High Performance Synchronous Buck EVM Using the TPS51120

User's Guide

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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

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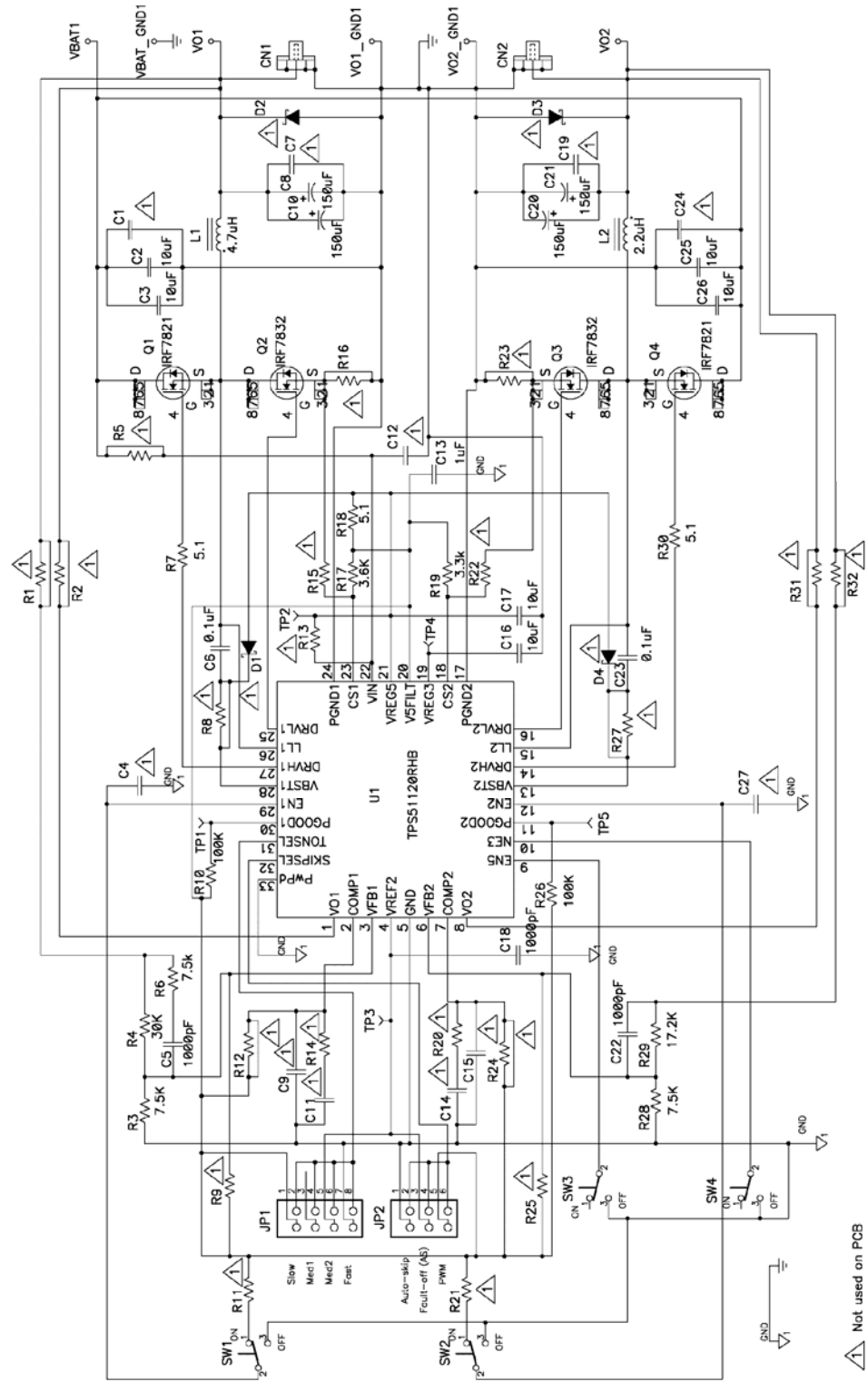
3. Schematic

