

Relaying Practices Subcommittee

***Guide for the Application of Rogowski Coils used for
Protective Relaying Purposes***

Chair: Ljubomir Kojovic

Established: January 2004

Output: Report to Subcommittee

Assignment: Discuss the need for development of a Guide for the Application of Rogowski Coils used for Protective Relaying Purposes. If approved, develop the guide.

Contents *(subject to change)*

- 1. Overview**
 - 1.1 Scope**
 - 1.2 Purpose**
- 2. References**
- 3. Definitions**
- 4. Principle of Rogowski coil operation**
- 5. Different types of Rogowski coils**
- 6. Performance characteristics (linearity, accuracy, sensitivity, frequency response)**
- 7. Installation considerations (installations, grounding, and shielding)**
- 8. IEC Standards on instrument transformers (relevant to Rogowski coils)**
- 9. Testing (type, routine, and field testing)**
- 10. Interface requirements with relays**
- 11. Applications for protective relaying**
- 12. Bibliography**
- Annex: Other non-conventional technologies for current measurements**

CIGRE

Study Committee B5 : Protection and Automation

... "The Rogowski current sensor and the voltage divider are shown to be capable of meeting the new requirements. These sensors have become technically feasible due to the introduction of micro-processors in the secondary equipment"...

... "Optical principles and Rogowski coils are used with good practical results both in GIS and AIS."...

IEC 60044-8

First edition 2002-07

Instrument transformers

Part 8: Electronic current transformers

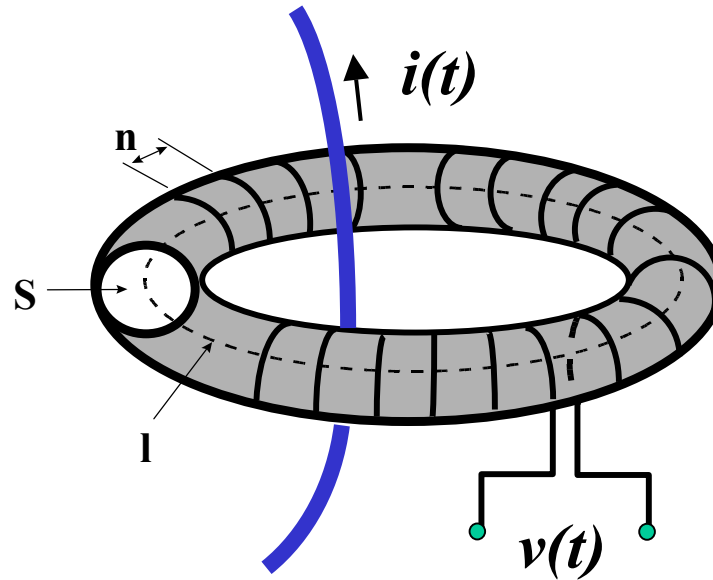
IEC 61850-9-1: Communication networks and systems in substations

Part 9-1: Specific communication service mapping (SCSM) – Sampled analogue values over serial unidirectional multidrop point to point link

IEC 61850-9-2: Communication networks and systems in substations

Part 9-2: Specific communication service mapping (SCSM) – Sampled analogue values over ISO 8802-3

