ROCOIL 'WALL-MOUNTED' ROGOWSKI COIL CURRENT MEASURING SYSTEM

FEATURES

- Three-channel Integrator enclosed in a steel cabinet..
- Can measure up to hundreds of kA.
- Input and output protection against surges.
- Either voltage or current-driver analogue outputs.
- Sensitivity can be specified by the user.
- Sensing coils can be replaced without the need for re-calibration.
- Can be used with two coils for each input to give the sum (or difference) of the currents in two conductors.
- Excellent low-frequency response.
- Power supply failure indication. (Optional)
- Flexible Rogowski coils can be fitted without 'breaking' the conductor
- Powered from either 230V or 110 V mains supply.
- Withstands very large overloads for an indefinite time.

1. INTRODUCTION

The **Rocoil**® Wall-mounted system is a three-channel integrator that can be used in conjunction with either flexible or rigid Rogowski coils to provide accurate current measurement in an industrial environment. The integrators are mounted in a steel cabinet with a hinged door.

The Rogowski coil sensors provide complete isolation from the circuit being measured and have no effect on the current even for very low-impedance circuits. These integrators provide an output which can be either a voltage or current waveform which accurately reproduces the waveform of the current being measured. This includes complex waveforms, which have a high harmonic content, and transients.

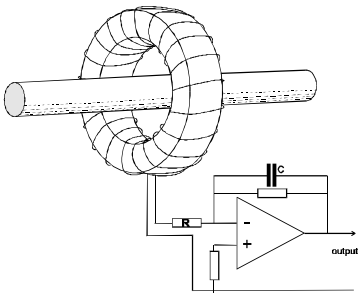
The measuring system cannot be harmed by current overloads. Also, unlike a current transformer there is no danger from high voltages if the output from the coil is open-circuited.

There are other devices that measure electric current without making electrical contact with the conductor. Many of these, including the conventional current transformer, use a ferromagnetic core and are subject to magnetic saturation effects that limit the range of currents that they can measure. A Rogowski coil, on the other hand, is 'linear'; it does not saturate and the mutual inductance between the coil and the conductor is independent of the current. Many of the useful features of Rogowski coil systems result from their linearity.

1. They have a wide dynamic range so that the same coil can be used to measure both very small and very large currents.
2. Calibration is easier because the coil may be calibrated at any convenient current level and the calibration will be accurate for all currents including very large ones.
3. They respond accurately to transient currents, including asymmetrical transients which makes them an excellent choice for use in protection systems and for measuring current pulses.

2. THE ROGOWSKI COIL PRINCIPLE

The coil is an 'air cored' toroidal winding placed round the conductor such that the alternating magnetic field produced by the current induces a voltage in the coil. The coil is effectively a mutual inductor coupled to the conductor being measured and the voltage output direct from the coil is proportional to the rate of change of current. The special design of the coil ensures that its output is



not influenced significantly if the conductor is positioned 'off-centre'. The design also ensures that the influence from currents and magnetic fields external to the coil is minimal.

To complete the transducer the coil output voltage is integrated electronically to provide an output that reproduces the current waveform. This combination of coil and integrator provides a system where the output is independent of frequency, which has an accurate phase response and which can measure complex current waveforms. By varying the integration parameters (C and R) the sensitivity of the complete measuring system, measured in Amperes per Volt, can be varied over about five orders of magnitude. The output from the integrator can be used with any form of electronic indicating device such as a voltmeter, oscilloscope, protection system or metering equipment.

3. COIL SENSORS (Rogowski Coils)

The integrator can be used with either Flexible or Rigid coils.

3.1 Flexible Coils (types 1000, 1100, 1200, 4000): Flexible Rogowski coils can be used for measuring electric current in large or awkwardly-shaped conductors, where space round the conductor is limited and for the measurement of very large currents (100's of kA).

Flexible coils are suitable for measurements requiring an accuracy of about 1%.

The coil is fitted by wrapping it round the conductor to be measured and bringing the ends together. The ends are fitted with a locating system to ensure that they are aligned correctly. The locating system can be either a 'push-together' type or a 'screw-together' type. Screw-together is more suitable for permanent installations.

Electrical connection to the coil is at one end only. The other end is 'free' to be threaded round awkwardly-shaped conductors or conductors in confined spaces.

It is not necessary to mount the coil so that it is circular nor is it necessary to have the conductor exactly in the centre of the loop. Off-centre operation does not normally introduce errors of more than I - 2%. If the coil is long enough it can be wrapped more than once round the conductor provided the ends are brought together correctly. The output is proportional to the number of wraps.

It will normally be necessary to build a framework to support the coil round the conductor. The design of the framework will depend on the conductor configuration.

3.2 Rigid Coils (type 2100): Rigid Rogowski coils have a greater accuracy and stability than flexible coils and excellent rejection of interference caused by external magnetic fields. They are not suitable for large conductors because the maximum aperture is less than 150mm.

