High Performance Synchronous Buck EVM Using the TPS51120

User's Guide

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third–party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof.
Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Copyright . 2005, Texas Instruments Incorporated

CONTENTS

1. Description ····4
2. Electrical Performance Specifications····5
3. Schematic····6
4. Test Setup and Results ····7
5. Configuration ····7
6. EVM Assembly Drawing and PCB layout····8
7. List of Materials····9
8. References····10

1. Description

The TPS51120 is a highly sophisticated dual current mode synchronous step-down controller. It is a full featured controller designed to run directly off three to four-cell Li-ion battery and provide high power and 5V and/or 3.3V standby regulation for all the downstream circuitry in a notebook computer system. High current, 100-mA, 5-V or 3.3-V on-board linear regulators have glitch-free switch over function to SMPS and can be kept alive independently during standby state. The pseudo-constant frequency adaptive on-time control scheme supports full range of current mode operation including simplified loop compensation, ceramic output capacitors as well as seamless transition to reduced frequency operation at light-load condition. Optional D-CAP™ mode operation optimized for SP-CAP or POSCAP output capacitors allows further reduction of external compensation parts.

TPS51120EVM-001 evaluation module is a high efficiency, dual synchronous buck converter providing 5 V at 6 A and 3.3 V at 6 A from 8 V to 25 V input. This user's guide describes the TPS51120EVM-001 performance in D-CAP™ mode and $R_{DS(on)}$ current sensing.

2. ELECTRICAL PERFORMANCE

Table1. Electrical Performance

SPECIFICATIONS		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input voltage range (VBAT)			8	12	25	V
CH1	Output voltage			5		V
	Operating frequency	TONSEL : VREF2 VBAT=12V, Iout1=6A		280		kHz
	Output current	VBAT: 8V to 25V	6			A
	Over current limit	VBAT=12V		10		A
	Output ripple voltage	VBAT=12V, Iout1=6A		40		mVp-p
CH2	Output voltage			3.3		V
	Operating frequency	TONSEL : VREF2 VBAT=12V, Iout2=6A		430		kHz
	Output current	VBAT: 8V to 25V	6			A
	Over current limit	VBAT=12V		10		A
	Output ripple voltage	VBAT=12V, Iout2=6A		45		mVp-p