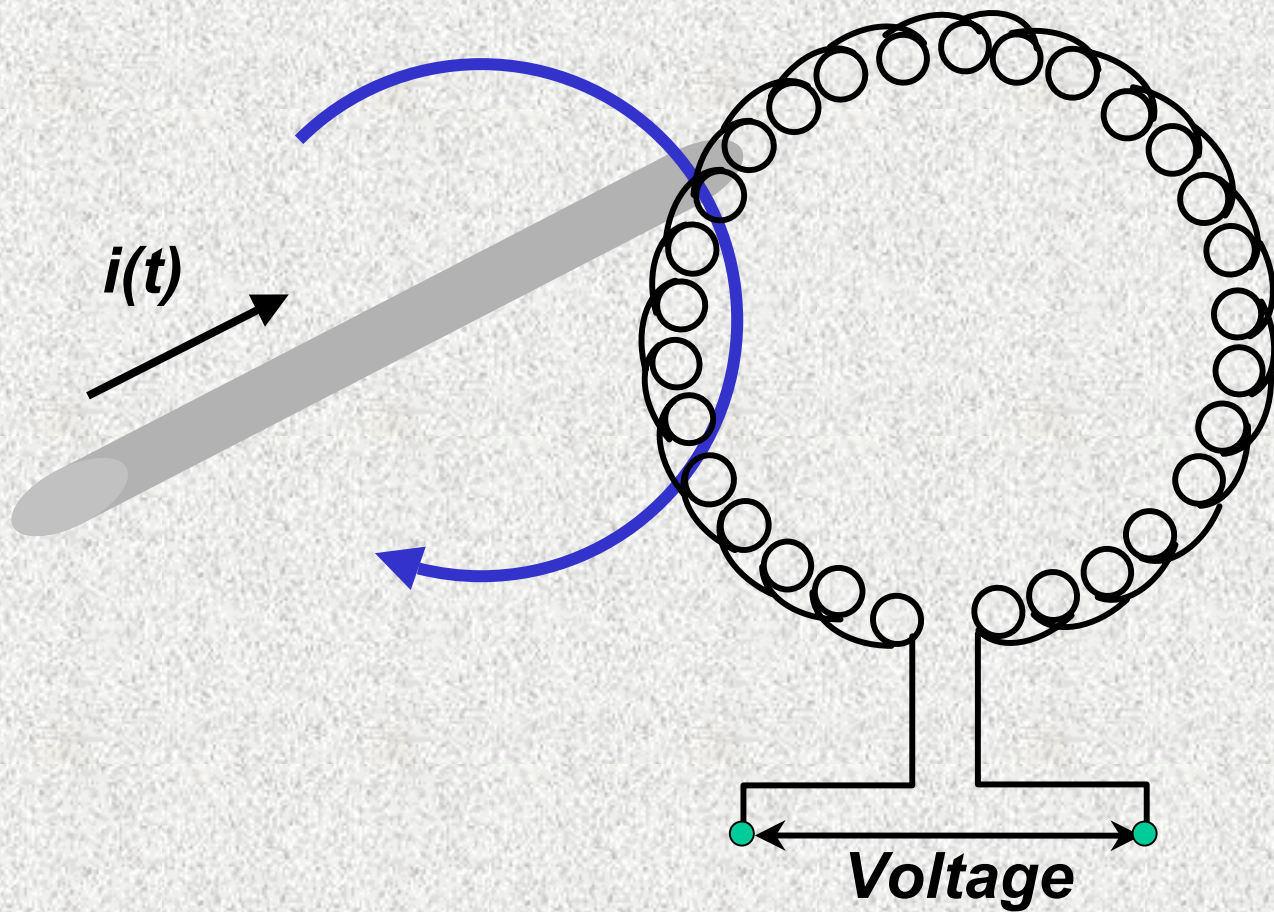
Principle of Operation

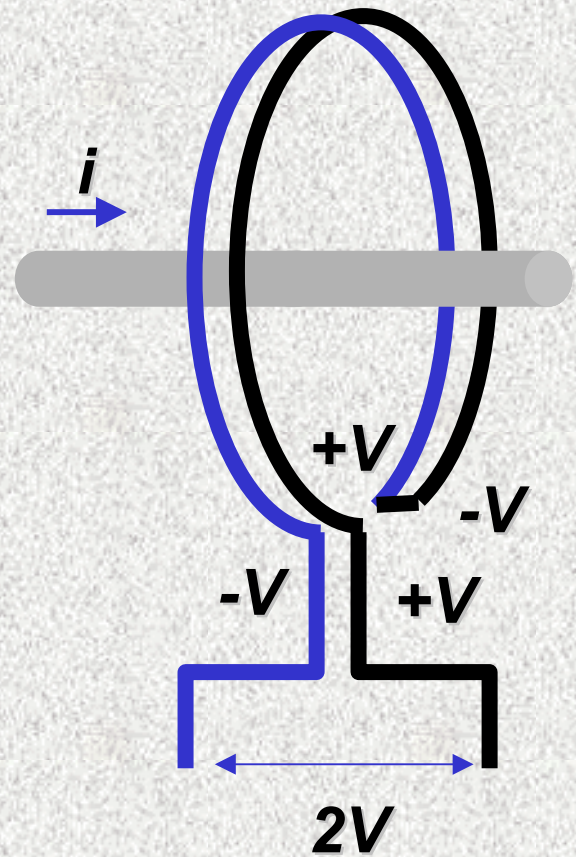
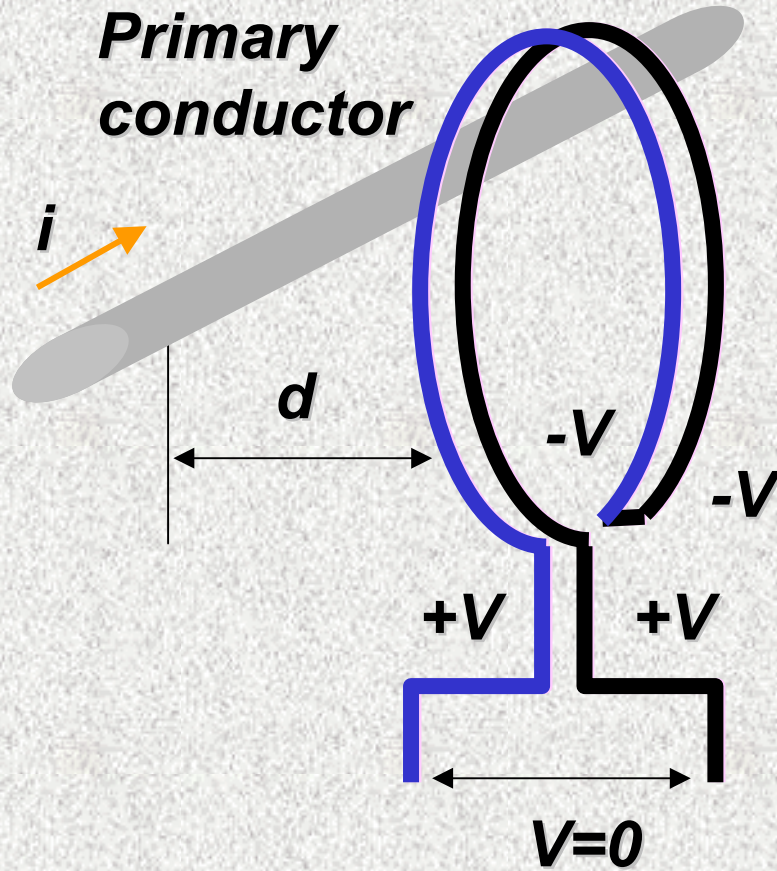