3.3 Phasing: If several coils are being used they should be mounted in the same sense (i.e. with all the output leads coming off all clockwise or all anti-clockwise) and the outputs will then be in phase.

3.4 Insulation: Unless otherwise specified it should not be assumed that the coils are insulated against high voltages. Additional insulation should be used with conductors carrying dangerous voltages.

3.5 Connections: The coils are connected to the integrator by a 5mm 'twinax' cable which is normally permanently attached to the coil. The cable length can be at least 100m if required.

3.6 Calibration: The coils are fitted with calibration resistors to make them interchangeable. A coil can be replaced without the need to re-calibrate the whole system.

4. INTEGRATOR

4.1 Enclosure: The integrator is housed in a steel enclosure with dimensions typically 300 x 300 x 120mm. Access for coil inputs, outputs and mains supply are via cable glands. Coils are normally connected to the integrator using LEMO connectors. Output connections and mains supply input are by screw connectors inside the enclosure.

4.2 Power supply: The instrument is driven from a mains supply which can be switched for either 230 or 110V. A linear power supply is used rather than a switch-mode type to minimise circuit noise. The supply incorporates a mains input filter.

The power supply can be fitted with its own monitoring system. This consists of a normally-closed relay contact which will open if there is a power supply failure.

4.3 Integrator Description: the integrator converts the output from the coil to either a voltage or a current which accurately reproduces the current waveform. The overall sensitivity of the system can be specified by the user. The standard configuration has three independent integrators and is suitable for three-phase current measurement. If required each integrator can be configured to accept the inputs from two coils. The output then represents the sum or difference of the currents in the two coils.

For a **voltage-output** system sensitivity is defined in Amperes/Volt (A/V). The current being measured is equal to the instantaneous voltage at the output multiplied by the A/V value. For example at 10kA/V a 1V output means an instantaneous current of 10kA . This is the same as if the measurement were made using a 0.1mΩ shunt only there is no direct connection with the circuit being measured and the system does not respond down to DC. The maximum voltage output is about 12V peak, so for a 10kA/V system the maximum measurable current is 120kA peak or about 85kA rms.

For a **current-output** system the sensitivity is specified to give the ratio of input and output currents subject to a maximum output current of 20mA peak (14mA rms).

4.4 Load Conditions:

For a **voltage-output** system the output impedance is 51Ω. For best accuracy the integrator should be used with high-impedance recording/monitoring equipment having an input impedance preferably greater than 50kΩ.

For a **current-output** system the maximum burden is 500Ω.

4.5 Accuracy: For flexible coils accuracy is about ±1%.

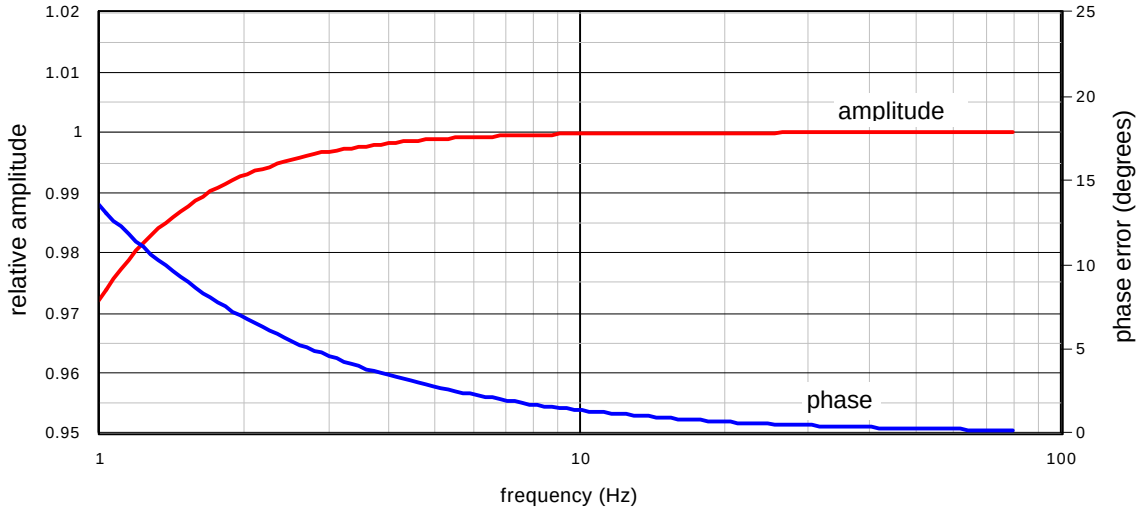
Effect of Temperature on Accuracy: The output is affected by both the temperature of the coil and the temperature of the integrator. These are specified separately because the coil and the integrator may be used in different environments

The temperature coefficient due to the coil depends on the type of coil used and other factors and it is impossible to give an accurate general figure for this. A typical value is -0.01% /°C.

