ROCOIL 'DIN-AC' ROGOWSKI COIL INTEGRATOR

FEATURES

- Compact integrator for DIN-rail mounting.
- Voltage output reproducing the current wave-form
- Measures from less than 20A up to hundreds of kA.
- Input and output protected against surges.
- Sensitivity can be specified by the user.
- Sensing coils can be replaced without the need for re-calibration.
- Can be used with two coils to give the sum (or difference) of the currents in two conductors.
- Flexible Rogowski coils can be fitted without 'breaking' the conductor
- Powered from an external DC supply.
- Output is isolated from the DC supply
- Withstands very large overloads for an indefinite time.

1. INTRODUCTION

The **Rocoil**® DIN-AC integrator is a single-channel integrator that can be used in conjunction with either flexible or rigid Rogowski coils to provide accurate current measurement where an analogue voltage output is required. It is capable of measuring complex wave-forms and transient wave-forms with a high harmonic content

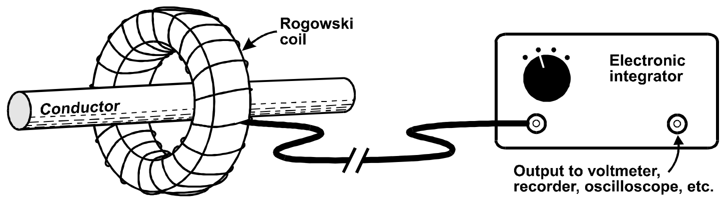
The Rogowski coil sensors provide complete isolation from the circuit being measured and have no effect on the current being measured even for very low-impedance circuits.

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. Coils can be built which are very compact and can be fitted in confined spaces. They are thus very useful for retrofit applications.

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 wave-form. 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 wave-forms. 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 high-impedance 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 1012, 1112, 1232, 4022): 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 (hundreds 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 may sometimes 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 can be used for measurements with an accuracy of 0.1%. They are not suitable for large conductors because the maximum aperture is less than 170mm.

3.3 Phasing: If two coils are being used for current summing they should be mounted in the same sense (i.e. with both the output leads coming off clockwise or both anticlockwise) and the outputs will then add. If the outputs are mounted in the opposite sense the outputs will subtract

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, although a long output lead will reduce the bandwidth. The DINAC integrator uses screw-type connectors.

3.6 Calibration: Except for interchangeable systems integrators and coils are supplied as pairs which are calibrated together. For flexible coils the uncertainty in the calibration is less than 1%. If either the coil or the integrator needs to be replaced it may not be possible to guarantee the same uncertainty without re-calibrating the complete system. However we can measure the mutual inductance of replacement coils and provide an estimate of the errors.

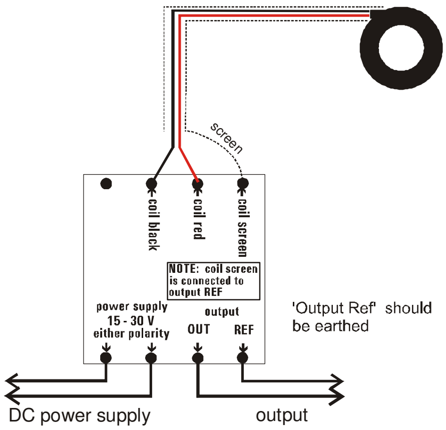
3.7 Interchangeable Coils: Some systems are provided with interchangeable coils. This means that any coil can be used with any integrator which uses the same interchangeable system. Coils can be replaced if they become damaged or they can be changed for coils of a different length without the need to re-calibrate the whole system. Integrators are marked to indicate the interchangeable system being used (e.g. '2500R') and the coils are also marked, usually at the connector.

4. INTEGRATOR

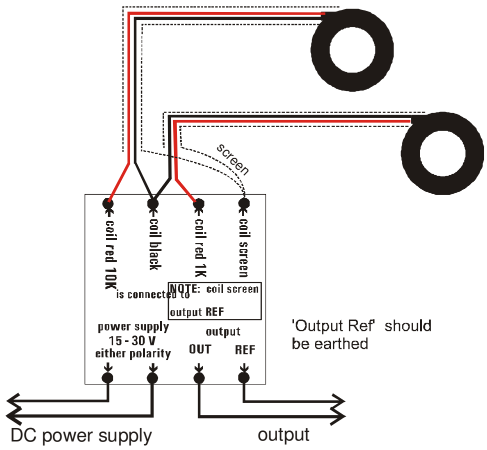
4.1 Integrator Description: The integrator converts the output from the coil to a voltage which accurately reproduces the current wave-form. The sensitivity (i.e. the current to give 1V output) can be specified by the user over a range from about 10A/V to several hundred kA/V.

4.2 Power Supply: The instrument is powered by an external DC power supply with a nominal voltage of 24V. This must be supplied by the user. Supply voltages in the range 15 - 30V DC are acceptable. The current consumption is about 34mA. The internal circuitry is isolated from the power supply which means that several units can be operated from the same supply without any risk that they will interfere with each other.

