



Undergraduate
Research Scholars

OFFICE OF UNDERGRADUATE RESEARCH

BACKGROUND

- A matrix converter (MC) topology for high voltage power delivery to industrial-scale computing operations
- A modern method for achieving high-efficiency power conversion with improved power density [1]
- Capable of bidirectional power flow, direct AC/AC conversion, and soft switching [2]

PROBLEM STATEMENT

- The rise of energy-intensive computing, such as AI model training, cloud computing, data centers, and crypto mining, creates a need to optimize distribution to these loads.
- Gallium nitride (GaN) FETs promise greater power density than silicon carbide (SiC)

3x1 MATRIX CONVERTER

- An LC filter feeds a high voltage 3-phase AC signal into six digitally controlled bidirectional GaN switches paired with RC snubbers to suppress voltage spikes
- Gate drivers controlled by PWM signals output a high frequency single phase AC signal to be converted to DC by a rectifier on the secondary side

WBG Devices-Based Matrix Converter for 3-Phase AC to DC Conversion in Industrial Computing Applications

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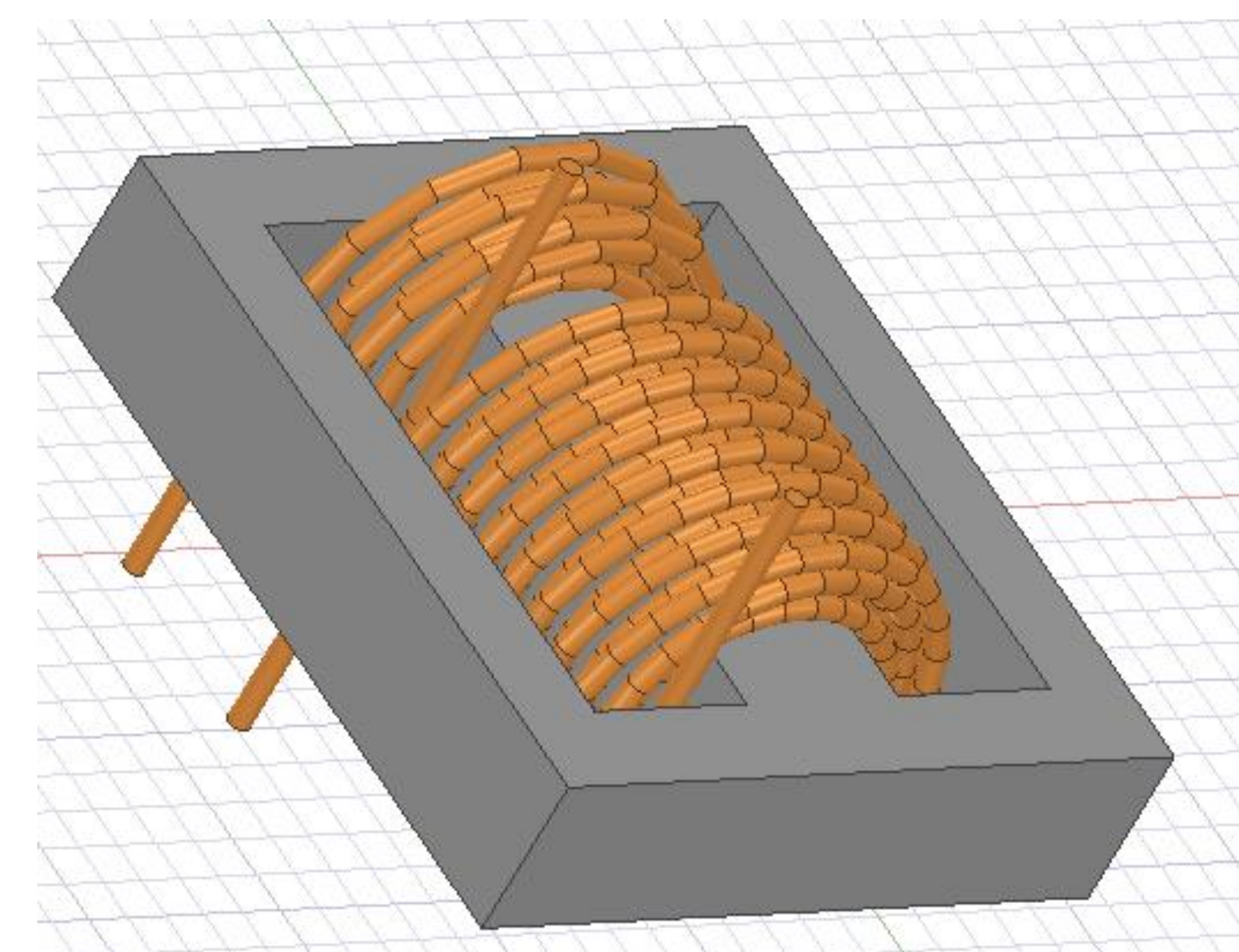


Figure 1. Transformer model in ANSYS Maxwell, a software used for simulating electromagnetic devices.

