

Using the UCC28250EVM-564

User's Guide



Literature Number: SLUU441A
September 2010–Revised October 2011

Half-Bridge DC-to-DC Converter With Secondary-Side Control

1 Introduction

This EVM is to aid in evaluating UCC28250 PWM device with secondary-side control in DC-to-DC symmetrical half-bridge converter topology. The targeted application is telecom module design with nominal 48-V input. UCC28250 is a PWM controller that can be used for primary-side control or secondary-side control. In this EVM, UCC28250 is placed at the secondary side to make secondary-side control.

2 Description

The EVM is a 100-W symmetrical half-bridge DC-to-DC converter that converts 36 V to 75 V DC to a regulated output voltage 3.3 V and maximum 30-A load current.

2.1 Typical Applications

- Telecom Power Supplies with Secondary-Side Control
- Server Systems
- Datacom
- DSP's, ASIC's, and FPGA's

2.2 Features

- Start up from telecom input voltage 36 V to 75 V DC with initial assistance of external auxiliary supply on the secondary side.
- Regulated output voltage 3.3 V with maximum 30-A load current.
- Smooth and monotonic output voltage turn on with up to 90% pre-biased output voltage.
- Output voltage regulation from no load to full load, and from low line to high line.
- Secondary-side Enable ON/OFF function and manual switch.
- Secondary-side control.
- Voltage-mode control.
- Control-driven synchronous rectifier.
- Non-latching output over voltage protection.
- Hiccup over current protection.
- Telecom basic isolation from primary to secondary 1500 V.

CAUTION

Before doing any test with this EVM, please read this document especially [Section 3](#) through [Section 6](#). Without a thorough reading of this document, strange behavior of operation and possible damage may be resulted in the test.

3 Electrical Performance Specifications

Table 1. UCC28250EVM-564 Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
Voltage range		36	48	75	V
Maximum input current	$V_{IN} = 36\text{ V}$ and $I_{OUT} = 30\text{ A}$			3.5	A
No load input current	$V_{IN} = 75\text{ V}$			90	mA
Output Characteristics					
Output voltage, V_{OUT}	Output current = 0 A	3.25	3.3	3.35	V
Output load current, I_{OUT}				30	A
Output voltage regulation	Line regulation: input voltage = 36 V to 75 V			0.15%	
	Load regulation: output current = 0 A to 23 A			0.15%	
Output voltage ripple	At $I_{OUT} = 30\text{ A}$			50	mVpp
Output over current		35			A
Systems Characteristics					
Switching frequency			200		kHz
Operation frequency			400		
Peak efficiency			91%		
Full load efficiency			90%		
Operating temperature	Min 200 LFM force air flow		45		°C

4 Schematic

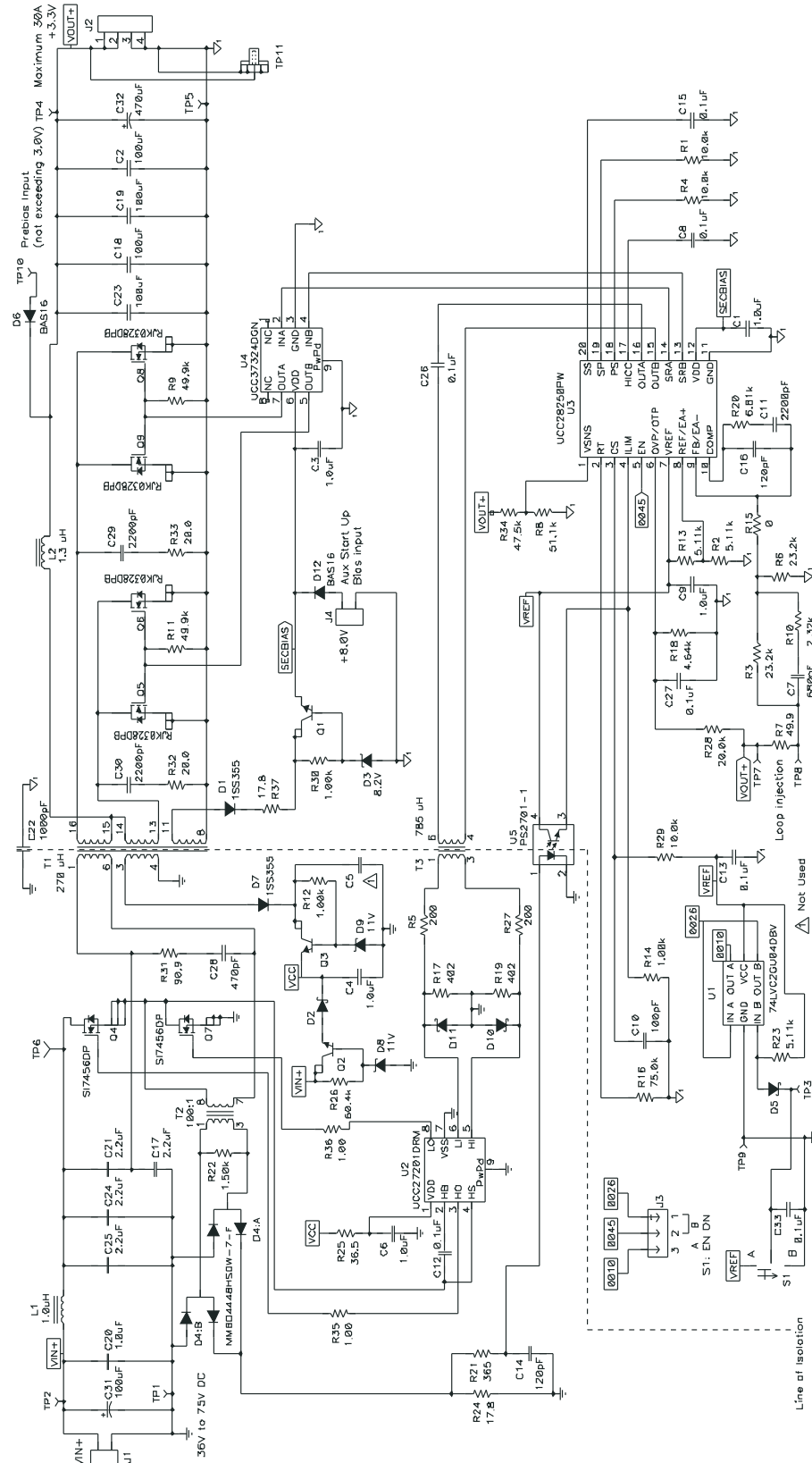


Figure 1. UCC28250EVM-564 Schematic

5 Test Setup

5.1 Test Equipment

Voltage source for main power: HP 6015A DC power supply

Voltage source for secondary initial bias: 8.0-V/0.1-A DC voltage source compatible

Multimeters: Fluke 45 dual display multimeter

Output load: HP 6060A DC electronic load

Oscilloscope: Tektronix TDS 460 A 400 MHz

Fan: 200 LFM minimum compatible

Recommended wire gauge: AWG #18 for input voltage connection. AWG #16 for output load connection.

