

Stacked class E resonant Very High Frequency converter for European mains power factor correction



Frederik Spliid, Ahmed Ammar & Arnold Knott

Technical University of Denmark, DTU Electrical Engineering, Electronics group

Elektrovej 325, 2nd floor, DK-2800 Kgs. Lyngby, Denmark

Introduction

- Great demand for compact PFCs in LED products.
- Driver size can be reduced by increasing switching frequency.
- This poster: design of 50 W resonant VHF AC/DC converter

Design

- Stacked configuration reduce voltage stresses and improve efficiency. [1]
- Class E inverter and class DE rectifier enables zero-voltage switching.

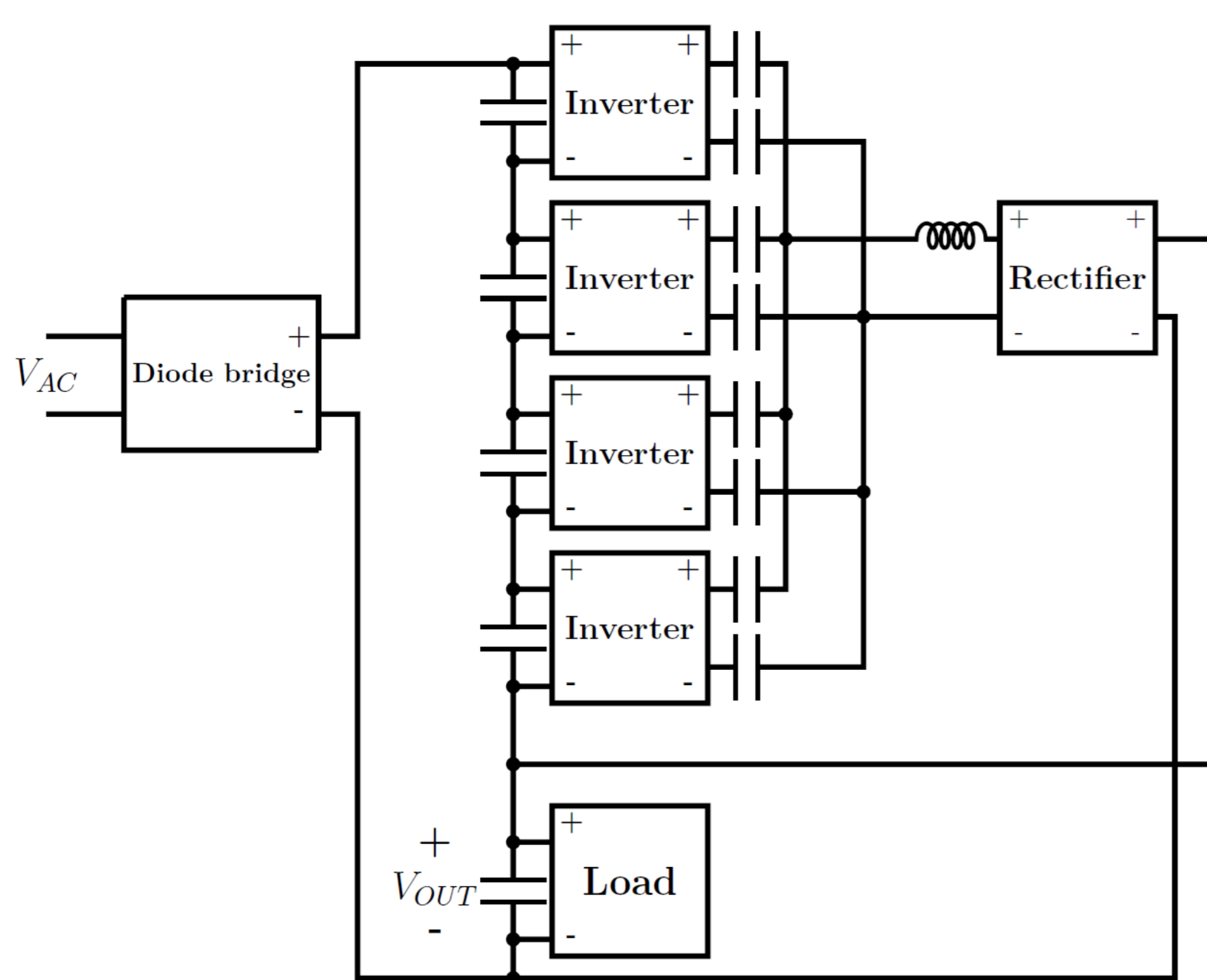


Fig. 1 Stacking configuration.

