

# **High Performance Synchronous Buck EVM Using the TPS51123**

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## Contents

1	Introduction .....	2
2	Performance Specification Summary .....	2
3	Schematic.....	3
4	Test Setup and Results .....	4
5	Configuration .....	6
6	Physical Layouts .....	7
7	List of Materials.....	11
8	References .....	12

## List of Figures

1	TPS51123-EVM Schematic Diagram .....	3
2	Equipment Setup for TPS51123EVM board .....	4
3	5-V Startup Waveforms .....	5
4	3.3-V Startup Waveforms .....	5
5	5-V Load Transient Response .....	5
6	3.3-V Load Transient Response .....	5
7	Top Layer Routing .....	7
8	Bottom Layer Routing .....	8
9	Inner Layer 1 .....	9
10	Inner Layer 2.....	10

## List of Tables

1	Performance Specification Summary .....	2
2	Switching Frequency Selection .....	6
3	Operation Mode Selection .....	6
4	TPS51123 List of Materials .....	11

## 1 Introduction

The TPS51123 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 TPS51123 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 device operates with supply input voltages ranging from 5.5 V to 28 V and supports output voltages from 2 V to 5.5 V.

The TPS51123EVM evaluation module is a high-efficiency, dual synchronous buck converter providing 5 V at 8 A and 3.3 V at 8 A from a 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 <sub>IN</sub>	Input voltage range	Voltage applied to VBAT	8		25	V
<b>CHANNEL1</b>						
V <sub>OUT</sub>	Output voltage			5		V
f	Operating frequency	V <sub>TONSEL</sub> = V <sub>VREF</sub> , V <sub>VIN</sub> = 12 V, I <sub>OUT</sub> = 6 A		245		kHz
I <sub>OUT</sub>	Output current	8 V ≤ V <sub>VIN</sub> ≤ 25 V	8			A
I <sub>OC</sub>	Overcurrent limit	V <sub>VIN</sub> = 12 V		10		
<b>CHANNEL2</b>						
V <sub>OUT</sub>	Output voltage			3.3		V
f	Operating frequency	V <sub>TONSEL</sub> = V <sub>VREF</sub> , V <sub>VIN</sub> = 12 V, I <sub>OUT</sub> = 6 A		305		kHz
I <sub>OUT</sub>	Output current	8 V ≤ V <sub>VIN</sub> ≤ 25 V	8			A
I <sub>OC</sub>	Overcurrent limit	V <sub>VIN</sub> = 12 V		10		

