100% electronic current sensors

Capteurs de courant 100% électronique
Technical presentation summary

1 The customer’s needs
2 The aimed applications
3 The technology
4 The range
5 The main characteristics
6 The options and accessories
7 The electrical connections
8 The used standards
9 The technical documentation

1 The customers’ needs

- Price
- High quality
- High performances
- Reliability
- Compactness
- Latest standards
- Reliable supplier
2 The aimed applications

- Industrial applications
  - UPS, windmills, welding, electrolysis ...

- Traction applications
  - Sub-stations (mainly)...

First typical technology of substitution:
- To replace the entire function (shunt + isolation conditioner)

- Ratings targeted: 2 to 20 kA (Ipn)
- Markets: Industry & Traction
2 The aimed applications

- Other technologies to replace:
  - Depending on customer application, it is possible to use NCS instead of other current measurement technologies:
    - Closed loop Hall effect sensors
    - Open loop Hall effect sensors
    - Rogowski coils
    - Current transformers

- Specific applications:
  - Need of a large hole for a low nominal primary current:
    - Conductor in Aluminium (low current density)
    - Cable with thick insulation (medium voltage)
    - Several conductors through the hole
    - Specific bus bar dimensions
3 The technology

- Functionning principle
  - Application of the Ampere’s theorem:
    \[ \oint_C \vec{H} \cdot d\vec{l} = I \]
    *The integration of the magnetic field vector \( \vec{H} \) on a closed contour \( C \) leads to the primary current \( I \):*
  
    \[ \text{In the air: } \vec{B} = \mu_0 \cdot \vec{H} \]

- Technology:
  - Detection of the magnetic field with Hall effect probes
  - Full electronic concept (no magnetic core)

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3 The technology

- Functionning principle
- Major function
  - To measure ac and dc high currents (\( > 2\text{kA} \))
3 The technology

- Major advantages of the NCS technology
  - Galvanic isolation
  - Wide continuous measuring range
  - No power dissipation (no heating)
4 The range

- General range presentation: markets & ratings

NCS125

Traction Industry

2…10kA

NCS165

Traction Industry

4…20kA

4 The range

- NCS range: NCS125 and NCS165 (2 sizes)
- Internal hole: 125 mm and 165 mm

<table>
<thead>
<tr>
<th>Hole (mm)</th>
<th>Ipmax (kA peak)</th>
<th>Is1 at Ip (mA peak)</th>
<th>Ipmax (kA peak)</th>
<th>Is2 at Ipmax (mA peak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCS125-2</td>
<td>125</td>
<td>2</td>
<td>±20</td>
<td>10</td>
</tr>
<tr>
<td>NCS125-4</td>
<td>125</td>
<td>4</td>
<td>±20</td>
<td>20</td>
</tr>
<tr>
<td>NCS125-6</td>
<td>125</td>
<td>6</td>
<td>±20</td>
<td>30</td>
</tr>
<tr>
<td>NCS125-10</td>
<td>125</td>
<td>10</td>
<td>±20</td>
<td>30</td>
</tr>
<tr>
<td>NCS165-4</td>
<td>165</td>
<td>4</td>
<td>±20</td>
<td>20</td>
</tr>
<tr>
<td>NCS165-6</td>
<td>165</td>
<td>6</td>
<td>±20</td>
<td>30</td>
</tr>
<tr>
<td>NCS165-10</td>
<td>165</td>
<td>10</td>
<td>±20</td>
<td>30</td>
</tr>
<tr>
<td>NCS165-20</td>
<td>165</td>
<td>20</td>
<td>±20</td>
<td>40</td>
</tr>
</tbody>
</table>