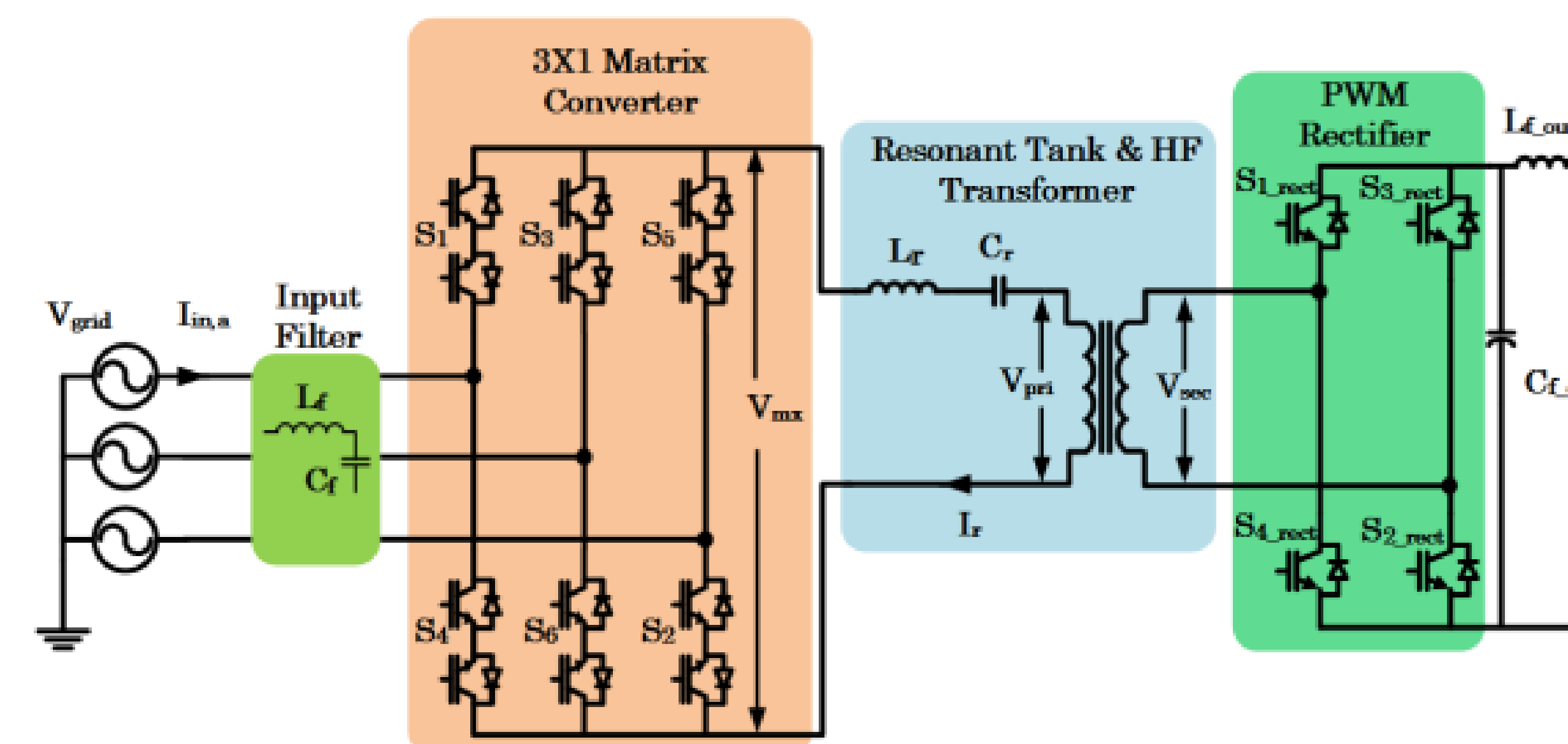


Figure 2. Matrix converter topology for high voltage energy transfer [1].

