

LM25005 Evaluation Board

National Semiconductor
Application Note 1749
Robert Bell
November 7, 2007



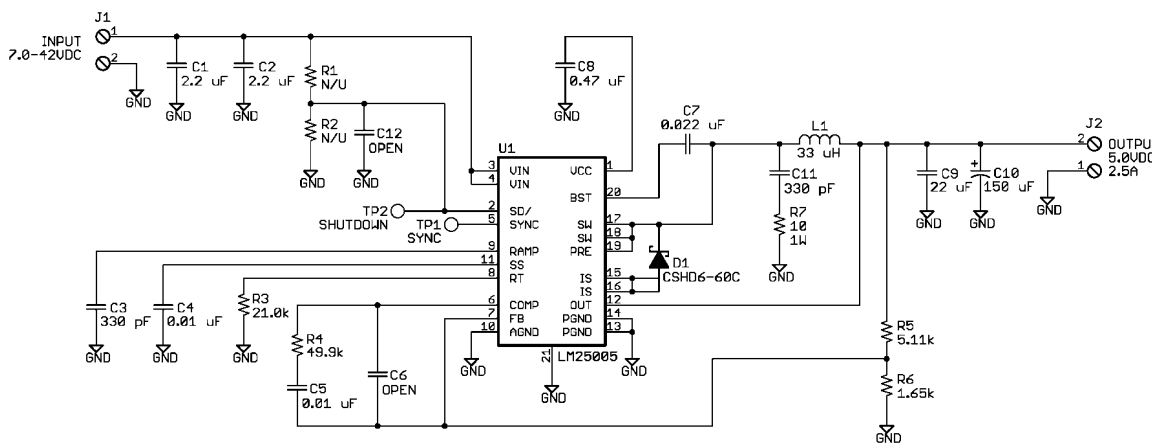
Introduction

The LM25005 evaluation board is designed to provide the design engineer with a fully functional power converter based on Emulated Current Mode Control to evaluate the LM25005 regulator IC. The evaluation board provides a 5V output with a 2.5A current capability. The ultra-wide input voltage ranges from 7V to 42V. The design operates at 300kHz, a good compromise between conversion efficiency and solution size. The printed circuit board consists of 2 layers of 2 ounce copper on FR4 material with a thickness of 0.06 inches. This application note contains the evaluation board schematic, Bill-of-Materials (BOM) and a quick setup procedure. Refer to the LM25005 datasheet for complete circuit design information.

The performance of the evaluation board is as follows:

- Input Range: 7 to 42V
- Output Voltage: 5V
- 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

Evaluation Board Schematic



30044101

Powering and Loading Considerations

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

QUICK SETUP PROCEDURE

Step 1: Set the power supply current limit to 3.5A. Turn off the power supply. Connect the power supply to the Vin terminals.

Step 2: Connect the load, with a 2.5A capability, to the Vout terminals. Positive connection to J2 and negative connection to J3.

Step 3: The SD pin should be left open for normal operation.

Step 4: Set Vin to 24V with no load applied. Vout should be in regulation with a nominal 5V output.

Step 5: Slowly increase the load while monitoring the output voltage, Vout should remain in regulation with a nominal 5V output as the load is increased up to 2.5 Amps.

Step 6: Slowly sweep the input voltage from 7 to 42V, Vout should remain in regulation with a nominal 5V output.

Step 7: Temporally short the SD pin to GND to check the shutdown function.

Step 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.

AIR FLOW

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

POWERING UP

Using the shutdown pin provided will allow 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 volts 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.

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).

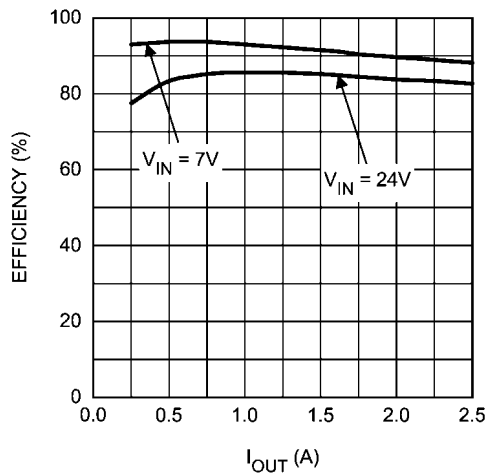
SYNCHRONIZATION

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. Refer to the LM25005 datasheet for complete information.

Performance Characteristics

EFFICIENCY PLOTS

Figure 1 shows the conversion efficiency versus output current for several input voltage conditions.

