

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 1500 V
- Voltage output
- PCB mount
- 8 pins
- 5 V unipolar power supply.

## Advantages

- Low consumption and low losses
- Compact design
- Very low sensitivity to common mode voltage variations
- Excellent accuracy (offset, sensitivity, linearity)
- Low temperature drift
- High immunity to external interferences.

## Applications

- Single or three phase inverters
- AC variable speed drives and servo motor drives
- Static converters for DC motor drives
- Uninterruptible Power Supplies (UPS)
- Power supplies for welding applications.
- Auxiliary converters
- Substations.

## Standards

- EN 50155: 2007
- EN 50121-3-2: 2015
- EN 50124-1: 2001
- IEC 61010-1: 2010
- IEC 61800-1: 1997
- IEC 61800-2: 2015
- IEC 61800-3: 2017
- IEC 61800-5-1: 2007
- IEC 62109-1: 2010.

## Application Domain

- Traction (trackside and onboard)
- Industrial.

### Absolute maximum ratings

Parameter	Symbol	Unit	Value
Maximum supply voltage ( $V_p = 0$ V, 0.1 s)	$U_{C\ max}$	V	6
Maximum supply voltage (working) (-40 ... 85 °C)	$U_{C\ max}$	V	5.25
Maximum primary voltage (-40 ... 85 °C)	$V_{P\ max}$	V	1500
Maximum steady state primary voltage (-40 ... 85 °C)	$V_{P\ N\ max}$	V	1000

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	4.2	100 % tested in production
Impulse withstand voltage 1.2/50 $\mu$ s	$\hat{U}_w$	kV	7.84	
Partial discharge RMS test voltage ( $q_m < 10$ pC)	$U_t$	V	1500	
Insulation resistance	$R_{INS}$	M $\Omega$	200	
Clearance (pri. - sec.)	$d_{Cl}$	mm	See dimensions drawing on page 9	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	$CTI$	V	600	
Maximum DC common mode voltage	$V_{HV+} + V_{HV-}$ and $ V_{HV+} - V_{HV-} $	kV	$\leq 1.5$ $\leq V_{PM}$	

### Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max
Ambient operating temperature	$T_A$	°C	-40		85
Ambient storage temperature	$T_S$	°C	-50		90
Mass	$m$	g		22	

## Electrical data

At  $T_A = 25\text{ °C}$ ,  $+U_C = +5\text{ V}$ ,  $R_M = 2\text{ k}\Omega$ , unless otherwise noted.

Lines with a \* in the conditions column apply over the  $-40 \dots 85\text{ °C}$  ambient temperature range.

Parameter	Symbol	Unit	Min	Typ	Max	Conditions
Primary nominal RMS voltage	$V_{PN}$	V		1000		*
Primary voltage, measuring range	$V_{PM}$	V	-1500		1500	*
Measuring resistance	$R_M$	$\Omega$	2000			*
Secondary nominal RMS voltage	$V_{SN}$	V		3.83		*
Secondary voltage	$V_S$	V	+0.5		+4.5	*
Supply voltage	$U_{CDC}$	V	4.75	5	5.25	* 5 V $\pm$ 5 % DC
Rise time of $U_C$ (10-90 %)	$t_{rise}$	ms			100	
Current consumption @ $U_C = +5\text{ V}$ at $V_P = 0\text{ V}$	$I_C$	mA		35		See temperature variation on figure 4
Offset voltage	$V_O$	V	2.492	2.5	2.508	100 % tested in production
Temperature variation of $V_O$	$V_{OT}$	mV	-25		25	* $-40 \dots 85\text{ °C}$
Sensitivity	$G$	mV/V		1.333		2 V for primary 1500 V
Sensitivity error	$\varepsilon_G$	%	-0.8		0.8	$\varepsilon_G @ V_{PN}$
Thermal drift of sensitivity	$\varepsilon_{GT}$	%	-0.4		0.4	*
Linearity error	$\varepsilon_L$	% of $V_{PM}$	-0.2		0.2	$\pm 1500\text{ V}$ range
Overall accuracy	$X_G$	% of $V_{PN}$	-1 -1.5		1 1.5	* 25 °C; 100 % tested in production; $-40 \dots 85\text{ °C}$
Output RMS noise voltage	$V_{no}$	$\mu\text{V}$		600		10 Hz to 100 kHz
Reaction time @ 10 % of $V_{PN}$	$t_{ra}$	$\mu\text{s}$		1.7		
Response time @ 90 % of $V_{PN}$	$t_r$	$\mu\text{s}$		10		0 to 1000 V step, 6 kV/ $\mu\text{s}$
Frequency bandwidth	$BW$	kHz		47 26		-3 dB -1 dB
Start-up time	$t_{start}$	ms		20		*
Resistance of primary	$R_P$	M $\Omega$		12.6		*
Total primary power loss @ $V_{PN}$	$P_P$	W		0.080		*

