ROGOWSKI COIL INTEGRATOR

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Team 18

PROJECT OVERVIEW

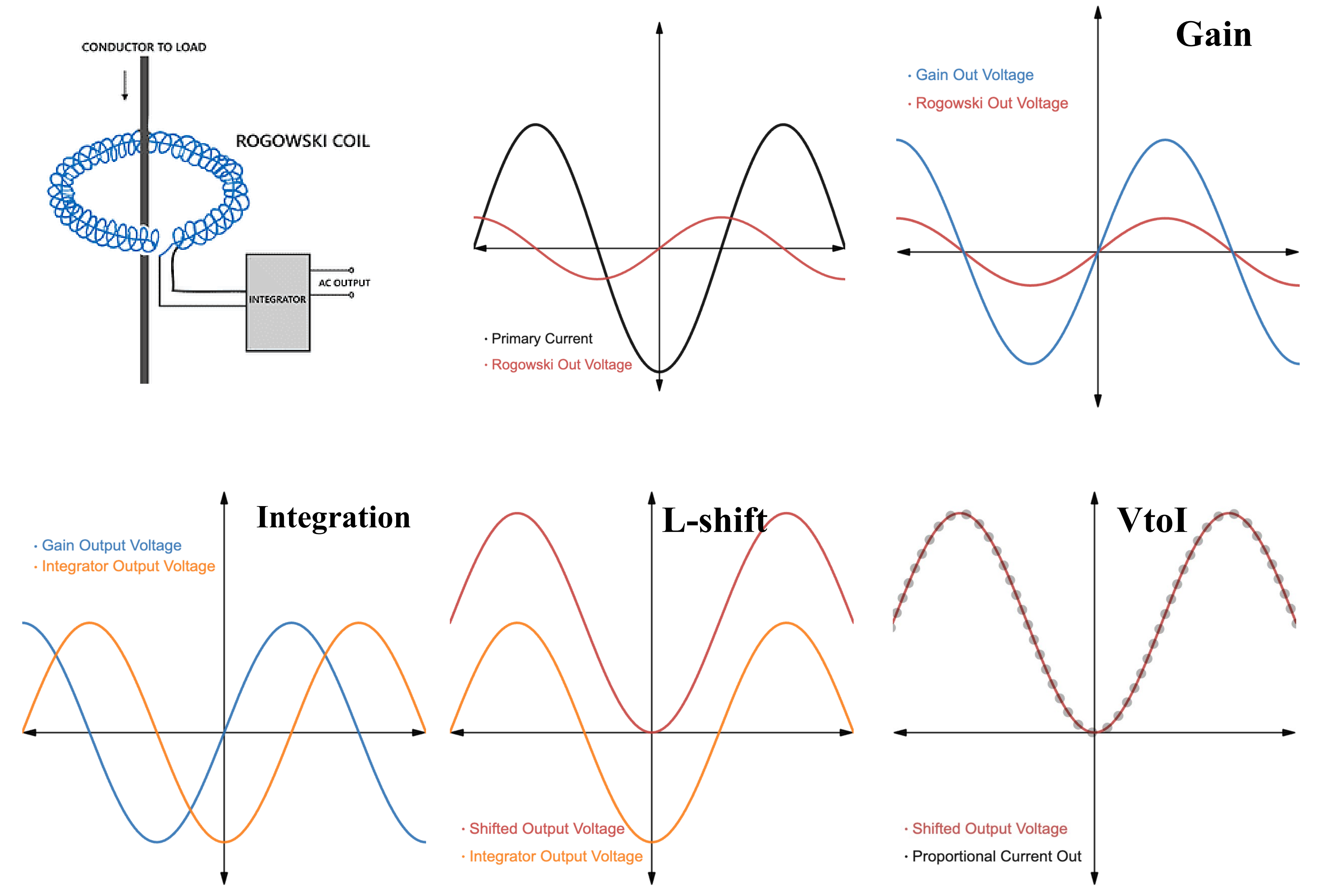
The objective of this project is to create an integrator that can take in different voltage signals from a Rogowski coil and output a current proportional to the input current to the Rogowski coil. The integration circuit, combined with the Rogowski coil, serves as an alternative to the conventional current transformer commonly used for current measurement applications.