3 Schematic

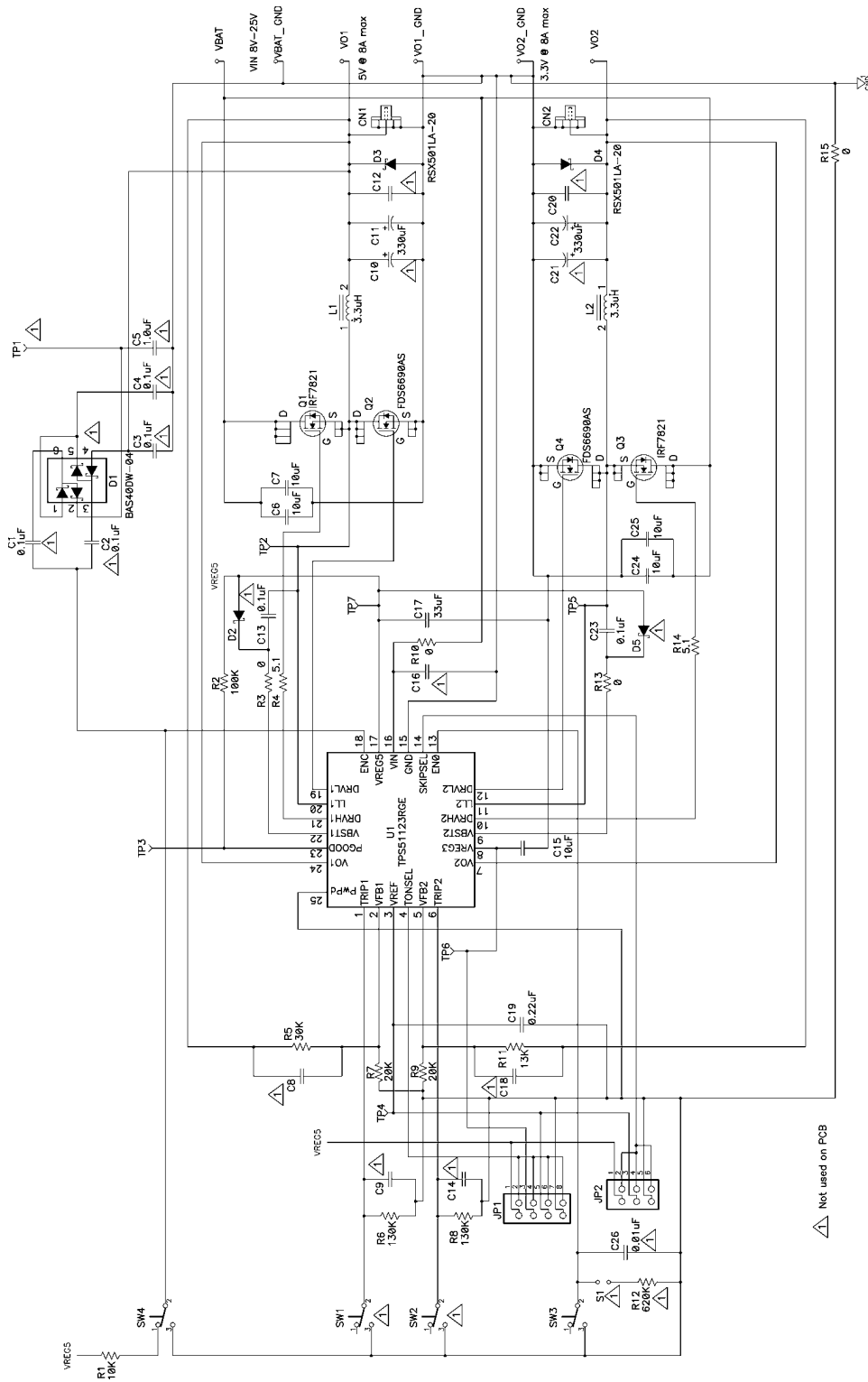
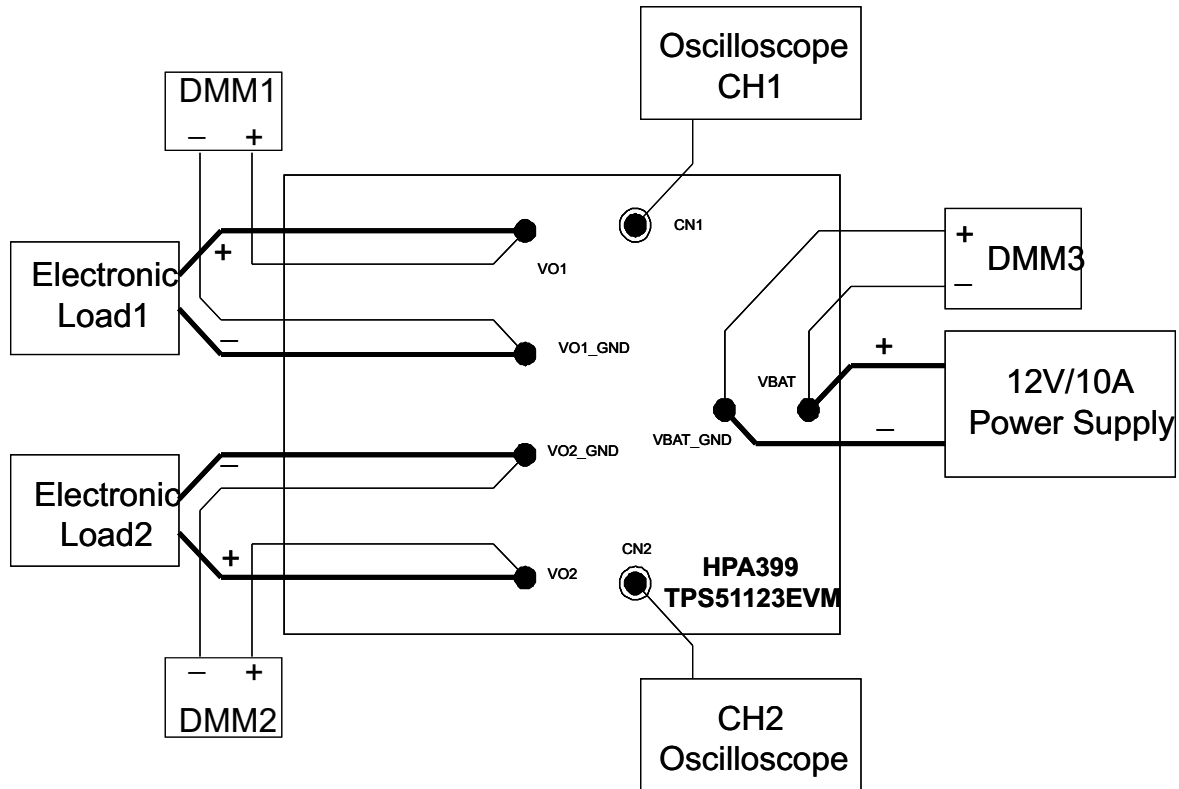


