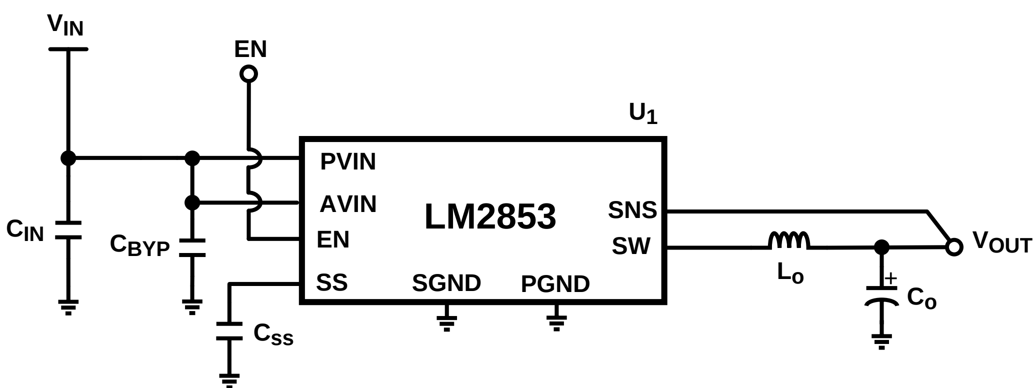
AN-1513 LM2853 Evaluation Board

1 Introduction

The LM2853 synchronous SIMPLE SWITCHER® buck regulator is a synchronous switching regulator capable of delivering up to 3A of current into a load. The LM2853 represents the ultimate in ease of use, as internal type-3 compensation minimizes the necessary external components and eases the selection of those components. The LM2853 is capable of accepting an input voltage between 3.0V and 5.5V and delivering an output voltage that is factory programmable from 0.8V to 3.3V in 100mV increments. The nominal switching frequency of the LM2853 is 550 kHz.

The LM2853 Evaluation Board was designed to accommodate three standard output voltage options (1.2V/1.8V/3.3V) using the same layout and external components. Just five external components are included on the board, and the entire 3A power supply occupies a minimum amount of space (1.2” by 0.82”) on a two layer PCB without sacrificing efficiency or performance. The input voltage can be varied over the entire operating range of the LM2853 (3.0V to 5.5V) for testing purposes. Also, the board is designed to be stable with all standard LM2853 voltage options, so if another voltage option needs to be tested, the LM2853 IC can be removed and replaced with the desired option.

2 Schematic



3 Bill Of Materials

ID	Part Number	Type	Size	Parameters	Qty	Vendor
U1	LM2853	3A Buck	HTSSOP-14	x.xV	1	Texas Instruments
C_{IN}	GRM31CR60J476ME19	Capacitor	1206	47 µF	1	Murata
C_{BYP}	GRM21BR71C105KA01	Capacitor	0805	1 µF	1	Murata
C_{SS}	VJ0805Y222KXXA	Capacitor	0603	2.2 nF	1	Vishay-Vitramon
L_O	DO3316P-472	Inductor	DO3316P	4.7 µH	1	Coilcraft
C_O	TPSD227X06R0050	Capacitor	D Case	220 µF (50 mΩ)	1	Vishay-Sprague

4 Performance

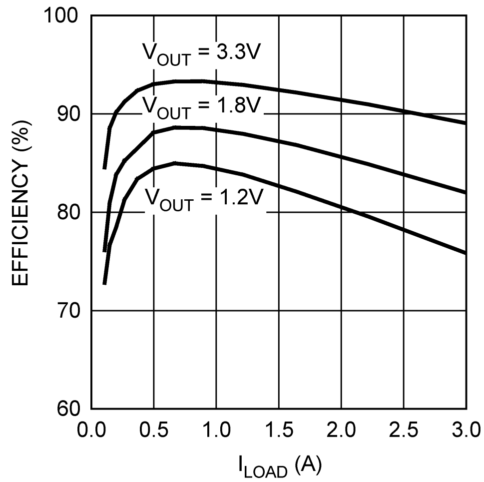


Figure 1. Efficiency vs. I_{LOAD} (V_{IN} = 5V)

