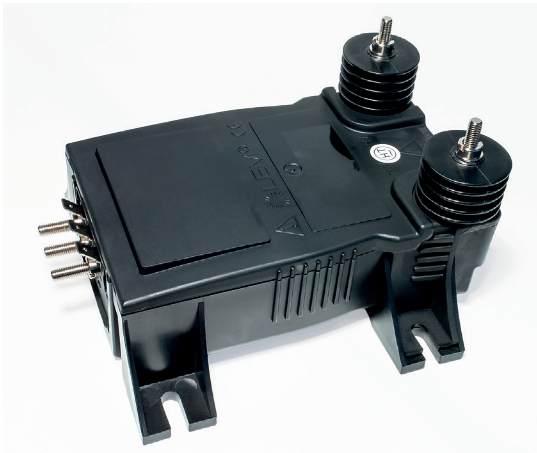
Voltage transducer DV 6400

V_{PN} = 6400 V

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 9050 V
- Current output
- Footprint compatible with OV, CV 4 and LV 200-AW/2 families
- Primary input on M5 threaded studs
- Secondary output on Faston and M5 threaded studs + Safety nuts
- Primary on the top.

Advantages

- Low consumption and low losses
- Compact design
- Good behavior under common mode variations
- Excellent accuracy (offset, sensitivity, linearity)
- Response time 60 µs
- 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
- On-board energy meters
- Energy metering.

Standards

- EN 50155: 2007
- EN 50124-1: 2017
- EN 50121-3-2: 2015.

Application Domain

- Traction (fixed and onboard).

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Absolute maximum ratings

Parameter	Symbol	Unit	Value	Comment
Maximum supply voltage (V_P = 0 V, 0.1 s)	$\pm U_{C\ max}$	V	±34	
Maximum supply voltage (working) (−40 … 70 °C)	$\pm U_{C\ max}$	V	±26.4	
Maximum primary voltage (−40 … 70 °C)	$V_{P\ max}$	V	9050	
Maximum steady state primary voltage (−40 … 70 °C)	$V_{P\ N\ max}$	V	6400	

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

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC insulation test, 50 Hz, 1 min	U_d	kV	18.5	100 % tested in production
Impulse withstand voltage 1.2/50 µs	$\hat{U}_W$	kV	30	
Partial discharge extinction RMS voltage @ 10 pC	U_e	V	7050	
Insulation resistance	R_{INS}	MΩ	200	measured at 500 V DC
Clearance (pri. - sec.)	d_{Cl}	mm	see dimensions drawing on page 8	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm		Shortest path along device body
Case material	-	-	V0 according to UL 94	
Comparative tracking index	CTI		600	

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max
Ambient operating temperature	T_A	°C	−40		70
Ambient storage temperature	T_S	°C	−50		85
Mass	m	g		620	

Electrical data

At T_A = 25 °C, U_C = ±24 V, R_M = 100 Ω, unless otherwise noted.
Lines with a * in the conditions column apply over the −40 … 70 °C ambient temperature range.

Parameter	Symbol	Unit	Min	Typ	Max	Conditions	
Primary nominal RMS voltage	V_{PN}	V			6400	*	
Primary voltage, measuring range	V_{PM}	V	−9050		9050	*	
Measuring resistance	R_M	Ω	0		133	*	For $\lvert V_{PM} \rvert <$ 9050 V, max value of R_M is given on figure 1
Secondary nominal RMS current	I_{SN}	mA			50	*	
Secondary current	I_S	mA	−70.7		70.7	*	
Supply voltage	$\pm U_C$	V	±13.5	±24	±26.4	*	
Rise time of U_C (10-90 %)	t_{rise}	ms			100		
Current consumption @ $U_C = \pm$ 24 V at $V_P = 0$ V	I_C	mA		20 + I_S	25 + I_S		
Offset current	I_O	µA	−50	0	50		100 % tested in production
Temperature variation of I_O	I_{OT}	µA	−80 −100		80 100	 *	−25 … 70 °C −40 … 70 °C, 100 % tested in production
Sensitivity	G	µA/V		7.8125			50 mA for 6400 V
Sensitivity error	ε_G	%	−0.2	0	0.2		
Thermal drift of sensitivity	ε_{GT}	%	−0.5 −0.8		0.5 0.8	 *	−25 … 70 °C −40 … 70 °C
Linearity error	ε_L	% of V_{PM}	−0.1		0.1	*	±9050 V range
Overall accuracy	X_G	% of V_{PN}	−0.3 −0.7 −1		0.3 0.7 1	 *	25 °C; 100 % tested in production −25 … 70 °C −40 … 70 °C
Output RMS noise current	I_{no}	µA		10			1 Hz to 100 kHz
Reaction time @ 10 % of V_{PN}	t_{ra}	µs		21			
Response time @ 90 % of V_{PN}	t_r	µs		48	60		0 to 6400 V step, 6 kV/µs
Frequency bandwidth	BW	kHz		12 6.5 1.6			3 dB 1 dB 0.1 dB
Start-up time	t_{start}	ms		190	250	*	
Resistance of primary (winding)	R_P	MΩ		23		*	
Total primary power loss @ V_{PN}	P_P	W		0.77		*	

