100% electronic voltage sensors

Capteurs de tension
100% électronique
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Technical presentation summary

1. The customer’s needs
   - Price
   - High quality
   - High performances
   - Reliability
   - Compactness
   - Latest standards
   - Reliable supplier

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 advantages
9. The used standards
10. The technical documentation
2 The aimed applications

- Traction applications
  - Power converters
    - Catenaries d.c. voltage
    - Motor phase voltages, etc...
  - Battery voltages
  - Auxiliary voltages

3 The technology

- Functioning principle
  
  The primary voltage to be measured is applied directly to the sensor terminals: HT+ (positive high voltage) and HT- (negative high voltage or earth). This voltage is passed through an insulating amplifier and is then converted into a secondary output current $I_S$. This secondary current $I_S$ is electrically insulated from the primary voltage to which it is exactly proportional. The voltage sensor measures instantaneous values.

  In contrast to closed loop Hall effect technology, this fully electronic technology does not use magnetic circuits or Hall probes. This allows the measurement of direct or alternating voltages with electrical insulation between the primary and secondary circuits.

  The primary voltage to be measured is applied directly to the sensor terminals: HT+ (positive high voltage) and HT- (negative high voltage or earth). This voltage is passed through an insulating amplifier and is then converted into a secondary output current $I_S$. This secondary current $I_S$ is electrically insulated from the primary voltage to which it is exactly proportional. The voltage sensor measures instantaneous values.

  In the same way as for current sensors, this secondary current $I_S$ can be then passed through a measuring resistance $R_M$. The measuring voltage $V_M$ at the terminals of this measuring resistance $R_M$ is therefore also exactly proportional to the primary voltage. The electrical supply to the sensor is also insulated from the primary voltage.
3 The technology

- Technologies comparison for voltage sensing

<table>
<thead>
<tr>
<th></th>
<th>VS</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measuring range</strong></td>
<td>1.5 $U_{PN}$ (continuously)</td>
<td>1.5 $U_{PN}$ (50 sec/hr)</td>
</tr>
<tr>
<td><strong>Bandwidth</strong></td>
<td>13 kHz</td>
<td>1 kHz</td>
</tr>
<tr>
<td><strong>Response time</strong></td>
<td>&lt; 15µsec</td>
<td>20 to 200µsec</td>
</tr>
<tr>
<td><strong>Accuracy (-40 to +85°C)</strong></td>
<td>±1.7% at $U_{PN}$</td>
<td>±3% to ±5% at $U_{PN}$</td>
</tr>
<tr>
<td><strong>High current influence</strong></td>
<td>Very low</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Partial discharges</strong></td>
<td>High (EN50207)</td>
<td>Low</td>
</tr>
</tbody>
</table>

3 The technology

- Technologies comparison for voltage sensing

<table>
<thead>
<tr>
<th></th>
<th>Low power primary resistors</th>
<th>Primary resistors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No heat sink</td>
<td>Heat sink</td>
</tr>
<tr>
<td></td>
<td>Low power primary resistors included</td>
<td>Primary resistor included</td>
</tr>
<tr>
<td></td>
<td>(no power to dissipate)</td>
<td>(about 10W to dissipate)</td>
</tr>
<tr>
<td><strong>Not calibrated sensors</strong></td>
<td>All the VS sensors are calibrated</td>
<td>1 external primary resistor of about 100 W to 200 W (additional cost and higher power to dissipate)</td>
</tr>
<tr>
<td><strong>Overall dimensions</strong></td>
<td>138 x 63 x 64 (size 0)</td>
<td>152 x 63 x 89 (EM type )</td>
</tr>
<tr>
<td></td>
<td>168 x 134 x 93 (size 1)</td>
<td>196 x 135 x 105 (TM type)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>450g (size 0)</td>
<td>550g (EM type)</td>
</tr>
<tr>
<td></td>
<td>1500g (size 1)</td>
<td>1600g (TM type)</td>
</tr>
</tbody>
</table>
3 The technology

Major advantages of the VS technology (electronic technology)
- Electrical isolation
- High accuracy
- Fast response time
- Excellent immunity to electromagnetic fields
- Excellent linearity
- Wide continuous measuring range
- Low power dissipation (no heating)

