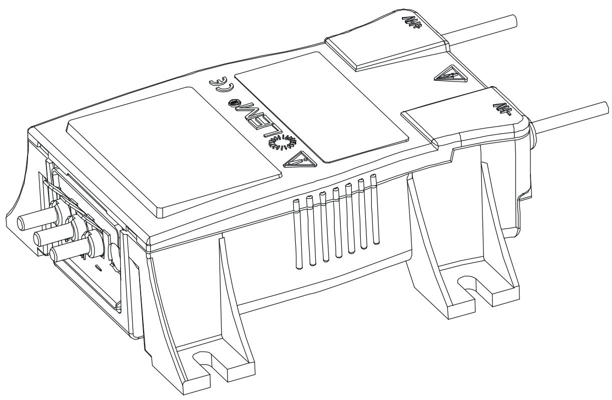
Voltage Transducer

V_{PN} = 1200 V

Ref: DV 1200/SP2

For the electronic measurement of voltages: DC, AC, pulsed ..., with a galvanic isolation between the primary circuit (high voltage) and the secondary circuit (electronic circuit).



Features

- Bipolar and isolated voltage measurement up to 1800 V
- Current output
- Input cables for increased insulation, output on faston and M5 studs
- Footprint compatible with OV, CV4 series and LV 200-AW/2.

Advantages

- Low consumption and losses
- Compact design
- Good behaviour under common mode variations
- Excellent accuracy (offset, gain, linearity)
- Response time 60 µs
- Low temperature drift
- High immunity to external interferences.

Applications

- Single or three phases inverter
- Propulsion and braking chopper
- Propulsion converter
- Auxiliary converter
- High power drives
- Substations
- On-board energy meters.

Standards

- EN 50155
- EN 50121-3-2
- EN 50124-1
- Isolated plastic case material recognised according to UL 94-V0.

Application domain

- Traction (fix and onboard).

Absolute maximum ratings

Parameter	*Symbol*	*Value*
Maximum supply voltage for current output DVs (terminal +$\mathbf{V}_C$ to -$\mathbf{V}_C$, no input voltage, 0.1 s)		68 V
Maximum supply voltage (working) (-40..85°C)	± $\mathbf{V}_C$	±26.4 V
Maximum input voltage (1.2/50µs exponential shape)		10 kV
Maximum input voltage (-40..85°C)		6 kV
Maximum steady state input voltage (-40..85°C)	$\mathbf{V}_{PN}$	1200 V see derating on figure 2
Output short circuit for output current DVs (terminal M to supply mid-point)		10 min at ±26.4 $\mathbf{V}_{PN}$ and 85°C For continuous short circuit, use figure 2
ESD rating, Human Body Model (HBM)		4 kV

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.

Isolation characteristics

Parameter	*Symbol*	*Unit*	*Min*	*Comment*
RMS voltage for AC insulation test 50/60 Hz / 1 min	$\mathbf{V}_d$	kV	18.5	100% tested in production
Insulation resistance	$\mathbf{R}_{IS}$	MΩ	200	measured at 500 V AC
RMS voltage for partial discharge extinction @ 10 pC	$\mathbf{V}_e$	V	5000	
CTI of case material	**CTI**	-	600	
Clearance and creepage	See dimensions drawing on page 8			

Environmental and mechanical characteristics

Parameter	*Symbol*	*Unit*	*Min*	*Typ*	*Max*
Ambient operating temperature	$\mathbf{T}_A$	°C	-40		85
Ambient storage temperature	$\mathbf{T}_S$	°C	-50		90
Mass	$\boldsymbol{m}$	g		620	
Standards	EN 50155: 2007 EN 50121-3-2: 2006 EN 50124-1: 2001				

Electrical data DV 1200/SP2

At $\mathbf{T}_A$ = 25 °C, $\mathbf{V}_C$ = ± 24 V, $\mathbf{R}_M$ = 100 Ω, unless otherwise noted.
Parameters with a * in the conditions column apply over the -40.. 85°C ambient temperature range.

