AN-1748 LM5005 Evaluation Board

1 Introduction

The LM5005 evaluation board is designed to provide the design engineer with a fully functional power converter based on emulated current mode control to evaluate the LM5005 regulator IC. The evaluation board provides a 5 V output with a 2.5A current capability. The ultra-wide input voltage ranges from 7 V to 75 V. The design operates at 300 kHz, a good compromise between conversion efficiency and solution size. The printed circuit board (PCB) consists of 2 layers of 2 ounce copper on FR4 material with a thickness of 0.06 inches. This document contains the evaluation board schematic, Bill-of-Materials (BOM) and a quick setup procedure. For complete circuit design information, see the *LM5005 High Voltage 2.5 Amp Buck Regulator Data Sheet* (SNVS397).

The performance of the evaluation board is as follows:

Input Range: 7 to 75 V

Output Voltage: 5 V

Output Current: 0 to 2.5A

Frequency of Operation: 300 KHz

Board Size: 2.75 X 1 X 0.4 inches

Load Regulation: 1%

Line Regulation: 0.1%

Over Current Limiting

2 Evaluation Board Schematic

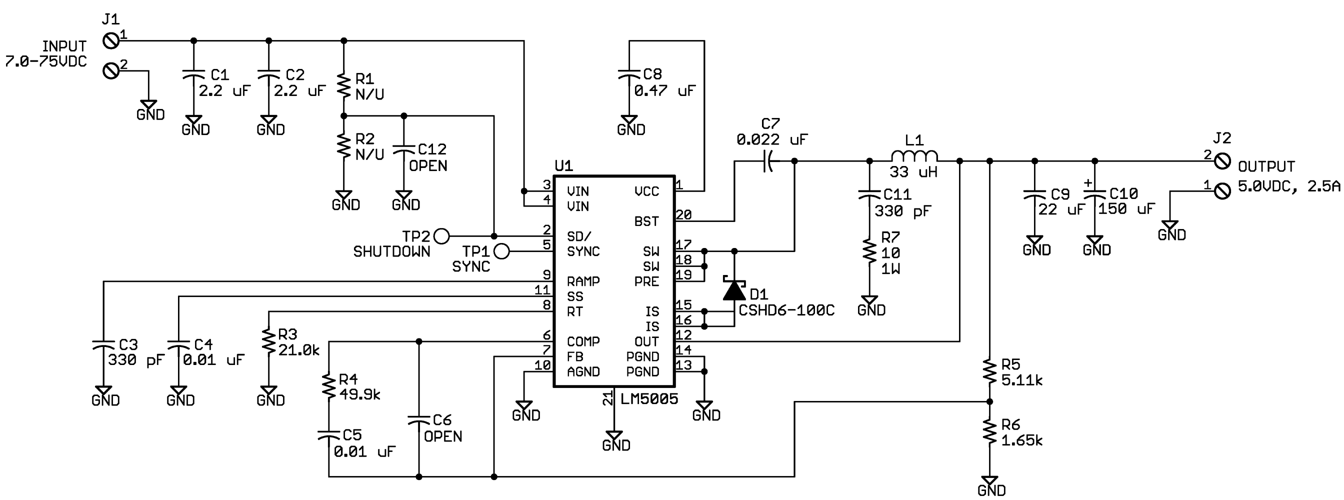

Figure 1. Schematic

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3 Powering and Loading Considerations

Read this entire page prior to attempting to power the evaluation board.

3.1 Quick Setup Procedure

1. Set the power supply current limit to 3.5A. Turn off the power supply. Connect the power supply to the V_{IN} terminals.
2. Connect the load, with a 3A capability, to the V_{OUT} terminals. Positive connection to J2 and negative connection to J3.
3. Leave the SD pin open for normal operation.
4. Set V_{IN} to 24 V with no load applied. V_{OUT} should be in regulation with a nominal 5 V output.
5. Slowly increase the load while monitoring the output voltage, V_{OUT} should remain in regulation with a nominal 5 V output as the load is increased up to 2.5 Amps.
6. Slowly sweep the input voltage from 7 V to 75 V, V_{OUT} should remain in regulation with a nominal 5 V output.
7. Temporally short the SD pin to GND to check the shutdown function.
8. Increase the load beyond the normal range to check current limiting. The output current should limit at approximately 3.8A. The power supply (Vin source) current limit may need to be increased for this step. Cooling is critical during this step.