- Important note: NCS sensors withstand Ipmax continuously
4 The range

- NCS range: NCS125 and NCS165 (2 sizes)
- Internal hole: 125 mm and 165 mm

<table>
<thead>
<tr>
<th>Hole (mm)</th>
<th>Ip (kA peak)</th>
<th>Vs1 at Ip (V peak)</th>
<th>Ipmax (kA peak)</th>
<th>Vs2 at Ipmax (V peak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCS125-2</td>
<td>125</td>
<td>2 ±10</td>
<td>10</td>
<td>±10</td>
</tr>
<tr>
<td>NCS125-4</td>
<td>125</td>
<td>4 ±10</td>
<td>20</td>
<td>±10</td>
</tr>
<tr>
<td>NCS125-6</td>
<td>125</td>
<td>6 ±10</td>
<td>30</td>
<td>±10</td>
</tr>
<tr>
<td>NCS125-10</td>
<td>125</td>
<td>10 ±10</td>
<td>30</td>
<td>±10</td>
</tr>
<tr>
<td>NCS165-4</td>
<td>165</td>
<td>4 ±10</td>
<td>20</td>
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<td>NCS165-6</td>
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<td>6 ±10</td>
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</tr>
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</tr>
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<td>NCS165-20</td>
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<td>40</td>
<td>±10</td>
</tr>
</tbody>
</table>

- Important note: NCS sensors withstand Ipmax continuously

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4 The range

- NCS125 and NCS165 standard current outputs:

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4 The range

- NCS125 and NCS165 standard voltage outputs:

![Graph showing voltage outputs vs current]

- NCS125 and NCS165 standard secondary outputs:
  - Connector output *(industrial version only)*:
    - Is1: ±20mA @ Ip (peak value)
    - Is2: ±20mA @ Ipmax (peak value)
    - Vs1: ±10V @ Ip (peak value)
    - Vs2: ±10V @ Ipmax (peak value)
  - Cable output *(industrial and traction versions)*:
    - Is1: ±20mA @ Ip (peak value)
    - Is2: ±20mA @ Ipmax (peak value)
    - Or
    - Vs1: ±10V @ Ip (peak value)
    - Vs2: ±10V @ Ipmax (peak value)
4 The range

- Industrial and Traction main differences:

<table>
<thead>
<tr>
<th></th>
<th>Industry</th>
<th>Traction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>±15V to ±24V (±2%)</td>
<td>±24V (±25%)</td>
</tr>
<tr>
<td>Test voltage</td>
<td>5kV</td>
<td>20kV</td>
</tr>
<tr>
<td>Partial discharges</td>
<td>1.25kV</td>
<td>4.3kV</td>
</tr>
<tr>
<td>Creepage distance</td>
<td>14mm</td>
<td>195mm</td>
</tr>
<tr>
<td>Clearance distance</td>
<td>14mm</td>
<td>76mm</td>
</tr>
<tr>
<td>EMC (refer to type test report)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 The range

- NCS125 mechanical layout
4 The range

- NCS165 mechanical layout

4 The range

- Standard NCS range synthesis

  - **Traction**
    - 20kV
    - ±24V (±25%)
    - Connector version
      - Current & Voltage output
    - Cable version
      - Voltage output
  - **Industry**
    - 5kV
    - ±15...±24V (±2%)
    - Connector version
      - Current & Voltage output
    - Cable version
      - Current output
      - Voltage output
5 The main characteristics

