A Buck DC-DC Converter with LT3991

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Objective:

The aim of this project was to make a DC-DC converter that can take anything between $4V_{DC}$ to $55V_{DC}$ and can produce $5V_{DC}$ output with low power consumption.

Background:

Parameter	Range
Input Voltage (V)	4.3 to 55
Output Voltage Range (V)	1.19V to 30V
Quiescent Current (µA)	2.8
Output Current (A)	Max 1.2
Operating Temp (°C)	–40°C to 125

Table 1 : LT3991 Specifications [1]

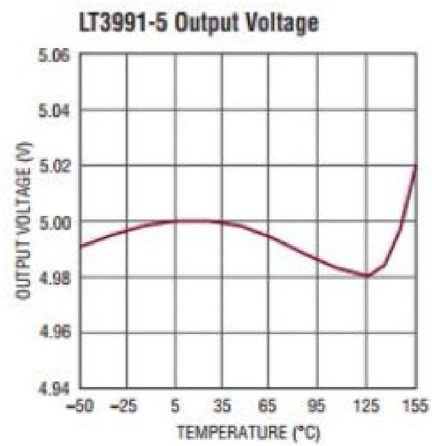

Figure 1 : Temperature v.s. Output Voltage [1]

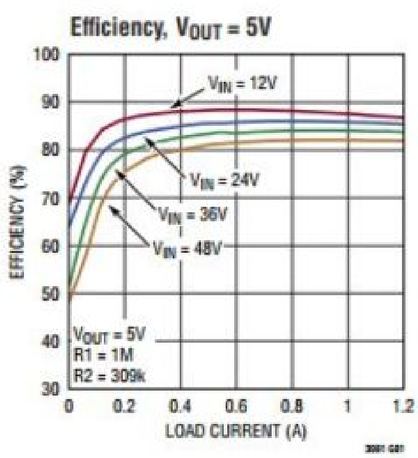

Figure 2 : Load current v.s. Efficiency [1]

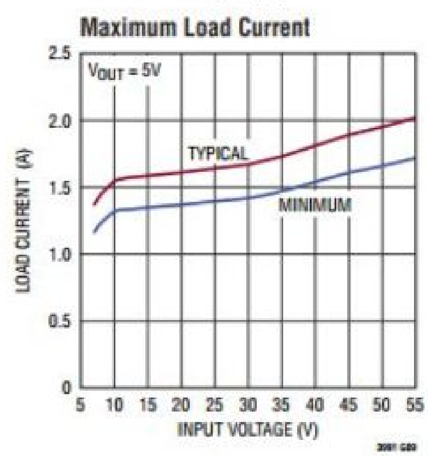

Figure 3 : Load Current v.s. Input Voltage[1]

Project Schematic:

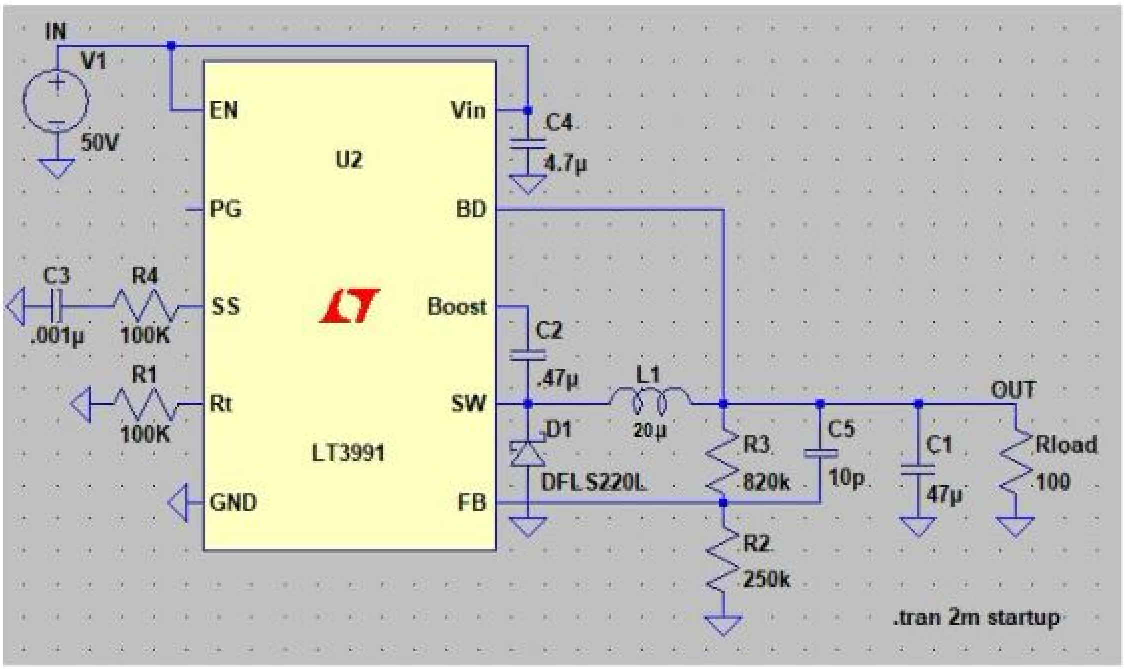

Figure 4 : 5V DC-DC Converter with LT3991 on LTSpice

Data Plots:

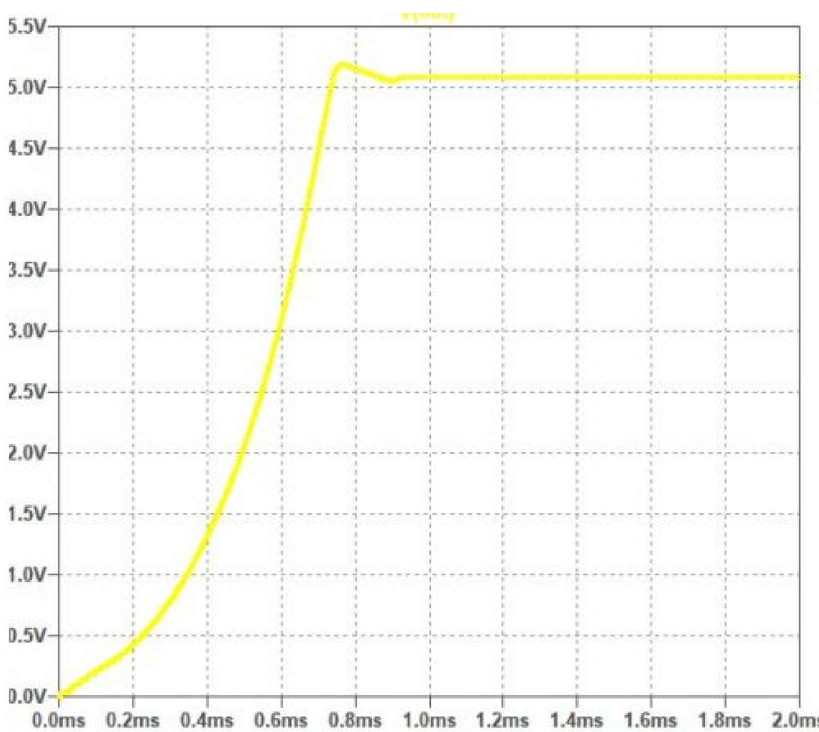

Figure 5 : DC-DC Converter output with V_{in}= 50V and V_{out} = 5V

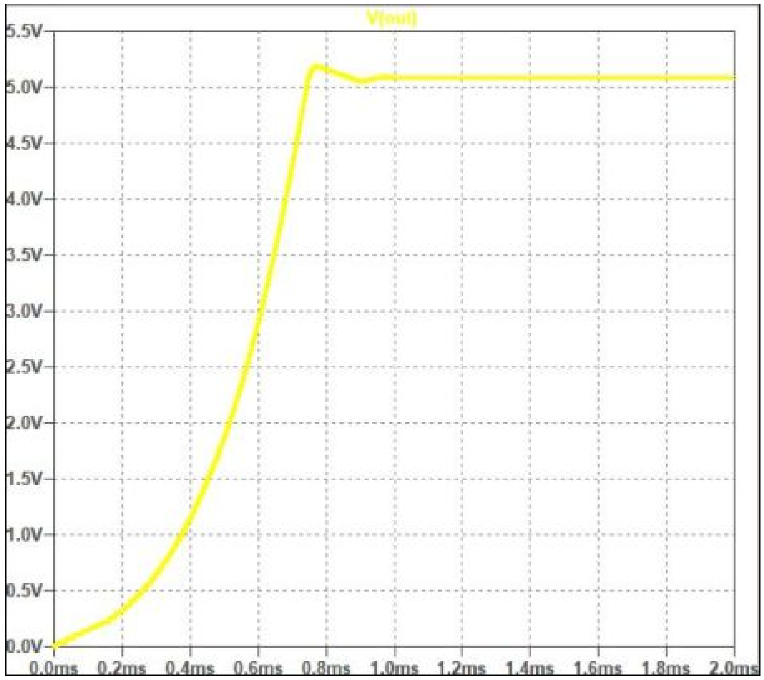

Figure 6 : DC-DC Converter output with V_{in}= 24V and V_{out} = 5V

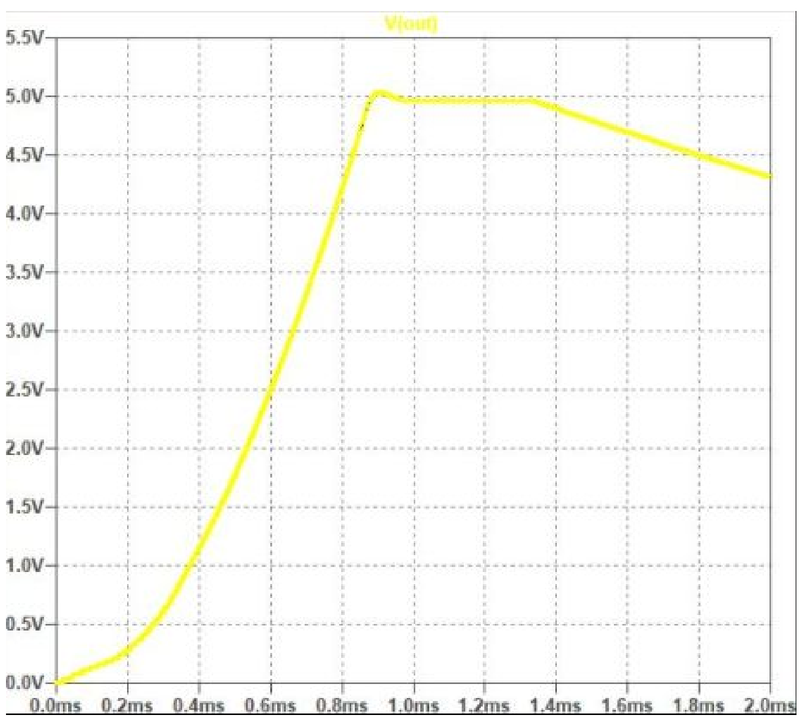

Figure 7 : DC-DC Converter output with V_{in}= 5V and V_{out} = 5V

Conclusion:

One of the main goals of this project is to design a system that has minimum power loss when its working.So linear voltage regulators would not be an option due to their high power dissipation.The output voltage of LT 3991 seemed to be steady between 5℃ and 40℃ and expected to be about 5.00V when set up as shown in Figure 4.Let's look at the extreme cases.When the IC is exposed to -50℃ the output voltage of the regulator is nearly 4.99V.The percentage difference between 5.00V and 5.00V is 0.2%,so this decrease in the output voltage of the regulator was acceptable in this project.The expected input voltage swing would be between 4V to 55V.Using this information we can say that efficiency of LT 3991 expected to be between 70% and 85% depending on the input voltage fed into it and when the load current was between 0A and 0.8A as shown in Figure 2.In Figure 3,maximum load current v.s. input voltage plot of LT3991 is shown.It is not expected to draw more than 1A from the voltage regulator LT 3991,so the need from the regulator was in the range of the limits,from 1A to 1.5A.When this schematic was simulated in LTSpice,with V_{in} = 40V,the output voltage of LT 3991 reached to 5.00V in about 1 ms.When the input voltage of LT 3991 was changed to 24V the output voltage reached to 5.00V in about 0.6 ms again.Let's say,as an extreme case,the input voltage of LT 3991 is 5V,the output reaches to 5.00V in 0.9 ms but falls below 4.5V after 1.4 ms.This means that the input voltage of the buck converter should not be less than 5V in order to get 5V regulated V_{out} from it.The quiescent current of LT 3991 is expected to be 2.8μA when no regulation at all.

References:

[1] *LT3991 Dataseet by Linear Technologies*. [Online]. Available: http://www.analog.com/media/en/technical-documentation/data-sheets/3991fa.pdf.