KEY SPECIFICATION

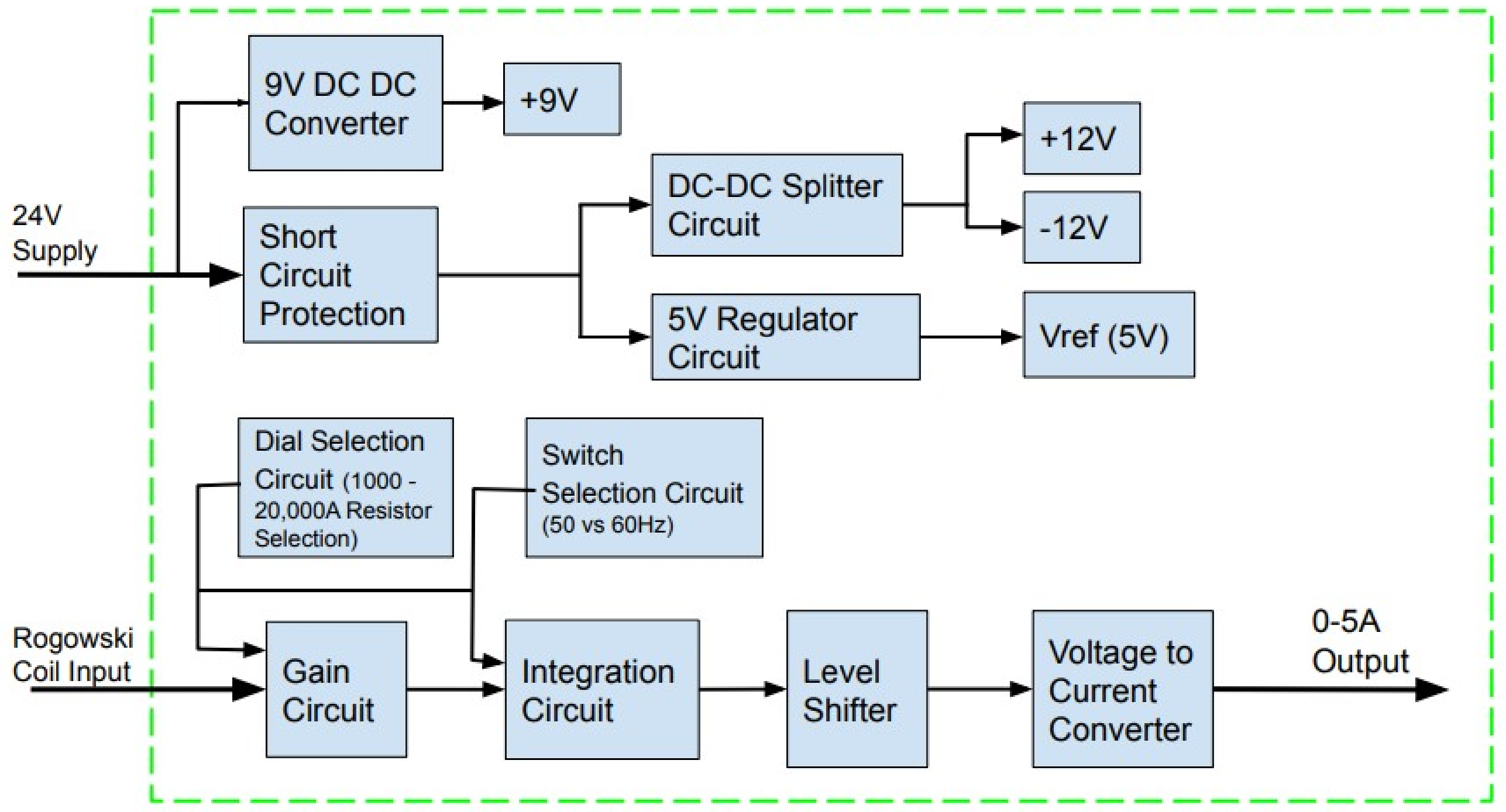
1. The input from the Rogowski coil will be 180mV/1000Amps at 60 Hz or 150mV/1000Amps at 50 Hz.
2. The integrator will have an output of 0 – 5 Amps AC and less than 0.1° phase shift.
3. The integrator will operate between temps of 0°C and 60°C.
4. The integrator will have selectable inputs to integrate AC currents at 1000, 2500, 5000, 10000, and 20000 A AC

