User's Guide

LM2655 Step-Down Converter Evaluation Module User's Guide

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1 Introduction

The LM2655 is a high efficiency current -mode controlled PWM step down switching regulator. Efficiencies > 90% are obtained with synchronous operation.

Internal low ON resistance MOSFET and an external N-channel MOSFET provide the highest efficiency design. For cost saving at the expense of some efficiency, the external MOSFET can be replaced with a suitable Shottky diode. (Asynchronous operation). The IC uses patented current sensing circuitry that eliminates the need for an external current sense resistor. A programmable soft start limits start-up current surges and provides a means of sequencing multiple power supplies.

The evaluation board can be obtained by ordering part number LM2655EVAL from your local Texas Instruments sales office, or the TI website at http://www.ti.com.

2 Evaluation Board Design

The LM2655 evaluation board is designed to supply 2.5 V at a maximum of 2.5A. The input voltage is from 4 V to 14 V. The board can be loaded with an SO-8 MOSFET as the lower switching element for lower switching losses than a Schottky Diode would provide by itself. The Schottky Diode, D1, improves efficiency.

Components were selected based on the design procedure in the *LM2655 2.5A High Efficiency Synchronous Switching Regulator Data Sheet* (SNVS072). The feedback resistors can be adjusted to achieve different output voltages. Use the formula:

$$R_{FB1} = R_{FB2}*(V_{out}-V_{ref})/V_{ref} \quad (1)$$

where V_{ref} = 1.238 V.

PCB layout is critical to reduce noises and ensure specified performance. For layout guidelines, see the *LM2655 2.5A High Efficiency Synchronous Switching Regulator Data Sheet* (SNVS072). The artwork for this evaluation board is included in this document.

The schematic of the evaluation board is shown in Figure 4-2 and the parts list is given in Table 4-1.

The LM2655 has both under voltage and over voltage shutdown protection on the output as well as under voltage lock out on the input. When the under voltage protection occurs, the output voltage can be pulled below ground by the inductor. In applications that must be protected from reverse polarity, an output clamping diode can be added across C_{OUT}.

3 Soft Start

Soft start in the LM2655 provides delay and current ramp-up rate control at startup. Both are a function of the value of C_{SS}. After a delay, pulses begin with the current limit set to zero then ramped up to full. The total time for soft start process is estimated as:

$$T_{ss} = C_{ss}\,(.6\text{ V}/2\ \mu\text{A}) + C_{ss}\,(2\text{ V}-.6\text{ V})//10\ \mu\text{A} \quad (2)$$

Which reduces to $T_{ss} = C_{ss}$ (440,000)

Table 3-1. Examples

C_{SS}	T_{SS}
470 pF	225.5 µs
1 nF	451 µs
2.2 nF	992 µs
4.7 nF	2.07 ms

To begin with, use 4.7nF. This will assure the circuit will get up and running under full load.

If the output voltage does not attain 80% of its intended voltage when the under voltage lockout is enabled, (C_{SS} too small) the regulator will latch off. The actual time required for the output voltage to rise will depend upon the value of the inductor, output capacitor, the load on start up, and the supply voltage, as well as the value of C_{SS}.

The calculated value of T_{ss} approximates the time that the under voltage and over voltage lock out circuitry will be delayed from the application of power.

4 LDelay

A capacitor at Ldelay provides an additional delay in enabling the undervoltage latch after the output voltage has reached 80% of its nominal. The value of the capacitor C_delay is determined by the equation:

$$T\_delay\ (mS) = C\_delay\ (nF) \times .4 \tag{3}$$

200pF is a good start point for this component.

