High precision fluxgate AC/DC current transducer for galvanically isolated measurement up to 11000 A

Features

- 7000 A rms nominal current
- 2500 :1 primary/secondary current ratio
- Current output through banana jacks
- Ø140 mm aperture
- 4 ppm total accuracy
- 1 ppm linearity
- 3 ppm offset
- Status signal and LED
- Mains powered control unit included

Description

High precision DC current transducer (DCCT) measuring up to 11000 A currents and continuously measuring 10000 A currents with a linearity error less than 1 ppm.

Based on the ultra stable Danisense closed loop flux gate technology, the DR10000IM has very low offset and ultra low drift.

The DR10000IM system consists of a sensor head and a mains powered control unit, connected by cable with multiple length options.

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

Applications

- Wind, solar and energy
- Electric vehicle (EV) test bench
- Power measurement and power analysis
- Battery testing and evaluation systems
- Current calibration purposes
- Stable power supplies
- Precision current sensing

Electrical specifications at 23 °C, V_S = ± 15 V supply voltage, R_M = 0.25 Ω

Parameter		Symbol	Unit	Min	Typ.	Max	Comment
Nominal primary AC current	Continuous	$I_{PN\ AC}$	Arms			7000	See Fig. 3 for details
Nominal primary DC current	Continuous	$I_{PN\ DC}$	A	-10000		10000	For other values see Fig. 2
Measuring range		I_{PM}	A	-11000		11000	See Fig. 2 & Fig. 3 for details
Overload capacity		I_{OL}	kA			20	Non-measured 100ms
Nominal secondary current	Continuous	I_{SN}	mA	-4000		4000	At nominal primary DC current
Primary / secondary ratio				2500		2500	$I_{primary}/I_{secondary}$
Measuring resistance		R_M	Ω	0	0.25		See Fig. 2 for details
Linearity error		ϵ_L	ppm	-1		1	ppm refers to reading
Offset current (including earth field)		I_{OE}	ppm	-3		3	ppm refers to $I_{PN\ DC}$
Offset temperature coefficient		TC_{IOE}	ppm/K	-0.1		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		80		Small signal. See Fig. 4
Response time to a step current I_{PN}		t_r	µs		3		From 10% to 90% of step current
Total accuracy without offset		ϵ_{tot}			*% of reading + % of full scale*		Full scale refers to $I_{PN\ DC}$.
	<10 Hz				0.0001 + 0.00001		For details, see Reading and full
	<100 Hz				0.002 + 0.00002		scale
	<1 kHz				0.5 + 0.00004		For other frequencies, see Linear
	<10 kHz				1 + 0.0003		interpolation of accuracy
	<80 kHz				40 + 0.004		specification.
Phase shift	<10 Hz				0.01°		
	<100 Hz				0.02°		
	<1 kHz				0.2°		
	<10 kHz				1°		
	<80 kHz				45°		
RMS noise	<100 Hz		ppm rms			0.1	ppm refers to $I_{PN\ DC}$
	<1 kHz					0.6	
	<10 kHz					4	
	<100 kHz					6	
Peak-to-peak noise	<100 Hz		ppm p-p			0.5	ppm refers to $I_{PN\ DC}$
	<1 kHz					3	
	<10 kHz					20	
	<100 kHz					30	
Fluxgate excitation frequency		f_{exc}	kHz		7.81		
AC Power supply voltage			V rms	90		264	50-60 Hz
AC current consumption			A rms	0.5		1.5	At I_{PM}
DC Power supply voltage			Vdc	127		370	
DC current consumption			A dc	0.4		1.1	At I_{PM}
Control unit operating temperature			°C	0		45	
Sensor head operating temperature			°C	0		70	See Fig. 3
Offset change with external magnetic field			ppm/mT			2	ppm refers to nominal current

1 ppm nominal = 4 μA secondary 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.

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

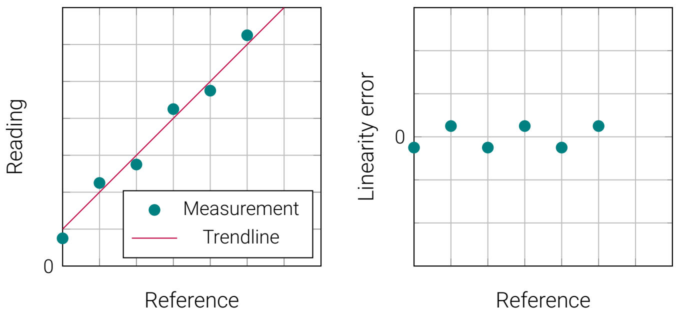

Figure 1: Linearity error definition

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, plus an offset of 0.001 % (of full scale). The device is measuring (reading) 10 A dc, and the accuracy is calculated as (3).