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.

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Typical performance characteristics

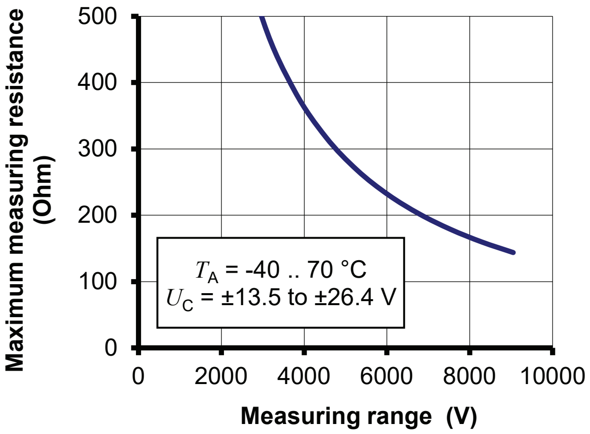

Figure 1: Maximum measuring resistance

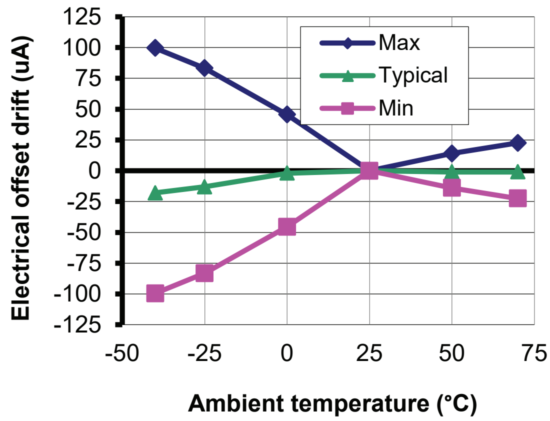

Figure 2: Electrical offset thermal drift

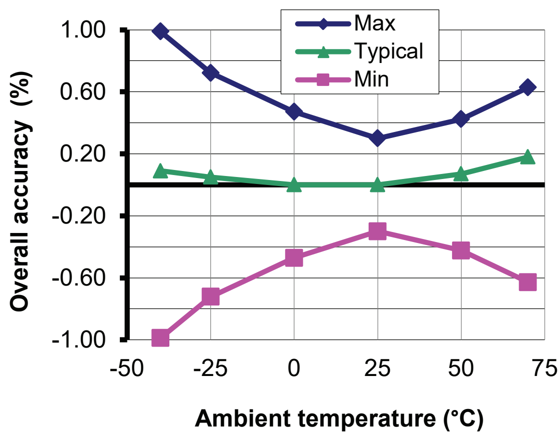

Figure 3: Overall accuracy in temperature

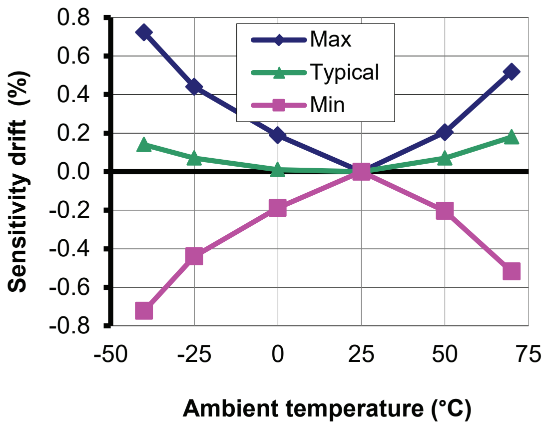

Figure 4: Sensitivity thermal drift

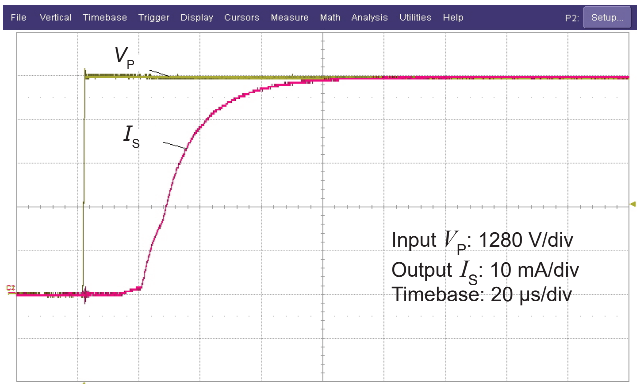

Figure 5: Typical step response (0 to 6400 V)