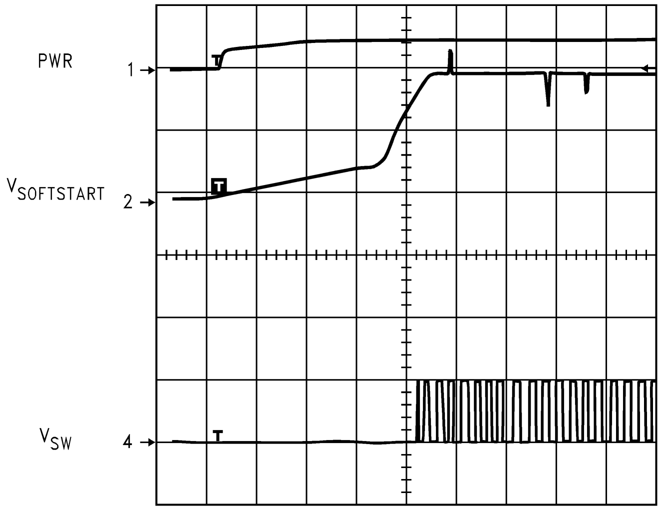
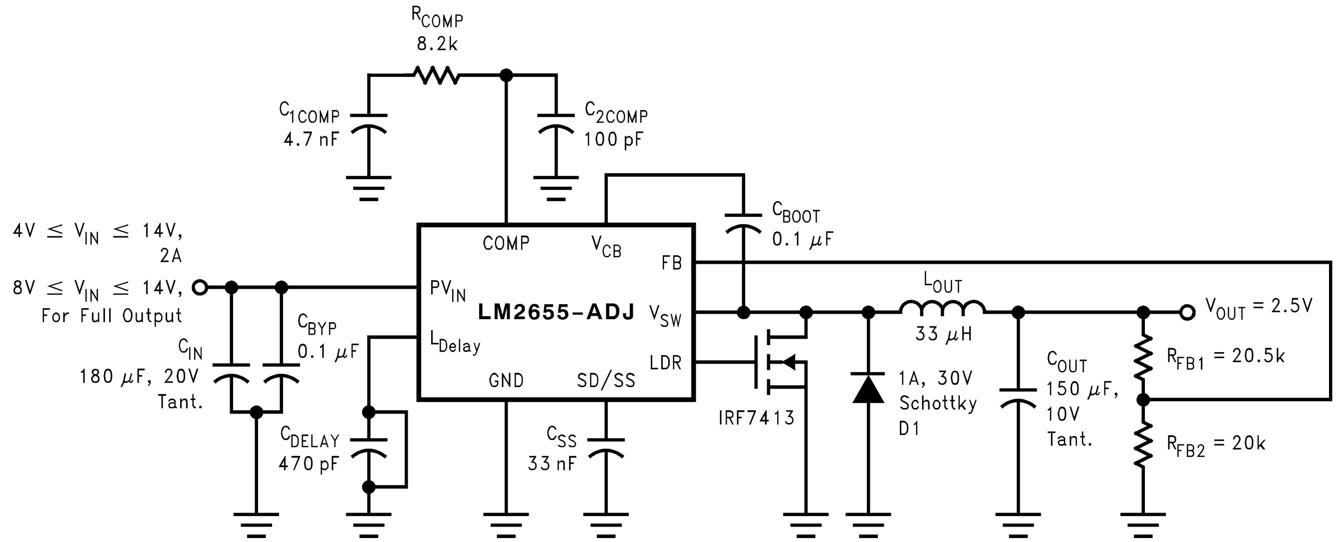


Figure 4-1. Start-Up Waveform

Table 4-1. Parts List

Component	Value	Description	Model Number
C_{OUT}	150 µF, 10 V	Output Capacitor	595D1570010 (Sprague) (Vishay)
C_{IN}	180 µF/20 V	Input Capacitor	595D1870020 (Sprague) (Vishay)
C_{DELAY}	200 pF, 0805	Delay	VJ0805Y221KXAA (Vishay)
C_{BYP}	0.1 µF, 0805	Bypass Capacitor	VJ0805Y104KXAA (Vishay)
C_{ss}	4.7 nF, 0805	Soft start	VJ0805Y472KXAA (Vishay)
Q1	3A, 30 V	Synchronous N-FET	IRF7413 or Si 4874 (International Rectifier or Siliconix)
D1	1A, 30 V (Schottky)	Catch Diode	MBRS130L (On Semiconductor)
L_{OUT}	15 µH, 3A	Power Inductor	MIDCOM DUS5121-150
C_{OUT}	150 µF, 10V	Output Capacitor	595D1570010 (Sprague) (Vishay)
C_{1COMP}	4.7nF, 0805	Compensation Capacitor	VJ0805Y472KXAA (Vishay)
C_{2COMP}	100 pF, 0805	Compensation Capacitor	VJ0805Y100KXAA (Vishay)
C_{BOOT}	0.1 µF, 50 V, 0805	Bootstrap Capacitor	VJ0805Y104KXAA (Vishay)
R_{COMP}	8.2k, 0805	Compensation Resistor	CRCW08058251F (Dale)
R_{FB1}	15k, 0805	Upper Feedback Resistor	CRCW08051502F (Dale)
R_{FB2}	10k, 0805	Lower Feedback Resistor	CRCW08051002F (Dale)
U1	LM2655	Voltage Regulator	LM2655 (Texas Instruments)