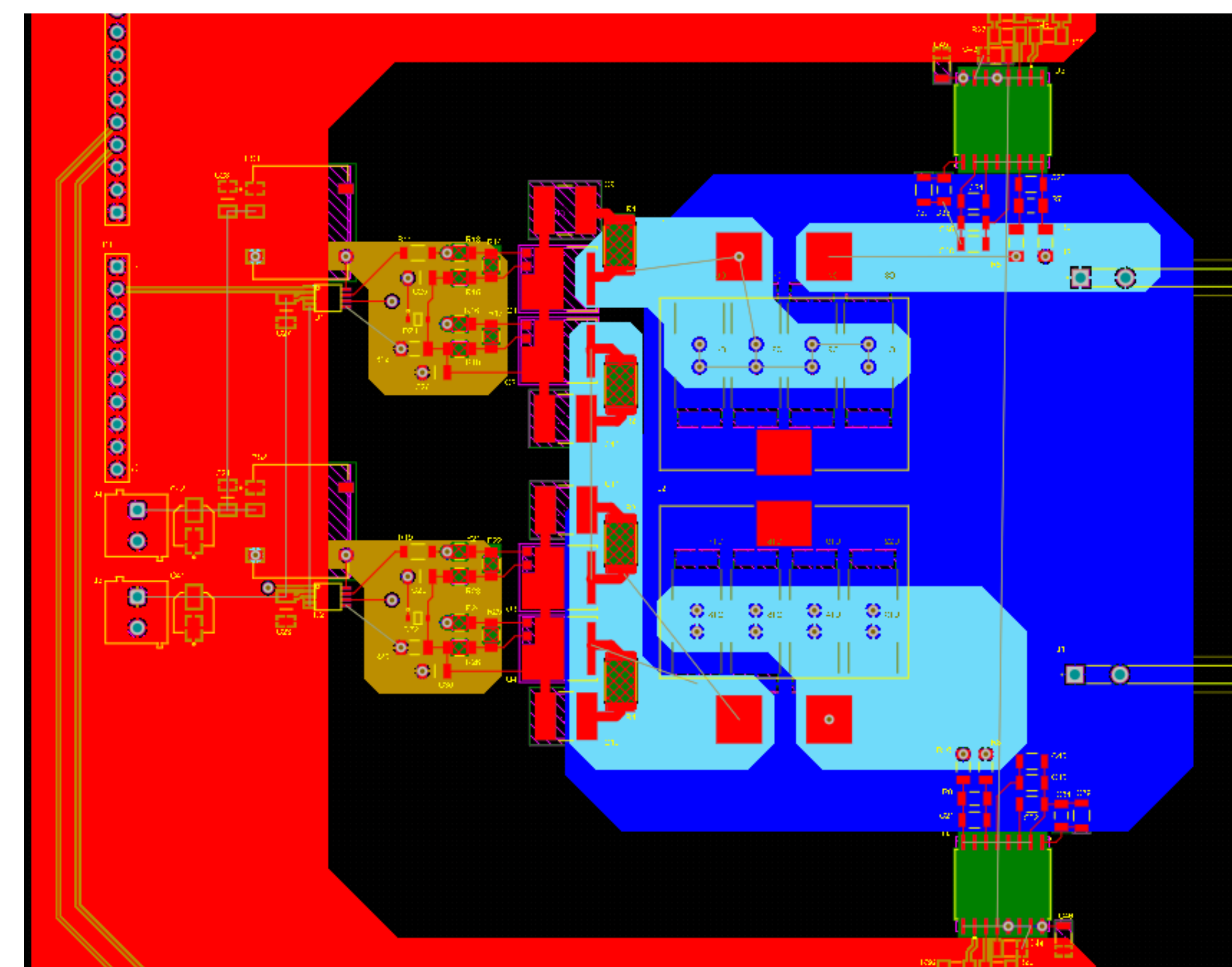


Figure 3. Single-phase MC design. Gate drivers (gold) and voltage sensors (green) separate low- and high-power elements.

HF TRANSFORMER

- Utilizes a Kool Mu HF Core from Magnetics, Inc. composed of aluminum, silicon, and iron to minimize core losses
- Winding made from Litz wire to reduce copper losses associated with high frequency operation

CONTROLS SCHEME

- TI LAUNCHXL and controlCARD controls the switching
- Algorithm for switching logic created, tested, and validated in PSIM
- Utilizing Typhoon HIL 602+ to combine software and hardware validation

ACKNOWLEDGEMENTS

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REFERENCES

- [1] J. J. Sandoval, S. Essakiappan and P. Enjeti, "A bidirectional series resonant matrix converter topology for electric vehicle DC fast charging," *2015 IEEE Applied Power Electronics Conference and Exposition (APEC)*, Charlotte, NC, USA, 2015, pp. 3109-3116, doi: 10.1109/APEC.2015.7104795.
- [2] H. S. Krishnamoorthy, P. Garg and P. N. Enjeti, "A matrix converter-based topology for high power electric vehicle battery charging and V2G application," *IECON 2012 - 38th Annual Conference on IEEE Industrial Electronics Society*, Montreal, QC, Canada, 2012, pp. 2866-2871, doi: 10.1109/IECON.2012.6389440.