## 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.

Typical performance characteristics

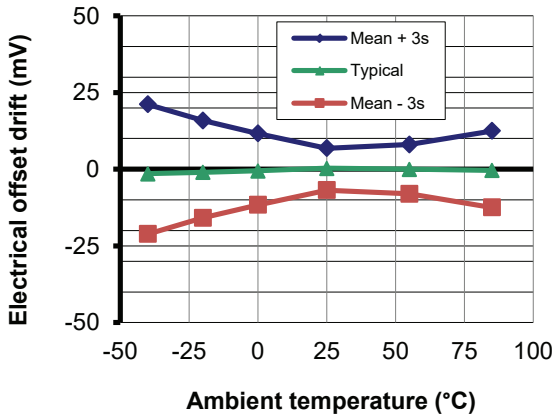


Figure 1: Electrical offset thermal drift

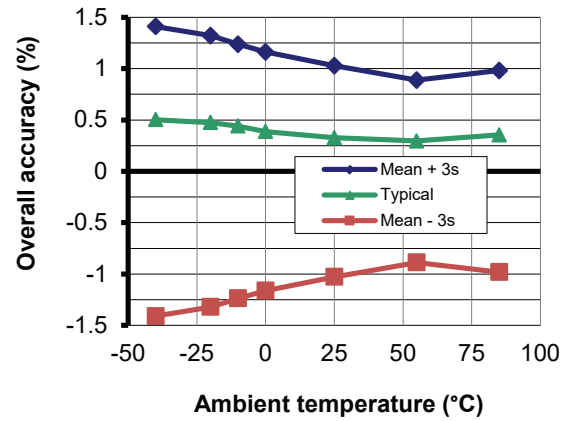


Figure 2: Overall accuracy in temperature

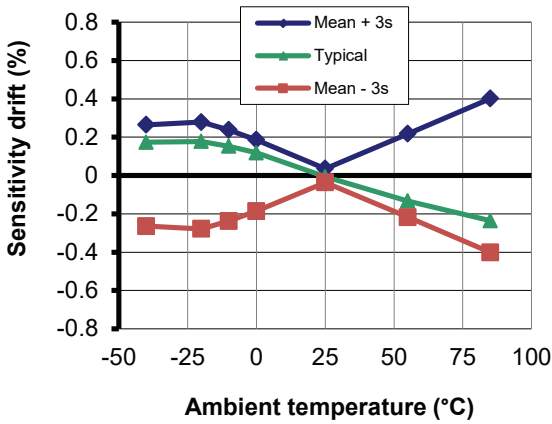


Figure 3: Sensitivity thermal drift

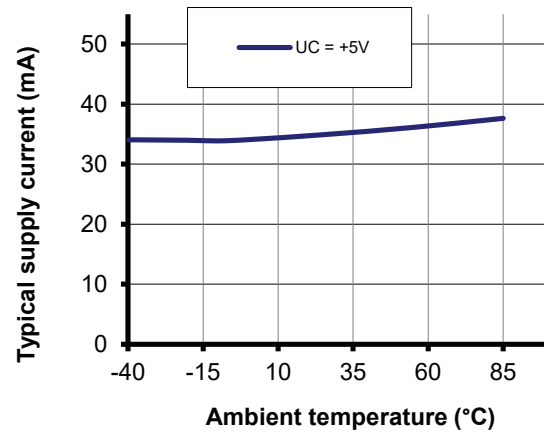


Figure 4: Supply current function of temperature

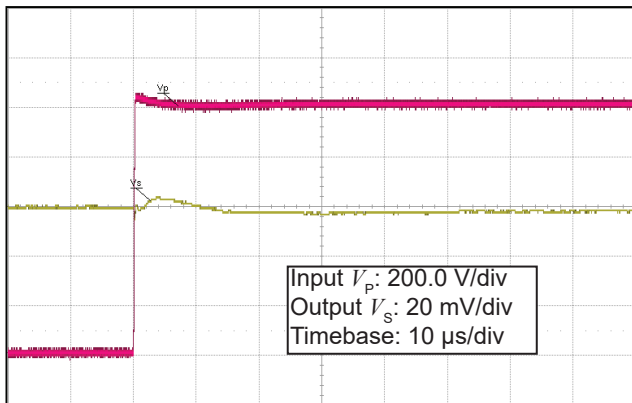


Figure 5: Detail of typical common mode perturbation (1000 V step with 6 kV/μs,  $R_M = 2 \text{ k}\Omega$ )

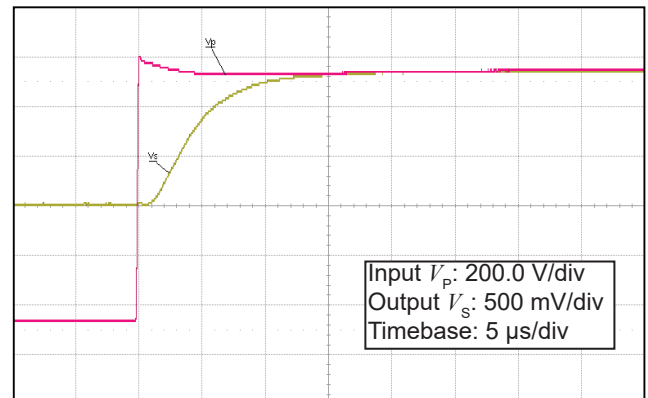


Figure 6: Typical step response (0 to 1000 V)