V_{OUT} = 1.23 * (R_{FB1} + R_{FB2})/R_{FB2}

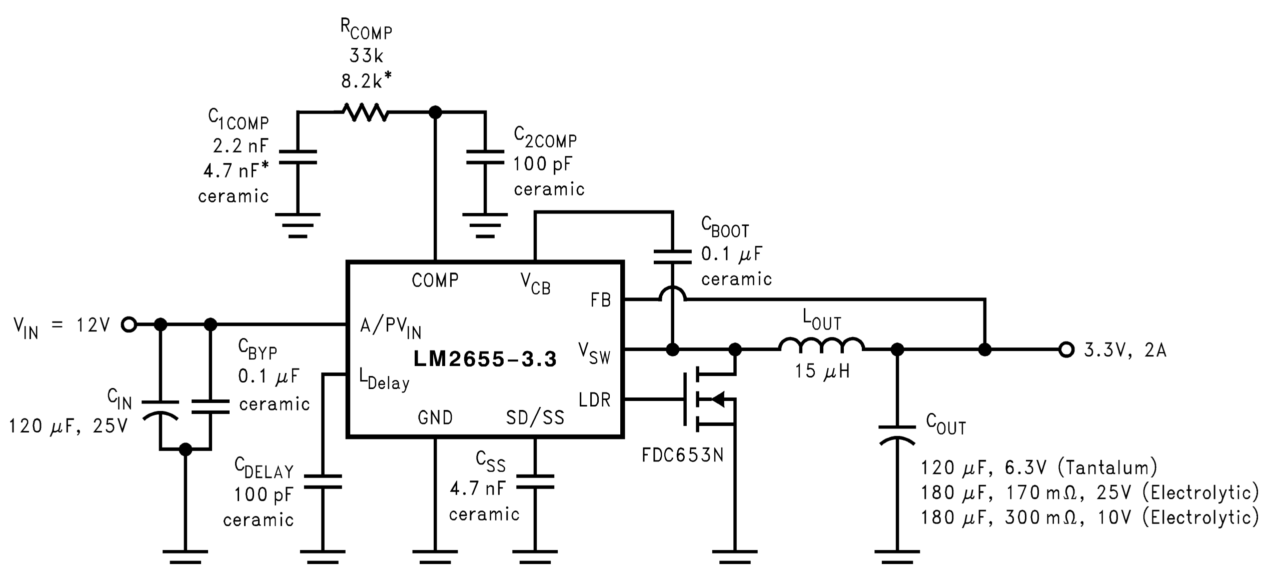
C_{DELAY} is shorted to turn off undervoltage protection.

A jumper between SD/SS and ground provides on/off functionality.

Shipped in synchronous mode. Take MOSFET out to run in Asynchronous mode. Diode is large to accommodate synchronous and asynchronous operation.

D1 will limit output1 Low V_{IN} ...
with 3A Diode V_{IN} Low Limit
is < 4V.

Figure 4-2. LM2655 Evaluation Board Schematic



* If electrolytic capacitors are used, make compensation network R_c = 8.2 kΩ and C_c = 4.7 nF.

Efficiency ≅ 91%

Figure 4-3. LM2655 Buck Converter (12V to 3.3V, Synchronous)