$$v(t) = -\mu_0 n S \frac{di(t)}{dt} = -M \frac{di(t)}{dt}$$

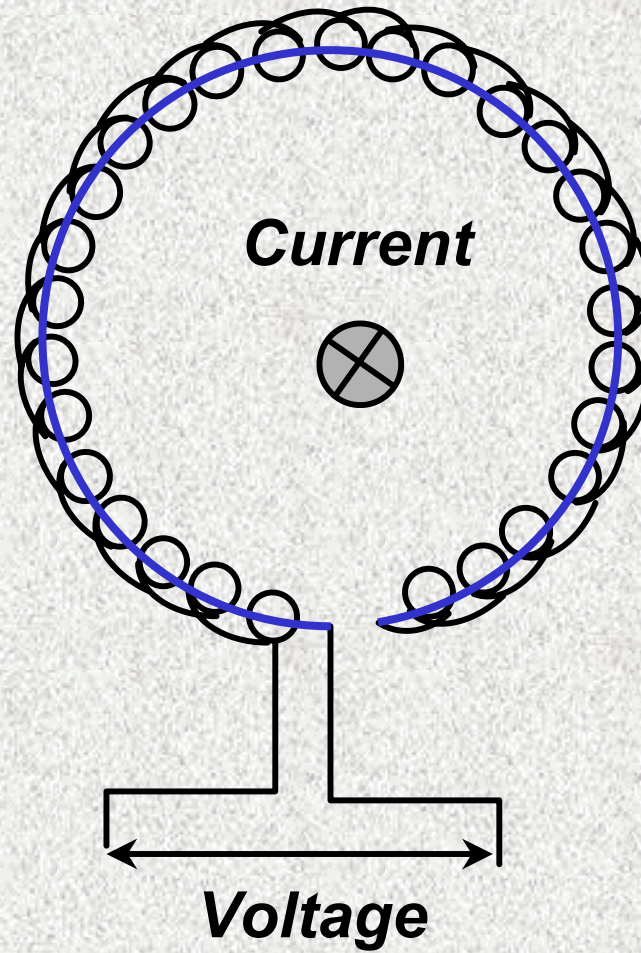
$$v(t) = \frac{M}{RC} i(t)$$

External Fields



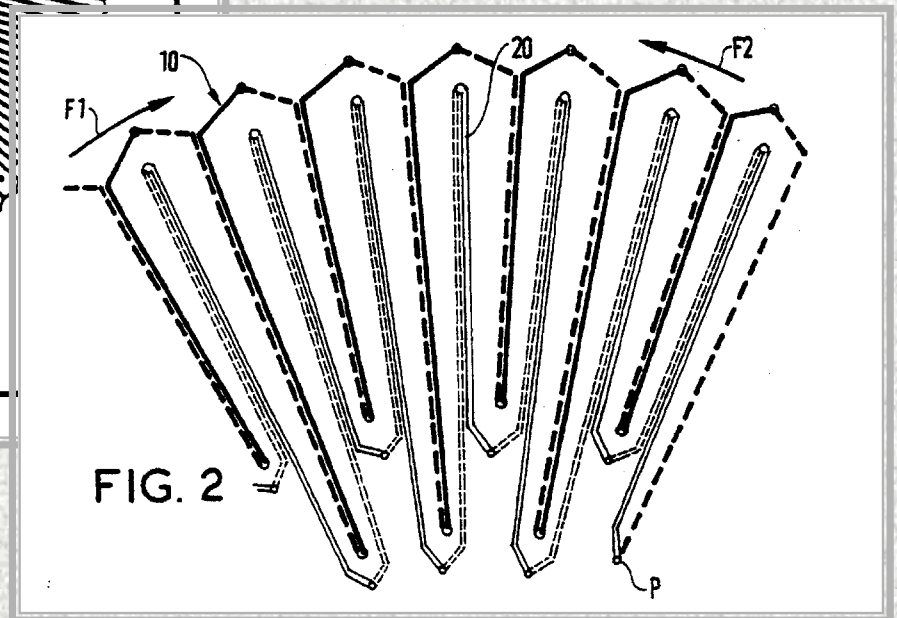
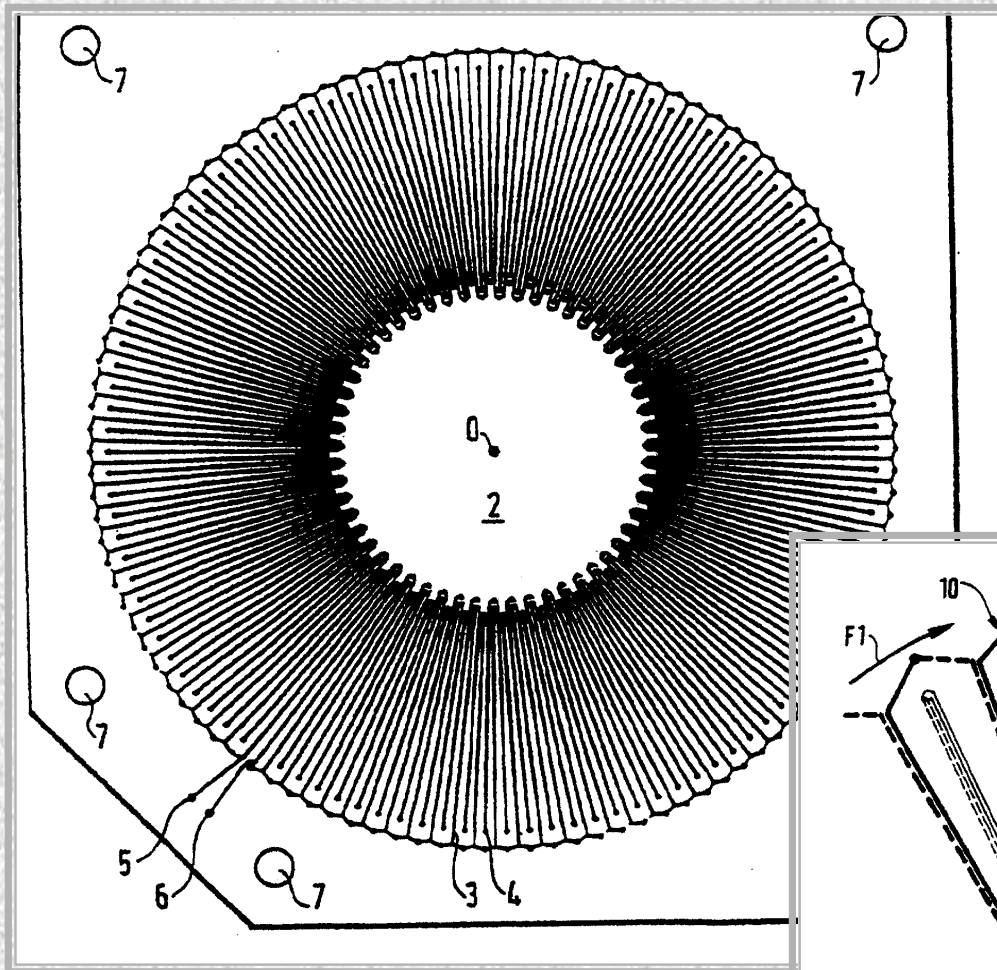


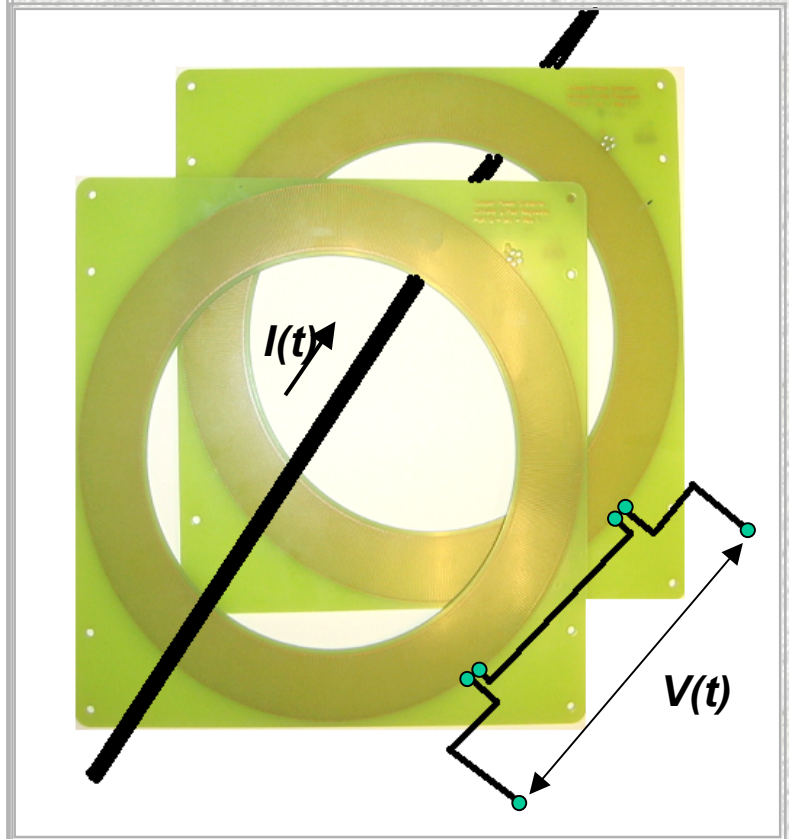
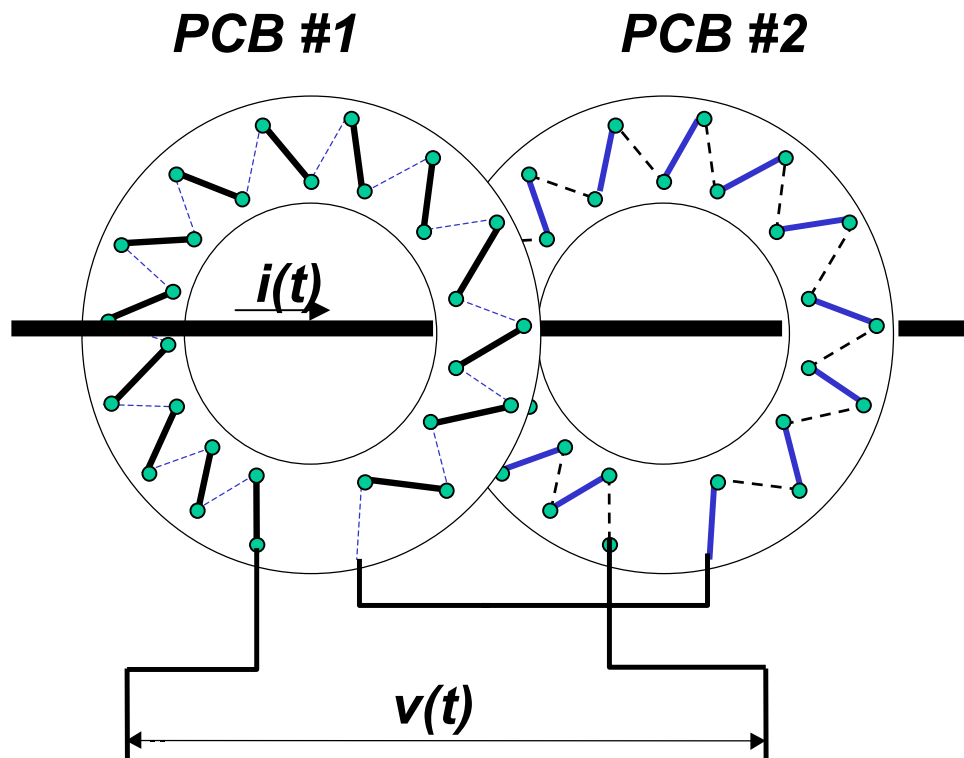
Rogowski Coil Design