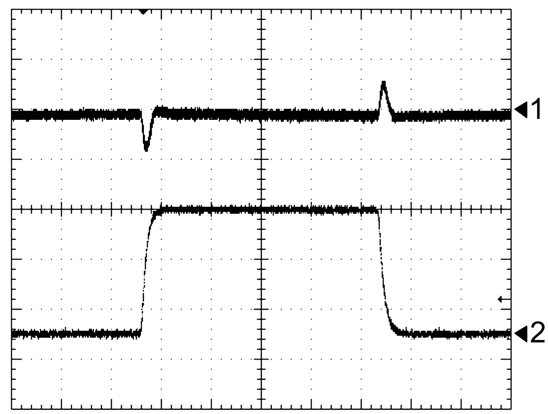


Figure 2. Horizontal Resolution: 200 µs/Div.
Trace 1: V_{OUT} (100 mV/Div.)
Trace 2: I_{LOAD} (1 A /Div.)

5 Component Selection

5.1 C_{IN} and C_{BYP}

The necessary RMS current rating of the input capacitor can be estimated by the following equation:

$$I_{RMS} = I_{LOAD}\sqrt{D(1\text{-}D)} \quad (1)$$

where the variable D refers to the duty cycle, and can be approximated by:

$$D = \frac{V_{OUT}}{V_{IN}} \quad (2)$$

From this equation, it follows that the maximum I_{RMS} will occur at a full 3A load current with the system operating at 50% duty cycle. Under this condition, the maximum I_{RMS} is given by:

$$I_{RMS} = 3A\sqrt{0.5 \times 0.5} = 1.5A \quad (3)$$

Ceramic capacitors feature a very large I_{RMS} rating in a small footprint, making a ceramic capacitor ideal for this application. A 47 µF ceramic capacitor from Murata with a 4.9A I_{RMS} rating provides the necessary input capacitance for the evaluation board. For improved load regulation and transient performance, an extra 1 µF ceramic capacitor is placed near to the AVIN pin from V_{IN} to GND. This small capacitor helps to filter high frequency noise pulses on the supply, and prevent those pulses from disturbing the analog control circuitry of the chip.

5.2 C_{SS}

The soft-start capacitor has been chosen to provide a soft-start time of roughly 3 ms. Using the internal soft-start resistance of 450 kΩ and the external soft-start capacitor value of 2.2 nF, the approximate soft-start time can be calculated as follows:

$$T_{SS} = 3 \times C_{SS} \times R_{SS} = 3 \times 2.2\text{ nF} \times 450\text{ k}\Omega = 2.97\text{ ms} \approx 3\text{ ms} \quad (4)$$

A 3 ms soft-start time will allow the LM2853 to start up gracefully without triggering over-current protection, regardless of the operating conditions.

5.3 L_O and C_O

The selection of the output filter components L_O and C_O, are intrinsically linked, as both of these parameters affect the stability of the system, and various characteristics of the output voltage. First, a 4.7 µH inductor is chosen to allow stable operation over the entire input voltage range (as per the datasheet recommendations) from 3.0V to 5.5V. The size of the inductor also directly affects the amplitude of the inductor current ripple. This amplitude can be calculated from the following equation:

$$\Delta I_L = \frac{D \times (V_{IN} - V_{OUT})}{f_{SW} \times L_O} \quad (5)$$

From this, it follows that the maximum inductor current ripple using standard operating conditions of the LM2853 and a 4.7 µH inductor will occur at V_{IN} = 5.5V, and V_{OUT} = 2.5V. Under these conditions the inductor current ripple is given as:

$$\Delta I_L = \left(\frac{2.5V}{5.5V}\right) \frac{(5.5V - 2.5V)}{550\ kHz \times 4.7\ \mu H} = 0.528A \quad (6)$$

This means an inductor must be selected with a saturation current higher than 3.264A to ensure that the inductor will never saturate during normal operating conditions. A Coilcraft DO3316P, 4.7 µH inductor provides the necessary current handling capabilities (I_{SAT} = 5.4A) in a relatively small footprint.