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

$$\epsilon_{tot} = 0.005\% \cdot 10A + (0.0015\% + 0.001\%) \cdot 500A = 13mA \tag{3}$$

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 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)

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

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

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

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).

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

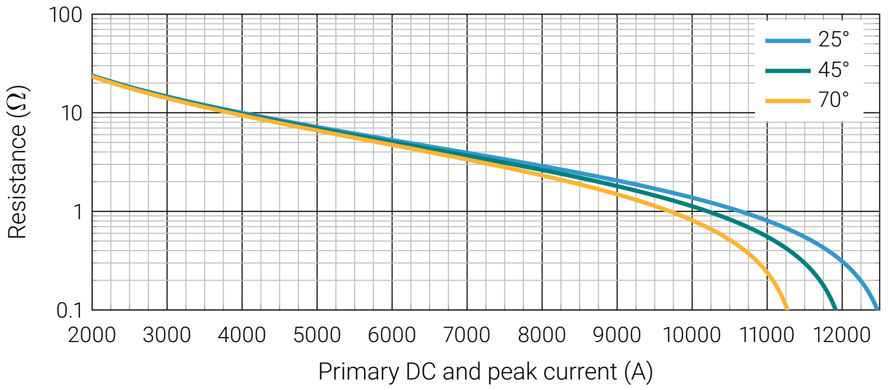

Figure 2: Maximum measurement resistor R_M vs. ambient temperatures

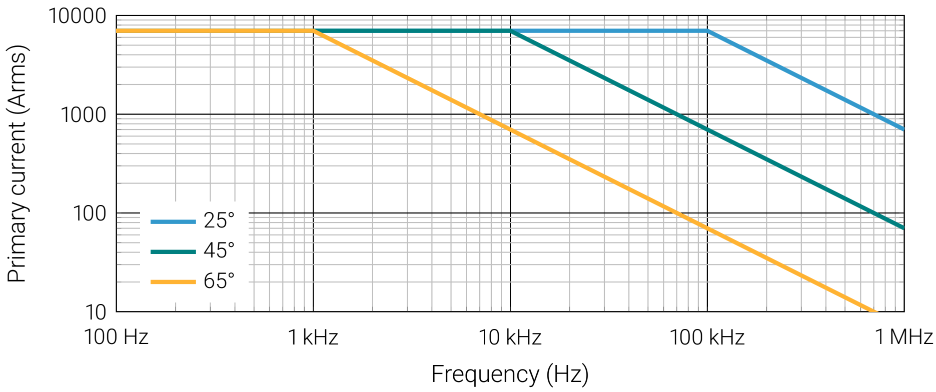

Figure 3: Maximum continuous primary current vs. frequency

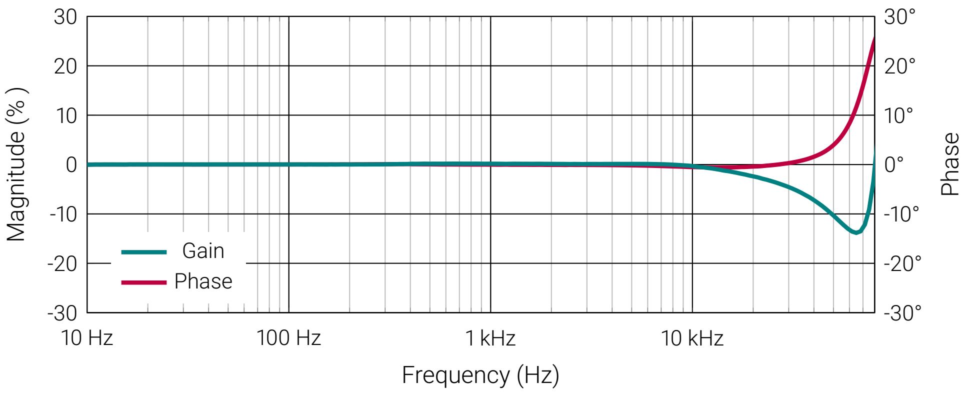

Figure 4: Frequency characteristics

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	60
Creepage distance		mm	60
Comparative tracking index (CTI)		V	> 600
Continuous working voltage according to IEC 61010-1 with:			
Uninsulated wire:	Non mains	V	5000
	CAT II (dc and rms)	V	1000
	CAT III (dc and rms)	V	1000
BASIC insulated wire:	Non mains	V	10000
	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	10000
	CAT II	V	9500
	CAT III	V	12500
BASIC insulated wire:	Non mains	V	5000
	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	0		70	
Storage temperature range	°C	-40		85	
Relative humidity	%	20		80	Non-condensing
Ingress protection rating				IP20	
Mass control unit	kg		6		
Mass sensor head	kg		19		

Connections: 4 mm banana jack; D-sub-9
EMC: EN 61326-1:2013
Safety: EN 61010-1 2010

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.

