Design of an interleaving DC/DC converter :

Given data:

Input voltage = 45-60V

Output Voltage = 3V

Output Current = 100A

Efficiency > 85%

Assumptions:

Switching Frequency = 20KHz

Duty ratio = 0.5

Calculations:

For this design we are using the Forward converter formulas:

Number of Transformer windings:

For Forward Converter,

Output Voltage = Input Voltage * Duty Cycle * (Number of turns of secondary winding /Number of turns of primary turns)

$$Vout = Vin * D* (N2/N1)$$

Let we take input voltage Vin = 60 volt; Output voltage Vout = 3 volt; Duty cycle D= 0.5

$$3 = 60*0.5*(N2/N1)$$

$$N2/N1= 1:10$$

To obtain 3 volt at its output side with 50 % duty cycle, we assumed that the voltage developed across secondary winding should be 6 volt for this, the voltage developed across primary winding would be 60 volt. We know the transformer EMF equation as

$$EMF = 4.44 * Frequency *Main Flux *Number of turns$$

From above equation, we can say that the emf induced in a winding depends upon the number of turns, therefore

$$EMF1/EMF2 = N1/N2 = 60/6 = 10/1$$

To maintain the turns ratio kept constant, we assumed that the turns ratio = 10/1 = 60/6.Let Tertiary winding number of turns should be taken as 60. i.e. Number of turns of primary winding N1 = 60 turns & Number of turns of secondary winding N2 = 6 turns

Turns Ratio i.e. N1/N2 = 10:1 = 60/6

For DC Input & Output,

Output Power Pout = Output voltage * Output current = 3*100 = 300 watt

Output Power (Pout) = 300 watt

All the parameters are set to per unit system. Set the output power equal to 300 watt with fundamental frequency 50 Hz.

V1 = 60 volt ; V2 = 6 volt ; V3 = 60 volt

R1 = R2 = R3 = L1 = L2 = L3 = 0

Transformer is modelled as three ideal winding with magnetizing inductance Lm, which is placed across primary winding, leakage inductance & losses are not included in this simplified transformer model.

Design of Converter Inductance Lx:

inductor plays an important role in this converter as it filters out the ripples present in linear transformer output. Let inductor current ripple should be less than 5%.

Therefore, ∂ILx = 0.05

Now Inductance of Forward converter is same as Buck Converter. Hence,

Lx = Vo *(1-D) /(∂ILx *F)

Lx = 3*(1-0.5) / (0.05 * 100 *10^3)

Lx = 0.3 milli-Henry

Here Inductance of both Inductors are same and it is equal to

Lx = Lx1 = Lx2 = 0.3 mH

Design of Capacitance C:

The main role of capacitor is to maintain the voltage across load kept constant. The capacitance of the capacitor for Forward converter formula is also same for conventional Buck converter and is given by

Cout = (1-D) / (8*F*F*Lx*(∂Vo/Vo)

Let the output voltage ripple should be less than 1%.

Therefore, (∂Vo/Vo) = 0.01

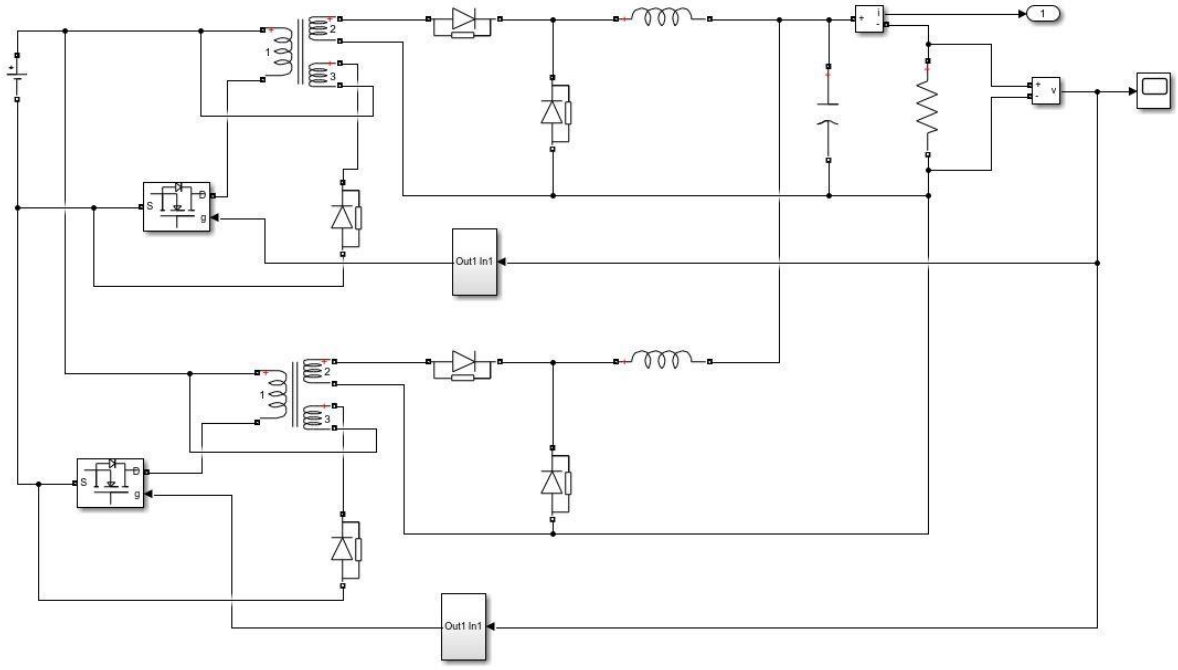
Cout = (1-0.5) /(8*100*100*10^6*0.01)

Cout = 2.08 * 10^-6 Farad = 2 micro-Farad

Cout = 2 uF

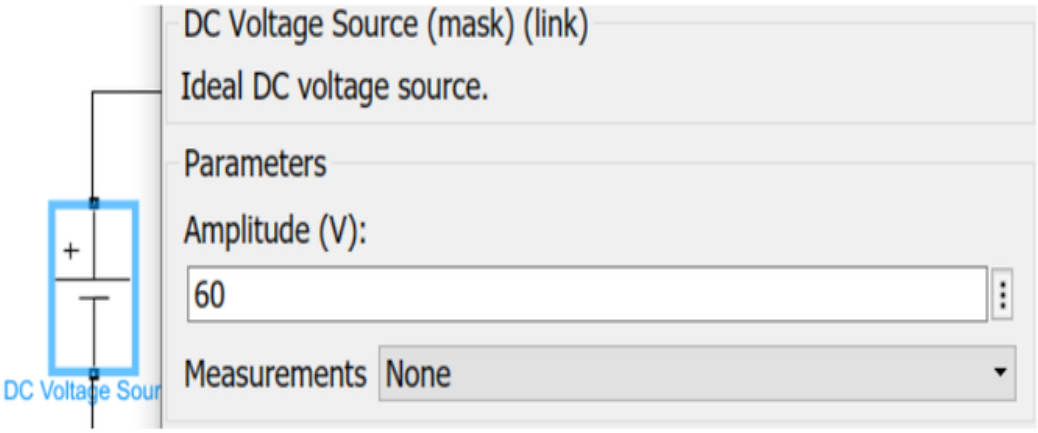
By parallelling the converters the input current can be shared among inductors so that high reliability and efficiency in power electronic systems can be obtained. In this paper, interleaved buck dc-dc converter is simulated using matlab/Simulink software. The converters are tested by varying the in/out voltage with a constant duty cycle in continuous conduction mode. The performance parameters of the converters are compared. The converters are controlled by interleaved switching signals, which have the same switching frequency but the shift in phase. Using interleaved converter we can get improved efficiency, reduced ripple voltage, reduced inductor current ripple, fast switching speed.

As for high efficiency we used multiphase system to increase the efficiency

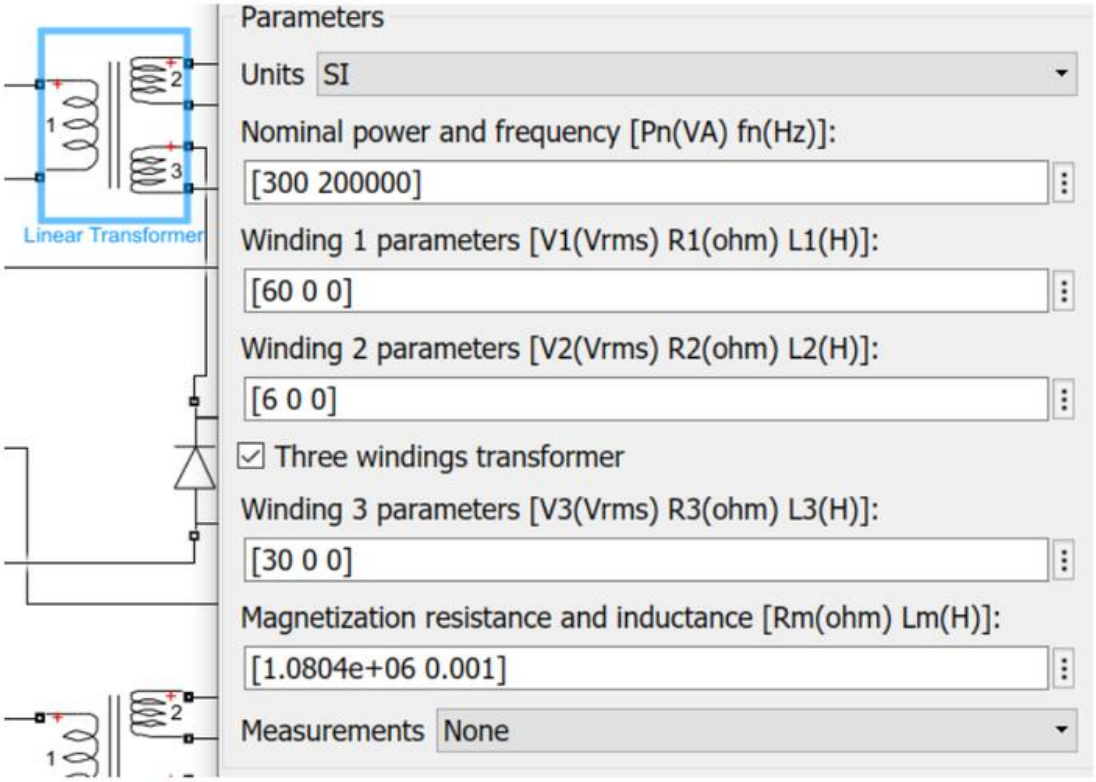


In this model we are using the following parameters which we calculated.

1) Input Voltage:

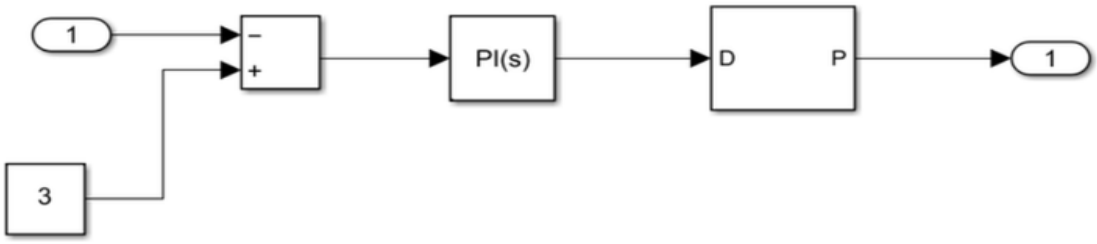


2)Transformer Capacity:

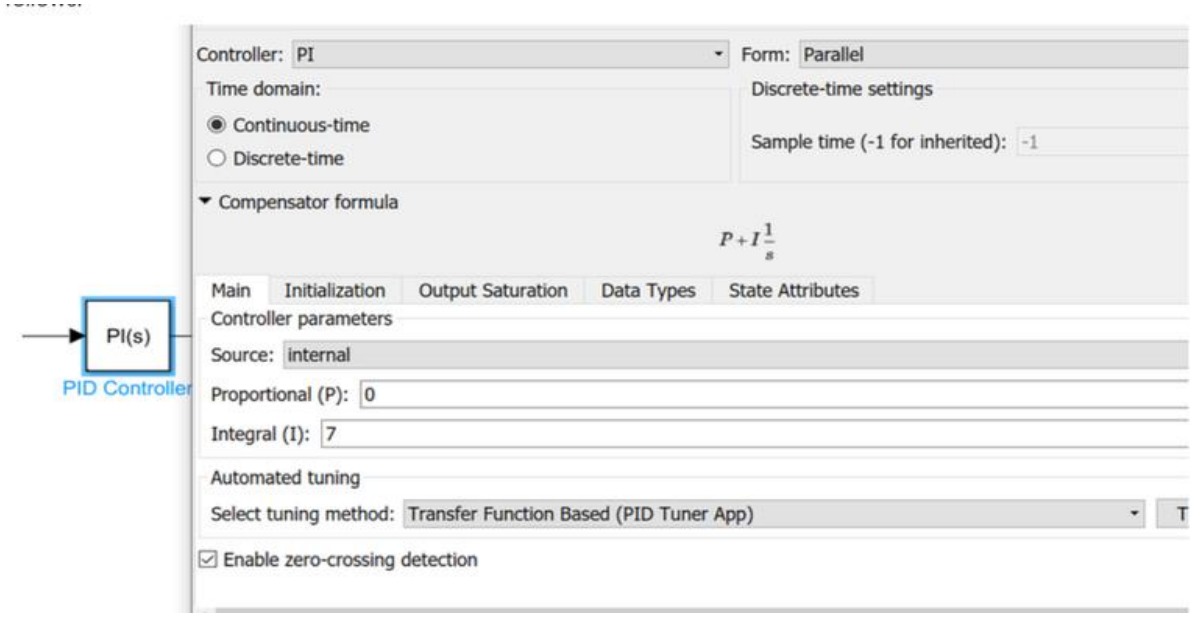


3) Output Load:

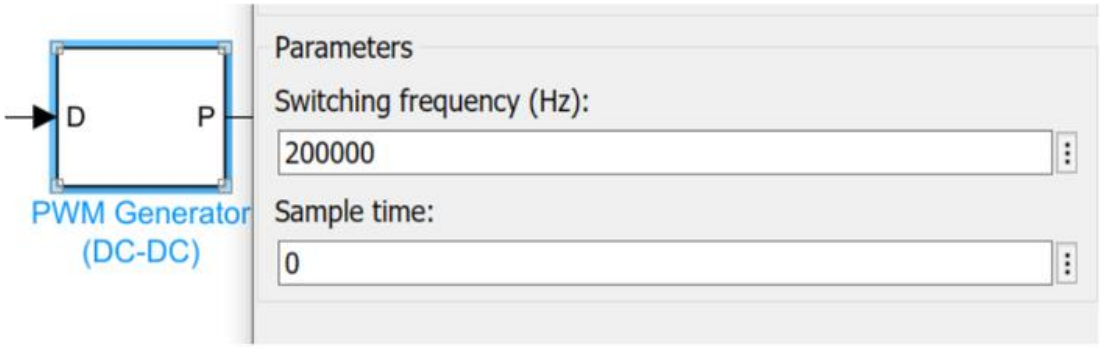
4) Gate Pulse:



As we required the 3V so we were given the reference as the constant 3 and PID get the tuned so PID value are as follows:

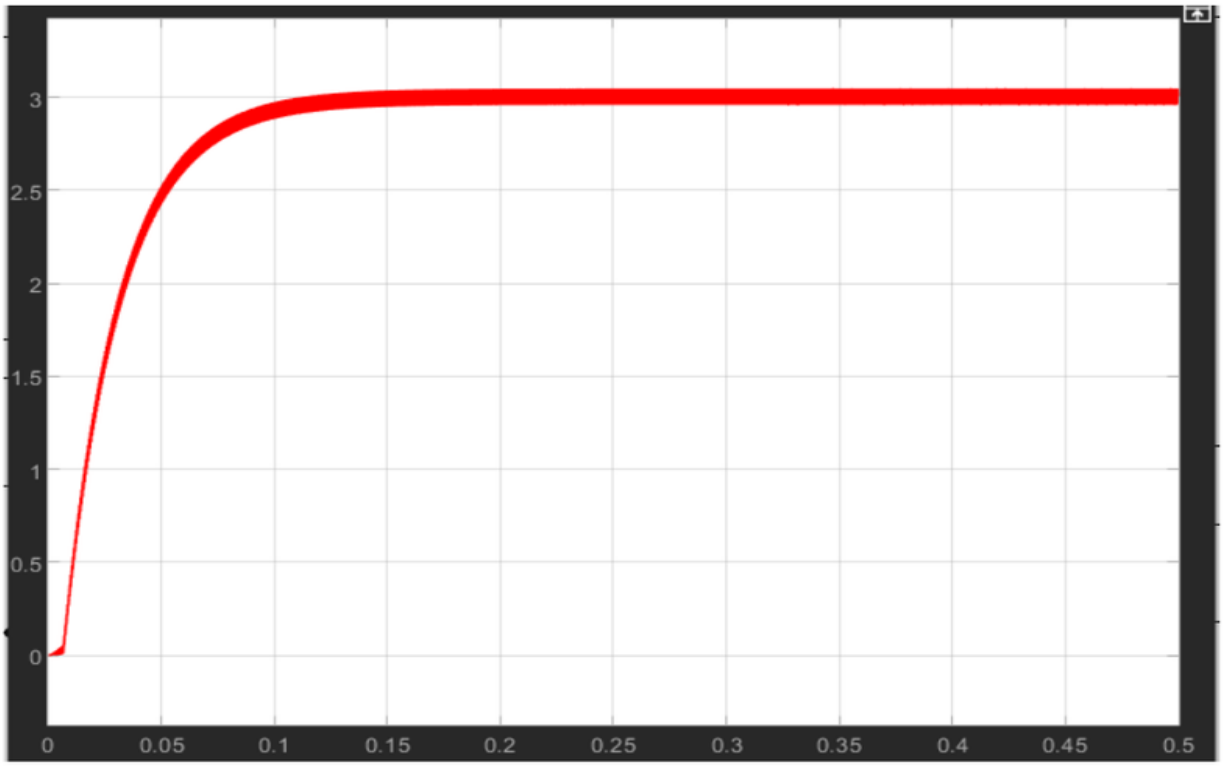


The frequency is chosen is 20000hz:



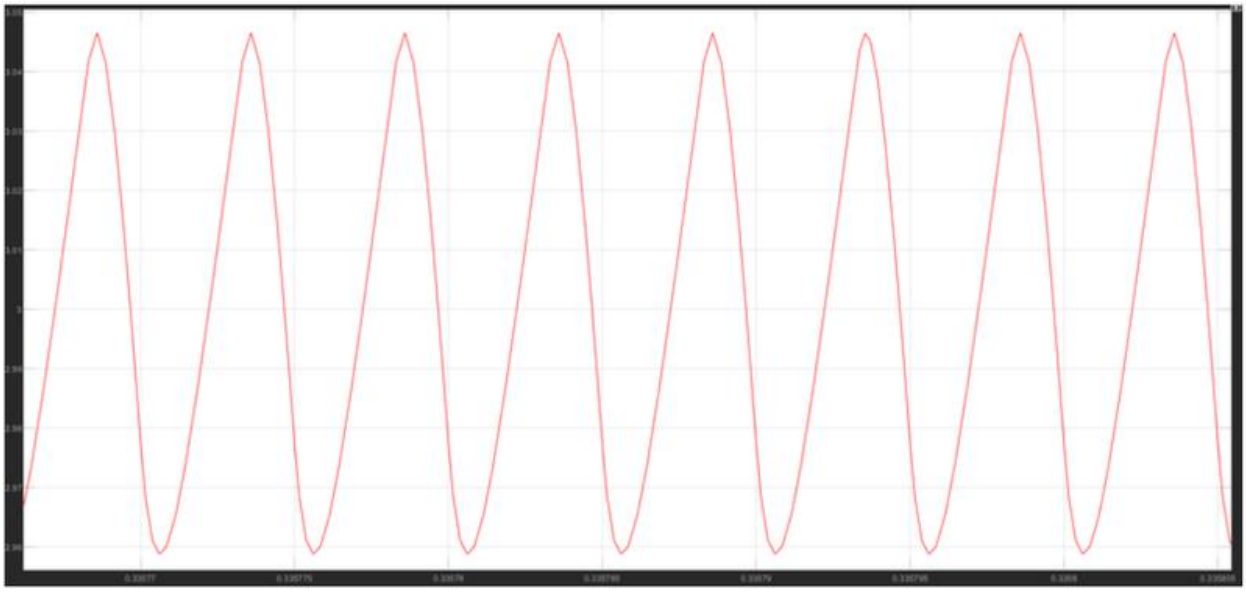
Now we run the model for 0.5 sec and get all outputs:

Output Voltage:



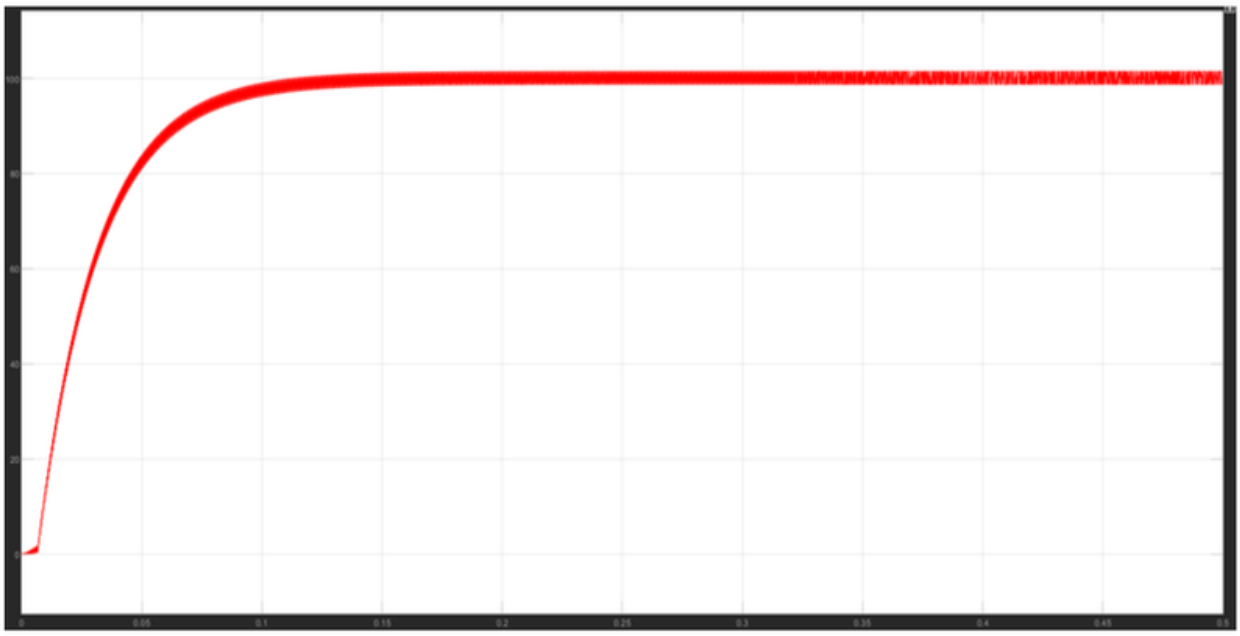
As we output voltage is getting 3 Volt same as we required with some ripples and ripple also same as we calculated which is shown in the following graph.