5.2 Recommended Test Setup

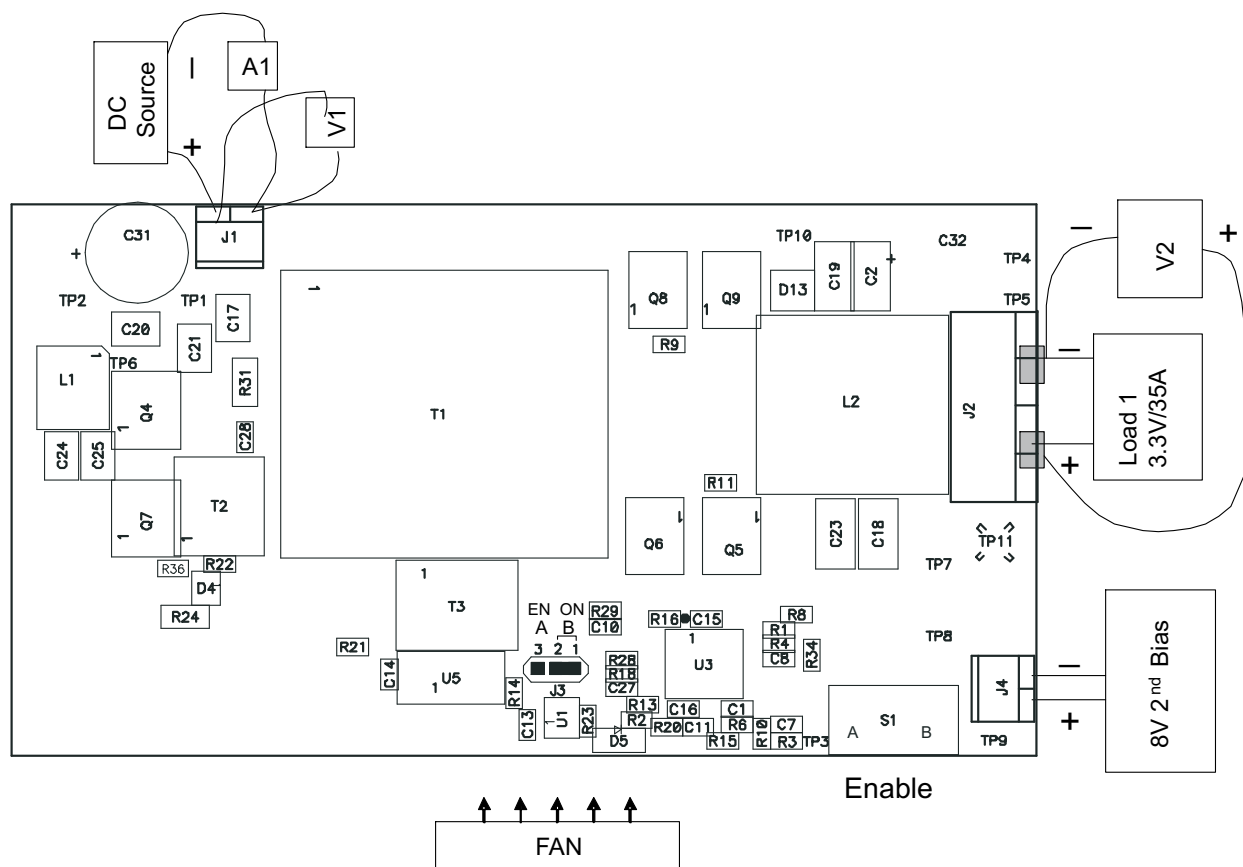


Figure 2. Recommended Test Set Up

5.3 List of Test Points

Table 2. Test Points Function

TEST POINTS	NAME	DESCRIPTION
TP1	PGND	Input voltage negative test point, for efficiency test
TP2	Vin	Input voltage positive test point, for efficiency test
TP3	En_ON	Board Enable On, default low logic, jumper placed on the right
TP4	VOUT+	Output voltage positive test point for efficiency
TP5	VOUT-	Output voltage negative test point for efficiency
TP6	VLine	Primary side positive input after input filter
TP7	Loop+	Feedback loop injection
TP8	Loop-	Feedback loop injection
TP9	GND	Primary side signal ground
TP10	Prebias+	Prebias output positive input
TP11	Vo_Ripple	Output voltage ripple test
J1	INPUT	Input voltage terminals
J2	OUTPUT	Output voltage terminals
J3	En_Logic	Set up enable high or low, default low, jumper cross pin 2 to 1
J4	2nd Bias	Secondary side initial bias, 8.0V

6 Test Procedure

Set up the EVM based on [Figure 2](#).

CAUTION

High voltage and high temperature present when the EVM is in operation!

6.1 Line/Load Regulation and Efficiency Measurement Procedure

1. Verify and confirm J3 jumper is placed across pin 2 to 1.
2. Verify switch S1 is on position A.
3. Connect the ammeter A1 (0 A to 10 A range) between DC source and J1 as shown in [Figure 2](#).
4. Prior to connecting the DC source, it is advisable to limit the source current to 4 A maximum. Make sure the DC source is initially set to 0 V and connected to J1 and A1 as shown in [Figure 2](#).
5. Connect voltmeter, V1 across the DC source as shown in [Figure 2](#).
6. Connect Load1 to J2 as shown in [Figure 2](#). Set Load1 to constant current mode to sink 0 A_{DC} before the input voltage on J1 is applied.
7. Connect voltmeter, V2 to J2 as shown in [Figure 2](#).
8. Connect 8.0 V 2nd Bias to J4. Turn its voltage into 8.0 V.
9. Turn on fan making sure to blow air directly on the EVM.
10. Increase the DC source voltage from 0 V to 36.0 V_{DC}.
11. Snap switch S1 to position B.
12. Remove 8.0 V 2nd Bias.
13. Measure V_{OUT} (V2), I_{OUT}, V_{IN} (V1) and I_{in} (A1).
14. Vary LOAD1 from 0 A to a higher value, up to 30 A_{DC}.
15. Repeat step 10.
16. Increase input voltage to a different value, up to 75 V, and repeat step 10 and 11.

6.2 Equipment Shutdown

1. Decrease Load1 to 0 A.
2. Snap switch S1 to position A.
3. Decrease V_{IN} from 75.0 V_{DC} to 0 V.
4. Shut down V_{IN} and Fan.
5. Shut down the load.

6.3 Notes for Operating this EVM

1. This EVM relies on external auxiliary power supply (8.0 V/0.1 A) to start up. After start up, the board can operate normally without the external auxiliary supply. If the auxiliary supply is removed, the board cannot start up without adding the auxiliary supply back after Enable Off.
2. This EVM does not have line under voltage ON/OFF feature. Please follow 6.1 and 6.2 to turn on and off the board. Strange behavior including damage may be observed if do not follow [Section 6.1](#) and [Section 6.2](#).
3. In evaluating protection features (OVP and OCP, etc.), the external auxiliary power supply should remain connected and setup at 8.0 V which is required to resume the EVM operation after a fault is cleared or in order to operate in hiccup mode in that regarding.

