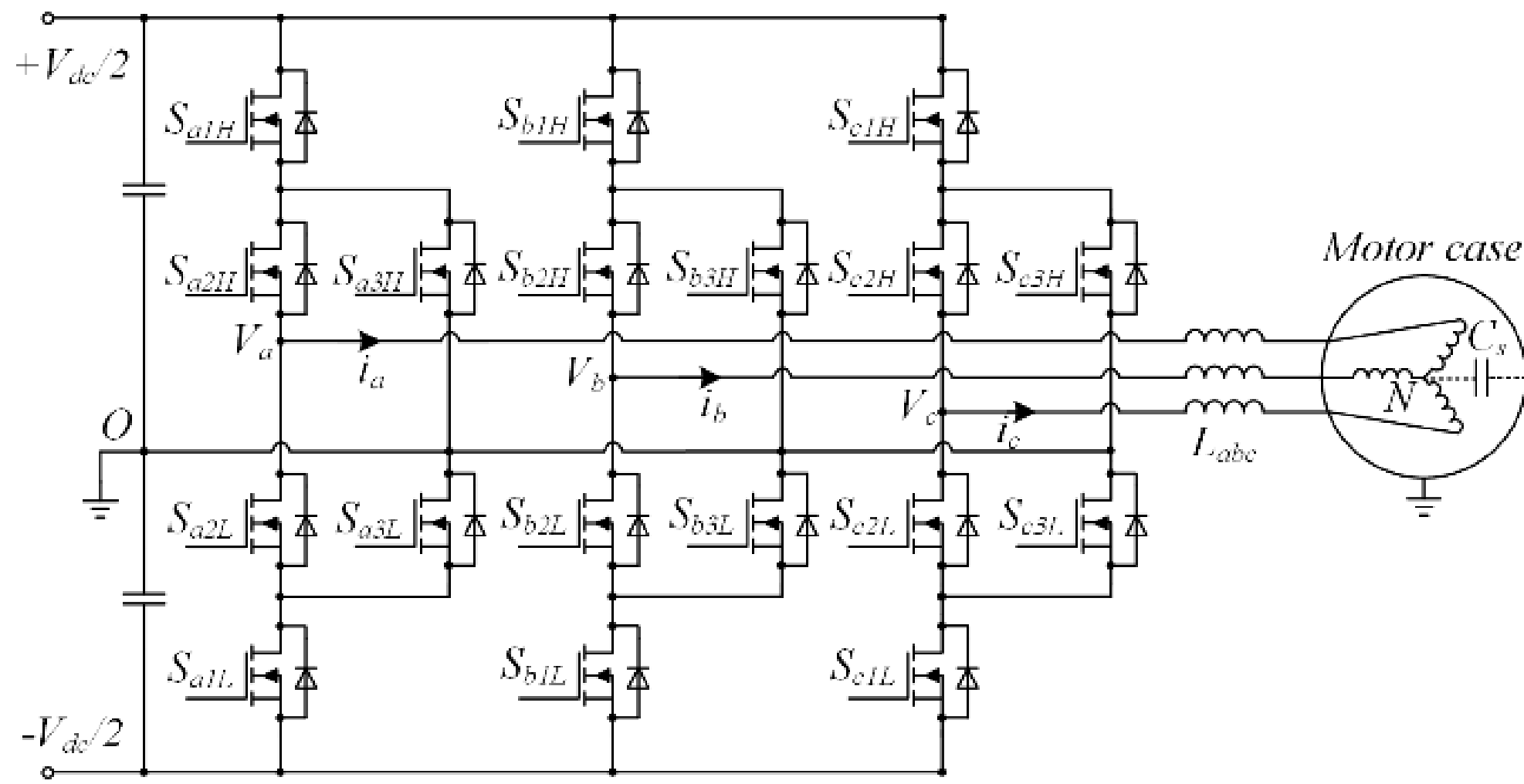


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BACKGROUND

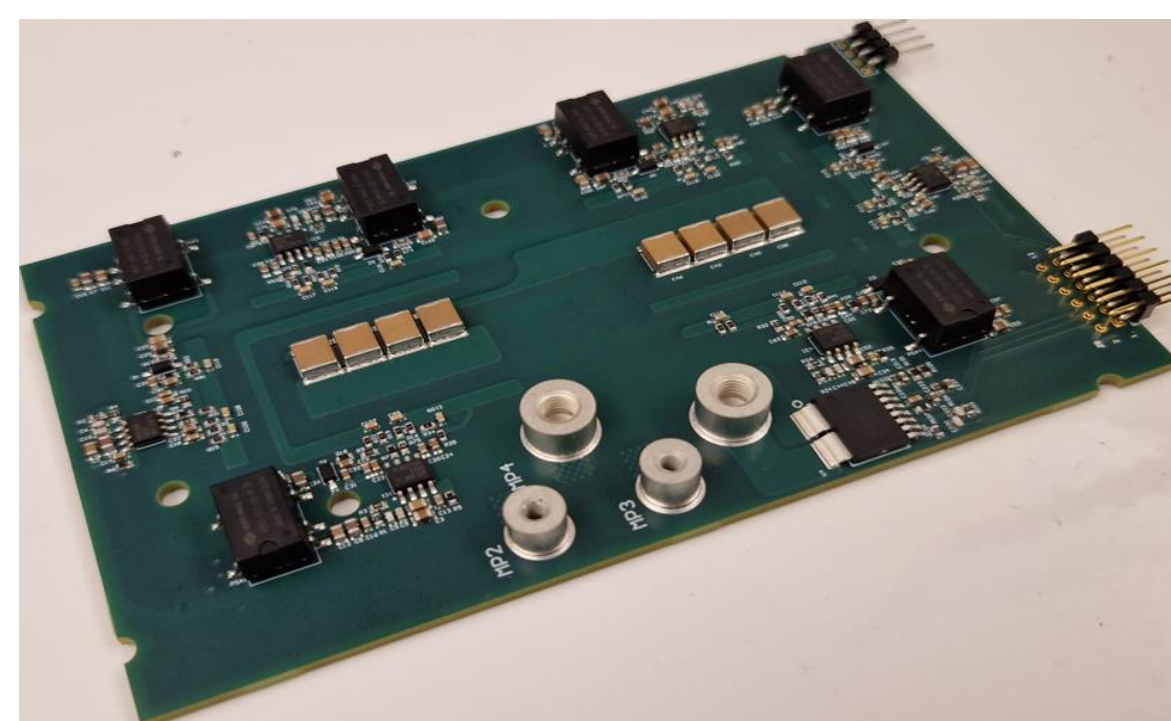


GaN HEMTs have been becoming popular among vehicle companies and their suppliers since the last decade, offering benefits including lower switching losses and higher efficiency. Three-level active neutral-point-clamped (ANPC) inverter enables the capability of handling the trending future 800 V battery system on electric vehicles with GaN devices. Meanwhile, three-level inverters greatly reduce the common mode voltage, which is the main cause of motor bearing voltage and current. This work features a 75 kVA/800 V inverter with off-the-shelf automotive-qualified 650 V/60 A GaN HEMTs. Three paralleled switches ensure enough peak current margin and low on-resistance.