Figure 1. TPS51123-EVM Schematic Diagram

## 4 Test Setup and Results

### 4.1 Test Setup

Connect test equipment and TPS51123EVM board as shown in Figure 2.



**Figure 2. Equipment Setup for TPS51123EVM board**

### 4.2 Test Procedure

1. Ensure the switches SW4 (ENC) 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 5-pin to 6-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 SW4 (ENC), CH1-output, and CH2-output start up.

### 4.3 Start-Up Performance

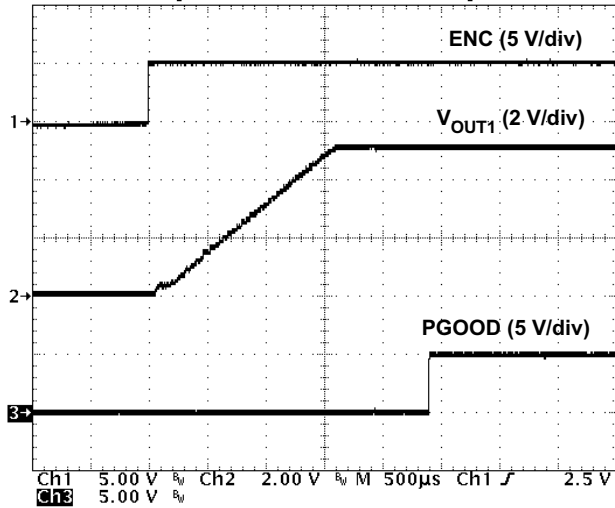


Figure 3. 5-V Startup Waveforms