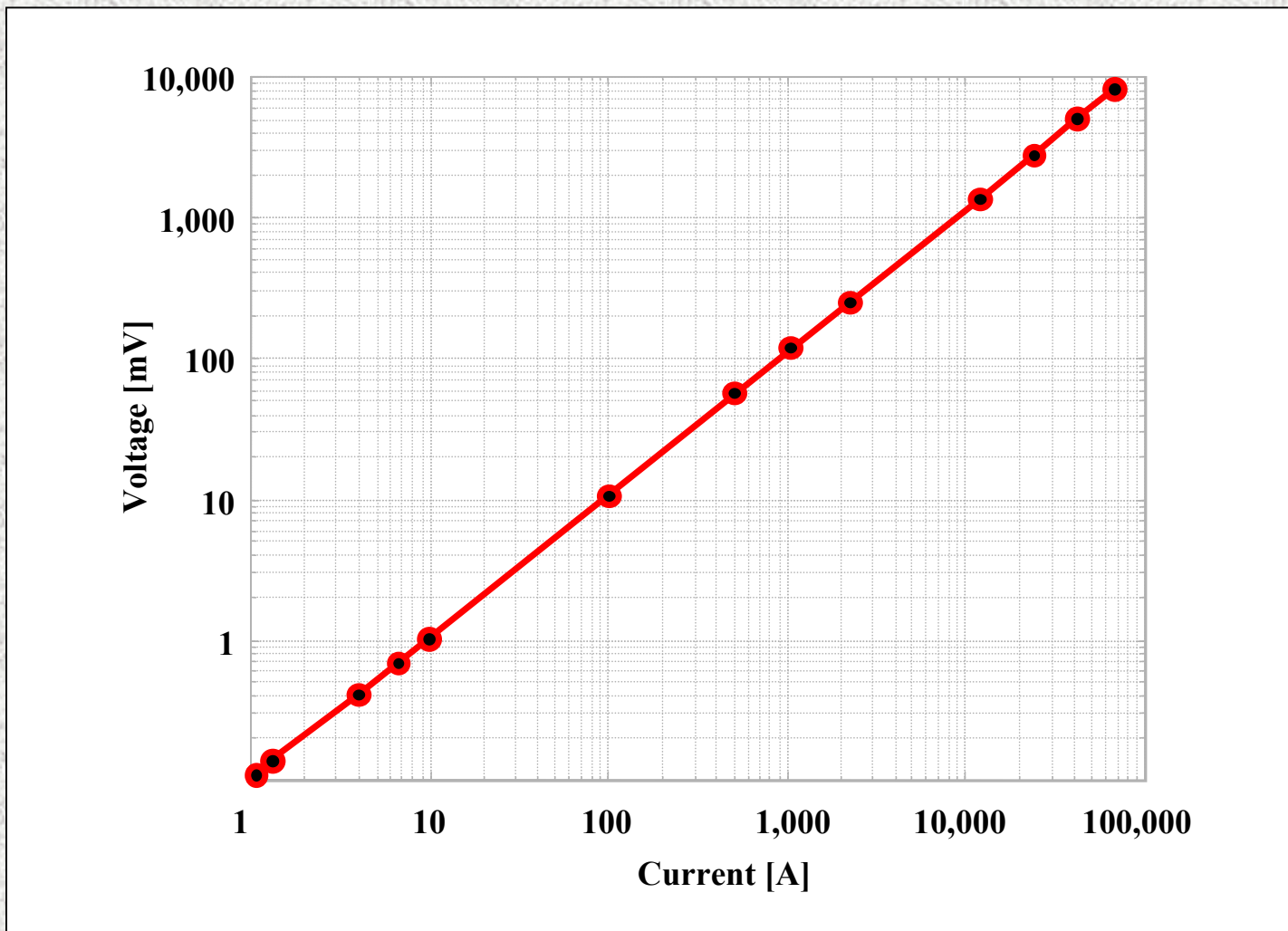
GEC Alsthom

<u>Patent No:</u>	<u>Date:</u>
5,414,400	May 09, 1995
5,442,280	August 15, 1995
5,461,309	October 24, 1995