3.2 Air Flow

Prolonged operation with high input voltage at full power causes the thermal shutdown circuit within the regulator IC to activate. A stand-alone fan with at lease 200 LFM should always be provided.

3.3 Powering Up

Using the provided shutdown pin allows powering up the source supply with the current level set low. It is suggested that the load be kept low during the first power up. Set the current limit of the source supply to provide about 1.5 times the anticipated wattage of the load. As you remove the connection from the shutdown pin to ground, immediately check for 5 V at the output.

A quick efficiency check is the best way to confirm that everything is operating properly. If something is amiss, you can be reasonably sure that it will affect the efficiency adversely. Few parameters can be incorrect in a switching power supply without creating losses and potentially damaging heat.

3.4 Over Current Protection

The evaluation board is configured with over-current protection. The output current is limited to approximately 3.8A. The thermal stress is quite severe while in an overloaded condition, limit the duration of the overload and provide sufficient cooling (airflow).

3.5 Synchronization

A SYNC pin has been provided on the evaluation board. This pin can be used to synchronize the regulator to an external clock or multiple evaluation boards can be synchronized together by connecting their SYNC pins together. For complete information, see the *LM5005 High Voltage 2.5 Amp Buck Regulator Data Sheet* (SNVS397).

4 Performance Characteristics

4.1 Efficiency Plots

Figure 2 shows the conversion efficiency versus output current for several input voltage conditions.

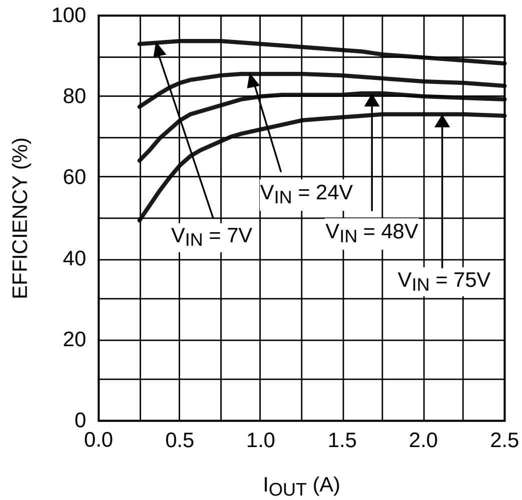
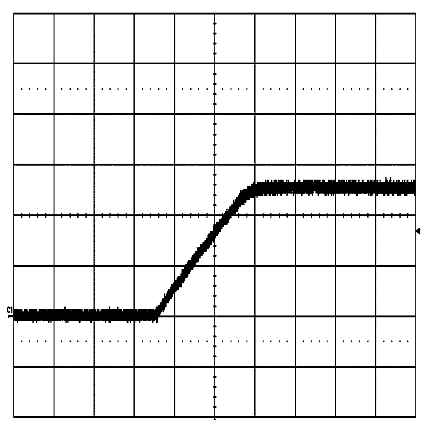


Figure 2. Conversion Efficiency Versus Output Current

4.2 Turn-On Waveform

When applying power to the LM5005 evaluation board a certain soft-start sequence occurs. Figure 3 shows the output voltage during a typical start-up sequence.

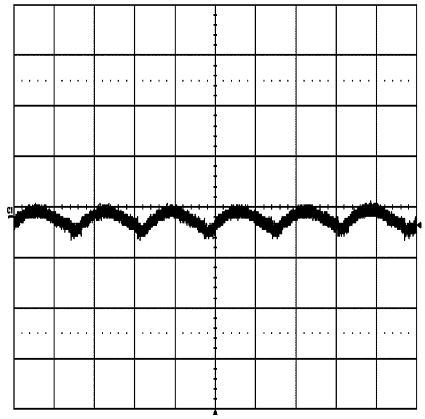


Conditions: Input Voltage = 36VDC, Output Current = 2A
Trace 1: Output Voltage Volts/div = 2V
Horizontal Resolution = 500 µsec/div

Figure 3. Output Voltage During a Typical Start-Up Sequence

4.3 Output Ripple Waveform

Figure 4 shows the output voltage ripple. This measurement was taken with a very short ground clip and 20 MHZ bandwidth limiting.