- NCS125: main characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>NCS125-2</th>
<th>NCS125-4</th>
<th>NCS125-6</th>
<th>NCS125-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. input current $I_{pn}$ (continuously)</td>
<td>kA peak</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Max. input current $I_{pmax}$ (continuously)</td>
<td>kA peak</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Max. not measurable overload</td>
<td>kA peak</td>
<td>40</td>
<td>80</td>
<td>120</td>
<td>200</td>
</tr>
<tr>
<td>Output current $I_{s1} @ I_{pn}$</td>
<td>mA peak</td>
<td></td>
<td></td>
<td></td>
<td>±20</td>
</tr>
<tr>
<td>Output current $I_{s2} @ I_{pmax}$</td>
<td>mA peak</td>
<td></td>
<td></td>
<td></td>
<td>±20</td>
</tr>
<tr>
<td>Output voltage $V_{s1} @ I_{pn}$</td>
<td>V peak</td>
<td></td>
<td></td>
<td></td>
<td>±10</td>
</tr>
<tr>
<td>Output voltage $V_{s2} @ I_{pmax}$</td>
<td>V peak</td>
<td></td>
<td></td>
<td></td>
<td>±10</td>
</tr>
<tr>
<td>Accuracy @ $I_{pn}$ and @ +25°C</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td>±1</td>
</tr>
<tr>
<td>Delay time (typical)</td>
<td>µS</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>di/dt correctly followed</td>
<td>A/µS</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 100</td>
</tr>
<tr>
<td>Bandwidth (@-1dB)</td>
<td>kHz</td>
<td></td>
<td></td>
<td></td>
<td>0…10</td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>kV; 50Hz; 1min</td>
<td></td>
<td></td>
<td></td>
<td>±15…±24</td>
</tr>
<tr>
<td>Power supply</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td>±10</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>ºC</td>
<td></td>
<td></td>
<td></td>
<td>-40…+85</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>ºC</td>
<td></td>
<td></td>
<td></td>
<td>-50…+90</td>
</tr>
</tbody>
</table>

- For further requests, please contact us.

5 The main characteristics

- NCS165: main characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>NCS165-4</th>
<th>NCS165-6</th>
<th>NCS165-10</th>
<th>NCS165-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. input current $I_{pn}$ (continuously)</td>
<td>kA peak</td>
<td>4</td>
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<tr>
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<td></td>
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<tr>
<td>Output current $I_{s2} @ I_{pmax}$</td>
<td>mA peak</td>
<td></td>
<td></td>
<td></td>
<td>±20</td>
</tr>
<tr>
<td>Output voltage $V_{s1} @ I_{pn}$</td>
<td>V peak</td>
<td></td>
<td></td>
<td></td>
<td>±10</td>
</tr>
<tr>
<td>Output voltage $V_{s2} @ I_{pmax}$</td>
<td>V peak</td>
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6 The options and accessories

NCS125 & NCS165: mechanical options
- Brackets
- For horizontal mounting
- For vertical mounting
- For fixing on a bus bar
- Bus bars

NCS125 & NCS165: terminals options
- Standard output connections:
  - 6 wire shielded cable (2 m)
  - 8 pin locable connector
- Optional output connections:
  - Other to be defined upon request
6 The options and accessories

- NCS125 & NCS165: electrical options
  - Specific gain for the output current Is
  - Specific gain for the output voltage Vs
  - Multiple output voltage or current
  - Output current 4-20 mA: see next page
    (with unipolar supply voltage 0...+15 to +24 Vdc)

6 The options and accessories

- NCS125 & NCS165
  - Optional output: current 4-20 mA

Is1 or Is2 for **ac** primary current

Is1 or Is2 for **dc** primary current
6 The options and accessories

- NCS125 & NCS165: the accessories

- Side plates kit (without bar)
- Female connector kit (set of 10 pieces)

7 The electrical connections

- NCS125 & NCS165: connection diagram

- Current
- Output

- Rm1 & Rm2 with Rmin: 0Ω and Rmax: 350Ω
7 The electrical connections

NCS125 & NCS165: connection diagram

Rm1 & Rm2 ≥ 10kΩ

8 The used standards: Industrial applications

EN50178 (Oct 1997)

Safety requirements

- Rated voltage: 1000V rms or 1500Vdc
- Pollution degree: PD2 (pollution normally conducting and random condensation)
- Insulation distance: OV3 (fixed installations with requirements of reliability and disponibility:
  - 14 mm air distance (reinforced insulation)
  - material group II (400≤CTI<600)
- Creepage distance: 14.2mm (reinforced insulation) with grooves having minimum 2 mm
- Partial discharges: 1.25kV (10pC)
8 The used standards: Industrial applications

- EN50178 (Oct 1997)….
- Environmental requirements
  - Climatic
    - Tab 6, class 2K3
    - -20…+70°C
    - 95% relative humidity
    - max 60gr of water / m³
    - 70 à 106kPa
  - EMC
    - design and tests in accordance with EN61000-6-2 and EN61000-6-4