- GaN devices with low parasitic capacitance enable high switching frequency.
- Air-core inductors gives high Q magnetics at high frequencies.
- Self-resonant gate driver enables VHF switching [2].

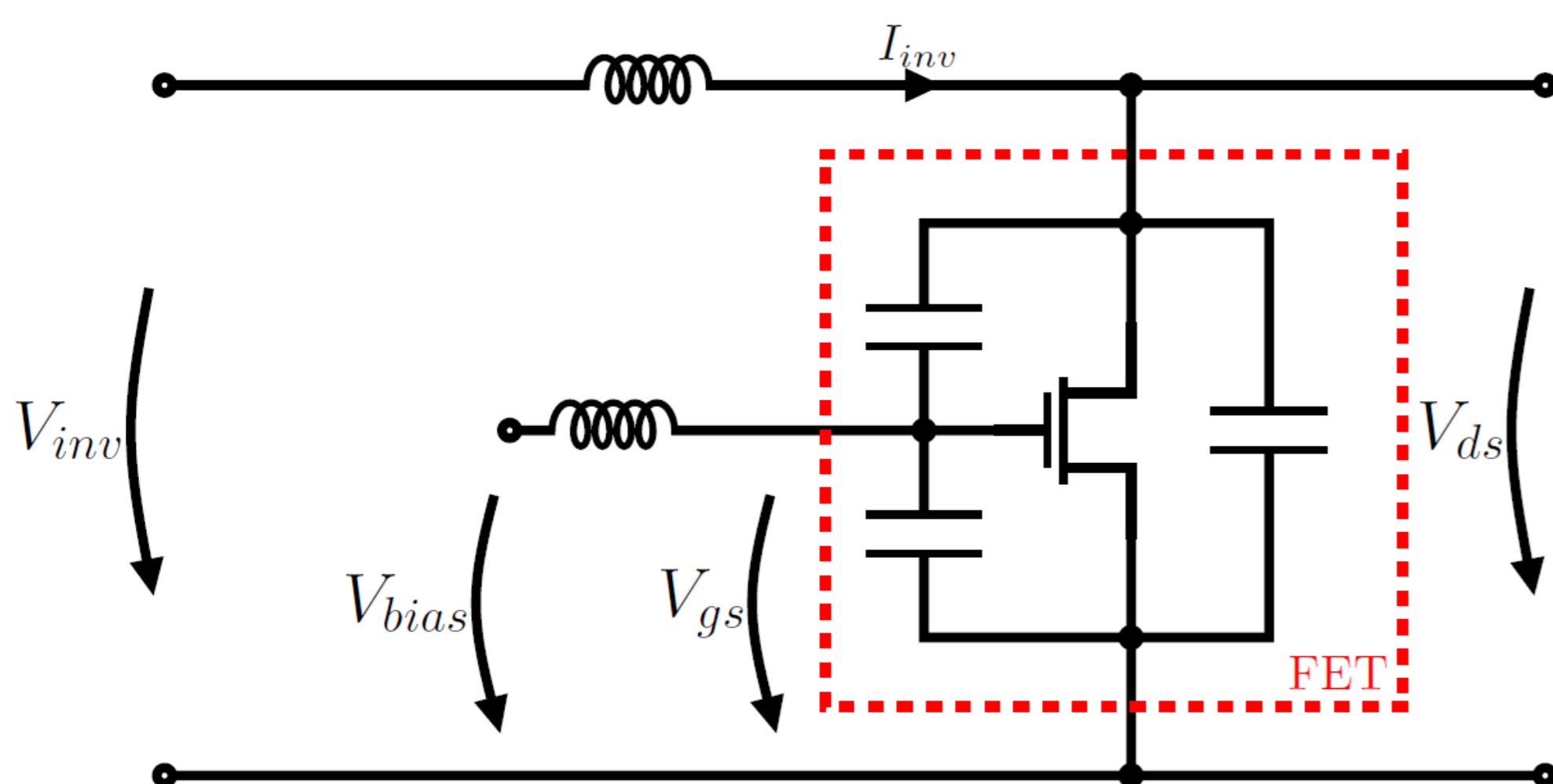


Fig. 2 Class E inverter stage with self-oscillating resonant gate drive

| | |
|----------------------------|-----------------------------|
| Input voltage | 230 V _{AC} @ 50 Hz |
| Output voltage | 110 V _{DC} |
| Switching frequency | 30-37 MHz |

