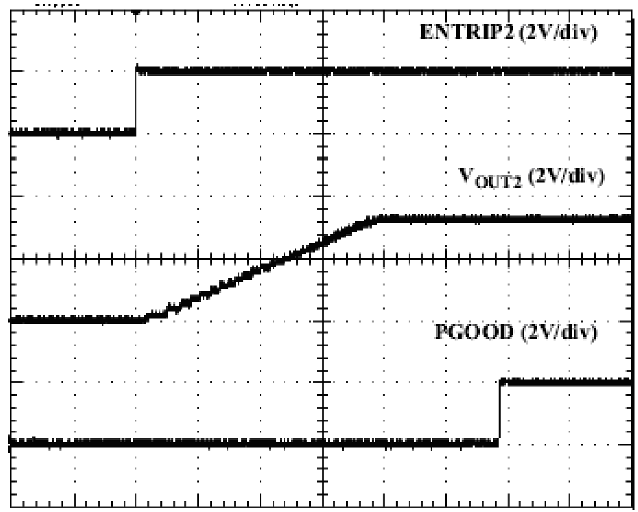

Figure 4. 3.3-V Startup Waveforms

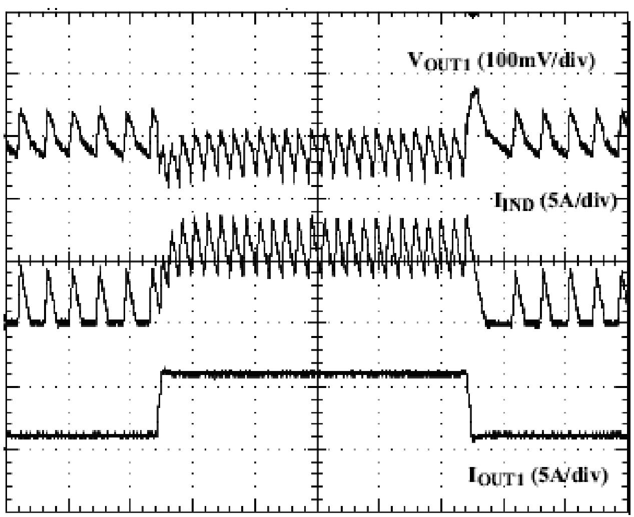

Figure 5. 5-V Load Transient Response

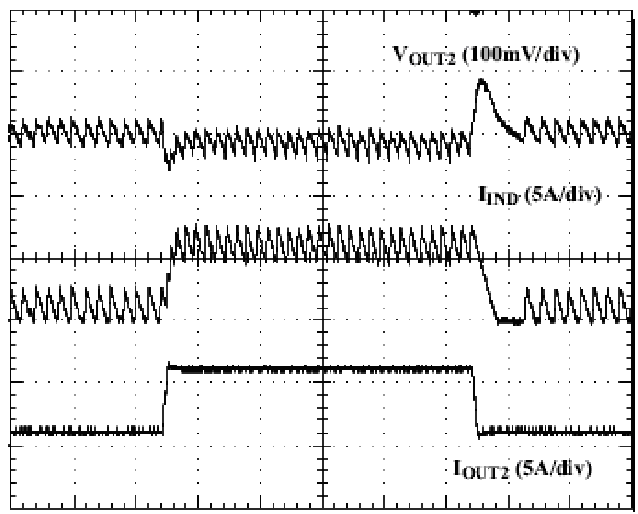

Figure 6. 3.3-V Load Transient Response

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.