7 Performance Data and Typical Characteristic Curves

Figure 3 through Figure 11 present typical performance curves for UCC28250EVM-564.

7.1 Efficiency

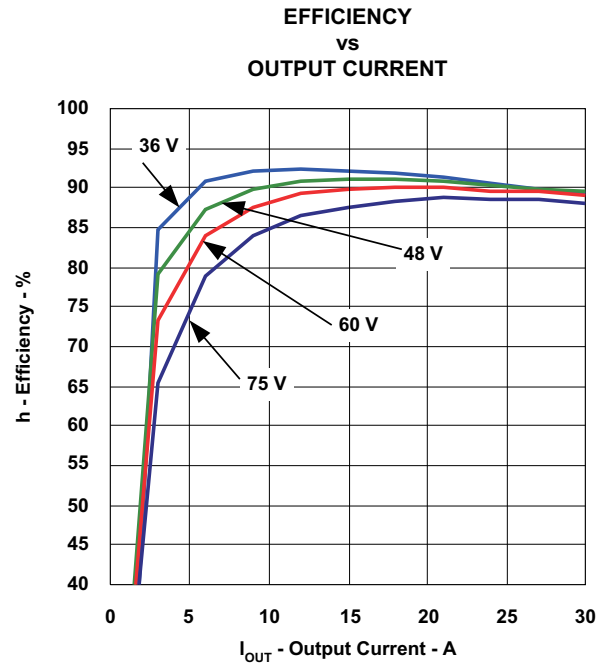


Figure 3. Efficiency

7.2 Load Regulation

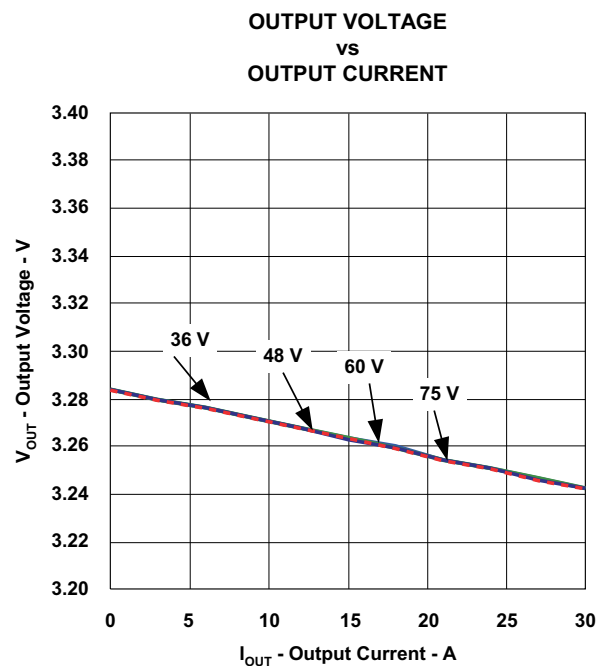


Figure 4. Load Regulation

7.3 Bode Plot

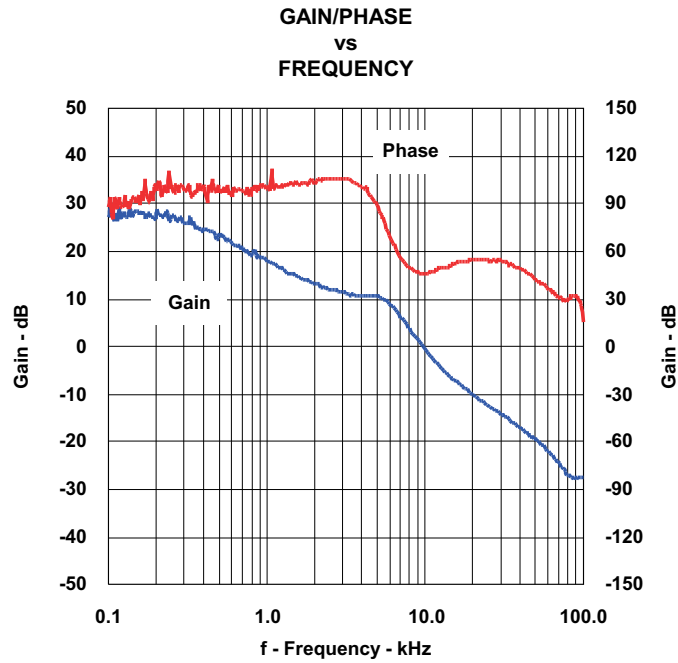


Figure 5. Loop Response Gain and Phase

7.4 Turn-On Waveform

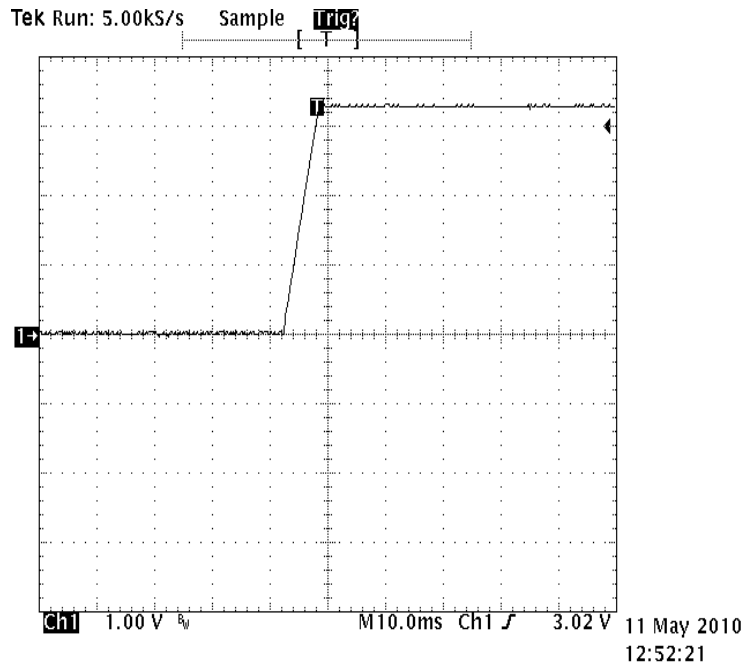


Figure 6. Enable Turn-On Waveform