Typical performance characteristics

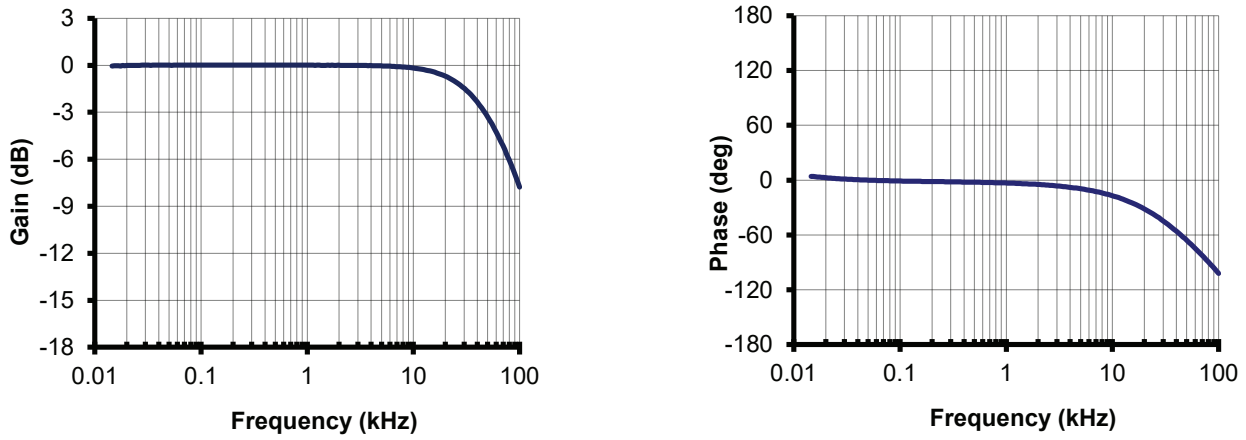


Figure 7: Typical frequency and phase response

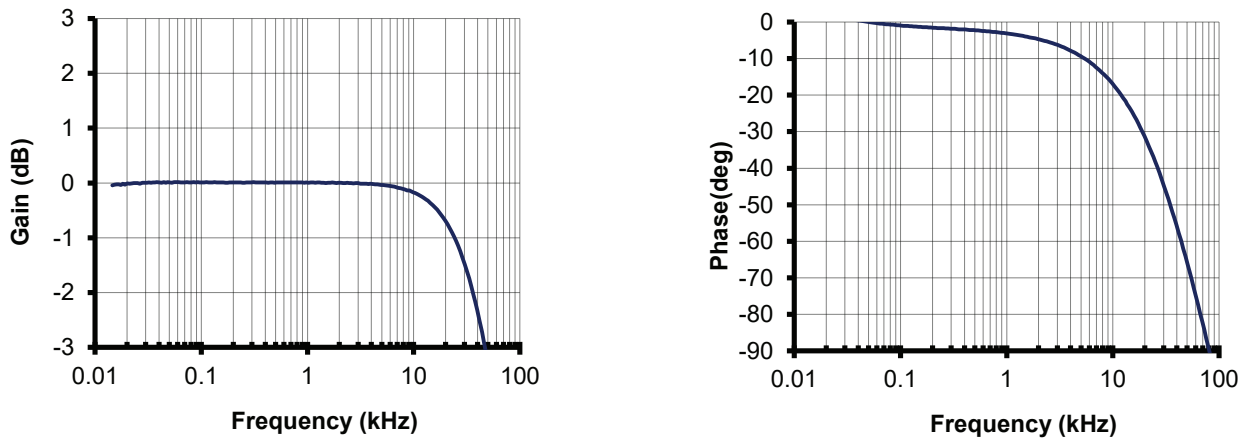


Figure 8: Typical frequency and phase response (detail)

Typical performance characteristics continued

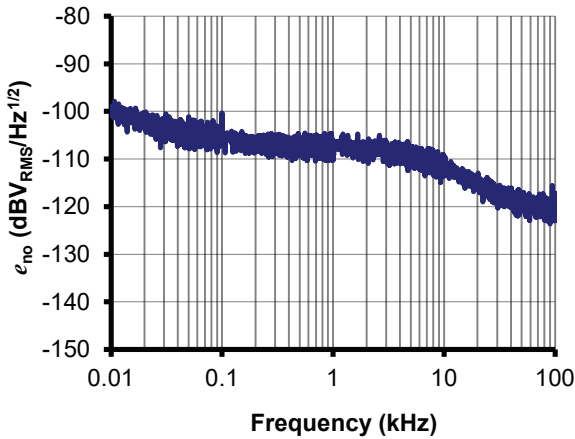


Figure 9: Typical output noise voltage spectral density  $e_{no}$  with  $R_M = 2 \text{ k}\Omega$

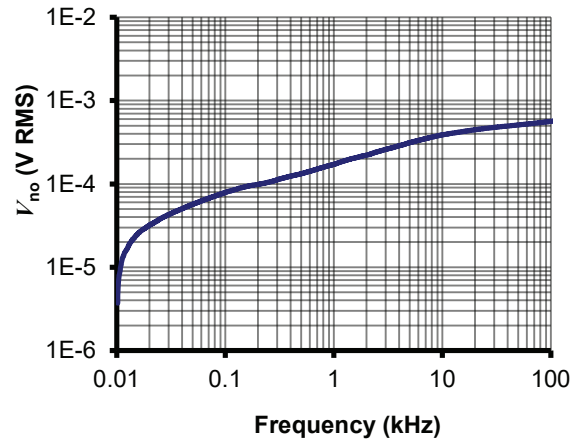


Figure 10: Typical total output RMS noise voltage with  $R_M = 2 \text{ k}\Omega$

