Ultra-stable, high precision (ppm class) fluxgate technology DN Series current transducer for non-intrusive, isolated DC and AC current measurement up to 1500 A


## Features

- Ø41mm aperture
- 1 ppm linearity
- 5 ppm offset
- Compact aluminium housing
- Current output
- High stability closed loop fluxgate technology

## Applications

- Electric vehicle (EV) test bench
- Power measurement and power analysis
- MPS for particles accelerators
- Gradient amplifiers for MRI devices
- Batteries testing and evaluation systems
- Current calibration purposes

## Electrical specifications at 23 °C, ± 15 V supply voltage

| Parameter | | Symbol | Unit | Min | Typ. | Max | Comment |
|---|---|---|---|---|---|---|---|
| Nominal primary AC current | | $I_{PN\ AC}$ | Arms | | | 1000 | See Fig. 3 & Fig. 4 for details |
| Nominal primary DC current | | $I_{PN\ DC}$ | A | -1000 | | 1000 | For other values see Fig. 2 |
| Measuring range | | $\hat{I}_{PM}$ | A | -1500 | | 1500 | See Fig. 2 & Fig. 4 for details |
| Overload capacity | | $\hat{I}_{OL}$ | A | | | 5000 | Non-measured 100ms |
| Short term overrange | <30 minutes | | Arms | | | 1200 | $U_c = \pm 15V$, $R_M = 1\,\Omega$, $T_a = 35°C$ |
| Nominal secondary current | | $I_{SN}$ | mA | -666.67 | | 666.67 | At nominal primary DC current |
| Primary / secondary ratio | | | | | 1500 | | $I_{primary}/I_{secondary}$ |
| Measuring resistance | | $R_M$ | $\Omega$ | 0 | 1.5 | | See Fig. 2 and Fig. 3 for details |
| Linearity error | | $\epsilon_L$ | ppm | -1 | ±0.3 | 1 | ppm refers to $I_{PN\ DC}$ |
| Offset current (including earth field) | | $I_{OE}$ | ppm | -5 | 1 | 5 | ppm refers to $I_{PN\ DC}$ |
| Offset temperature coefficient | | $TC_{IOE}$ | ppm/K | -0.1 | ±0.02 | 0.1 | ppm refers to $I_{PN\ DC}$ |
| Offset stability over time | | | ppm/month | -0.1 | | 0.1 | ppm refers to $I_{PN\ DC}$ |
| Bandwidth | | f(±3dB) | kHz | | 400 | | Small signal. See Fig. 5 |
| Response time to a step current $I_{PN}$ | | $t_r$ | µs | | 1 | | To 90% of step current |
| Total accuracy | | $\epsilon_{tot}$ | | *% of reading + % of full scale* | | | Without offset. |
| | <10 Hz | | | | 0.0001 + 0.0001 | | Full scale refers to $I_{PN\ DC}$. |
| | <100 Hz | | | | 0.0002 + 0.0002 | | For details, see Reading and full |
| | <1 kHz | | | | 0.01 + 0.0003 | | scale |
| | <10 kHz | | | | 0.15 + 0.0004 | | For other frequencies, see Linear |
| | <100 kHz | | | | 5 + 0.0015 | | interpolation of accuracy |
| | <400 kHz | | | | 30 + 0.003 | | specification. |
| Phase shift | <10 Hz | | | | 0.01° | | |
| | <100 Hz | | | | 0.01° | | |
| | <1 kHz | | | | 0.02° | | |
| | <10 kHz | | | | 0.2° | | |
| | <100 kHz | | | | 3° | | |
| | <400 kHz | | | | 45° | | |
| RMS noise | <10 Hz | | ppm rms | | 0.2 | 0.4 | ppm refers to $I_{PN\ DC}$ |
| | <100 Hz | | | | 0.2 | 0.4 | |
| | <1 kHz | | | | 0.2 | 0.4 | |
| | <10 kHz | | | | 0.2 | 0.4 | |
| | <100 kHz | | | | 1.5 | 4 | |
| Peak-to-peak noise | <10 Hz | | ppm p-p | | 0.2 | 0.6 | ppm refers to $I_{PN\ DC}$ |
| | <100 Hz | | | | 0.5 | 1 | |
| | <1 kHz | | | | 0.6 | 1 | |
| | <10 kHz | | | | 1.4 | 4 | |
| | <100 kHz | | | | 4 | 10 | |
| Fluxgate excitation frequency | | $f_{exc}$ | kHz | | 31.25 | | |
| Power supply voltages | | $U_c$ | V | ±14.25 | | ±15.75 | |
| Idle current consumption | | | mA | | ±81 | | Primary current = 0 A |
| Current consumption at max current | | | A | -1.1 | | 1.1 | At $\hat{I}_{PM}$ |
| Power consumption | | | W | | | 18.5 | At $\hat{I}_{PM}$ |
| Operating temperature range | | $T_a$ | °C | -40 | | 85 | |
| Offset change with external magnetic field | | | ppm/mT | -4 | ±2 | 4 | ppm refers to nominal current |
| Offset change with power supply voltage changes | | | ppm/V | -0.2 | ±0.05 | 0.2 | ppm refers to nominal current |