Intended use

The DR10000IM is designed to measure current up to 11000 A.
Please see the product manual: https://danisense.com/user-manual

Safety instructions

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

⚠ There is a risk of electrical shock if an uninsulated busbar with high voltages is touching the metal enclosure of the transducer. Please ensure, before powering up the system, that no uninsulated wire can touch the metal enclosure.

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. Make sure the unit is properly connected to earth ground. Do not block the ventilation openings on the side panels. If the fan does not operate properly contact Danisense for repair.

Instruction for use

⚠ Only apply primary current when transducer head is connected to electronics control box to avoid damaging the device.

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 the transducer head to the electronics control box (DSCU-1) using the supplied cable.
4. Connect a low impedance amperemeter, measuring resistor or power analyzer on the secondary output (4mm red and black connectors on the DSCU-1 control unit).
5. When all connection are secured - connect mains power.
6. Apply primary current.

Mounting

- If the electronics control unit is intended for desk use, mount the rubber feet which are part of the package.
- If the electronics control unit is intended for Rack mounting, use the screw kit for mounting and do not mount the rubber feet.
- It is mandatory to support the unit when rack mounted, either on the sides or backside.

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)

Package content

- Transducer head (DS10000)
- Electronics control box (DSCU-1) 19” 2U rack mountable
- AC power cable - region specific
- 5 m cable for connecting DS10000 and DSCU-1 (Other lengths available upon request, pricing may differ)

