AN–1694 LM20242 Evaluation Board

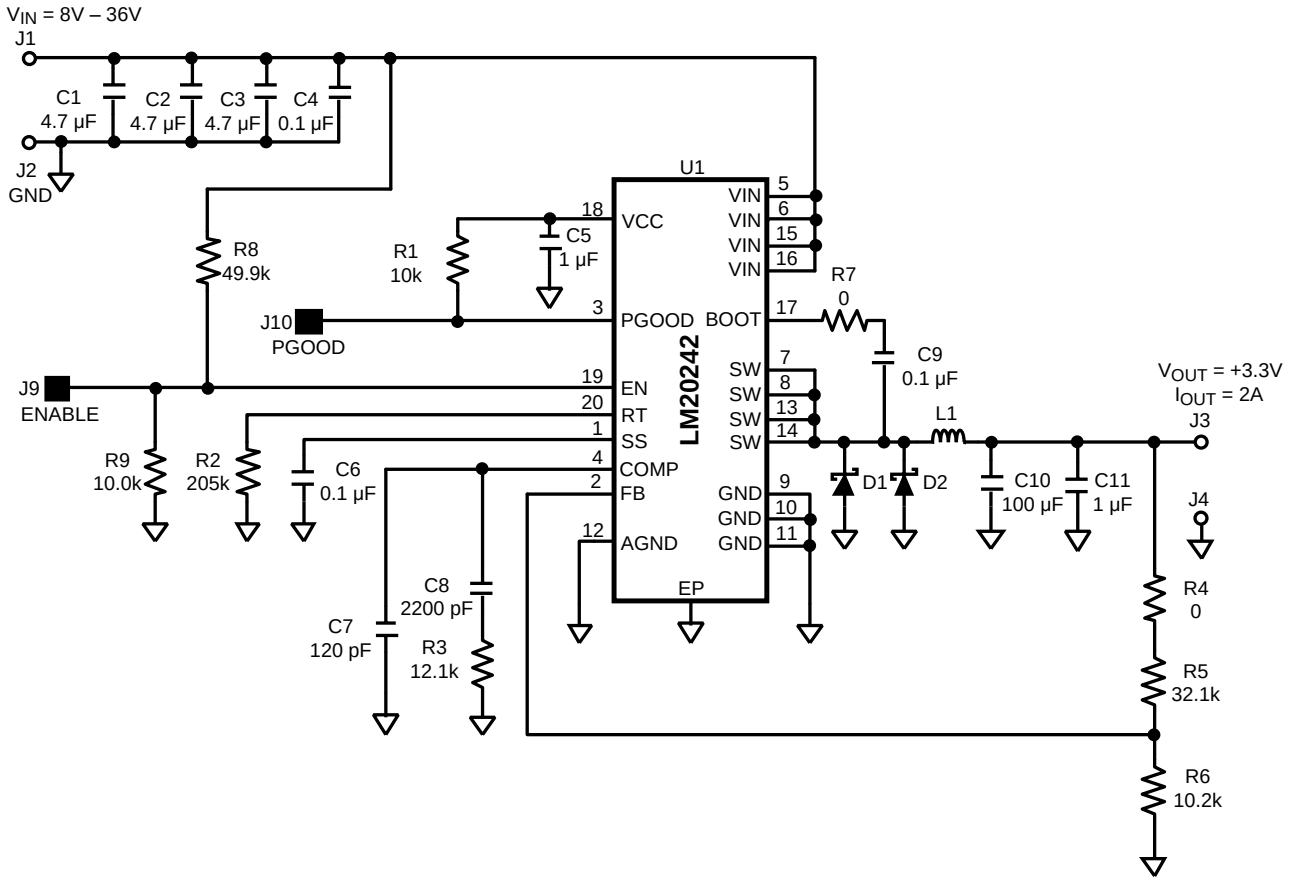
1 Introduction

The LM20242 synchronous rectifier Buck evaluation board is designed to provide the design engineer with a fully functional Buck power converter based on Current Mode Control to evaluate the LM20242 switching regulator IC. The evaluation board provides a 3.3 V output with 2A current capability. The input voltage ranges from 8 V to 36 V. The design operates at 300 kHz, 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 0.062 inches. This document contains the evaluation board schematic, Bill of Materials (BOM) and a quick setup procedure. For complete circuit design information, see the *LM20242 36V, 2A PowerWise™ Adjustable Frequency Synchronous Buck Regulator Data Sheet* (SNVS534).