## Linearity error

Linearity error is defined as the deviation from a straight line. The straight line is a linear regression trend line based on the least squares method of the measurement points from 0 to positive max current and another trendline is calculated from 0 to negative max current. The difference between each measured point and the linear trend line is the linearity error. The linearity error $\epsilon_L$ can be expressed as (1), where $I_{reading}$ is the measurement result and $I_{fitted}$ is the regression value.

$$\epsilon_L = I_{reading} - I_{fitted} \tag{1}$$

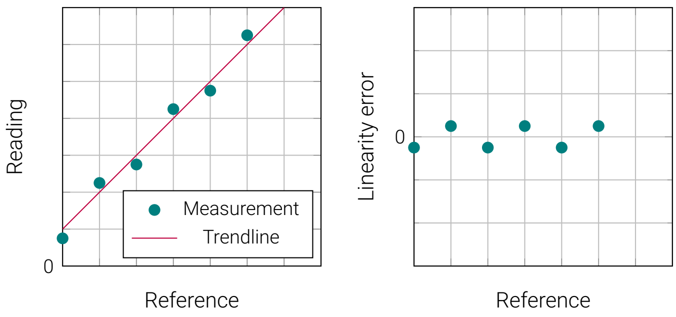


Figure 1: Linearity error definition

## Reading and full scale

Reading is the actual value measured at a given time. Full scale is the rated nominal value of the device. If a given current $I_{reading}$ is measured, the total accuracy is calculated as (2). Example: A 500 A rated device has a specification of 0.005% + 0.0015% (reading + full scale) at < 10 Hz. The device is measuring (reading) 10 A dc, and the accuracy is calculated as (3).

$$\epsilon_{tot} = \epsilon_{reading} \cdot I_{reading} + \epsilon_{fullscale} \cdot I_{PNDC} \tag{2}$$

$$\epsilon_{tot} = 0.005\% \cdot 10A + 0.0015\% \cdot 500A = 8mA \tag{3}$$

## Primary and secondary current/voltage

The secondary current $I_S$ or voltage $V_S$ is calculated by using the transfer ratio k, as in (4).

$$I_S = \frac{I_P}{k}, \qquad V_S = \frac{I_P}{k} \tag{4}$$

## Converting from ppm of nominal to secondary current/voltage

The nominal primary current is the rated current for the device. If $\epsilon_{ppm}$ is the error in ppm referred to nominal, use (5) to convert to ampere primary current. If the primary/secondary transfer ratio is k, use (6) to convert to ampere secondary current. If the device has voltage output, use (7)

$$\epsilon_{P_{ampere}} = \epsilon_{ppm} \cdot I_{PNDC} \cdot 1 \times 10^{-6} \tag{5}$$

$$\epsilon_{S_{ampere}} = \epsilon_{ppm} \cdot \frac{I_{PNDC}}{k} \cdot 1 \times 10^{-6} \tag{6}$$

$$\epsilon_{S_{volt}} = \epsilon_{ppm} \cdot \frac{I_{PNDC}}{k} \cdot 1 \times 10^{-6} \tag{7}$$

## Linear interpolation of accuracy specification

If the accuracy at a specific frequency is required, it is possible to use linear interpolation between known points. If the frequency f is $f_1 < f < f_2$ and the accuracy at the frequency $\epsilon(f)$ is $\epsilon(f_1) < \epsilon(f) < \epsilon(f_2)$, then the accuracy at f is found as (8).

$$\epsilon(f) = \frac{f_2 - f_1}{\epsilon(f_2) - \epsilon(f_1)}(f - f_1) + \epsilon(f_1) \tag{8}$$