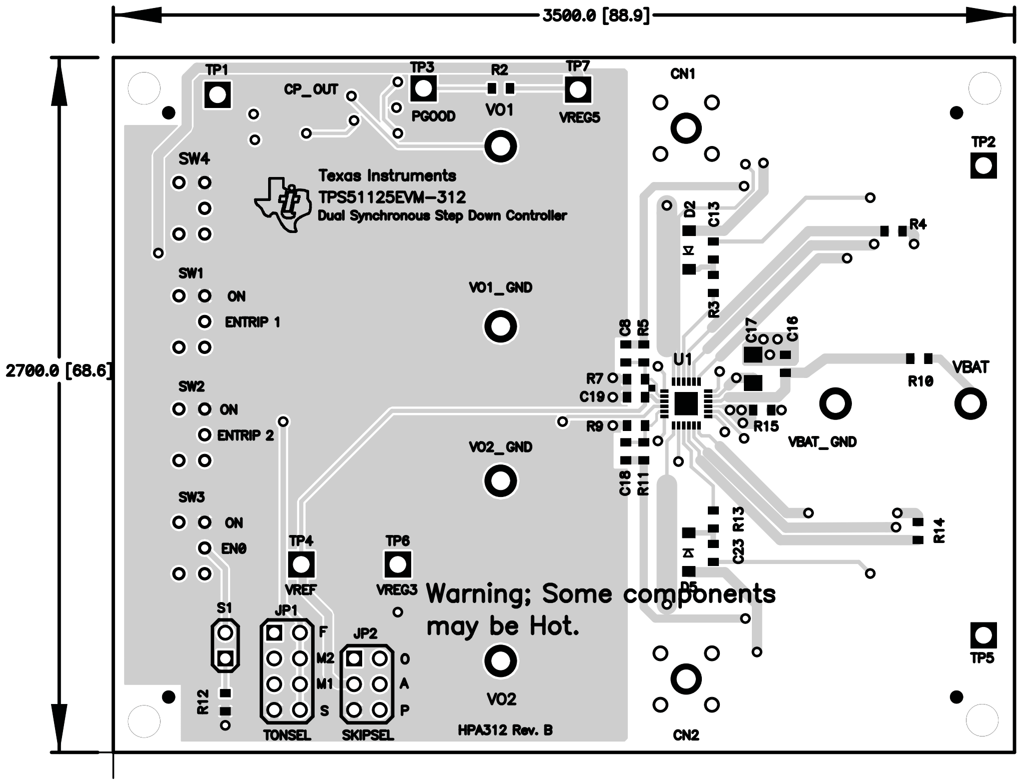

Figure 7. Top Layer Routing

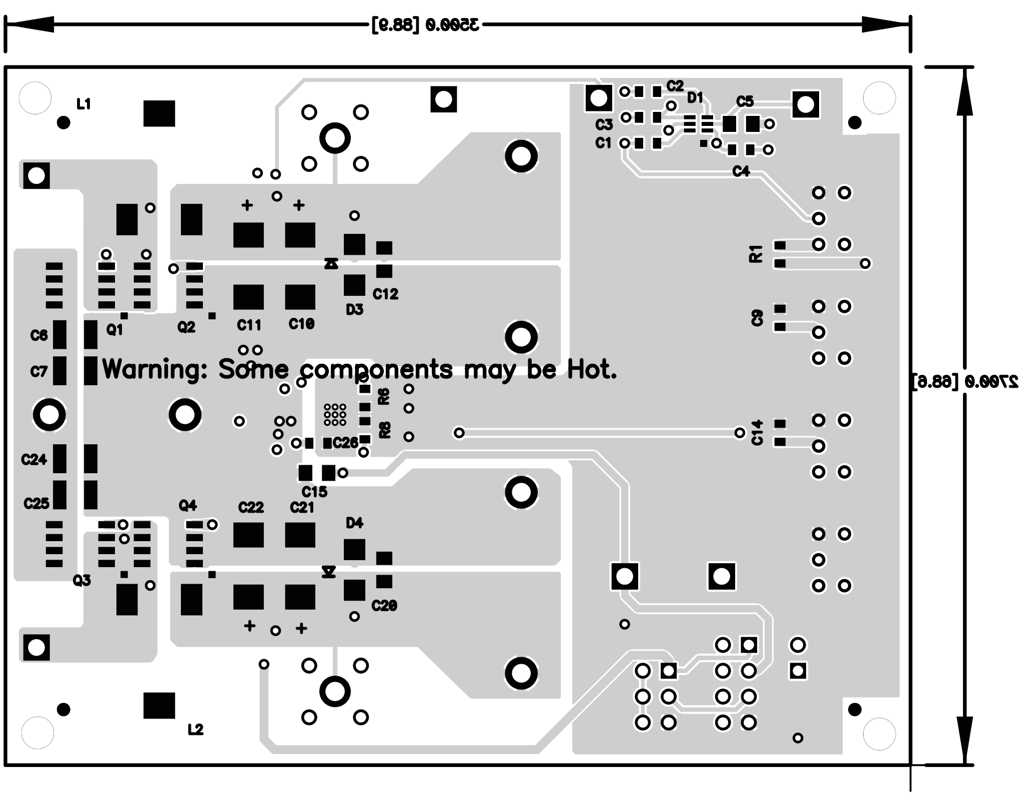

Figure 8. Bottom Layer Routing

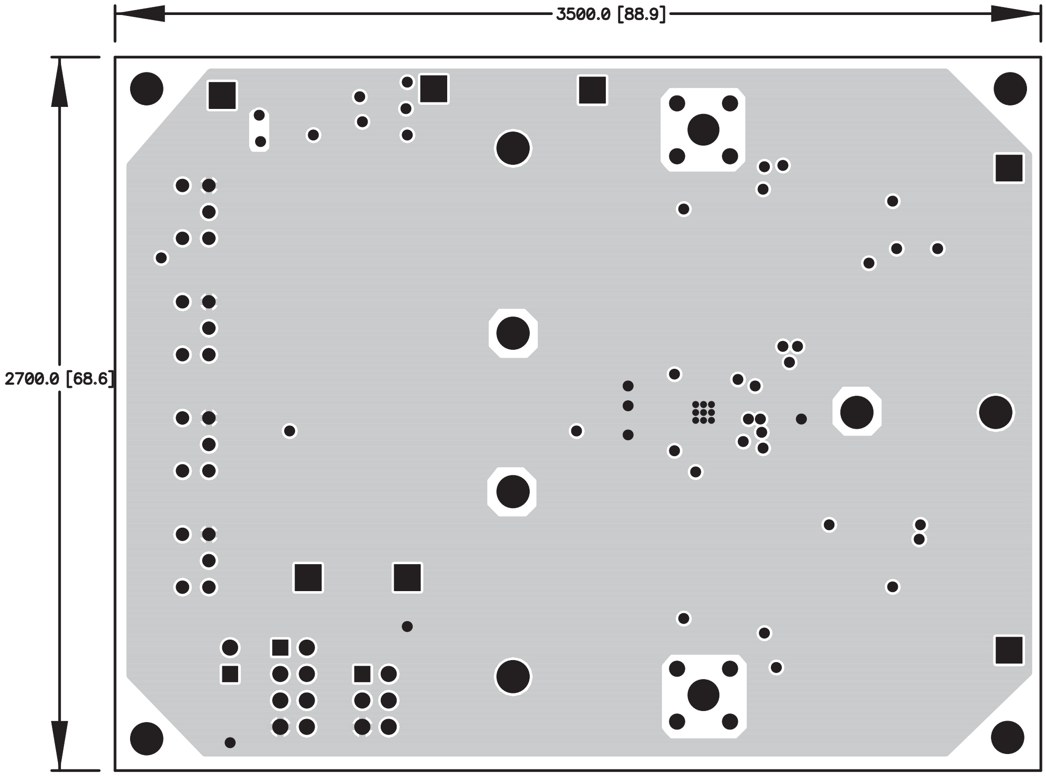

Figure 9. Inner Layer 1

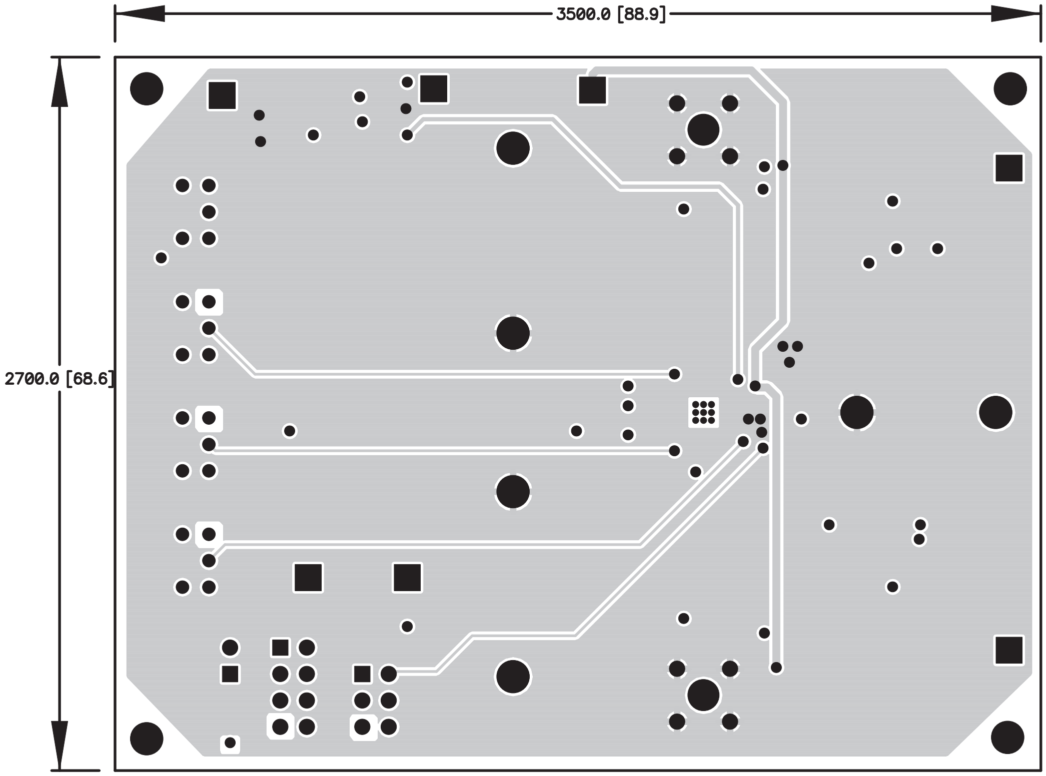

Figure 10. Inner Layer 2

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, 2×4-pin, 100 mil spacing (36-pin strip)	0.20 × 0.40 in	Sullins	PTC36DAAN
JP2	1	Header, 2×3-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)

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

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.

Concerning EVMs including radio transmitters

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.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 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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EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
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.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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