CAENels
Gear For Science

FLUCS
DCCT SERIES

Precision Current Transducers
Working Principles

Current measurement is a critical task in many different fields of applications: power inverters, high performance power supplies, test & measurement setups as well as calibration systems.

Many different techniques are used when needing to measure both DC and AC currents, ranging from shunt resistor voltage drop sensing to Hall effect based sensors.

All of these solutions present some critical drawbacks:

- **shunt resistors** present reasonable linearity behaviour but they are not isolated from the conductor to be measured and they are not suitable for high-current applications because of large power dissipation and high temperature dependence;
- **Hall effect** sensors are isolated from the measured conductor but they have very high temperature dependance, poor linearity as well as poor precision and the saturation effect to deal with.

The CAEN ELS **0-FLUCS** (0-FLUx Current Sensor) technology is based on a DC Current Transformer – i.e. **DCCT** – principle and it represents the right solution in order to obtain maximum performances.

The basic concept behind this sensor series, that allows to measure both DC and AC currents with a large bandwidth, is briefly presented.

By applying a signal – i.e. the excitation signal I_E – to a particular ferromagnetic material, a symmetical saturation behaviour is obtained. This symmetry is then unbalanced by the application of an external field, which is generated by the current flowing into the conductor that has to be measured (the primary current I_P).

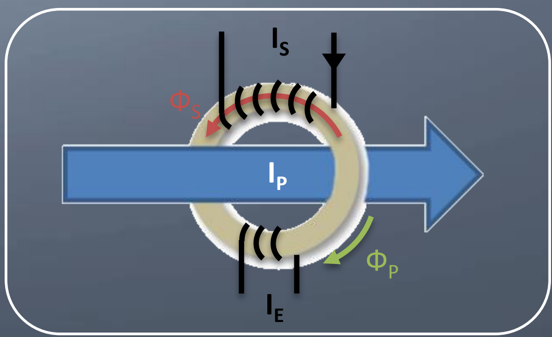
The application of an additional current into a separate winding – i.e. secondary current I_S with a transformation ratio of N respect to the primary current I_P – allows the symmetrical saturation behaviour to be restored.

This secondary current I_S is then a scaled version of the primary current that has to be measured. By sensing this secondary current I_S, the value of the primary one could be estimated:

$$I_P = N \cdot I_S$$

The zero flux condition then refers to the the situation where a null magnetic flux is restored on the sensor:

$$\Phi_P + \Phi_S = 0$$

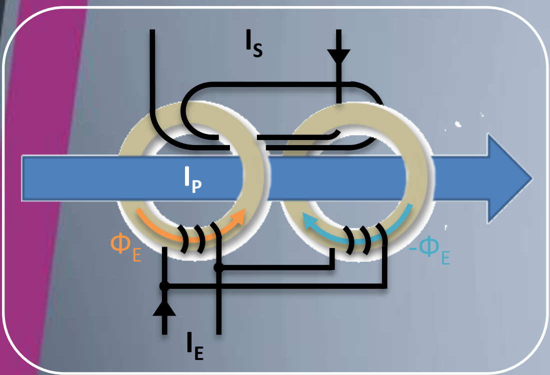


Basic 0-FLUCS principle

The described basic approach has some

secondary effects that need to be considered: the excitation current I_E generates a magnetic flux - i.e. Φ_E – that induces a current onto the primary conductor and can then affect the measurement (perturbating also the secondary circuit).

By adding an extra-core, identical to the one where the excitation signal is applied, and by applying the same inverted excitation signal, the induced magnetic field generated is greatly reduced and theoretically nulled, thus eliminating the perturbation on the primary conductor.



Compensation of excitation field

The addition of a further winding, dedicated to improve the AC response of the whole detecting system, leads to a flat frequency response over some hundreds of kHz.

The advantages of this current detecting system are:

- DC and AC current measuring capability;
- electrical isolation from the circuit to be measured;
- high measuring range (up to kA);
- excellent linearity;
- large bandwidth;
- high efficiency (at higher currents);
- negligible temperature dependance (sub-ppm level);
- extremely low offset (trimmable to zero);
- very high precision and accuracy.

The CAEN ELS precision current tranducer series ranges from PCB-mount devices (as low as ±13A primary current) to kA-rated devices.

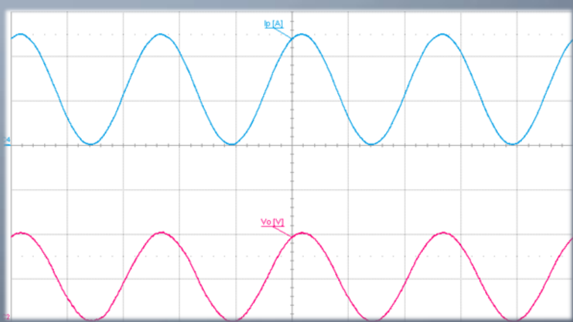
CT-PCB Series

CT-200/300/400 Series

One critical task is to convert the secondary current to a measurable voltage level: this is greatly affected by the burden resistor specifications and by the conversion circuit performances. By considering a K conversion ratio between output voltage V_O and current I_S, the value of the primary current can be estimated:

$$I_P = N/K \cdot V_O$$

CAEN ELS provides sensors with either secondary current output (preferred in critical noise pick-up applications) and with integrated current-to-voltage conversion in order to guarantee the best performances on the market having ppm-level temperature dependance also on voltage-output versions.



Primary measured current I_P and V_O output

Check out our website www.caenels.com in order to find more information on commercially available models and for inquiries about custom solutions.

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