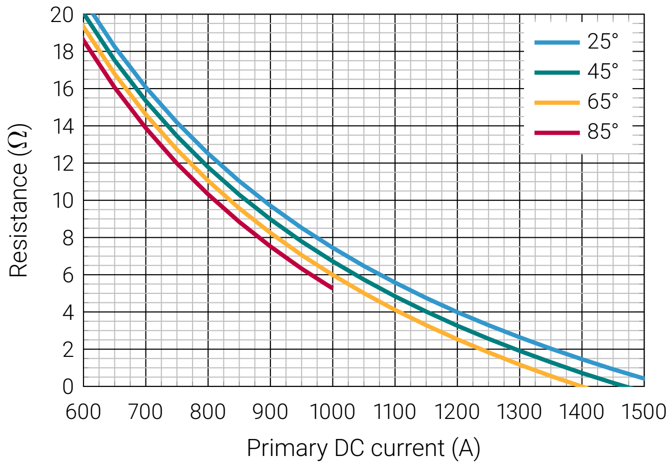


Figure 2: Maximum measurement resistor vs. ambient temperatures

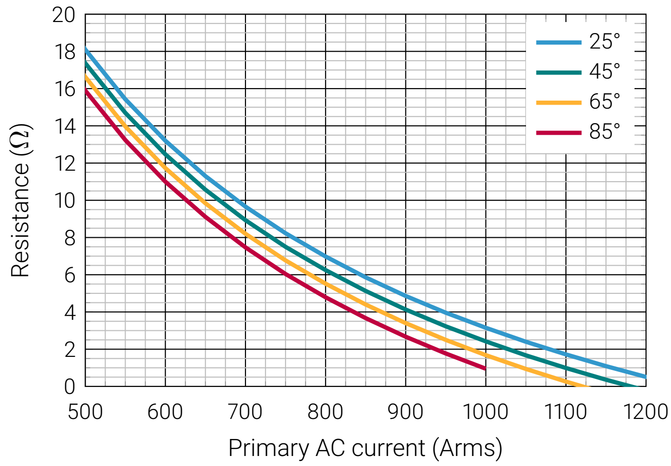


Figure 3: Maximum measurement resistor vs. ambient temperatures

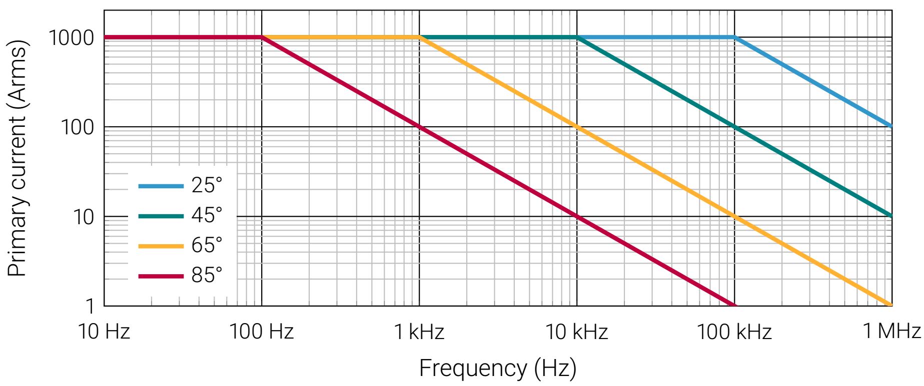


Figure 4: Maximum continuous primary current vs. frequency

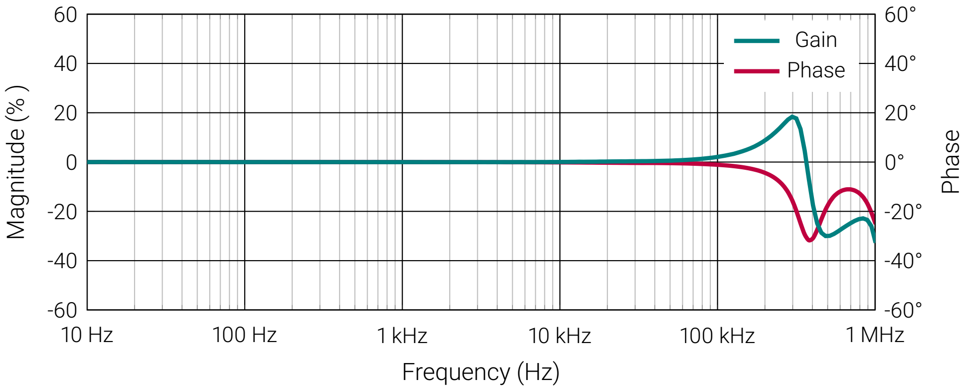


Figure 5: Frequency characteristics

## Isolation specifications according to IEC 61010-1

⚠ When using *REINFORCED insulated* wire, all wiring must be insulated for the highest voltage used. When using *BASIC insulated* or *uninsulated* wire, follow the specified voltages in the table below:

| Parameter | | Unit | Value |
|---|---|---|---|
| Clearance | | mm | 11 |
| Creepage distance | | mm | 11 |
| Comparative tracking index (CTI) | | V | > 600 |
| Continuous working voltage according to IEC 61010-1 with: | | | |
| *Uninsulated* wire: | Non mains | V | 1000 |
| | CAT II (dc and rms) | V | 1000 |
| | CAT III (dc and rms) | V | 600 |
| *BASIC insulated* wire: | Non mains | V | 2000 |
| | CAT II (dc and rms) | V | 1000 |
| | CAT III (dc and rms) | V | 1000 |
| Transient voltage according to IEC 61010-1 with: | | | |
| *Uninsulated* wire: | Non mains | V | 5000 |
| | CAT II | V | 9500 |
| | CAT III | V | 9500 |
| *BASIC insulated* wire: | Non mains | V | 7500 |
| | CAT II | V | 6000 |
| | CAT III | V | 8000 |

⚠ Do not connect the transducer to signals or use for measurements within Measurement Category IV, or for measurements on MAINs circuits or on circuits derived from Overvoltage Category IV which may have transient overvoltages above what the product can withstand. The product must not be connected to circuits that have a maximum voltage above the continuous working voltage, relative to earth or to other channels, or this could damage and defeat the insulation.

## Environmental and mechanical characteristics

| Parameter | Unit | Min | Typ | Max | Comment |
|---|---|---|---|---|---|
| Altitude | m | | | 2000 | |
| Usage | | | | | Designed for indoor use |
| Pollution degree | | | | 2 | |
| Operating temperature range | °C | -40 | | 85 | |
| Storage temperature range | °C | -40 | | 85 | |
| Relative humidity | % | 20 | | 80 | Non-condensing |
| Mass | kg | | 0.75 | | |

| | |
|---|---|
| Connections: | DSUB-9 |
| Standards: | EMC: EN 61326-1:2013-2021 |
| | Safety: IEC 61010-2-030:2021/A11:2021 and IEC 61010-1:2010/A1:2019 |
| External devices: | External devices connected to current transducers must comply with the standards IEC61010-1 and IEC62368-1 and be energy-limited circuitry |

| | |
|---|---|
| Cleaning: | The transducer should only be cleaned with a damp cloth. No detergent or chemicals should be used. |
| Temperature: | When multiple primary turns are used or high primary currents are applied the temperature around the transducer will increase, please monitor to ensure that the maximum ratings are not exceeded. It is recommended to have minimum 1 $mm^2$ per ampere in the primary bus bar. |

### Removable isolation plastic insert

⚠ If the isolation plastic insert is removed to increase aperture diameter, the user must ensure proper electrical insulation of the busbar according to IEC 61010-1 to meet the safety requirements to avoid electric shock.

### Intended use

The DN1000ID is designed to measure current up to 1500 A, and be powered by a DSSIU-4-1U or DSSIU-6-1U.
Please see the product manual: https://danisense.com/wp-content/uploads/2021/11/DS-Product-Manual-v1-2.pdf

### Instruction for use

1. Do not power up the device before all cables are connected.
2. Place the primary conductor through the aperture of the transducer.
3. Connect a DSUB cable between DSSIU-4(6)-1U and each sensor.
4. Connect a low impedance amperemeter, measuring resistor or power analyzer on the secondary output (4mm red and black connectors).
5. Ensure that no calibration connectors are attached when measuring primary current. Always avoid to create a calibration short circuit, between + and — calibration connection.
6. There is a risk of electrical shock if an uninsulated busbar with high voltages is touching the metal en- closure of the transducer. Please ensure before powering up the system that no primary busbar can touch the metal enclosure.
7. When all connection are secured - connect mains power.
8. Apply primary current.

### Advanced Sensor Protection Circuits “ASPC”

Developed to protect the current transducer from typical fault conditions:

- Unit is un-powered and secondary circuit is open or closed
- Unit is powered and secondary circuit is open or interrupted

Both DC and AC primary current up to 100% of nominal value can be applied to the current transducers in the above situations without damage to the electronics. Please notice that the transducer core can be magnetized in all above cases, leading to a small change in output offset current (less than 10ppm)

⚠ Do not disassemble the unit. If the green status LED is not operating with all cables connected and the system powered up, disconnect power and contact Danisense for further instruction. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