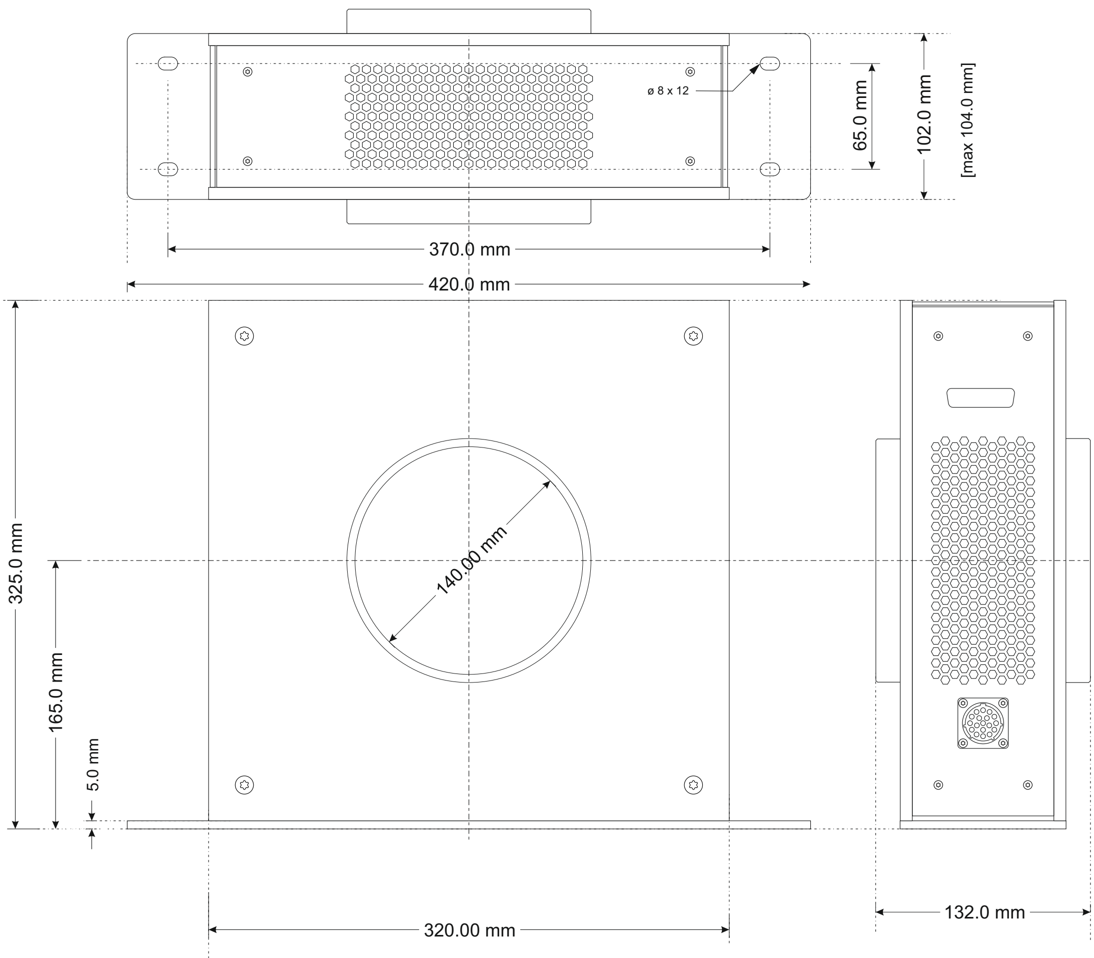

Figure 5: Dimensions of transducer head. 0.3 mm Tolerance

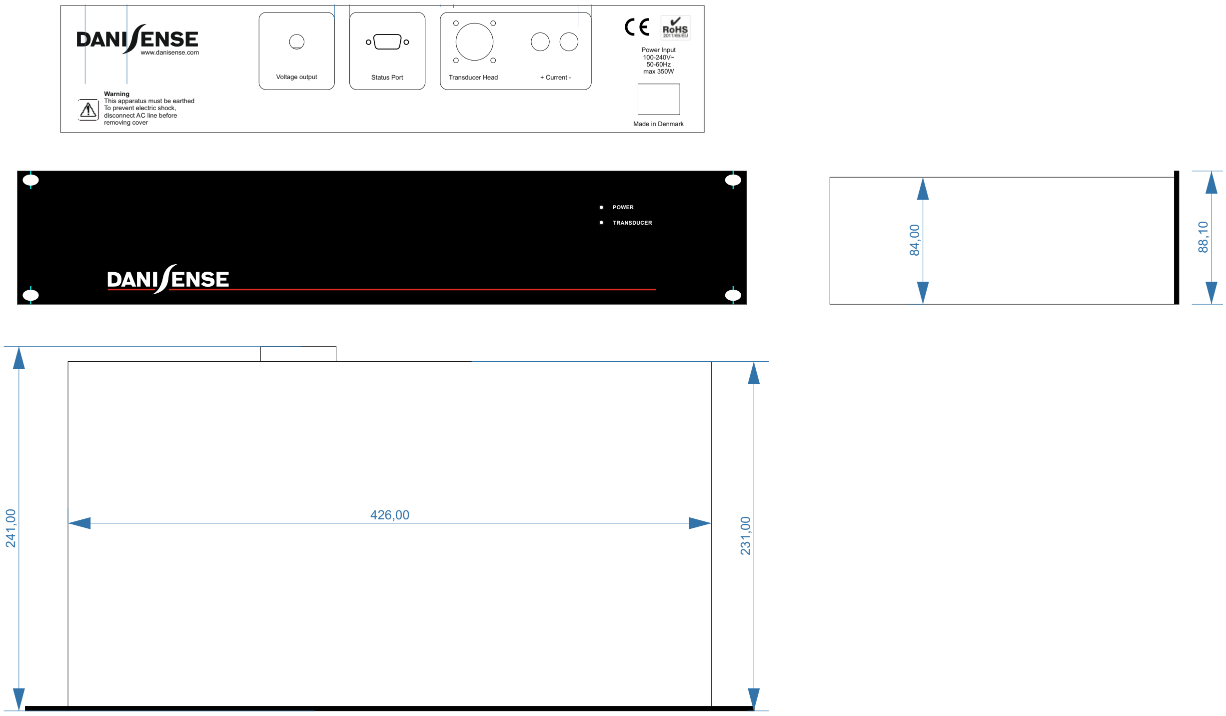

Figure 6: Dimensions of electronics control box. 0.3 mm general tolerance

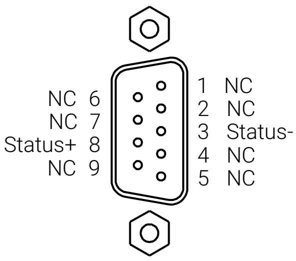

Figure 7: D-sub-9 connection pinout

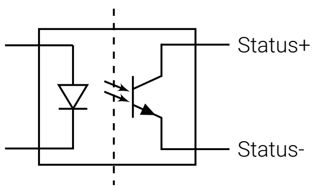

Figure 8: Status signal optocoupler

Mounting

Base plate mounting (Transducer head): 4 x 8 mm slotted holes, 6 Nm

Positive current direction

Is identified by a label on the housing.

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