Voltage transducer DVL 250

For the electronic measurement of voltage: DC, AC, pulsed..., with galvanic separation between the primary and the secondary circuit.

Features
- Bipolar and insulated measurement up to 375 V
- Current output
- Input and output connections with M5 threaded studs
- Compatible with AV 100 family.

Advantages
- Low consumption and low losses
- Compact design
- Good behavior under common mode variations
- Excellent accuracy (offset, sensitivity, linearity)
- Good response time
- Low temperature drift
- High immunity to external interferences.

Applications
- Single or three phase inverters
- Propulsion and braking choppers
- Propulsion converters
- Auxiliary converters
- High power drives
- Substations.

Standards
- EN 50155: 2007
- EN 50178: 1997
- EN 50124-1: 2001
- EN 50121-3-2: 2006.

Application Domain
- Traction (fixed and onboard)
- Industrial.
Absolute maximum ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum supply voltage (V_p = 0 V, 0.1 s)</td>
<td>±U_c</td>
<td>±34 V</td>
</tr>
<tr>
<td>Maximum supply voltage (working) (-40 .. 85 °C)</td>
<td>±U_c</td>
<td>±26.4V</td>
</tr>
<tr>
<td>Maximum input voltage (-40 .. 85 °C)</td>
<td>V_p</td>
<td>375 V</td>
</tr>
<tr>
<td>Maximum steady state input voltage (-40 .. 85 °C)</td>
<td>V_Pn</td>
<td>250 V see derating on figure 2</td>
</tr>
</tbody>
</table>

Absolute maximum ratings apply at 25 °C unless otherwise noted. Stresses above these ratings may cause permanent damage. Exposure to absolute maximum ratings for extended periods may degrade reliability.

Insulation coordination

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS voltage for AC insulation test, 50 Hz, 1 min</td>
<td>U_d</td>
<td>kV</td>
<td>8.5</td>
<td>100 % tested in production</td>
</tr>
<tr>
<td>Maximum impulse withstand voltage 1.2/50 µs exponential shape</td>
<td>U_Wmax</td>
<td>kV</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Partial discharge extinction rms voltage @ 10 pC</td>
<td>U_e</td>
<td>V</td>
<td>2700</td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>R_IS</td>
<td>MΩ</td>
<td>200</td>
<td>measured at 500 V DC</td>
</tr>
<tr>
<td>Clearance (pri. - sec.)</td>
<td>d_CI</td>
<td>mm</td>
<td>-</td>
<td>Shortest distance through air</td>
</tr>
<tr>
<td>Creepage distance (pri. - sec.)</td>
<td>d_CP</td>
<td>mm</td>
<td>-</td>
<td>Shortest path along device body</td>
</tr>
<tr>
<td>Case material</td>
<td>-</td>
<td>-</td>
<td>V0 according to UL 94</td>
<td></td>
</tr>
<tr>
<td>Comparative tracking index</td>
<td>CTI</td>
<td>V</td>
<td>600</td>
<td></td>
</tr>
</tbody>
</table>

Environmental and mechanical characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient operating temperature</td>
<td>T_a</td>
<td>°C</td>
<td>-40</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Ambient storage temperature</td>
<td>T_s</td>
<td>°C</td>
<td>-50</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>m</td>
<td>g</td>
<td>300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Electrical data**