7.5 Turn-On Waveform with Pre-biased Output Voltage

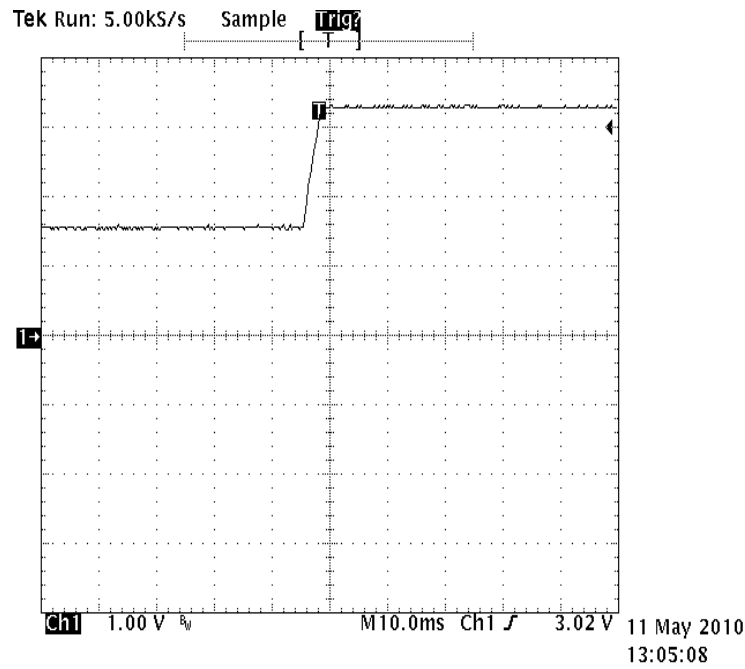


Figure 7. Enable Turn-On Waveform

7.6 Turn-On Waveform with Pre-biased Output Voltage

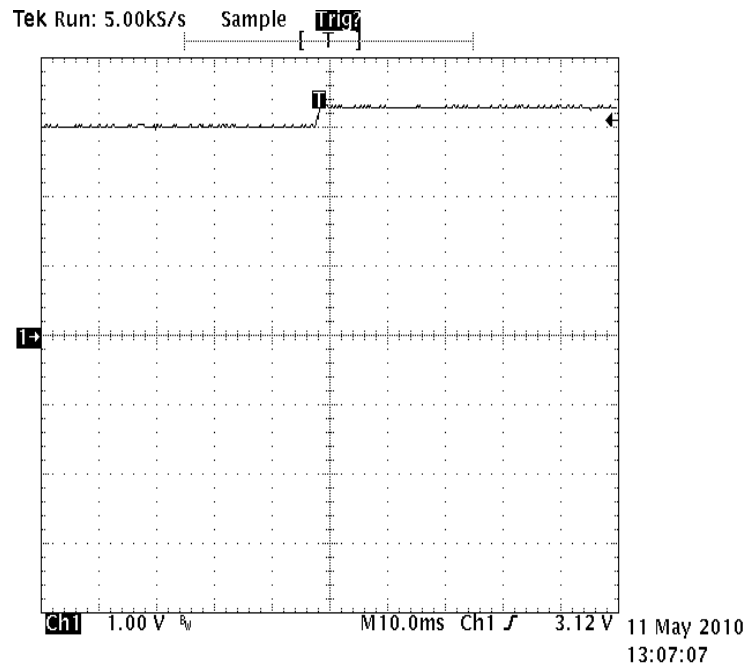


Figure 8. Enable Turn-On Waveform

7.7 Turn-On Waveform with Pre-biased Output Voltage

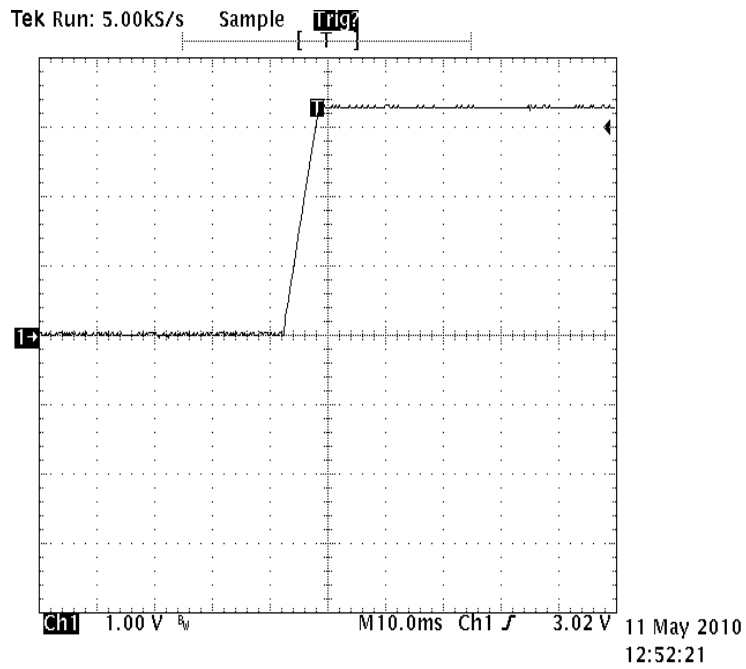


Figure 9. Enable Turn-On Waveform

7.8 Turn-Off Waveform

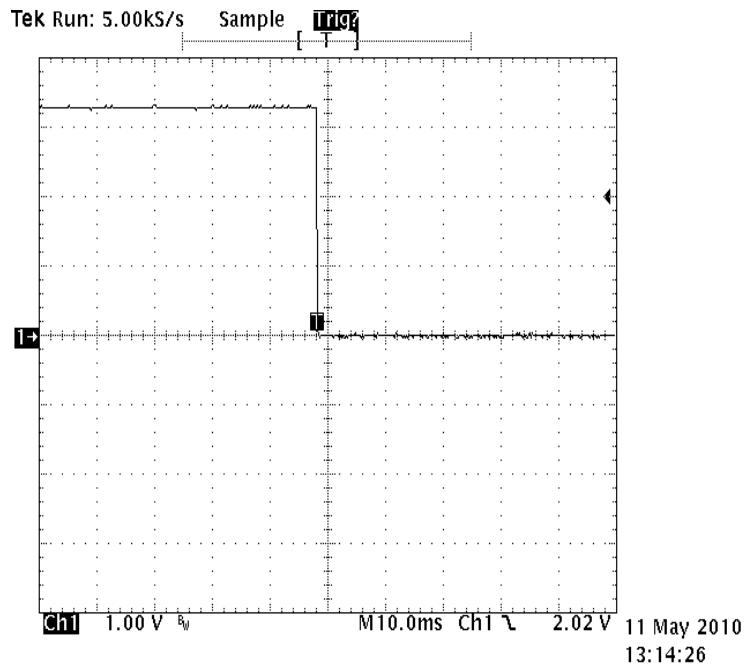


Figure 10. Enable Turn-Off Waveform

7.9 Output Ripple