The performance of the synchronous rectifier buck evaluation board is as follows:

- Input Range: 8 V to 36 V
- Output Voltage: 3.3 V, ±2%
- Output Current: 0 to 2A
- Frequency of Operation: 300 kHz
- Board Size: 2.15 X 2.0 X 0.6 inches
- Load Regulation: 0.1%
- Line Regulation: 0.1%
- Over Current Limiting

2 Evaluation Board Schematic



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 input source current limit to 1A. Turn off the input source. Connect the positive output of the input source to J1 and the negative output to J2.
2. Connect the load, with 2A capability, to J3 for the positive connection and J4 for the negative connection.
3. Leave the ENABLE pin, J9, open for normal operation.
4. Set the input source voltage to 12 V and the load to 0.1A. The load voltage should be in regulation with a nominal 3.3 V output.
5. Slowly increase the load while monitoring the load voltage at J3 and J4. It should remain in regulation with a nominal 3.3 V output as the load is increased up to 2 Amp.
6. Slowly sweep the input source voltage from 8 V to 36 V. The load voltage should remain in regulation with a nominal 3.3 V output.
7. Temporally short the ENABLE pin (J9) to GND (J2) to check the shutdown function.
8. Increase the load beyond the normal range to check current limiting while the input source is set to 12 V. The output current should limit at approximately 3.8A. The input source current limit should be increased for this step. Fan cooling is critical during this step.

3.2 Air Flow

Prolonged operation at full power and high ambient temperature will cause the thermal shutdown circuit within the regulator IC to activate. A fan with a minimum of 200 LFM should always be provided.

3.3 Powering Up

Using the ENABLE pin (J9) provided will allow powering up the input source with the current level set low. It is suggested that the load power be kept low during the first power up. Set the current limit of the input source to provide about 1.5 times the anticipated wattage of the load. As you remove the connection from the ENABLE pin to GND (J2), immediately check for 3.3 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.

3.4 Over Current Protection

The evaluation board is configured with cycle-by-cycle over-current protection. This function is completely contained in the LM20242. The peak current is limited to approximately 3.8A. The thermal stress on various circuit components is quite severe while in an overloaded condition, therefore limit the duration of the overload and provide sufficient cooling (airflow).

4 Performance Characteristics

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

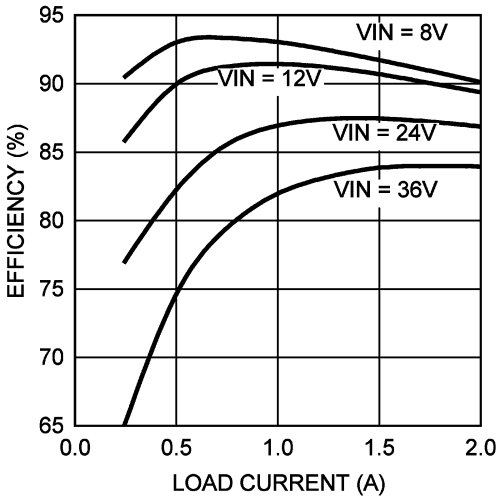
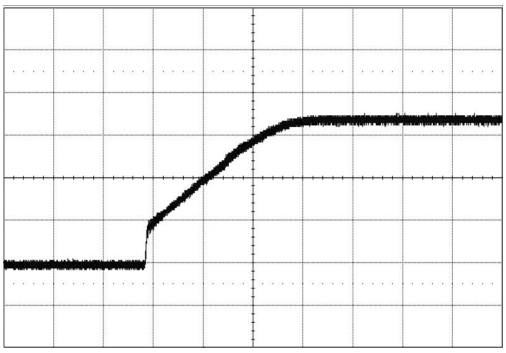


Figure 1. Efficiency Plots

TURN-ON WAVEFORM

When applying power to the LM20242 evaluation board a soft-start sequence occurs. Figure 2 shows the output voltage during a typical start-up sequence.