At $T_a = 25 \, ^\circ\text{C}$, $\pm U_C = \pm 24 \, \text{V}$, $R_m = 100 \, \Omega$, unless otherwise noted. Lines with a * in the conditions column apply over the -40..85 °C ambient temperature range.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary nominal rms voltage</td>
<td>$V_{\text{PN}}$</td>
<td>V</td>
<td>250</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Primary voltage, measuring range</td>
<td>$V_{\text{PM}}$</td>
<td>V</td>
<td>-375</td>
<td>375</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Measuring resistance</td>
<td>$R_m$</td>
<td>Ω</td>
<td>0</td>
<td>120</td>
<td></td>
<td>See derating on figure 2. For $</td>
</tr>
<tr>
<td>Secondary nominal rms current</td>
<td>$I_{\text{SN}}$</td>
<td>mA</td>
<td>50</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Secondary current</td>
<td>$I_s$</td>
<td>mA</td>
<td>-75</td>
<td>75</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>$\pm U_C$</td>
<td>V</td>
<td>±13.5</td>
<td>±24</td>
<td>±26.4</td>
<td>*</td>
</tr>
<tr>
<td>Rise time of $U_C$ (10-90 %)</td>
<td>$t_{\text{rise}}$</td>
<td>ms</td>
<td>100</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Current consumption @ $U_C = \pm 24 , \text{V}$</td>
<td>$I_c$</td>
<td>mA</td>
<td>20 + $I_s$</td>
<td>25 + $I_s$</td>
<td>100 % tested in production</td>
<td></td>
</tr>
<tr>
<td>Offset current</td>
<td>$I_o$</td>
<td>µA</td>
<td>-50</td>
<td>0</td>
<td>50</td>
<td>100 % tested in production</td>
</tr>
<tr>
<td>Temperature variation of $I_o$</td>
<td>$I_{\text{OT}}$</td>
<td>µA</td>
<td>-120</td>
<td>-150</td>
<td>120</td>
<td>-25 .. 85 °C</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>$G$</td>
<td>µA/V</td>
<td>200</td>
<td></td>
<td></td>
<td>50 mA for 250 V</td>
</tr>
<tr>
<td>Sensitivity error</td>
<td>$\epsilon_g$</td>
<td>%</td>
<td>-0.2</td>
<td>0</td>
<td>0.2</td>
<td>*</td>
</tr>
<tr>
<td>Thermal drift of sensitivity</td>
<td>$\epsilon_{\text{GT}}$</td>
<td>%</td>
<td>-0.5</td>
<td>0.5</td>
<td></td>
<td>± 250 V range</td>
</tr>
<tr>
<td>Linearity error</td>
<td>$\epsilon_l$</td>
<td>%</td>
<td>-0.5</td>
<td>0.5</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Overall accuracy</td>
<td>$X_a$</td>
<td>% of $V_{\text{PN}}$</td>
<td>-0.5</td>
<td>-1</td>
<td>0.5</td>
<td>25 °C; 100 % tested in production</td>
</tr>
<tr>
<td>Output rms current noise</td>
<td>$I_{\text{no}}$</td>
<td>µA</td>
<td>22</td>
<td></td>
<td></td>
<td>1 Hz to 100 kHz</td>
</tr>
<tr>
<td>Reaction time @ 10 % of $V_{\text{PN}}$</td>
<td>$t_{\text{ra}}$</td>
<td>µs</td>
<td>30</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Response time @ 90 % of $V_{\text{PN}}$</td>
<td>$t_r$</td>
<td>µs</td>
<td>50</td>
<td>60</td>
<td></td>
<td>0 to 250 V step, 6 kV/µs</td>
</tr>
<tr>
<td>Frequency bandwidth</td>
<td>$BW$</td>
<td>kHz</td>
<td>14</td>
<td>8</td>
<td>2</td>
<td>-3 dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-1 dB</td>
<td></td>
<td>-0.1 dB</td>
<td>*</td>
</tr>
<tr>
<td>Start-up time</td>
<td>$t_{\text{start}}$</td>
<td>ms</td>
<td>190</td>
<td>250</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Primary resistance</td>
<td>$R_1$</td>
<td>MΩ</td>
<td>2.7</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Total primary power loss @ $V_{\text{PN}}$</td>
<td>$P_P$</td>
<td>W</td>
<td>23</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

**Definition of typical, minimum and maximum values**

Minimum and maximum values for specified limiting and safety conditions have to be understood as such as well as values shown in “typical” graphs. On the other hand, measured values are part of a statistical distribution that can be specified by an interval with upper and lower limits and a probability for measured values to lie within this interval.

Unless otherwise stated (e.g. “100 % tested”), the LEM definition for such intervals designated with “min” and “max” is that the probability for values of samples to lie in this interval is 99.73 %. For a normal (Gaussian) distribution, this corresponds to an interval between -3 sigma and +3 sigma. If “typical” values are not obviously mean or average values, those values are defined to delimit intervals with a probability of 68.27 %, corresponding to an interval between -sigma and +sigma for a normal distribution. Typical, maximal and minimal values are determined during the initial characterization of a product.
Typical performance characteristics

**Figure 1: Maximum measuring range**

**Figure 2: Minimum measuring resistance**

For $T_A$ under 80 °C, the minimum measuring resistance is 0 Ω whatever $U_C$.

