Content is subject to change without notice

Pulse
A TECHNITROL COMPANY

Current Sense Devices

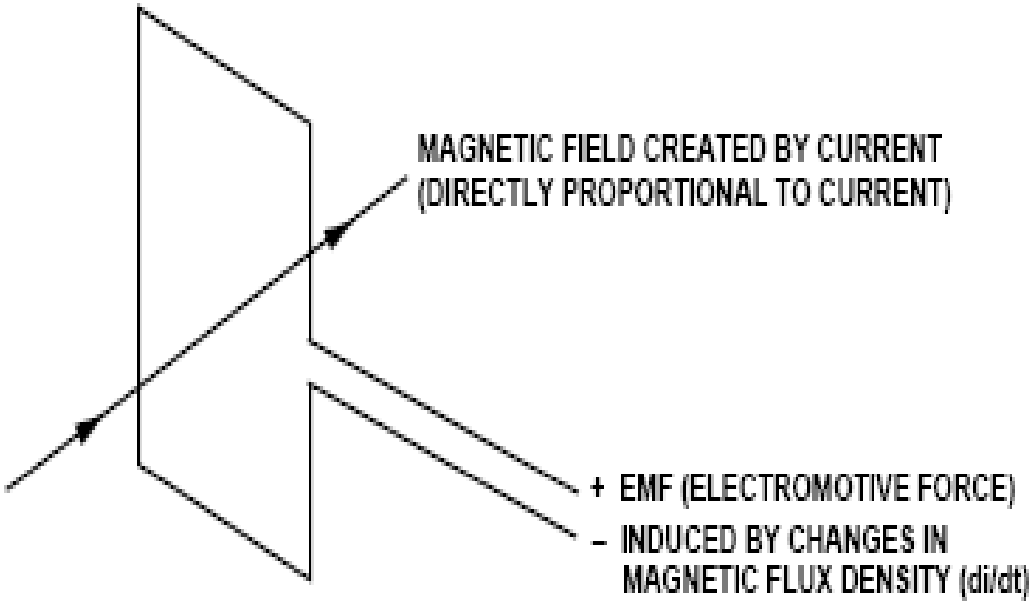
- A **current sensor** is a device that detects electrical current (AC or DC) in a wire, and generates a proportional signal

- AC current input,
  - analog output, which duplicates the wave shape of the sensed current
  - unipolar output, which is proportional to the average or RMS value of the sensed current

- DC current input,
  - unipolar, with a unipolar output, which duplicates the wave shape of the sensed current
  - bipolar output, which duplicates the wave shape of the sensed current
  - digital output, which switches when the sensed current exceeds a certain threshold

Current Sense Transformer

A Current Sense Transformer is coil of wire that will pick up the magnetic field created by the current in the main conductor. The EMF is a voltage signal that will be proportional to the current change.



Current Sensing for Power Metering

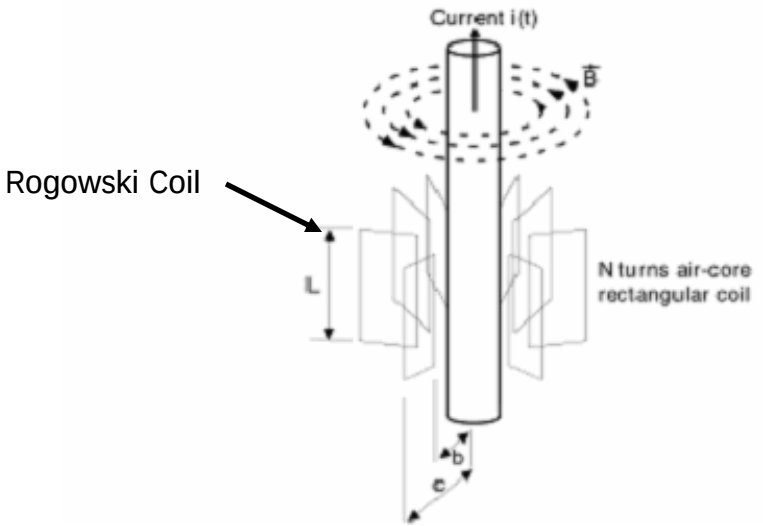
- Accurate current sensing is critical for power metering applications.
- Several technologies exist for current sensing including
  - Low resistance current shunts
  - Current transformer with amorphous metal core
  - Hall Effect devices
  - Rogowski Coils

Types of Current Sense Transformers

Current Sensing Technology	Low resistance current shunt	Current Transformer	Hal Effect Sensor	Rogowski Coil
Cost	Very Low	Medium	High	Low
Linearity over measurement range	Very Good	Fair	Poor	Very Good
High Current measuring capability	Very Poor	Good	Good	Very Good
Power consumption	High	Low	Medium	Low
DC/high current saturation problem	No	Yes	Yes	No
Output variation with temperature	Medium	Low	High	Very Low
DC offset problem	Yes	No	Yes	No
Saturation and Hysteresis problem	No	Yes	Yes	No

Rogowski Coils

- Consists of wire wound on a non magnetic core or an air core
- Detects the magnetic field created by the current change in the conductor and generates an EMF voltage proportional to it



$$EMF := \frac{\mu_{air} \cdot N \cdot L}{2 \cdot \pi} \cdot \ln\left(\frac{c}{b}\right) \cdot \frac{di}{dt}$$

- The Rogowski Coil output voltage must be integrated to obtain a voltage proportional to the measured current

Advantages of Rogowski Coils

- Low Cost
- Not influenced by external magnetic fields, and can be immune to magnetic tampering
- Are non-intrusive – draws no power from the main circuit
- Have a very wide Sensing bandwidth extending from 0.1 Hz up to 17 MHz
- Measures AC signals superimposed on a large DC Current
- Can measure large currents without saturating and can measure changes of current as fast as 40,000 A/μs

Development of Rogowski Coils

- Pulse is exploring the potential for use of Rogowski Coils as current sensors in power metering applications
- Issues for manufacturing Rogowski coils are being investigated:
  - Uniformity of the winding
  - Repeatability
  - Low output signal
  - Back winding of the coil to avoid external magnetic fields
- Pulse is working toward understanding the meter manufacturer's design requirements surrounding the Rogowski Coils, and is looking to engage with the power meter IC vendors to develop the technology for wider use