Figure 1. TPS51120 EVM schematic diagram

4. Test Setup and Results

4.1. Test setup

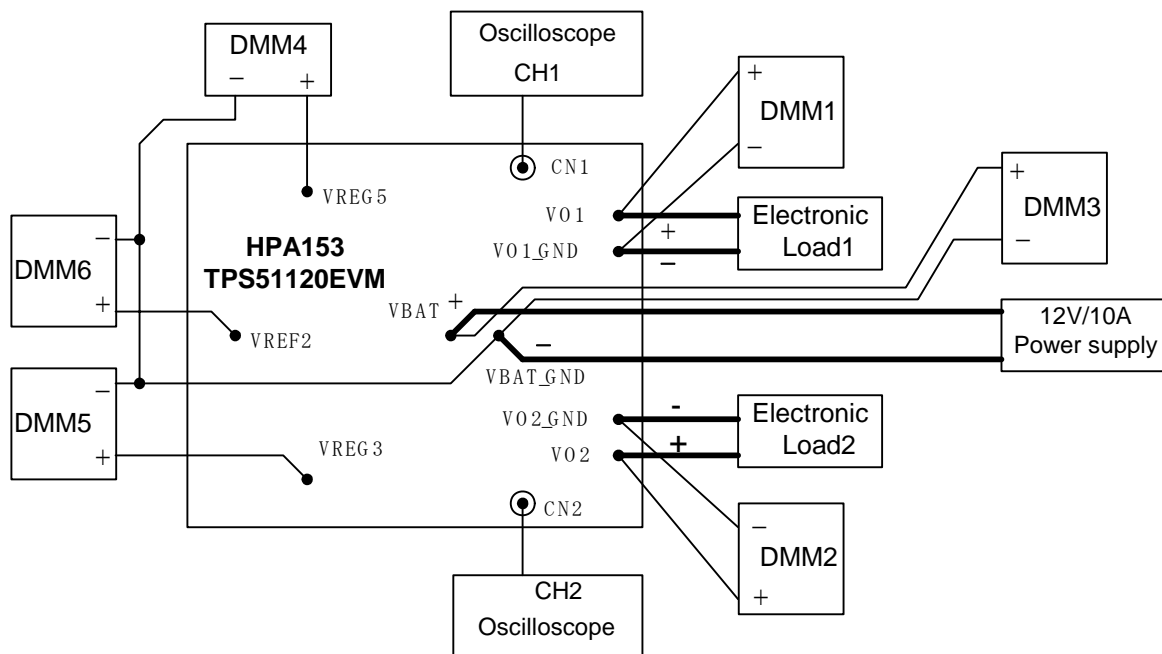Connect test equipment and TPS51120EVM-001 board as shown in Figure 2.

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.

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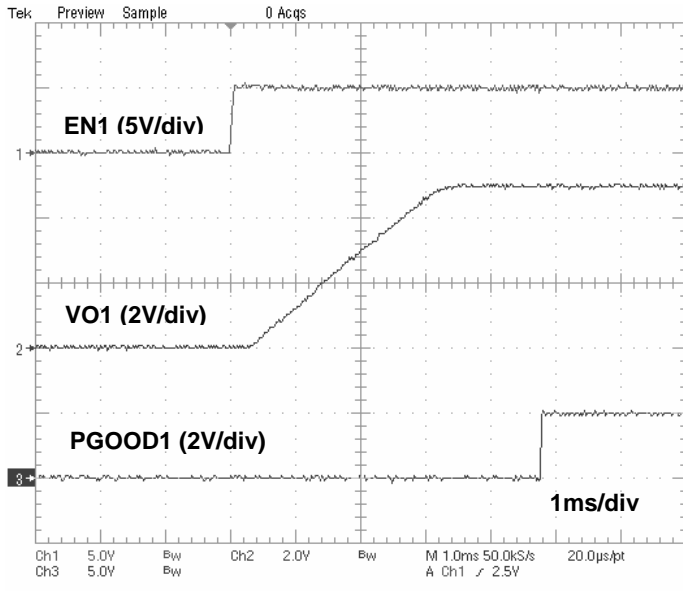
4.3. Start up performance
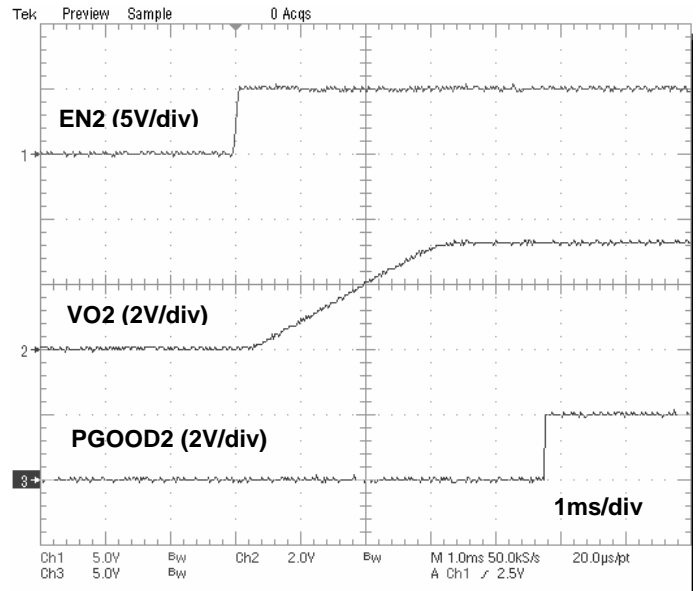

