High Performance Synchronous Buck EVM Using the TPS51124

User's Guide

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1. Description

The TPS51124 is a dual, adaptive on-time D-CAP™ mode synchronous buck controller. The part enables system designers to cost effectively complete the suite of notebook power bus regulators with the absolute lowest external component count and lowest standby consumption. The fixed frequency emulated adaptive on-time control supports seamless operation between PWM mode at heavy load condition and reduced frequency operation at light load for high efficiency down to milli-ampere range. The main control loop for the TPS51124 uses the D-CAP mode that optimized for low ESR output capacitors such as POSCAP or SP-CAP promises fast transient response with no external compensation. Simple and separate power good signals for each channel allow flexibility of power sequencing. The part provides a convenient and efficient operation with supply input voltages (V5IN, V5FILT) ranging from 4.5V to 5.5V, conversion voltages (Drain voltage for the synchronous high-side MOSFET) from 3V to 28V and output voltages from 0.76V to 5.5V.

HPA178 (TPS51124EVM) evaluation module is a high efficiency, dual synchronous buck converter providing 1.05V at 10A and 1.5V at 10A from 5V to 25V input. This user's guide describes the HPA178 performance in medium switching frequency.

2. ELECTRICAL PERFORMANCE

Table1. Electrical Performance

SPECIFICATIONS		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input voltage range (V5IN)			4.5	5.0	5.5	V
Input voltage range (VIN)			5	12	25	V
CH1	Output voltage			1.05		V
	Operating frequency	TONSEL : Float VIN=12V, Iout1=10A		300		kHz
	Output current			10		A
	Over current limit	VIN=12V		13		A
	Output ripple voltage	VIN=12V, Iout1=10A		35		mVp-p
CH2	Output voltage			1.5		V
	Operating frequency	TONSEL : Float VIN=12V, Iout2=10A		360		kHz
	Output current			10		A
	Over current limit	VIN=12V		13		A
	Output ripple voltage	VIN=12V, Iout2=10A		35		mVp-p

