

**MIDDLE EAST TECHNICAL UNIVERSITY**

**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING**

**EE 464- Hardware Project – 2023 Spring**

**Simulation Report**

**Isolated DC-DC Battery Charger**

**Peaky Converters**

Çağlar Umut Özten

Onur Toprak

# Introduction

Due to a variety of applications, including portable electronics and renewable energy systems, there is a constant need in modern power electronics for DC-DC converters that are dependable and efficient. The goal of this project is to design and build an isolated DC-DC converter that satisfies tight requirements for power efficiency, output voltage stability, and input voltage range.   
  
 This converter's goal is to convert an input voltage between 20 and 40 volts into a steady 12 volt output with a maximum power output of 60 watts. Additionally, the converter must have outstanding line and load regulation, with variances of no more than 3% across a range of input voltages and load circumstances, and the output voltage ripple should be kept to a maximum of 3%.

## Key Project Requirements:

**Closed-Loop Control:** A closed-loop control system is essential for maintaining precise regulation of the output voltage under changing input and load conditions. This ensures stability and reliability in various operating scenarios.

**Self-Powered Control Circuits:** The project restricts the use of external power supplies for control circuits, emphasizing the need for a self-powered solution that derives its operational energy from the main power source.

**Magnetic Design:** The magnetic design for the isolated DC-DC converter is a critical aspect that directly impacts performance, efficiency, and size of the converter. The key components requiring careful magnetic design include transformers and inductors.

## Additional Objectives:

Beyond meeting the basic specifications, additional project goals may involve enhancing the converter's efficiency, achieving a compact design, and exploring advanced techniques like soft switching to minimize switching losses and improve overall performance.

## Challenges and Opportunities:

Designing an efficient isolated DC-DC converter requires addressing challenges related to component selection, circuit layout, magnetic design (transformers and inductors), and control strategy. Balancing performance with factors like cost, size, and complexity presents opportunities for innovation and optimization throughout the design process.

Throughout this report, procedure of the DC-DC Isolated Converter will be explained. Step by step, examination of the topology selection, magnetic design and controller will be carried. After checking results with simulations, component selection and further consideratioons will be done.

# Topology Selection

## Flyback Converter:

The flyback converter is a type of isolated DC-DC converter that stores energy in the transformer during the ON time of the switching cycle and releases it to the output during the OFF time. Here's a simplified explanation of how it works:

**Operation:** During the ON time of the switching cycle, the primary winding of the transformer is energized, storing energy in the magnetic field of the transformer core.

**Energy Transfer:** When the switch turns OFF, the magnetic field collapses, inducing a voltage in the secondary winding of the transformer. This voltage is rectified and filtered to provide the desired output voltage.

**Isolation:** The flyback converter provides galvanic isolation between the input and output through the transformer, making it suitable for applications requiring isolation such as in power supplies and converters.

**Advantages:** Simple topology, low component count, and capability of stepping up or stepping down the input voltage.

**Disadvantages:** Typically higher output ripple, lower efficiency compared to forward converters especially at higher power levels, and limited to lower power applications due to transformer size and losses.

## Forward Converter:

The forward converter is another type of isolated DC-DC converter that transfers energy from the input to the output through a transformer during each switching cycle. Here's a brief overview of its operation:

**Operation:** The primary winding of the transformer is energized during the ON time of the switching cycle, transferring energy to the secondary winding.

**Energy Transfer:** Energy is transferred from the primary side to the secondary side of the transformer during each switching cycle, providing isolation and stepping up or stepping down the voltage depending on the transformer turns ratio.

**Continuous Energy Transfer:** Unlike the flyback converter, the forward converter operates with continuous energy transfer through the transformer, resulting in generally higher efficiency and lower output ripple.

**Advantages:** Higher efficiency, lower output ripple, and better regulation compared to flyback converters especially at higher power levels.

**Disadvantages:** More complex control circuitry, additional components such as freewheeling diodes and snubber circuits, and limited duty cycle due to transformer reset constraints.

In summary, the choice between flyback and forward converter topologies depends on specific application requirements including power level, efficiency targets, output ripple tolerance, and design complexity considerations. Each topology has its advantages and disadvantages, making them suitable for different types of DC-DC conversion applications.

We selected Forward Converter Topology due to high regulation neccessity.

# Analytical Calculations

# Magnetic Design

## Lm, leakage ind

# Closed Loop Controller

# Simulations

# Component Selection

# Further Considerations

## Efficency

## Ripple

# Conclusion