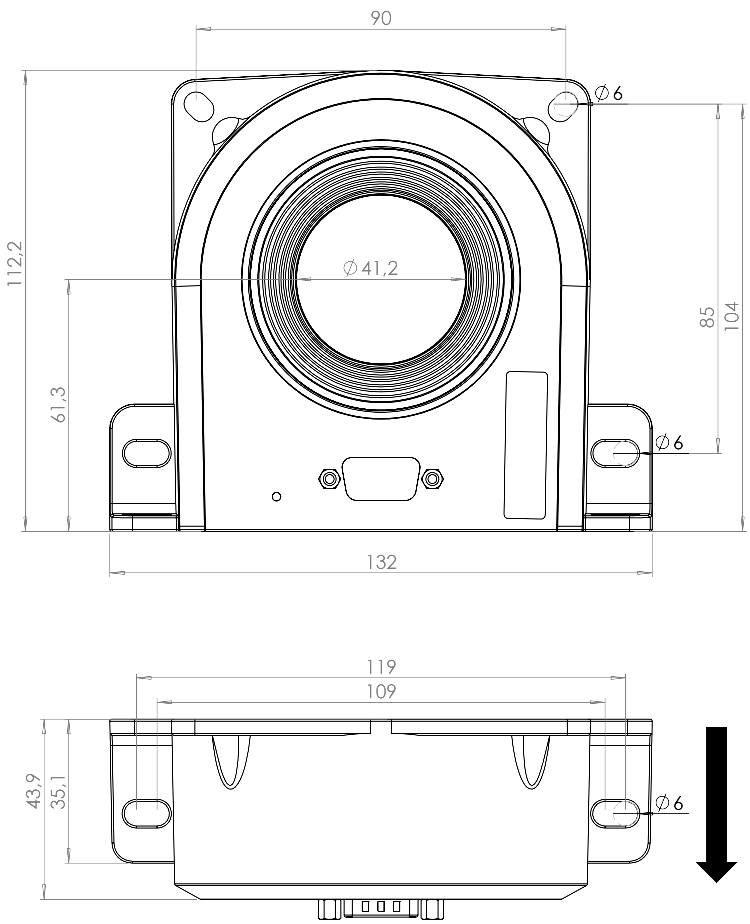


Figure 6: Dimensions of transducer. 0.3 mm Tolerance

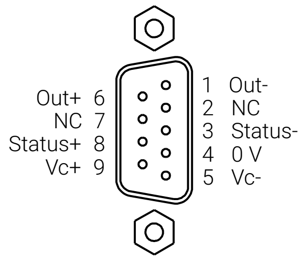


Figure 7: DSUB-9 connection pinout

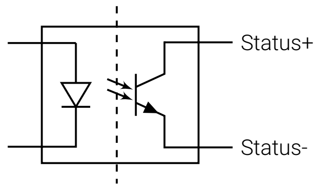


Figure 8: Status signal optocoupler

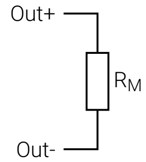


Figure 9: External measurement resistor connection

## Mounting

| | |
|---|---|
| Base plate mounting: | 2 slotted holes Ø6 mm |
| Back plate mounting: | 4 slotted holes Ø6 mm |
| Fastening torque: | 5.5 Nm |

## Positive current direction

Is identified by an arrow on the back side isolation plastic insert.

## Status signal

When the sensor is operating in normal condition the status pins (Status+ and Status-) are shorted by an optocoupler, see Fig. 8.

| | |
|---|---|
| Forward direction: | Pin 8 to pin 3 |
| Maximum forward current: | 10 mA |
| Maximum forward voltage: | 60 V |
| Maximum reverse voltage: | 5 V |

# Declaration of Conformity

Danisense A/S
Malervej 10
DK-2630 Taastrup
Denmark

Declares that under our sole responsibility that this product is in conformity with the provisions of the following EC Directives, including all amendments, and with national legislation implementing these directives:

Directive 2014/30/EU

Directive 2014/35/EU

And that the following harmonized standards have been applied

EEN 61010-1 (Third Edition):2010, EN 61010-1:2010/A1:2019

EN 61010-2-030:2021/A11:2021

EN 61326-1:2013

All DANISENSE products are manufactured in accordance with RoHS directive 2011/65/EU. Annex II of the RoHS directive was amended by directive 2015/863 in force since 2015, expanding the list of 6 restricted substances (Lead, Hexavalent Chromium, PBB, PBDE and Cadmium)

Danisense follows the provision in EN 63000:2018

| Place | | Date |
|---|---|---|
| Taastrup, Denmark | Henrik Elbæk | 2022-03-15 |