Simulating the LM2743 N-Channel MOSFET Synchronous Buck Regulator Controller

A buck converter is a DC-to-DC converter that steps down voltage along with providing voltage regulation
This application note is based on the IC part LM2743 datasheet manufactured by Texas Instruments.

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Overview

This application note has:

- A brief overview of the various device operating features
- Details about where to find this model

About the Device

LM2743 is a high-speed synchronous buck regulator controller with an accurate feedback voltage accuracy of ±2%. It can provide simple down conversion to output voltages as low as 0.6 V. The use of adaptive non-overlapping MOSFET gate drivers helps avoid potential shoot-through problems while maintaining high efficiency. The IC is designed for a more cost-effective option of driving only N-channel MOSFETs in both the high-side and low-side positions. It senses the low-side switch voltage drop for providing a simple, adjustable current limit.
The fixed-frequency voltage-mode PWM control architecture is adjustable from 50 kHz to 1 MHz with one external resistor. This wide range of switching frequency gives the power supply designer, the flexibility to make a better trade-off between component size, cost, and efficiency.

The features of this model include:

- An adjustable soft-start
- Switching frequency using an external resistor
- Low-side adjustable current sensing
- Power good flag and shutdown
- Output over-voltage and under-voltage detection
- Power stage input voltage from 1 V to 16 V
- Control stage input voltage from 3 V to 6 V

Where to Find This Model

The symbol for this part is available in the *SYNCH_CNTRL.OLB* library at the following location:
`<INSTALLATION>\TOOLS\CAPTURE\LIBRARY\PSPICE\SYNCH_CNTRL.OLB`