DESIGN

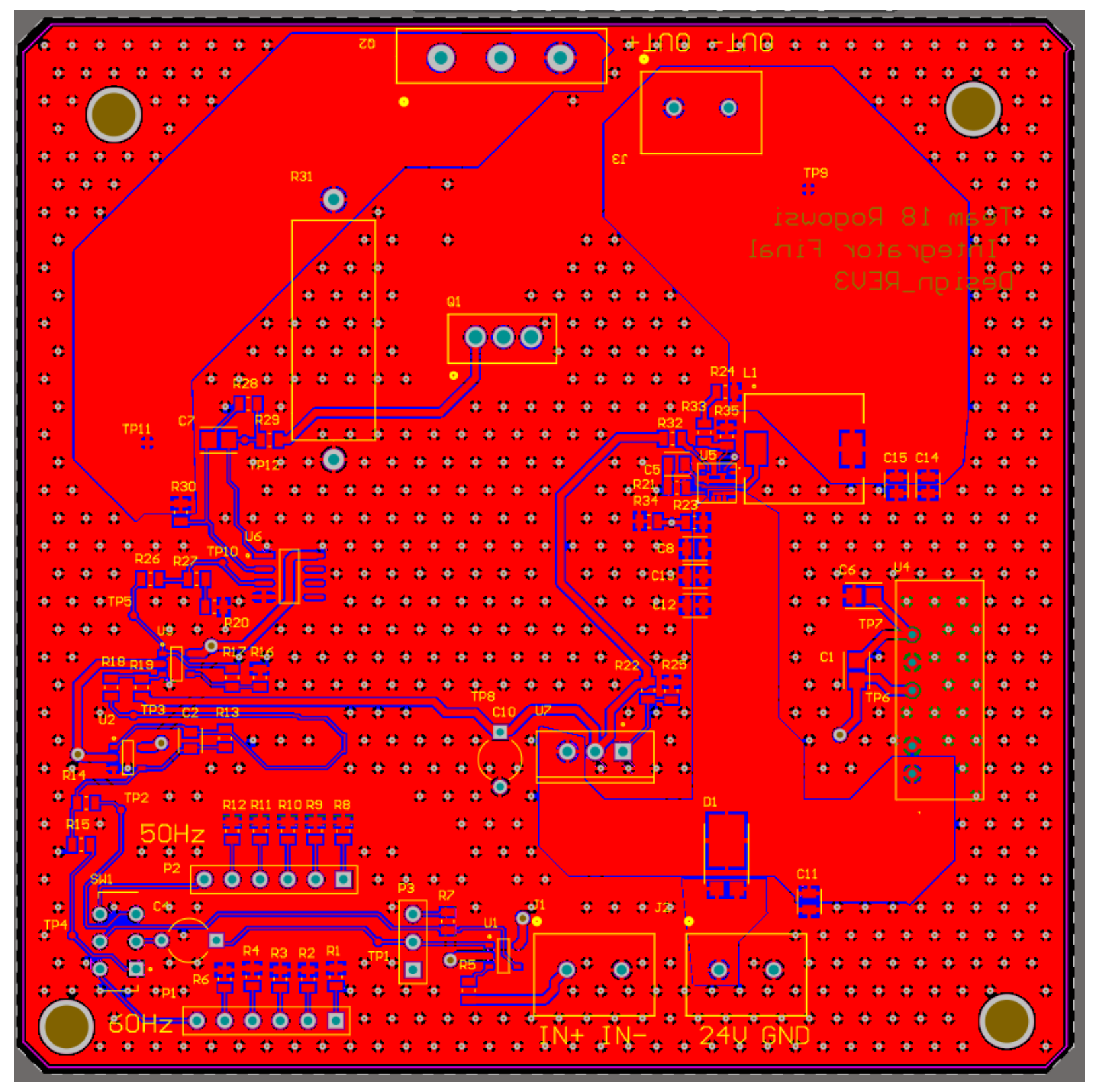
The design of the integrator circuit for current measurement with the Rogowski coil was approached with careful consideration of key factors such as linearity, phase-shift, and frequency bandwidth, as these aspects significantly impact the sensor's electrical performance. To ensure optimal performance, the integrator circuit was divided into four distinct stages: GAIN, INTEGRATION, LEVEL SHIFT and VOLTAGE TO CURRENT CONVERSION. Extensive research, analysis, simulation, prototyping and iterative testing were conducted to verify the performance and functionality of each stage, optimize parameters for efficiency and accuracy, and validate the design against specifications. Refer to the visual representation below for an overview of signal conditioning in each stage.