Typical performance characteristics

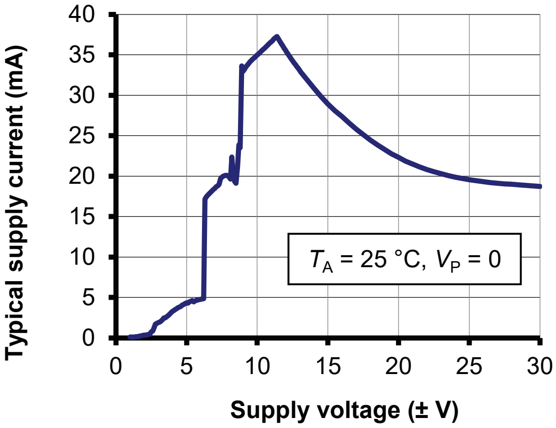

Figure 6: Supply current function of supply voltage

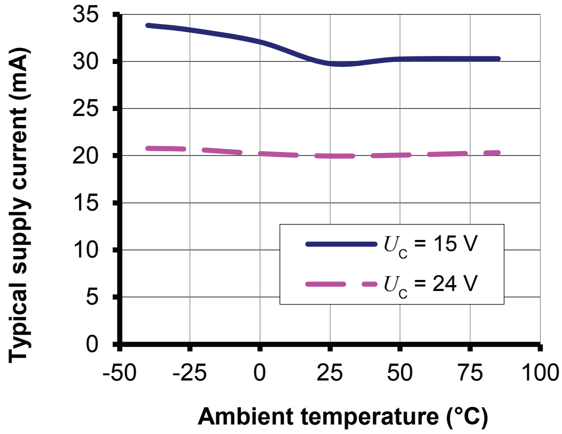

Figure 7: Supply current function of temperature

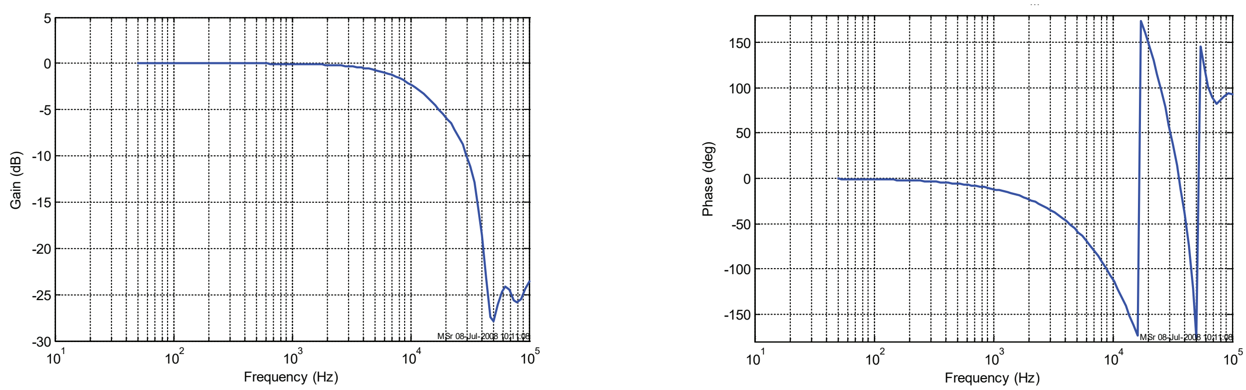

Figure 8: Typical frequency response

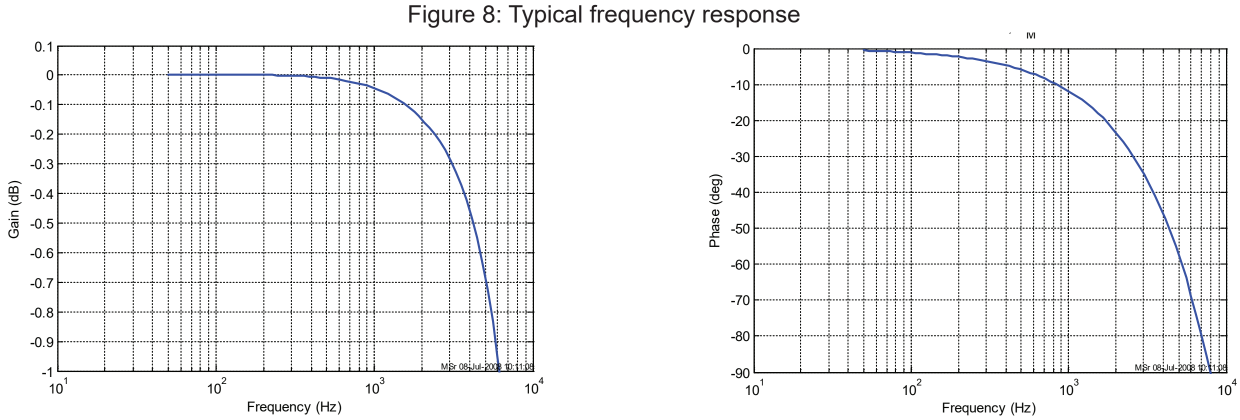

Figure 9: Typical frequency response (detail)