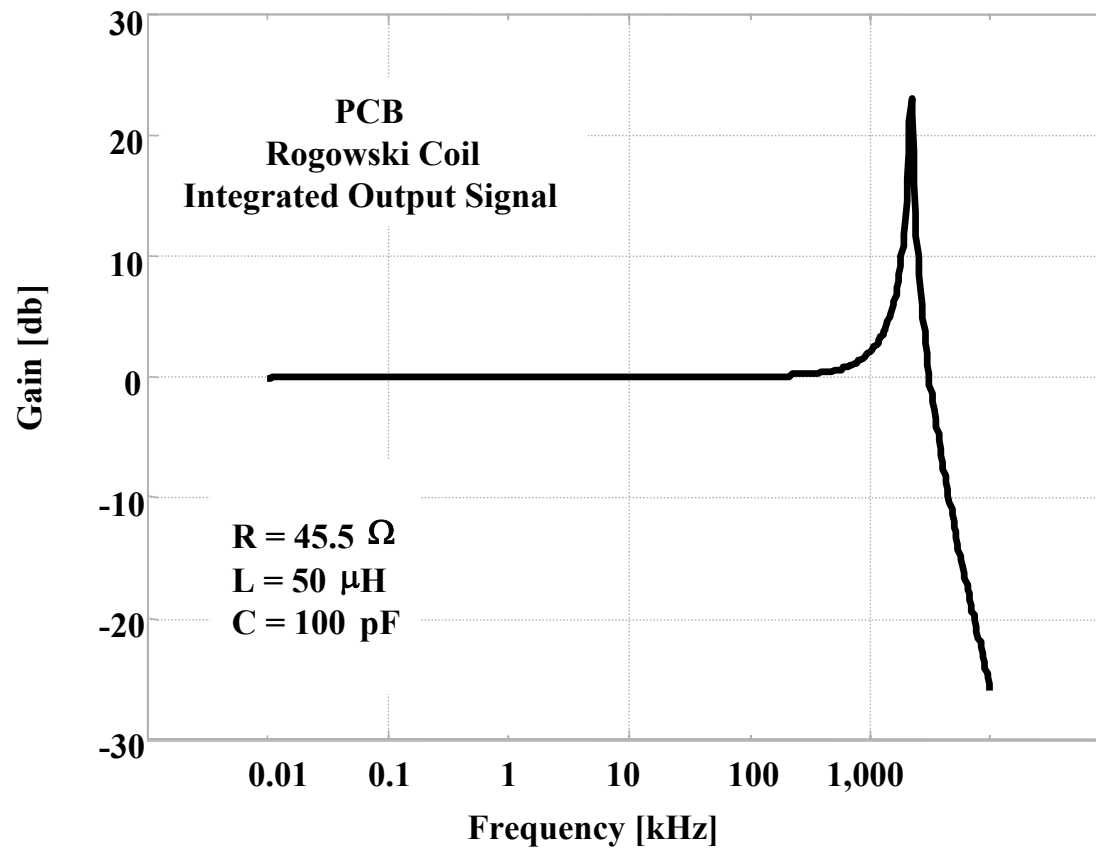




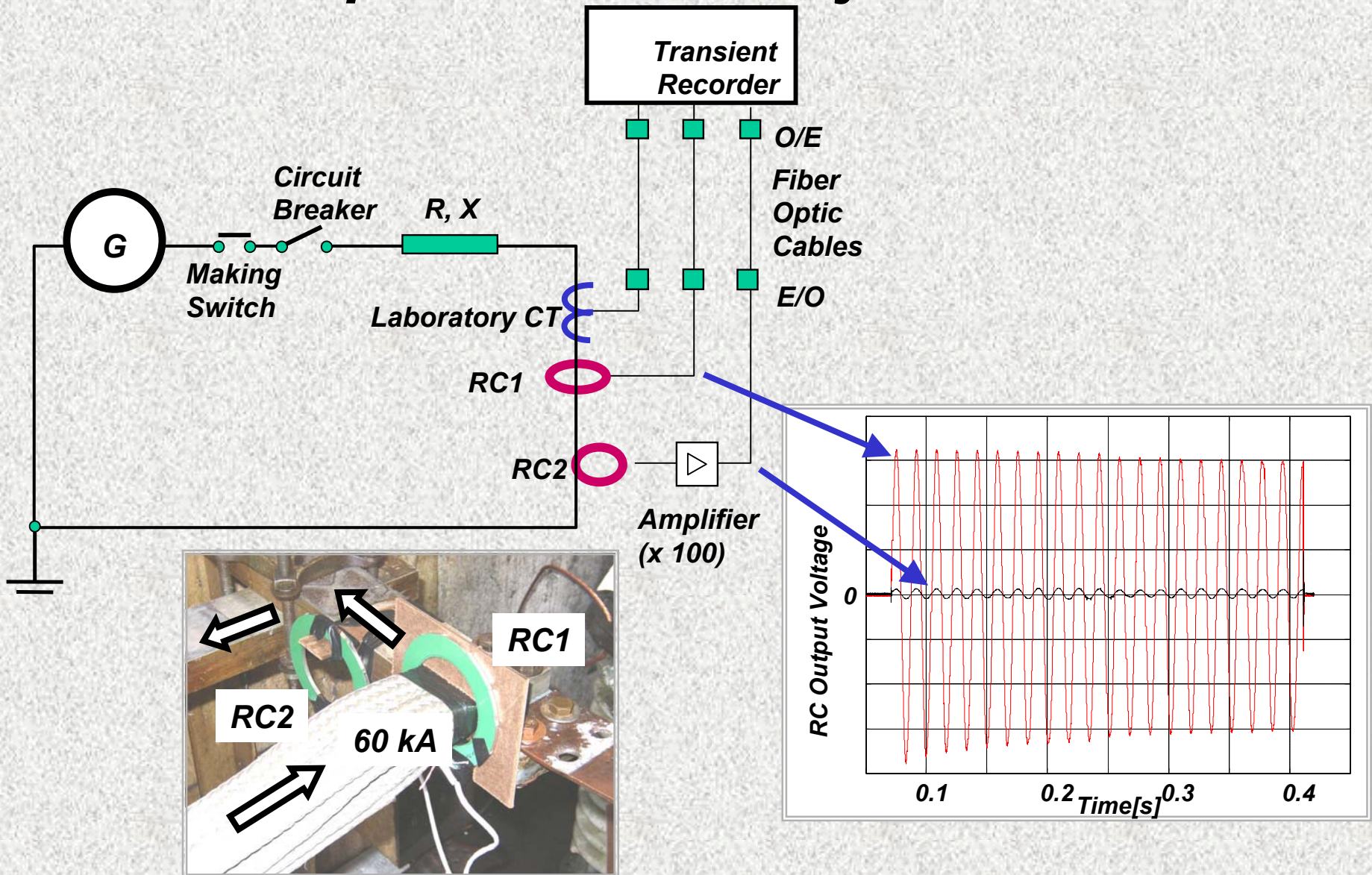
Linearity

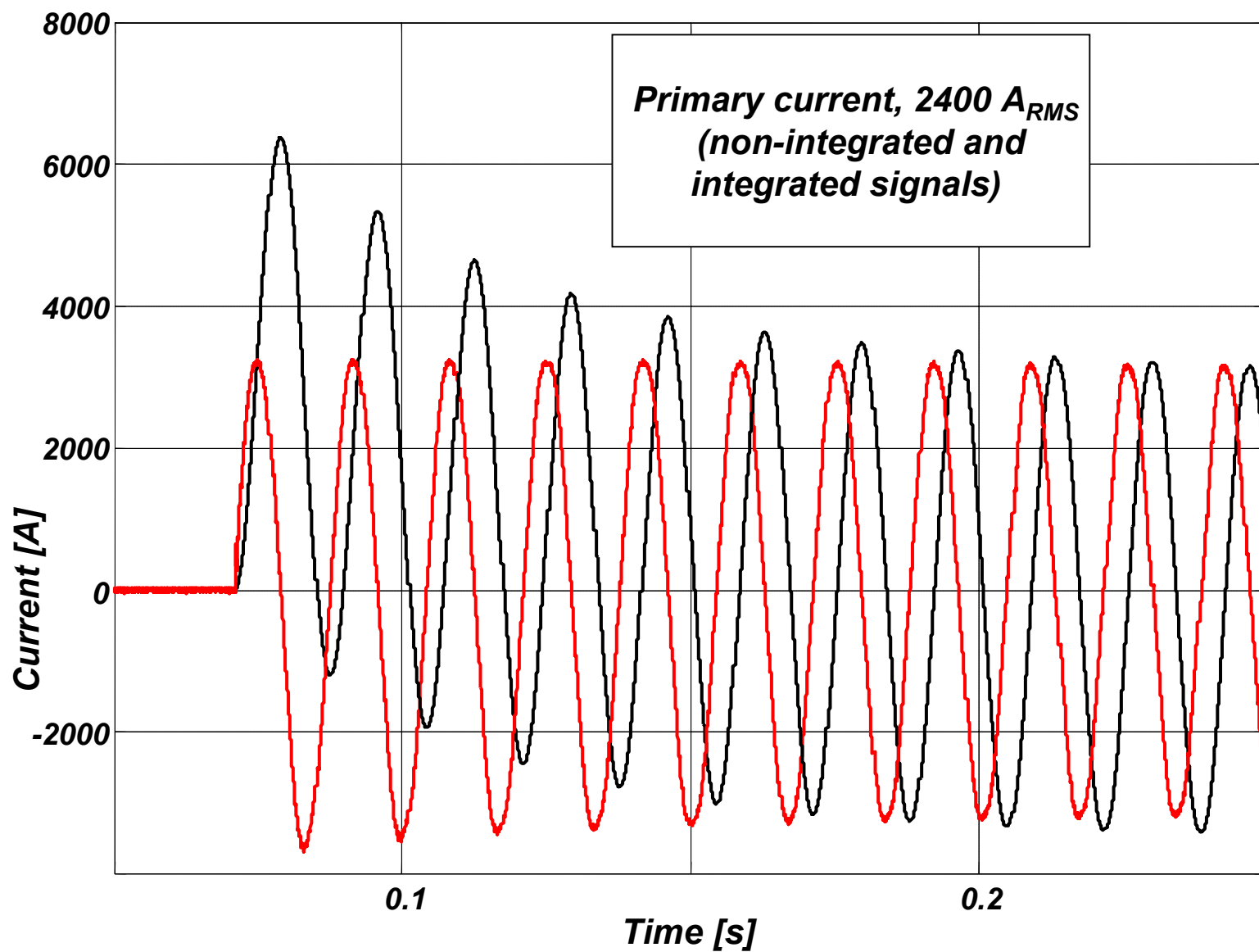


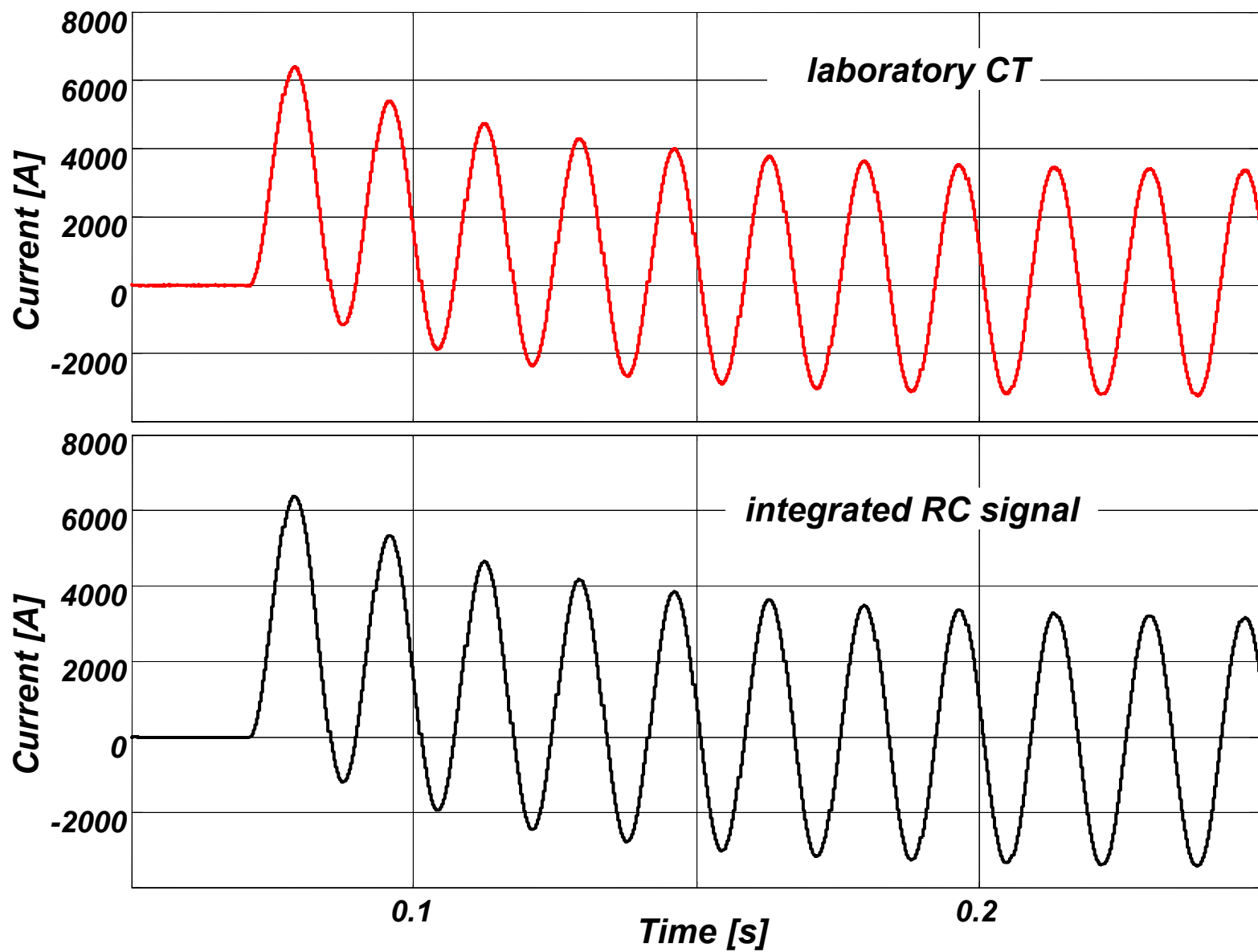
Frequency Response



The Impact from Nearby Conductors







The PCB RC current sensor has the following characteristics:

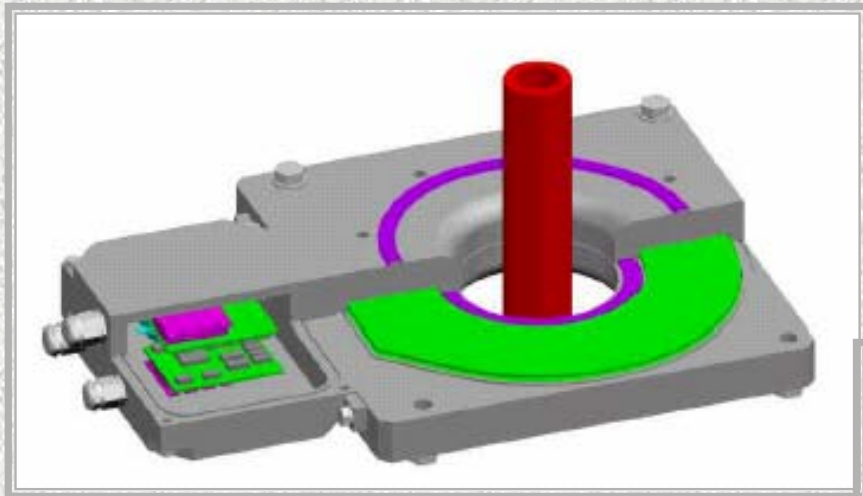
- 1. Measurement accuracy reaching 0.1 %***
- 2. Wide measurement range (the same coil can measure currents from 1 A to over 100 kA)***
- 3. Frequency response linear up to 1 MHz (and higher)***
- 4. Short-circuit withstand is unlimited with the window-type design***
- 5. Galvanic isolation from the primary conductors (similar to current transformers)***
- 6. Can be encapsulated and located around bushings or cables, avoiding the need for high insulation***
- 7. Can be custom sized for applications***
- 8. Can be built as a split core style for installation in existing systems***