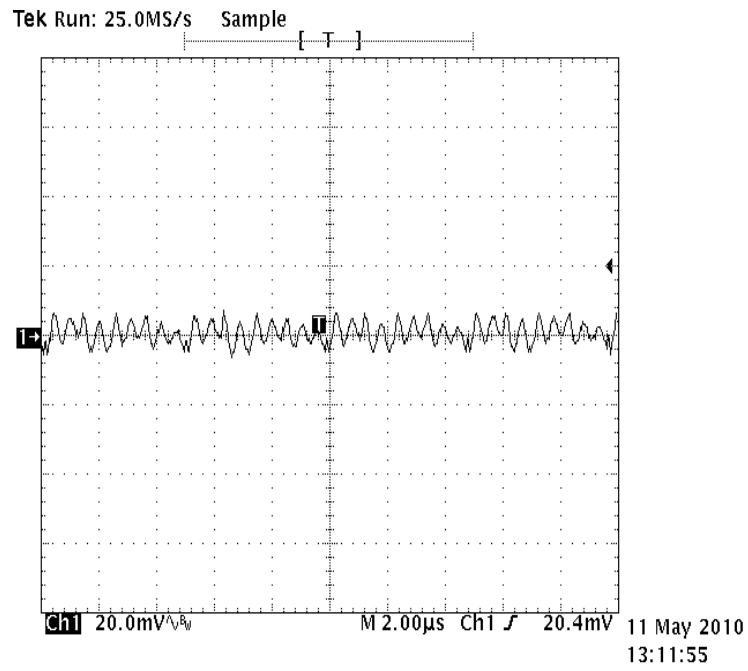


Figure 11. Output Ripple

8 EVM Assembly Drawing and PCB Layout

The following figures (Figure 12 through Figure 17) show the design of the UCC28250EVM-564 printed circuit board. PCB dimensions: L x W = 4.0 in x 2.3 in, PCB material: FR406 or compatible, four layers and 2-oz copper on each layer.

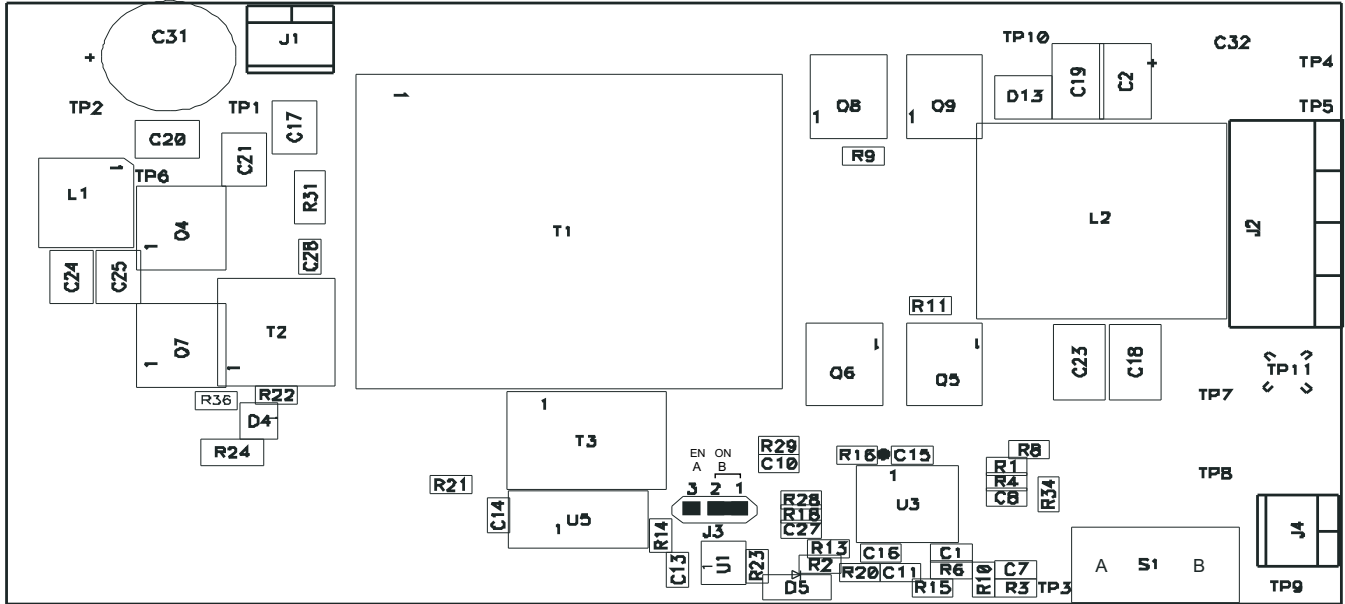


Figure 12. Top Layer Assembly Drawing (top view)

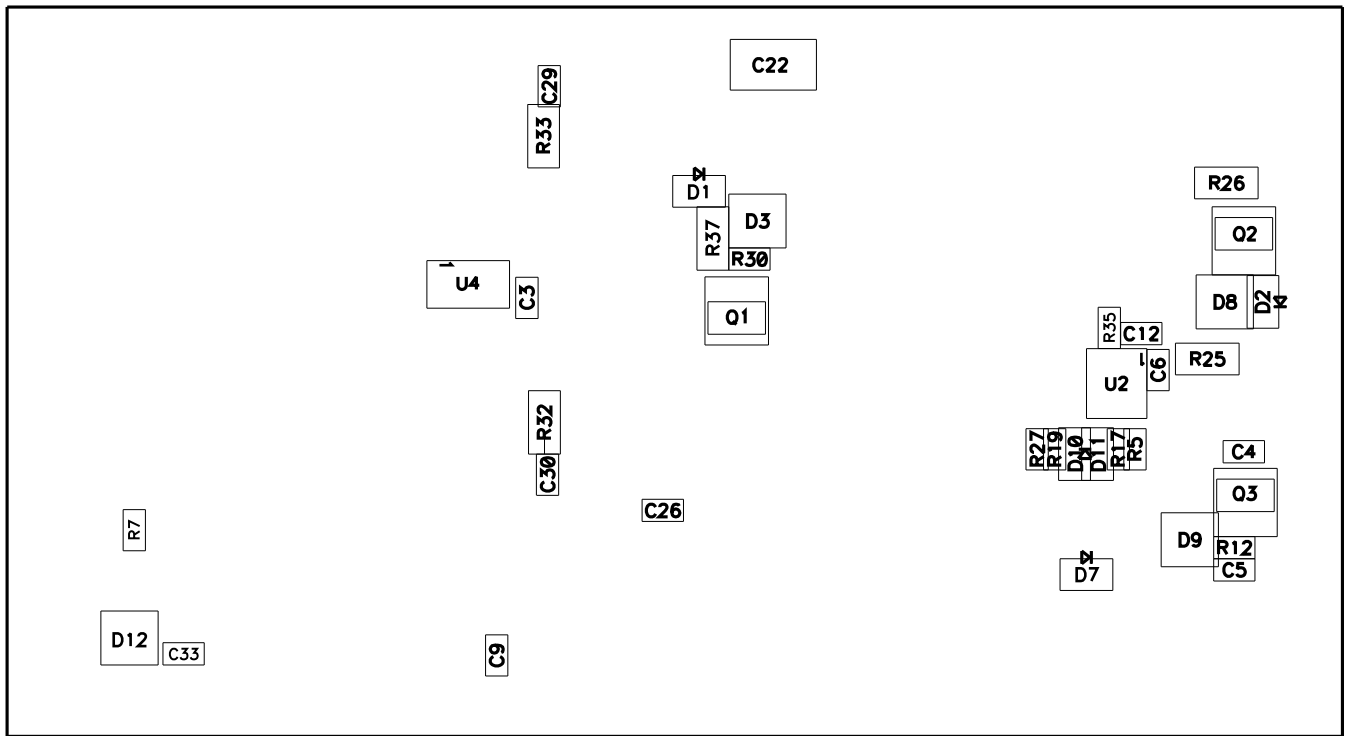


Figure 13. Bottom Assembly Drawing (bottom view)