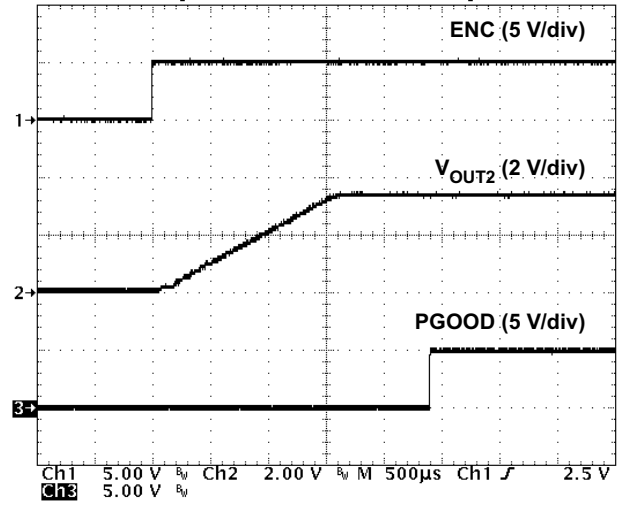


Figure 4. 3.3-V Startup Waveforms

### 4.4 Transient Performance

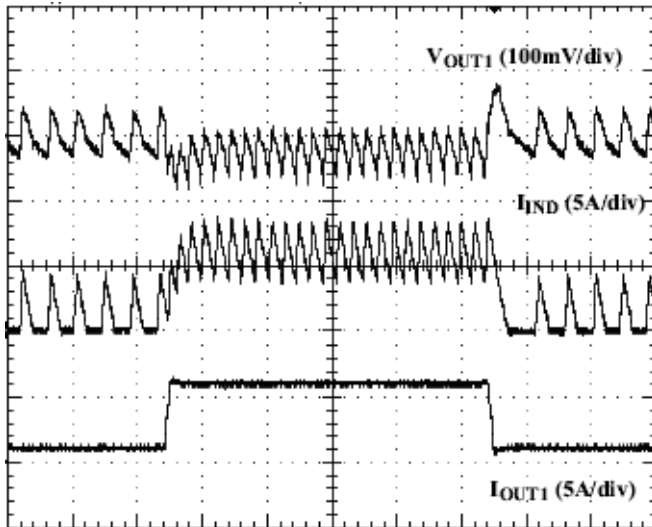


Figure 5. 5-V Load Transient Response

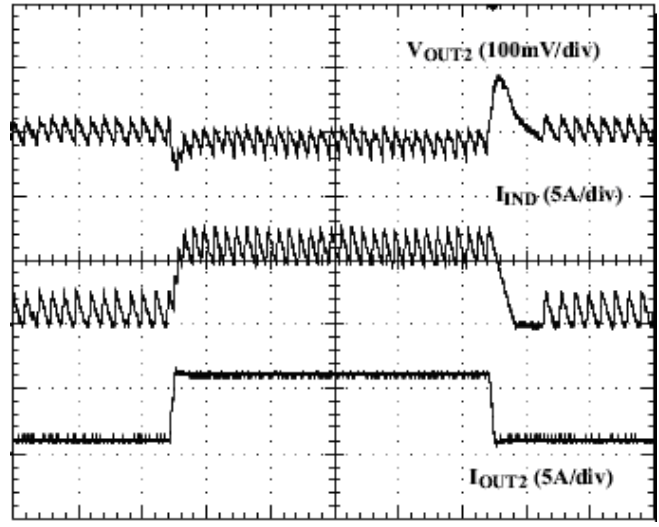