OrCAD Capture and PSpice Design Example

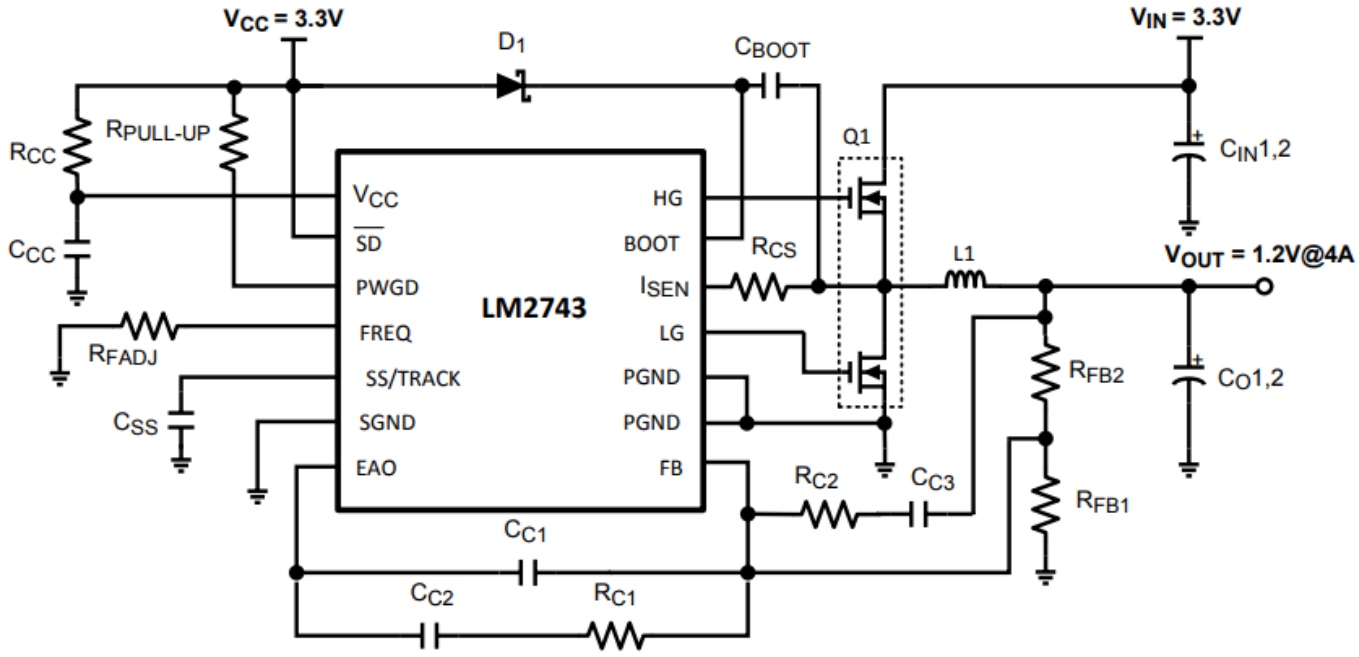

Figure 1 A typical application circuit for LM2743

Startup Operation

Figure 1 shows the typical application circuit diagram for LM2743. It is a synchronous buck topology that is down-converting 5 V to 2.5 V. Select *app_ckt_5_to_2.5-tran* as the simulation profile and simulate the test-bench. Place the probes as seen in Figure 2.

