

# Bidirectional Onboard Charger for Electric Vehicles

Graduate

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## Introduction:

Vehicle to Grid (V2G) is an increasingly popular technology. The battery of the electric car is also used as a local energy storage device. Thus, energy can be obtained from the car battery. This means that energy can be stored decentrally where it is produced and also provided again where it is consumed. For this purpose, the Dual Active Bridge (DAB) converter topology is investigated in this thesis. This converter consists of two full bridges and one transformer and it is possible to shift energy bidirectionally by different modulation of the switches. The specifications define a maximum transmission power of 11 kW. Here, the input voltage is constant 800 V and the output voltage range is 500-920 V depending on the battery state of charge. The maximum output current of 18 A should not be exceeded. The switching frequency is set to 135 kHz.

## Approach:

At the beginning, different modulation methods are analyzed. The purpose for this is to verify suitable modulation methods over the whole power and output voltage range in order to implement them later in a firmware.

The optimal modulation method is to be found with the help of the power electronic software PLECS. For this purpose, the used semiconductors and the transformer have to be modelled as accurately as possible in the simulation. The optimal modulation type should then be selected and implemented. Ultimately, this should be verified by measurements on the hardware. Another aim of this thesis is to determine the thermal losses of the transformer. The reason for this is that in a circuit simulator only copper losses of the transformer can be easily represented. In reality, however, ferrite losses also occur and these can therefore also be determined. For that reason, different measurement methods shall be investigated and the best method should be applied and verified.

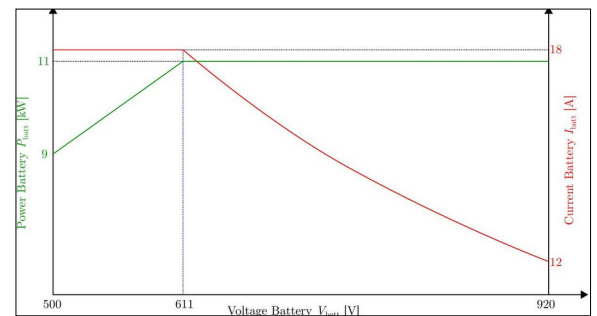
## Conclusion:

Using simulations in PLECS, it was shown that Brusa's modulation type was best suited for the DAB with the transformer provided and the specifications given. Besides more efficient results, the implementation is also simpler than with comparable modulation methods. The reason is that many modulation methods are computationally intensive, thus Look Up Tables (LUT) have to be integrated and the resolution is limited due to the memory capacity of the microcontroller. The comparison between the simulations in PLECS and the measurements on the hardware shows a good agreement. In the operating range, energy could be transferred at an efficiency of 98.1-99.2 %. The measurements in the working range could be performed up to an output voltage of 860 V. For the maximum output voltage of 920 V additional adjustments of the gate driver circuits are necessary. For the thermal loss determination, it has been shown

that a large number of measurements would be required for high accuracy. With a small number of measurements, only some basic estimates of the losses can be made.

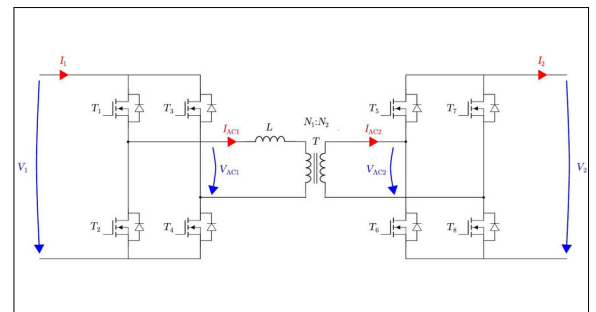
## Maximal Power and Current for the Power Derating of the Battery.

Own presentation



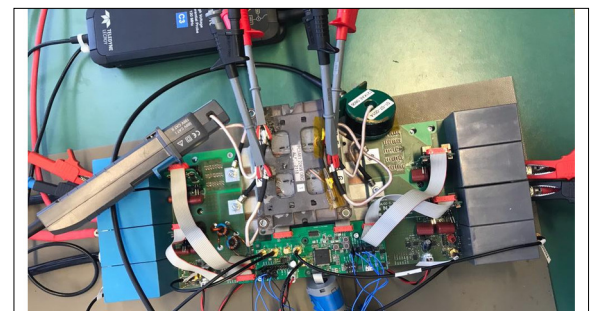
## Dual Active Bridge Converter Topology.

Dissertation Florian Krismer.



## Measurement Setup.

Own presentation



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