3. Schematic

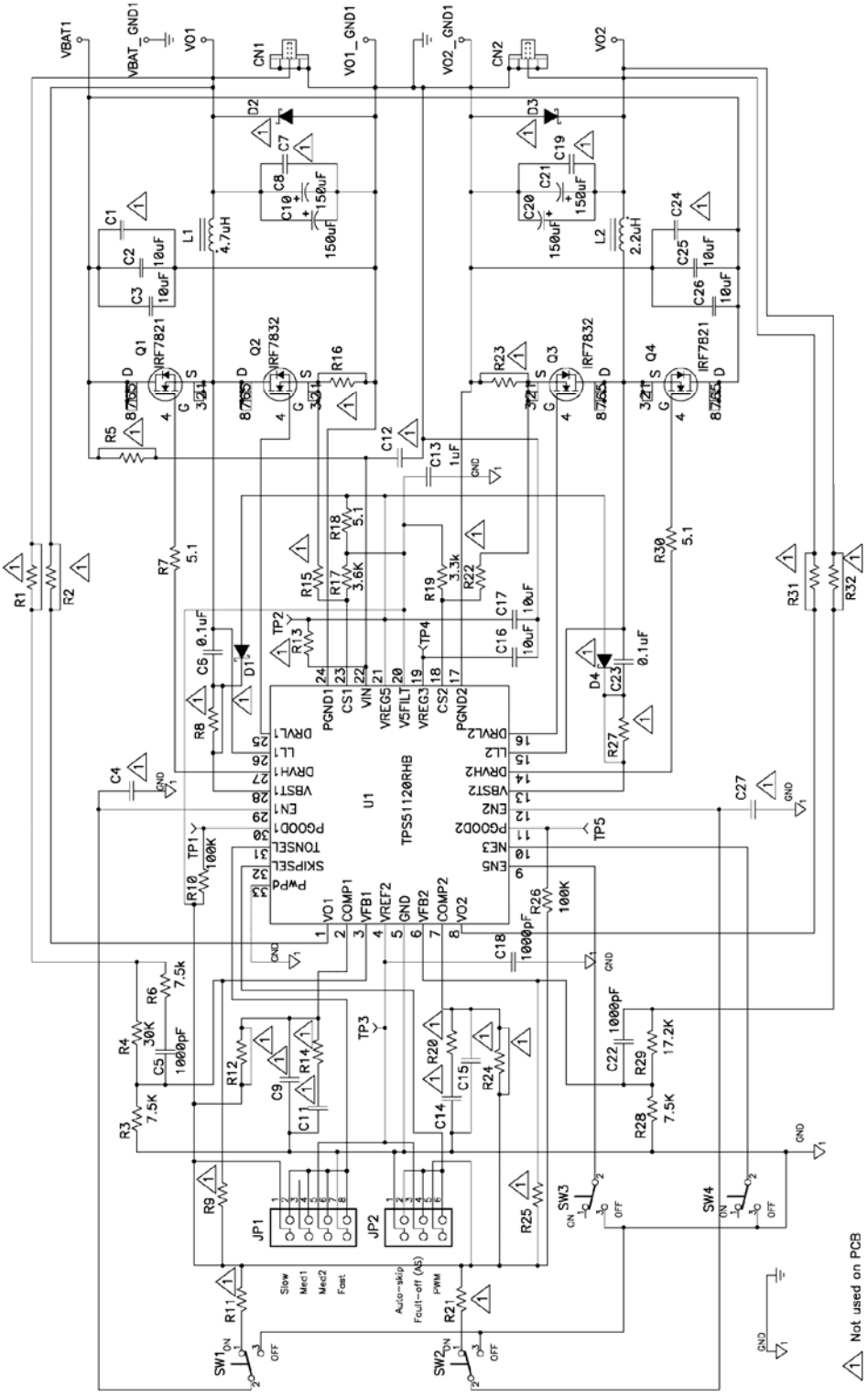


Figure 1. TPS51120 EVM schematic diagram

4. Test Setup and Results

4.1. Test setup

Connect test equipment and TPS51120EVM-001 board as shown in Figure 2.