Parameter	*Symbol*	*Unit*	*Min*	*Typ*	*Max*	*Conditions*	
Primary nominal voltage, rms	$\mathbf{V}_{PN}$	V			1200	*	
Primary voltage, measuring range	$\mathbf{V}_{PM}$	A	-1800		1800	*	
Measuring resistance	$\mathbf{R}_M$	Ω	0		140	*	See derating on figure 2 for $\lvert \mathbf{V}_{PM} \rvert$ <1800 V, max value of $\mathbf{R}_M$ is given in figure 1
Secondary nominal current, rms	$\mathbf{I}_{SN}$	mA			50	*	
Output range	$\mathbf{I}_S$	mA	-75		75	*	
Supply voltage	$\pm\mathbf{V}_c$	V	±13.5	±24	±26.4	*	
Current consumption @ $\mathbf{V}_C$ = ±24 V	$\mathbf{I}_C$	mA		20 + $\mathbf{I}_S$	25 + $\mathbf{I}_S$		
Offset current	$\mathbf{I}_O$	µA	-50	0	50		100% tested in production
Offset drift	$\mathbf{I}_{OT}$	µA	-250 -250 -300		250 250 300	*	-25°C .. 70°C -25 .. 85°C -40 .. 85°C; 100% tested in production
Sensitivity	**G**	µA/V		41.667			50 mA for 1200 V
Sensitivity error	e_G	%	-0.2	0	0.2		
Thermal drift of sensitivity		%	-0.5 -0.8 -0.8		0.5 0.8 0.8	*	-25°C .. 70°C -25 .. 85°C -40 .. 85°C
Linearity error	e_L	%	-0.1		0.1	*	±1800 V range
Overall accuracy	$\mathbf{X}_G$	% of $\mathbf{V}_{PN}$	-0.3 -0.9 -1.2 -1.2		0.3 0.9 1.2 1.2	*	25°C; 100% tested in production -25°C .. 70°C -25 .. 85°C -40 .. 85°C
Output current noise	$\mathbf{i}_{no}$	μA_{rms}		14			1 Hz to 100 kHz
Reaction time @ 10 % of $\mathbf{V}_{PN}$	$\mathbf{t}_{ra}$	µs		21			
Response time @ 90 % of $\mathbf{V}_{PN}$	$\mathbf{t}_r$	µs		48	60		0 to 1200 V step, 6 kV/µs
Frequency bandwidth	**BW**	kHz		12 6.5 1.6			3 dB 1 dB 0.1 dB
Start-up time		ms		190	250	*	
Primary resistance	$\mathbf{R}_1$	MΩ		23		*	
Total primary power loss @ $\mathbf{V}_{PN}$	**P**	W		0.06		*	

