Technical Note: CPCO and CPC, Recovery from Overcurrent

Equipment

- GMW CPCO Current Probe
- GMW CPC Current Probe

SENSOR OVERVIEW

The GMW CPC and CPCO Current Probes have no magnetic core unlike an open-loop or closed-loop Hall effect or similar Current Sensor. Instead, the magnetic field around the current is "sampled" by an array of "point" field sensors. A summing algorithm is used to generate an output signal that is a good approximation to the Ampere Line Integral along a line enclosing the current.

An important consequence of Ampere's Law is that for a current not enclosed by the line, the Line Integral is zero. The GMW summing algorithm is quite effective in rejecting magnetic fields from currents or magnetic field sources outside (not enclosed) by the Probe.

RECOVERY FROM OVERCURRENT

The Field Sensors used in the CPC and CPCO Probes have a linear response versus field over the nominal field range. Outside the field range the Sensors electrically saturate with the same polarity as the field. Thus, the output signal accurately gives the sign of the overload current. There is no damage to the Sensors when they saturate for however long the field is applied. When the field returns to within the Sensor field range the Sensors track the field within <10us with no electrical hysteresis and no damage.

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This behavior of the CPC and CPCO enables their application even if the peak current is very high, say 200kA as in a circuit breaker test. A Rogowski Coil AC Current Probe can be used to measure very high peak currents but since it is an AC Probe it does not accurately show the current return to zero. A GMW DC/AC CPC or CPCO can be used in parallel with the AC Probe to show the current behavior once the primary current is within range. The output signal is accurate within a delay of about 10us.

A typical Hall- or MR-based Current Sensor has a Core with a gap and the Hall or MR Sensor is in the gap. With an open-loop Current Sensor the core magnetically saturates toward high current and after the current recovers there is a magnetic remanence in the Core which is effectively a zero offset. A closed-loop Current Sensor has a compensation Coil and a servo circuit drives a Compensation Current through the Coil to maintain a flux in opposition to that generated by the primary current. This maintains the core at about "zero net flux" and the field sensor in the Core gap at about zero field. The Closed-loop Sensors have very good performance until the Compensation Current reaches the nominal limit. Above that current the Core Saturates. Under this condition some zero flux Current Sensors oscillate and the output signal has no relation to the primary current. With some Sensors operating in this state with a continuous current overload can lead to permanent damage. Often it is hard to find the consequences of current overload in the published specification.

An advantage of Closed-Loop/Zero flux Current Sensors is they can have high Sensitivity, good Linearity, and a large dynamic range (maximum current/equivalent noise current).