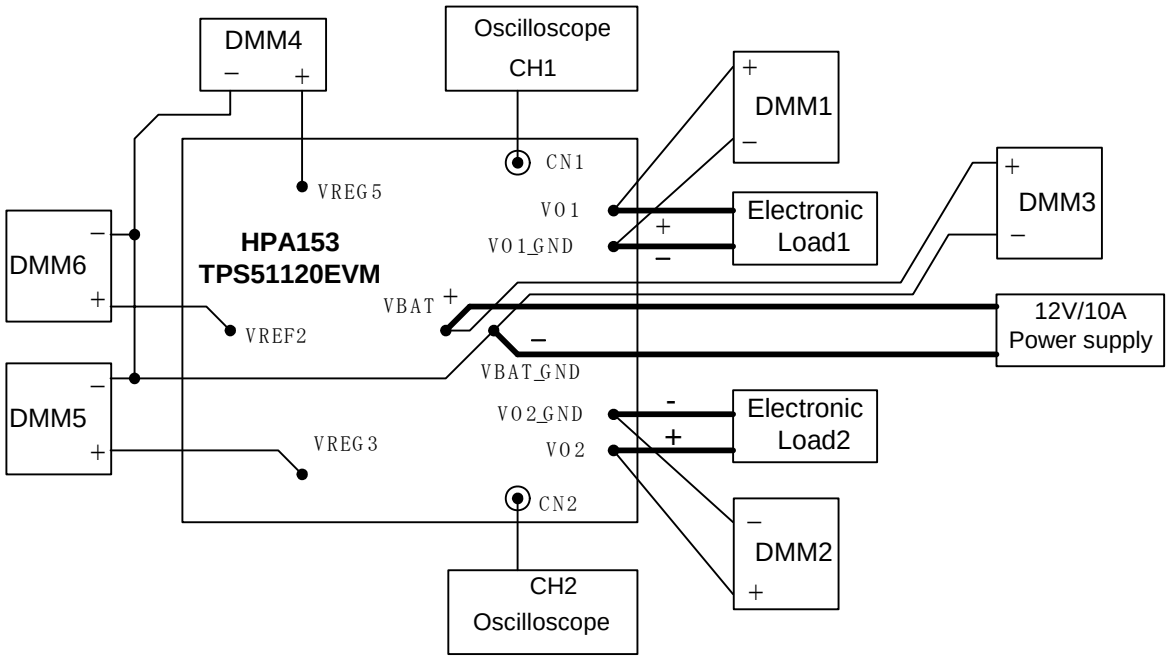


Figure 2. Equipment setup for TPS51120EVM-001 board

4.2 Test procedure

1. Make sure the switches SW1 (EN1), SW2 (EN2), SW3 (EN5) and SW4 (EN3) are in "OFF" position.
2. Make sure the shunt jumper for JP1 is set 5-pin to 6-pin (Med2), and shunt jumper for JP2 is set 1-pin to 2-pin (Auto-skip).
3. Apply appropriate VBAT voltage to VBAT1 and VBAT_GND1 terminals.
4. Turn on SW3 (EN5) and VREG5 (5V-LDO) starts up.
5. Turn on SW4 (EN3) and VREG3 (3.3V-LDO) starts up.
6. When SW3 and SW4 stay on, VREF2 (2V-REF) enables.
7. When SW3 and SW4 stay on and turn on SW1 (EN1), CH1-output will start up.
8. When SW3 and SW4 stay on and turn on SW2 (EN2), CH2-output will start up.

