

ELECTRICAL AND ELECTRONICS ENGINEERING

ee463 statıc power conversıon



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METU-EEE

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1. INTRODUCTION
   1. Introduction to Power Electronics

Power electronics are a relatively new electronic development area. Basic electronics include inductors capacitors and various transistors; however, these electronics are widely used under 5-20Volts and never exceed 1-2 Amperes of current drawn.

Contemporary advancements in power electronics area enabled usage of high voltage rating electronic components. MOSFETs that can withstand hundreds of volts and Amperes, Capacitors that are bigger than commercial automobiles are a few examples of power electronics area.

A professional interest in power electronics area is the concept of converters. These converters can be categorized but not limited to AC-DC converters and DC-DC converters, also there are filter elements and gate drive elements that accompany power electronics. Filter elements are much like in circuits and systems theory but with larger capacitor and inductor components and much less stages (generally only one stage).

* 1. Introduction to Project

Gate drives are much complicated in power electronics, now we are combining relatively very high voltages and currents and very low voltages and currents. Gate drives such as optocoupler, Arduino microprocessor unit and such require 5-10 V to operate and draw 20-30 mA, while these components operate at these ratings power electronics and motors in the scope of this project are rated with 400-600Volts and 10-20Amperes. Even a fraction of these ratings will cause volatile destruction on drive elements.

1. DESCRIPTION
   1. Problem Description

We are tasked to operate a DC motor with following ratings:

The aforementioned DC motor is to be operated with the following grid:

The grid and DC motor will be connected through our power electronic project.

* 1. Possible Solutions
     1. 3-Phase Thyristor Rectifier

Three phase thyristor rectifier requires a zero-crossing detection device and phase lag gate signals.

* + 1. 1-Phase Thyristor Rectifier

One phase thyristor rectifier gives comparably low voltage to three phase, this will create extensive load to DC-DC converter side, also one phase thyristor bridge requires 4 thyristors while three phase requires just 2 more (6 total).

* + 1. Diode Rectifier + Buck Converter

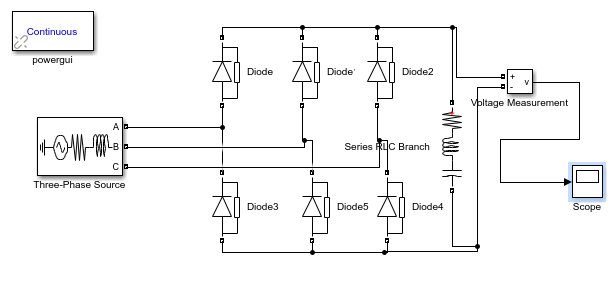
Diode rectifier is uncontrolled AC-DC converter, its output has high ripple but 6 pack diode rectifier is a robust design alternative. After diode rectifier there needs to be a controlled buck converter that will decrease the Vdc.

* 1. Solution Approach

We aim to accomplish the given task with Diode bridge rectifier and Buck converter. Main reason is that implementation of the trigger circuits of the three phase rectifiers are rather harder than trigger circuit of the buck converters which needs simple duty cycle. Second reason is that we planned to design a speed control system under various loads and duty cycle is more convenient to manipulate in a feedback controller system.

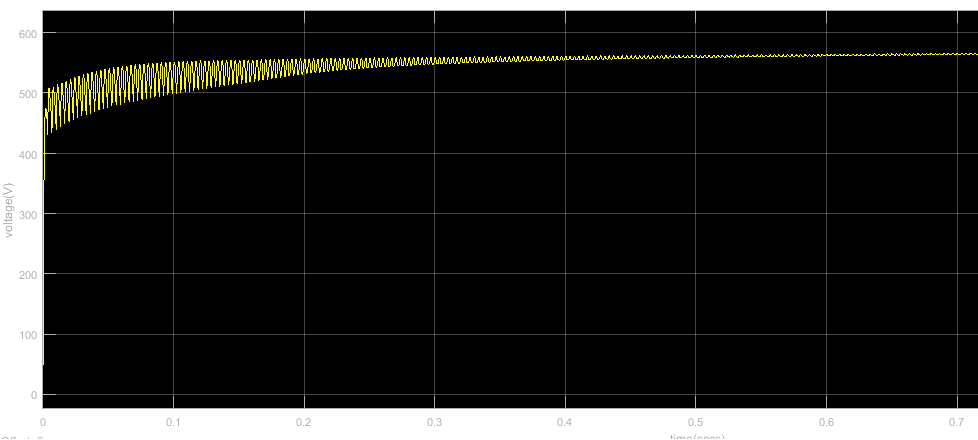
1. SIMULATIONS
   1. AC-DC Diode Bridge Converter

An AC-DC converter topology given in figure 1.

