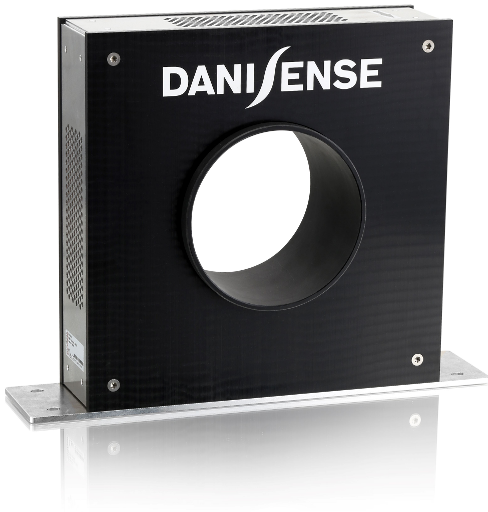
High precision fluxgate AC/DC current transducer for galvanically isolated measurement up to 5500 A

Features

- 3600 A rms nominal current
- 10 V output at 5000 A
- Ø150 mm aperture
- 52 ppm total accuracy
- 7 ppm linearity
- 15 ppm offset
- Status signal and LED
- Control unit included



CE
RoHS 2011/65/EU
UK CA

Description

High precision DC current transducer (DCCT) measuring up to 5500 A currents and continuously measuring 5000 A currents with a linearity error less than 7 ppm.

Based on the ultra stable Danisense closed loop flux gate technology, the DR5000UX-10V/5000A has very low offset and ultra low drift.

The DR5000UX-10V/5000A system consists of a sensor head and a mains powered control unit, connected by cable with multiple length options.

With an integrated voltage output module (VOM) outputting 10 V at 5000 A, the DR5000UX-10V/5000A makes accurate high current measurement easy.

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, $V_S = \pm$ 15 V supply voltage

Parameter		Symbol	Unit	Min	Typ.	Max	Comment
Nominal primary AC current		$I_{PN\ AC}$	Arms			3600	Refer to Fig. 2 for derating
Nominal primary DC current		$I_{PN\ DC}$	A	-5000		5000	Refer to Fig. 2 for derating
Measuring range		I_{PM}	A	-5500		5500	Refer to Fig. 2 for derating
Overload capacity		I_{OL}	kA			20	Not measuring. < 100ms
Nominal secondary voltage		V_{SN}	V	-10		10	At nominal primary DC current
Transfer ratio		k	A/V	500		500	$I_{primary}/V_{secondary}$
Output resistance		R_O	Ω		1.2		At DC
Linearity error		ϵ_L	ppm	-7		7	ppm refers to reading
Ratio error			ppm	-30		30	ppm refers to reading
Ratio temperature coefficient			ppm/K	-1.5		1.5	ppm refers to reading
Ratio stability			ppm/month	-10		10	ppm refers to reading
Offset (including earth field)			ppm	-15		15	ppm refers to $I_{PN\ DC}$
Offset temperature coefficient			ppm/K	-0.3		0.3	ppm refers to $I_{PN\ DC}$
Offset stability over time			ppm/month	-0.1		0.1	ppm refers to $I_{PN\ DC}$
Bandwidth		$f(\pm 3\text{dB})$	kHz		80		Small signal. See Fig. 3
Response time to a step current I_{PN}		t_r	µs		3		At 90% of step current
Total accuracy without offset		ϵ_{tot}			*% of reading + % of full scale*		Full scale refers to $I_{PN\ DC}$.
	0-10 Hz				0.0037 + 0.00005		For details, see Reading and full
	<100 Hz				0.0037 + 0.0001		scale
	<1 kHz				0.5 + 0.0010		For other frequencies, see Linear
	<10 kHz				1 + 0.005		interpolation of accuracy
	<80 kHz				40 + 0.008		specification.
Phase shift	<10 Hz				0.01°		
	<100 Hz				0.02°		
	<1 kHz				0.2°		
	<10 kHz				1°		
	<80 kHz				60°		
RMS noise	<100 Hz		ppm rms			0.2	ppm refers to $I_{PN\ DC}$
	<1 kHz					2	
	<10 kHz					10	
	<100 kHz					15	
Peak-to-peak noise	<100 Hz		ppm p-p			1	ppm refers to $I_{PN\ DC}$
	<1 kHz					10	
	<10 kHz					50	
	<100 kHz					75	
Fluxgate excitation frequency		f_{exc}	kHz		7.81		
AC Power supply voltage			V rms	90		264	50-60 Hz
AC current consumption			A rms	0.45		1.2	At I_{PM}
DC Power supply voltage			Vdc	127		370	
DC current consumption			A dc	0.3		0.8	At I_{PM}
Control unit operating temperature			°C	0		45	
Sensor head operating temperature			°C	0		70	See Fig. 2
Offset change with external magnetic field			ppm/mT		4		ppm refers to $I_{PN\ DC}$

1 ppm nominal = 10 μV secondary voltage.