4.3. Start up performance

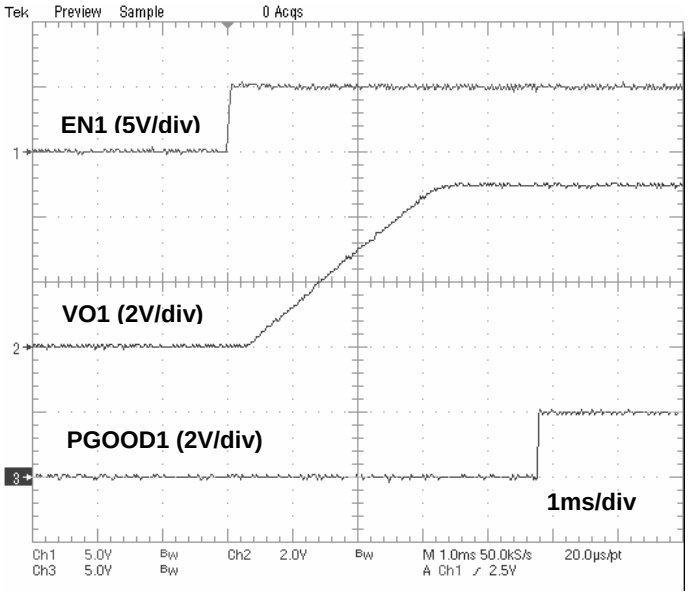


Figure3. 5-V Startup Waveforms

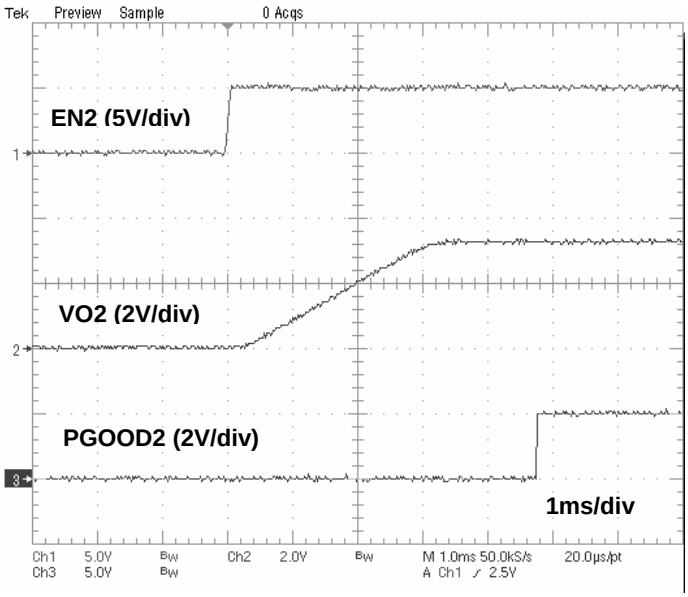


Figure4. 3.3-V Startup Waveforms

4.4. Transient performance

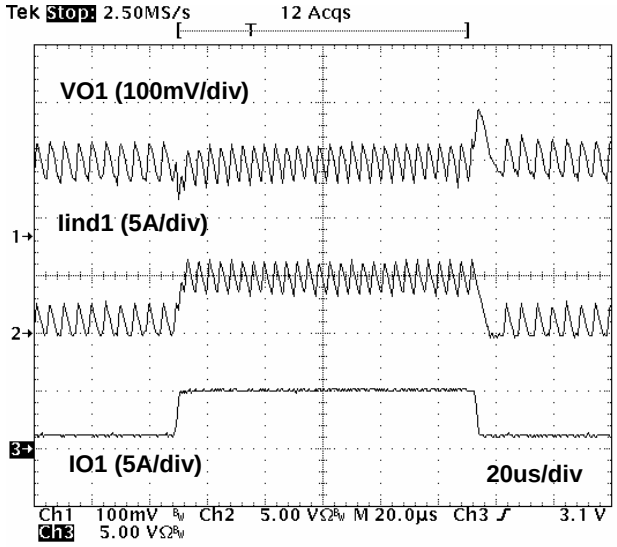


Figure5. 5-V Load Transient Response

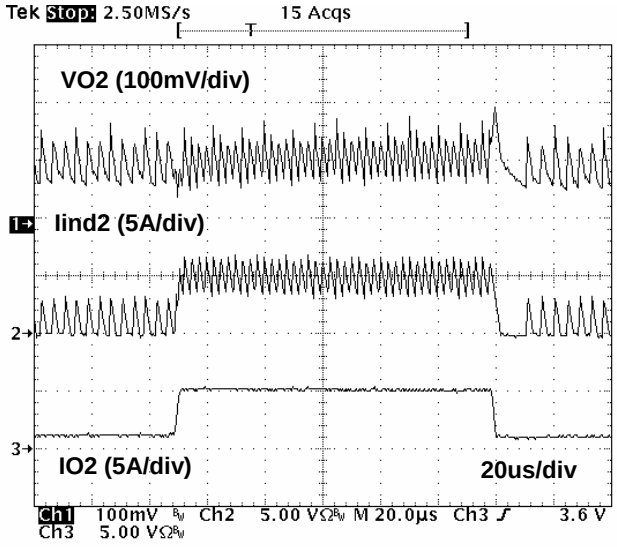


Figure6. 3.3-V Load Transient Response

5. Configuration

This EVM could be set as user's desirable configurations.
Please refer to the following specific configuration setting sections.

5.1 Switching Frequency selection

Switching frequency can be set by the TONSEL pin using JP1 on the EVM.
Default setting is Medium2.

Table 2. Switching Frequency selection

Jumper (JP1) set to	Frequency		
	Typ	CH1	CH2
Top (1-2 pin shorted)	Slow	180kHz	270kHz
2nd (3-4 pin shorted)	Medium1	220kHz	330kHz
3rd (5-6 pin shorted)	**Medium2**	**280kHz**	**430kHz**
Bottom (7-8 pin shorted)	Fast	380kHz	580kHz

(Note; Frequencies are approximate)

5.2 Skip mode and Faults disable selection

Skip mode can be set by the SKIPSEL pin using JP2 on the EVM.
In addition Faults disable mode could be selected for debugging purpose.
Default setting is Auto-skip and Fault enable.