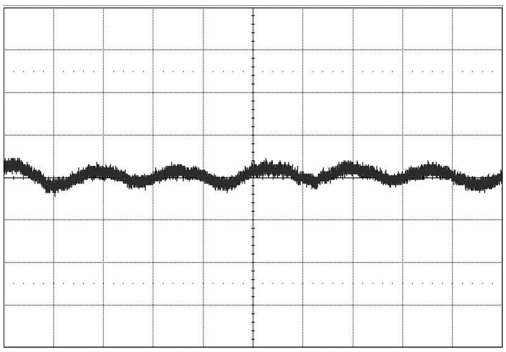


Conditions: Input Voltage = 12 VDC, Output Current = 2A
Trace 1: Output Voltage Volts/div = 1 V
Horizontal Resolution = 5ms/div

Figure 2. Output Voltage During a Typical Start-Up

OUTPUT RIPPLE WAVEFORM

Figure 3 shows the output voltage ripple. This measurement was taken with the scope probe tip placed on the J3 load terminal and the scope probe ground "barrel" pushed against the J4 load terminal. The scope bandwidth is set to 20 MHz.

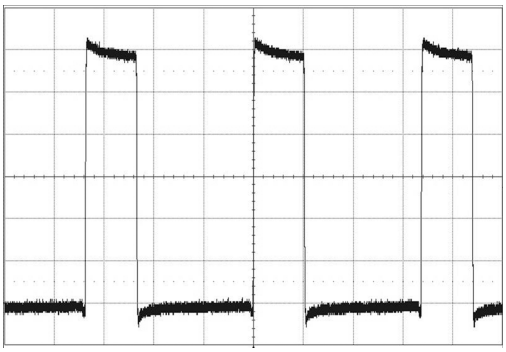


Conditions: Input Voltage = 12 VDC, Output Current = 2A,
Bandwidth Limit = 20 MHZ
Trace 1: Output Ripple Voltage Volts/div = 20 mV
Horizontal Resolution = 2 µs/div

Figure 3. Output Voltage Ripple

PRIMARY SWITCHNODE WAVEFORM

Figure 4 shows the typical SW pin voltage during continuous conduction mode (CCM).



Conditions: Input Voltage = 12 VDC, Output Current = 2A,
Bandwidth Limit = 20 MHZ
Trace 1: LM20242 SW Pin Volts/div = 2 V
Horizontal Resolution = 1 µs/div

Figure 4. SW Pin Voltage During Continuous Conduction Mode (CCM)