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.

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

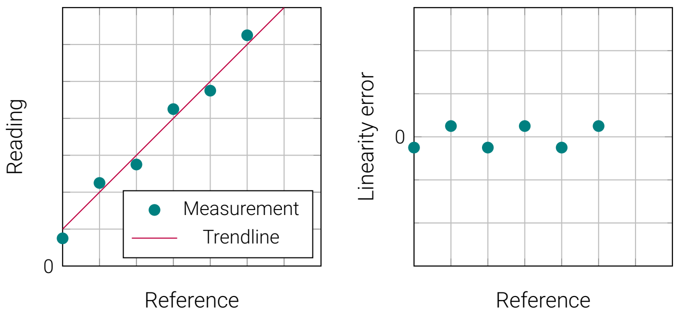


Figure 1: Linearity error definition

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).

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

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

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).

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

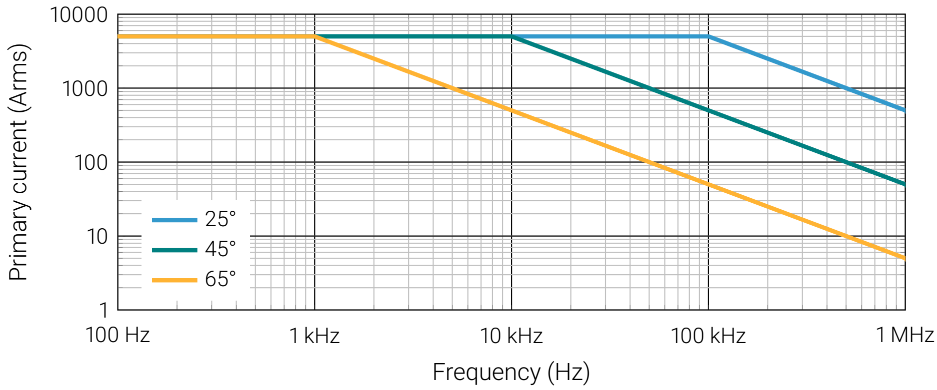


Figure 2: Maximum continuous primary current vs. frequency

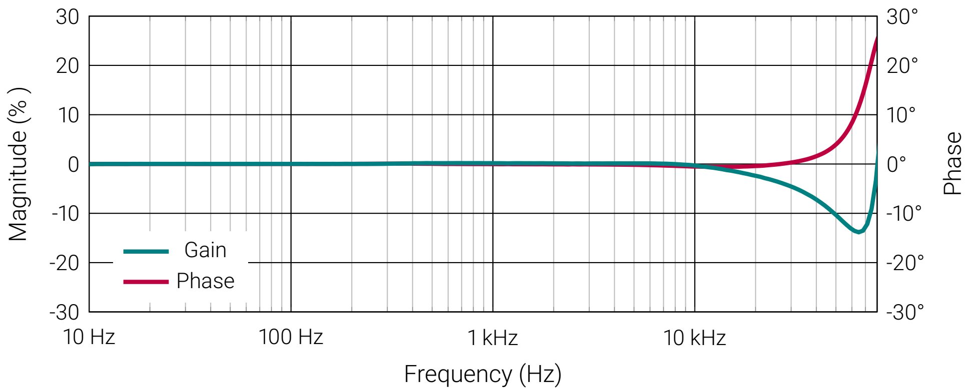


Figure 3: Frequency characteristics

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:		V	
Uninsulated wire:	Non mains		5000
	CAT II (dc and rms)		1000
	CAT III (dc and rms)		1000
BASIC insulated wire:	Non mains		10000
	CAT II (dc and rms)		1000
	CAT III (dc and rms)		1000
Transient voltage according to IEC 61010-1 with:		V	
Uninsulated wire:	Non mains		10000
	CAT II		9500
	CAT III		12500
BASIC insulated wire:	Non mains		5000
	CAT II		6000
	CAT III		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		17		

Connections: 3 pin XLR mini; 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 DR5000UX-10V/5000A is designed to measure current up to 5500 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 pass primary current through aperture 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 (DR5000) to the electronics control box (DSCU-1) using the supplied cable.
4. Connect a precision voltage analyzer to the XLR cable for analysis purposes.
5. Ensure that the BLACK and RED current output banana connections on the back side are shorted, see Fig. 4.
6. When all connection are secured - connect mains power.
7. Apply primary current.

