High precision fluxgate AC/DC current transducer for galvanically isolated measurement up to 1500 A

Features

- 1000 A rms nominal current
- 1500 primary/secondary current ratio
- Current output
- Ø41 mm aperture
- 7 ppm total accuracy
- 1 ppm linearity
- 5 ppm offset
- Status signal and LED

Description

High precision DC current transducer (DCCT) measuring up to 1500 A currents and continuously measuring 1000 A currents with a linearity error less than 1 ppm. With a large aperture and removable isolation insert allowing wide cable terminals, the DN1000ID has an overrange capability of 1200 A rms up to 30 minutes.

Based on the ultra stable Danisense closed loop flux gate technology, the DN1000ID has very low offset and ultra low drift. Noise is best in class with sub-ppm rms noise in the frequency range up to 10 kHz.

It provides high resolution for precise monitoring, reliable and consistent performance, and a compact and rugged design for easy installation and durability.

Applications

- Electric vehicle (EV) test bench
- Power measurement and power analysis
- Particles accelerators
- MRI devices and medical scanners
- Batteriy testing and evaluation systems
- Current calibration purposes
- Precision current sensing

Electrical specifications at 23 °C, $V_S = \pm 15$ V supply voltage

Parameter		Symbol	Unit	Min	Typ.	Max	Comment
Nominal primary AC current	Continuous	$I_{PN\ AC}$	Arms			1000	See Fig. 3 & Fig. 4 for details
Nominal primary DC current	Continuous	$I_{PN\ DC}$	A	-1000		1000	For other values see Fig. 2
Measuring range		I_{PM}	A	-1500		1500	See Fig. 2 & Fig. 4 for details
Overload capacity		I_{OL}	A			5000	Non-measured 100ms
Short term overrange	<30 minutes						$V_s = \pm 15V$; $R_M = 1\,\Omega$; $T_a = 35°C$
Nominal secondary current	Continuous	I_{SN}	mA	-666.67		666.67	At nominal primary DC current
Primary / secondary ratio					1500		$I_{primary}/I_{secondary}$
Measuring resistance		R_M	Ω	0	1.5		See Fig. 2 and Fig. 3 for details
Linearity error		ϵ_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		ϵ_{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		V_s	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 I_{PM}
Power consumption			W			18.5	At 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 ϵ_L can be expressed as (1), where $I_{reading}$ is the measurement result and I_{fitted} is the regression value.

$$\epsilon_L = I_{reading} - I_{fitted} \quad (1)$$

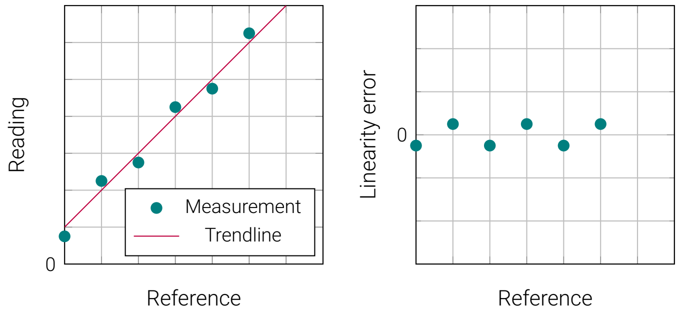

Figure 1: Linearity error definition

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).

$$\epsilon_{tot} = \epsilon_{reading} \cdot I_{reading} + \epsilon_{fullscale} \cdot I_{PNDC} \quad (2)$$

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

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).

$$I_S = \frac{I_P}{k}, \qquad V_S = \frac{I_P}{k} \quad (4)$$

Converting from ppm of nominal to secondary current/voltage

The nominal primary current is the rated current for the device. If ϵ_{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)

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

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

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

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).