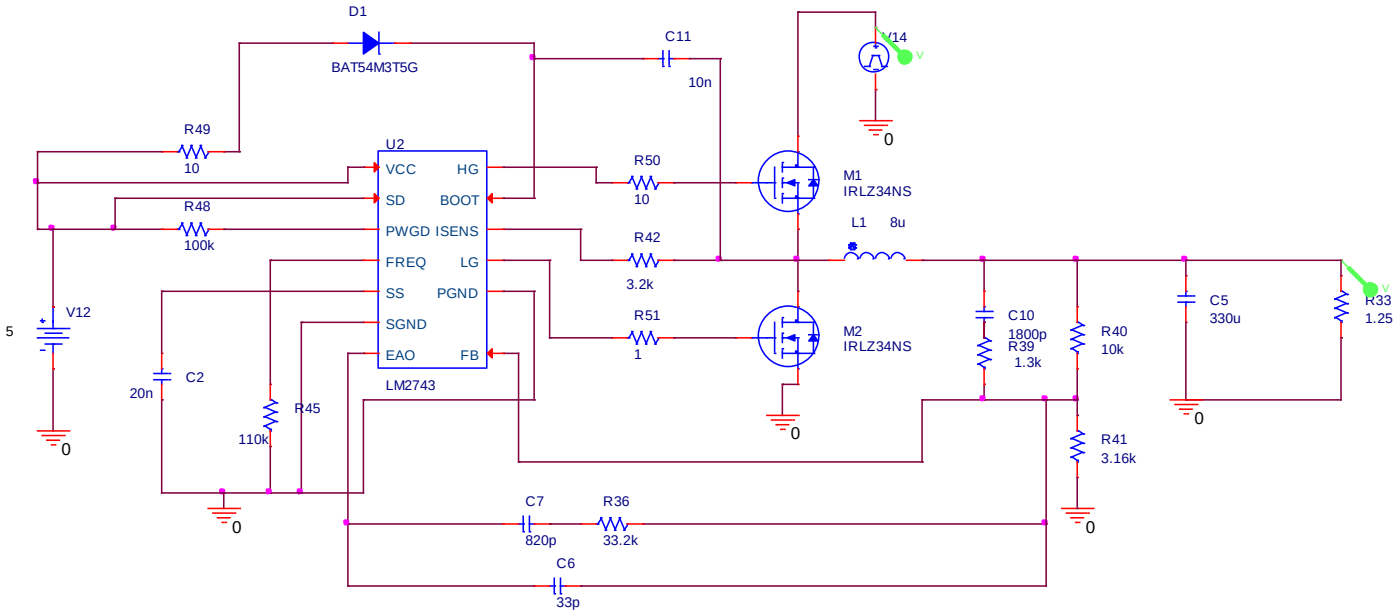

Figure 2 Single-ended mode operation for LM2743

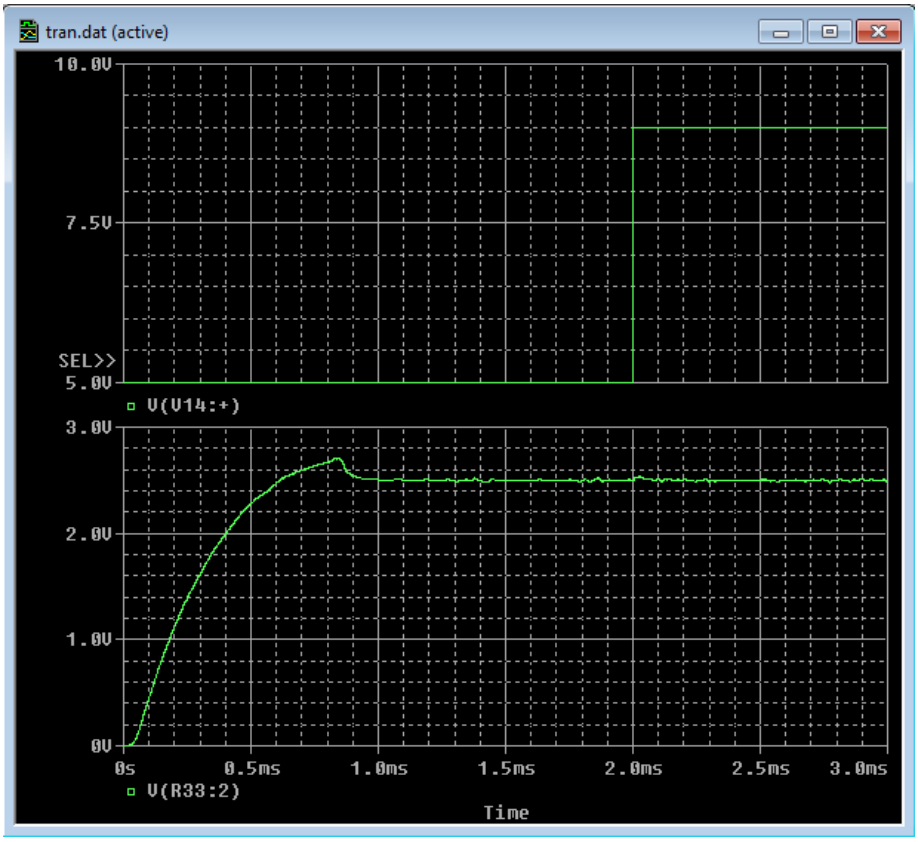

Figure 3: Simulation output for the buck converter

From the simulation shown in Figure 3, you can observe that till 2 ms, the input voltage is 5 V and it is down converted to 2.5 V. After 2 ms the input voltage rises to 9 V, but the output voltage does not change, and remains fixed at 2.5 V, and we observe voltage regulation.

Power Good Operation

In LM2743, a high voltage on PWGD Pin indicates that the input supply to the IC Model is in good state without any over-voltage and under-voltage conditions in the system. It also signifies that from the output side the output voltage is regulated. When the feedback pin voltage is between 72% and 118% of 0.6 V, it indicates that the power is good from the output side.