Figure 4: DSCU-1 electronics control box back side with current output shorting shown

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, see figure 5.

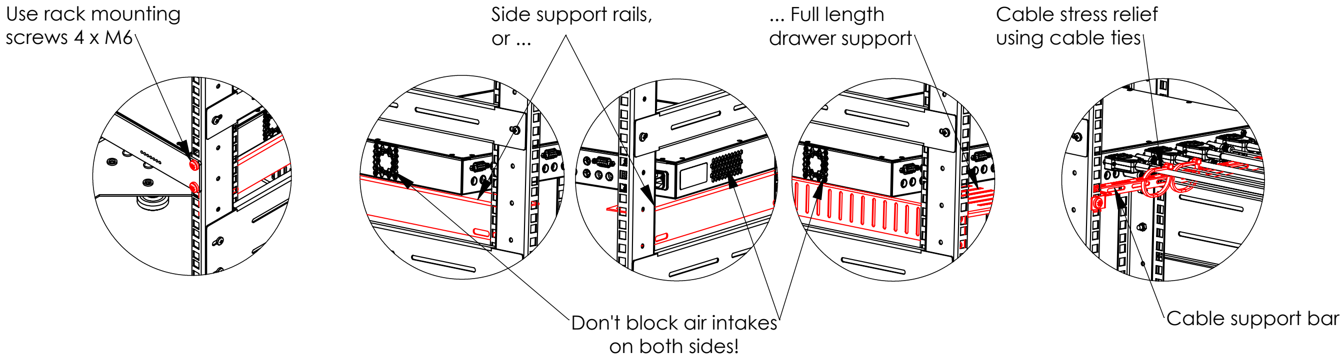


Figure 5: DSCU Rack mounting guidelines

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).

ASPC is located in the electronics control box (DSCU-1) and requires that the transducer head is connected to DSCU-1 using the supplied head cable in order to ensure proper functioning of the protection circuit. Although ASPC is designed to protect electronics against most common usage mistakes, it is mandatory to follow the "Instruction for use" as the opposite can lead to safety hazard and equipment damage with subsequent warranty void.

Package content

- Transducer head (DR5000)
- Electronics control box (DSCU-1) 19" 2U rack mountable
- AC power cable - region specific
- 5 m cable for connecting DR5000 and DSCU-1 (Other lengths available upon request, pricing may differ)
- 2 m XLR Mini cable to connect the voltage output to 4mm banana plugs (+, - and cable shield)
- Short circuit banana plug

