

**EE463 - STATIC POWER CONVERSION**

**Hardware Project: AC to DC Motor Drive**

**Members:**

**Hakan Saraç**

**Yusuf Yılmaz**

**Ceren Yalçın**

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Design decisions

* Topology Selection: Discuss the advantages and disadvantages of each topology, and decide on a topology.

Computer simulations

* Computer Simulations: According the your topology selection, you are going to run computer simulations, to prove the performance characteristics of your drive. It is best to simulate as detailed as possible to catch possible hardware problems (for example, how to generate control/gate signals).

Component selection

* Component Selection: According to your analytical calculations and computer simulations decide on which components you are going to use. Not only choose the power components, but also decide on the control, and axillary components.

Test Results

* It should contain your results with the motor running (data can be collected on the demo day, but preferably earlier). The report can contain any other useful tests (i.e. functionality of the switches, tests with R load etc.)

**Design decisions**

**Topology Selection**

We have discussed the advantages and disadvantages of each three topology to make a controlled rectifier that will be used to drive a DC Motor.

|  |  |  |
| --- | --- | --- |
| Topology | Advantages | Disadvantages |
| 3-Phase Thyristor Rectifier | - Easier 4 Quadrant Operation Implementation  - Low Output Ripple  - Less Passive Elements | - Thyristor Control |
| 1-Phase Thyristor Rectifier | - Easier 4 Quadrant Operation Implementation  - Less Passive Elements | - High Output Ripple  - Thyristor Control |
| Diode Rectifier + Buck Converter | - Easier Control of Semiconductors  - Easier Implementation  - Low Output Ripple | - Hard Implementation of 4 Quadrant Operation  - More Passive Elements |

At first sight, 3-Phase Thyristor Rectifier is the best option because it requires less passive elements and 4-quadrant operation is easier to implement. However, the control of the thyristor rectifiers is hard to implement, because sampling of the phases is necessary for the gate driving. Therefore, we decided not the use thyristors to rectify the AC voltages.

The implementation of the diode rectifier with a buck converter is easier because no synchronization is needed. Even though this topology requires more passive elements, the control signals for the semiconductors is much easier compared to the thyristor rectifiers. Furthermore, the number of passive elements can be reduced if THD and efficiency of the drive is not an important issue.

Considering all these, we have decided to move on with the diode rectifier with a buck converter topology. The schematic of the circuit is given below.

**Modeling of the topology**

After deciding on the converter topology. The model is constructed on Simulink and component selection is made accordingly. The DC Motor to be driven has 220V voltage rating and 2800W power output. The other specifications of the DC motor are as follows:

- Armature Winding: 28 Ω, 13.3 mH

- Series Winding: 65 mΩ, 260 uH

- Shunt Winding: 8.26 kΩ, 6.4 H

- Interpoles Winding: 0.8 Ω, 5.8 mH

We modeled the motor with the shunt field because it is more suitable for the no load operations.

**Component Selection**

The required components are listed below.

- 2 Capacitors

- 1 Inductor

- 1 Switching element

- 1 3-Phase Diode Bridge Rectifier

- 1 Diode

The RMS of the line to neutral voltage of the 3-phase line is chosen as 95V which provides around 220V DC voltage at the output of the diode rectifier. At no load, the voltage and current values are observed for each components and ratings of the components is made accordingly.

The capacitors are chosen as aluminum electrolytic whose ratings are 450V 680µF. We couldn’t find the datasheet of the capacitors. They are named Kendeil K01450381.

The average voltage across the 3-phase diode bridge rectifier is 222V. However, while starting the voltage value reached up to 383.6V. The average output current is 7.46A however the current swings between 0 and 28.65A. The reason for this swing is because we only used a capacitor for the filtering at the output of the rectifier. The component we chose is named SBR3516 which is capable of carrying 35A and can withstand up to 1600V.

The maximum voltage across the switching element is around 231.8V and average current flowing through it is around 7.48A and swings between 9.7A and 5A (at 100% duty cycle). Considering these, we have decided to use RJH60F7ADPK IGBT. VCE and IC ratings are 600V and 50A(100°C) respectivel y.

The maximum voltage across the freewheeling diode is 382.5 V and average current flowing through is 7.48A at %100 duty cycle.

**Component selection**

**Test Results**