4.3 Single / Dual Coil Versions: The single-coil version (DIN-AC) has an input for one coil only. The dual-coil version (DINAC2) can sum the contributions from two coils to give the total current in two separate conductors. This is a true 'algebraic' sum of the two current wave-forms. When summing currents it is



Single Coil Version



Two Coil Version

important. to ensure that the coils are connected in the correct phase relative to each other so that their contributions add rather than subtract (section 3.3). A dual-coil version can also be used with one coil only if needed. The other input should be left open-circuited.

The figure shows the power supply connections and the method of connecting coils in single coil and dual coil versions. The power supply can be connected either polarity.

4.4 Two-Range Versions: The two inputs of a DINAC2 can be calibrated to give different sensitivities. The sensitivity will depend on which input is used.

4.5 Protection: The integrator input incorporates a Gas Discharge Tube (GDT) to protect the input circuitry from transient voltages caused by a fast current edge applied to the Rogowski coil.

The output circuitry uses a Transzorb suppresser to protect against surges induced in the output leads.

4.6 Overload Capability: The output voltage is linear up to about 13 x the nominal sensitivity. For example with a 1kA/V sensitivity the output will be linear up to about 13kA. (Note this refers to the peak current and not the RMS). For overloads that exceed the linear limit the integrator will saturate but it will not be damaged.

4.7 Noise: Typically less than 10mV peak to peak referred to the output.

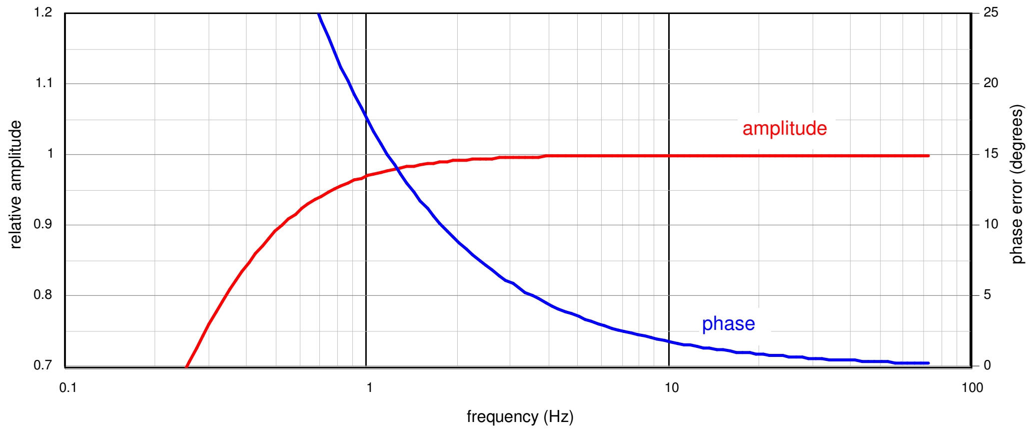
4.8 Output impedance: Approximately 51 ohms. For best accuracy the integrator should be used with high-impedance recording/monitoring equipment with an input impedance of at least 50k ohms.

4.9 Earthing: Because the output of the integrator is floating it is recommended that the 'Output REF' side of the circuit is earthed at some point.

4.10 Measurement Accuracy: For flexible coils ±1%. For rigid coils ±0.1%.

4.11 High-Frequency Response: The transducer can be used for measurements at power frequency including harmonics up to 10kHz. The high-frequency capability is determined largely by the type of coil used. With some coils measurements can be made to much higher frequencies

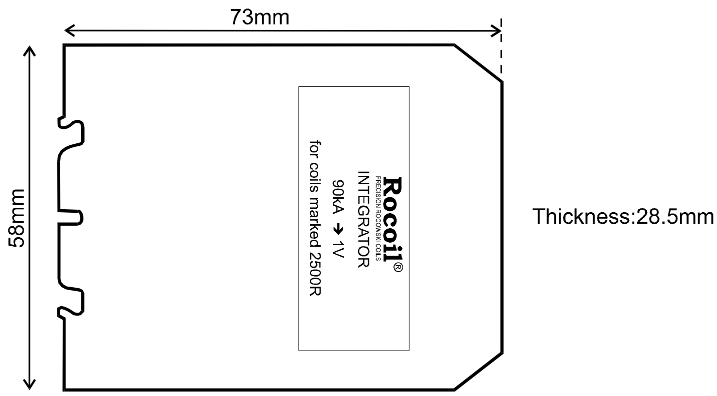
4.12 Low-frequency Response: This depends on several factors including the type of coil and the sensitivity. The graph shows a typical amplitude and phase response for a system, with sensitivity of 100A or more / Volt, used with a Type 1000 flexible coil.



A good low-frequency response is useful when monitoring power-frequency transients where the wave-form can have a 'DC offset' which lasts for a few cycles.

4.13 RMS Version: Instead of the normal AC output the integrator can be configured to give a DC output proportional to the true RMS value of the current**.**

4.14 Enclosure: The integrator is housed in a plastic enclosure with dimensions 73 x 58 mm (not including the rail clip). Connections for the coil inputs and current output / power supply are via screw connectors.



Rail mounting clip is not shown