5 Layout and Bill of Materials (BOM)

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

Table 1. Bill of Materials

Designator	Qty	Part Number	Description	Value
C1-3	3	GRM32ER71H475KA88L	CAPACITOR, 1210 X7R CER, MURATA	4.7µ, 50 V
C4	1	C2012X7R2A104K	CAPACITOR, 0805 X7R CER, TDK	0.1µ, 100 V
C5	1	GRM188R71A105KA61D	CAPACITOR, 0603 X7R CER, MURATA	1µ, 10 V
C6,9	2	C1608X7R1H104K	CAPACITOR, 0603 X7R CER, TDK	0.1µ, 50 V
C7	1	C1608C0G1H121J	CAPACITOR, 0603 COG CER, TDK	120p, 50 V
C8	1	C1608C0G1H222J	CAPACITOR, 0603 COG CER, TDK	2200p, 50 V
C10	1	C1210C107M9PAC	CAPACITOR, 1210 X5R CER, KEMET	100µ, 6.3 V
C11	1	GRM21BR71H105KA12L	CAPACITOR, 0805 X7R CER, MURATA	1µ, 50 V
D1,2	2	MBR0540	DIODE, SCHOTTKY, SOD123, FAIRCHILD	500 mA, 40 V
L1	1	MSS1278-153ML	INDUCTOR, COILCRAFT 12 mm x 12 mm	15 µH, 3.5A
R1,9	2	CRCW06031002F	RESISTOR, 0603, VISHAY	10k
R2	1	CRCW06032053F	RESISTOR, 0603, VISHAY	205k
R3	1	CRCW06031212F	RESISTOR, 0603, VISHAY	12.1k
R4,7	2	CRCW06030000Z0EA	RESISTOR, 0603, VISHAY	0
R5	1	CRCW06033212F	RESISTOR, 0603, VISHAY	32.1k
R6	1	CRCW06031022F	RESISTOR, 0603, VISHAY	10.2k
R8	1	CRCW06034992F	RESISTOR, 0603, VISHAY	49.9k
U1	1	LM20242	SWITCHING REGULATOR, TI	
J1,2,3,4	4	1503-2	0.112" TURRET TERMINAL, KEYSTONE	TERMINAL, TURRET
J9,10	2	5002	TERMINAL, SINGLE PIN, KEYSTONE	TESTPOINT, LOOP