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

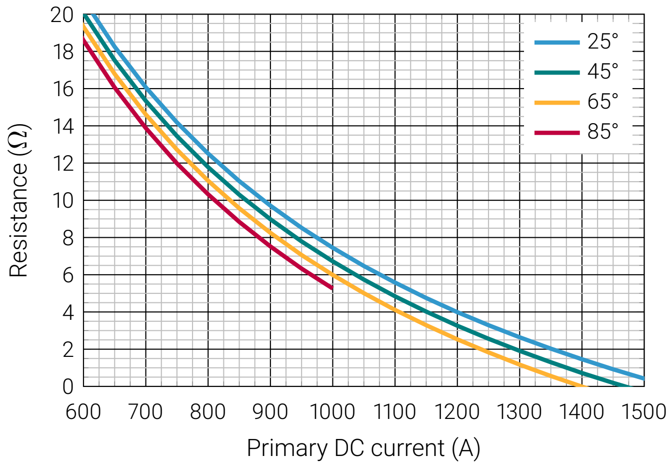

Figure 2: Maximum measurement resistor R_M vs. ambient temperatures

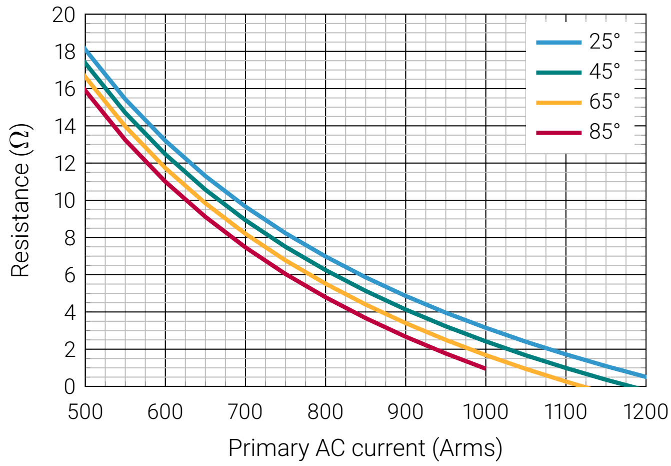

Figure 3: Maximum measurement resistor R_M vs. ambient temperatures

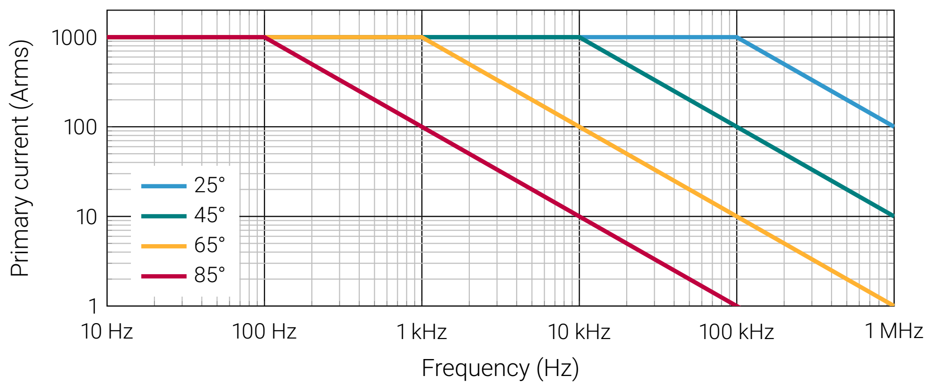

Figure 4: Maximum continuous primary current vs. frequency

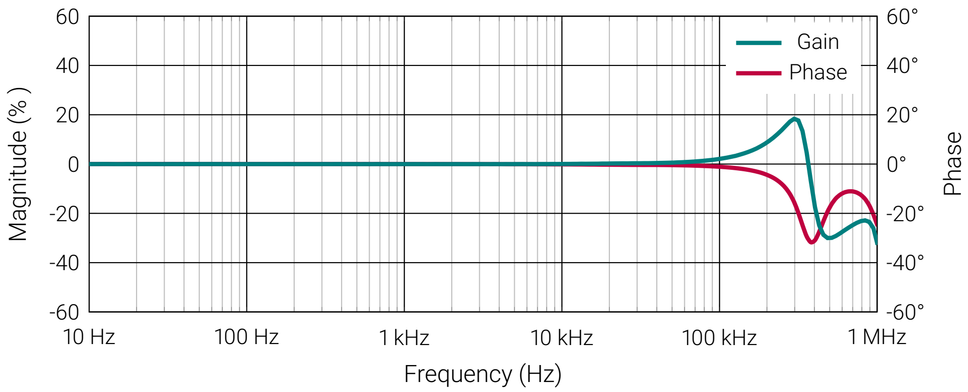

Figure 5: Frequency characteristics

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
Ingress protection rating				IP20	
Mass	kg		0.75		

Connections:	DSUB-9
EMC:	EN 61326-1:2013-2021
Safety:	IEC 61010-2-030:2021/A11:2021 and IEC 61010-1:2010/A1:2019
Random vibration test:	IEC 60068-2-64:2008

Shock test:	IEC 60068-2-27:2009
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 or similar power supplies. Please see the product manual: https://danisense.com/wp-content/uploads/2021/11/DS-Product-Manual-v1-2.pdf

Instruction for use

⚠ Please follow the polarity of the voltage supply to avoid damaging the device. See Fig. 7.