Typical performance characteristics

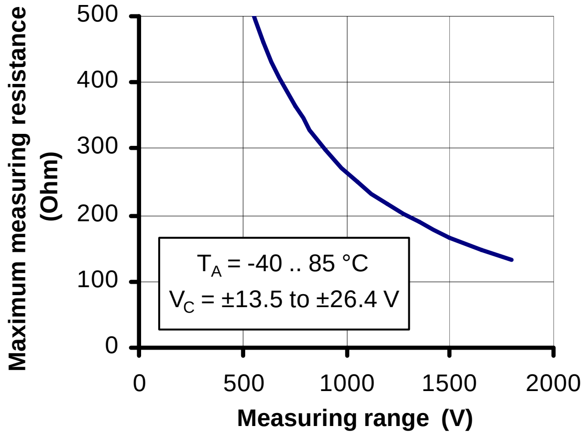


Figure 1: Maximum measuring resistance

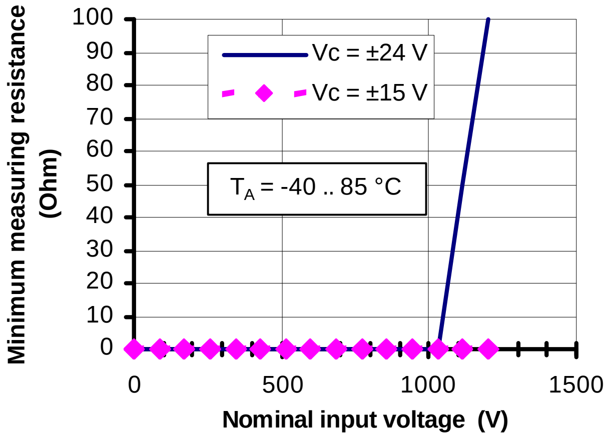


Figure 2: Minimum measuring resistance;
For T_A under 80°C, the minimum measuring resistance is 0 W whatever Vc

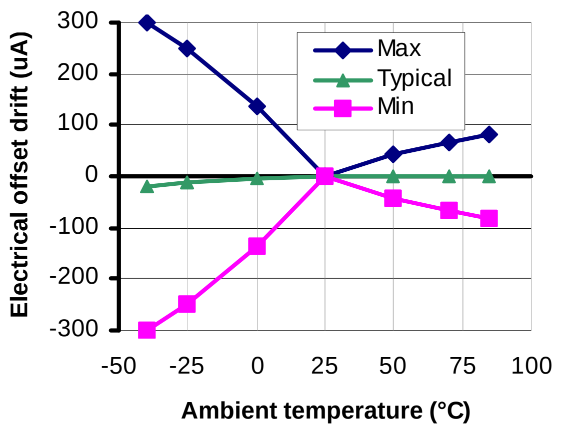


Figure 3: Electrical offset thermal drift

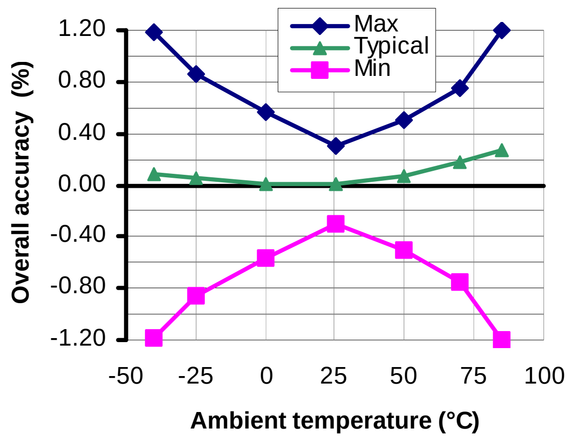


Figure 4: Overall accuracy in temperature

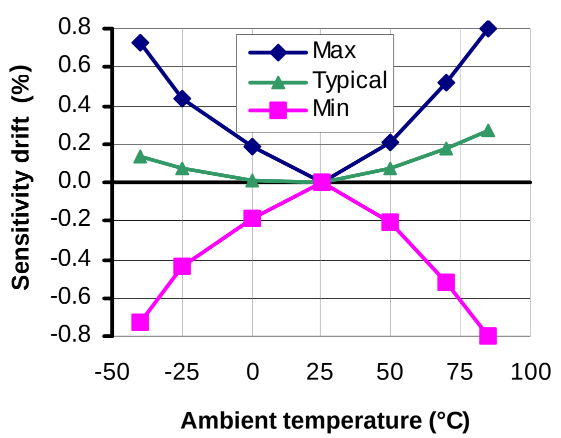


Figure 5: Sensitivity thermal drift

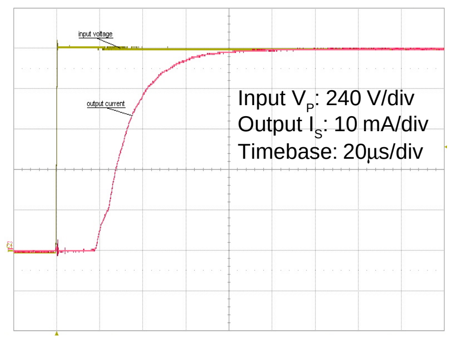


Figure 6: Typical step response (0 to 1200 V)