3. Schematic

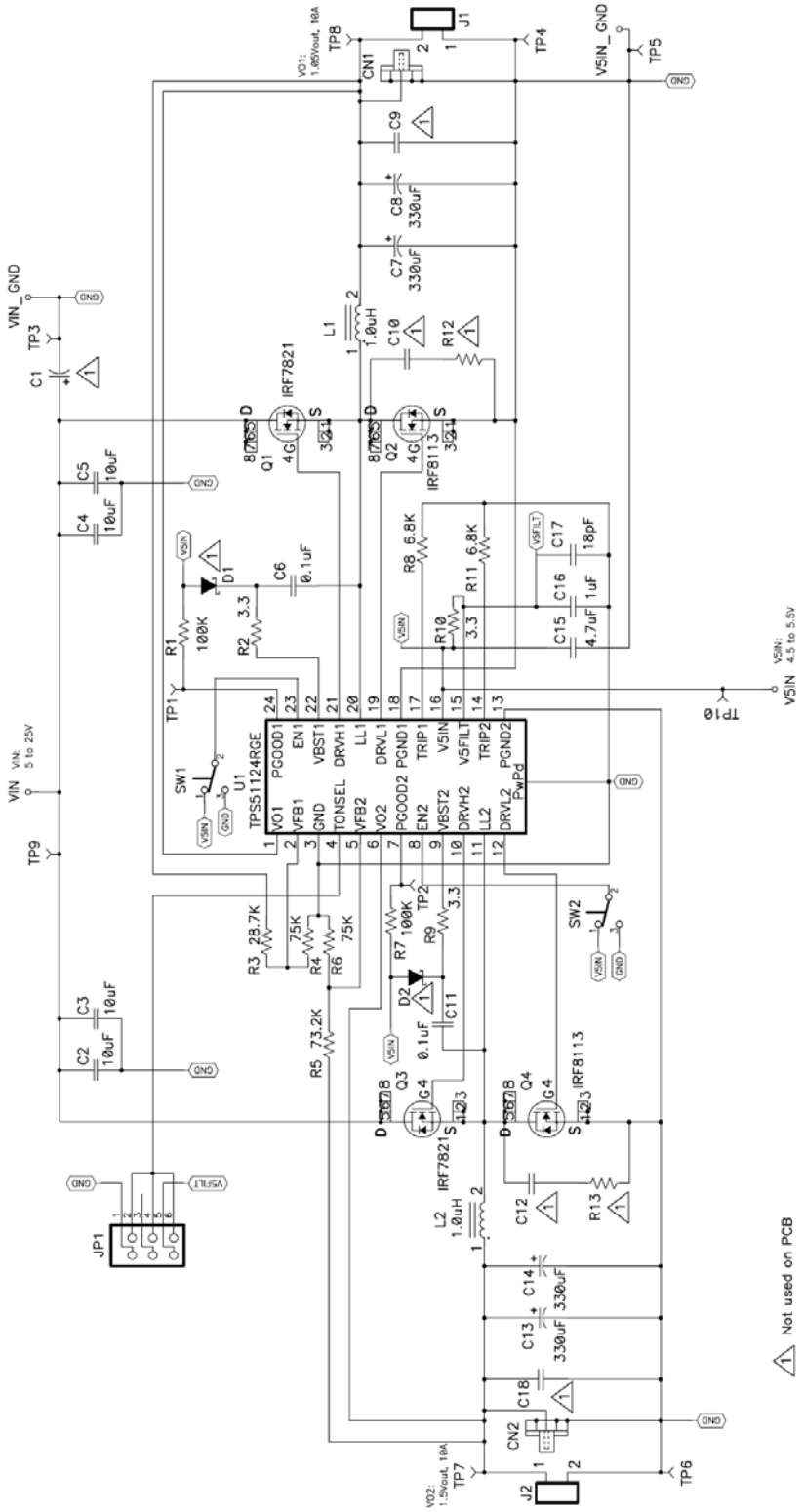


Figure 1. TPS51124 EVM schematic diagram

4. Test Setup and Results

4.1. Test setup

Connect test equipment and HPA178 EVM board as shown in Figure 2.

