

Middle East Technical University

Electrical & Electronics Engineering Department

EE463 – Static Power Conversion I

Hardware Project

Complete Simulation Report

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# **Introduction**

# **Problem Definition**

# **Possible Topologies for Solution**

## **Single Phase Thyristor Rectifier**

## **Three Phase Thyristor Rectifier**

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*Figure x. Three phase thyristor rectifier schematic****.***

Six thyristors are employed in the three phase thyristor rectifier. Thyristors are activated using gate signal generators to regulate output voltage. Theoretical output voltage calculation is as follows,

**Advantages**

* Without using an extra converter, the output voltage can be managed with a three phase thyristor rectifier.
* Output voltage ripple of this topology is lower than the single phase thyristor rectifier topology.
* THD of this topology is lower. Since, the third harmonic of the input current is not observed.
* Back-to-back three phase thyristor rectifiers can be used to achieve four quadrant operation.

**Disadvantages**

* Thyristors are more expensive than regular diodes as component, and six thyristors make up this topology. This topology is therefore more expensive than other alternatives.
* Three phase thyristor rectifier topology requires the usage of six separate gate signals. In order to do this, gate drivers and additional components are needed. It raises the price and makes the structure more difficult.
* It is challenging to synchronize gate drivers. Since it should be taken into account, the zero crossing issue.

## **Three Phase Diode Rectifier and Buck Converter**

There are two sections of this topology. Three phase ac grid voltage is rectified in the first section to low ripple dc voltage. In the second section, we use a buck converter to adjust the output voltage using the switch's duty cycle.



*Figure x. Three phase diode rectifier schematic****.***

There is no control of average output voltage for three phase diode rectifier. Calculation of the output voltage is as follows,

In order to control the output voltage, a buck converter must be used after the rectifier circuit.



*Figure x. Buck converter schematic****.***

The input dc voltage is step-down to the desired level by the buck converter. A MOSFET that is driven by a gate signal is used to regulate output voltage. Outpur voltage of a buck converter simply calculated as,

As we connect the rectifier and the buck converter, the output voltage becomes,

**Advantages**

* This topology has low voltage ripple in output.
* Only one gate signal is needed for this topology, and it will be supplied to operate the buck converter. In comparison to other topologies, this system is hence simpler. Additionally, syncing the signals is not needed in this topology.
* The cost of this system is lower than that of thyristor rectifiers.

**Disadvantages**

* Four quadrant operation is not supported by this topology. There is no method to obtain four quadrants because a diode rectifier can only operate in one quadrant.
* As a result of using an external diode in the buck converter, the predicted efficiency is lower than topologies with thyristors.

# **Topology Selection and Reasoning**

# **Simulations of Selected Topology**

## **Three Phase Diode Rectifier Simulation**

## **Buck Converter Simulation**

## **Three Phase Diode Rectifier and Buck Converter Simulation**

# **Simulation of Controller**

# **Component Selection**

# **Thermal Analysis**

# **Conclusion**

# **References**