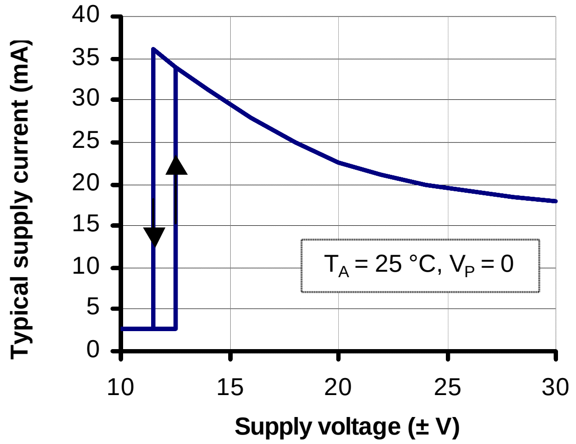


Figure 7: Supply current function of supply voltage

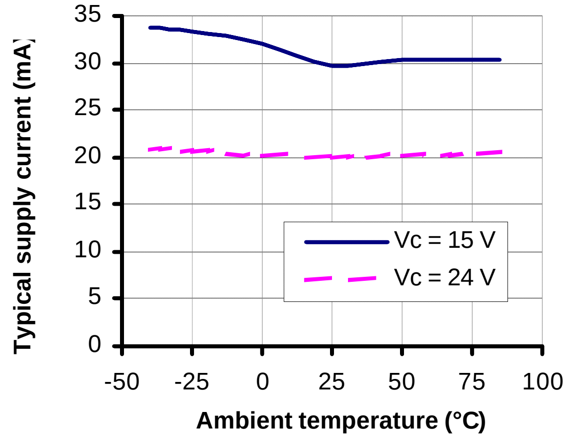


Figure 8: Supply current function of temperature

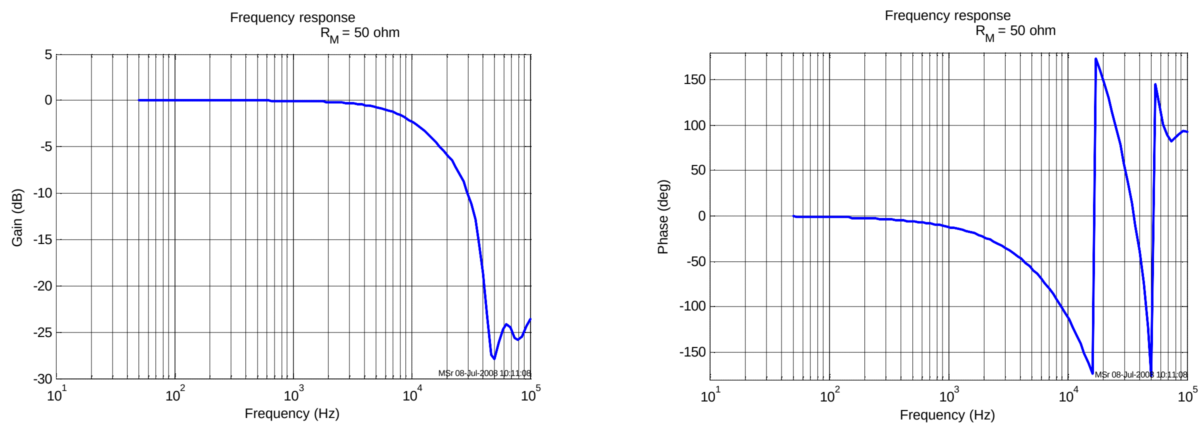


Figure 9: Typical frequency response

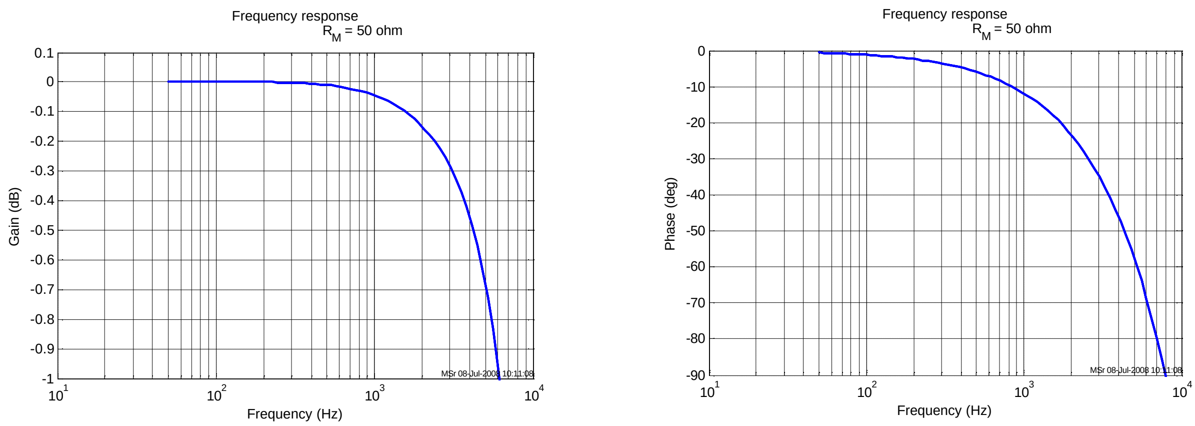


Figure 10: Typical frequency response (detail)