6 PCB Layout

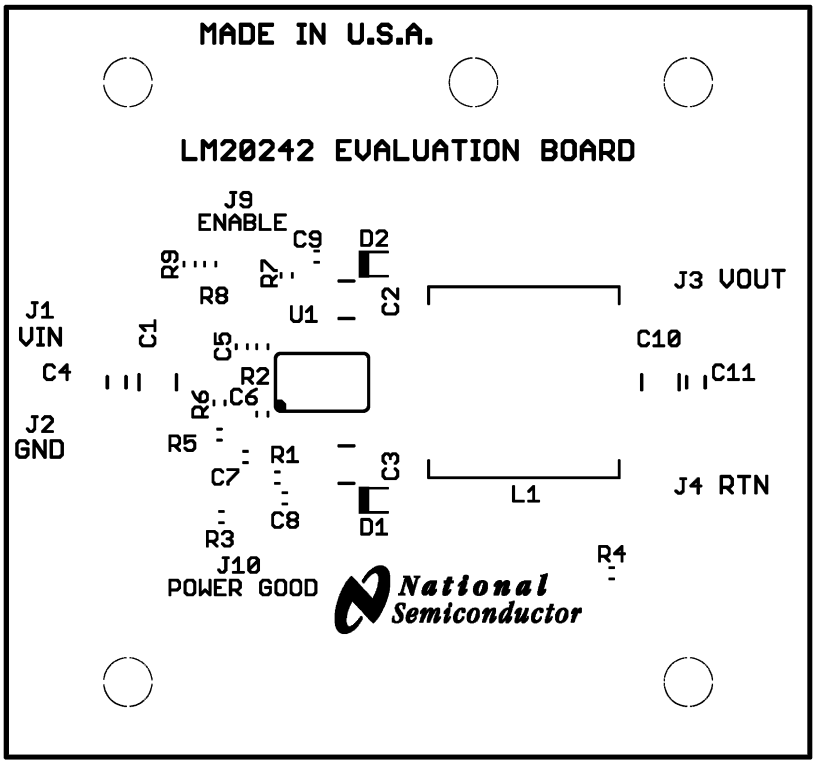


Figure 5. Silkscreen

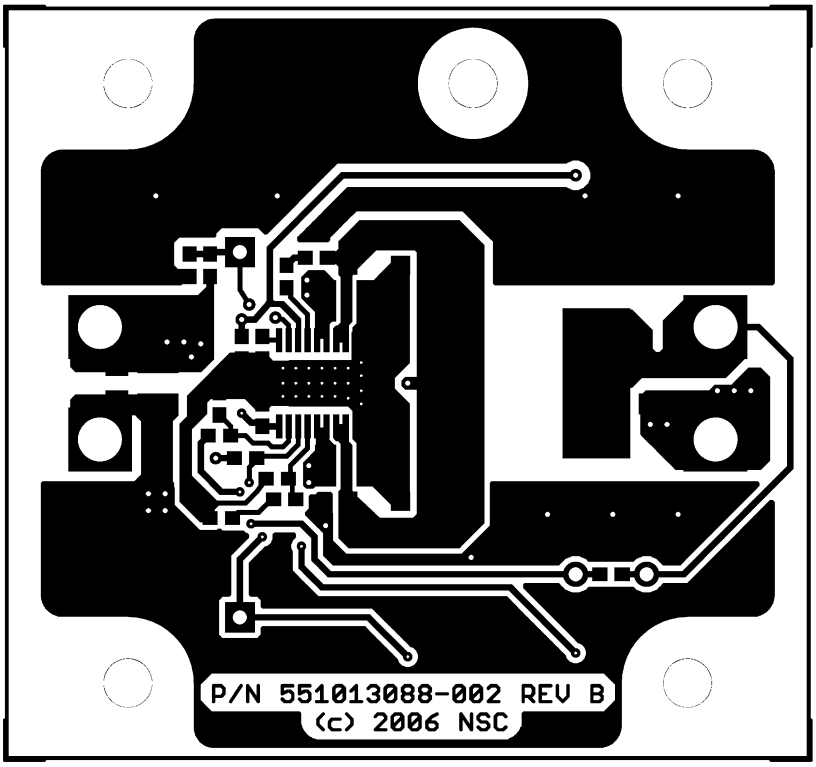


Figure 6. Component Side

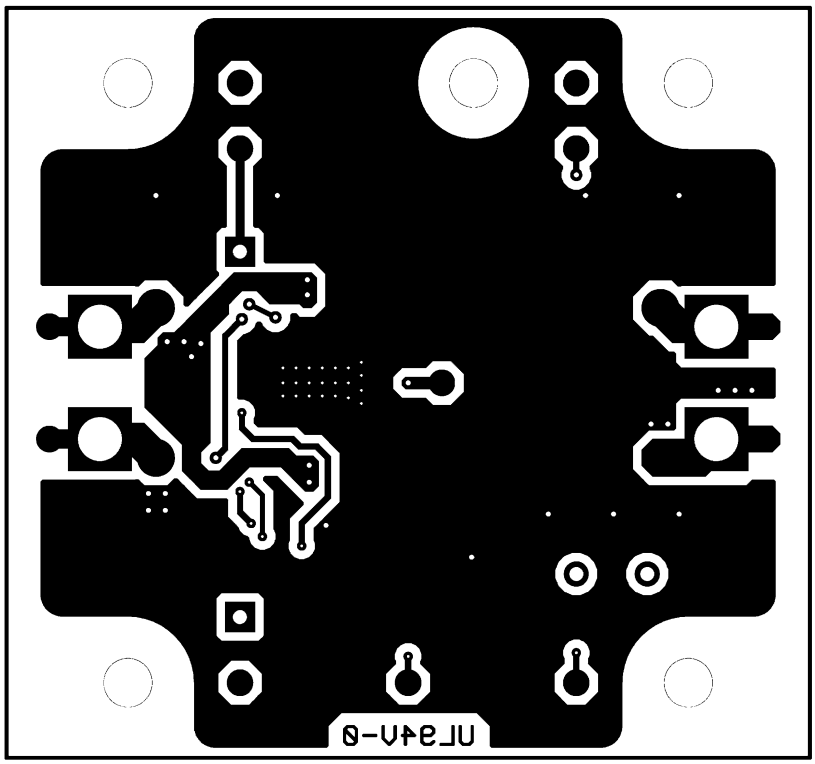


Figure 7. Solder Side

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