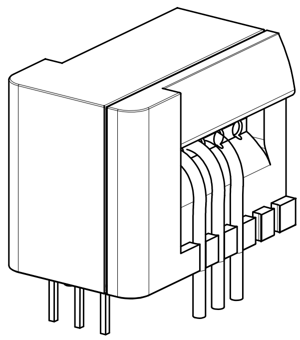
Current Transducer CAS series I_{PN} = 6, 15, 25, 50 A

Ref: CAS 6-NP, CAS 15-NP, CAS 25-NP, CAS 50-NP

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



Features

- Closed loop (compensated) multi-range current transducer
- Voltage output
- Single supply
- Isolated plastic case material recognized according to UL 94-V0
- Compact design for PCB mounting.

Advantages

- Very low temperature coefficient of offset
- Very good dv/dt immunity
- LTS compatible footprint
- Reduced height.

Applications

- AC variable speed and servo motor drives
- Static converters for DC motor drives
- Battery supplied applications
- Uninterruptible Power Supplies (UPS)
- Switched Mode Power Supplies (SMPS)
- Power supplies for welding applications.

Standards

- EN 50178
- UL 508
- IEC 61010-1 (safety).

Application Domain

- Industrial.

Absolute maximum ratings

Parameter	Symbol	Unit	Value
Supply voltage	V_C	V	7
Primary conductor temperature		°C	110
Non repetitive primary current pulse (20 µs), in powered or unpowered state	$\hat{I}_P$	A	20 x I_{PN}
ESD rating, Human Body Model (HBM)		kV	4

Stresses above these ratings may cause permanent damage. Exposure to absolute maximum ratings for extended periods may degrade reliability.

Isolation characteristics

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC isolation test 50/60Hz/1 min	V_d	kV	4.2	
Impulse withstand voltage 1.2/50 µs	$\hat{V}_w$	kV	7.6	
Partial discharge extinction voltage @ 10 pC (rms)	V_e	V	1000	
Clearance distance (pri. - sec.)	**dCI**	mm	7.7	Shortest distance through air
Creepage distance (pri. - sec.)	**dCp**	mm	7.7	Shortest path along device body
Creepage distance (pri. .- sec.)	-	mm	6.3	When mounted on PCB with recommended layout
Case material	-	-	V0 according to UL 94	
Comparative tracking index	**CTI**	V	600	
Application example	-	-	300 V CAT III PD2	Reinforced isolation, non uniform field according to EN 50178, EN 61010
Application example	-	-	600 V CAT III PD2	Simple isolation, non uniform field according to EN 50178, EN 61010
According to UL 508: primary potential involved in Volts RMS AC or DC	-	V	600	For use in a pollution degree 2 environment

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	-40		85	
Ambient storage temperature	T_S	°C	-55		105	
Mass	m	g		9		
Standards	EN 50178, IEC 60950-1, IEC 61010-1, IEC 61326-1, UL 508					

Electrical data CAS 6-NP

At T_A = 25°C, V_C = + 5 V, N_P = 1 turn, R_L = 10 kΩ, unless otherwise noted.