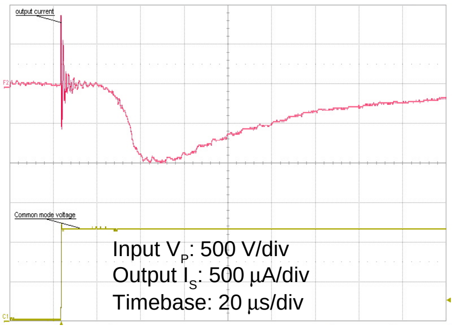


Figure 11: Typical common mode perturbation (1200 V step with 6 kV/ms, R_M = 100 W)

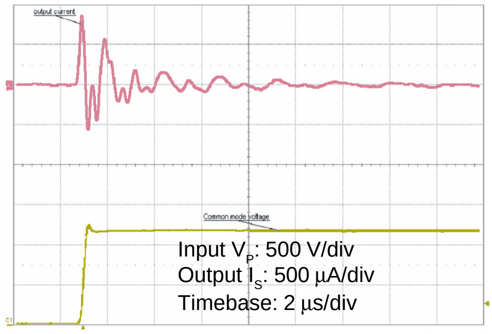


Figure 12: Detail of typical common mode perturbation (1200 V step with 6 kV/ms, R_M = 100 W)

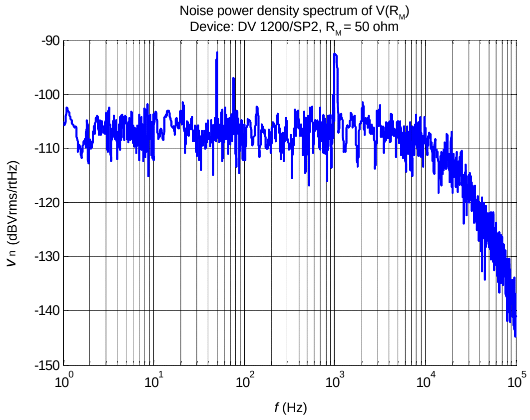


Figure 13: Noise power density of V(R_M)

