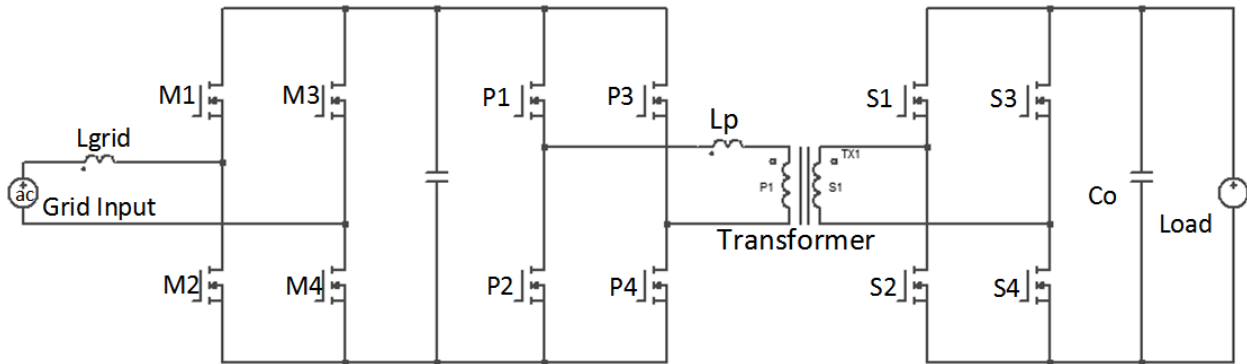


## Planar Transformer vs WCM Transformer

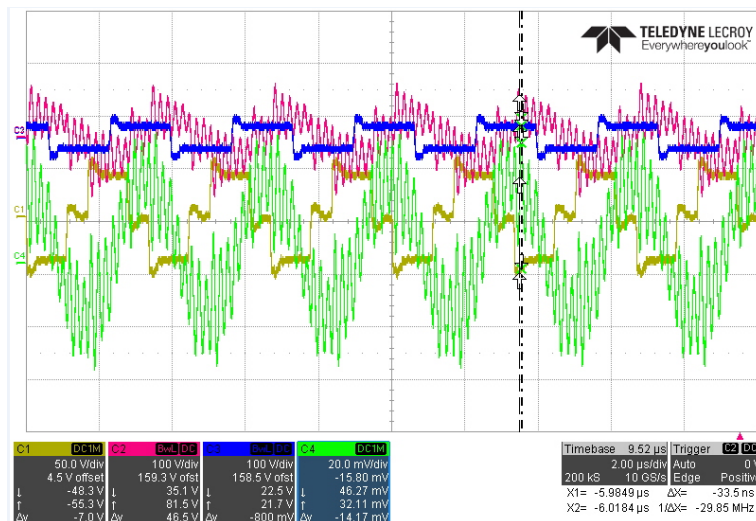
The collaboration between Kettering University and Hella Electronics is to build a high-efficiency level-2 battery charger for electric vehicle. The input voltage is a single-phase 208VAC, output voltage is 200~450VDC, and the rated power is 7.2kW. The target efficiency is >97% in contrast to 94% of most presently existing chargers.

The selected topology is shown as below. All devices P1~P4 and S2~S4 are GaN HEMTs provided by GaN Systems. The switching frequency is up to 500kHz.

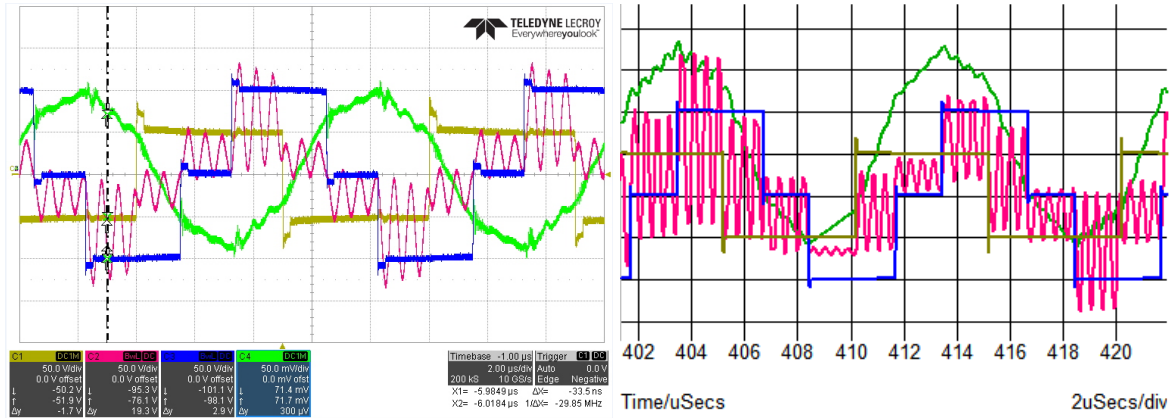


For the planar transformer (130mm\*90mm\*40mm),  $L_p=10\mu\text{H}$  is a standalone inductor placed outside of the transformer. For WCM transformer,  $L_p$  is integrated inside the transformer thereby saves the space

When the output voltage is 400V, below is the experimental waveform with the planar transformer equipped, where the green curve is the secondary-side current of the transformer measured by the Rogowski coil.



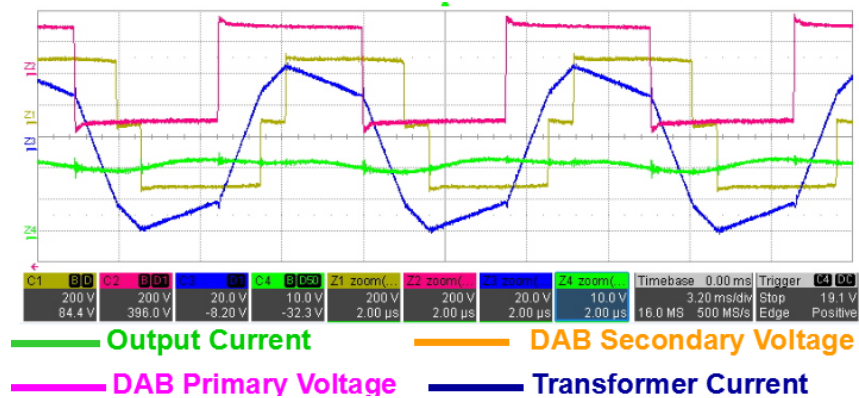
The significant oscillation is caused by the winding capacitance. 3nF capacitance is measured across the secondary-side winding. In our simulation, once this 3nF capacitance is placed in the model, we observe exactly the same current waveform, shown as below. Here the purple line is the secondary-side current. Such high-frequency oscillation makes the system unable to work.



(a) Experimental waveform

(b) simulation waveform

With the WCM transformer to suppress the winding capacitance, such oscillation disappeared, shown as below.



With no current oscillation, the designed charger successfully reached 7.2kW@98% efficiency.