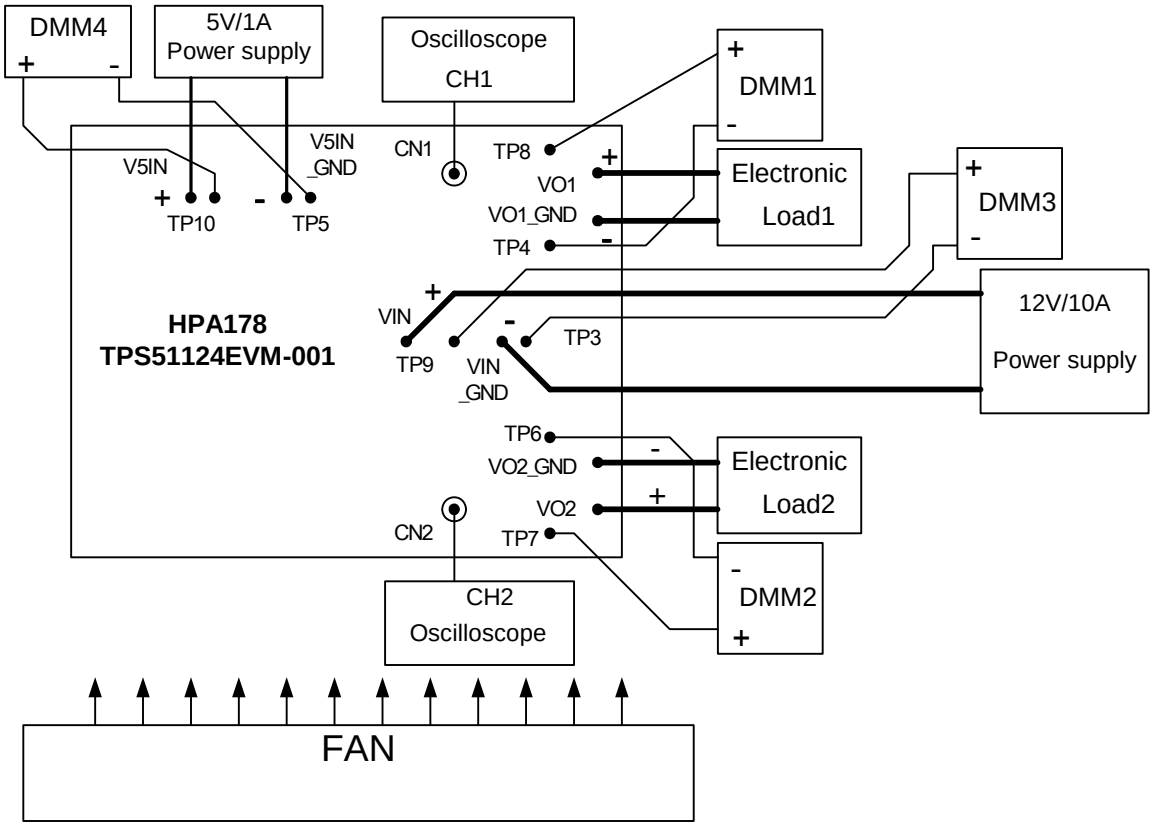


Figure 2. Equipment setup for HPA178 EVM board

4.2 Test procedure

1. Make sure the switches SW1 (EN1), SW2 (EN2) are in "OFF" position.
2. Make sure the shunt jumper for JP1 is set 3-pin to 4-pin (Med).
3. Apply appropriate V5IN voltage to V5IN and V5IN_GND terminals.
4. Apply appropriate VIN voltage to VIN and VIN_GND terminals
5. Turn on SW1 (EN1), CH1-output will start up.
6. Turn on SW2 (EN2), CH2-output will start up.