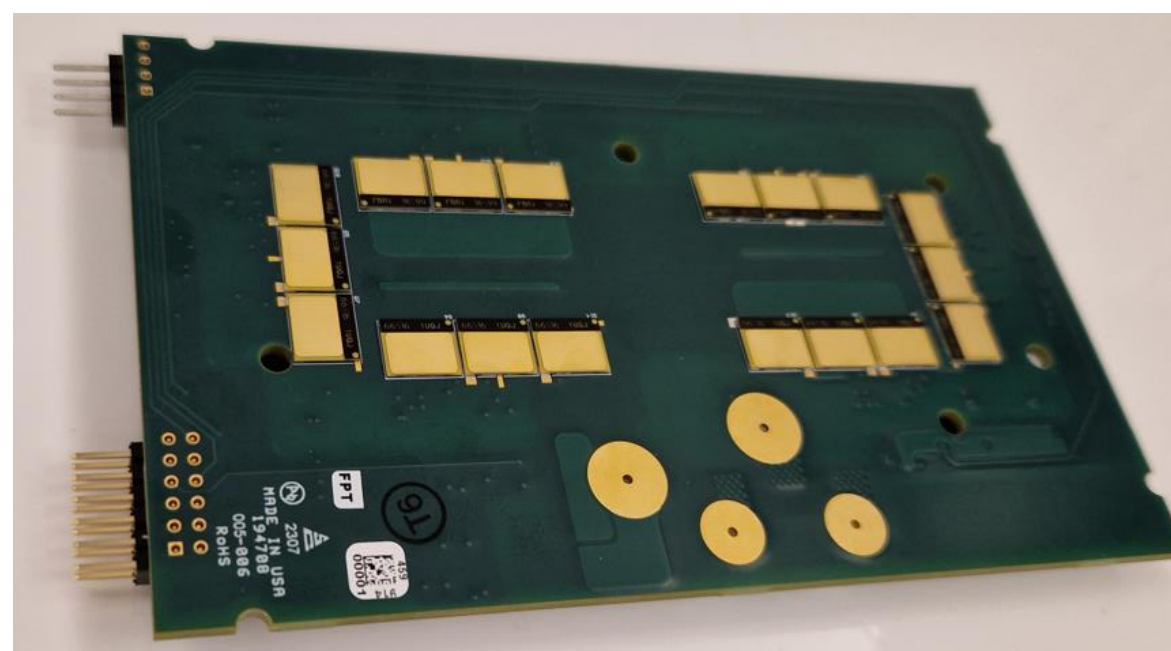
BUILD AND TEST

The phase-leg design follows a rule of zero cross of HV/LV regions and partial flux canceling. Upper and lower sides have almost equal distance to the DC input and AC output terminals. The terminals have equal heights with the gate driver power supplies. Low profile switches are put on the back side.

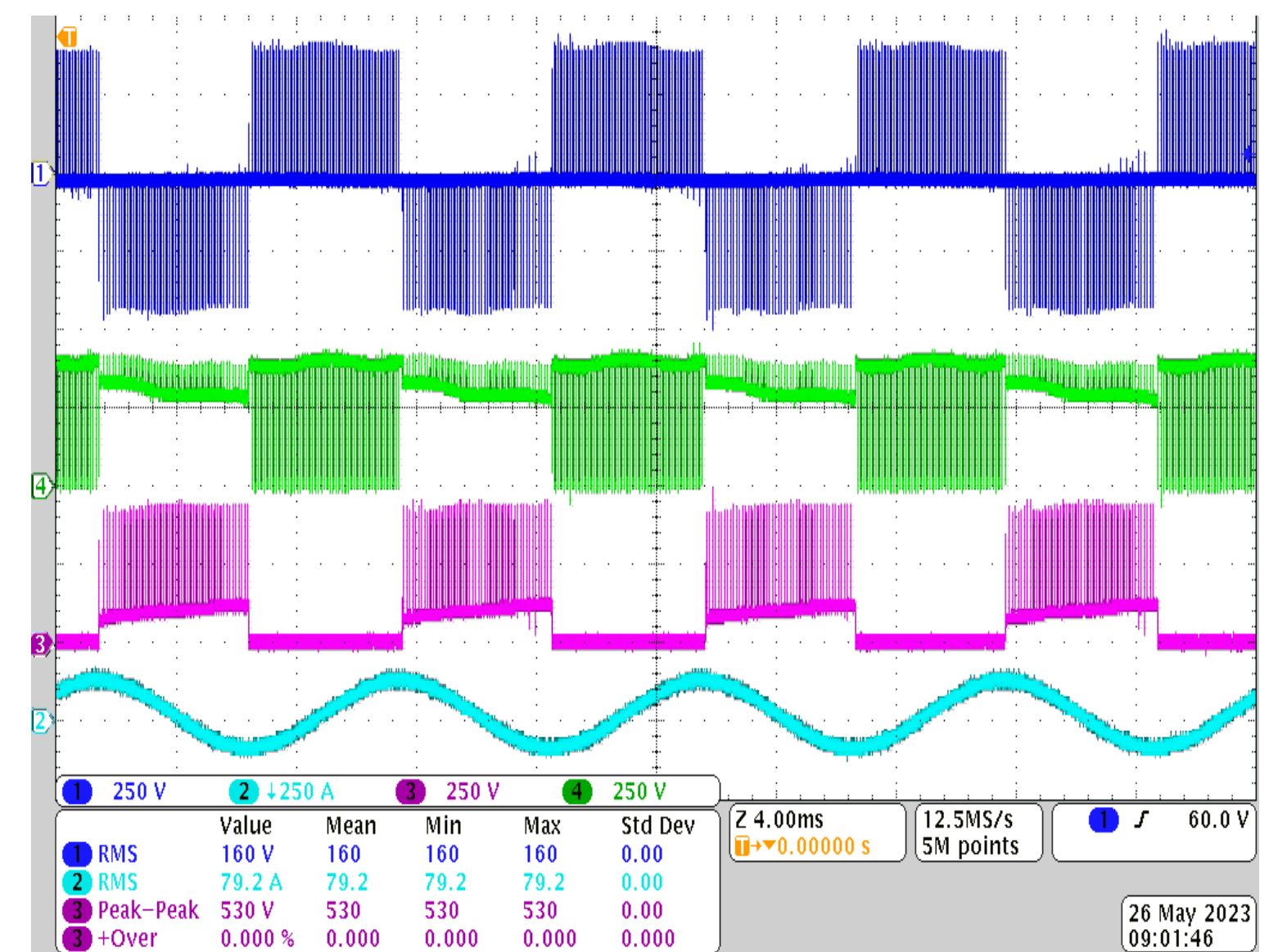
The 3L inverter generally demonstrate higher efficiency on lighter load.