- Testing (see details in the concerned Type Test Report)
  - Functioning
    - @ +25°C, @-40°C, @+85°C
    - delay time
    - di/dt
    - bandwidth
    - overload
    - magnetic environment
  - Other climatic tests
    - salt mist
    - humid heat
    - storage
8 The used standards: Industrial applications

- **EN50178 (Oct 1997)…**
  - Testing (see details in the concerned Type Test Report)
    - Dielectric: dielectric test, insulation resistance, dielectric overload, partial discharges
    - EMC (immunity): burst
      - **EN61000-6-2**
        - surges, electrostatic discharges, conducted perturbations, electromagnetic fields, network magnetic fields

8 The used standards: Industrial applications

- **EN50178 (Oct 1997)…**
  - Testing (see details in the concerned Type Test Report)
    - EMC (emission): conducted, radiated
      - **EN61000-6-4**
    - Mechanical: vibrations, shocks
8 The used standards: railways applications

- **EN50155 (Dec 2002)**
  - Testing (see details in the concerned Type Test Report)
  - Functioning: @ +25°C, @-40°C, @+85°C
    - delay time
    - di/dt
    - bandwidth
    - overload
    - magnetic environment
    - power supply over/under voltage
  - Other climatic tests: salt mist
    - humid heat cycling
    - storage

8 The used standards: railways applications

- **EN50123-1 (May 1995)** for substations up to 3kVdc
  - Main requirements
    - Rated voltage \( U_N \): 3000Vdc
    - Max. repetitive Voltage \( U_{NM} \): 4800Vdc
    - Dielectric tests: 16.8kV (50Hz, 1min)
    - Air distance (outdoor): 76mm
    - Over voltage category: 0V3
    - Pollution degree: PD3A
8 The used standards: railways applications

- EN50163 (Nov 1995) for substations up to 3kVdc
  - Standard rated voltages
    - Rated voltage ($U_N$) | 750Vdc | 1500Vdc | 3000Vdc
    - $U_{max1}$ (permanent) | 900Vdc | 1800Vdc | 3600Vdc
    - $U_{max2}$ (max. 5 min) | 950Vdc | 1950Vdc | 3900Vdc
    - $U_{max3}$ (20msec) | 1269Vdc | 2538Vdc | 5075Vdc

- EN50121-5 (Sep 2000) for substations up to 3kVdc
  - Electro-magnetic compatibility (see details in the concerned Type Test Report)
    - Immunity
      - burst
      - surges
      - electrostatic discharges
      - conducted perturbations
      - electromagnetic fields
      - network magnetic fields
    - Emission
      - conducted
      - radiated
8 The used standards: railways applications

- IEC61373 (Jan 1999) for ground mobile equipments
  - Vibrations and shocks (see details in the concerned Type Test Report)
    - Tests: random vibrations with functional sensor
    - Tests: random vibrations without functional sensor
    - Tests: shocks
  - Vibrations severity: class B

8 The used standards: railways applications

- EN50124-1 (Jan 1999)
  - Insulation coordination
    - Rated voltage: 3000Vdc
    - Pollution degree: PD3A (low conductivity and humidity with long term condensation)
    - Insulation distance: OV3 (same as OV4 with less requirements on over voltages, reliability & disponibility)
      - Insulation distance: 76 mm air distance (reinforced insulation)
      - Insulation distance: material group II (400≤CTI<600)
    - Creepage distance: 195mm (reinforced insulation) with grooves having minimum 2.5 mm
    - Partial discharges: 4.3kV (10pC)
8 The used standards: railways applications

- EN50121-3-2 (Sep 2000) for ground mobile equipments
  - Electro-magnetic compatibility (see details in the concerned Type Test Report)
  - Immunity & Emission: same as per EN50121-5 but with some higher levels during tests

9 The technical documentation

- Technical file
  - Technical presentation: this document
  - Mounting instructions
  - Data sheets
  - Type tests report
  - MTBF calculation
  - Fire/smoke certificate
  - Environmental certificate
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