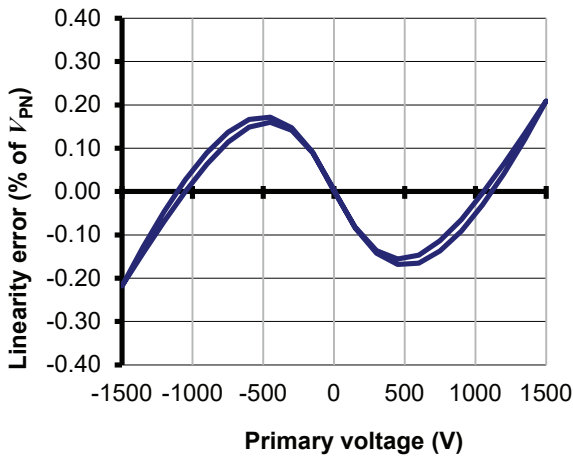


Figure 11: Typical linearity error at 25 °C

Figure 9 (output noise voltage spectral density) shows that there are no significant discrete frequencies in the output. Figure 10 confirms the absence of steps in the total output RMS noise voltage that would indicate discrete frequencies. To calculate the noise in a frequency band  $f1$  to  $f2$ , the formula is:

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

with  $V_{no}(f)$  read from figure 10 (typical, RMS value).