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**Figure1:** AC-DC converter

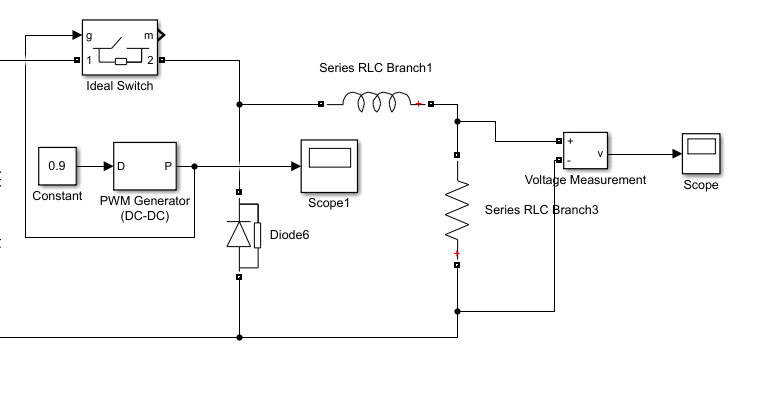
Output voltage waveform is given in figure 2.



**Figure 2:** Output Voltage Waveform of AC-DC converter

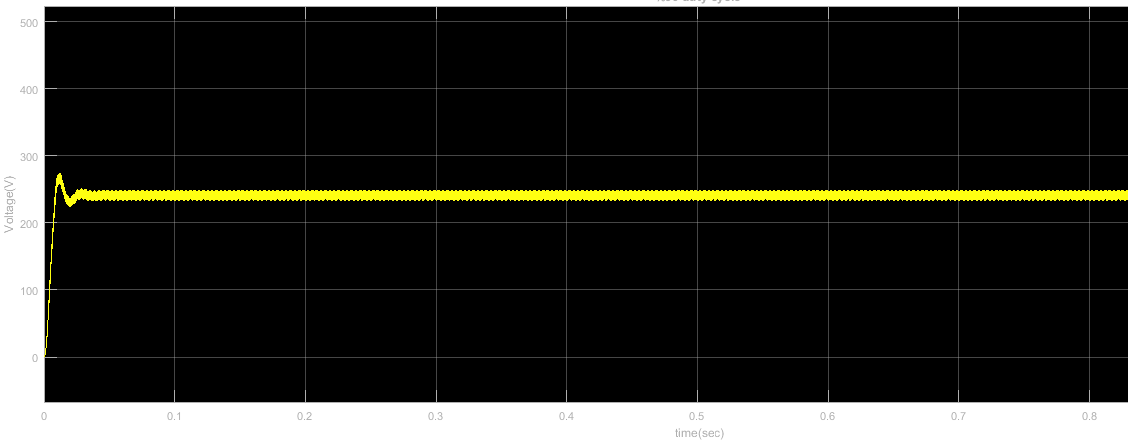
* 1. DC-DC Buck Converter

Buck converter is represented in figure 3.

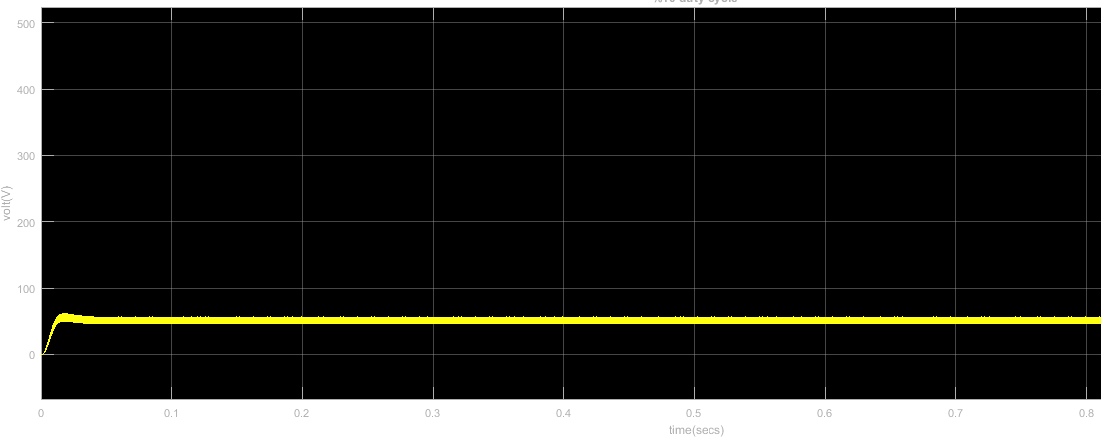


**Figure 3:** Buck converter.

Corresponding output voltages with %90 and %10 duty cycles are in figure 4 and 5 respectively.



**Figure 4:** %90 duty cycle.



**Figure 5:** %10 duty cycle.

* 1. Overall System Design
  2. Heat dissipation and Heatsinks
  3. Filtering Elements and Protection

In case of any fault, high voltage may damage the low voltage euipments and some of these equipments are rather expensive. Therefore, we used TLP250 model optocoupler in order to separate the high voltage and low voltage circuits from each other.

We used simple capacitive filter after AC-DC converter in order to suppress the sudden changes on the voltage value due to voltage drops on the grid line.

1. EXPERIMENTAL RESULTS
2. DEMONSTRATION
3. REFERENCES
4. APPENDICES