Tab. 1 Converter specifications

Simulation performance

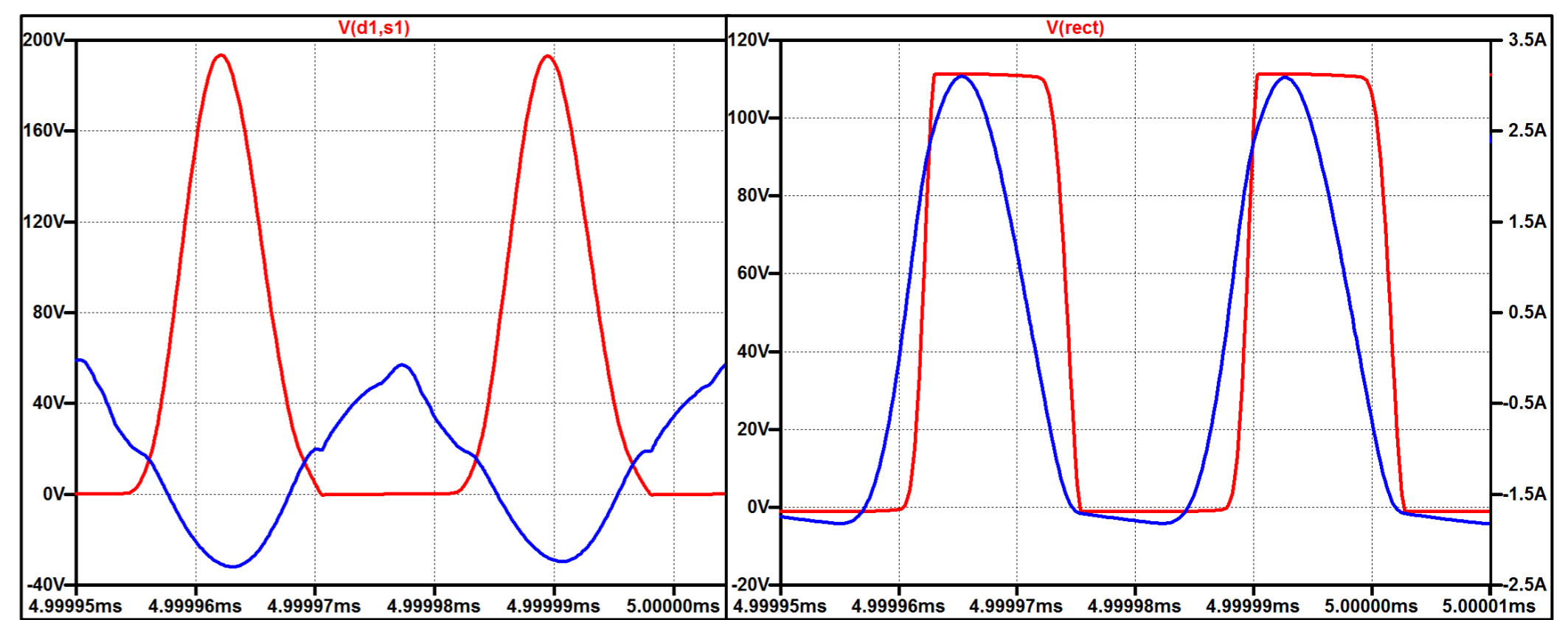


Fig. 3 Left: V_{ds} (red) and 10x scaled V_{gs} (blue) of inverter switch
Right: Rectifier input voltage (red) and current (blue)