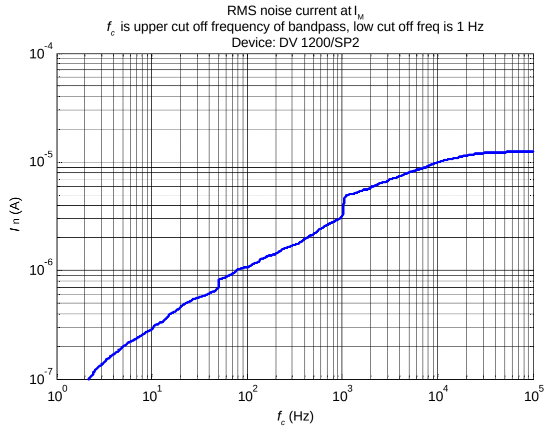


Figure 14: Total output current noise

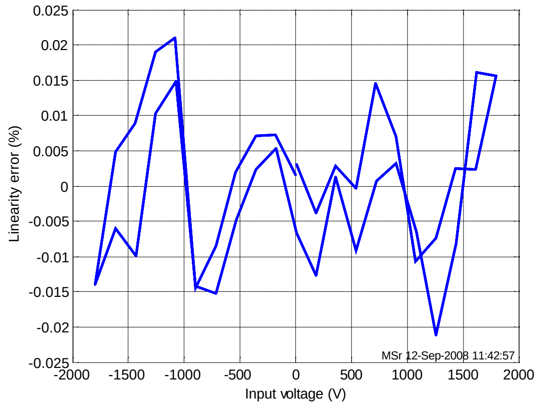


Figure 15: Typical linearity error

Performance parameters definition

The schematics used to measure all electrical parameters are:

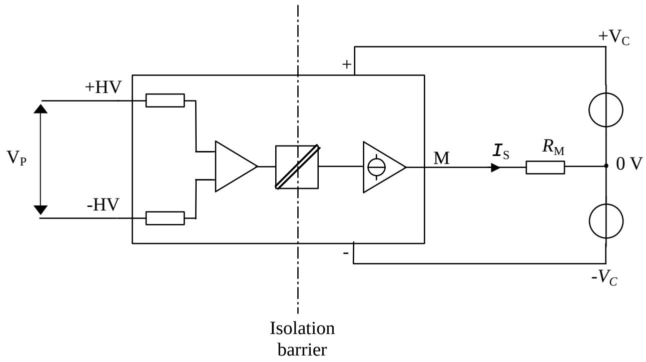


Figure 20: standard characterization schematics for current output transducers (R_M = 50 W unless otherwise noted)

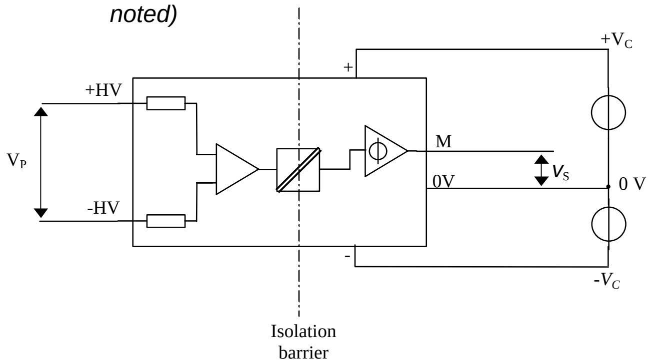


Figure 21: standard characterization schematics for voltage output transducers

For all the following explanations, the output currents $\mathbf{I}_S$, $\mathbf{I}_O$, $\mathbf{I}_{OT}$ … should be replaced by voltages for transducers with voltage output: $\mathbf{V}_S$, $\mathbf{V}_O$, $\mathbf{V}_{OT}$ …

Transducer simplified model

The static model of the transducer at temperature $\mathbf{T}_A$ is:
$I_S = G\,V_P$ + error

In which
error = $\mathbf{I}_{OE} + \mathbf{I}_{OT}(T_A) + \varepsilon_G G V_P + \varepsilon_{GT} G V_P + \varepsilon_L G V_{PM}$