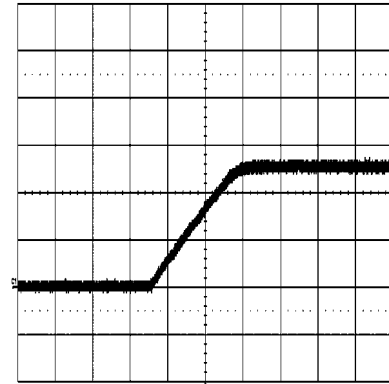


30044102

FIGURE 1.

TURN-ON WAVEFORM

When applying power to the LM25005 evaluation board a certain soft-start sequence occurs. Figure 2 shows the output voltage during a typical start-up sequence.



30044103

Conditions: Input Voltage = 36VDC, Output Current = 2A

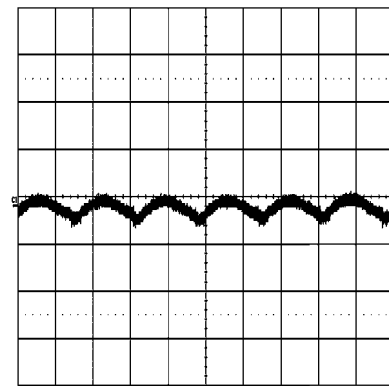
Trace 1: Output Voltage Volts/div = 2V

Horizontal Resolution = 500 μ sec/div

FIGURE 2.

OUTPUT RIPPLE WAVEFORM

Figure 3 shows the output voltage ripple. This measurement was taken with a very short ground clip and 20MHz bandwidth limiting.



30044104

Conditions: Input Voltage = 36VDC Output Current = 2A Bandwidth Limit = 20MHz

Trace 1: Output Ripple Voltage Volts/div = 50mV

Horizontal Resolution = 2 μ sec/div

FIGURE 3.

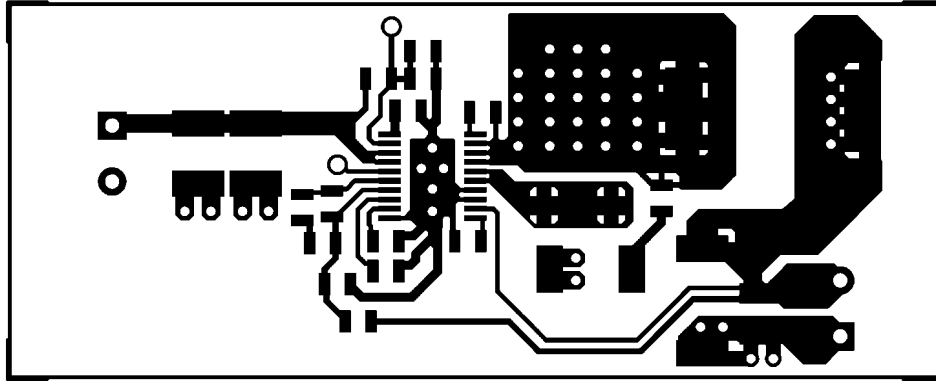
Layout and Bill of Materials

The Bill of Materials is shown below, including the manufacturer and part number.