Figure 6. 3.3-V Load Transient Response

## 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	Auto skip
VREF	PWM only
VREG5	Out-of-Audio™

## 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.

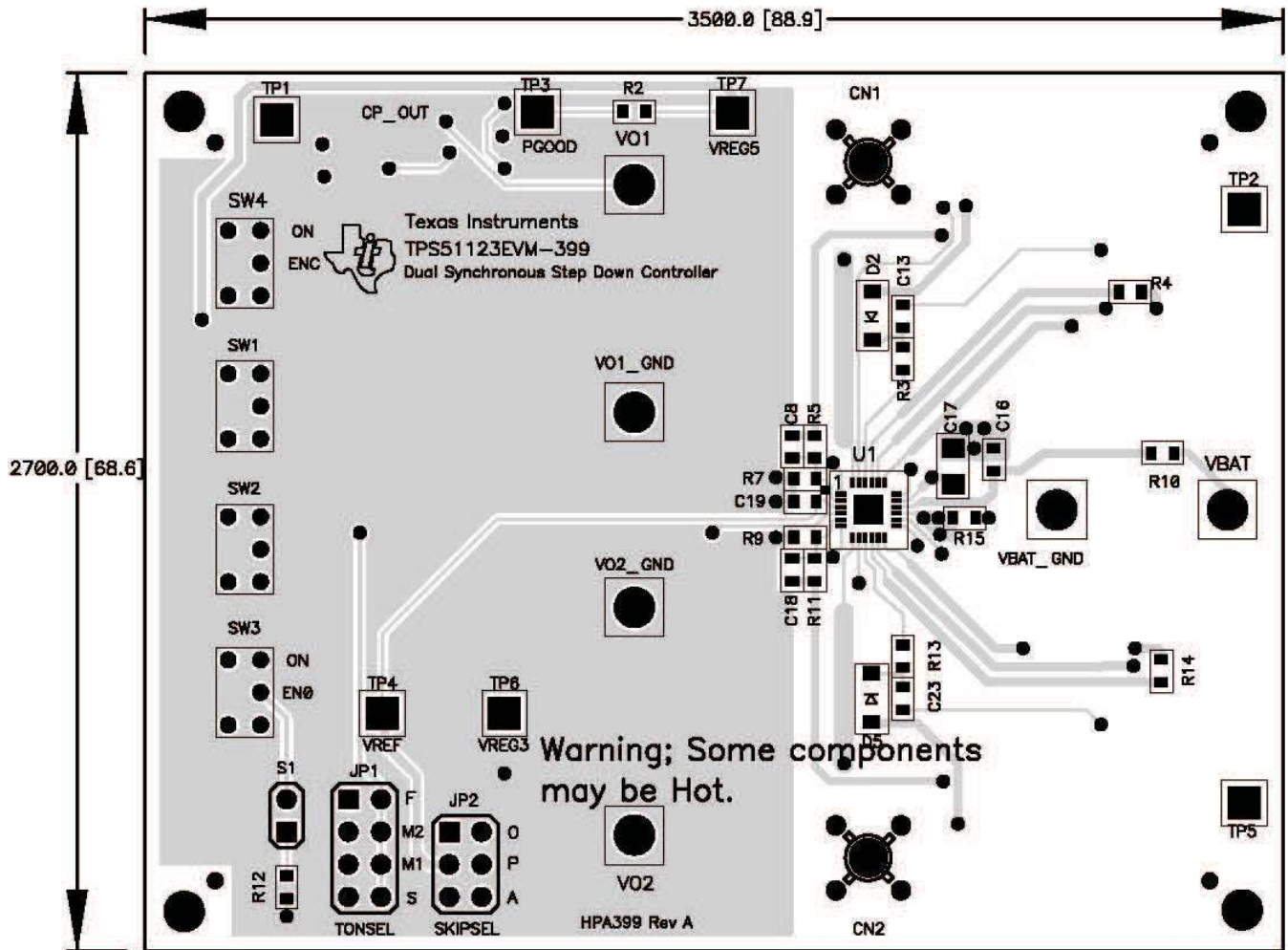


Figure 7. Top Layer Routing