Rogowski Coil Designs

by

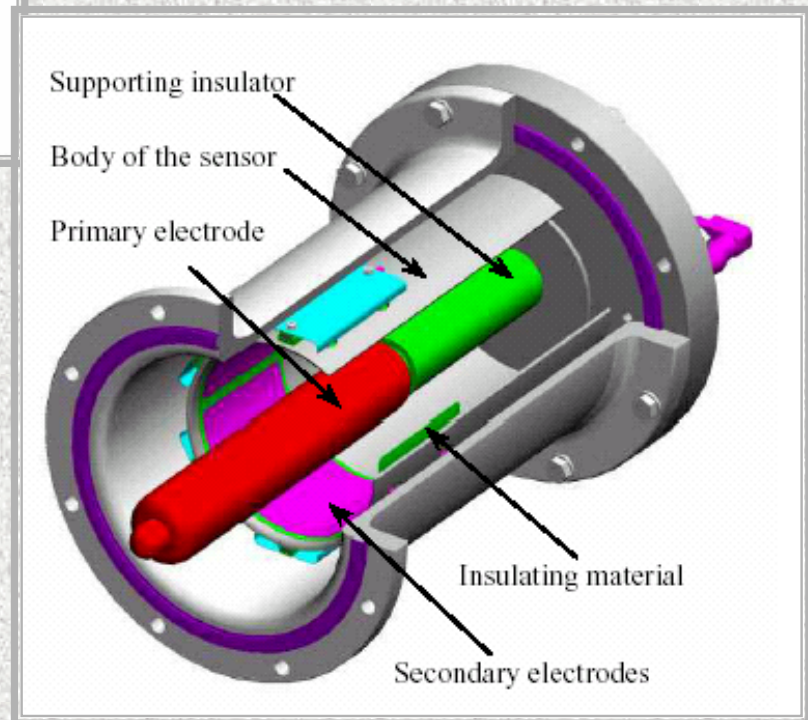
Companies

GEC Alsthom



Rogowski Coil

Capacitive Divider



GEC Alsthom



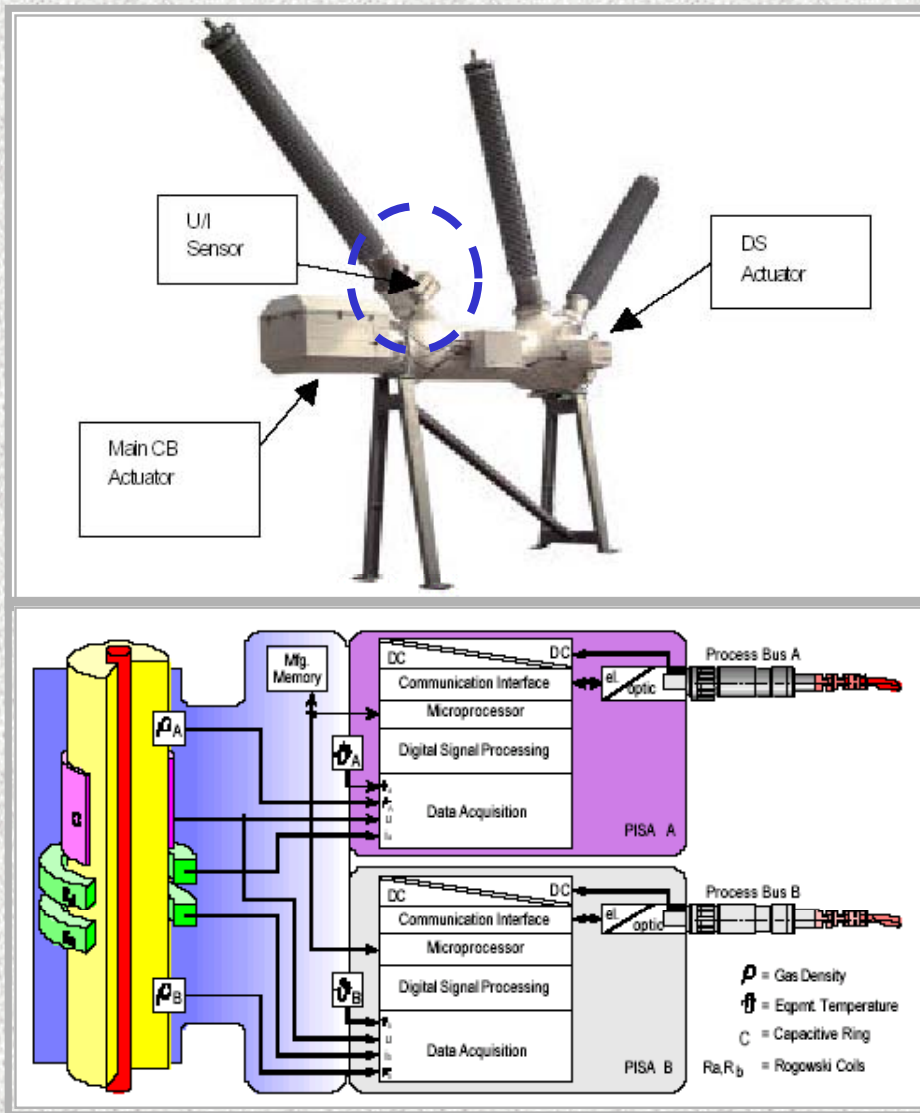
***Rogowski Electronic Current Transformer
(550 kV Gas Insulated Substation)***

ABB



... "The combined voltage and current sensor allows measuring current and voltage with one device."

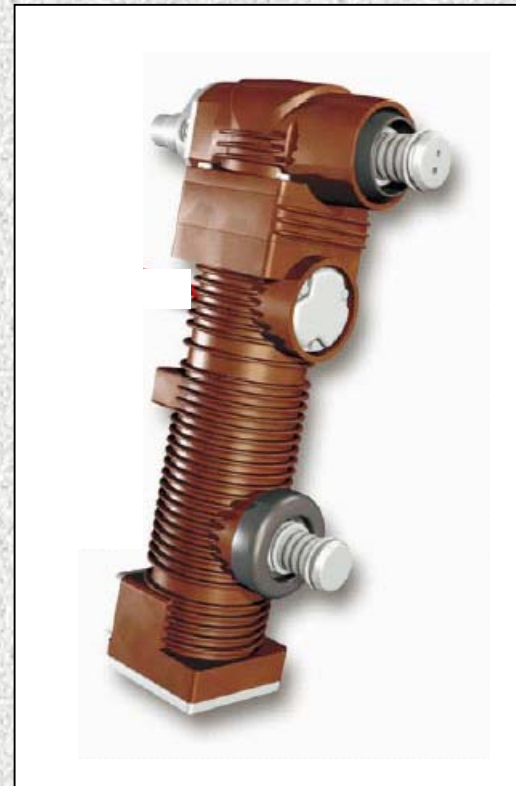
The sensor consists of a Rogowski coil for the current measurement and a capacitive voltage sensor for the voltage measurement. It provides an accuracy, that is good enough for revenue metering purposes and at the same time the current measurement is linear over a range from 400 A up to 63 kA and therefore good for all protection purposes."...