Example:

What is the noise from 100 to 1 kHz?

Figure 10 gives:

$V_{no}(100 \text{ Hz}) = 78 \text{ }\mu\text{V}$  and  $V_{no}(1 \text{ kHz}) = 171 \text{ }\mu\text{V}$ .

The output RMS noise current is therefore.

$$\sqrt{(171 \times 10^{-6})^2 - (78 \times 10^{-6})^2} = 152 \text{ }\mu\text{V}$$

### Performance parameters definition

The schematic used to measure all electrical parameters is:

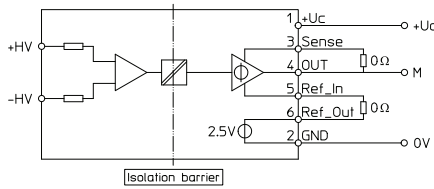


Figure 12: Standard characterization schematic for voltage output transducers

### Transducer simplified model

The static model of the transducer at temperature  $T_A$  is:

$$V_S = G \cdot V_P + \varepsilon$$

In which

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

- $V_S$  : secondary voltage (V)
- $G$  : sensitivity of the transducer (V/V)
- $V_P$  : primary voltage (V)
- $V_{PM}$  : primary voltage, measuring range (V)
  
- $T_A$  : ambient operating temperature (°C)
- $V_{OE}$  : electrical offset voltage (V)
- $V_{OT}(T_A)$  : temperature variation of  $V_O$  at temperature  $T_A$  (V)
- $\varepsilon_G$  : sensitivity error at 25 °C
- $\varepsilon_{GT}(T_A)$  : thermal drift of sensitivity at temperature  $T_A$
- $\varepsilon_L$  : 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  $V_{PM}$ .

The linearity error  $\varepsilon_L$  is the maximum positive or negative difference between the measured points and the linear regression line, expressed in % of the maximum measured value.

### Offset

The offset voltage  $V_O$  is the residual output voltage when the input voltage is zero.

The temperature variation  $V_{OT}$  of the offset voltage  $V_O$  is the variation of the offset from 25 °C to the considered temperature.

### Overall accuracy

The overall accuracy  $X_G$  is the error at  $V_{PN}$ , 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.

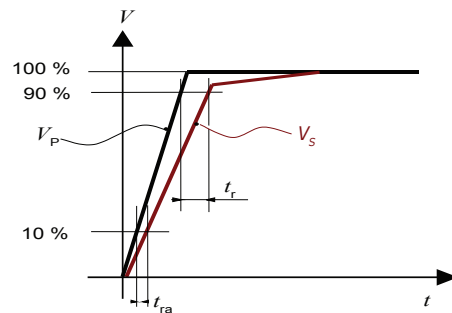
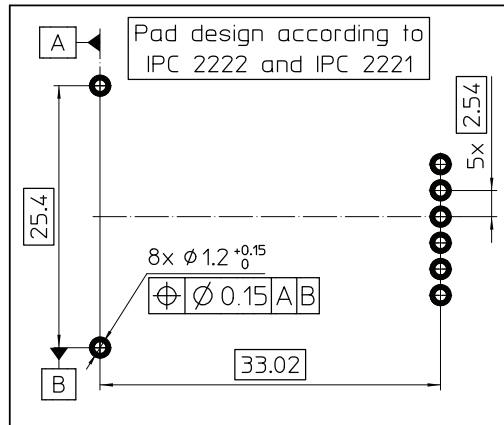