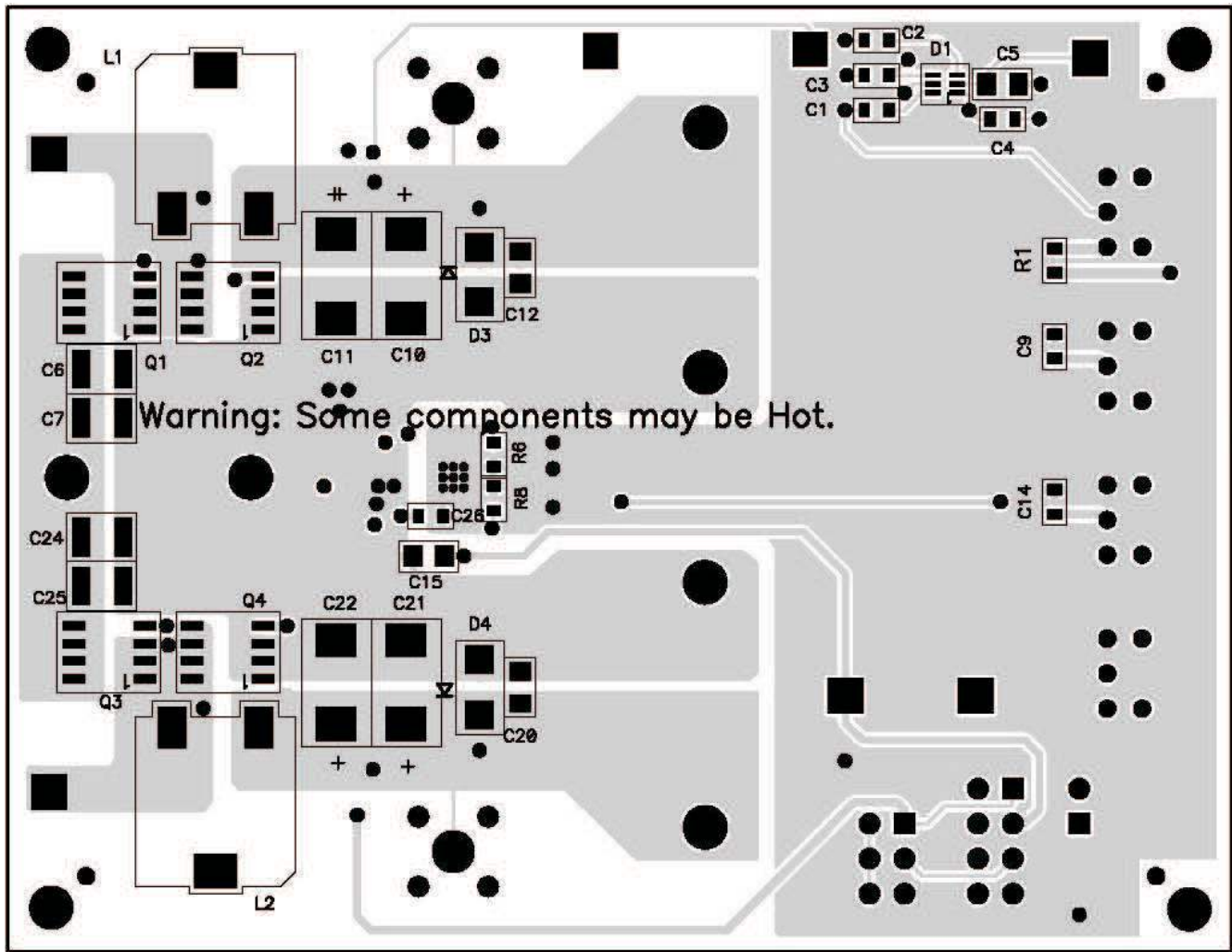


Figure 8. Bottom Layer Routing



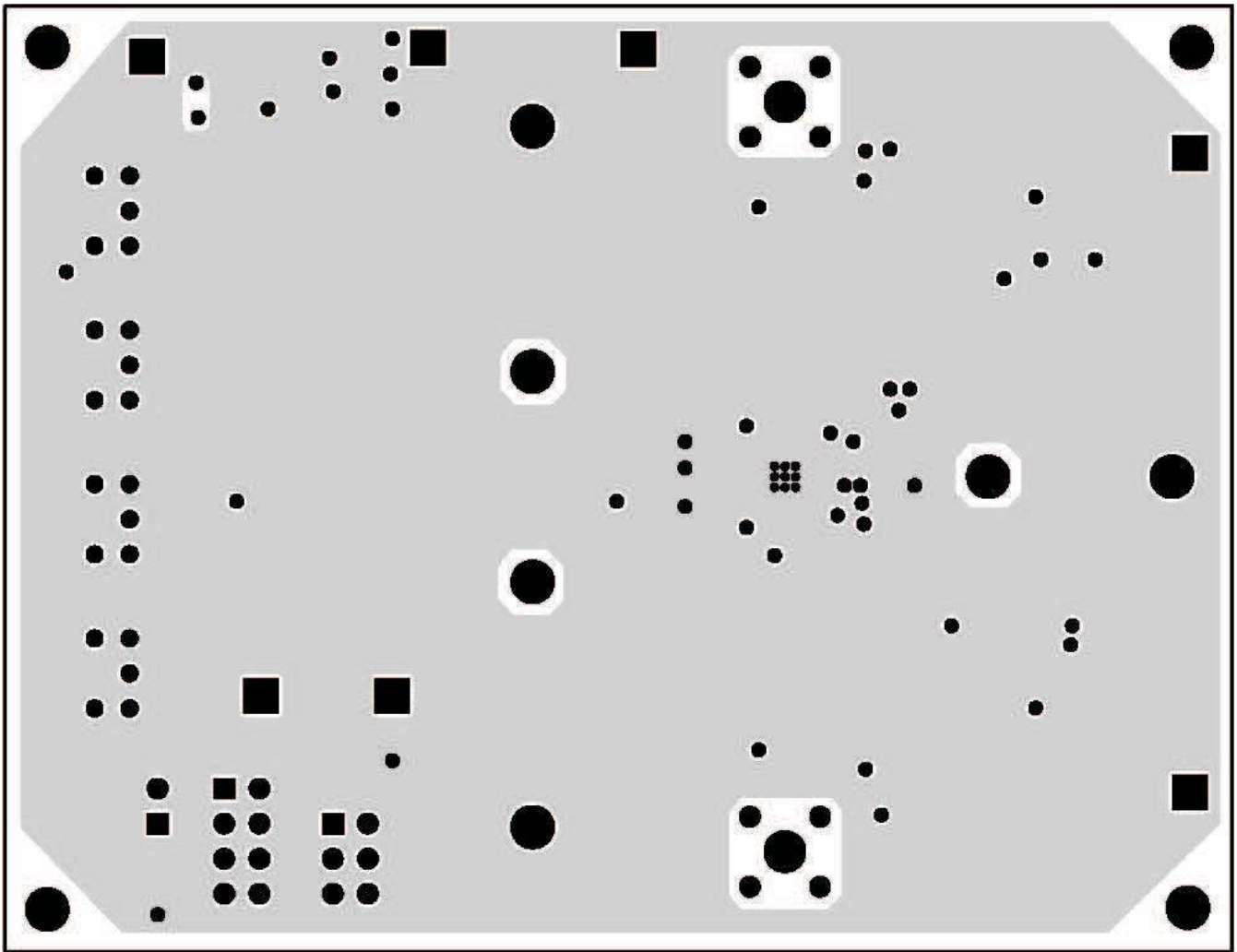


Figure 9. Inner Layer 1

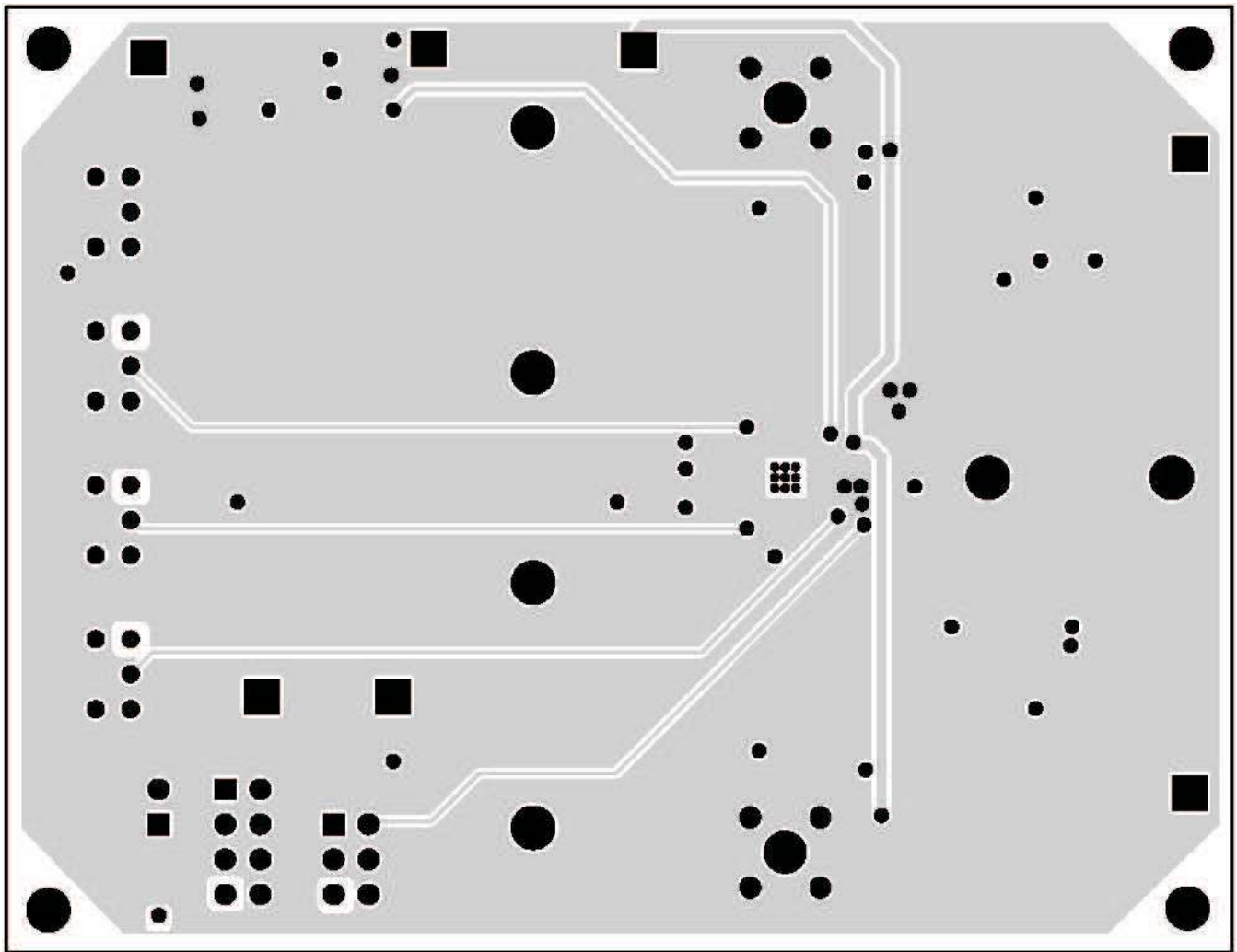


Figure 10. Inner Layer 2

## 7 List of Materials

List of materials for the TPS51123-EVM.