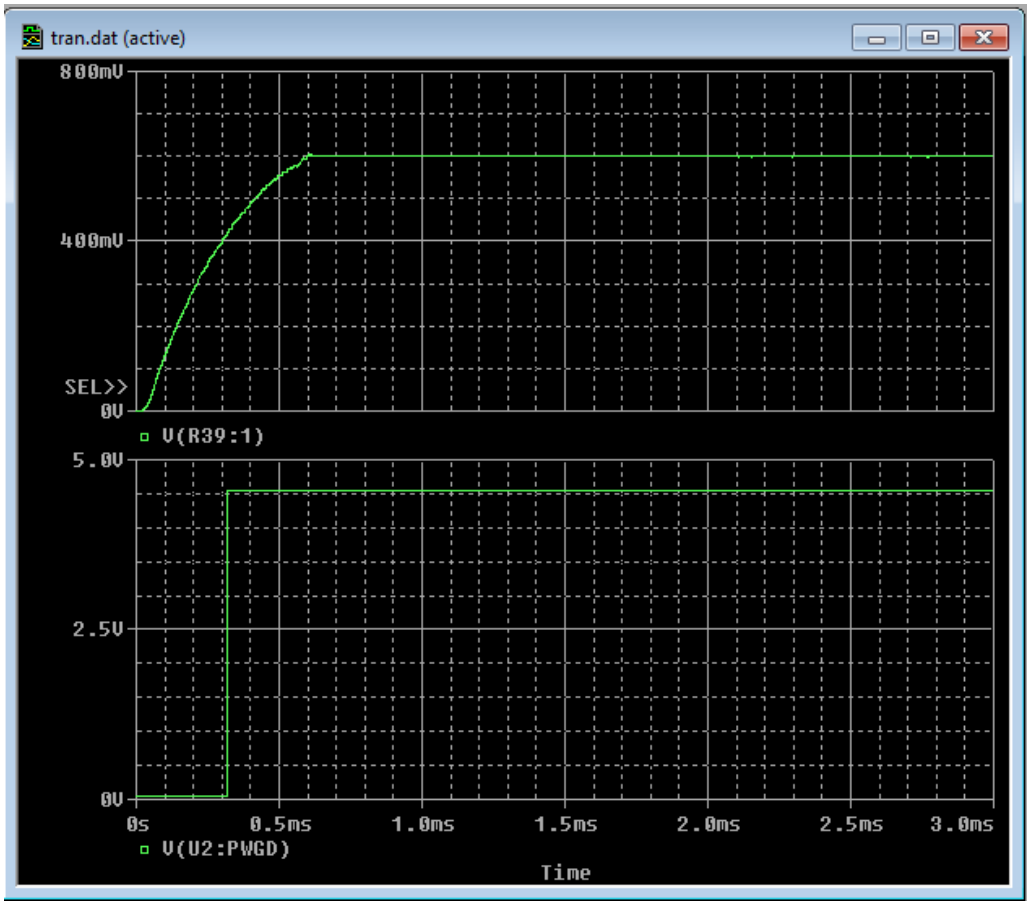

Figure 4 Power good feature operation

Soft-Start Operation

To prevent an overshoot in the output in the initial starting of the model, a soft-start operation is implemented. A soft start of the LM2743 can be adjusted by connecting a cap value at the SS pin. More the cap value, the more time it will take for the output to ramp up. Change the value of capacitor attached to the SS pin to 2 nF and simulate the test-bench. Overlap the two outputs obtained. You will see the output as seen in Figure 5. The green probe is for the SS cap value 20 nF and red probe for 2 nF.

