In the name of wisdom

Power electronic project

Dr.Abbas Ketabi

Amirhossein Shoaraye Nejati

(9521010039)

School of electrical and computer engineering

Kashan university

Winter 2019

Introduction:

A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element: a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).

At first, before start simulation, we have to calculate state equations in ON/OFF mode:

A) if switch= off:

In a way we have:

So we can achieve state equations for two above equations:

While:

B) If switch=on:

While:

After considering state equations in both modes, we will be able to calculate the working point, if we assume zero for input and derivations of states, we will have:

As we know this relation is working for boost converter:

So by considering working point, we assume:

As we learnt in modern control, by this equation we can calculate system transfer function:

In mode: ON, we have:

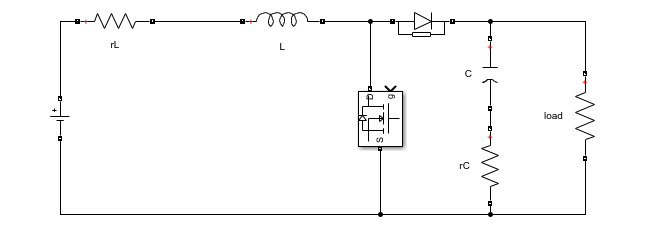
Then, if we use the amounts which mentioned for circuits elements in project statement table:



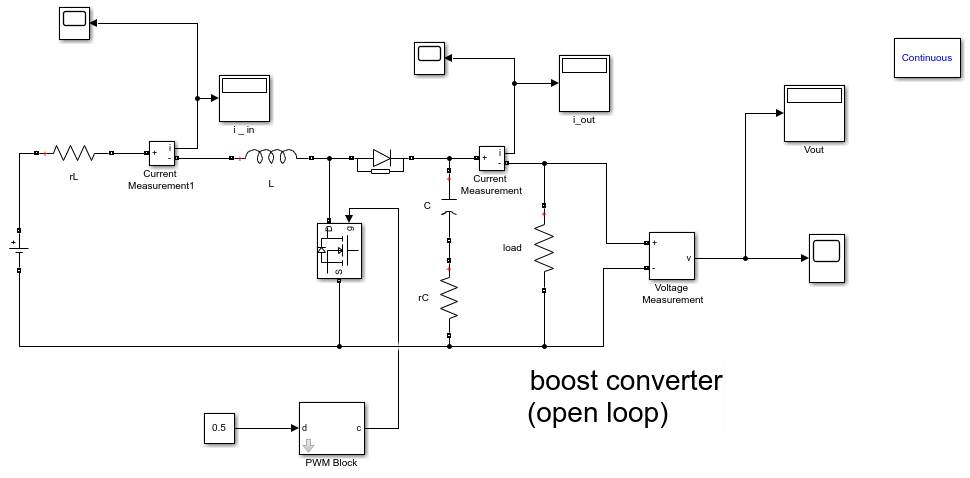
The final transfer function will be:

Also for and , we have:

Now, we have to apply the converter schematic and the amounts we have achieved in MATLAB Simulink:



At first, we create a simple boost converter in which increase voltage without a controller (open loop):

