Serial Number: _____ - _____

Powertek

DC*flex*

INSTRUCTIONS FOR USE

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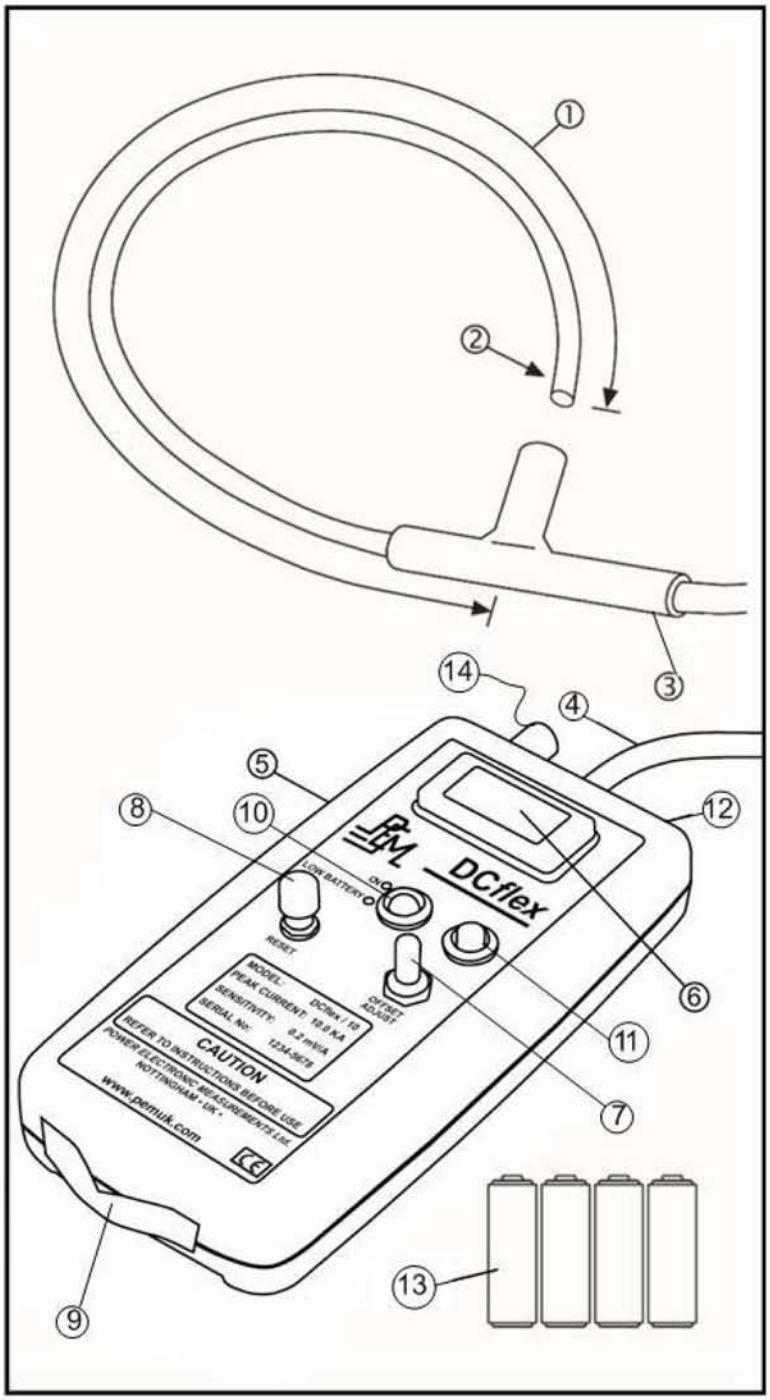
INTRODUCTION

These instructions should be followed whenever the DCflex is used. They are intended to help the user obtain the best and safest performance from the transducer.

The DCflex



1. Rogowski coil (loop)
2. 'Free end' of the Rogowski coil
3. Ferrule (the connecting mechanism for closing the Rogowski coil).
4. Cable connecting the Rogowski coil to the integrator electronics
5. Enclosure for the integrator electronics
6. 3½ digit LCD display.
7. OFFSET ADJUST trimmer.
8. RESET push button
9. Clip for attaching lanyard.
10. LED indicator
    - GREEN - CWT is ON
    - RED – low battery
11. Push button ON / OFF switch
12. Socket for connecting external DC supply
13. 4 x AA batteries
14. BNC output

DCflex SPECIFICATIONS

OUTPUT AND CURRENT RATINGS

The DCflex has a 3½ digit LCD display output mounted on the front of the box.

