Rocoil
PRECISION ROGOWSKI COILS

ROCOIL '8141RM' INTEGRATOR FOR A ROGOWSKI TRANSDUCER

NOTE: the ranges shown in the picture are not the only ones available

FEATURES

- Voltage output reproducing the current wave-form.
- Measures from less than 1 A to hundreds of kA.
- Four sensitivity ranges which can be selected digitally.
- Very wide range of sensitivity values in one unit.
- Range values can be specified by the user.
- Very good for transient measurements.
- Flexible sensors can be fitted without 'breaking' the conductor.
- Powered from an external DC supply.
- Integrator output is isolated from the power supply.
- Withstands very large overloads for an indefinite time.

1. INTRODUCTION

The **Rocoil®** 8141RM integrator is a single-channel integrator that can be used in conjunction with rigid or flexible Rogowski sensors to provide accurate current measurement where an analogue voltage output is required. It is capable of measuring complex wave-forms and transient wave-forms which have a high harmonic content.

The Integrator has four sensitivity values which are selected by applying 'high' or 'low' voltages to two digital inputs. An internal switch is used to determine a default range which the integrator will revert to when the digital inputs are not connected.

The Rogowski 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 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 sensor, on the other hand, is 'linear'; it does not saturate and the mutual inductance between the sensor and the conductor is independent of the current. Many of the useful features of Rogowski sensor systems result from their linearity.

1. They have a wide dynamic range so that the same sensor can be used to measure both very small and very large currents.
2. Calibration is easier because the sensor may be calibrated at any convenient current level and the calibration will be accurate for all currents including very large ones.
3. Sensors can be built which are very compact and can be fitted in confined spaces. They are thus very useful for retrofit applications.

2. INTEGRATOR

2.1 Integrator Description: The integrator converts the output from the sensor to a voltage which accurately reproduces the current wave-form. This integrator can have four different sensitivities (sensitivity is the current to give 1V output). The sensitivity is selected by applying signals to two digital inputs.

2.2 Power Supply: The instrument is powered by an external DC power supply with a nominal voltage of 24 V . This must be supplied by the user. Supply voltages in the range 15 - 30V DC are acceptable. If a supply voltage less than 15V is used the unit will still work but the peak output voltage is reduced (Section 2.4). The current consumption is about 34mA at 24V.

The internal circuitry is isolated from the external power supply which means that several units can be operated from the same supply without the risk that they will interfere with each other.

2.3 Protection: The integrator incorporates a Gas Discharge Tube (GDT) to protect the integrator from transient voltages caused by a fast current edge applied to the Rogowski sensor. The output circuitry uses a Tranzorb suppresser to protect against surges induced in the output leads

2.4 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 limit the integrator will saturate and give an inaccurate reading but it will not be damaged.

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

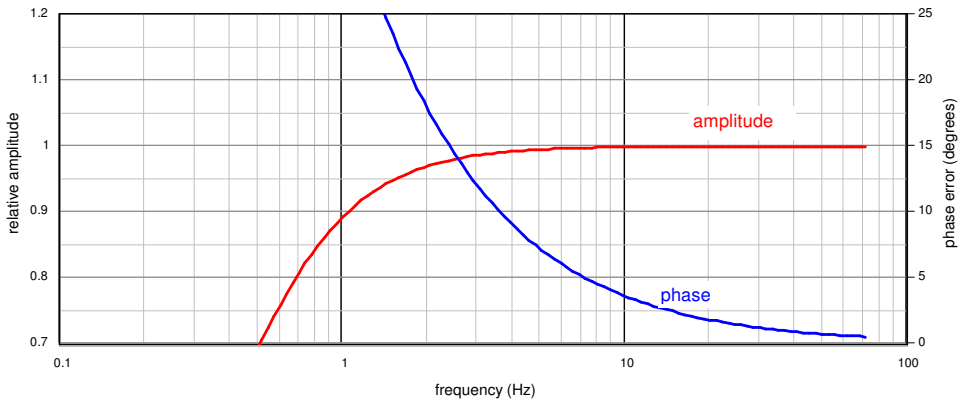
2.6 Output Impedance: Approximately 51 ohms. For best accuracy the integrator should be used with high-impedance recording / monitoring equipment having an input impedance of at least 50k ohms.

2.7 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.

2.8 Measurement Accuracy: For flexible sensors ±1%. For rigid sensors ±0.1%.

2.9 High-Frequency Response: The integrator can normally be used for measurements at power frequency and harmonics up to about 10kHz. The high-frequency capability is determined largely by the type of sensor used. With some sensors measurements can be made to much higher frequencies.

2.10 Low-Frequency Response: This depends on several factors including the type of sensor 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 sensor.



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.

2.11 Digital Control: The range is selected by applying 'high' or 'low' signals to the digital inputs, D1 and D2

D2	D1	Range
high	*high*	Range 1
low	*high*	Range 2
high	*low*	Range 3
low	*low*	Range 4

Conventionally, Range 1 is the least sensitive range and Range 4 is the most sensitive range. LEDs on the front panel indicate which range is selected.