4.3. Start up performance

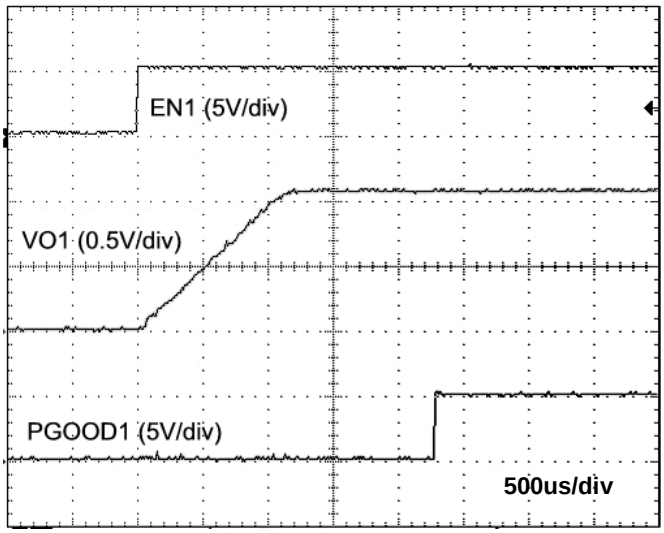


Figure3. 1.05V Startup Waveforms

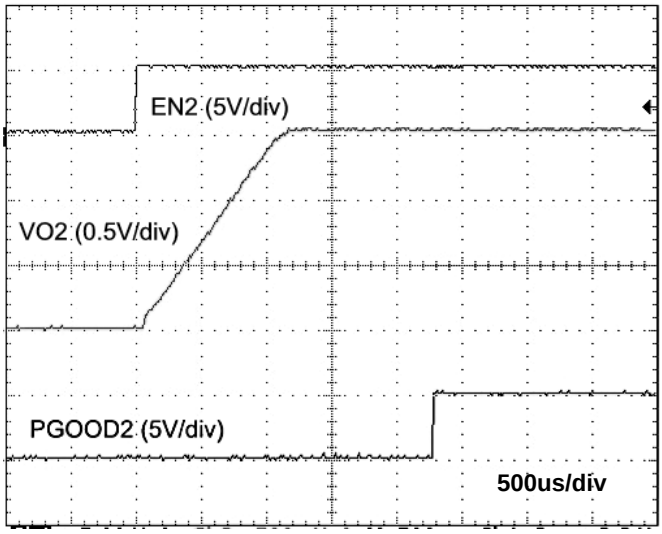


Figure4. 1.5V Startup Waveforms

4.4. Transient performance

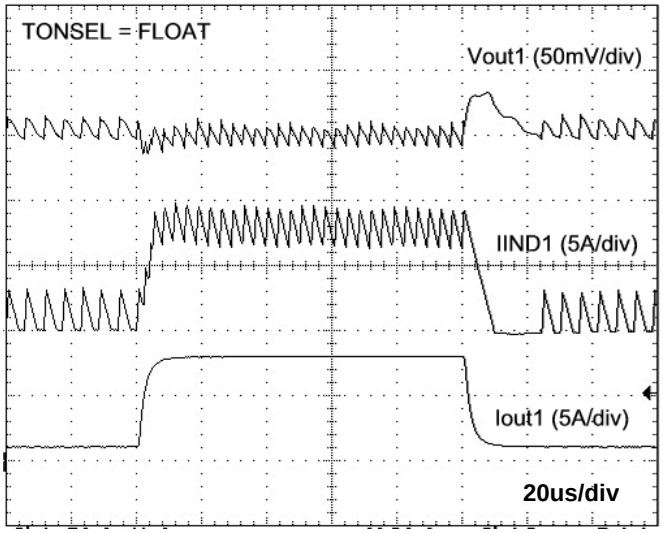


Figure5. 1.05V Load Transient Response

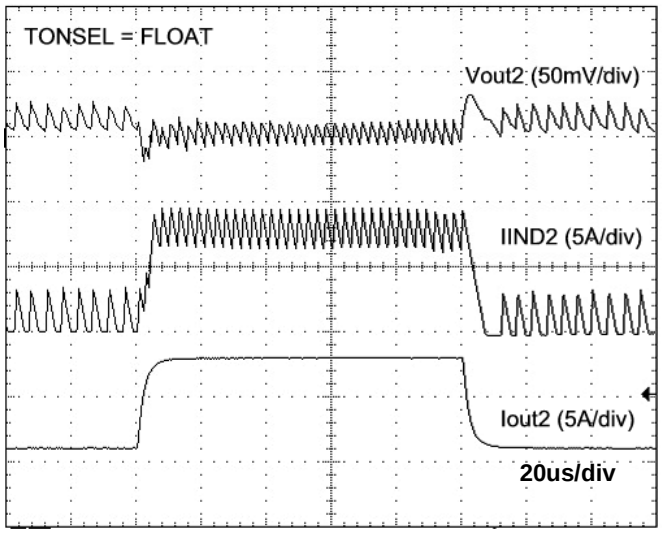


Figure6. 1.5V Load Transient Response

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 Medium.

Table 2. Switching Frequency selection

Jumper (JP1) set to	TONSEL	Frequency		
		Typ	CH1	CH2
Top (1-2 pin shorted)	GND	Slow	240kHz	300kHz
CENTER (3-4 pin shorted)	Float	Medium	300kHz	360kHz
Bottom (5-6 pin shorted)	V5FILT	Fast	360kHz	420kHz

(Note; Frequencies are approximate)

5.2 Bootstrap Diode selection

Bootstrap diodes (D1, D2) are not populated on this EVM since TPS51124 has built-in them.
External Schottky diodes can be added in order to further improve the efficiency.