$\mathbf{I}_S$: the secondary current (A)
G: the sensitivity of the transducer (A/V)
$\mathbf{V}_P$: the voltage to measure (V)
$\mathbf{V}_{PM}$: the maximum input voltage. This value is used to measure linearity error (V)
$\mathbf{T}_A$: the ambient temperature (°C)
$\mathbf{I}_{OE}$: the electrical offset current (A)
$\mathbf{I}_{OT}(\mathbf{T}_A)$: the temperature variation of $\mathbf{I}_O$ at temperature $\mathbf{T}_A$ (A)
ε_G: the sensitivity error at 25°C
ε_{GT}: the sensitivity error thermal drift
ε_L: the 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:

$$\text{error} = \sqrt{\sum (error\_component)^2}$$

Sensitivity and linearity

To measure sensitivity and linearity, the primary voltage (DC) is cycled from 0 to $\mathbf{V}_{PM}$, then to -$\mathbf{V}_{PM}$ and back to 0 (equally spaced $\mathbf{V}_{PM}$/10 steps).
The sensitivity **G** is defined as the slope of the linear regression line for a cycle between ± $\mathbf{V}_{PM}$.

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.

Magnetic offset

Due to its working principle, this type of transducer has no magnetic offset current $\mathbf{I}_{OM}$.

Electrical offset

The electrical offset current $\mathbf{I}_{OE}$ is the residual output current when the input voltage is zero.
The temperature variation $\mathbf{I}_{OT}$ of the electrical offset current $\mathbf{I}_{OE}$ is the variation of the electrical offset from 25°C to the considered temperature.

Overall accuracy

The overall accuracy at 25°C $\mathbf{X}_G$ is the error in the -$\mathbf{V}_{PN}$ ..+$\mathbf{V}_{PN}$ range, relative to the rated value $\mathbf{V}_{PN}$.
It includes:

- the electrical offset $\mathbf{I}_{OE}$
- the sensitivity error ε_G
- the linearity error ε_L

$\mathbf{X}_G$ is lower than the arithmetic sum of its components (see end of § Transducer simplified model on this page for explanations).

Response and reaction times

The response time $\mathbf{t}_r$ and the reaction time $\mathbf{t}_{ra}$ are shown in the next figure.
Both slightly depend on the primary voltage dv/dt. They are measured at nominal voltage.