OUTPUT (Full Scale FS)	1.999V (resolution 0.001V)
PEAK CURRENT (FS)	_____ kA
HIGH FREQUENCY -3dB (LCD DISPLAY)	8Hz
The DCflex has an additional BNC output. The can be plugged into a high impedance recording device, such as an oscilloscope, to monitor the DC current at the same time as the current is displayed on the LCD display.	
OUTPUT (Full Scale FS)	2.0V
PEAK CURRENT (FS)	_____ kA
MIN. OUTPUT LOADING	1MΩ (for rated accuracy)
TYP. HIGH FREQUENCY -3dB (BNC OUTPUT)	10kHz

POWER SUPPLY

The DCflex can be powered by both battery or an external DC voltage. With the external DC supply present the batteries are inoperative.

BATTERY TYPE	4 (four) 1.5V AA alkali
BATTERY LIFE	> 100hours
DC SOCKET TYPE	2.1 or 2.5mm jack socket – polarity indicated on the front panel of the DCflex
DC VOLTAGE	12 to 24Vdc (±10%)
DC QUIESCENT SUPPLY CURRENT	5mA (12 to 24Vdc)

OPERATING TEMPERATURE

ROGOWSKI COIL AND CABLE	-20 to +100°C
INTEGRATOR ELECTRONICS	0 to +40 °C

DIMENSIONS

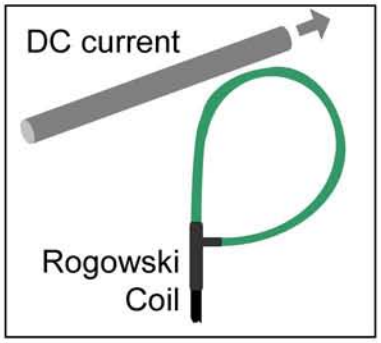
ROGOWSKI COIL	Length (circumference) _____ mm/ Thickness (cross section) 8.5mm
CABLE LENGTH	1.5m (from coil to enclosure)
INTEGRATOR ENCLOSURE	H= 183mm, W =93mm, D= 32mm

PEAK COIL INSULATION

PEAK COIL INSULATION	2kV peak

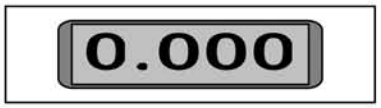
BASIC OPERATION

Switch the DCflex on by pressing the grey push button. The green LED will light to show the unit is operational. Allow the DCflex 2 minutes to settle before proceeding. If the LED is RED then the batteries need replacing.

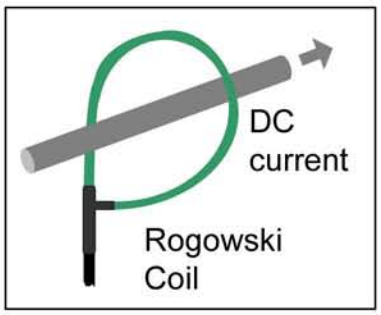


Make sure the Rogowski coil is clipped together but NOT around the conductor under test.

Press the red RESET button and **keep it pressed** whilst trimming the OFFSET ADJUST to give a zero reading on the LCD display.

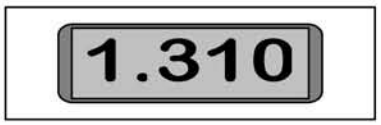


When the LCD display is zero release the RESET BUTTON.



Unclip the Rogowski coil and clip it around the conductor under test as quickly as practicable. The output from the LCD display should be ignored during this process.

Once the **Rogowski coil free end is fully clipped into its socket** take a reading from the LCD display or from the oscilloscope or other recording device into which the BNC output is connected.



Converting this voltage using the 'Sensitivity mV/A' clearly labelled on the front of the DCflex gives the value of your DC current.

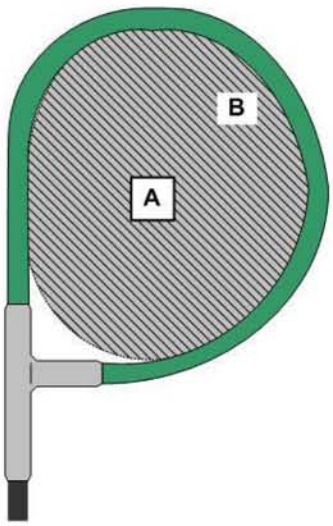
OBTAINING THE BEST MEASUREMENT

ACCURACY

The accuracy of the DCflex is dependant on the following:

The position and size of the conductor relative to the coil circumference

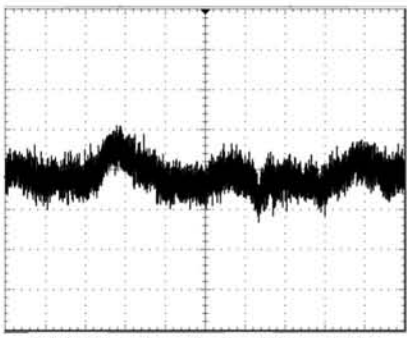
The DCflex is calibrated using a highly stable current source. The conductor is kept central in the Rogowski coil (position **A** on the diagram shown right). The DCflex is calibrated to an accuracy of ±0.4% of reading. The DCflex is supplied with a calibration certificate detailing the procedure and those comparative measurement devices with traceable certification to UKAS.