Conditions: Input Voltage = 36 VDC Output Current = 2A Bandwidth Limit = 20 MHz
Trace 1: Output Ripple Voltage Volts/div = 50mV
Horizontal Resolution = 2 µsec/div

Figure 4. Output Voltage Ripple

5 Layout and Bill of Materials (BOM)

The Bill of Materials is shown in Table 1, including the manufacturer and part number.

Table 1. 5 V, 2.5A Demo Board Bill of Materials (BOM)

Item		Part Number	Description	Value
C	1	C4532X7R2A225M	CAPACITOR, CER, TDK	2.2µ, 100 V
C	2	C4532X7R2A225M	CAPACITOR, CER, TDK	2.2µ, 100 V
C	3	C0805C331G1GAC	CAPACITOR, CER, KEMET	330p, 100 V
C	4	C2012X7R2A103K	CAPACITOR, CER, TDK	0.01µ, 100 V
C	5	C2012X7R2A103K	CAPACITOR, CER, TDK	0.01µ, 100V
C	6	OPEN	NOT USED	
C	7	C2012X7R2A223K	CAPACITOR, CER, TDK	0.022µ, 100 V
C	8	C2012X7R1C474M	CAPACITOR, CER, TDK	0.47µ, 16 V
C	9	C3225X7R1C226M	CAPACITOR, CER, TDK	22µ, 16 V
C	10	EEFHE0J151R	CAPACITOR, SP, PANASONIC	150µ, 6.3 V
C	11	C0805C331G1GAC	CAPACITOR, CER, KEMET	330p, 100 V
C	12	OPEN	NOT USED	
D	1	CSHD6-100C	DIODE, 100V, CENTRAL	
		6CWQ10FN	DIODE, 100V, IR (D1-ALT)	
L	1	DR127-330	INDUCTOR, COOPER	33 µH
R	1	OPEN	NOT USED	
R	2	OPEN	NOT USED	
R	3	CRCW08052102F	RESISTOR	21 kΩ
R	4	CRCW08054992F	RESISTOR	49.9 kΩ
R	5	CRCW08055111F	RESISTOR	5.11 kΩ
R	6	CRCW08051651F	RESISTOR	1.65 kΩ
R	7	CRCW2512100J	RESISTOR	10, 1W
U	1	LM5005	REGULATOR, Texas Instruments	