Figure 13: response time  $t_r$  and reaction time  $t_{ra}$

**PCB Footprint in mm.**

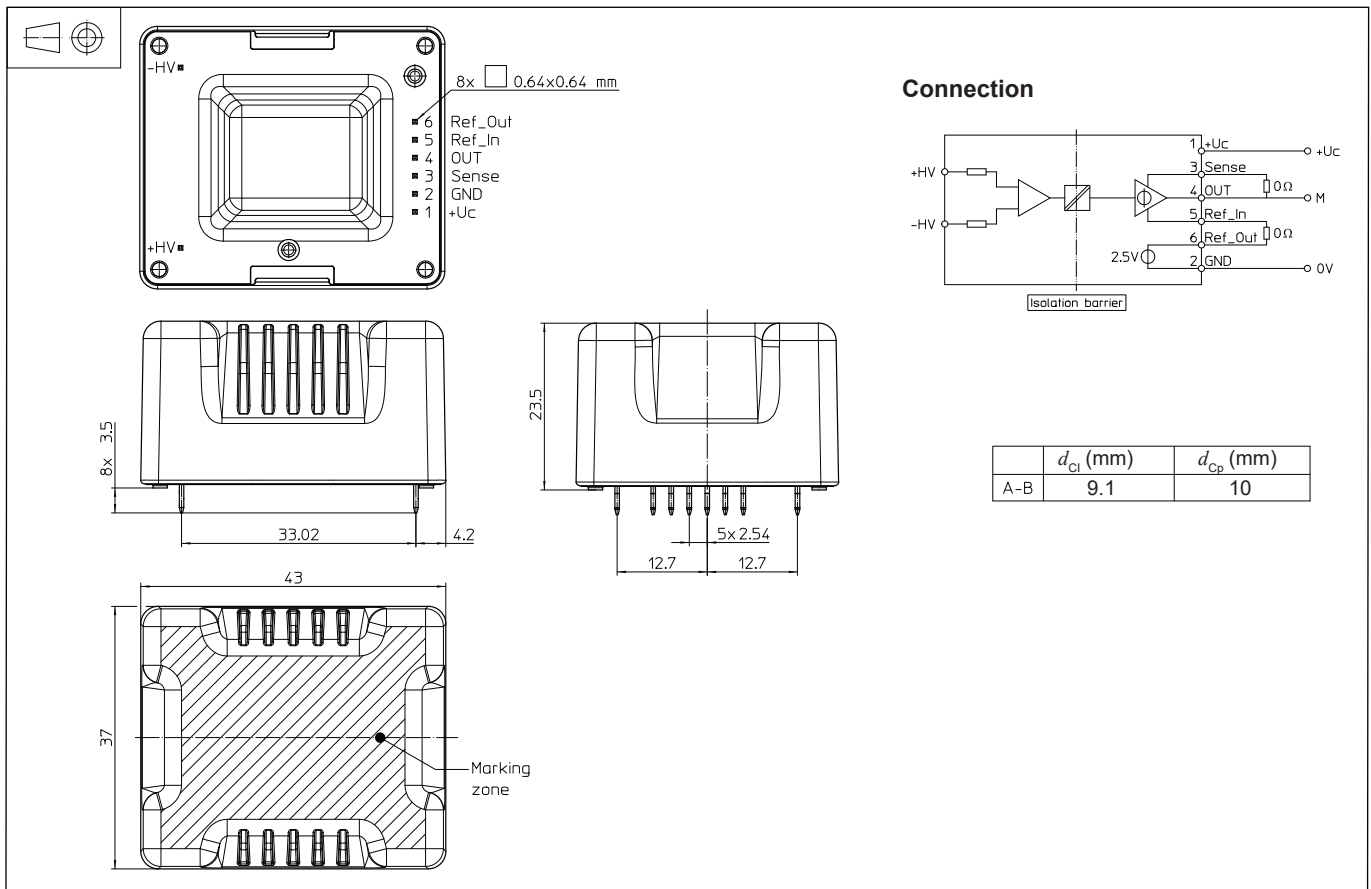


Recommended Customer PCB Layout  
Opposite Transducer side

**Assembly on PCB**

- Recommended PCB hole diameter 1.2 mm for primary pin  
1.2 mm for secondary pin
- Maximum PCB thickness 2.4 mm



**Dimensions (in mm)**

**Mechanical characteristics**

- General tolerance: 0.5 mm
- Transducer fastening: 8 holes  $\varnothing$  0.64 mm

**Remarks**

- $V_s$  is positive when a positive voltage is applied on +HV.
- The transducer is directly connected to the primary voltage.
- Care must be taken to maintain the creepage and clearance distances with the board design using proper PCB techniques.
- 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](#).
- This is a standard model. For different versions (supply voltages, sensitivity, unidirectional measurements...), please contact us.

**Safety**

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



Caution

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. All installations, maintenance and servicing operations must be carried out by trained operators. Failure to observe the installation instructions may compromise the protection provided by the unit.