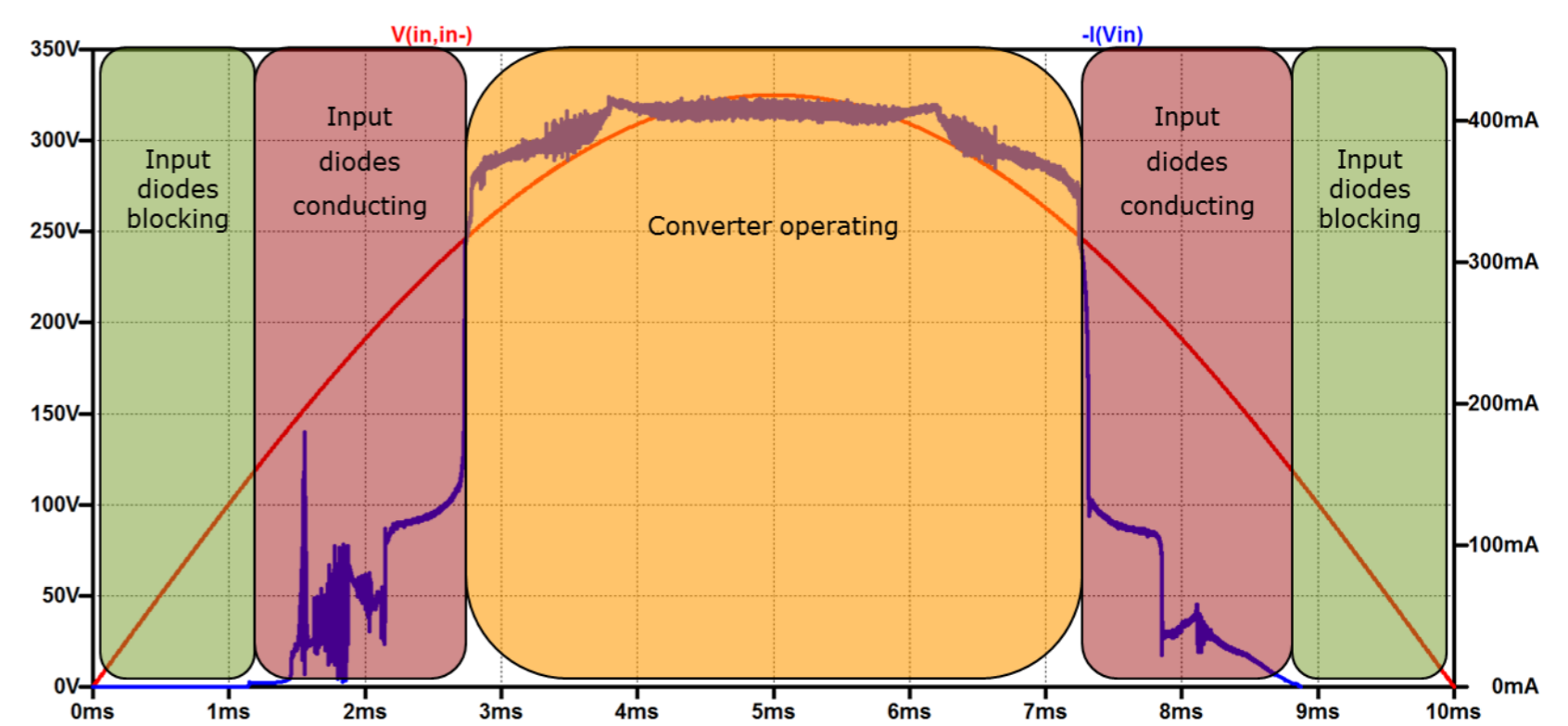


Fig. 4 Input voltage (red) and current (blue)

| | |
|--------------------------|--------|
| Output power | 52.2 W |
| Efficiency | 90.3 % |
| Power Factor | 93 % |
| Input current THD | 38 % |

Tab. 2 Simulated converter performance

Conclusion

- Stacked topology reduce voltage stresses.
- GaN transistors and air-core inductors enable VHF operation
- Self-oscillating gate drive enables open-loop operation

References

- [1] M. Madsen et al., "Input-Output Rearrangement of Isolated Converters", in *Proceedings of 2015 IEEE Power and Energy Conference at Illinois, 2015*.
- [2] M. Madsen et al., "Self-oscillating resonant gate drive for resonant inverters and rectifiers composed solely of passive components", in *Twenty-Ninth Annual IEEE Applied Power Electronics Conference and Exposition (APEC), 2014*.
- [3] J. Pedersen et al., "US Mains Stacked Very High Frequency Self-oscillating Resonant Power Converter with Unified Rectifier", in *Thirty-first Annual IEEE Applied Power Electronics Conference and Exposition (APEC), 2016*

Acknowledgement



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731466