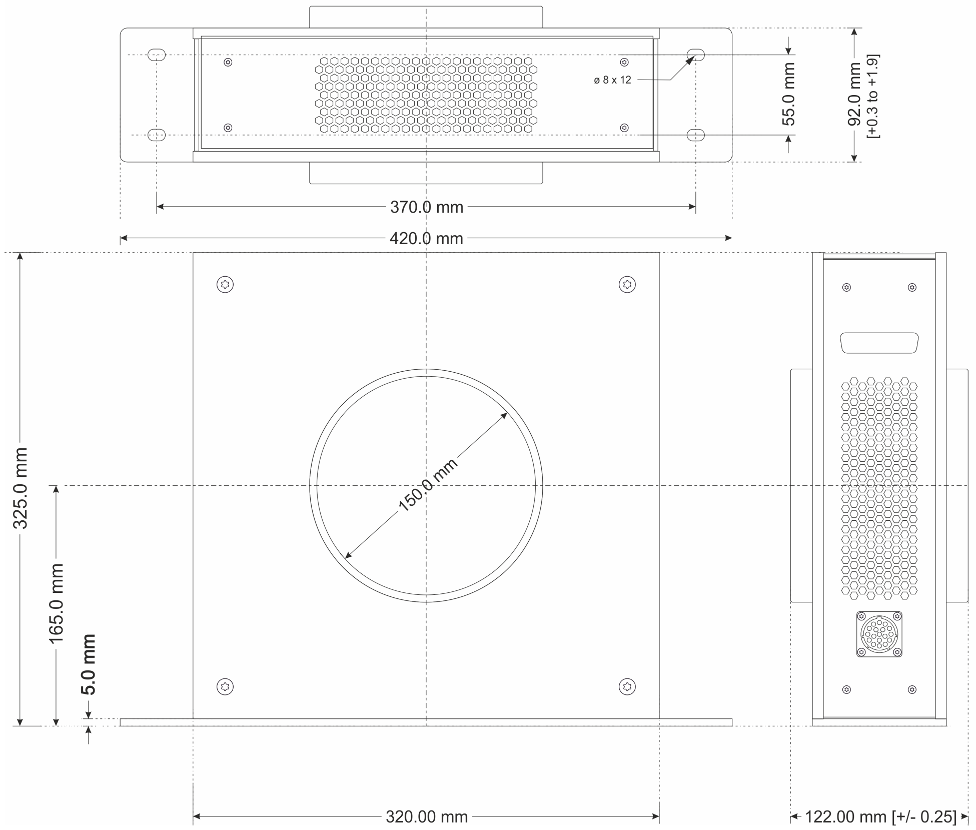


Figure 6: Dimensions of transducer head. 0.3 mm Tolerance

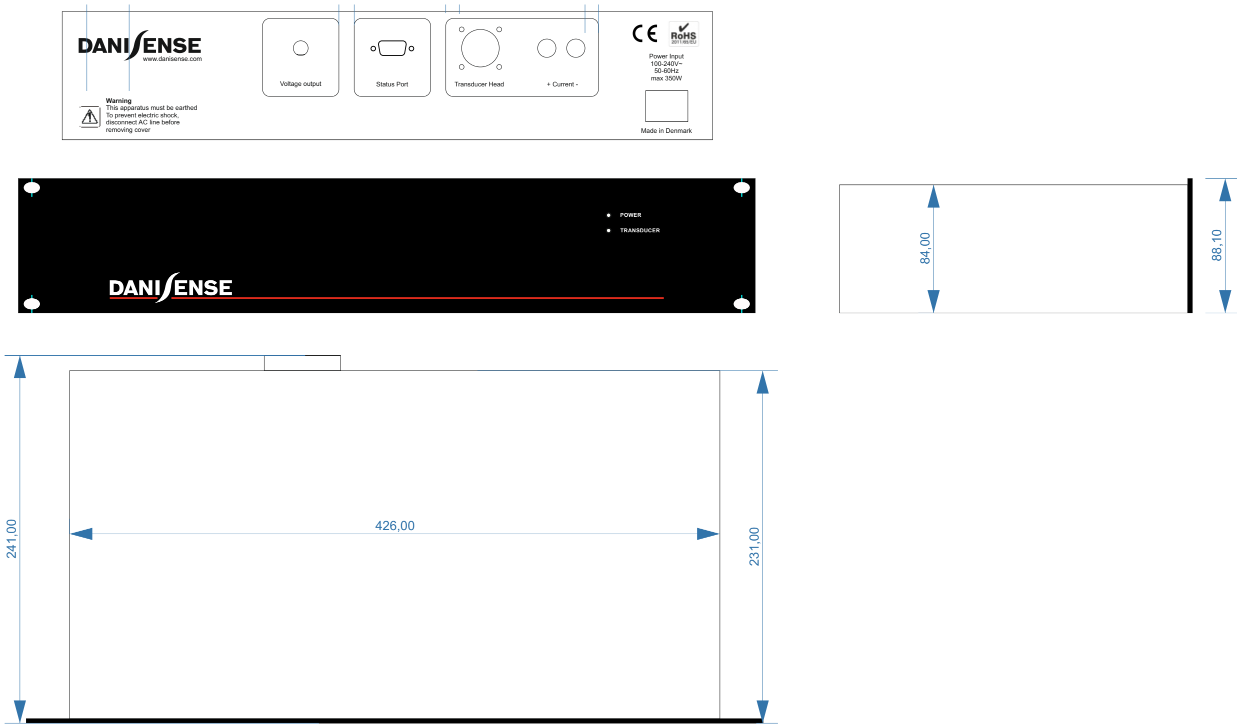


Figure 7: Dimensions of electronics control box. 0.3 mm general tolerance

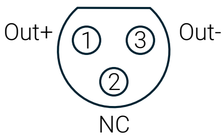


Figure 8: XLR Mini voltage reading output pinout

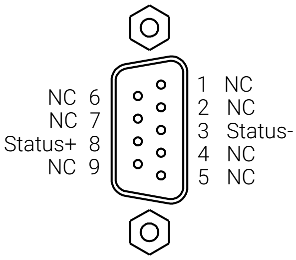


Figure 9: D-sub-9 connection pinout

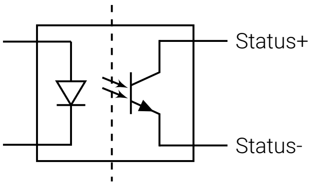


Figure 10: Status signal optocoupler

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. 10. 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