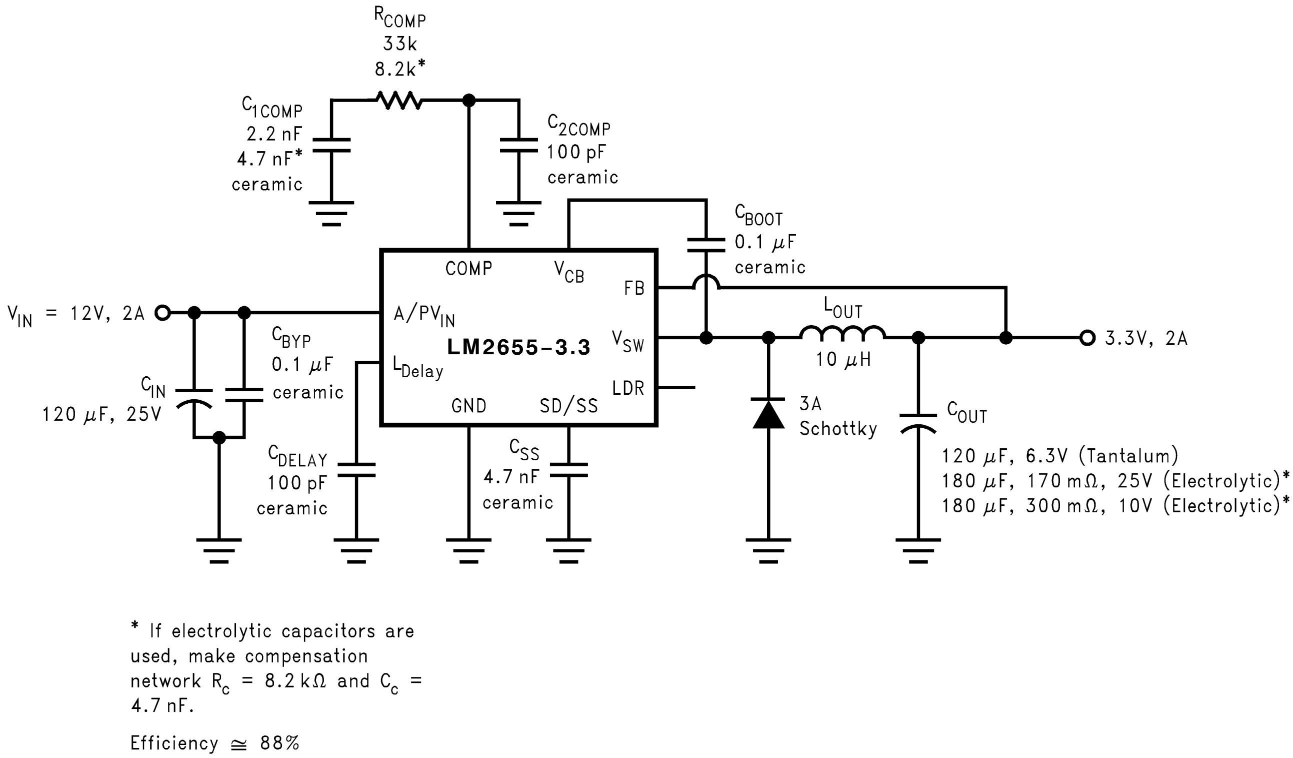


Figure 4-4. LM2655 Buck Converter (12V to 3.3V, Asynchronous)