6 PCB Layout

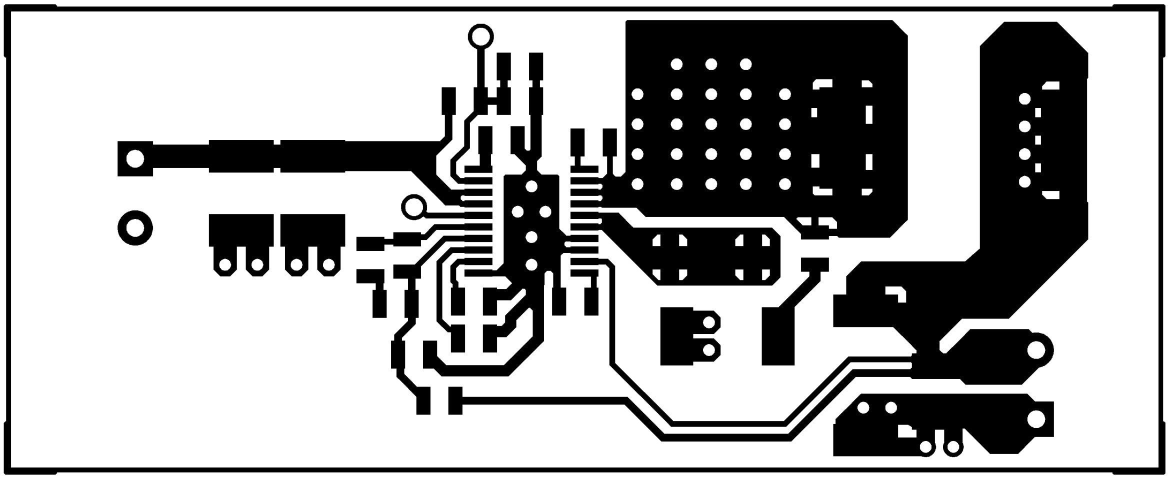


Figure 5. Component Side

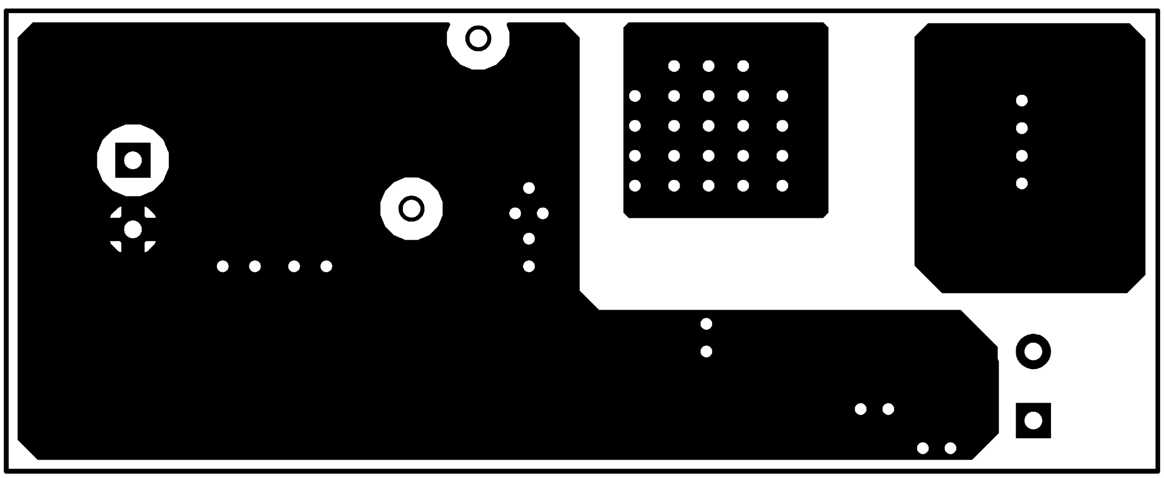


Figure 6. Solder Side

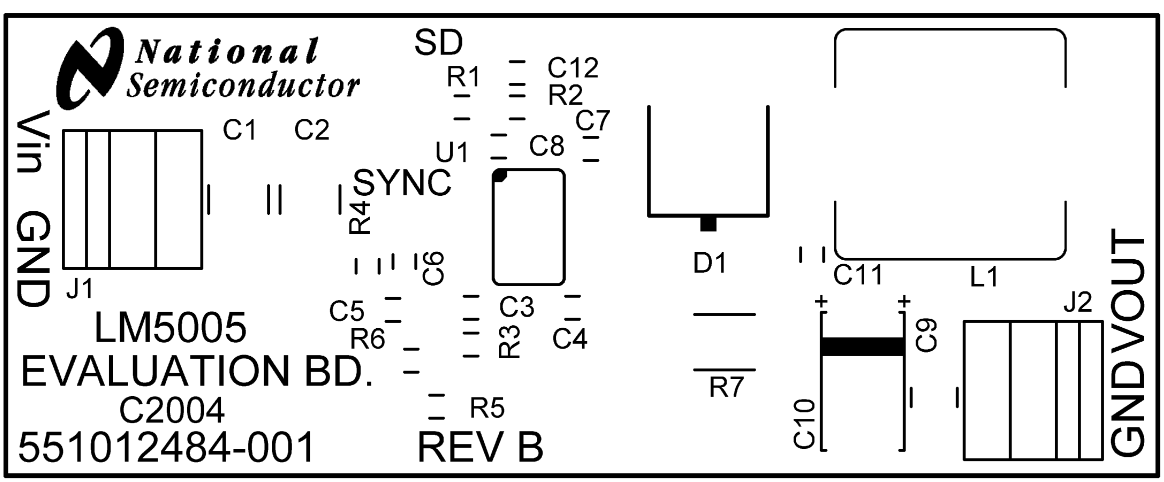


Figure 7. Silkscreen

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