CMC Rogowski current probe for measuring hf bearing currents

PEM has developed a flexible, clip-around, current probe to measure high frequency bearing currents in large motor drives. The probe is a modified version of our industry leading CWT range of Rogowski current sensors. This customised probe features:

- An electrostatically screened Rogowski coil. The screen attenuates the effects of unwanted interference due to capacitive coupling from local voltages sources.
- A low frequency (-3dB) bandwidth to attenuate any large fundamental power frequency currents. This significantly improves the SNR for measurement of high frequency bearing currents.
- A high frequency (-3dB) bandwidth of ≥ 10MHz for coil circumferences up to 1m.
- A wide range of Rogowski coil sizes suitable for even the largest machine shafts.
- Option of two outputs:
  - Optional small 3 ½ digit LCD display showing the true rms of the measured current. This enables a quick, simple diagnostic test for the presence of hf bearing currents.
  - A BNC output enabling the engineer to look at the bearing current waveform and perform full diagnostics with an oscilloscope.
<table>
<thead>
<tr>
<th>Type</th>
<th>Sensitivity (mV/A)</th>
<th>Peak current (A)</th>
<th>Rated current LCD Display (A)</th>
<th>Noise max (mV pk-pk)</th>
<th>LF (-3dB) bandwidth $f_L$ typ. (kHz)</th>
<th>LF (-1%) bandwidth typ. (kHz)</th>
<th>HF (-3dB) bandwidth $f_H$ typ. (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMC015</td>
<td>200.0</td>
<td>30.0</td>
<td>2.0</td>
<td>15.0</td>
<td>19.0</td>
<td>50.0</td>
<td>10.0</td>
</tr>
<tr>
<td>CMC03</td>
<td>100.0</td>
<td>60.0</td>
<td>10.0</td>
<td>10.0</td>
<td>7.0</td>
<td>20.0</td>
<td>10.0</td>
</tr>
<tr>
<td>CMC06</td>
<td>50.0</td>
<td>120.0</td>
<td>20.0</td>
<td>10.0</td>
<td>2.0</td>
<td>10.0</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Higher current ranges available on request

- BNC OUTPUT: ±6.0V corresponding to 'Peak current'
- LCD DISPLAY:
  - 1.999 – for CMC015
  - 10.00 – for CMC03
  - 19.99 – for CMC06

CALIBRATION AND POSITIONAL ACCURACY: Calibrated to ±0.3% with conductor central in the loop. Supplied with traceable certification. Variation with conductor position in the coil loop typically ±2%

LCD DISPLAY ADDITIONAL ERRORS:

- Crest factor
  - For a waveform with a crest factor <3 there are no additional conversion errors. For a waveform with a crest factor ≥3 an additional reading error must be added
  
<table>
<thead>
<tr>
<th>Crest Factor</th>
<th>Additional Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>+ 0.1%</td>
</tr>
<tr>
<td>10</td>
<td>+ 1%</td>
</tr>
</tbody>
</table>

RMS conversion error

Due to various non-linearities in the RMS conversion process, and within the bandwidth of the RMS to DC converter, the conversion error will be <0.2% of reading at full scale and 0.4% of reading at 20% full scale current. The errors are quantified below:

<table>
<thead>
<tr>
<th>20% Peak current</th>
<th>100% Peak current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion error</td>
<td>+0.2%</td>
</tr>
<tr>
<td>Non-linearity error</td>
<td>+0.2%</td>
</tr>
</tbody>
</table>

COIL LENGTHS: 330, 500, 700 and 1000mm as standard – up to 10m as custom

CABLE LENGTHS: 2.5 and 4m as standard – other cable lengths available as custom

COIL INSULATION: 10kV peak

Safe peak working voltage to earth. 10kV coils are flash tested at 15kVrms for 60 seconds with the sleeve added. Information about continuous use of the coils at high voltage can be obtained from PEM.

POWER SUPPLY: Battery 4 x AA (1.5V standard alkali batteries) – lifetime approx. 20hrs

- plus- 2.1/2.5mm socket for 12 to 24V (±10%) DC input


Generating the order code

- Type + LCD display or BNC only + Power supply / Cable length (m) / Coil circumference (mm)

- e.g. CMC06 – 50mV/A for the BNC output only version, battery supply, 2.5m cable from coil to integrator, 1000mm circumference coil

CMC06

- e.g. CMC05 – 200mV/A for the BNC output version AND the LCD display, battery supply, 4m cable from coil to integrator, 2000mm circumference coil

CMC015

If you have any queries regarding the CMC or require specifications outside our standard ranges please do not hesitate to contact us.
Typical performance characteristics

Fig 1. Bode plot of low frequency bandwidth
This is the same for both BNC output and LCD display

Fig 2. Graph of hf frequency response for a 1000mm coil vs. a 5000mm coil – Model CMC06 50mV/A
BNC output only – Showing the variation of hf performance with coil length
Fig 3. Graph of hf frequency response for a CMC03 with a fixed coil length 1000mm. Compares the BNC output with the hf bandwidth for the output on the LCD display.

Current is 20% full scale

The bandwidth on the LCD output is limited by the RMS to DC converter.

Using a precision RMS to DC converter we can offer a 3dB bandwidth of >3.5MHz from 20-100% peak current.

The typical 1%, 10% and -3dB (30%) bandwidth at 100% and 20% full scale is listed in the table below:

<table>
<thead>
<tr>
<th>Input Current</th>
<th>1% Bandwidth</th>
<th>10% Bandwidth</th>
<th>3dB (30%) Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Full Scale</td>
<td>400KHz</td>
<td>2.0MHz</td>
<td>4.0MHz</td>
</tr>
<tr>
<td>20% Full Scale</td>
<td>200KHz</td>
<td>1.0MHz</td>
<td>3.5MHz</td>
</tr>
</tbody>
</table>

At currents below 20% peak current input the high frequency bandwidth is reduced.