4 The range

General range presentation:
- 50V r.m.s. up to 4200V r.m.s.
  - 50V r.m.s. => VS50B
  - 125V r.m.s. => VS125B
  - 250V r.m.s. => VS250B
  - 500V r.m.s. => VS500B
  - 750V r.m.s. => VS750B
  - 1000V r.m.s. => VS1000B
  - 1500V r.m.s. => VS1500B
  - 2000V r.m.s. => VS2000B
  - 3000V r.m.s. => VS3000B
  - 4000V r.m.s. => VS4000B
  - 4200V r.m.s. => VS4200B
4 The range

- VS range:
  - Technology: 100% electronic
  - Measuring range: ± 1.5 x U_{PN} (continuously)
  - Temperature: -40°C to +85°C
  - Supply voltage: ±12V…±24V
  - Bandwidth: 0 to 13kHz
  - Global accuracy: ±1.7% (-40°C to +85°C)
  - Dielectric strength: EN50124-1 (from 3.3kV up to 12kV)
  - Options: primary & secondary terminals, output current (size 1)

VS range mechanical layout

VS50B to VS1500B
Size 0
4 The range

- VS range mechanical layout

5 The main characteristics

- VS range main standard characteristics

<table>
<thead>
<tr>
<th>Nominal primary voltage</th>
<th>VS50B</th>
<th>VS125B</th>
<th>VS250B</th>
<th>VS500B</th>
<th>VS750B</th>
</tr>
</thead>
<tbody>
<tr>
<td>U_PV</td>
<td>50</td>
<td>125</td>
<td>250</td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>Measuring range @V r.m.s.</td>
<td>≤±12V...±24V ±5%</td>
<td>≤±75</td>
<td>≤±187.5</td>
<td>≤±375</td>
<td>≤±750</td>
</tr>
<tr>
<td>Secondary current at U_PV</td>
<td>i_2</td>
<td>mA</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy at U_PV</td>
<td>Err%</td>
<td>@ ±25°C</td>
<td>%</td>
<td>&lt;=±0.9</td>
<td></td>
</tr>
<tr>
<td>Linearity</td>
<td>Lin</td>
<td>0.01U_PV ... 1.5U_PV</td>
<td>%</td>
<td>&lt;=0.3</td>
<td></td>
</tr>
<tr>
<td>Delay time</td>
<td>dt</td>
<td>µs</td>
<td>&lt;=10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dv/dt correctly followed</td>
<td>dv/dt</td>
<td>V/µs</td>
<td>&lt;=0.6</td>
<td>&lt;=1.5</td>
<td>&lt;=3</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>BW</td>
<td>kHz</td>
<td>&lt;=13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. no-load consumption current</td>
<td>i_ao @ ±24V ±5%</td>
<td>mA</td>
<td>&lt;=50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dielectric strength Primary/Secondary</td>
<td>U_d_pis 50 Hz, 1 min</td>
<td>kV</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>U_V</td>
<td>±5%</td>
<td>V dc</td>
<td>±12 ... ±24</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>T_op</td>
<td>°C</td>
<td>-40 ... +85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>T_st</td>
<td>°C</td>
<td>-50 ... +90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5 The main characteristics

VS range main standard characteristics

<table>
<thead>
<tr>
<th>Nominal primary voltage</th>
<th>UPN</th>
<th>V Nom.</th>
<th>Measuring range</th>
<th>Umax @ ±12V...±24V ±5%</th>
<th>V peak</th>
<th>Secondary current at UPN</th>
<th>If</th>
<th>mA</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS1000B</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
<td>4200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS1500B</td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
<td>3000</td>
<td>4000</td>
<td>4200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS2000B</td>
<td>2000</td>
<td>2500</td>
<td>3000</td>
<td>4000</td>
<td>4500</td>
<td>4700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS3000B</td>
<td>3000</td>
<td>3500</td>
<td>4000</td>
<td>4500</td>
<td>4700</td>
<td>4900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS4000B</td>
<td>4000</td>
<td>4500</td>
<td>5000</td>
<td>5500</td>
<td>5700</td>
<td>5900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS4200B</td>
<td>4200</td>
<td>4700</td>
<td>5200</td>
<td>5700</td>
<td>5900</td>
<td>6100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Accuracy at UPN Err% @ +25°C % <=±5.0