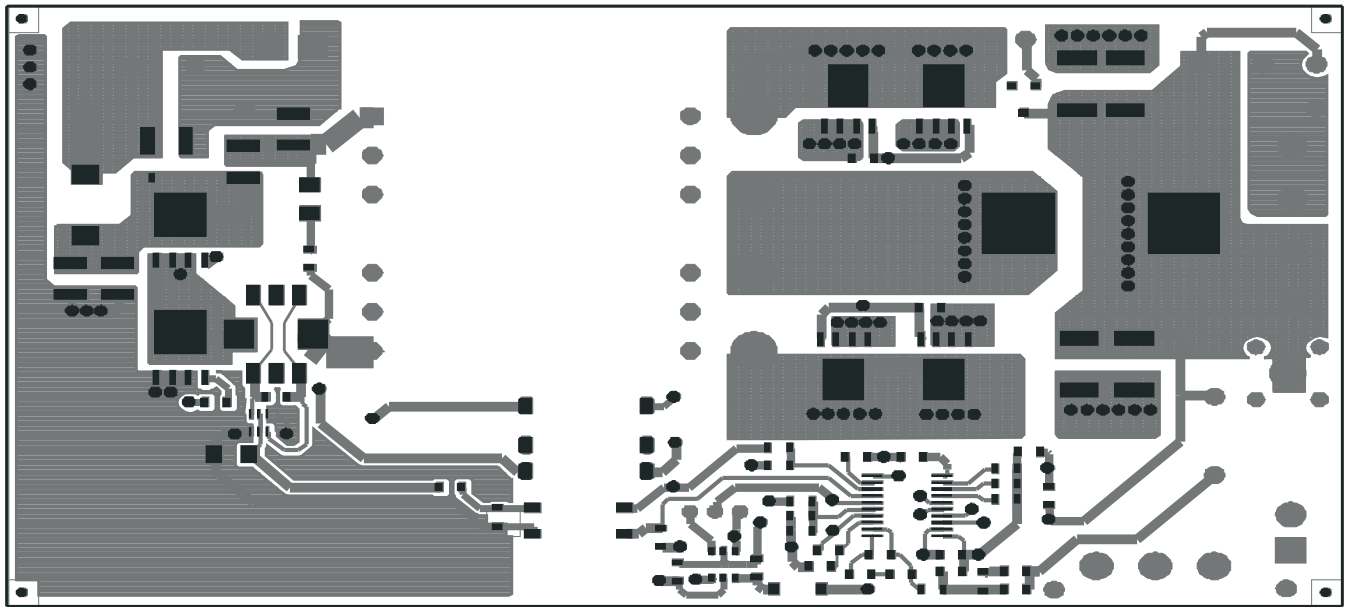


Figure 14. Top Copper (top view)

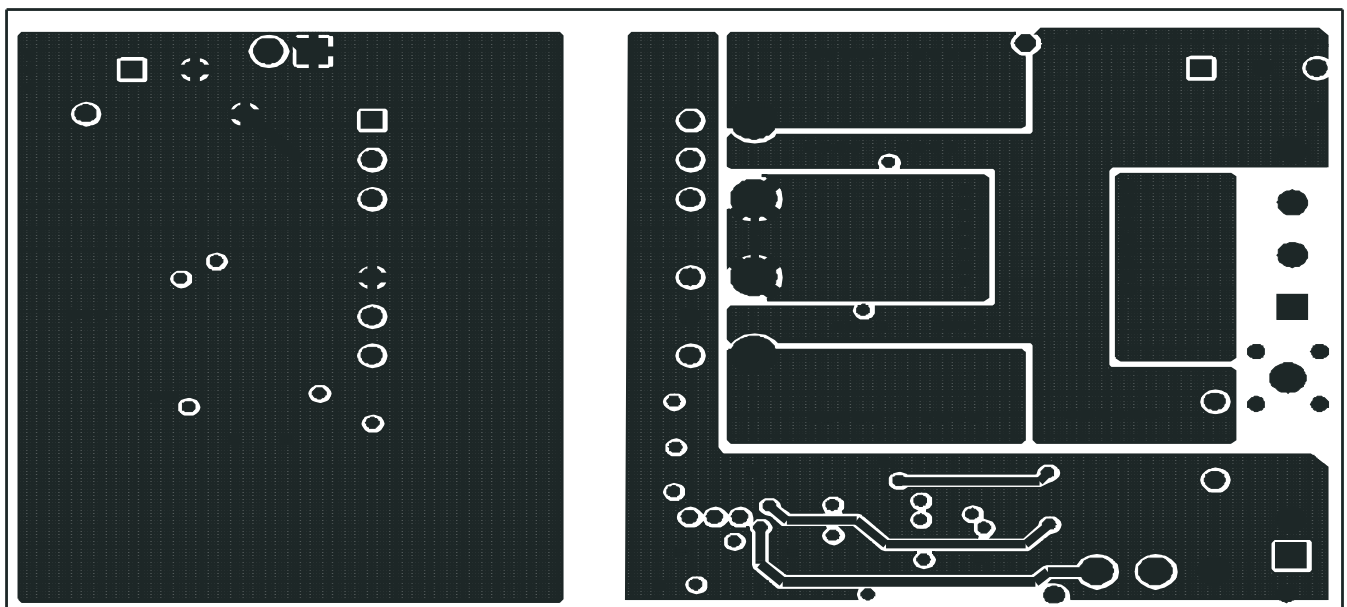


Figure 15. Internal Layer 1 (top view)