As an example of how the output can vary with conductor position a 20cm^2 conductor is moved around the Rogowski coil (shaded area **B** on the diagram right). The output does not vary from the calibrated value by more than ±0.5% of reading. As the conductor gets larger this error will reduce.

Uncertainty due to low frequency noise

The integrator op-amp generates a random low frequency noise. An example of the noise produced by the DCflex is shown in the oscilloscope trace right. This noise adds 'uncertainty' to the DCflex measurement.



5A/div, Timebase 20sec/div

The noise is 10A p-p max.. Its effect reduces with increased current magnitude e.g. for the 10kA version a noise of 10Ap-p represents 0.1% of FS and for the 40kA version only 0.025% of FS.

Display error

0.1% of FS (due to offset and non-linearity errors in the LCD display).

Temperature coefficient

-0.016 %/°C Clip-around Rogowski coil
±0.017 %/°C Electronics

MEASUREMENT DRIFT

SET-UP DRIFT	0.025% per sec (of reading) From reset to clipping the coil into its socket around the bus bar.
OUTPUT DRIFT	< 5.0A per sec From clipping the coil into its socket to taking a reading

The DCflex is a single shot measurement. The integrator offset needs to be nulled to zero before taking a reading. Once nulled the integrator will begin to drift – this is termed 'Set-Up Drift'.

Once the Rogowski coil has been clipped around the conductor the reading displayed on the LCD meter will begin to drift – this is termed 'Output Drift'.

For example if the user is measuring a 10kA dc current and it takes 10 seconds from nulling the integrator to clipping it in place around the conductor, then a further 5 seconds before looking at the display, the drift error will be;

Set –up drift = 0.025% of 10kA /s * 10 seconds = 25A
Output drift = 5A/s * 5 seconds = 25A

Then,

$$\text{Drift error} = \frac{(\text{output drift} + \text{set-up drift})}{10\text{kA}} * 100 = 0.5\% \text{ of reading}$$

The drift error can be significantly reduced by taking two measurements in relatively quick succession and then averaging the result ie.

Measurement 1. – As per 'Basic Operation'

The Rogowski coil should be clipped together NOT encircling the conductor
Reset
Trim the offset adjust to give zero reading
Un-clip coil and clip-around conductor
Take first reading (+ve output voltage), (Reading 1.)

Measurement 2.

The Rogowski coil should remain clipped around the conductor under test.
Reset – but do not trim the offset adjust
Un-clip the coil and clip together again away from the conductor
Take second reading (-ve output voltage), (Reading 2.)

Average reading =

$$\frac{(\text{Reading 1.} - \text{Reading 2. (remembering the second reading will be the opposite polarity to the first)})}{2}$$

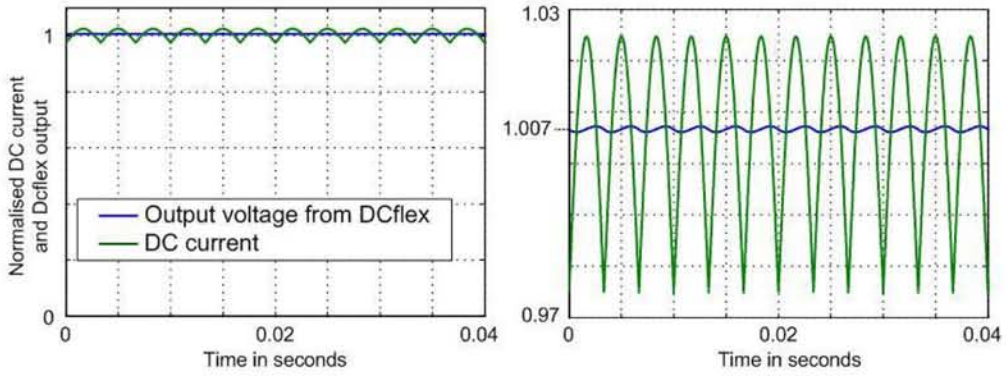
By not nulling the output to zero in between readings the user guarantees that the drift is in the same direction for both readings, assuming that it takes roughly the same amount of time to do the procedure in both directions the effect of the drift is significantly reduced.

MEASURING A DC CURRENT WITH AN AC RIPPLE COMPONENT

Large DC currents are often created by a power electronic converter whose switching operation adds an ac ripple component to the dc current.

OUTPUT FROM THE 3½ DIGIT LCD DISPLAY

The LCD display has a low pass filter on the output which sets the high frequency -3dB cut-off to 8Hz. This attenuates the effect of any ripple component.