Table 3. Skip Mode selection

Jumper (JP2) set to	Skip	Faults
Top (1-2 pin shorted)	**Auto-skip**	**Enable**
2nd (3-4 pin shorted)	Auto-skip	disable
Bottom (5-6 pin shorted)	PWM	Enable

5.3 Output Voltage setting selection

Output voltage can be set by the VFBx pin using some resistors on the EVM.
Default setting is Adjustable output.

Table 4-1. Output Voltage setting selection (CH1)

	R3	R4	R9
Adjustable output	**7.5kΩ**	**30kΩ**	**Open**
Fixed output ; 5V	Open	Open	0Ω

Table 4-2. Output Voltage setting selection (CH2)

	R28	R29	R25
Adjustable output	**7.5kΩ**	**17.2kΩ**	**Open**
Fixed output ; 3.3V	Open	Open	0Ω

5.4 Control Scheme selection

Control scheme can be set by the COMPx pin, using some resistors and capacitors on the EVM. Default setting is D-CAP mode.

Table 5-1. Control Scheme selection (CH1)

	R12	C9	C11	R14
D-CAP mode	**Shorted**	**Open**	**Open**	**Open**
Current mode	Open	Put on	Put on	Put on

(Note; When current mode is selected please add appropriate parts on C9, C11 and R14 and cut the trace between R12's pads.)

Table 5-2. Control Scheme selection (CH2)

	R24	C15	C14	R20
D-CAP mode	**Shorted**	**Open**	**Open**	**Open**
Current mode	Open	Put on	Put on	Put on

(Note; When current mode is selected please add appropriate parts on C15, C14 and R20 and cut the trace between R24's pads.)