Linearity Lin 0.1 UPN...1.5 UPN % <=±0.3

Delay time dt µs <=10

dv/dt correctly followed dv/dt V/µs <=12 <=18 <=24 <=36 <=48 <=50

Bandwidth BW kHz <=13

Max. no-load consumption current Iao @ ±24V/±5% mA <=50

Dielectric strength Primary/Secondary Ud_p/s 50 Hz, 1 min kV 5.5 6.5 8 12 12 12

Supply voltage Vdc ±5% V dc ±12...±24

Operating temperature T°op °C -45...+65

Storage temperature T°st °C -60...+60

6 The options and accessories

VS range : electrical options

- Nominal secondary current I_{SN}:
  - I_{SN} for (U_{PN})= 20mA for size1 only (2000V ≤ U_{PN} ≤ 4200V)
  - I_{SN} for (U_{PN})= 80mA

VS range : terminals options

- Standard output connections:
  - 3 x M5 studs
  - 3 x 6.35 x 0.8 Faston
6 The options and accessories

- Optional output connections:
  - Shielded cable
  - 3 or 4 inserts
  - LEMO Connector
  - Others on request...

7 The electrical connections

- VS range: connection diagram
  - Bi-directionnal power supply

![Diagram of power supply connections](attachment:image.png)
7 The electrical connections

- Uni-directionnal power supply

![Diagram of uni-directionnal power supply]

\[ 0 \ldots -V_A \quad +V_A \ldots 0 \]

8 The advantages

- Construction
  - The first and most compact product since 1997
  - High performance
    - High external magnetic fields rejection
    - High measuring capabilities
  - A traction voltage sensor 100% resin potted
    - Electronic board protected
    - Withstand high vibration constraints
    - High thermal capacities
  - The best compromise: performance/volume/price
  - Recyclable packaging
8 The advantages

- Set-up flexibility
  - Accurate customer's needs optimise sensor selection knowing:
    - Max. permanent operating temperature
    - Max. measurable voltage with duration
    - Max. over voltage (not measurable) with duration
    - Max. voltage on burden resistance at $U_{\text{P MAX}}$
    - Min. supply voltage
  - Mechanical flexibility due to compact sensor design

9 The used standards: railways applications

- EN50155
  - Testing (see details in the concerned Type Test Report)
    - Functioning: @ +25°C, @-40°C, @+85°C
      - response time
      - $dv/dt$
      - bandwidth
      - overload
      - magnetic environment
      - power supply over/under voltage
  - Other climatic tests: salt mist
    - humid heat cycling
    - storage
9 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

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9 The used standards: railways applications

- **EN50124-1**
  - Insulation coordination
    - Rated voltage: 1500Vdc (VS50…VS1500)
    - Pollution degree: PD3 (low conductivity and humidity with short term condensation)
    - Insulation distance: OV2 (same as OV1 with higher requirements on over voltages, reliability & disponibility)
    - Insulation distance: 22 mm air distance (reinforced insulation)
    - Insulation distance: material group II (400<CTI<600)
    - Creepage distance: 59 mm (reinforced insulation) with grooves having minimum 1 mm
    - Partial discharges: up to 2.2kV (10pC) following sensor
9 The used standards: railways applications

- **EN50124-1**
  - Insulation coordination
    - Rated voltage: 3000Vdc (VS2000…VS4200)
    - Pollution degree: PD3 (low conductivity and humidity with short term condensation)
    - Insulation distance: OV2 (same as OV1 with higher requirements on over voltages, reliability & disponibility)
      - 40 mm air distance (reinforced insulation)
      - Material group II (400<CTI<600)
    - Creepage distance: 118 mm (reinforced insulation) with grooves having minimum 1.5 mm
    - Partial discharges: up to 4.3kV (10pC) following sensor

- **EN50121-3-2 for ground mobile equipments**
  - Electro-magnetic compatibility (see details in the concerned Type Test Report)
    - Emission: Conducted emission (tab 5)
    - Radiated emission (tab 6)
The used standards: railways applications

- EN50121-3-2 for ground mobile equipments
  - Electro-magnetic compatibility (see details in the concerned Type Test Report)
    - Immunity
      - Electrical fast transients burst
      - Electrostatic discharge
      - Conducted perturbations
      - Radiated electromagnetic fields

The technical documentation

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