One three-level leg (top view)



One three-level leg (bottom view)

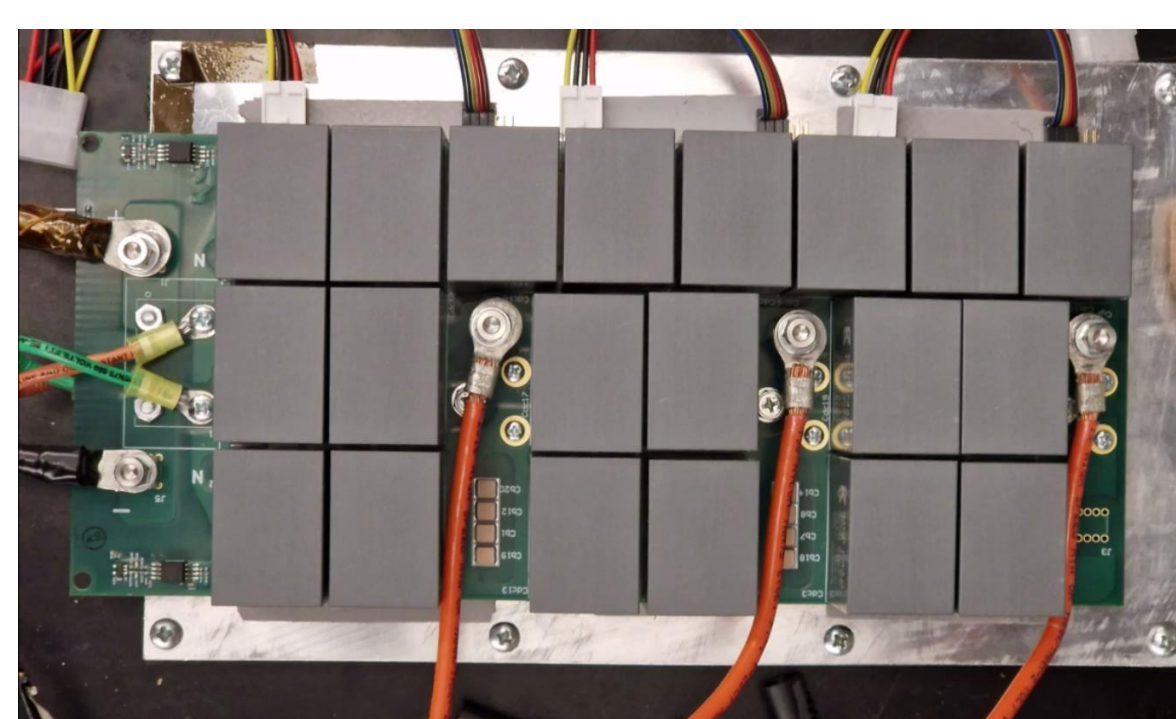


DC bus is 800Vdc, phase current ~79.2Arms and the overall power is 77.6kVA (RL load)