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Typical performance characteristics continued

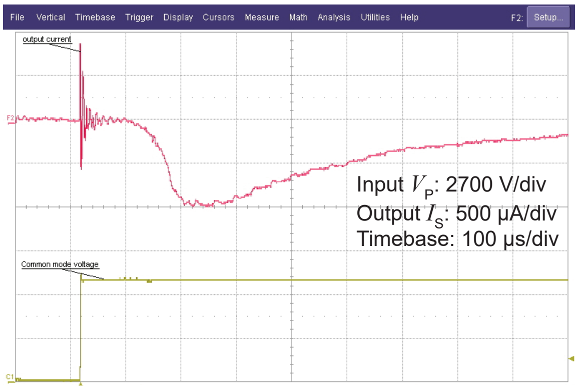

Figure 10: Typical common mode perturbation (6400 V step with 6 kV/µs R_M = 100 Ω)

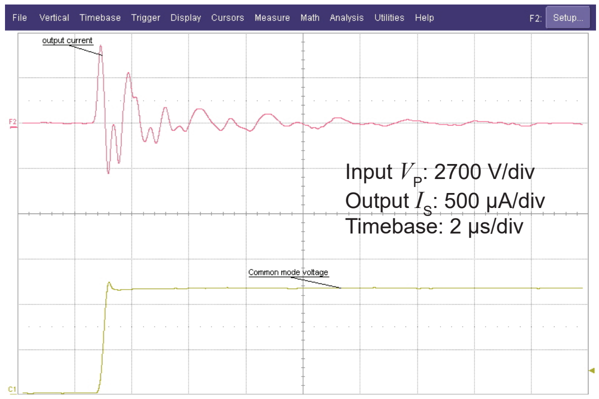

Figure 11: Detail of typical common mode perturbation 6400 V step with 6 kV/µs, R_M = 100 Ω)