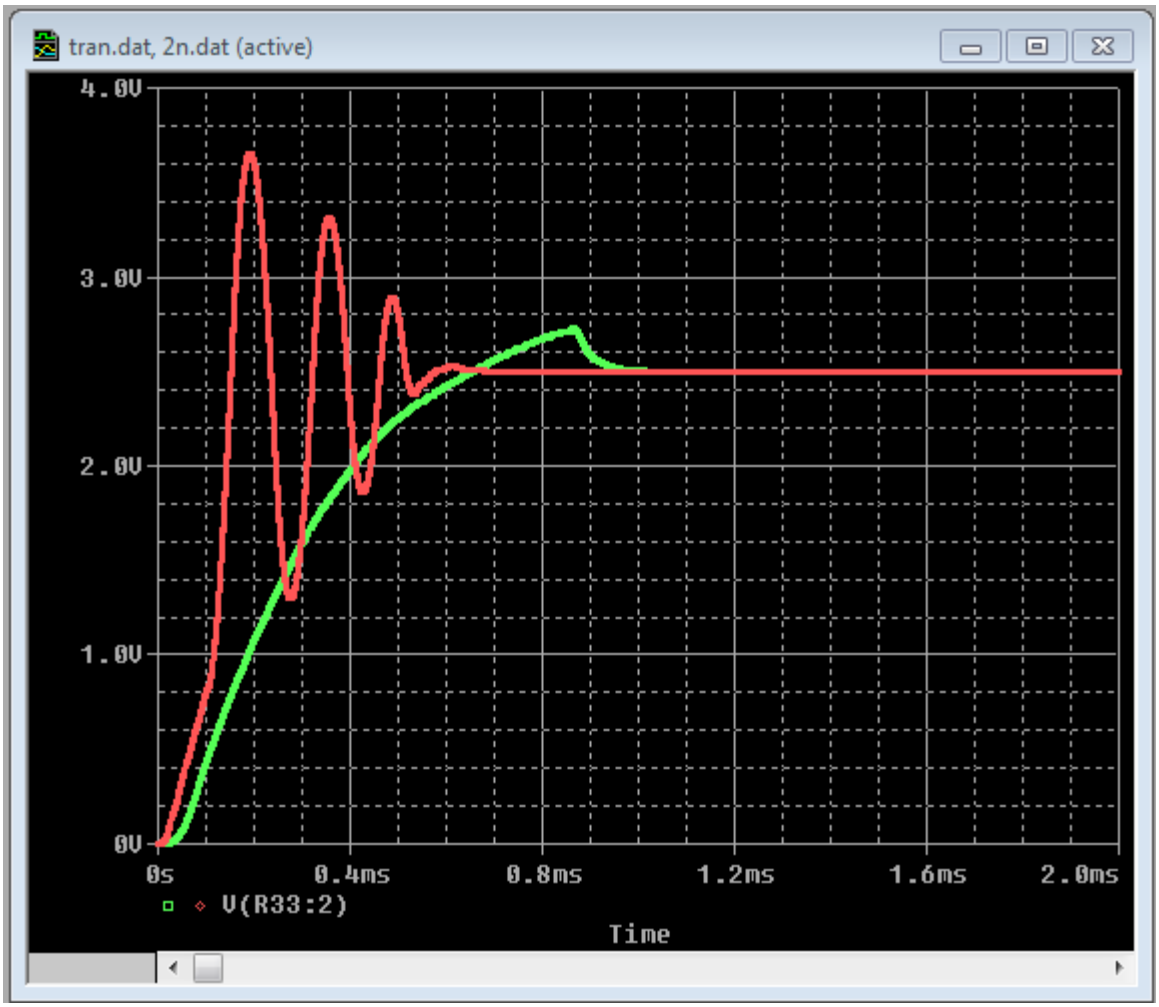

Figure 5 Variation in output caused by soft-start capacitor value changes

Frequency Adjusting Capability

This IC model works within the switching frequency range of 5 kHz to 1 MHz. The frequency value is set by connecting an external resistor to the FREQ pin. The switching frequency to resistor value relation is given by the following equation:

$$R_{FADJ} = -5.93 + 3.06 \frac{10^7}{f_{SW}} + 0.24 \frac{10^{12}}{(f_{SW})^2}$$

From the simulation, currently, the switching frequency observed is 269.86 kHz putting this value in this equation, we get RFADJ= 110 k which is the value specified for R45. Now, change the value of R45 to 80 k and observe that the resultant frequency is 362.65 kHz and this adheres to equation listed.

The next figure shows the waveform that you will see in the simulation and its corresponding frequency on FREQ PIN.

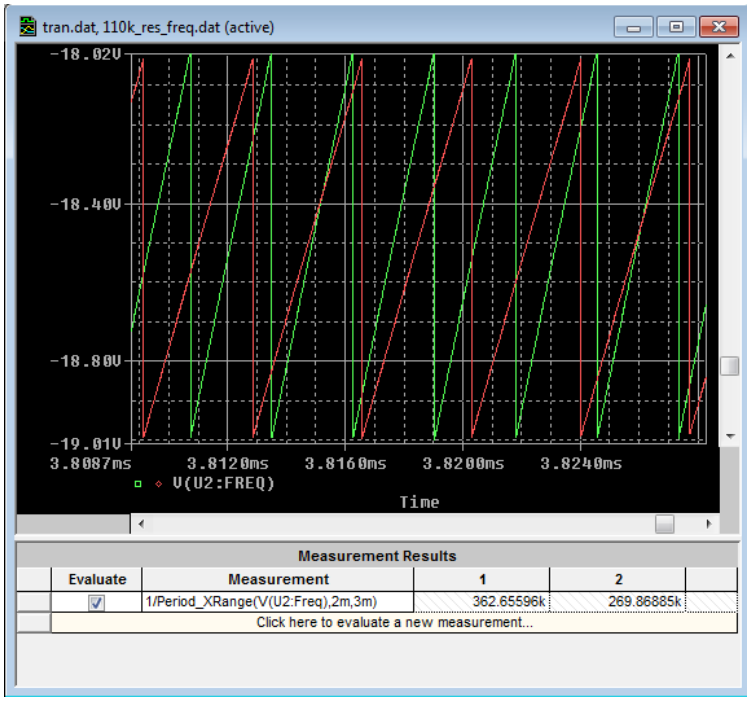

Figure 6 Variation in switching frequency because of the RFADJ resistor

Limitations of Model Implemented in PSpice

The following known limitations exist at this time:

- Some of the typical electrical characteristic values in datasheet might not match the model
- The temperature effects are not modeled

References

This document is based on the LM2743 datasheet.