The ESR of the output capacitor affects both the ripple voltage at the output and the overall stability of the loop. In order to keep the output voltage ripple manageable under all operating conditions, an ESR value of 50 mΩ is selected. As per the datasheet recommendations, a capacitance of 220 µF will ensure stability regardless of V_{IN} and V_{OUT} when coupled with 4.7 µH inductor and 50 mΩ ESR. An AVX low-ESR 6.3V tantalum capacitor provides the necessary ESR and capacitance to stabilize the loop and control the output voltage ripple, with suitable voltage derating for up to a 3.3V output.

6 PCB Layout

The PCB layout of the LM2853 demo board was designed to occupy as little board space as possible, while still following sound layout guidelines and techniques. The input capacitor, C_{IN} is placed as close as possible to the PVIN pins and the PGND pins, to minimize stray resistance and inductance between C_{IN} and the LM2853. Likewise, the AVIN bypass capacitor is placed as close as possible to the AVIN and SGND pins. PGND and SGND are connected to each other and the ground plane at a single point, the exposed pad of the LM2853. Also, in order to help conduct heat to the ground plane and away from the LM2853, an array of vias is used to connect the exposed pad to the ground plane, instead of a single via. Finally, the sense pin trace is intentionally routed away from the SW node to minimize any EMI pickup.

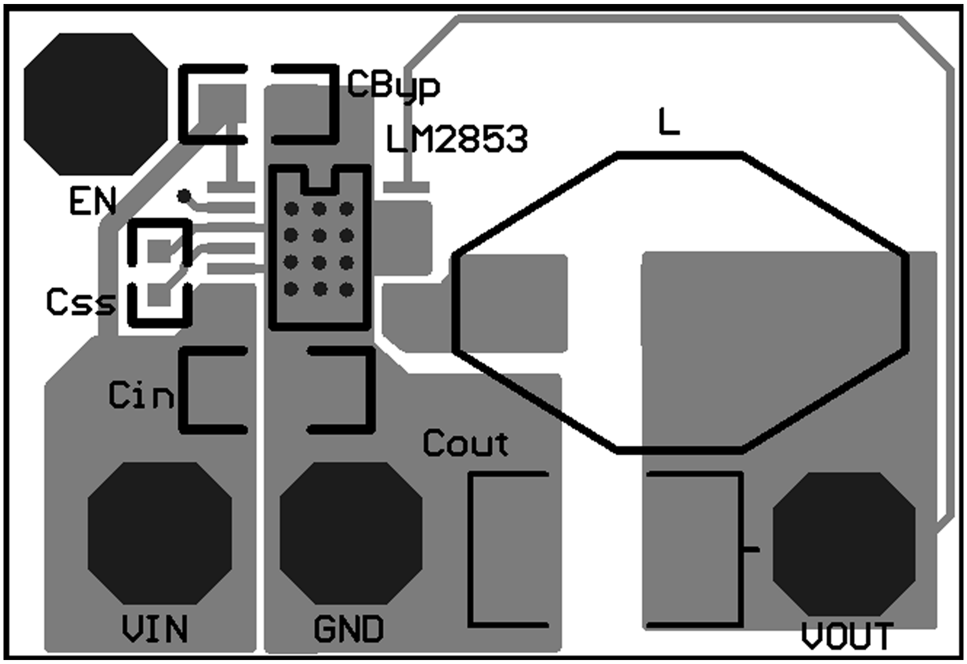


Figure 3. Top Layer (not to scale)

Figure 4. Bottom Layer (not to scale)

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