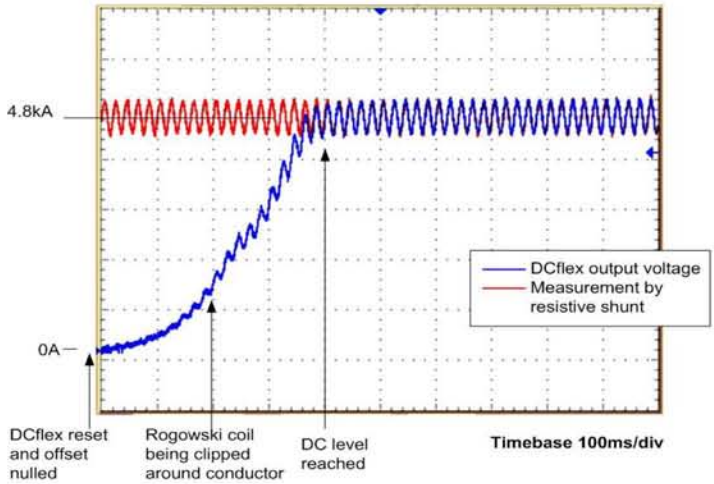
DCflex measurement of a DC current with a 5% rectified sinusoidal ac ripple component at 300Hz

The example above shows a DC current with a 5% rectified sinusoidal ac ripple component at 300Hz such as may be encountered at the output of a three phase rectifier with resistive load.

It is important to note that the resultant measurement is the MEAN COMPONENT of the current and NOT THE RMS. The second waveform is expanded to show the ripple component and the output from the DCflex in greater detail. The output from the DC flex is the mean DC value (=1.007) and not the rms value which would be larger (=1.010). The output has a very small ripple, 0.1% of the output signal. If the DC current was large enough this measurement ripple would just be visible as a flickering of the last digit on the LCD display of between say 1.001 and 1.002.

OUTPUT FROM THE BNC SOCKET

Sometimes the customer may wish to examine both DC and the ripple component. In such cases the user can connect the output BNC socket on the DCflex via a BNC:BNC cable to an oscilloscope. In this way both the DC component and ripple can be displayed. The scope or other recording device must be high impedance, >1MΩ for rated accuracy. The example shows a 4.8kA DC current with a 50Hz ripple superimposed.



The mean output from the DCflex will drift in time at a rate of 5A/s. To take another reading the coil must be unclipped, or clipped around the conductor once more.

SAFETY AND PRE-USE CHECKS

Throughout this instruction sheet there are a number of warnings which must be observed to ensure safe operation of this unit. These warnings are identified by the following symbol:

PEM accepts no responsibility for any accidents or damage resulting from careless use, or non-observance of these instructions.

The integrity of the insulation around the Rogowski coil itself should be VISUALLY INSPECTED before use, and the unit should NOT BE USED if there are signs of damage.

When bending the flexible coil around a conductor, avoid tight bends and sharp edges that could damage the coil.

The voltage rating (safe PEAK working voltage) is clearly labelled on the coil. The rating is normally 2kV peak green coil. The removable silicone sleeve supplied with the Rogowski coil provides mechanical protection only.

The ratings are derived from the following standard test. All coils supplied by PEM including the ferrule connecting the coil to the cable are flash tested for 1 minute at 4kVrms using a 50Hz sinewave without the removeable sleeve fitted.

The voltage ratings are appropriate for intermittent use of the DCflex as a test instrument and not for continuous use in a permanent installation.

For permanent installation the coil should be situated such that corona, which would eventually damage the coil insulation, cannot occur. For information regarding permanent installation of PEM's Rogowski coils on high voltage equipment please consult PEM.

For reasons of safety it is important that the part of the current carrying conductor around which the Rogowski coil is connected must be insulated. PEM will not accept any liability for any damage to equipment or personnel arising from connecting the coil around a bare (un-insulated) conductor.

WHAT HAPPENS IF THE PEAK CURRENT IS EXCEEDED?

	If the peak current is exceeded the LCD will display either '1' or '-1' to the left of the display as the user reads it. The other digits will be blank.

WARRANTY

The coil is guaranteed to be free from defects due to materials and workmanship for 12 months and the integrator for 24 months from the date of despatch from Power Electronic Measurements Ltd. In the event of a defect or incorrect operation of the unit where the transducer has not been misused the DCflex should be returned to PEM with all freight charges to be paid by the customer. Correction shall be in the form of repair or replacement.

RETURNING DCflex's FOR RECALIBRATION OR REPAIR

If it is necessary to return the DCflex to PEM for repair whether or not under warranty please contact PEM in advance for shipping instructions (see below for contact details). To facilitate customs clearance it is important to follow the correct procedure otherwise import tax will be charged. PEM will not accept units sent for recalibration or repair if the this procedure is not followed.

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