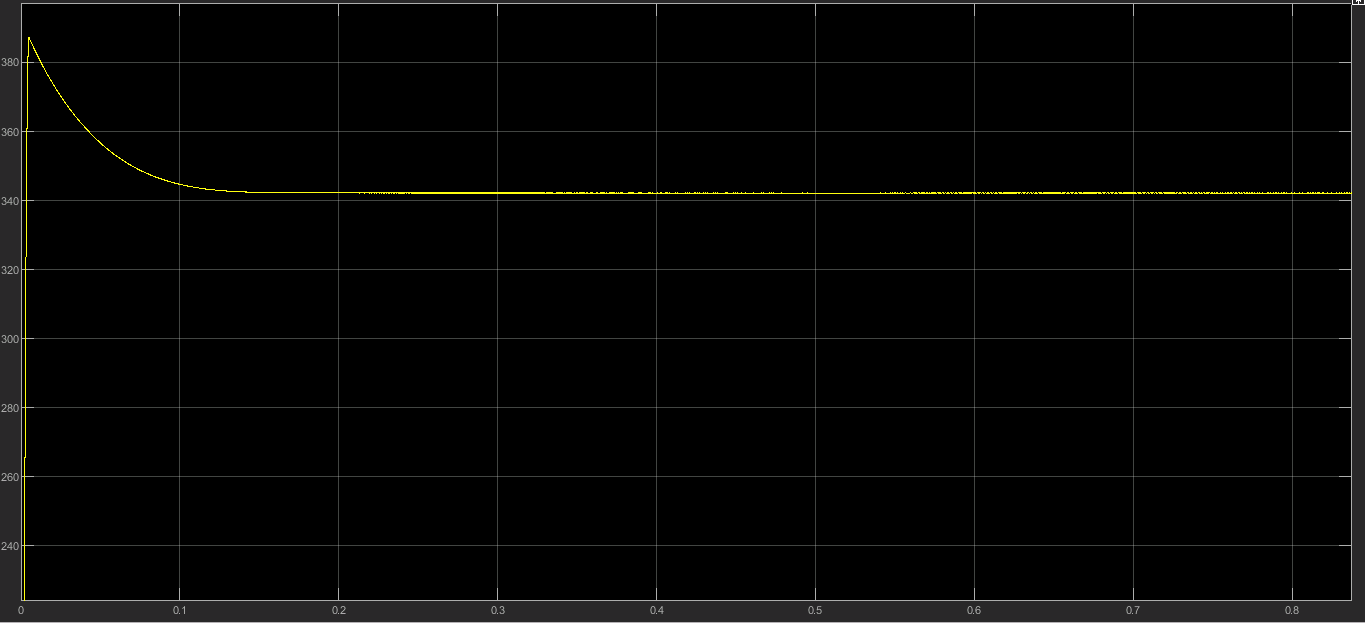


As it is obvious in this model, we only used a PWM block and a duty cycle block in order to trigger the MOSFET switch. Now we can look at input current and output voltage waveforms of this simulation:

A) Input current:

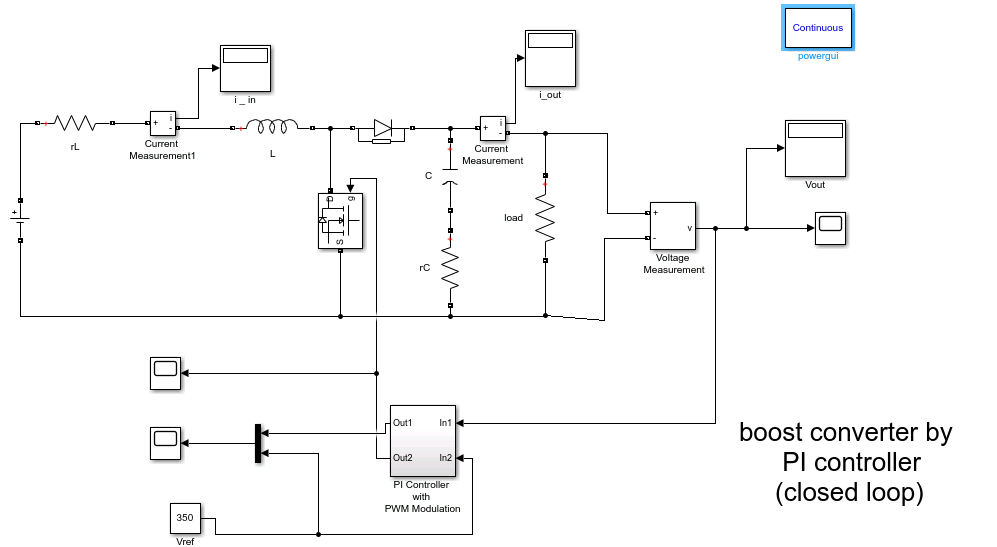


B) Output voltage:

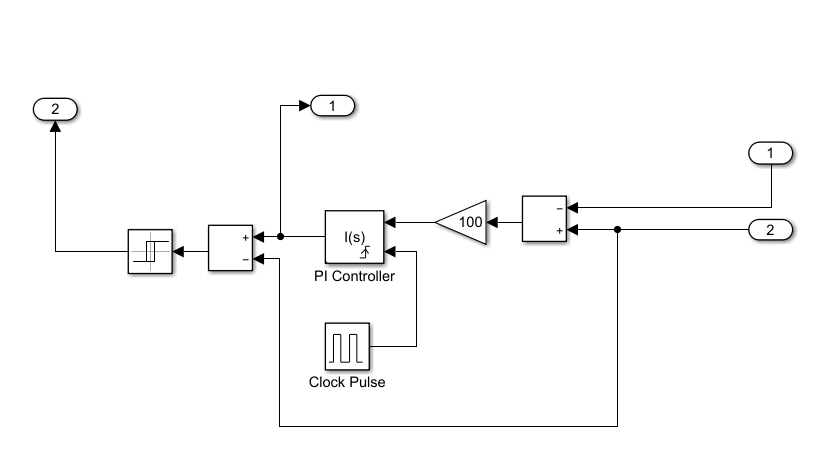


Also the maximum of the output voltage as it can be seen in the previous diagram is about 390 v.

After that, we coupled a designed PI controller to have a better output voltage (closed loop):

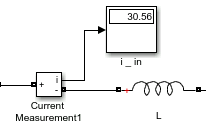


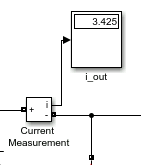
If we take a closer look to the schematic of this controller, it is vivid that we used a PWM generator and a relay in order to make the system follow our voltage reference :( it should be noticed we set clock pulse frequency on 20KHZ)

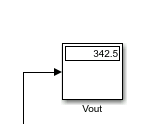


Now we use this circuit as a controller block which act as a feedback from output voltage.

Let’s observe properties of this closed loop model:

A) Input current: B) output current:

   
C) Output voltage:



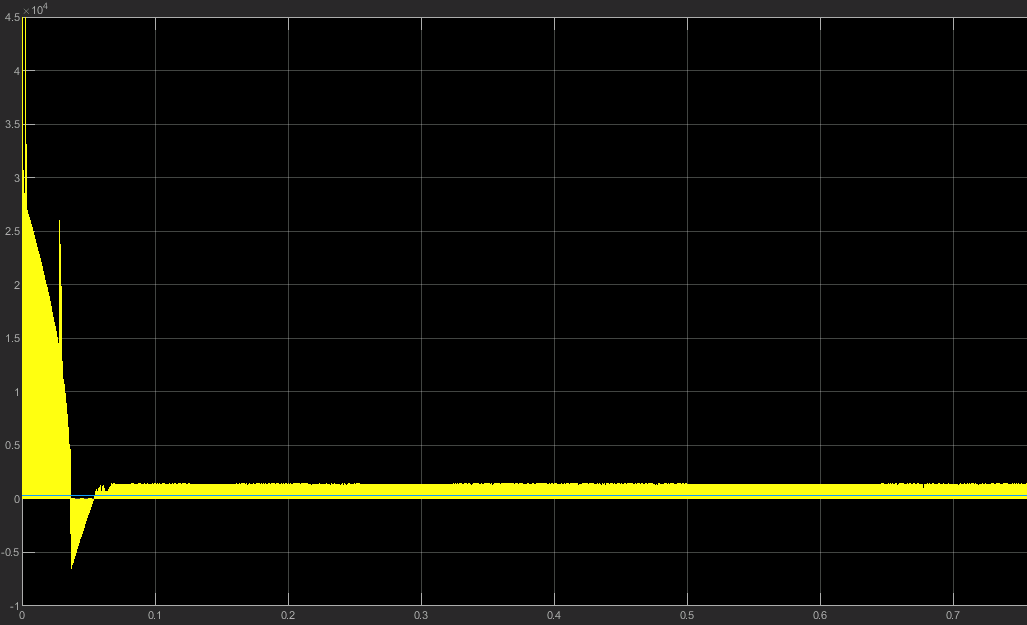
D) Output voltage waveform:



E) Control signal waveform:

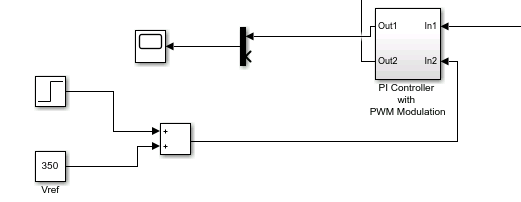


F) PI controller output waveform:

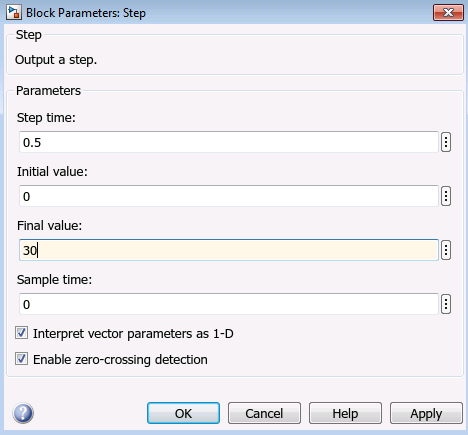


Finally, we want to apply some step changes in input voltage and reference voltage and investigate their effects:

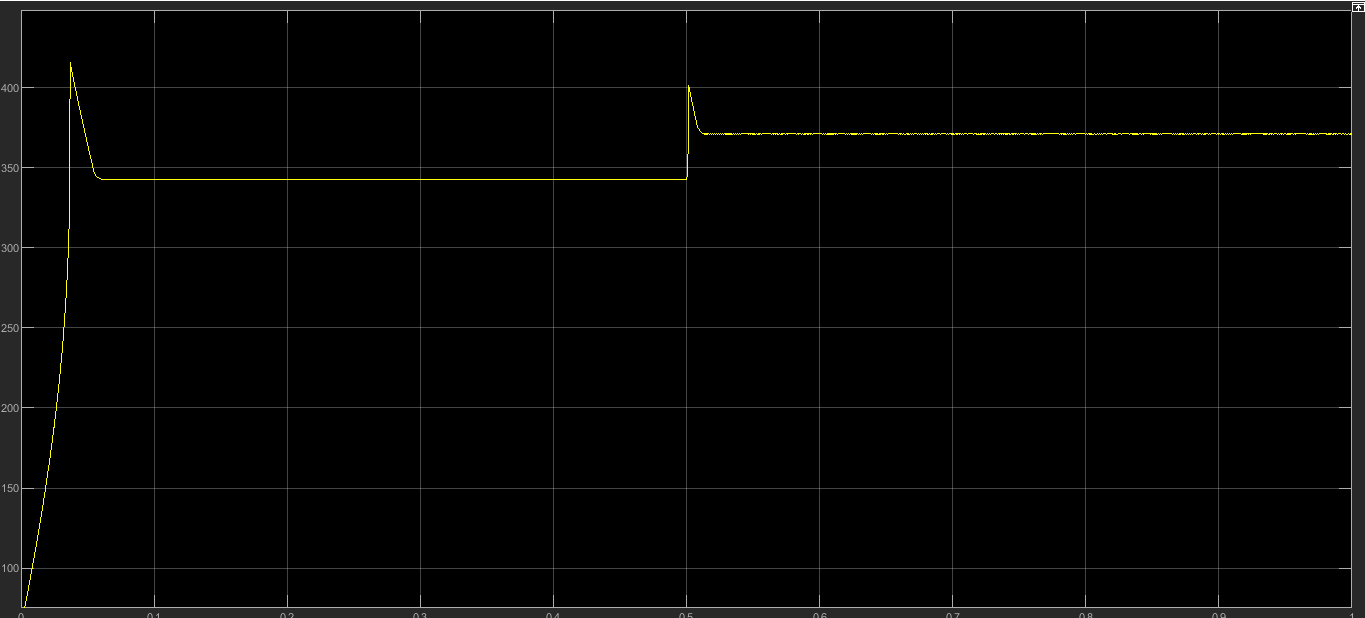
For apply a step change in reference voltage and increase it from 350 to 380v, we have to add a step block and an add block to our model and also tune the step block:



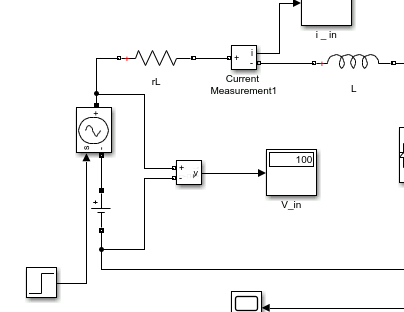
In this study the 30v step change has set on t=0.5s:



And then we can observe this change effect on the output voltage:



At last, at Vref=350, apply 20v step change to input voltage. For this action we used a step block and a controlled voltage source:



Let’s consider its affection on the output voltage waveform:

