SIMULATION RESULTS

There are two different simulations for R load and RL load; that is, motor. Initially, simulations are observed for R load because practically R load tests are tried before motor tests. In the laboratory, R loads are durable for 3 A so Input peak voltage is 80 V line to line and output current is nearly 3 A at the simulations. Also, duty cycle is 0.7. Also, R is 17.7Ω because in the laboratory, each resistors are 50 Ω and maximum current can be obtained if each load are tied parallel.

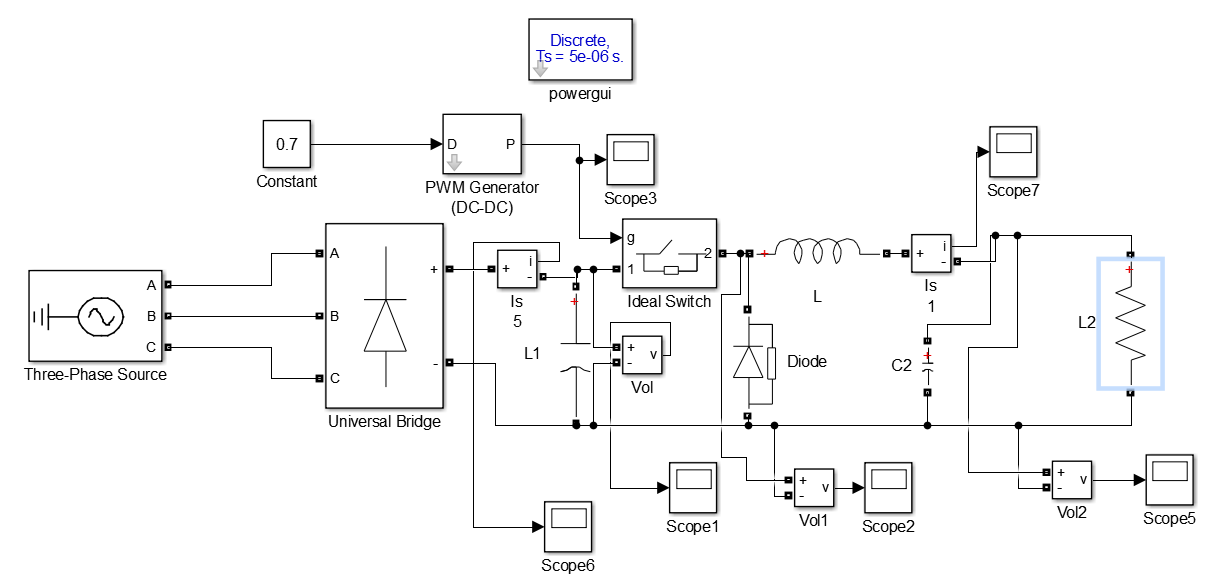


Figure 1: Circuit Schematic with R Load (Without Gate Driver)

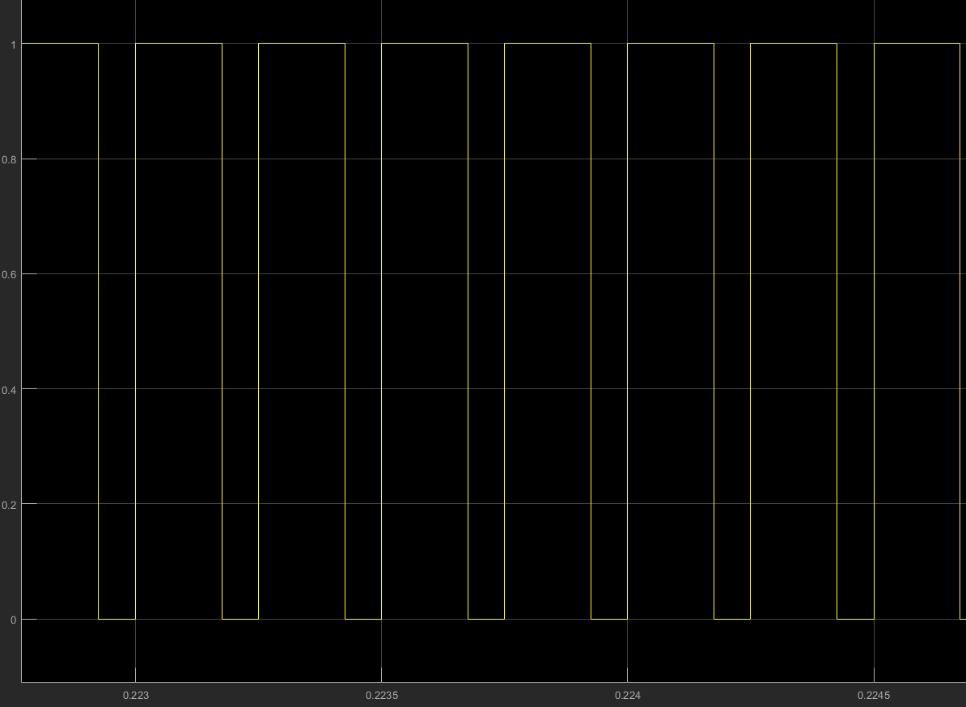


Figure 2: Duty Cycle is 0.7

Duty cycle is 0.7 for all simulation results.



Figure 3: Input Voltage for R load

Input line to line voltage is 80 Vpeak at the simulations for R load.

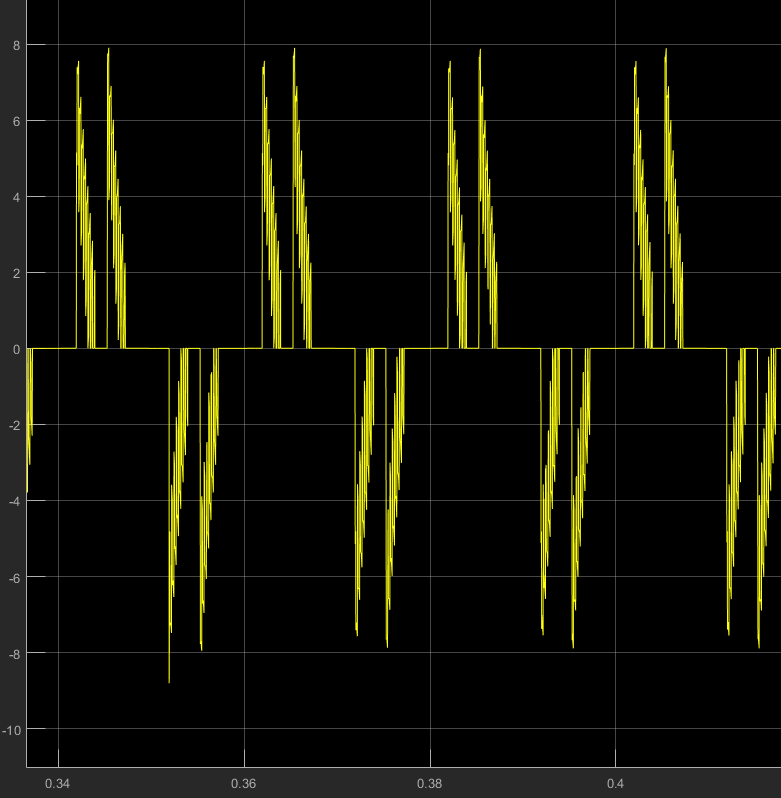


Figure 4: Input Current for R load

There is a capacitor for filtering after three phase diode rectifier. Therefore capacitor try to charge and input current is observed as Figure 4. If there were not a capacitor, third harmonics would disappear and waveform would be similar to sinusoid wave except third harmonics.

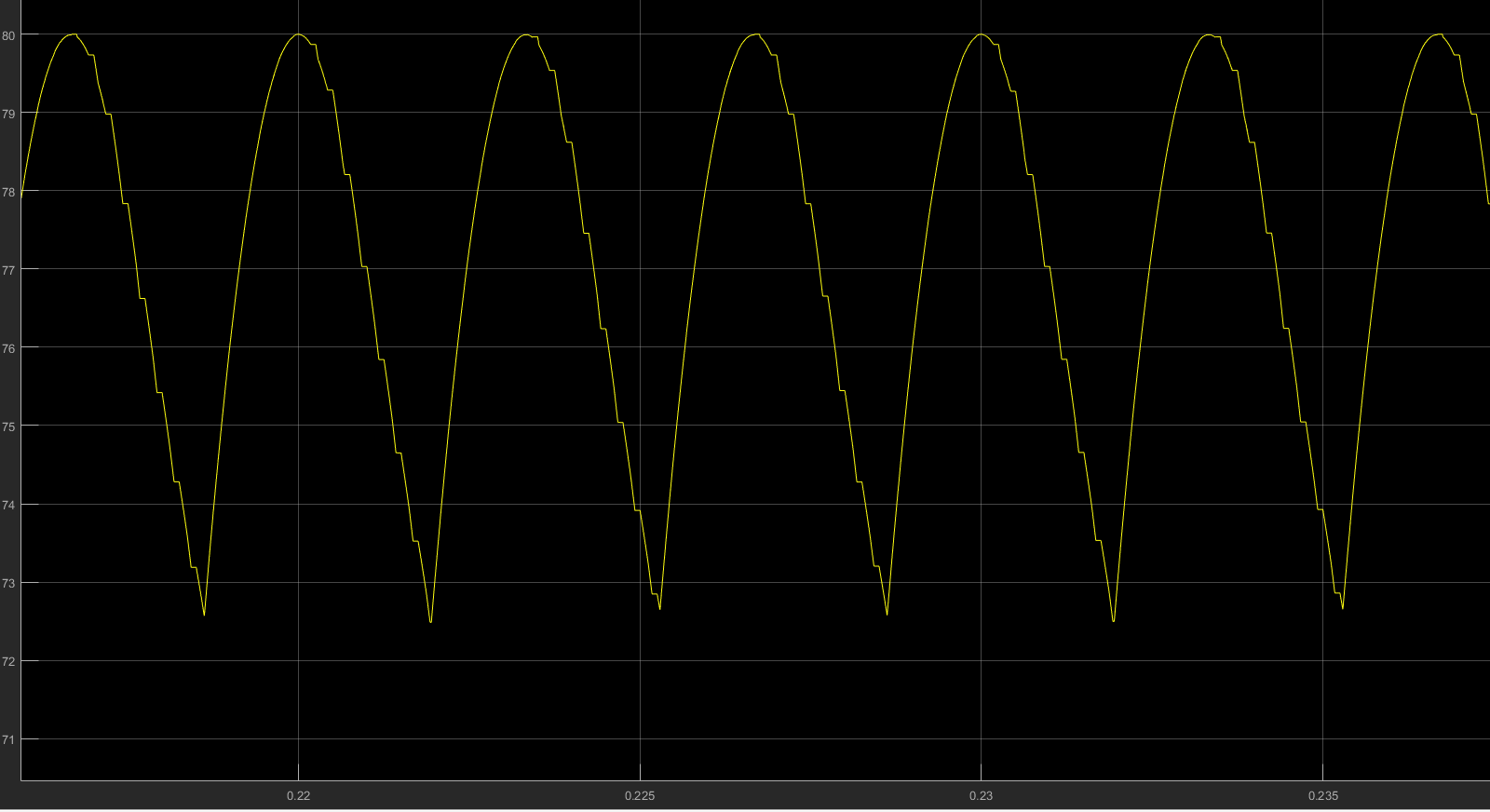


Figure 5: Output of Three Phase Diode Rectifier with 470 uF Capacitor Filter

There is output voltage of three phase diode rectifier at Figure 5. Output voltage have 6 pulse waveform and the frequency is 300 Hz. Also, output ripple is between 73 and 80 V so ripple is 7 V. If there were not a capacitor for filtering, output ripple of three phase diode rectifier would be 11 V.

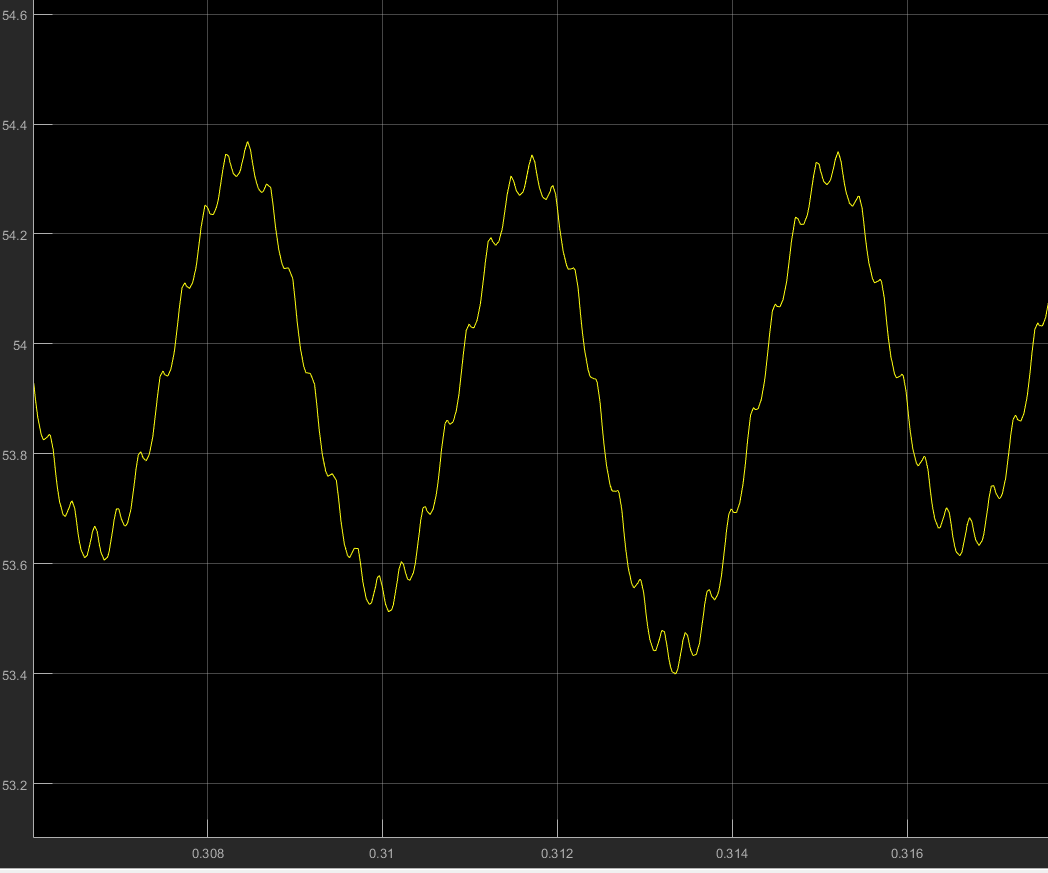


Figure 6: Output Voltage for R Load

After the output of the three phase diode rectifier, buck converter is used and output voltage ripple is observed as Figure 6 from the simulation. At the buck converter side 680 uF capacitor and 2.8 mH inductor are used and ripple is nearly 1 V. If capacitor value is increased, the ripple will decrease.

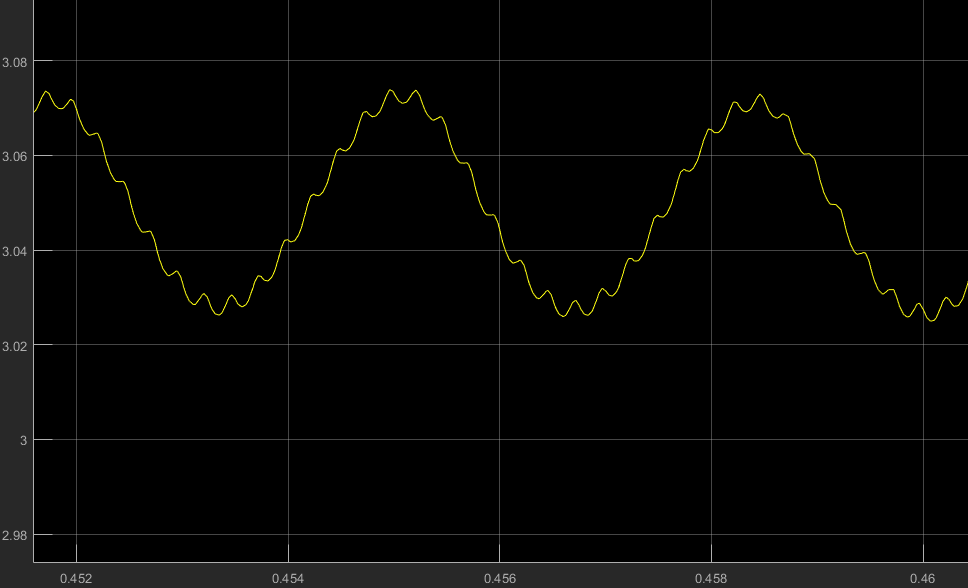


Figure 7: Output Current for R Load

There is an R load so Output current and output voltage have similar waveform because

Therefore, output ripple has almost DC characteristic and ripple is decreased if capacitance is increased.

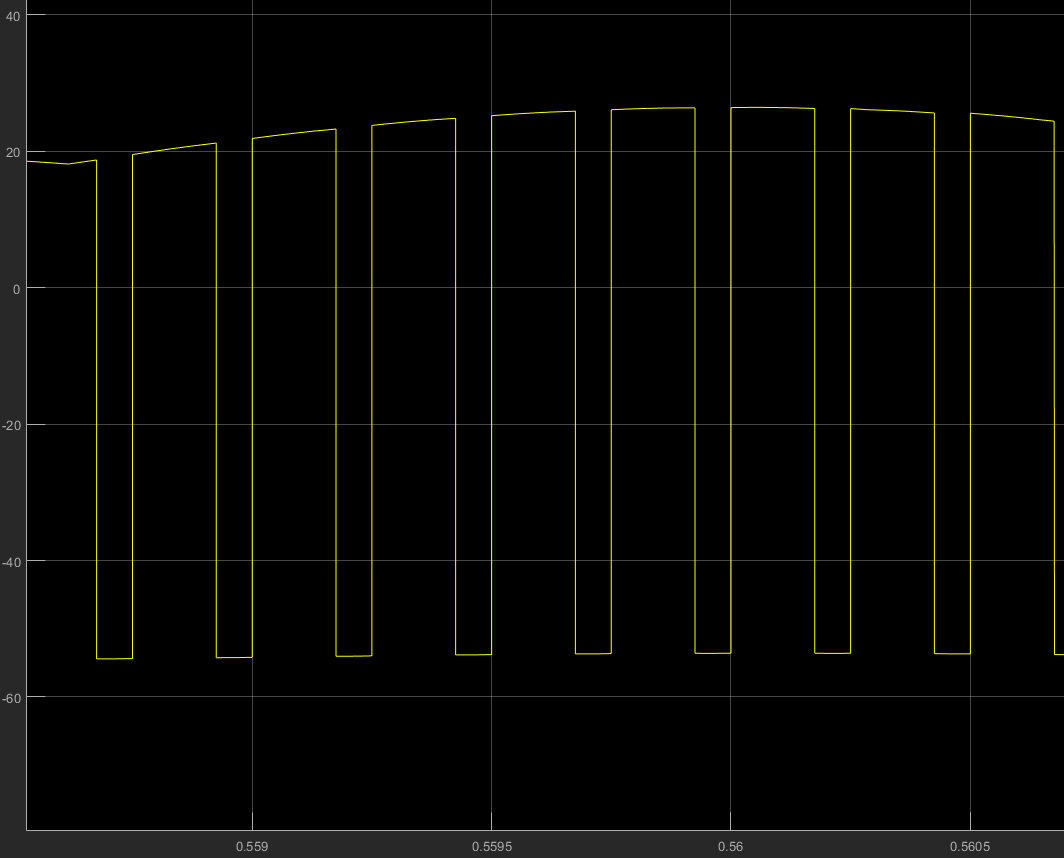


Figure 8: Inductor Voltage for R load

Inductor voltage has Vd-Vo value for switch ON state and it has –Vo value for switch OFF state. Also, continuous conduction mode is observed from the simulation for 4 kHz switching frequency.

Secondly, Simulations are done for motor load. To do this, motors parameters are determined as

* Armature Winding: 28 Ω, 13.3 mH
* Series Winding: 65 mΩ, 260 uH
* Shunt Winding: 8.26 kΩ, 6.4 H
* [Interpoles](https://www.quora.com/Electrical-Machines-What-do-interpoles-do-in-DC-motors) Winding: 0.8 Ω, 5.8 mH

Duty cycle is again 0.7 and output voltage is nearly 220 V at this part. Threfore input line to line voltage is nearly 320Vpeak.

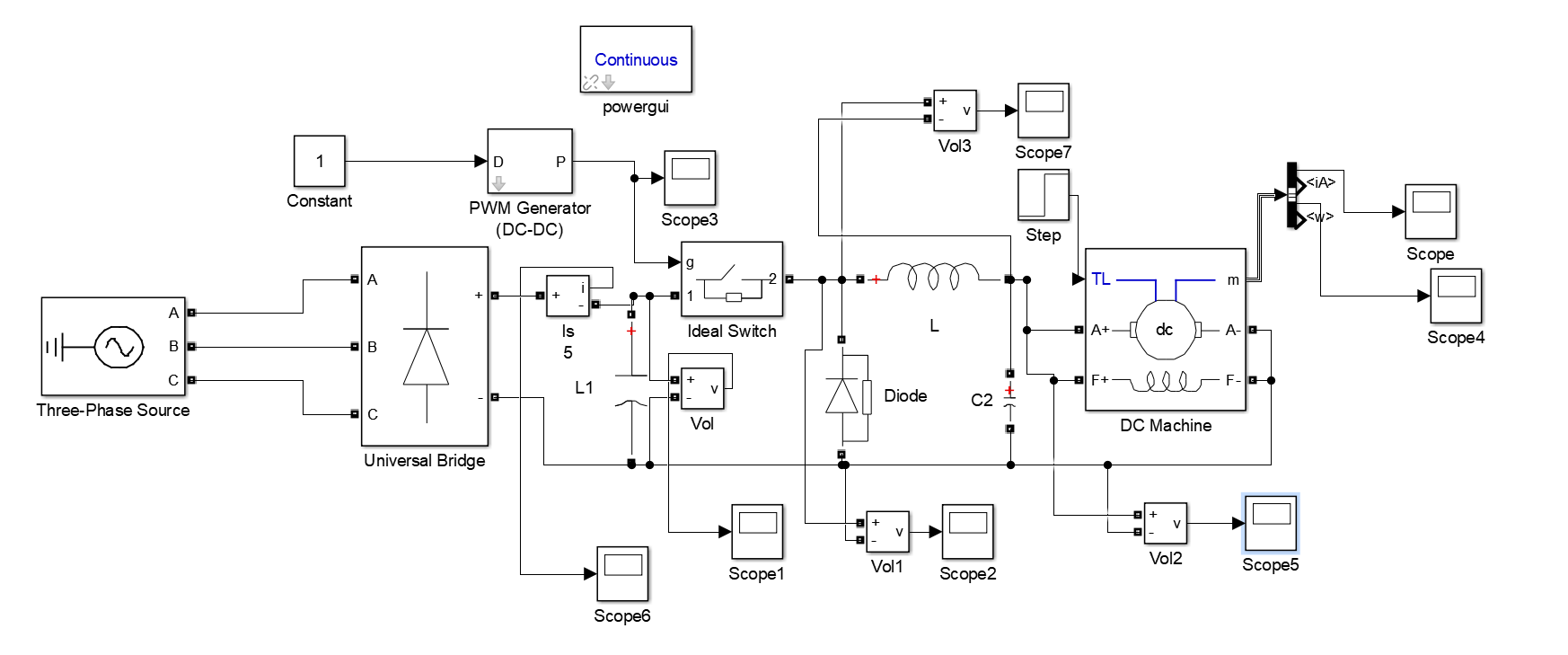


Figure 9: Circuit Schematic with DC Motor (Without Gate Driver)



Figure 10: Input Voltage Waveform for 320 Vpeak line to line

Input line to line voltage is 320 Vpeak as shown in Figure 10.

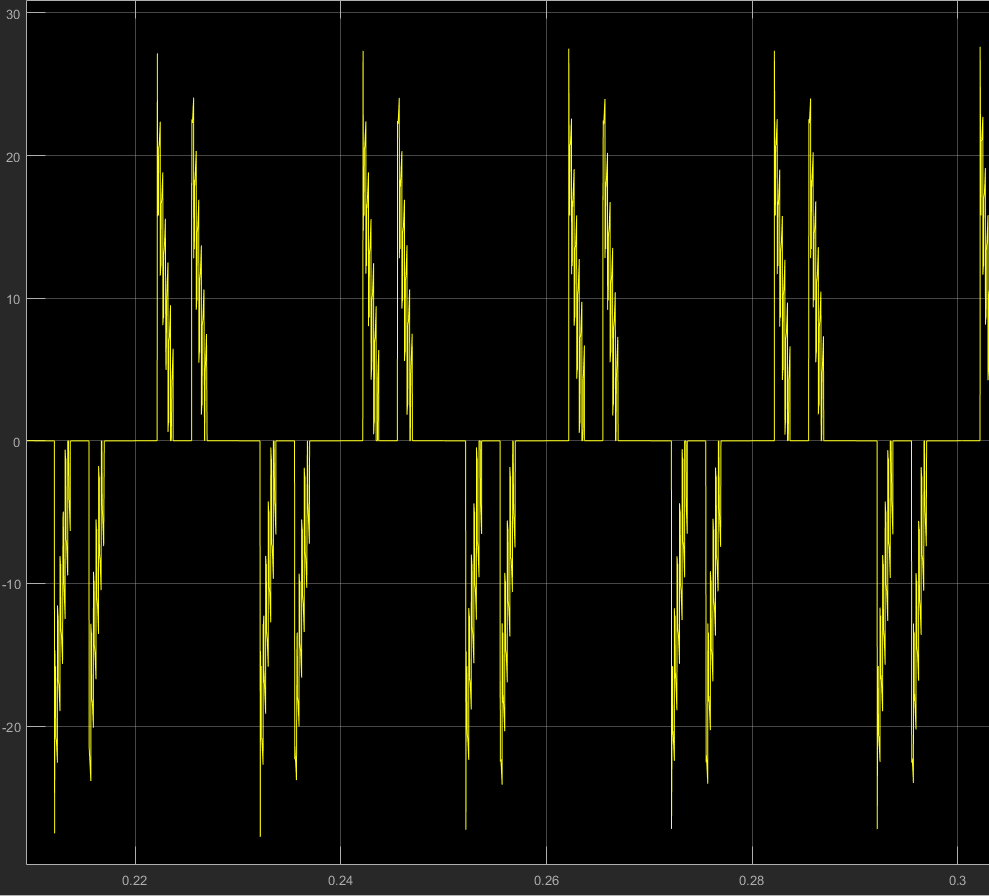


Figure 11: Input Current Waveform for 320 Vpeak line to line

Similar to R load, there is a capacitor after three phase diode rectifier and it try to charge and input current has a characteristic as shown in Figure 11.

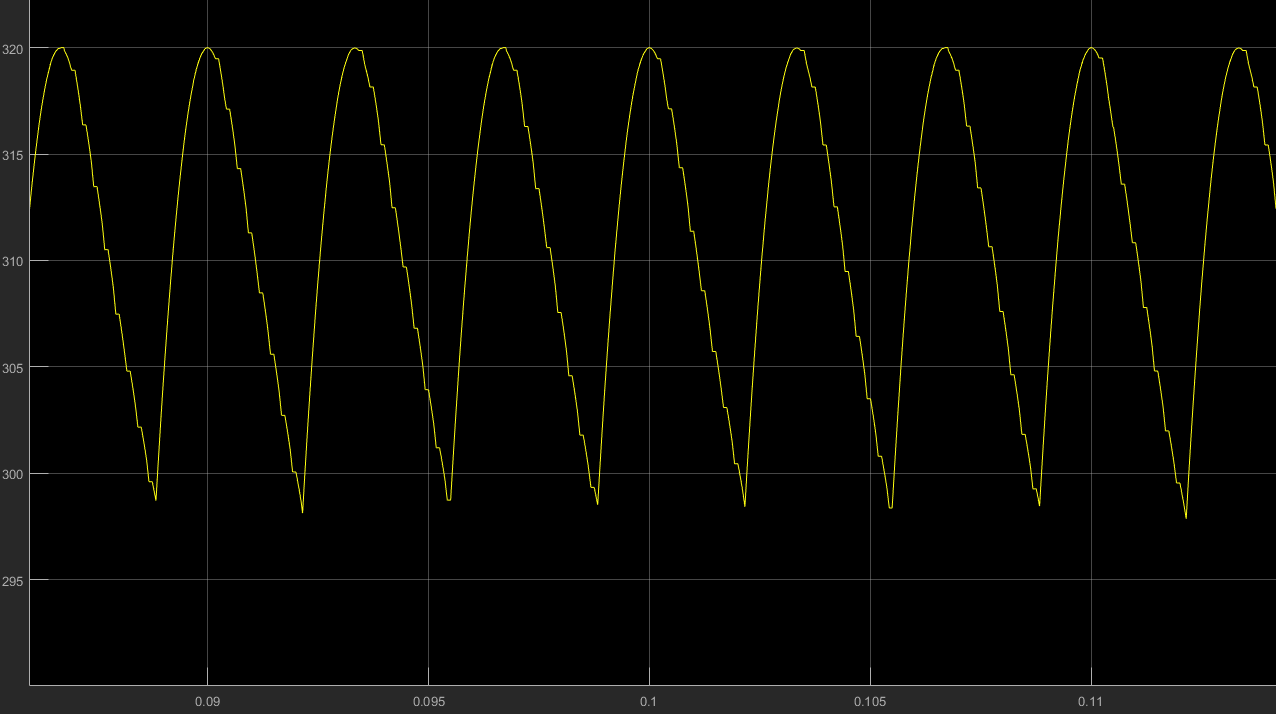


Figure 12: Output Voltage of 3 Phase Rectifier After 470 uF Capacitor Filter

As shown in Figure 12, output voltage of the three phase rectifier has six pulse characteristic and 300 Hz frequency is observed. Output ripple is nearly 20 V for 320 V peak voltage; that is ripple is nearly 6.25%. If there was not a capacitor after three phase diode rectifier, output ripple would be nearly 43 V; that is 13.45%.

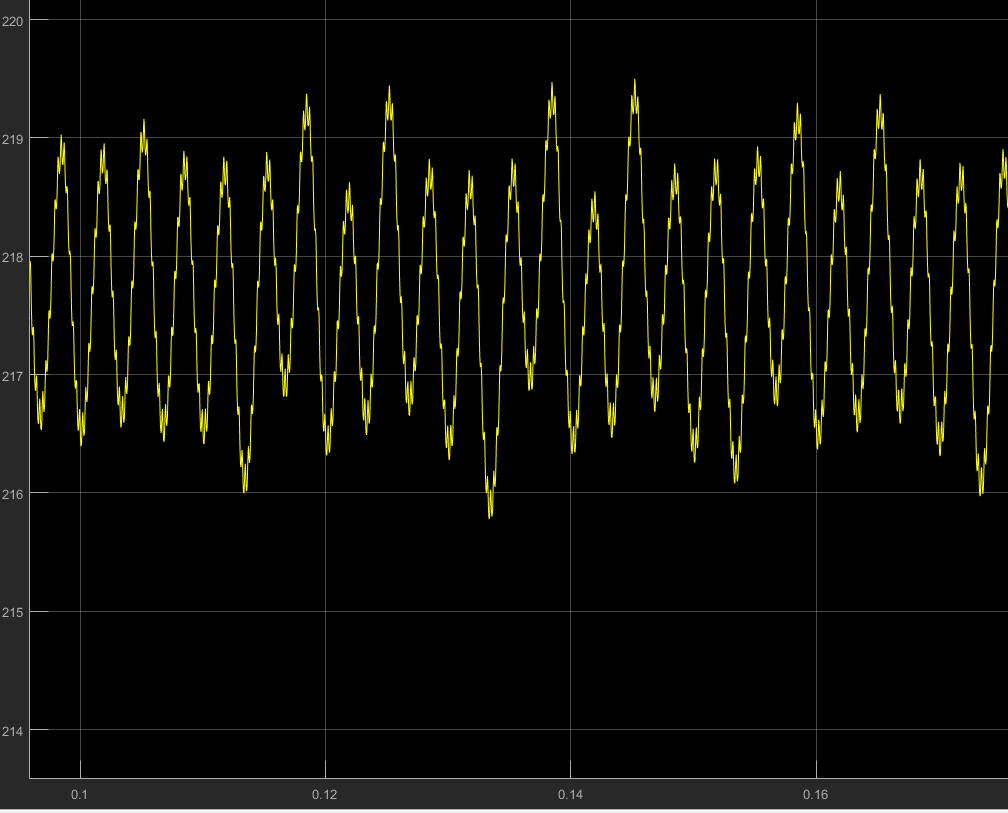


Figure 13: Output Voltage when D=0.7 and input voltage 320 Vline

There is output voltage waveform for motor load in Figure 13. There is buck converter after three phase rectifier and thanks to LC filter at the buck converter side, output voltage ripple is very low, which is nearly 1.4%. There is some spikes, however, it does not affect the motor considerably.