TABLE 1. 5V, 2.5A Demo Board Bill of Materials

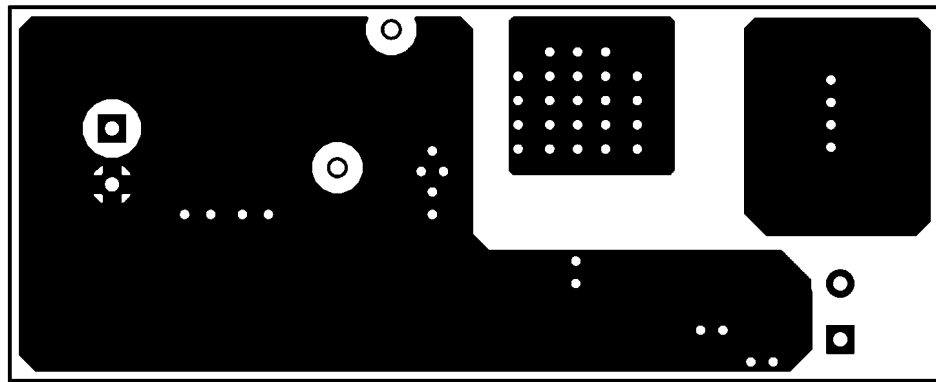
Item		Part Number	Description	Value
C	1	C4532X7R2A225M	CAPACITOR, CER, TDK	2.2 μ , 100V
C	2	C4532X7R2A225M	CAPACITOR, CER, TDK	2.2 μ , 100V
C	3	C0805C331G1GAC	CAPACITOR, CER, KEMET	330p, 100V
C	4	C2012X7R2A103K	CAPACITOR, CER, TDK	0.01 μ , 100V
C	5	C2012X7R2A103K	CAPACITOR, CER, TDK	0.01 μ , 100V
C	6	OPEN	NOT USED	
C	7	C2012X7R2A223K	CAPACITOR, CER, TDK	0.022 μ , 100V
C	8	C2012X7R1C474M	CAPACITOR, CER, TDK	0.47 μ , 16V
C	9	C3225X7R1C226M	CAPACITOR, CER, TDK	22 μ , 16V
C	10	EEFHE0J151R	CAPACITOR, SP, PANASONIC	150 μ , 6.3V
C	11	C0805C331G1GAC	CAPACITOR, CER, KEMET	330p, 100V
C	12	OPEN	NOT USED	
D	1	CSHD6-60C	DIODE, 60V, CENTRAL	
		6CWQ10FN	DIODE, 100V, IR (D1-ALT)	
L	1	DR127-330	INDUCTOR, COOPER	33 μ H
R	1	OPEN	NOT USED	
R	2	OPEN	NOT USED	
R	3	CRCW08052102F	RESISTOR	21k Ω
R	4	CRCW08054992F	RESISTOR	49.9k Ω
R	5	CRCW08055111F	RESISTOR	5.11k Ω
R	6	CRCW08051651F	RESISTOR	1.65k Ω
R	7	CRCW2512100J	RESISTOR	10, 1W
U	1	LM25005	REGULATOR, NATIONAL SEMICONDUCTOR	

PCB Layout



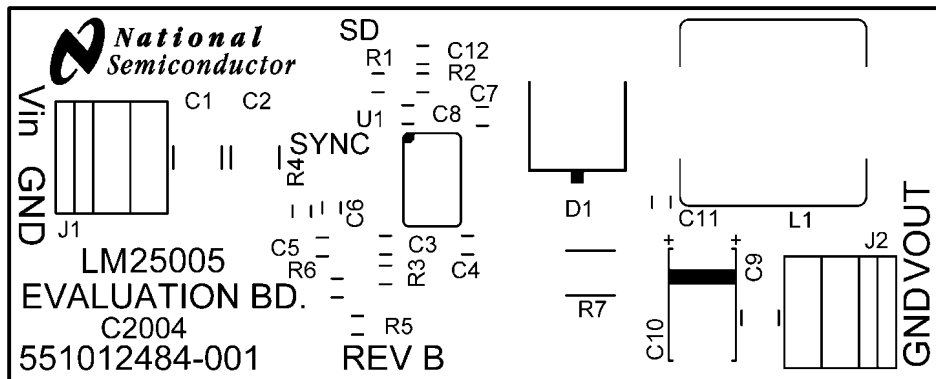
Component Side

30044105



Solder Side

30044106



Silkscreen

30044107

Notes

AN-1749

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:

Products		Design Support	
Amplifiers	www.national.com/amplifiers	WEBENCH	www.national.com/webench
Audio	www.national.com/audio	Analog University	www.national.com/AU
Clock Conditioners	www.national.com/timing	App Notes	www.national.com/appnotes
Data Converters	www.national.com/adc	Distributors	www.national.com/contacts
Displays	www.national.com/displays	Green Compliance	www.national.com/quality/green
Ethernet	www.national.com/ethernet	Packaging	www.national.com/packaging
Interface	www.national.com/interface	Quality and Reliability	www.national.com/quality
LVDS	www.national.com/lvds	Reference Designs	www.national.com/refdesigns
Power Management	www.national.com/power	Feedback	www.national.com/feedback
Switching Regulators	www.national.com/switchers		
LDOs	www.national.com/ldo		
LED Lighting	www.national.com/led		
PowerWise	www.national.com/powerwise		
Serial Digital Interface (SDI)	www.national.com/sdi		
Temperature Sensors	www.national.com/tempensors		
Wireless (PLL/VCO)	www.national.com/wireless		

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2007 National Semiconductor Corporation

For the most current product information visit us at www.national.com



National Semiconductor Americas Customer Support Center
 Email: new.feedback@nsc.com
 Tel: 1-800-272-9959

National Semiconductor Europe Customer Support Center
 Fax: +49 (0) 180-530-85-86
 Email: europe.support@nsc.com
 Deutsch Tel: +49 (0) 69 9508 6208
 English Tel: +49 (0) 870 24 0 2171
 Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Support Center
 Email: ap.support@nsc.com

National Semiconductor Japan Customer Support Center
 Fax: 81-3-5639-7507
 Email: jpn.feedback@nsc.com
 Tel: 81-3-5639-7560