6. EVM Assembly Drawing and PCB layout



Figure 7. Top Assembly

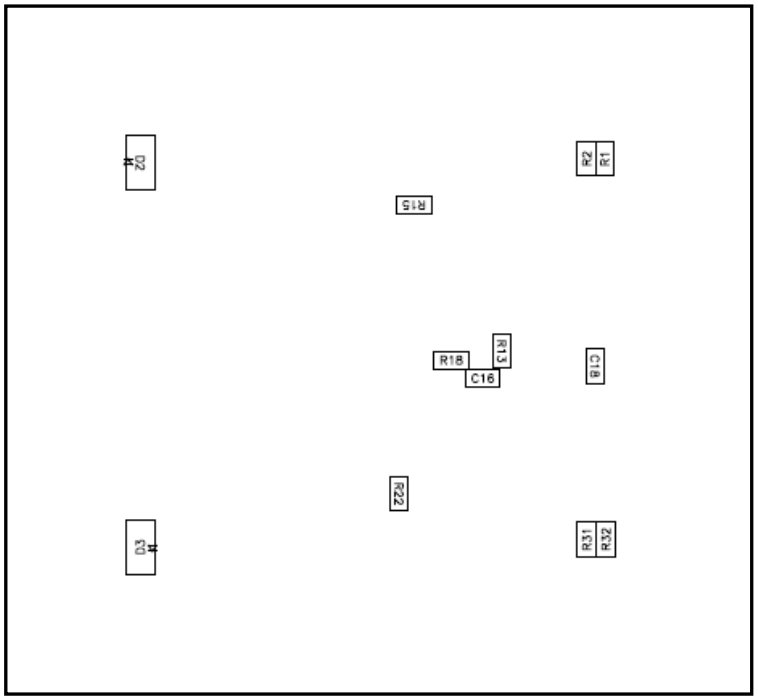


Figure 8. Bottom Assembly

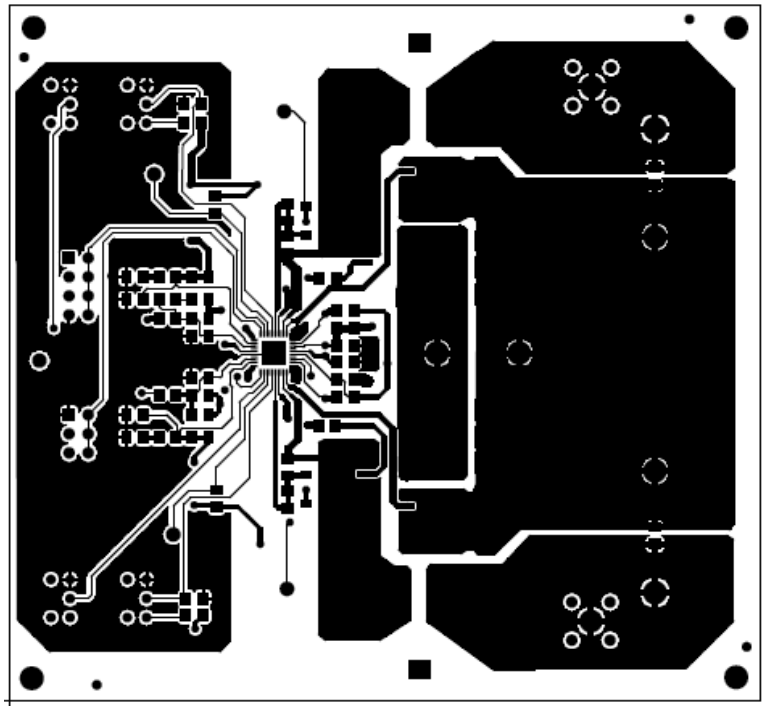


Figure 9. Top Layer

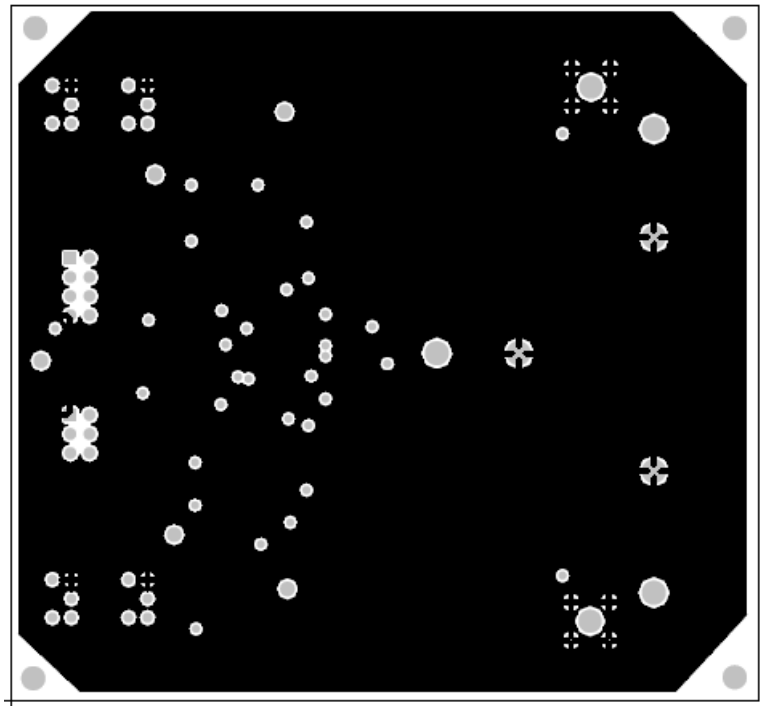


Figure 10. Inner Layer 1

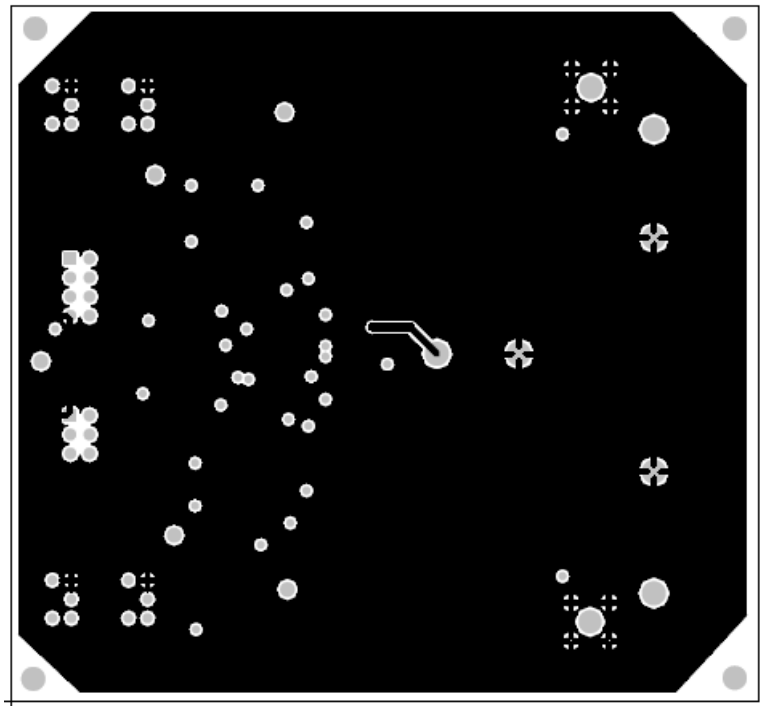


Figure 11. Inner Layer 2

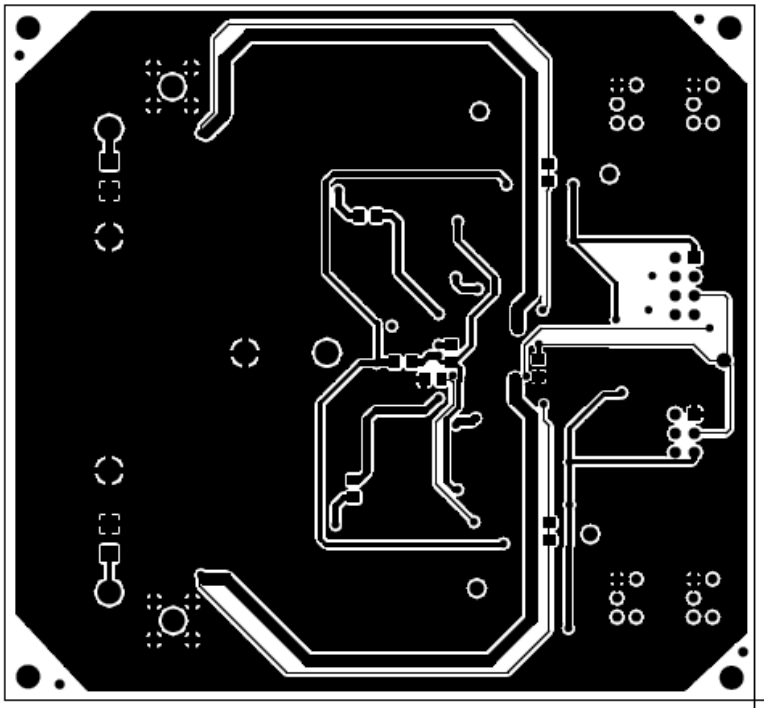


Figure 12. Bottom Layer

7. List of Materials

Table 7-1. List of Materials

Reference Designator	QTY	Description	Size	Mfr	Part Number
--	2	Shunt, 100-mil, Black	0.100	3M	929950-00
C1, C24	0	Capacitor, Ceramic	1210	Any	Any
C13	1	Capacitor, Ceramic, 1μF, 6.3V, BJ, 20%	0805	TDK	C2012X5R0J105K
C16, C17	2	Capacitor, Ceramic, 10μF, 6.3V, BJ, 20%	0805	TDK	C2012X5R0J106K
C2, C3, C25, C26	4	Capacitor, Ceramic, 10μF, 25V, BJ , 20%	1210	Taiyo Yuden	TMK325BJ106MM
C4, C7, C9, C11, C12, C14, C15, C19, C27	0	Capacitor, Ceramic	0805	Any	Any
C5, C18, C22	3	Capacitor, Ceramic, 1nF, 50V, BJ, 20%	0805	Std	Std