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 on the DSSIU-4/6-1U).
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. When all connection are secured - connect mains power.
7. Apply primary current.

⚠ 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 uninsulated wire can touch the metal enclosure.

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.

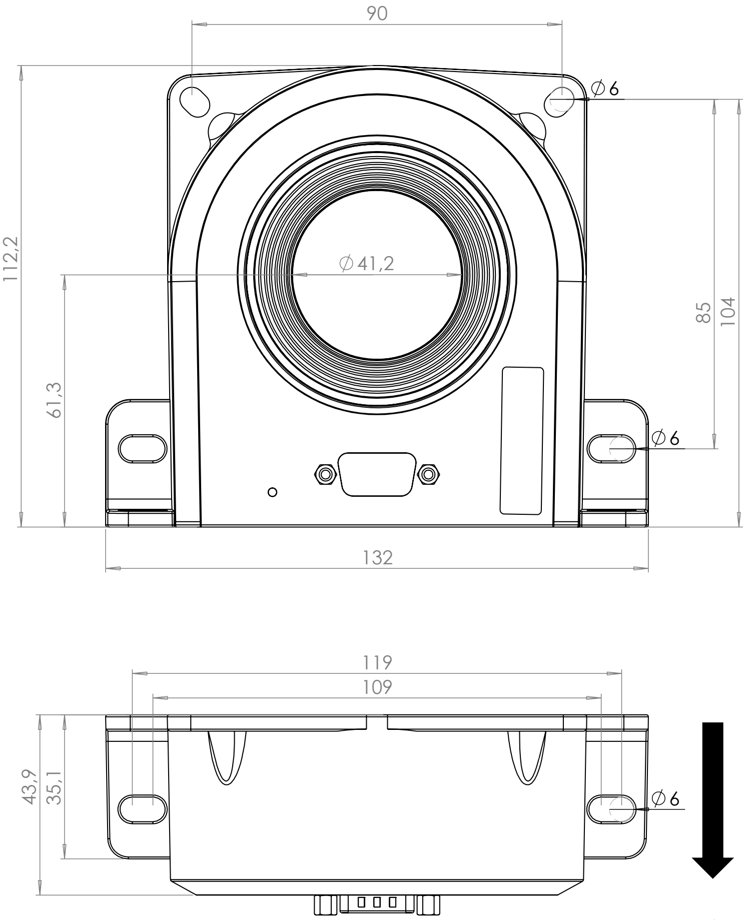

Figure 6: Dimensions of transducer. 0.3 mm Tolerance

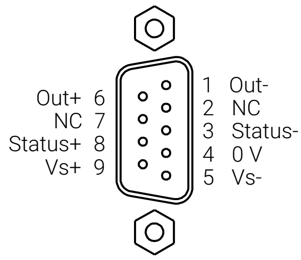

Figure 7: DSUB-9 connection pinout

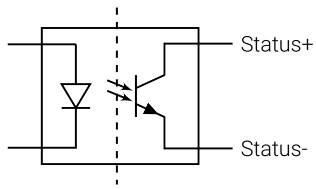

Figure 8: Status signal optocoupler

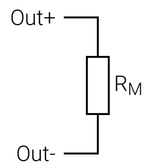

Figure 9: External measurement resistor connection, see Fig. 2 and Fig. 3

Mounting

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

Pin out description

1	Out-	Measurement output negative terminal
2	NC	No connection
3	Status-	Status signal negative terminal
4	0 V	0 V connection for supply voltage
5	V_S-	Negative supply voltage
6	Out+	Measurement output positive terminal
7	NC	No connection
8	Status+	Status signal positive terminal
9	V_S+	Positive supply voltage

Positive current direction

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

Status signal and LED

When the sensor is operating in normal condition the status pins (Status+ and Status-) are shorted by an optocoupler and the green status LED is ON, see Fig. 8. When a fault is detected, or the power is off, the status pins are opened and the green status LED is OFF. Status signal optocoupler ratings found below:

Forward direction:	Status+ to Status- (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