A typical temperature coefficient for an integrator is + 0.06%/°C.

4.6 Frequency Response*:* Stated accuracy applies in the range 20Hz to 10kHz

Low frequency -3dB point: Typically less than 1Hz. This can be extended to lower frequencies if required, for example, for transient measurements. The figure shows typical amplitude and phase response curves

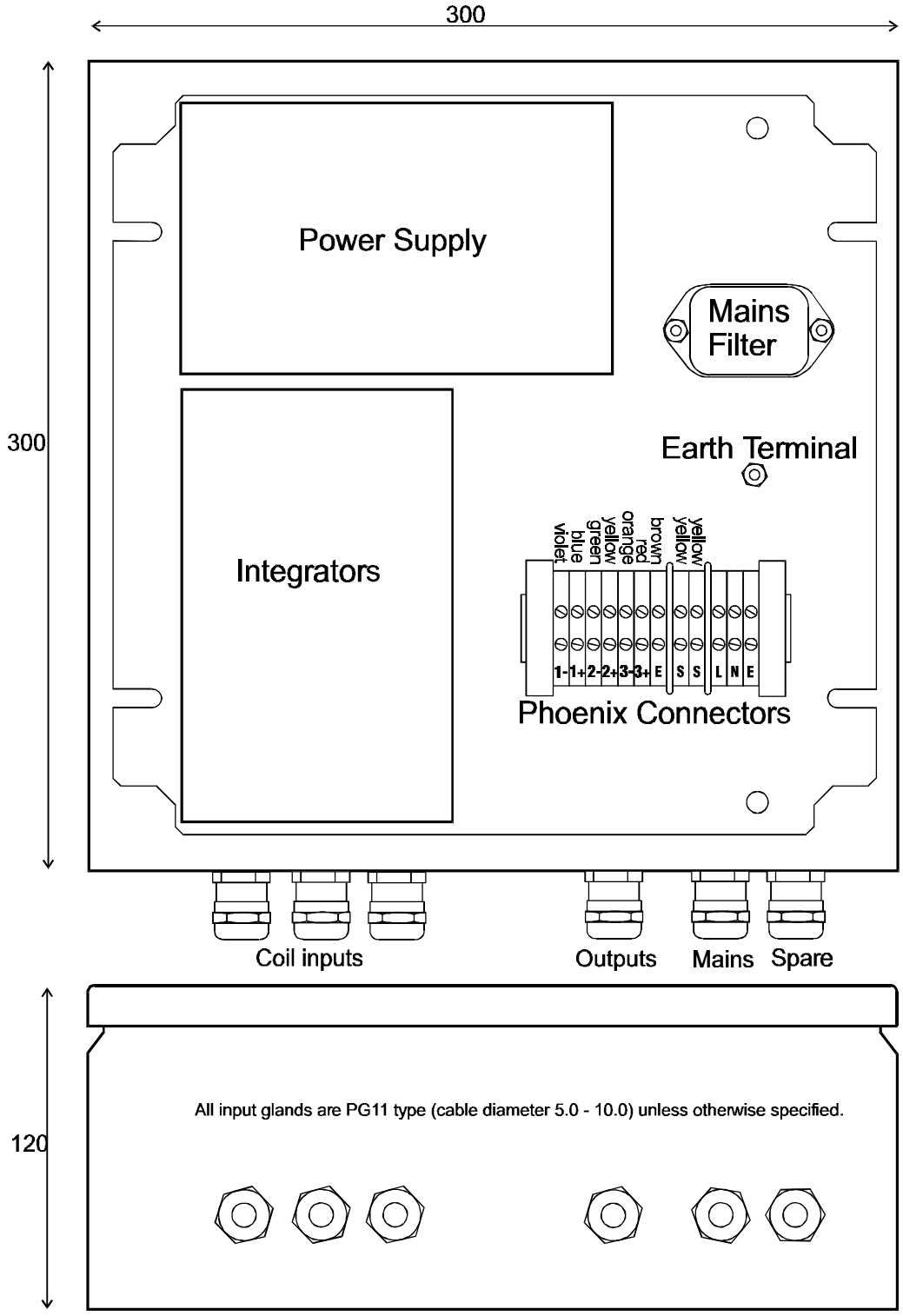


4.7 Output Noise: For a voltage-output version this is typically less than 1mV rms referred to the output. For example at 10kA/V, the noise is equivalent to less than 10A..

For a current-output version the noise is about 2μA.

4.8 Protection: The integrator inputs incorporate Gas Discharge Tubes (GDT) to protect the input circuitry from transient voltages caused by a fast current edge applied to the Rogowski coil.

The output circuitry uses Transzorb suppressors and diodes to protect against surges induced in the output leads.



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