C6, C23	2	Capacitor, Ceramic, 0.1μF, 50V, BJ, 20%	0805	Std	Std
C8, C10, C20, C21	4	Capacitor, POSCAP, 150μF, 6.3-V 55-mΩ, 20%	7343	SANYO	6TPB150ML
CN1, CN2	2	Adaptor, 3.5-mm probe clip (or 131-5031-00)	0.2	Tektronix	131-4244-00
D1, D4	0	Diode, Schottky, 0.5A, 30V	SOD-123	Any	Any
D2, D3	0	Diode, Schottky, 1-A, 30-V	SMA	Any	Any
JP1	1	Header, 2x4-pin, 100mil spacing (36-pin strip)	0.20 x 0.40 inch	Sullins	PTC36DAAN
JP2	1	Header, 2x3-pin, 100mil spacing (36-pin strip)	0.20 inch x 0.30	Sullins	PTC36DAAN
L1	1	Inductor, 4.7uH, 12.8A, 8.8-mΩ	0.496 x 0.532 inch	Toko	FDA1254-4R7M
L2	1	Inductor, 2.2uH, 17.8A, 4.5-mΩ	0.496 x 0.532 inch	Toko	FDA1254-2R2M
Q1, Q4	2	MOSFET, N-ch, 30-V, 11-A, 9.1-mΩ	SO8	IR	IRF7821
Q2, Q3	2	MOSFET, N-ch, 30-V, 16-A, 4.0-mΩ	SO8	IR	IRF7832
R1, R2, R5, R8, R9, R11, R12, R13, R14, R15, R20, R21, R22, R24, R25, R27, R31, R32	0	Resistor, Chip,	0805	Any	Any
R10, R26	2	Resistor, Chip, 100kΩ, 1/10W, 1%	0805	Std	Std