5 Board Layout

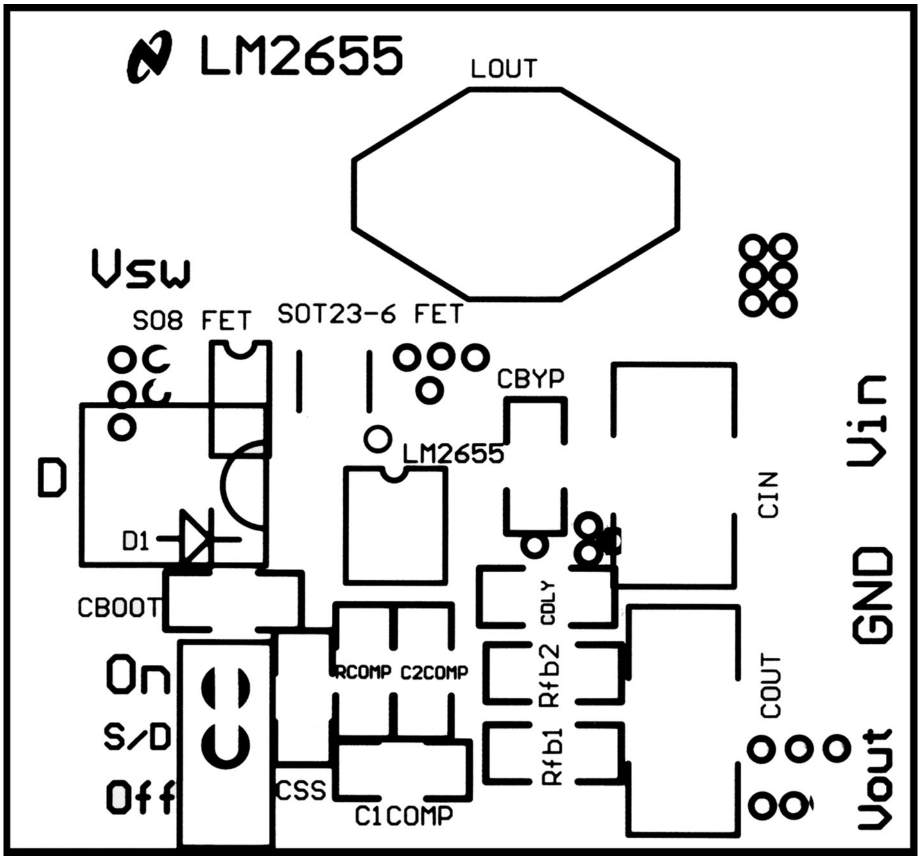


Figure 5-1. Slik Screen

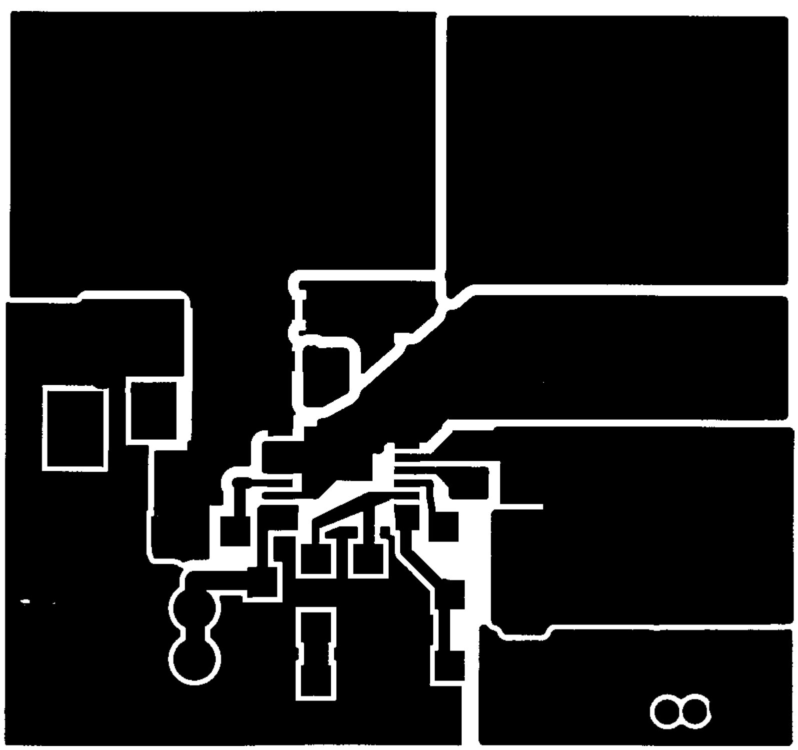


Figure 5-2. Top Layer

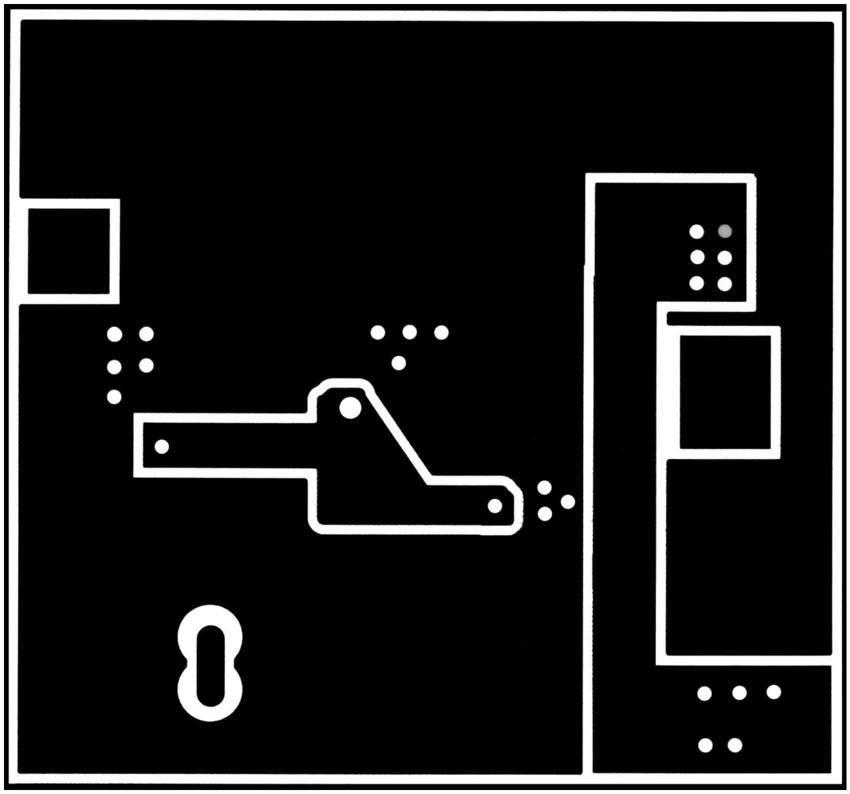


Figure 5-3. Bottom Layer

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision D (April 2013) to Revision E (December 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.	2
• Updated the user's guide title	2

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