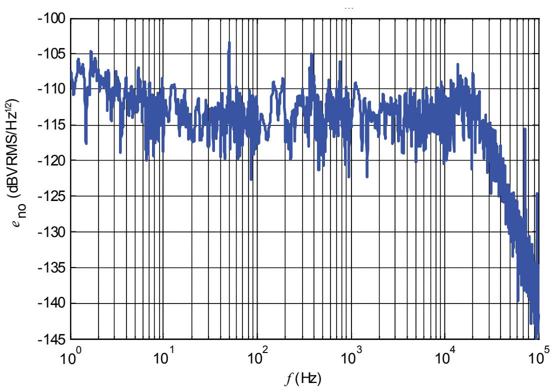

Figure 12: Typical output RMS noise voltage spectral density with R_M = 50 Ω

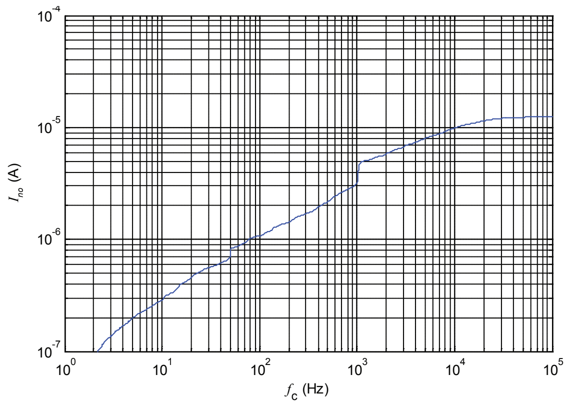

Figure 13: Typical total output RMS noise current with R_M = 50 Ω (f_c is upper cut-off frequency of band low cut off frequency is 1 Hz)

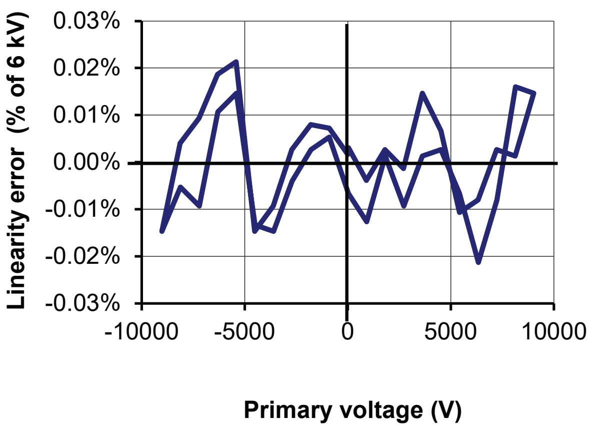

Figure 14: Typical linearity error

Figure 12 (output RMS noise voltage density) shows that there are no significant discrete frequencies in the output. Figure 13 confirms the absence of steps in the total output RMS noise current that would indicate discrete frequencies. To calculate the noise in a frequency band $f1$ to $f2$, the formula is:

$$I_{no}(f1 \text{ to } f2) = \sqrt{I_{no}(f2)^2 - I_{no}(f1)^2}$$

with $I_{no}(f)$ read from figure 13 (typical, RMS value).

Example:
What is the noise from 10 to 100 Hz?
Figure 13 gives I_{no}(10 Hz) = 0.32 µA and I_{no}(100 Hz) = 1 µA.
The output RMS current noise is therefore.

$$\sqrt{(1 \times 10^{-6})^2 - (0.32 \times 10^{-6})^2} = 0.95\ \mu A$$

Performance parameters definition

The schematic used to measure all electrical parameters are:

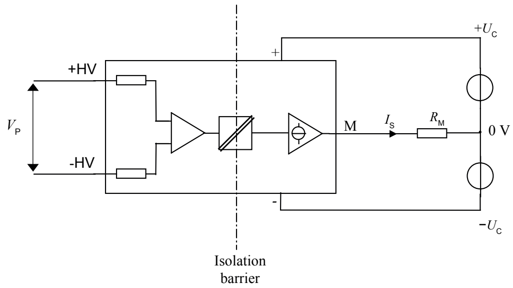

Figure 15: standard characterization schematics for current output transducers (R_M = 50 Ω unless otherwise noted)

Transducer simplified model

The static model of the transducer at temperature T_A is:

$I_S = G \cdot V_P + \varepsilon$

In which

$\varepsilon = I_{OE} + I_{OT}(T_A) + \varepsilon_G \cdot G \cdot V_P + \varepsilon_{GT}(T_A) \cdot G \cdot V_P + \varepsilon_L \cdot G \cdot V_{PM}$

- I_S : secondary current (A)
- G : sensitivity of the transducer (μA/V)
- V_P : primary voltage (V)
- V_{PM} : primary voltage, measuring range (V)
- T_A : ambient operating temperature (°C)
- I_{OE} : electrical offset current (A)
- $I_{OT}(T_A)$: temperature variation of I_O at temperature T_A (μA)
- ε_G : sensitivity error at 25 °C
- $\varepsilon_{GT}(T_A)$: thermal drift of sensitivity at temperature T_A
- ε_L : linearity error

This is the absolute maximum error. As all errors are independent, a more realistic way to calculate the error would be to use the following formula:

$$\varepsilon = \sqrt{\sum_{i=1}^{N} \varepsilon_i^2}$$

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 ε_L is the maximum positive or negative difference between the measured points and the linear regression line, expressed in % of the maximum measured value.