**Figure 3: Electrical offset thermal drift**

**Figure 4: Overall accuracy in temperature**

**Figure 5: Sensitivity thermal drift**

**Figure 6: Typical step response (0 to 250 V)**
Typical performance characteristics (continued)

Figure 7: Supply current function of supply voltage

Figure 8: Supply current function of temperature

Figure 9: Typical frequency and phase response

Figure 10: Typical frequency and phase response (detail)
Typical performance characteristics continued

Figure 11: Typical common mode perturbation
(2000 V step with 6 kV/µs $R_m = 100 \, \Omega$)

Figure 12: Detail of typical common mode perturbation
(2000 V step with 6 kV/µs $R_m = 100 \, \Omega$)

Figure 13: Typical noise voltage density of V ($R_m$)
with $R_m = 50 \, \Omega$

Figure 14: Typical total output current noise (rms)
with $R_M = 50 \, \Omega$
($f_c$ is upper cut-off frequency of bandpass,
low cut off frequency is 1 Hz)

Figure 13 (noise voltage density) shows that there are no
significant discrete frequencies in the output.
Figure 14 confirms the absence of steps in the total output
current noise that would indicate discrete frequencies.
To calculate the noise in a frequency band $f_1$ to $f_2$, the
formula is:

$$I_n(f_{1\text{to}f_2}) = \sqrt{I_n(f_2)^2 - I_n(f_1)^2}$$

with $I_n(f)$ read from figure 14 (typical, rms value).

Example:

What is the noise from 10 to 100 Hz?
Figure 14 gives $I_n(10 \, \text{Hz}) = 0.3 \, \mu\text{A}$ and $I_n(100 \, \text{Hz}) = 1 \, \mu\text{A}$.
The output current noise (rms) is therefore.

$$\sqrt{(1.0 \times 10^{-6})^2 - (3.0 \times 10^{-7})^2} = 0.95 \, \mu\text{A}$$

Figure 15: Typical linearity error at 25 °C
Performance parameters definition

Sensitivity and linearity

To measure sensitivity and linearity, the primary voltage (DC) is cycled from 0 to \( V_{PM} \), then to \(- V_{PM} \) and back to 0 (equally spaced \( V_{PM}/10 \) steps).

The sensitivity \( G \) is defined as the slope of the linear regression line for a cycle between \( \pm V_{PM} \).

The linearity error \( \varepsilon_{L} \) is the maximum positive or negative difference between the measured points and the linear regression line, expressed in \% of the maximum measured value.

Magnetic offset

Due to its working principle, this type of transducer has no magnetic offset current \( I_{OM} \).

Electrical offset

The electrical offset current \( I_{OE} \) is the residual output current when the input voltage is zero.

The temperature variation \( I_{OT} \) of the electrical offset current \( I_{OE} \) is the variation of the electrical offset from 25 °C to the considered temperature.

Overall accuracy

The overall accuracy \( X_{G} \) is the error at \( \pm V_{PN} \) relative to the rated value \( V_{PN} \).

It includes all errors mentioned above.

Response and reaction times

The response time \( t_r \) and the reaction time \( t_{ra} \) are shown in the next figure.

Both depend on the primary voltage \( dv/dt \). They are measured at nominal voltage.
**Dimensions (in mm)**

![Dimensions Diagram]

**Mechanical characteristics**

- General tolerance: ± 1 mm
- Transducer fastening: 2 holes Ø 6.5 mm
  - 2 M6 steel screws
- Recommended fastening torque: 4 N·m
- Connection of primary: 2 M5 threaded studs
- Recommended fastening torque: 2.2 N·m
- Connection of secondary: 3 M5 threaded studs
- Recommended fastening torque: 2.2 N·m

**Remarks**

- $I_s$ is positive when a positive voltage is applied on $+HV$.
- The transducer is directly connected to the primary voltage.
- The primary cables have to be routed together all the way.
- The secondary cables also have to be routed together all the way.
- Installation of the transducer is to be done without primary or secondary voltage present.

**Safety**

This transducer must be used in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the manufacturer’s operating instructions.

Caution, risk of electrical shock

When operating the transducer, certain parts of the module can carry hazardous voltage (eg. primary busbar, power supply). Ignoring this warning can lead to injury and/or cause serious damage. This transducer is a build-in device, whose conducting parts must be inaccessible after installation. A protective housing or additional shield could be used. Main supply must be able to be disconnected.