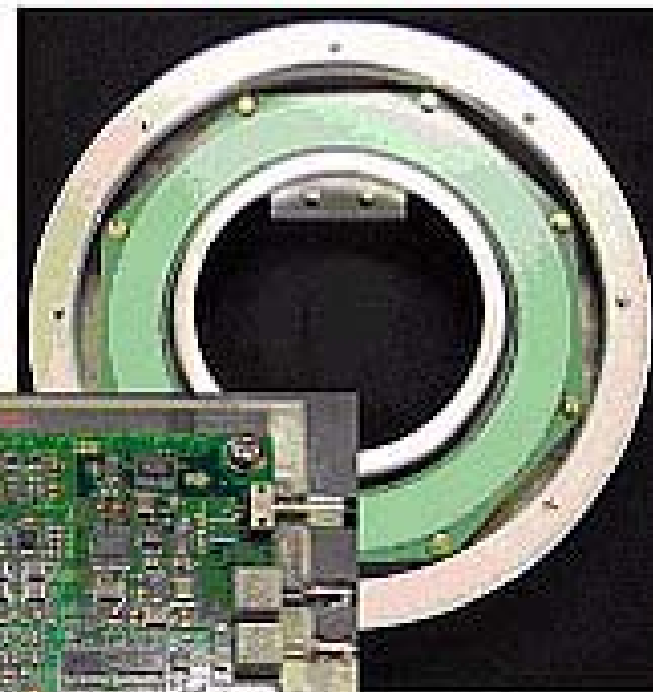
ABB



Rated voltage	12 kV	24 kV
Rated current	630 - 3150 A	630 - 2500 A
Short-time current	16 - 40 kA, 3 s	16 - 31.5 kA, 3 s
Open arc test	16 - 40 kA, 1 s	16 - 31.5 kA, 1 s
Dimensions, H x D x W	2040/2240 x 1050 x 650/975 mm	



Toshiba

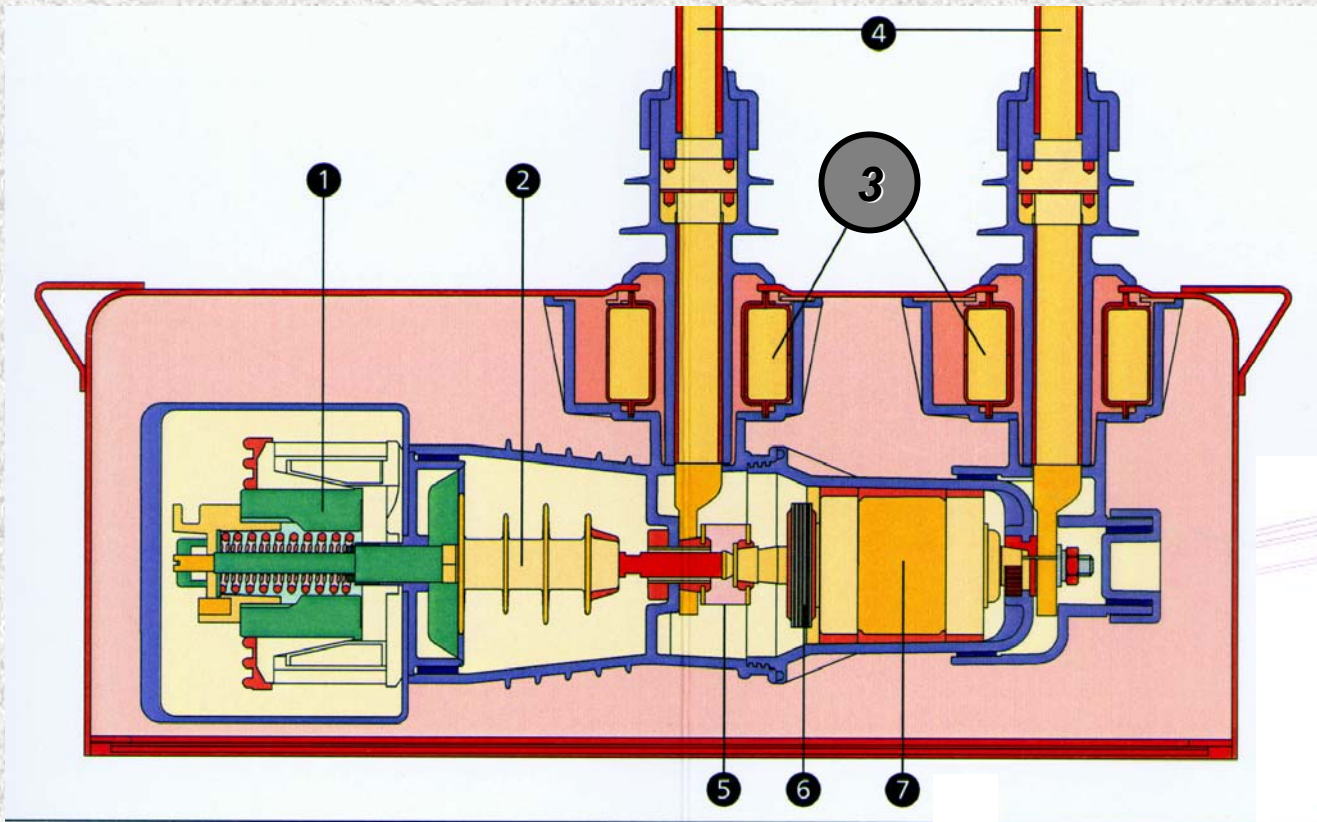


**A/D
converter**

**Optical Fiber
Insulator**

KELMAN

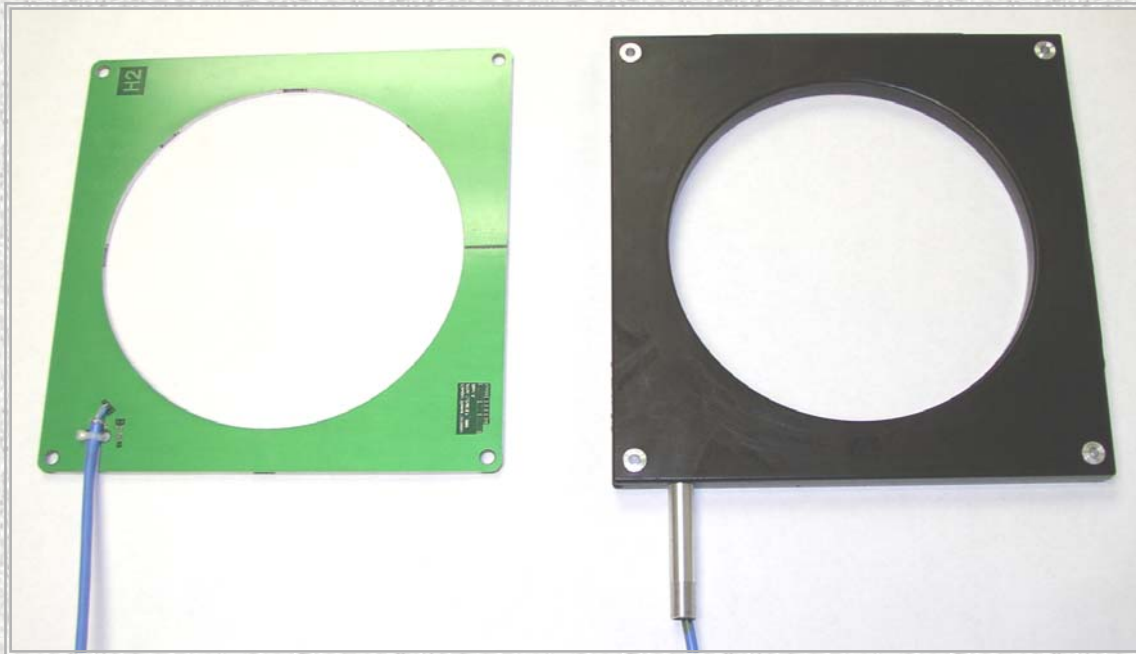
12 kV - 24 kV, 600 A



- 1. **Magnetic Actuator**
- 2. **Drive Rod**
- 3. **Rogowski Coil**
- 4. **Cable**
- 5. **Vacuum Interrupter**



Cooper Power Systems



Cooper Power Systems