**Table 4. TPS51123 List of Materials**

REFERENCE DESIGNATOR	QTY	DESCRIPTION	SIZE	MFR	PART NUMBER
C13, C23	2	Capacitor, Ceramic, 0.1 $\mu$ F, 50 V, X5R, 10%	0603	muRata	GRM188B31H104K
C10, C21	0	Capacitor	7.3 $\times$ 4.3 mm	Any	Any
C11, C22	2	Capacitor, POS, 330 $\mu$ F, 6.3 V, 25 m $\Omega$ , 20%	7.3 $\times$ 4.3 mm	SANYO	6TPE330ML
C12, C20	0	Capacitor	0805	Any	Any
C15	1	Capacitor, Ceramic, 10 $\mu$ F, 6.3 V, X5R, 10%	0805	TDK	C2012X5R0J106K
C17	1	Capacitor, Ceramic, 33 $\mu$ F, 6.3 V, X5R, 20%	1206	TDK	C3216JB0J336M
C19	1	Capacitor, Ceramic, 220 nF, 16 V, X5R, 10%	0603	muRata	GRM188B31C224K
C26	0	Capacitor	0603	Any	Any
C5	0	Capacitor	0805	Any	Any
C6, C7, C24, C25	4	Capacitor, Ceramic, 10 $\mu$ F, 25 V, BJ, M	1210	Taiyo Yuden	TMK325BJ106MM
C1, C2, C3, C4, C8, C9, C14, C16, C18	0	Capacitor	0603	Any	Any
CN1, CN2	2	Adaptor, 3.5-mm probe clip ( or 131-5031-00)	0.2	Tektronix	131-4244-00
D1	0	Diode	SOT363	Any	Any
D2, D5	0	Diode, Schottky, 0.5 A, 30 V	SOD-123	Any	Any
D3, D4	2	Diode, Schottky, 3 A, 20 V	SMA	Rohm	RSX501LA-20 OR RSX510L-20
JP1	1	Header, 2 $\times$ 4-pin, 100 mil spacing (36-pin strip)	0.20 $\times$ 0.40 inch	Sullins	PTC36DAAN
JP2	1	Header, 2 $\times$ 3-pin, 10 mil spacing (36-pin strip)	0.20 $\times$ 0.30 inch	Sullins	PTC36DAAN
L1, L2	2	Inductor, high-current, 3.3 $\mu$ H, 14 A, 7.3 m $\Omega$ , SMT	0.425 $\times$ 0.45 inch	Toko	FDA1055-3R3M
Q1, Q3	2	MOSFET, N-channel, 30 V, 11 A, 9.1 m $\Omega$	SO8	IR	IRF7821
Q2, Q4	2	MOSFET, N-channel, 30 V, 11 A, 12.5 m $\Omega$	SO8	Fairchild	FDS6690AS
R3, R10, R13, R15	4	Resistor, Chip, 0 $\Omega$ , 1/16 W, 1%	0603	Std	Std
R12	1	Resistor, Chip, 620 k $\Omega$ , 1/16W, 1%	Any	Std	Std
R11	1	Resistor, Chip, 13 k $\Omega$ , 1/16W, 1%	0603	Any	Any
R5	1	Resistor, Chip, 30 k $\Omega$ , 1/16W, 1%	0603	Std	Std
R2	1	Resistor, Chip, 100 k $\Omega$ , 1/16W, 1%	0603	Std	Std
R6, R8	2	Resistor, Chip, 130 k $\Omega$ , 1/16W, 1%	0603	Std	Std
R7, R9	2	Resistor, Chip, 20 k $\Omega$ , 1/16W, 1%	0603	Std	Std
R1	1	Resistor, Chip, 10 k $\Omega$ , 1/16W, 1%	0603	Std	Std
R4, R14	2	Resistor, Chip, 5.1 $\Omega$ , 1/16W, 1%	0603	Std	Std
S1	1	Header, 2-pin, 100 mil spacing, (36-pin strip)	0.20 in. $\times$ 0.20 in.	Sullins	PTC36SAAN
SW1, SW2	0	Switch	0.28 in. $\times$ 0.18 on.	Any	Any
SW3, SW4	2	Switch, ON-ON mini toggle	0.28 in. $\times$ 0.18 on.	Nikkai	G-12AP
TP1	0	Test Point	0.125 in. $\times$ 0.125 in.	Any	Any
TP2, TP3, TP4, TP5, TP6, TP7	6	Test point, yellow, through-hole	0.125 in. $\times$ 0.125 in.	Keystone	5014
U1	1	Dual Synchronous Step-Down Controller With OOA Operation and 100-mA LDO	QFN-24	TI	TPS51123RGE

**Table 4. TPS51123 List of Materials (continued)**

REFERENCE DESIGNATOR	QTY	DESCRIPTION	SIZE	MFR	PART NUMBER
VBAT_GND, VBAT, VO1, VO2, VO1_GND, VO2_GND	6	Pin, wiring terminal	0.12(D) × 0.4 inch	Mill Max	3138-2-00-15-00-00-080
-	1	PCB, 3.5	3.5 in. × 2.7 in. × 0.062 in.	Any	TPS51123-EVM
	2	Shunt, 2POs, gold	0.100 × 0.200 inch	Molex	15-29-1025
	4	Standoff M/F hex 4-40 nylon	0.625 inch	Keystone	4803
	4	Nut hex 4-40 nylon	0.25 inch	Building Fasteners	NY HN 440

## 8 References

TPS51123 Datasheet, Dual-Synchronous Buck Controller ([SLUS890](#))

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### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 4.4 V to 16 V and the output voltage range of 2.3 V to 4.4 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. 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 75°C. The EVM is designed to operate properly with certain components above 100°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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