Figure 14: Output current when D=0.7 and input voltage 320 Vline

Armature resistance is given as 28Ω for the motor so output current should be 1/28 of the voltage characteristic. In other words, waveform characteristic of output voltage is similar to that of output current; however magnitudes are different of course. Ripple is low which is nearly 1.3%.

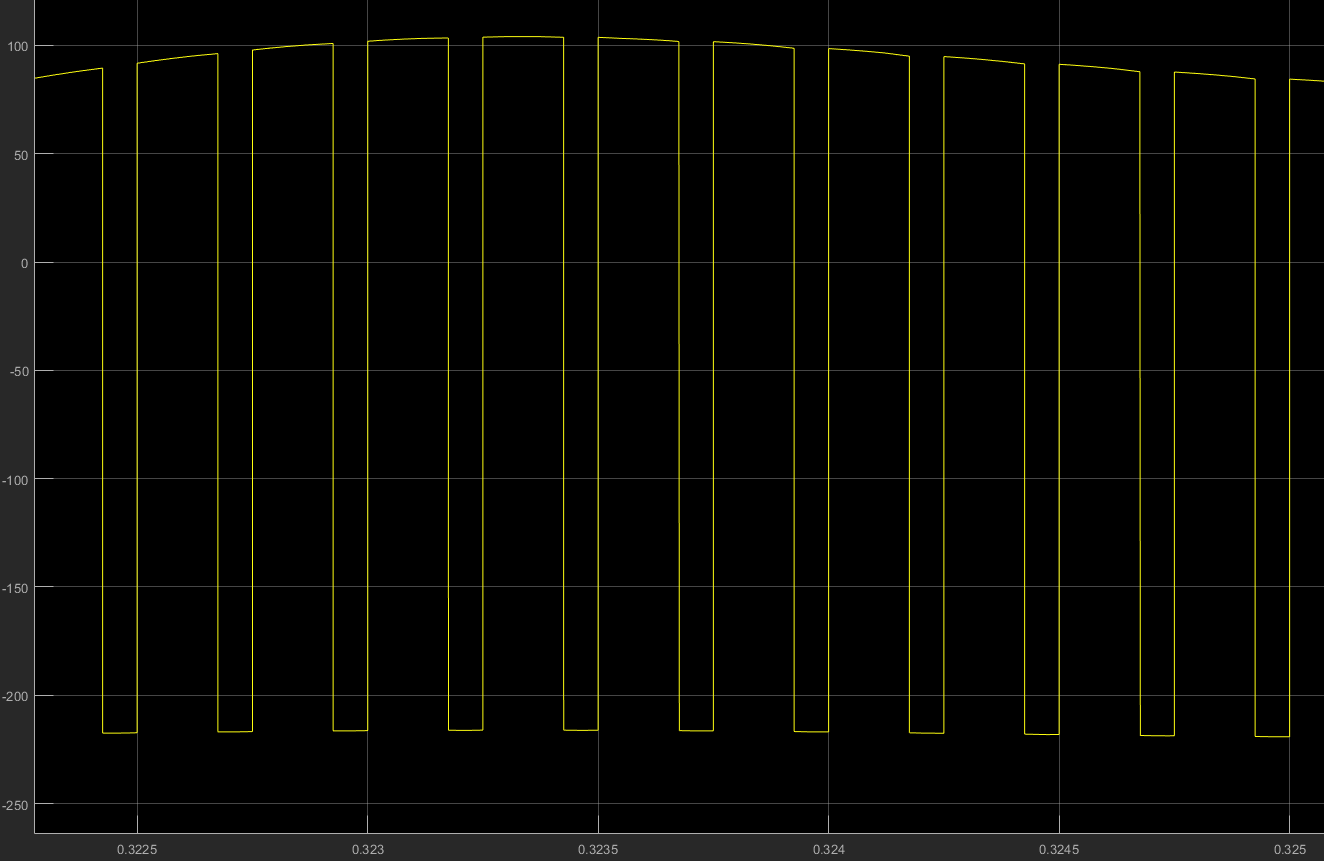


Figure 15: Inductor voltage when D=0.7 and input voltage 320 V (line to line)

There is inductor voltage waveform at Figure 15. Continuous conduction mode is observed at the simulation. If switching frequency is decreased, discontinuous conduction mode can be observed because