Figure3. 5-V Startup Waveforms

Figure4. 3.3-V Startup Waveforms
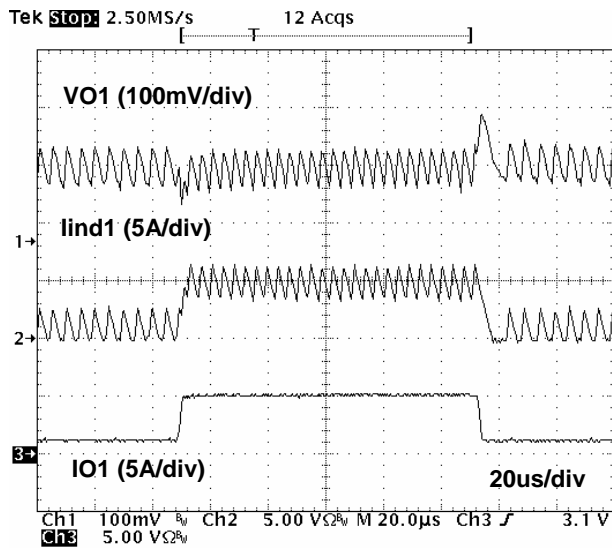
4.4. Transient performance
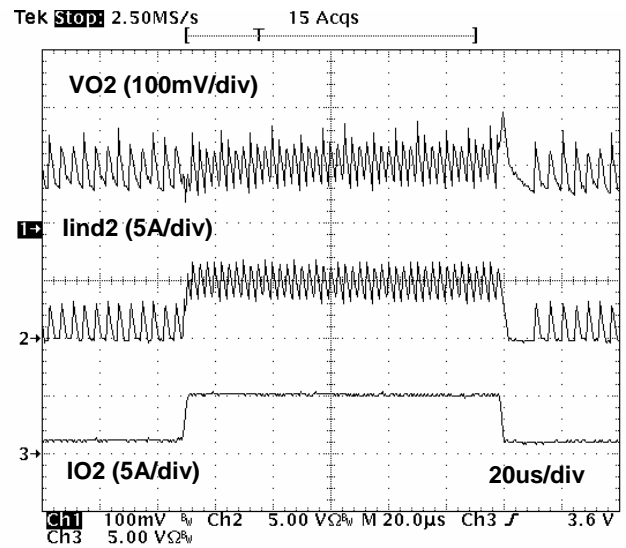

Figure5. 5-V Load Transient Response

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

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5.4 Control Scheme selection

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

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.)
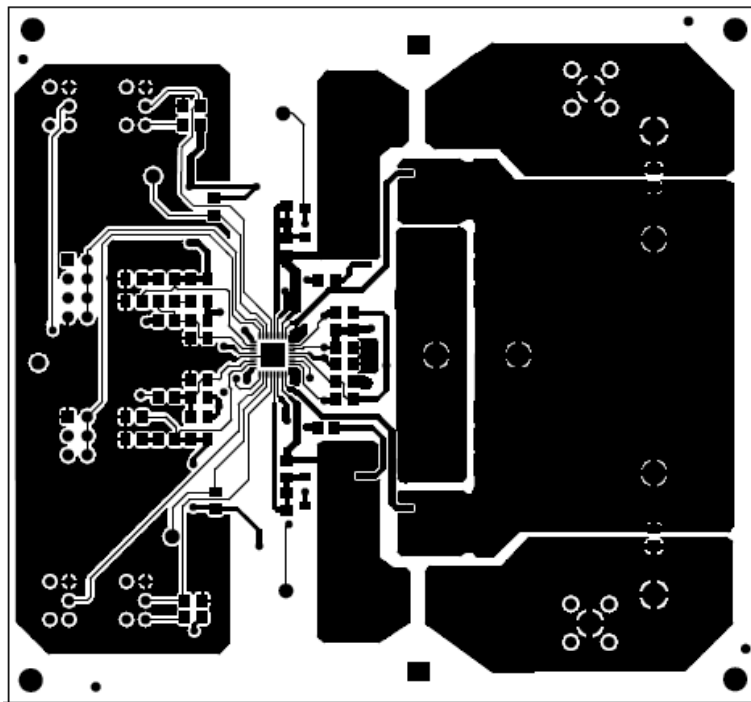
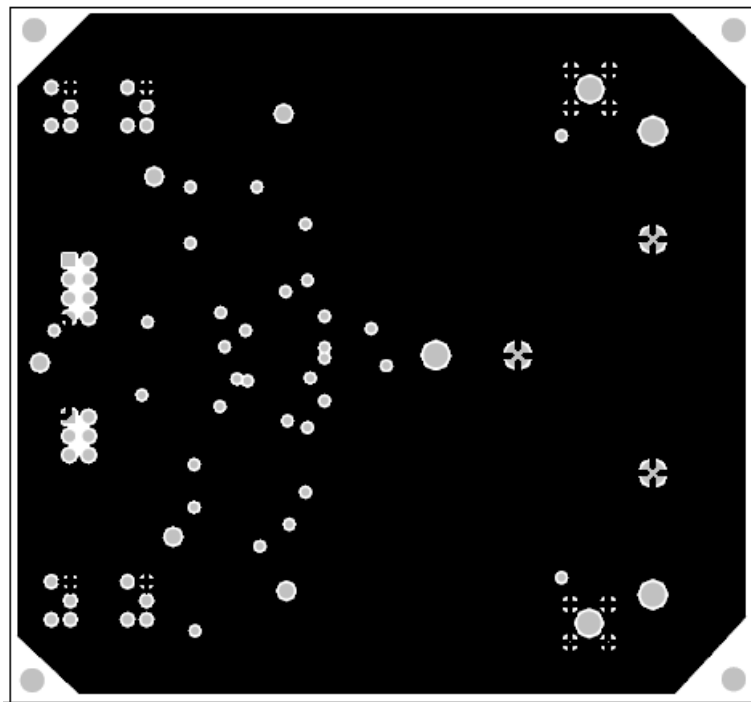## 6. EVM Assembly Drawing and PCB layout

Figure 7. Top Assembly

Figure 8. Bottom Assembly

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Figure 9. Top Layer
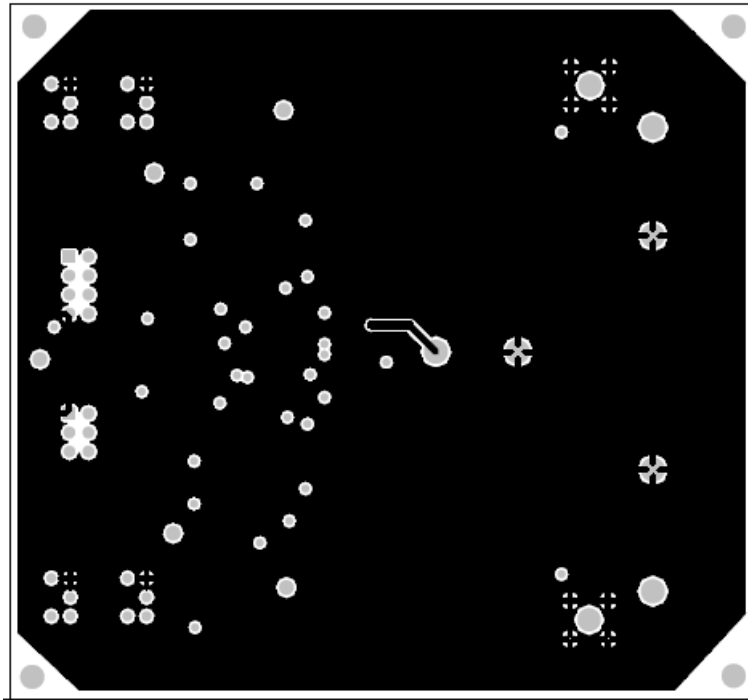

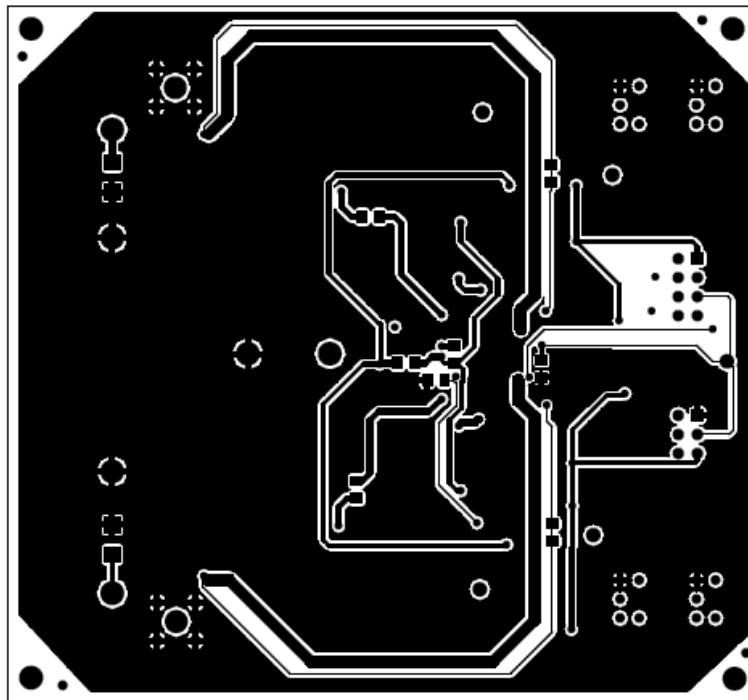**Figure 10. Inner Layer 1**

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)