The digital inputs must be referenced to the 'digital REF' terminal. A 'low' signal is less than 1V. A 'high' signal is greater than 2V. If the default switch is set correctly (see the next section) a 'high' input can be generated by leaving the input open -circuit and a 'low' is generated by shorting the input to 'Ref'

2.12 Default Range: When no digital signals are applied the sensitivity reverts to a default value. The default is determined by settings on a switch inside the unit. The switch can be accessed by removing the cover The cover should be removed carefully to avoid displacing the LEDs which show through the lid and replaced equally carefully.

The switch is used to set the digital inputs to high (on) or low (off) to determine the default range. External voltages applied to the D1 and D2 inputs will override the switch settings.

The unit is supplied with the default pre-set to *high / high* selecting Range 1 as the default. In this setting ranges can conveniently be selected by short-circuiting or open-circuiting the digital inputs without the need to apply voltages.

NOTE: Some parts of the circuit are very sensitive to short circuits. In particular if the power supply rails are shorted to each other or to 'common' the DC-DC converter will be permanently damaged. If you adjust the switch when it is powered up it is recommended that you do not use a metal implement.

2.13 Enclosure: The integrator is housed in a die-cast metal box with dimensions 98 x 64 x 36mm (not including the connectors). Connections are via plug-in terminal blocks.

3. ROGOWSKI SENSORS

3.1 Flexible Sensors (Types 1012, 1112, 1232, 4022): Flexible Rogowski sensors 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 sensors are suitable for measurements requiring an accuracy of about 1%.

The sensor 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 sensor 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 sensor 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 sensor 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 sensor round the conductor. The design of the framework will depend on the conductor configuration.

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

3.3 Connections: The sensors are connected to the integrator by a 5mm 'twin-ax' cable which is normally permanently attached to it. The cable length can be at least 100m, if required, although a long output lead will reduce the bandwidth. The 8141RM integrator uses plug-in screw-type connectors.

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

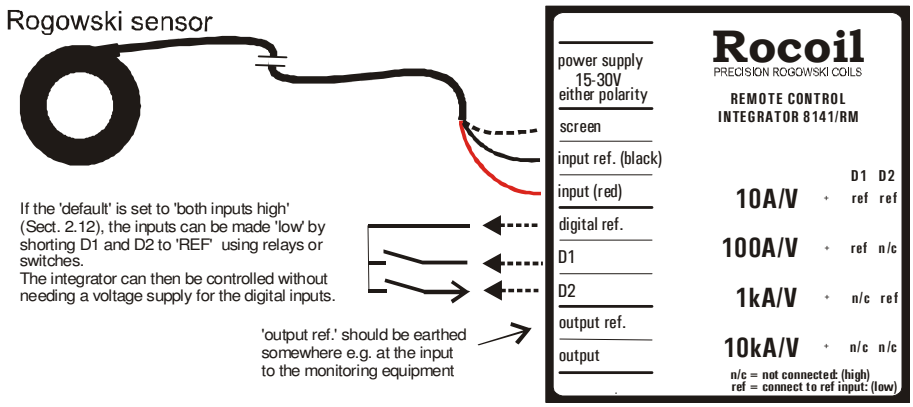
3.5 Interchangeable Sensors: Some systems are provided with interchangeable sensors. This means that any sensor can be used with any integrator which uses the same interchangeable system. Sensors can be replaced if they become damaged or they can be changed for sensors of a different length without the need to re-calibrate the whole system. Integrators are marked to indicate the interchangeable system being used (e.g.

'2500R') and the sensors are also marked, usually at the connector. The 8141RM can sometimes be configured to work with an interchangeable system but the accuracy is reduced for sensitivities below about 1kA/V

4 CONNECTIONS:

NOTE: It is important to ensure that the connections are made properly. From experience some problems with the integrator can be attributed to poor connections. The screw connectors should be opened fully before inserting the conductor. Test each connection afterwards by pulling on the conductor.

NOTE: All the REF. terminals and the metal box are connected together internally.



4.1 Power Supply:

The integrator is powered by an external DC supply of 15 - 30 V. The power may be connected either polarity.

The power supply is isolated from the integrator circuitry which means that several units can be operated from the same power supply without the risk that their outputs will interfere with each other.

4.2 Sensor Inputs:

Usually red or brown sensor lead, black sensor lead, screen. With some sensors the black lead and screen are already connected together. These can be connected to 'input ref'

4.3 Integrator Output:

OUT: AC output to monitoring unit. The monitoring unit should preferably have an input impedance greater than 50k ohms

REF: Output reference terminal. This terminal should be earthed somewhere or the integrator output may be distorted.

4.4 Digital Inputs:

Voltages can be applied to the digital inputs 'D1' and 'D2'. These voltages are referenced to the 'Digital REF' terminal. When no voltages are applied the range selected is the default value. The default range can be selected internally as described in Section 2.12. If the internal switch is set to high/high the integrator can be controlled by shorting the inputs 'D1' and/or 'D2' to 'REF' and no external voltage supply is needed.