Parameter	Value	Unit
Udc1	0.76364	kV
Idc1	19.991	A
P1	15.262	kW
Urms3	0.54018	kV
Irms3	65.783	A
S3	35.535	kVA
Urms4	0.53884	kV
Irms4	63.767	A

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Under full load, the RL load test reveals a worst efficiency no lower than 98%



DC-link capacitor board

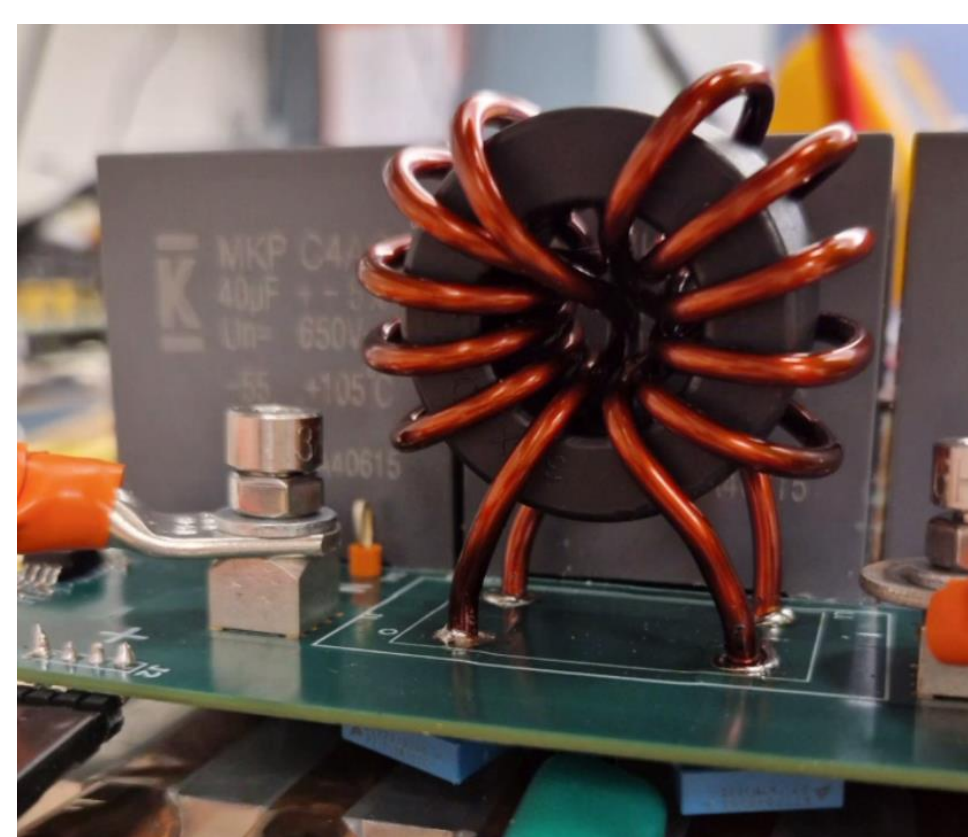
From top to bottom, the scope shows the phase voltage, two switch voltages, and the phase current. In this particular time frame, the switch voltage peaks around 530 V, 82% out of 650 V rating.

The general efficiency can be further increased if the topology is further optimized, so that a better switching scheme can be used without any concern of over-voltage.

APPLICATIONS AND FUTURE WORKS

Benefits of 3L inverter have been investigated through several tests. By measuring the EMI noise, it is proved that the DC-side common mode filter can be much smaller 2L to meet the CISPR-25 standard. Since the CM voltage is lowered, the bearing current inflicted on the motor is also reduced, under same motor speed, same modulation index and DC voltage.

Bearing current prediction and optimization are some of the potential research.



CM Choke measured 42 mm with windings