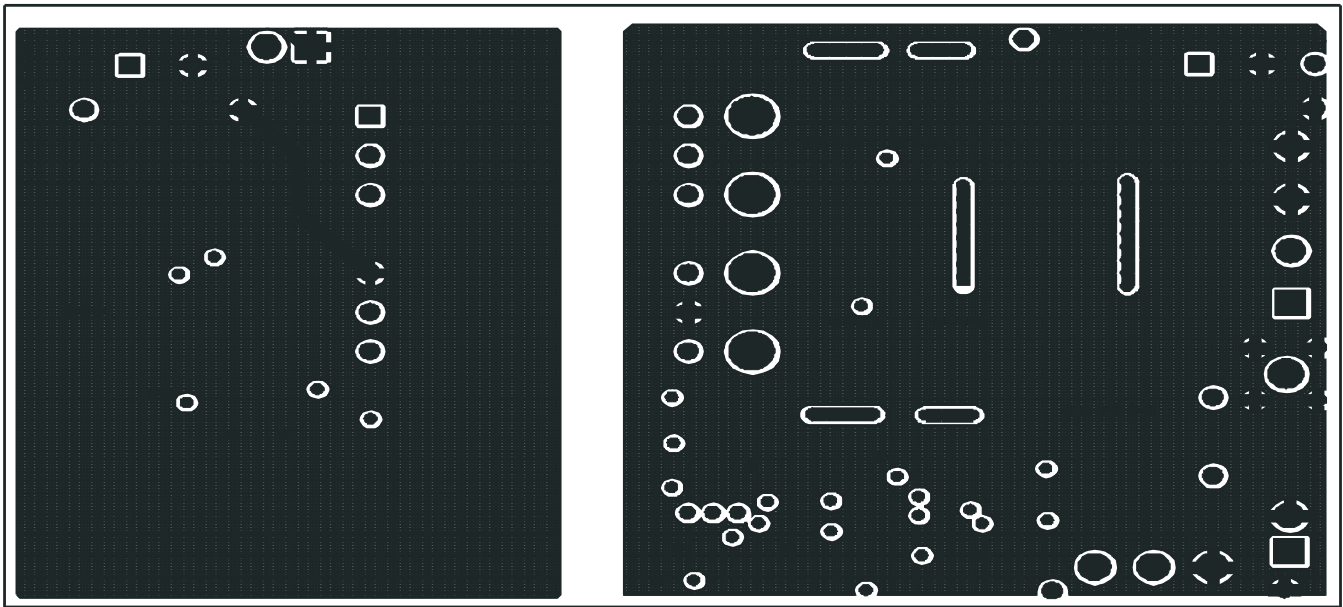


Figure 16. Internal Layer 2 (top view)

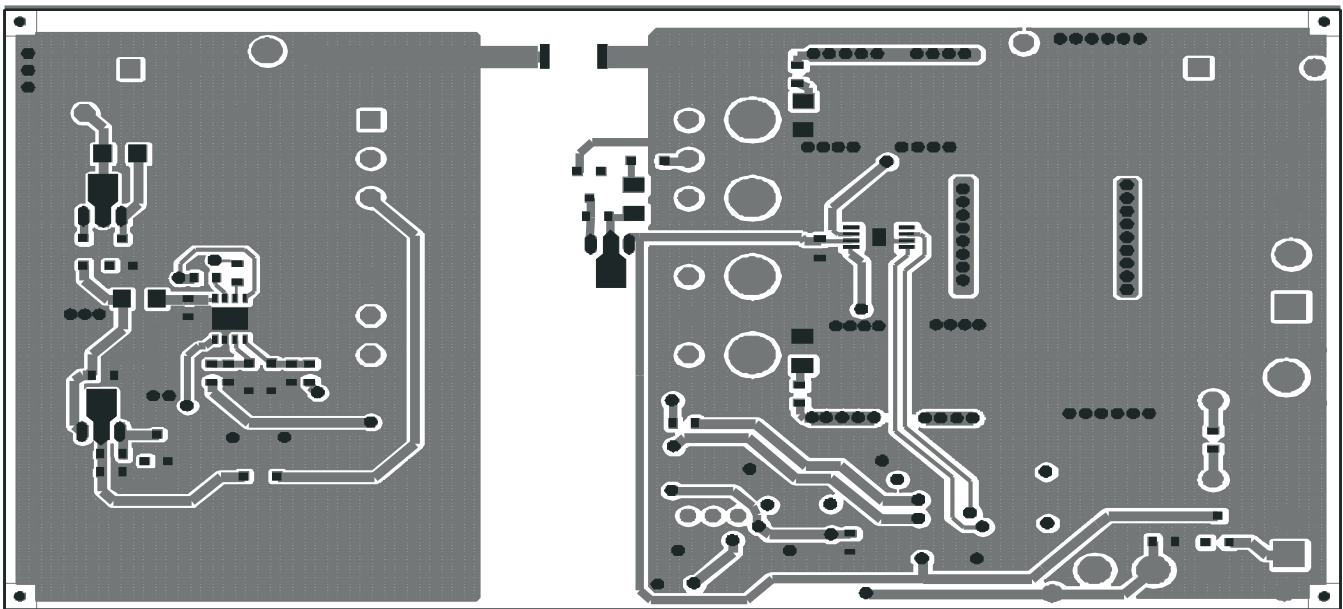


Figure 17. Bottom Copper (top view)

9 List of Materials

The EVM components list according to the schematic shown in [Figure 1](#).