R16, R23	0	Resistor, Metal Strip, 1 W, 1%	2512	Std	Std
R17	1	Resistor, Chip, 3.6kΩ, 1/10W, 1%	0805	Std	Std
R19	1	Resistor, Chip, 3.3kΩ, 1/10W, 1%	0805	Std	Std
R29	1	Resistor, Chip, 17.2kΩ, 1/10W, 1%	0805	Std	Std
R3, R6, R28	3	Resistor, Chip, 7.5kΩ, 1/10W, 1%	0805	Std	Std
R4	1	Resistor, Chip, 30kΩ, 1/10W, 1%	0805	Std	Std
R7, R18, R30	3	Resistor, Chip, 5.1Ω, 1/10W, 1%	0805	Std	Std
SW1, SW2, SW3, SW4	4	Switch, ON-ON Mini Toggle	0.28 x 0.18""	Nikkai	G12AP
TP1, TP2, TP3, TP4, TP5	5	Pin, Probe monitor	0.12(D) x 0.4 inch	Mill Max or MAC8	LC-2-S

Table 7-2. List of Materials

Reference Designator	QTY	Description	Size	Mfr	Part Number
U1	1	IC, Dual Current Mode, Sync. Step-down Controller	QFN32	TI	TPS51120RHB
VO1, VO2, VO1_GND1, VO2_GND1, VBAT_GND1, VBAT1	6	Pin, Wiring Terminal	0.12(D) X 0.4 inch	Mill Max or MAC8	3183-2-00-15-00-00-080 or WT-3-1

8. References

1. TPS51120 Datasheet, Dual Current Mode, Synchronous Step-Down Controller (SLUS670)