MEASUREMENT SYSTEM FOR HIGH CURRENT SHUNTS DC CHARACTERIZATION AT CMI

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Method: measurement of ratio of output voltages of the tested and the reference standard by dual channel multimeter. Thus, the resistance of tested standard is calculated:

\[ R_x = \frac{U_x}{U_E} \cdot R_E \]

Standards: oil filled and placed in the oil bath, traceability to QHS.

<table>
<thead>
<tr>
<th>Nom.value</th>
<th>Current level</th>
<th>Type</th>
<th>Producer</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1 Ω</td>
<td>1A - 3A</td>
<td>1682</td>
<td>Tinsley</td>
</tr>
<tr>
<td>0,02 Ω</td>
<td>5A - 10A</td>
<td>1682</td>
<td>Tinsley</td>
</tr>
<tr>
<td>0,01 Ω</td>
<td>10A - 20A</td>
<td>RN I</td>
<td>Metra</td>
</tr>
<tr>
<td>0,001 Ω</td>
<td>30A - 100A</td>
<td>RN I</td>
<td>Metra</td>
</tr>
</tbody>
</table>
PC AND TC MEASUREMENTS

POWER COEFFICIENT MEASUREMENTS

The power coefficient is easily calculated as:

\[ PC_R = \Delta R / \Delta P \]

PCR measured and calculated in current range of 50% - 100% of nominal current.

Typical values of PCR
- **Foil shunts:**
  - < ±4 ppm, unc. < 3.1 ppm
- **Cage shunts:**
  - < ±1.5 ppm, unc. < 1.5 ppm

TEMPERATURE COEFFICIENT MEASUREMENTS

The temperature coefficient is easily calculated as:

\[ TC_R = \Delta R / \Delta T \]

TCR measured in temperature range from 18 °C up to 28(30) °C at 1/10 of nominal current.

Typical values of TCR
- **Foil shunts:**
  - -2.8  +0.2  +8 ppm, unc. < 2.1 ppm
- **Cage shunts:**
  - -0.8  +1.7 ppm, unc. < 1.7 ppm
Power dependence

Relative change of R to 1/10 of nominal power (ppm)

Power (W)

BM1  BM2  BM3  BZ3  BZ4  B50/1  V12/80A/2
Temperature dependence

Relative change of R to 18°C (ppm)

Temperature (°C)

BM1, BM2, BM3, BZ3, BZ4, B50/1, V12/80A/2, V12/40A/2, BZ2
CAGE SHUNTS RESULTS

Power dependence

relative change of $R$ to $1/10$ of nominal power (ppm)

Power (W)

-30
-20
-10
0
10
20
30
40
50
60
70
80
90

SP CS3C-0703
SP CS2D-0812
SP CS2D-0813
JV 10 A
CMI 10 A
SIQ 20 A
SIQ 5 A
Temperature dependence of cage shunts
TC and PC measurements combined

Temperature dependence of cage shunts
TC and PC measurements combined

Temperature (°C)

Relative change of R to 18°C (ppm)

SP CS3C-0703 TC
SP CS3C-0703 PC
CMI10A/1 TC
CMI10A/1 PC
<table>
<thead>
<tr>
<th>Origin</th>
<th>Serial No.</th>
<th>Nominal I (A)</th>
<th>Nominal R (mΩ)</th>
<th>Shunt type</th>
<th>I (A)</th>
<th>temp. range (°C)</th>
<th>TC (ppm/°C)</th>
<th>Unc. (ppm/°C)</th>
<th>current range (A)</th>
<th>PC (ppm/W)</th>
<th>Unc. (ppm/W)</th>
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<td>SIQ</td>
<td>SIQ07023</td>
<td>5</td>
<td>150</td>
<td>cage</td>
<td>0,5</td>
<td>18°C...28°C</td>
<td>1,1</td>
<td>0,7</td>
<td>2,5A...5A</td>
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<td>1,2</td>
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<td>0,33</td>
<td>5A...10A</td>
<td>-1,5</td>
<td>1,2</td>
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<tr>
<td>JV</td>
<td>-</td>
<td>10</td>
<td>90</td>
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<td>1</td>
<td>18°C...28°C</td>
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<td>0,9</td>
<td>5A...10A</td>
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<td>1,2</td>
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<td>BZ1</td>
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<td>42</td>
<td>foil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5A...15A</td>
<td>-28,3</td>
<td>1,2</td>
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<td>0,48</td>
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<td>35</td>
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<td>2</td>
<td>18°C...28°C</td>
<td>3,2</td>
<td>0,7</td>
<td>10A...20A</td>
<td>4,1</td>
<td>1,0</td>
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<td>cage</td>
<td>2</td>
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<td>1,67</td>
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<td>0,82</td>
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<td>20</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
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<td>-1,4</td>
<td>3,1</td>
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<td>V12/40A/2</td>
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<td>9,5</td>
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<td>5</td>
<td>18°C...30°C</td>
<td>6,8</td>
<td>1,1</td>
<td>20A...40A</td>
<td>0,51</td>
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<td>SP</td>
<td>CS2D-0812</td>
<td>50</td>
<td>16</td>
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<td>15</td>
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<td>25A...50A</td>
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<td>V12/80A/2</td>
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<td>8,0</td>
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<td>0,68</td>
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<td>B50/1</td>
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<td>0,16</td>
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<td>18°C...28°C</td>
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<td>0,5</td>
<td>50A...100A</td>
<td>-0,68</td>
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<tr>
<td>SP</td>
<td>CS2D-0813</td>
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<td>8</td>
<td>cage</td>
<td>10</td>
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<td>1,2</td>
<td>1,7</td>
<td>50A...100A</td>
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<td>BM2</td>
<td>100</td>
<td>5</td>
<td>foil</td>
<td>10</td>
<td>18°C...28°C</td>
<td>7,3</td>
<td>1,5</td>
<td>50A...100A</td>
<td>-1,1</td>
<td>1,0</td>
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<tr>
<td>BEV</td>
<td>BM3</td>
<td>100</td>
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<td>10</td>
<td>18°C...28°C</td>
<td>6,8</td>
<td>1,5</td>
<td>50A...100A</td>
<td>-1,3</td>
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</table>
CONCLUSIONS

Most significant influences of measurements (except of working standard calibration): temperature influence on air cooled shunts and/or standard deviation of measured voltages ratio.

Future work focus on measuring of temperature dependence of Vishays resistors.

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REFERENCES