REDESIGNING A CLASSIC

High frequency ranges bring speed and noise immunity improvements to the established CWT range of wideband Rogowski current probes, says *Chris Hewson*, Power Electronic Measurements

Power electronics is now embedded in power utility and transmission, renewable power generation, industrial processes such as induction heating and welding, traction applications and electric vehicles. Rogowski technology is just one method of current measurement competing for the power electronic engineer's attention. Current transformers (CTs) offer very high bandwidth and isolation, combination Hall effect and CT current probes offer very wide bandwidth and DC current capability, shunts do not offer the isolation but are available in a range from low cost embedded sensors to highly accurate devices, co-axial shunts offer GHz capability and Fluxgate sensors, though bandwidth limited, offer exceptional accuracy.

Figure 1: One of the original CWT units (left) with a rigid opening, Rogowski coil and the latest CWT (right) with a flexible, clip-around coil

One example of rapid change in power electronics is the challenge posed by the recent revolution in semiconductor switches. They have higher blocking voltages, higher temperature operation, increasingly compact planar construction and faster turn on and off times. The fundamental benefits of measuring semiconductor currents with Rogowski current probes still apply: low insertion impedance of less than 15pH for a 100mm coil, remote passive probe head capable of high temperature operation, high frequency bandwidths in the MHz range enabling measurement of fast current transients, isolated measurement - and they can be as thin as 1.6mm and clip-around. Developments in semiconductor materials, such as SiC and GaN continue to push the limits of these probes.

One area of significant improvement in PEM's diverse CWT range of wideband Rogowski current probes has been the increase in bandwidth coupled with improvements in voltage field immunity. This is a difficult balance because electrostatic shielding of a Rogowski coil can reduce its bandwidth. PEM has patented a new technique to gain improvements in both the speed of the probe response and its ability to attenuate interference from voltage fields. These are the new HF variants of the CWT range. The CWTHF and CWTMiniHF50 employ these improvements, for example the new CWTMiniHF50 with a 100mm long, 3.5mm thick Rogowski coil, has a bandwidth of 50MHz enabling measurement of rise-times of just 12ns. A typical measurement of turn-on time in a GaN MOSFET (Figure 2) compares the CWTMiniHF50 probe with a co-axial shunt. The Rogowski coil is located at a part of the circuit in close proximity to a voltage transient of approximately 40V/ns. The voltage transient shows no influence on the CWTMiniHF50 measurement, conversely the non-isolated co-axial shunt, although measuring the same current, has to be connected at the earthed end of the circuit which is not always possible in high sided measurements. The delay of the CWTMiniHF50 is predictable and can be compensated for in power loss measurements.

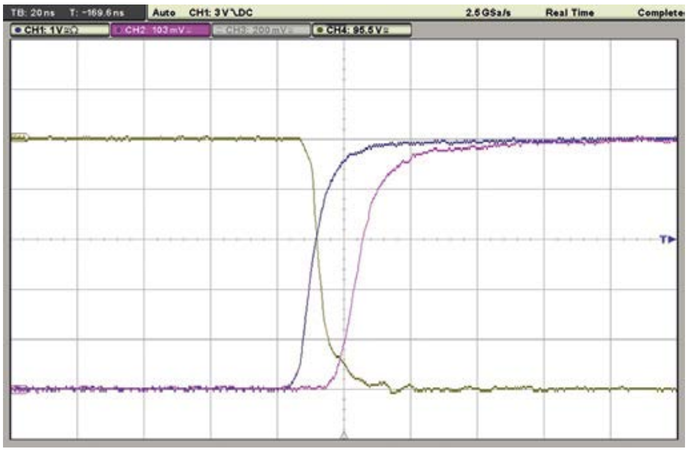

Figure 2: A typical measurement of turn-on time in a GaN MOSFET compared with the CWTMiniHF50 probe with a co-axial shunt

Traditional current probes and CTs employing magnetic materials are typically limited to operation at 70ºC. With semiconductors running at 125ºC and higher in increasingly compact converter designs, a probe needs to be able to operate continuously at 125ºC. Rogowski coils are remote from their signal processing electronics.

With careful design, using resins and plastics with stable temperature characteristics, it is possible to achieve continuous high temperature operation and reduced measurement drift with temperature. The compact CWT Ultra-mini, CWTMiniHF and CWTMiniHF50 probes are rated from -40 to +125ºC, and tested with 1000s hours of temperature cycling operation. Shrinking converter sizes mean it is increasingly difficult to get a probe into a power electronic circuit to perform measurements. The CWTMiniHF50 probe offers an improvement in coil size (see Figure 3) and is believed to be the smallest shielded Rogowski probe on the market. The CWT Ultra-mini probe, which although not shielded offers a high bandwidth measurement and a coil thickness of just 1.6mm allowing measurement in semiconductor devices as small as a T0220.

Figure 3: Left to right: shielded CWTminiHF50, CWT Ultra-mini and a prototype shielded, fixed core coil

At PCIM 2018, the company will demonstrate a tiny fixed core Rogowski current probe with a bandwidth above 50MHz which can be used for test or as an embedded sensor.

The CWTHF has coil lengths from 300 to 1000mm as standard with longer coils on request and 10kV peak coil insulation. A 300mm coil has a high frequency bandwidth of 30MHz and features the same voltage shielding capability as the CWTMiniHF coils. The CWTHF can be used on larger, higher voltage semiconductor devices and the improved e-field immunity and higher bandwidth opens up potential applications such as lightning current measurement, EMC studies (motor drives, traction and power utilities), short circuit fault detection and RF.