SYSTEM DIAGRAM

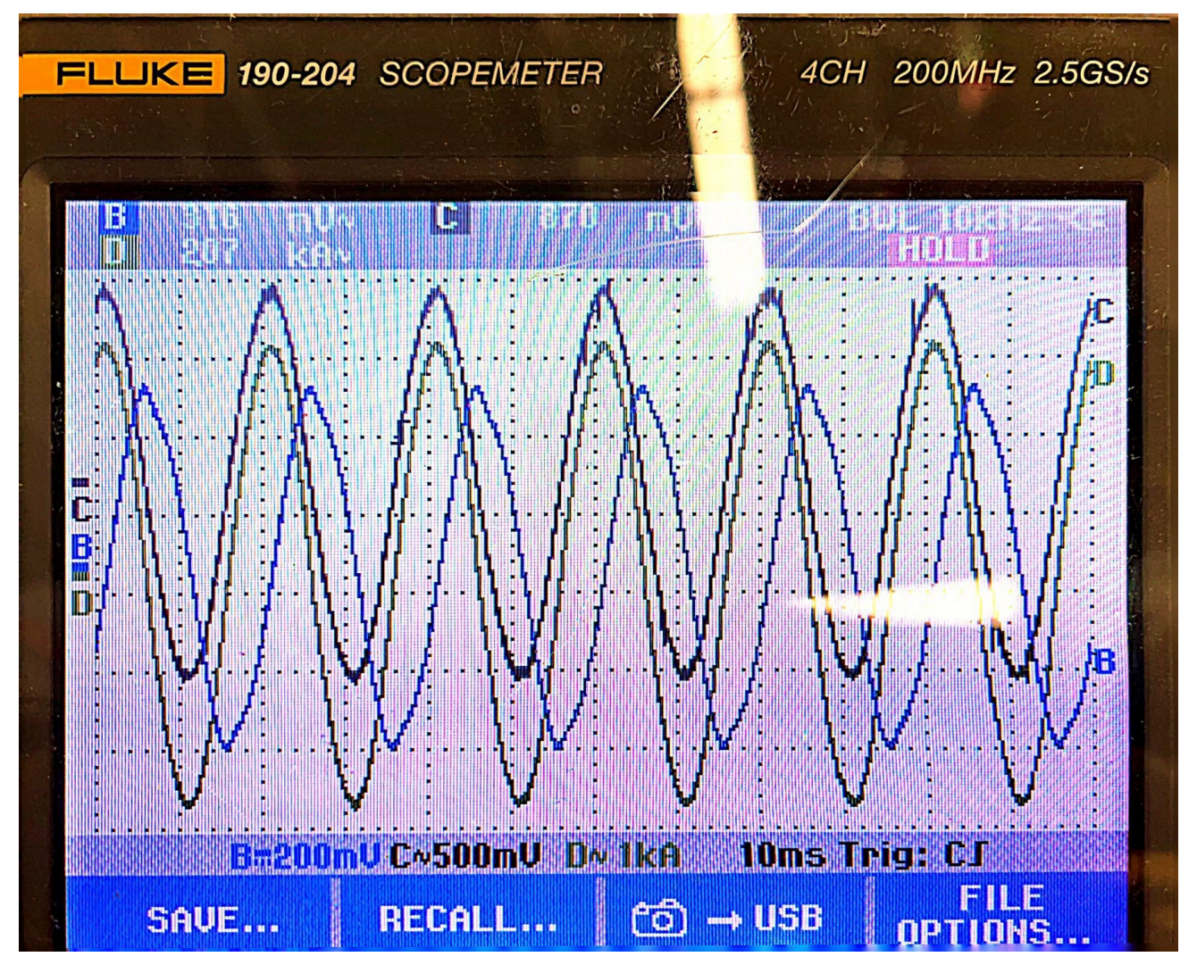


PCB



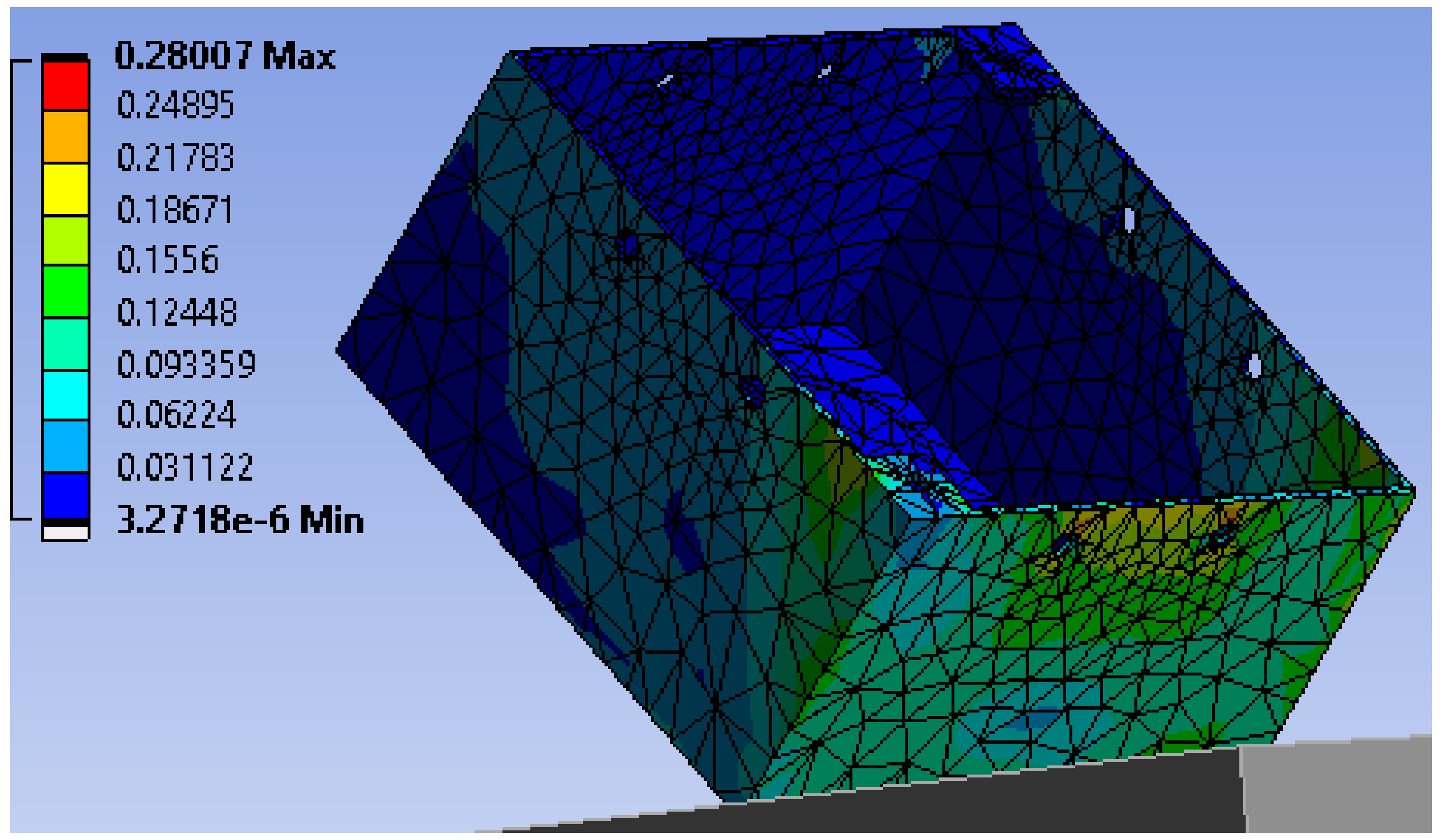
SIMULATION AND TESTING

LTSpice was utilized for initial simulation, verifying the circuit design. Breakout PCBs were then designed and tested for each system stage, followed by the integration of all stages onto a single PCB for comprehensive testing. This iterative process allowed for validation of individual components and the overall system performance. Simulation and testing played a vital role in identifying and addressing design issues, resulting in an optimized and functional system design.



ENCLOSURE DESIGN

The enclosure is an aluminum electrical box with dimensions 4”x4”x2.125”. Aluminum has a high thermal conductivity which means that it has a faster heat transfer rate than other metals like steel The enclosure was modified in order to bolt the transistor to the enclosure. This causes the enclosure to act like a heat sink for the transistor. The PCB was attached to the enclosure with nylon standoffs and an adhesive. Finite element analysis (FEA) was performed on the enclosure with the standoffs and PCB to see what the maximum stresses would be if the integrator was dropped from five feet. The maximum stress from the analysis was found to be 0.28 MPa which is much lower than the tensile strength of the aluminum enclosure and the nylon standoffs.



CHALLENGES

Component selection posed challenges in finding a suitable transistor capable of handling the power requirement and precision of the system. Thermal dissipation was a challenge due to the large amount of current flowing through the system, requiring effective heat management strategies.