The ripple of output voltage:



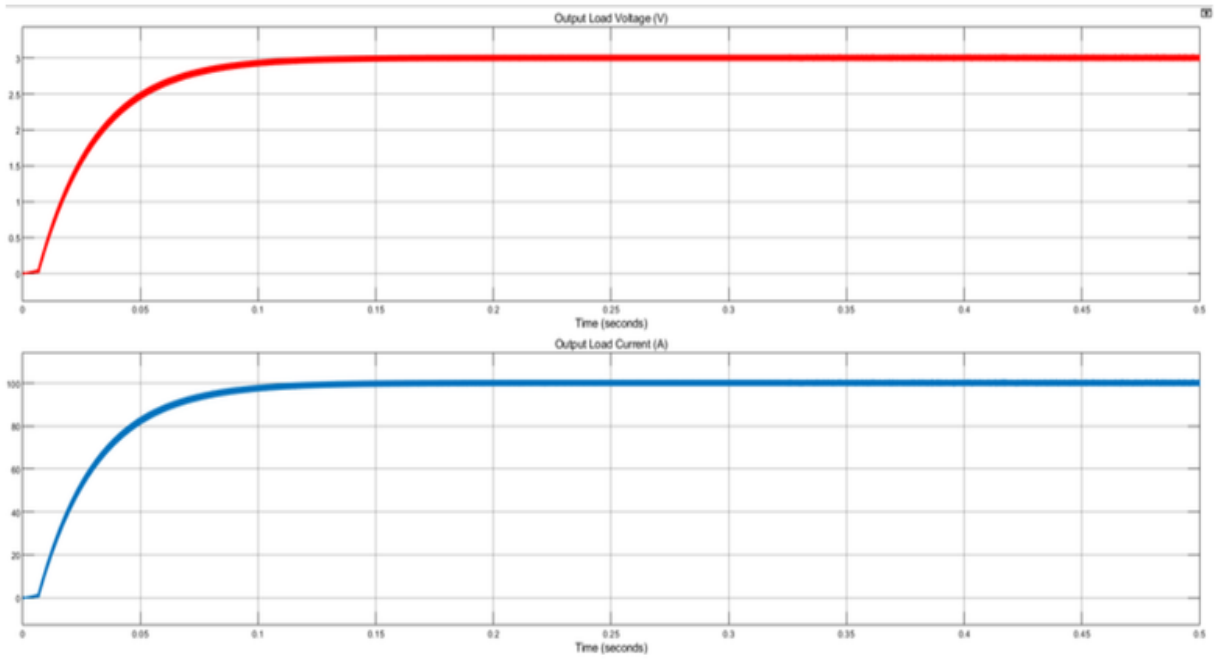
Output Current:

Current is 100A this is because of the isolated system

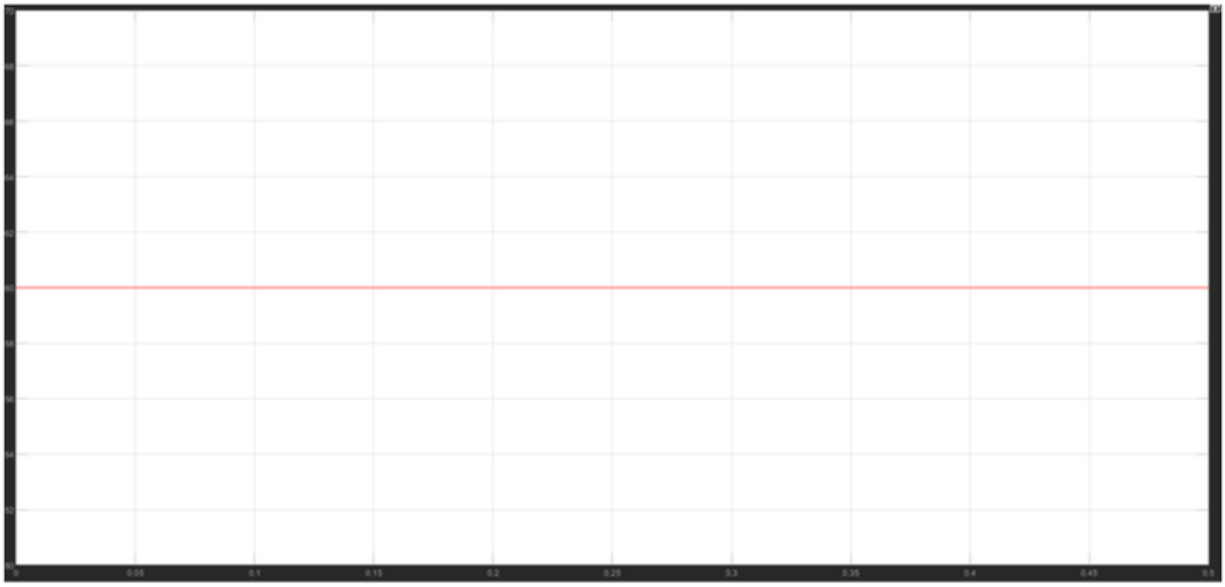


and multiphase system getting the perfect as same as requirements:

Output voltage and current:

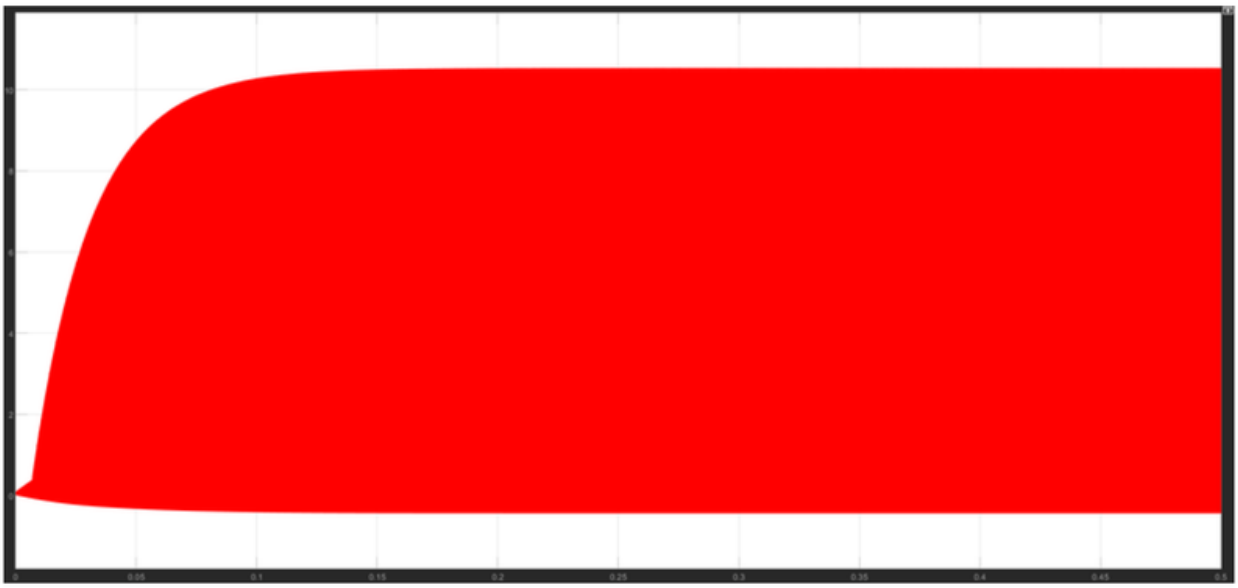


Input Voltage:

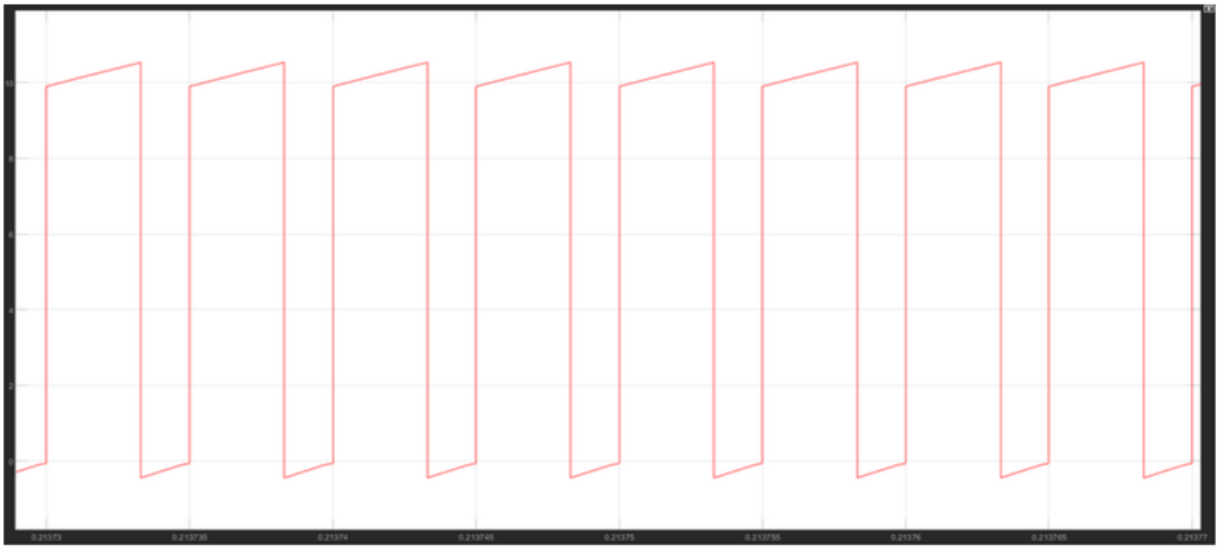


As our input voltage is 60 V given the converter.

Input current:

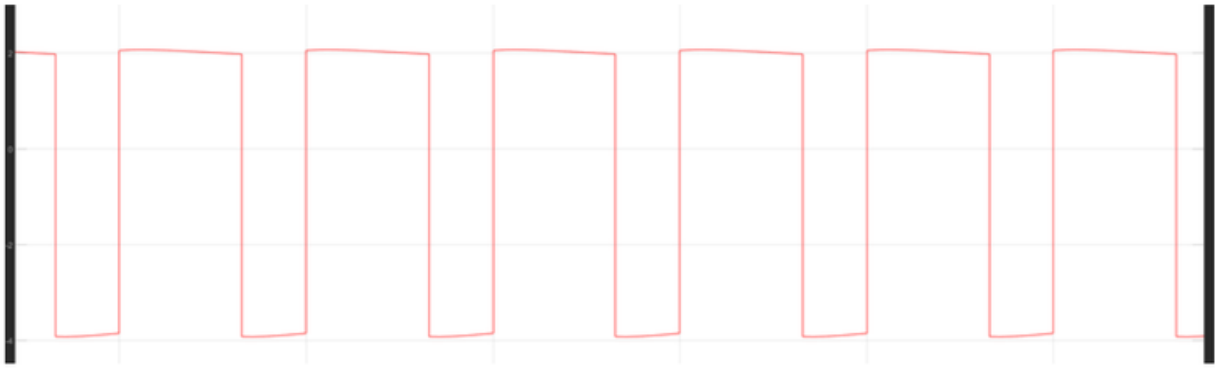


Because of switching action of MOSFET input current is looking like this if Zoom it, it will look like step voltage which is shown in the following graph



The current amplitude is max is 10volt and the minimum voltage is near to zero so as calculate the average value then ware getting 4.7A approximately.

Inductor Voltage:



Voltage is as plus and magnitude are 2V and -4V.

1. The main aim is to get the efficiency as higher as possible and as you see in our requirement are getting approximately same.

so we can say that our efficiency is above/more than 90%.

1. As efficiency is calculated from output power/input power so as we calculated for this converter as following:

Input Voltage = 60V

Input Current = 5A

Output Voltage = 3V

Output Current = 100A
from all the above data we get the input power is 300w and output power is also 300W

So our efficiency of 100% without considering the ripple in voltage and current, if we consider the ripple in voltage and current, if we consider the ripple also we can get the efficiency more than 90%.

Conclusion:

Those we designed the DC/DC converter the given data and get the required output with more than 90% efficiency.