Table 3. UCC28250EVM-564 List of Materials

QTY	REF DES	DESCRIPTION	PART NUMBER	MFR
5	C1, C3, C4, C6, C9	Capacitor, ceramic, 50 V, X5R, $\pm 10\%$, 1.0 μF , 603	Std	Std
1	C10	Capacitor, ceramic, 50 V, NP0, $\pm 10\%$, 100 pF, 603	Std	Std
3	C11, C29, C30	Capacitor, ceramic, 50 V, X7R, $\pm 10\%$, 2200 pF, 603	Std	Std
2	C14, C28	Capacitor, ceramic, 50 V, X7R, $\pm 10\%$, 470 pF, 603	Std	Std
1	C16	Capacitor, ceramic, 50 V, NP0, $\pm 5\%$, 120 pF, 603	Std	Std
4	C17, C21, C24, C25	Capacitor, ceramic, 100 V, X7R, $\pm 10\%$, 2.2 μF , 1210	Std	Std
4	C2, C18, C19, C23	Capacitor, ceramic, 6.3 V, X5R, $\pm 10\%$, 100 μF , 1812	Std	Std
1	C20	Capacitor, ceramic, 100 V, X7R, $\pm 10\%$, 1.0 μF , 1210	Std	Std
1	C22	Capacitor, ceramic, 2 kV, X7R, $\pm 10\%$, 1000 pF, 1808	Std	Std
1	C31	Capacitor, aluminum, 100 V, 105°C, $\pm 20\%$, 100 μF , 0.315 inch	EEU-PC2A101	Panasonic
1	C32	Capacitor, aluminum, 25 V, 105°C, $\pm 20\%$, 470 μF , 0.315 inch	UVZ1E471MPD	Nichicon
0	C5	Capacitor, ceramic, 50 V, X7R, $\pm 10\%$, Not used, 603	Std	Std
1	C7	Capacitor, ceramic, 50 V, X7R, $\pm 10\%$, 680 pF, 603	Std	Std
7	C8, C12, C13, C15, C26, C27, C33	Capacitor, ceramic, 50 V, X7R, $\pm 10\%$, 0.1 μF , 603	Std	Std
2	D1, D7	Diode, switching, 90 V, 100 mA IFM, high speed, SOD-323	1SS355TE-17	Rohm
2	D12, D13	Diode, switching, 150 mA, 75 V, 350 mW, SOT23	BAS16	Vishay-Liteon
3	D2, D10, D11	Diode, Schottky, 350 mA, 40 V, SOD323	SD103AWS-7-F	Diodes Inc
1	D3	Diode, Zener, 8.2 V, 20 mA, 350 mW, 8.2V, SOT23	MMBZ5237B-7-F	Diodes Inc
1	D4	Diode, fast switching, 80 V, 500 mA, SOT-363	MMBD44448HSDW-7-F	Diodes
1	D5	Diode, Schottky, 0.5 A, 20 V, SOD-123	MBR0520L	Fairchild
2	D8, D9	Diode, Zener, 11 V, 20 mA, 350 mW, 11V, SOT23	MMBZ5241B-7-F	Diodes Inc
2	J1, J4	Terminal block, 2 pin, 6 A, 3.5 mm, 0.27 inch x 0.25 inch	OSTTE020161	OST
1	J2	Terminal block, 4 -pin, 15 A, 5.1 mm, 0.80 inch x 0.35 inch	ED120/4DS	OST
1	J3	Header, 3 pin, 2 mm spacing, 0.079 inch x 3 inch	TMM-103-01-T-S	Samtec Inc
1	L1	Inductor, SMT, 6 A, 8.8 m Ω , 1.0 μH , 0.287 inch x 0.268 inch	RLF7030T-1R0N6R4	TDK
1	L2	Inductor, power choke, $\pm 20\%$, 1.3 μH , 18.2 mm x 18.3 mm	7443556130	Würth Elektronik
3	Q1, Q2, Q3	Transistor, NPN high voltage, VCE 100 V, IC1A, SOT89	FCX493TA	Zetex
2	Q4, Q7	MOSFET, N-channel, 100 V, 5.7 A, 25 m Ω , PWRPAK S0-8	SI7456DP	Vishay
4	Q5, Q6, Q8, Q9	MOSFET, N-channel, 30 V, 50 A, 2.6 m Ω , LPAK	RJK0328DPB	Renesas
3	R1, R4, R29	Resistor, chip, 1/16 W, $\pm 1\%$, 10.0 k Ω , 603	Std	Std
1	R10	Resistor, chip, 1/16 W, $\pm 1\%$, 2.32 k Ω , 603	Std	Std
3	R12, R14, R30	Resistor, chip, 1/16 W, $\pm 1\%$, 1.00 k Ω , 603	Std	Std

Table 3. UCC28250EVM-564 List of Materials (continued)

QTY	REF DES	DESCRIPTION	PART NUMBER	MFR
1	R15	Resistor, chip, 1/16 W, $\pm 5\%$, 0 Ω , 603	Std	Std
1	R16	Resistor, chip, 1/16 W, $\pm 1\%$, 75.0 k Ω , 603	Std	Std
2	R17, R19	Resistor, chip, 1/16 W, $\pm 1\%$, 402 Ω , 603	Std	Std
1	R18	Resistor, chip, 1/16 W, $\pm 1\%$, 4.64 k Ω , 603	Std	Std
3	R2, R13, R23	Resistor, chip, 1/16 W, $\pm 1\%$, 5.11 k Ω , 603	Std	Std
1	R20	Resistor, chip, 1/16 W, $\pm 1\%$, 6.81 k Ω , 603	Std	Std
1	R21	Resistor, chip, 1/16 W, $\pm 1\%$, 681 Ω , 603	Std	Std
1	R22	Resistor, chip, 1/16 W, $\pm 1\%$, 1.50 k Ω , 603	Std	Std
2	R24, R37	Resistor, metal film, 1/4 W, $\pm 1\%$, 17.8 Ω , 1206	Std	Std
1	R25	Resistor, metal film, 1/4 W, $\pm 1\%$, 36.5 Ω , 1206	Std	Std
1	R26	Resistor, metal film, 1/4 W, $\pm 1\%$, 60.4 k Ω , 1206	Std	Std
1	R28	Resistor, chip, 1/16 W, $\pm 1\%$, 20.0 k Ω , 603	Std	Std
2	R3, R6	Resistor, chip, 1/16 W, $\pm 1\%$, 23.2 k Ω , 603	Std	Std
1	R31	Resistor, metal film, 1/4 W, $\pm 1\%$, 90.9 Ω , 1206	Std	Std
2	R32, R33	Resistor, metal film, 1/4 W, $\pm 1\%$, 20 Ω , 1206	Std	Std
1	R34	Resistor, chip, 1/16 W, $\pm 1\%$, 47.5 k Ω , 603	Std	Std
2	R35, R36	Resistor, chip, 1/16 W, $\pm 1\%$, 1 Ω , 603	Std	Std
2	R5, R27	Resistor, chip, 1/16 W, $\pm 1\%$, 200 Ω , 603	Std	Std
1	R7	Resistor, chip, 1/16 W, $\pm 1\%$, 49.9 Ω , 603	Std	Std
1	R8	Resistor, chip, 1/16 W, $\pm 1\%$, 51.1 k Ω , 603	Std	Std
2	R9, R11	Resistor, chip, 1/16 W, $\pm 1\%$, 49.9 k Ω , 603	Std	Std
1	S1	Switch, Actuator SPDT, 0.500 inch x 0.260 inch	1101M2S3CQE2	C & K
1	T1	Transformer, Half-Bridge $\pm 30\%$, 270 μH , 1.120 inch x 1.273 inch	AF5096	Vitec Electronics
1	T2	Xfmr, Current Sense, 100:01:00, 0.315 inch x 0.320 inch	CST2-100L	Coilcraft
1	T3	Transformer, 1 primary, 1 secondary, 785 μH , 0.460 x 0.340 inch	PA0185	Pulse
9	TP1, TP2, TP3, TP4, TP5, TP7, TP8, TP9, TP10	Pin, Thru Hole, Tin Plate, for 0.062 PCB's, 0.039 inch	3103-1-00-15-00-00-08-0	Mill-Max
1	TP11	Adaptor, 3.5-mm probe clip (or 131-5031-00), 0.200 inch	131-4244-00	Tektronix
1	U1	DUAL INVERTER GATE, 32mA, 3.3V, SOT23-6	SN74LVC2GU04DBVR	TI
1	U2	120 V Boot, 2.5A Peak, High-Freq. High-Side Low-Side Driver, QFN-8	UCC27201DRM	TI
1	U3	Advanced PWM Controller with Pre-Bias Operation, TSSOP-20	UCC28250PW	TI
1	U4	Dual 4-A High Speed Low-Side Power MOSFET Drivers , MSOP-8	UCC37324DGN	TI
1	U5	Photocoupler, SOP-4	PS2701-1	NEC

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 36 V to 75 V and the output voltage range of 3.3 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 60° C. The EVM is designed to operate properly with certain components above 60° 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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