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.

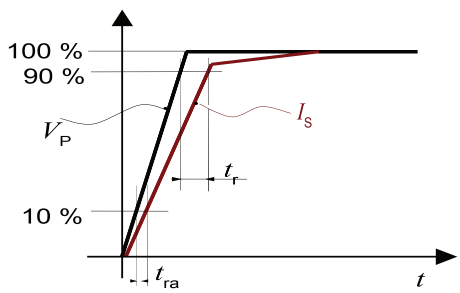

Figure 16: response time t_r and reaction time t_{ra}

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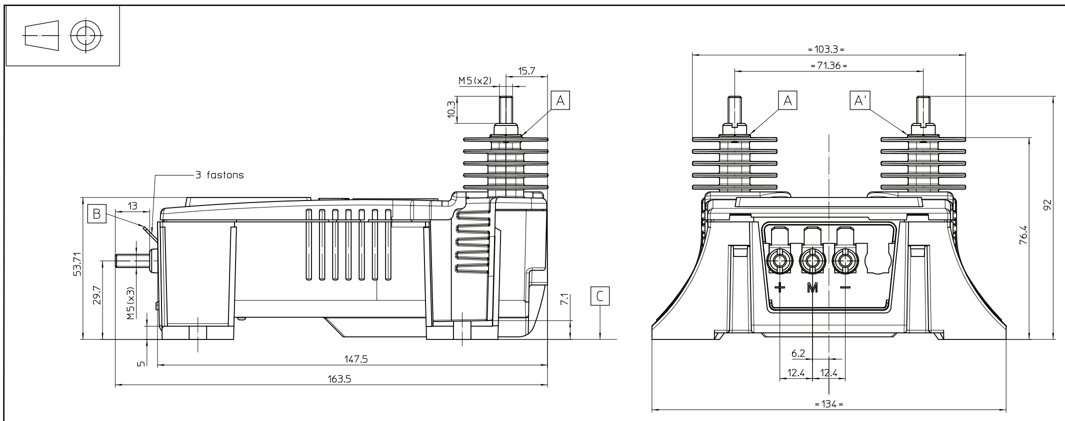
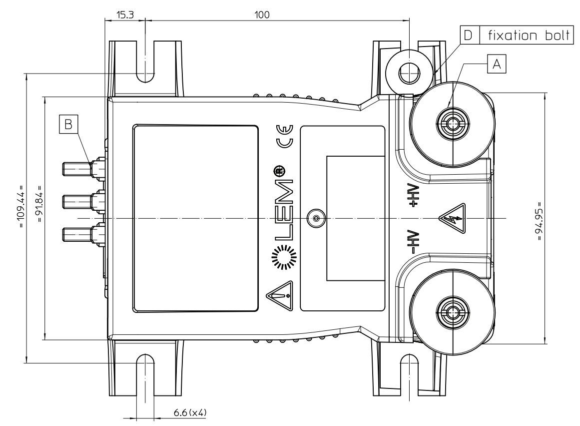
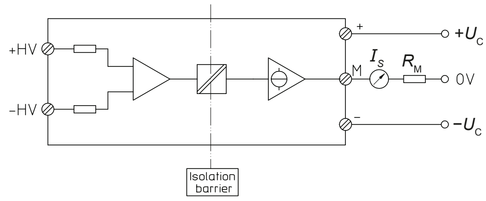
Dimensions (in mm)





	d_{Cl} (mm)	d_{Cp} (mm)
A-B	138.3mm	287.9mm
A-C	86mm	191mm
A-A'	60mm	311mm
A-D	74mm	168mm

Connection



Mechanical characteristics

- General tolerance ±1 mm
- Transducer fastening 4 M6 steel screws
  4 washers ext. ∅18 mm
  Recommended fastening torque 5 N·m
- Connection of primary M5 threaded studs
- Recommended fastening torque 2.2 N·m
- Connection of secondary 6.3 x 0.8 mm Faston and
  M5 threaded studs
  Recommended fastening torque 2.2 N·m

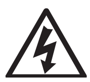
Remarks

- 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
- Installation of the transducer must be done unless otherwise specified on the datasheet, according to LEM Transducer Generic Mounting Rules. Please refer to LEM document N°ANE120504 available on our Web site: **Products/Product Documentation.**

Safety

This transducer must be used in limited-energy secondary circuits according to IEC 61010-1.

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 (e.g. primary connections, 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.