6. EVM Assembly Drawing and PCB layout

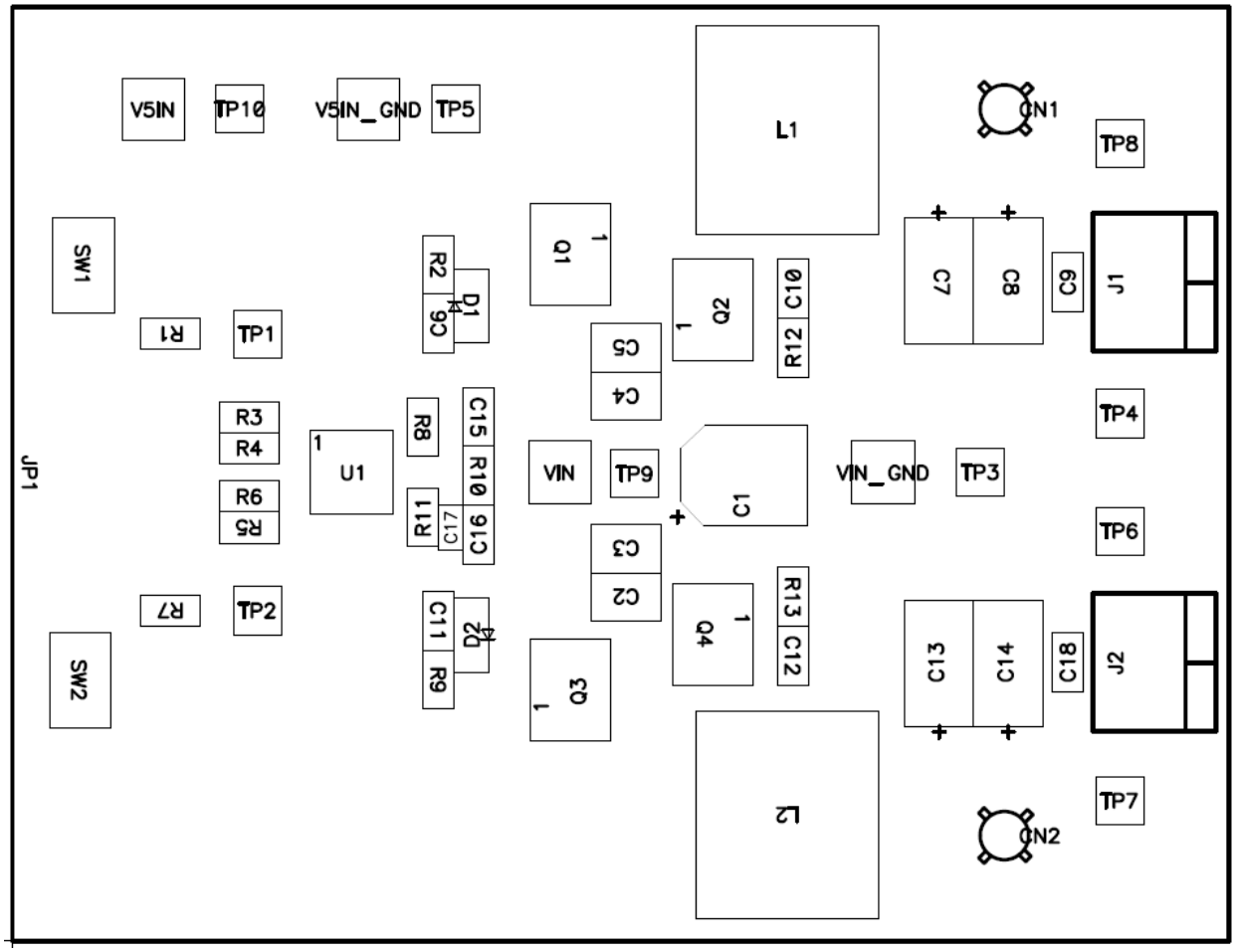


Figure 7. Top Assembly

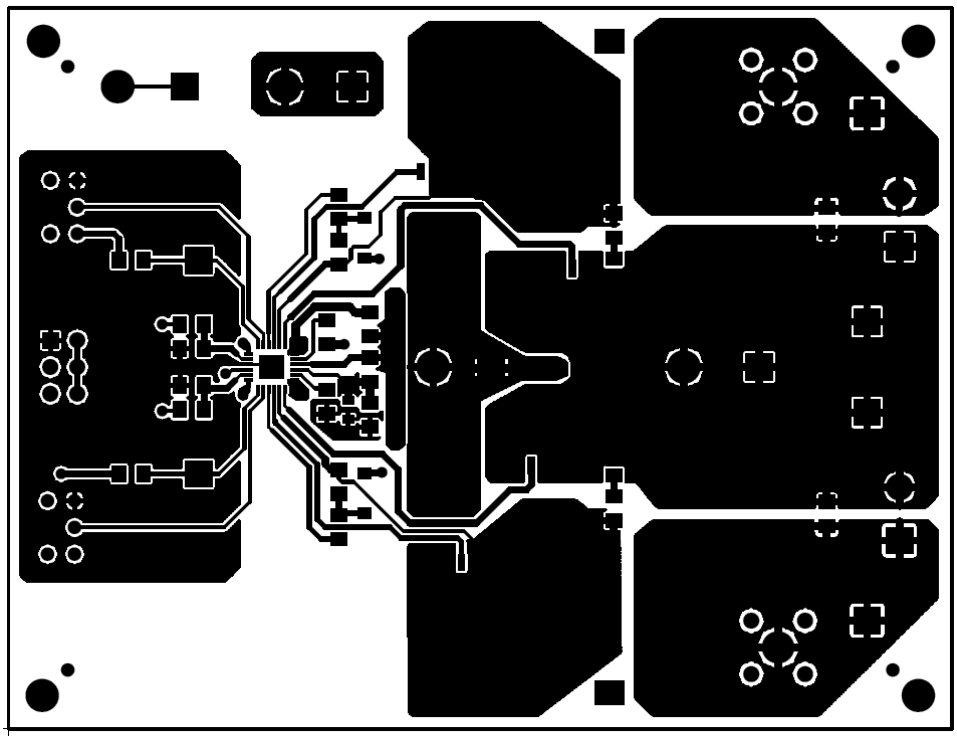


Figure 8. Top Layer

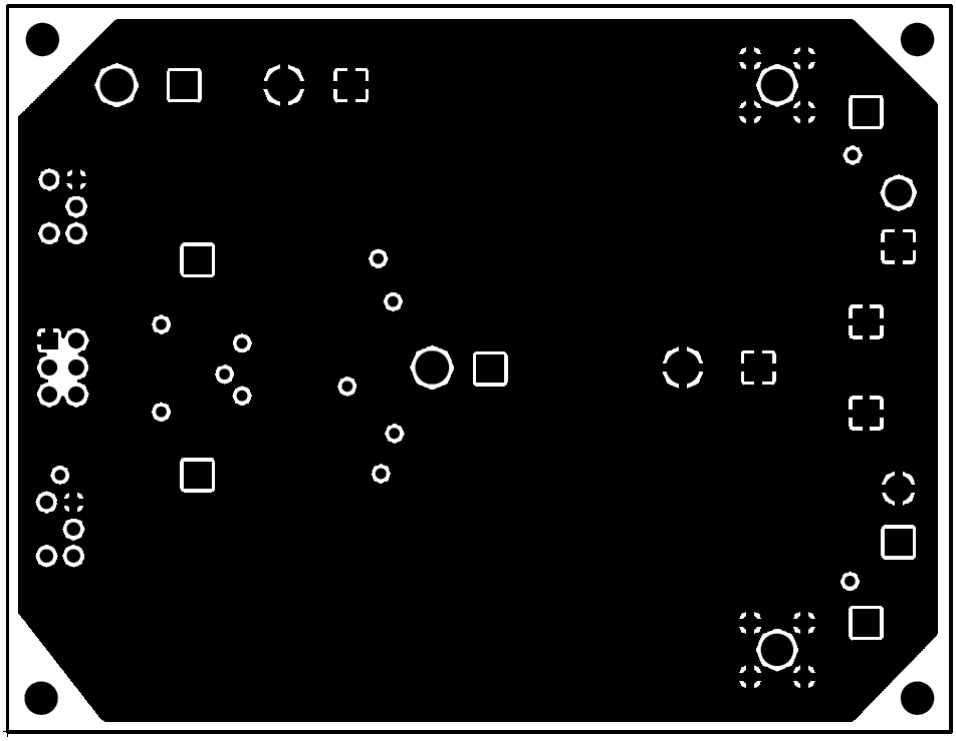


Figure 9. Inner Layer 1

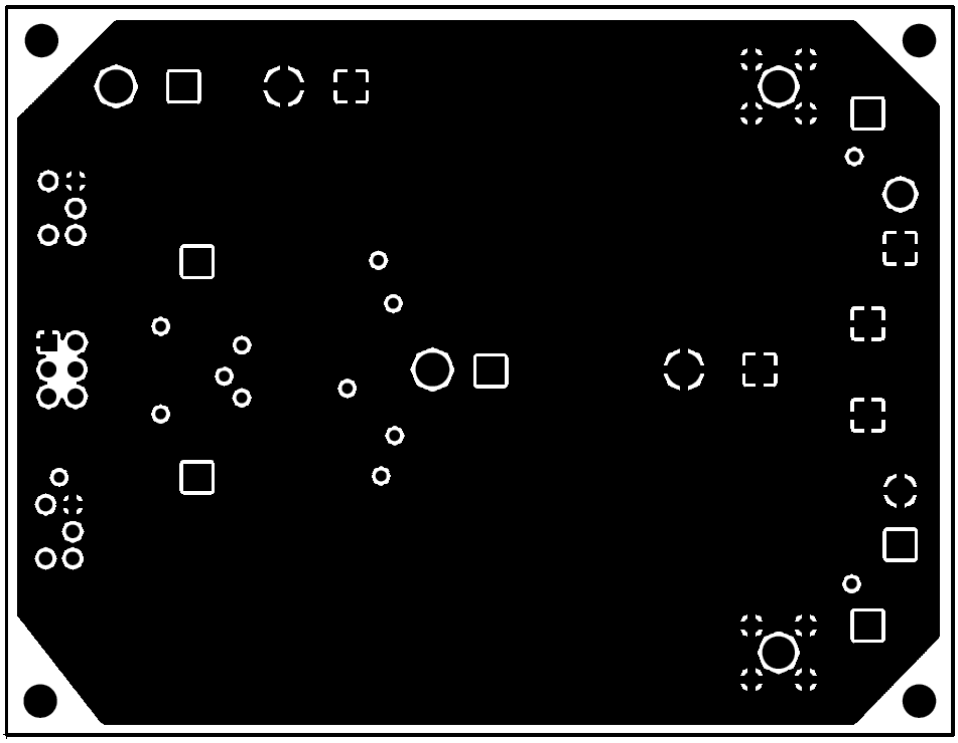


Figure 10. Inner Layer 2

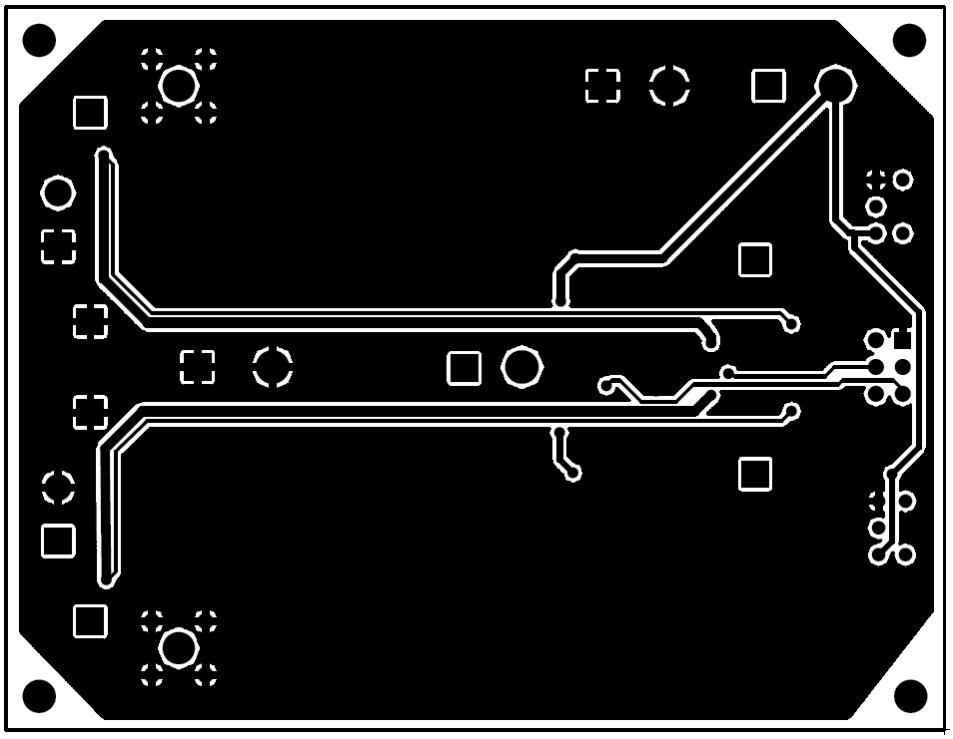


Figure 11. Bottom Layer

7. List of Materials

Table 3-1. List of Materials

Reference Designator	QTY	Description	Size	Mfr	Part Number
--	1	Shunt, 100-mil, Black	0.100	3M	929950-00
C1	0	Capacitor, Aluminum	0.26 x 0.26 inch	Any	Any
C13, C14	2	Capacitor, POSCAP, 330μF, 2.5-V 18-mΩ (or 15-mΩ), 20%	7343	SANYO	2R5TPE330MI or 2R5TPE330MF
C15	1	Capacitor, Ceramic, 4.7μF, 6.3V, BJ, 20%	0805	TDK	C2012X5R0J475K