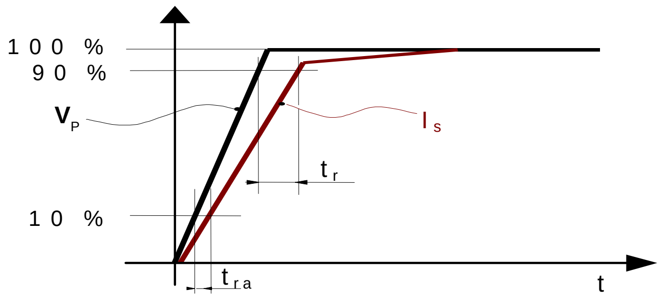
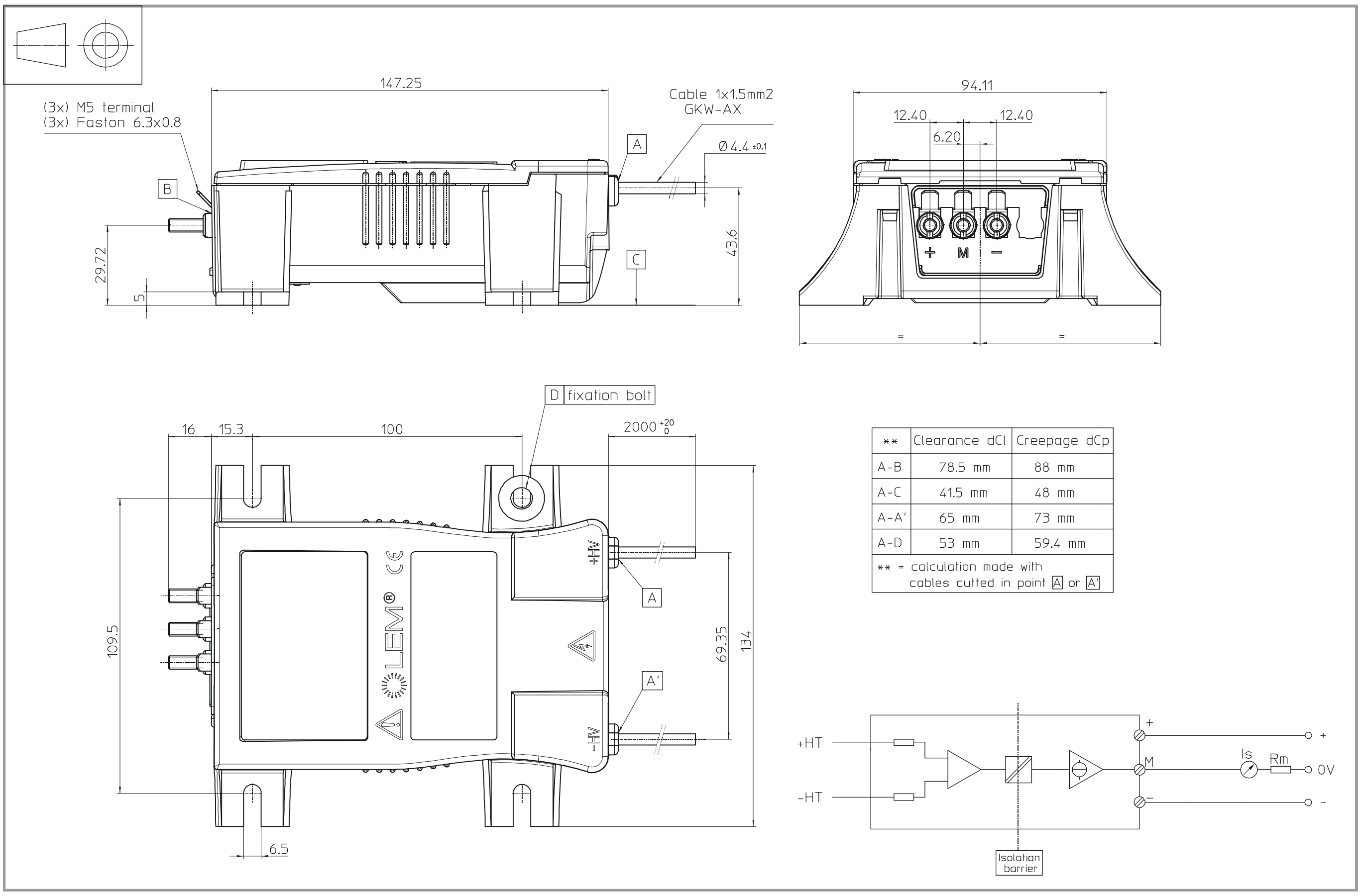


Figure 22: response time $\mathbf{t}_r$ *and reaction time* $\mathbf{t}_{ra}$

Dimensions DV 1200/SP2 (in mm. 1 mm = 0.0394 inch)



**	Clearance dCl	Creepage dCp
A-B	78.5 mm	88 mm
A-C	41.5 mm	48 mm
A-A'	65 mm	73 mm
A-D	53 mm	59.4 mm
** = calculation made with cables cutted in point A or A'		

Mechanical characteristics

- General tolerance ± 1 mm
- Transducer fastening 4 slots ∅ 6.5 mm
  4 M6 steel screws
  4 washer ext. ∅18 mm

  Recommended fastening torque 5 Nm or 3.7 lbf.ft
- Connection of primary 1 x 1.5 mm^2 cable GKW-AX
- Connection of secondary 6.3 x 0.8 mm fastons and
  M5 threaded studs

  Recommended fastening torque 2.2 Nm or 1.62 lbf.ft

There are several other variants for primary and secondary connections.

Remarks

- I_S is positive when a positive voltage is applied on +HV.
- The transducer is directly connected to the primary voltage.
- Installation of the transducer to be done without voltage presence.

Safety

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 (eg. primary busbar, power supply).
Ignoring this warning can lead to injury and/or cause serious damage.
This transducer is a built-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.