C16	1	Capacitor, Ceramic, 1μF, 6.3V, BJ, 20%	0805	TDK	C2012X5R0J105K
C17	1	Capacitor, Ceramic, 18pF, 50V, BJ, 20%	0805	Std	Std
C2, C3, C4, C5	4	Capacitor, Ceramic, 10μF, 25V, BJ , 20%	1210	TDK / Taiyo Yuden	C3225JB1E106 / TMK325BJ106MM
C6, C11	2	Capacitor, Ceramic, 0.1μF, 50V, BJ, 20%	0805	Std	Std
C7, C8	2	Capacitor, POSCAP, 330μF, 2.5-V 15-mΩ (or 18-mΩ), 20%	7343	SANYO	2R5TPE330MFor 2R5TPE330MI
C9, C10, C12, C18	0	Capacitor, Ceramic	0805	Any	Any
CN1, CN2	2	Adaptor, 3.5-mm probe clip (or 131-5031-00)	0.2	Tektronix	131-4244-00
D1, D2	0	Diode, Schottky, 0.5A, 30V	SOD-123	Any	Any
J1, J2	2	Terminal Block, 2-pin, 15-A, 5.1mm	0.40 x 0.35 inch	OST	ED1609
JP1	1	Header, 2x3-pin, 100mil spacing (36-pin strip)	0.20 inch x 0.30	Sullins	PTC36DAAN
L1, L2	2	Inductor, 1.0uH, 20.5A, 2-mΩ	0.496 x 0.532 inch	TOKO	FDA1254-1R0M
Q1, Q3	2	MOSFET, N-ch, 30-V, 11-A, 12.5-mΩ	SO8	IR	IRF7821
Q2, Q4	2	MOSFET, N-ch, 30-V, 13.8-A, 6.8-mΩ	SO8	IR	IRF8113
R1, R7	2	Resistor, Chip, 100kΩ, 1/10W, 1%	0805	Std	Std
R12, R13	0	Resistor, Chip	0805	Std	Std
R2, R9, R10	3	Resistor, Chip, 3.3Ω, 1/10W, 1%	0805	Std	Std
R3	1	Resistor, Chip, 28.7kΩ, 1/10W, 1%	0805	Std	Std
R4, R6	2	Resistor, Chip, 75kΩ, 1/10W, 1%	0805	Std	Std
R5	1	Resistor, Chip, 73.2kΩ, 1/10W, 1%	0805	Std	Std
R8, R11	2	Resistor, Chip, 6.8kΩ, 1/10W, 1%	0805	Std	Std
SW1, SW2	2	Switch, ON-ON Mini Toggle	0.28 x 0.18""	Nikkai	G12AP
TP1, TP2	2	Test point, White, Thru hole	0.125 x 0.125 inch	Keystone	5012
TP10	1	Test point, Orange, Thru hole	0.125 x 0.125 inch	Keystone	5013
TP3, TP4, TP5, TP6	4	Test point, Black, Thru hole	0.125 x 0.125 inch	Keystone	5011
TP7, TP8	2	Test point, Yellow, Thru hole	0.125 x 0.125 inch	Keystone	5014

Table 3-2. List of Materials

Reference Designator	QTY	Description	Size	Mfr	Part Number
TP9	1	Test point, Red, Thru hole	0.125 x 0.125 inch	Keystone	5010
U1	1	IC, Dual Synchronous Step-Down Controller for Low Voltage Power Rails	QFN32	TI	TPS51124RHB
VIN_GND, VIN, V5IN, V5IN_GND	4	Pin, Wiring Terminal	0.09(D) X 0.31 inch	Mill Max	3183-2-00-15-00-00-080

8. References

1. TPS51124 Datasheet, Dual Synchronous Step-Down Controller for Low Voltage Power Rails (SLVS616)