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current rms	I_{PN}	A		6		
Primary current, measuring range	I_{PM}	A	-20		20	
Number of primary turns	N_P	-		1,2,3		
Supply voltage	V_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$15 + \frac{I_P\ (mA)}{N_S}$	$20 + \frac{I_P\ (mA)}{N_S}$	N_S = 1731 turns
Output voltage	V_{OUT}	V	0.375		4.625	
Output voltage @ I_P = 0 A	V_{OUT}	V		2.5		
Electrical offset voltage	V_{OE}	mV	-10.4		10.4	100% tested V_{OUT} - 2.5 V
Electrical offset current referred to primary	I_{OE}	A	-0.1		0.1	100% tested
Temperature coefficient of V_{OUT} @ I_P = 0 A	TCV_{OUT}	ppm/K		±10	±80	ppm/K of 2.5 V - 40°C .. 85°C
Theoretical sensitivity	**Gth**	mV/A		104.2		625 mV/ I_{PN}
Sensitivity error	ε_G	%	-0.7		0.7	100% tested
Temperature coefficient of **G**	**TCG**	ppm/K			±40	- 40°C .. 85°C
Linearity error	ε_L	% of I_{PN}	-0.1		0.1	
Magnetic offset current (10 x I_{PN}) referred to primary	I_{OM}	A	-0.1		0.1	
Output current noise (spectral density) rms 100 .. 100 kHz referred to primary	i_{no}	μA/Hz½		36		R_L = 1 kΩ
Peak-peak output ripple at oscillator frequency **f** = 450 kHz (typ.)	-	mV		40	160	R_L = 1 kΩ
Reaction time @ 10 % of I_{PN}	t_{ra}	μs			0.3	R_L = 1 kΩ di/dt = 18 A/μs
Response time @ 90 % of I_{PN}	t_r	μs			0.3	R_L = 1 kΩ di/dt = 18 A/μs
Frequency bandwidth (± 1 dB)	**BW**	kHz	200			R_L = 1 kΩ
Frequency bandwidth (± 3 dB)	**BW**	kHz	300			R_L = 1 kΩ
Overall accuracy	X_G	% of I_{PN}			2.5	
Overall accuracy @ T_A = 85°C	X_G	% of I_{PN}			4.6	
Accuracy	**X**	% of I_{PN}			0.8	
Accuracy @ T_A = 85°C	**X**	% of I_{PN}			3.0	

Electrical data CAS 15-NP

At T_A = 25°C, V_C = + 5 V, N_P = 1 turn, R_L = 10 kΩ, unless otherwise noted.

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current rms	I_{PN}	A		15		
Primary current, measuring range	I_{PM}	A	-51		51	
Number of primary turns	N_P	-		1,2,3		
Supply voltage	V_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$15 + \frac{I_P\text{ (mA)}}{N_S}$	$20 + \frac{I_P\text{ (mA)}}{N_S}$	N_S = 1731 turns
Output voltage	V_{OUT}	V	0.375		4.625	
Output voltage @ I_P = 0 A	V_{OUT}	V		2.5		
Electrical offset voltage	V_{OE}	mV	-7.1		7.1	100% tested V_{OUT} - 2.5 V
Electrical offset current referred to primary	I_{OE}	A	-0.17		0.17	100% tested
Temperature coefficient of V_{OUT} @ I_P = 0 A	TCV_{OUT}	ppm/K		±7.5	±70	ppm/K of 2.5 V - 40°C .. 85°C
Theoretical sensitivity	Gth	mV/A		41.67		625 mV/ I_{PN}
Sensitivity error	ε_G	%	-0.7		0.7	100% tested
Temperature coefficient of **G**	TCG	ppm/K			±40	- 40°C .. 85°C
Linearity error	ε_L	% of I_{PN}	-0.1		0.1	
Magnetic offset current (10 x I_{PN}) referred to primary	I_{OM}	A	-0.1		0.1	
Output current noise (spectral density) rms 100 Hz .. 100 kHz referred to primary	i_{no}	μA/Hz½		90		R_L = 1 kΩ
Peak-peak output ripple at oscillator frequency **f** = 450 kHz (typ.)	-	mV		15	60	R_L = 1 kΩ
Reaction time @ 10 % of I_{PN}	t_{ra}	μs			0.3	R_L = 1 kΩ di/dt = 44 A/μs
Response time @ 90 % of I_{PN}	t_r	μs			0.3	R_L = 1 kΩ di/dt = 44 A/μs
Frequency bandwidth (± 1 dB)	BW	kHz	200			R_L = 1 kΩ
Frequency bandwidth (± 3 dB)	BW	kHz	300			R_L = 1 kΩ
Overall accuracy	X_G	% of I_{PN}			1.9	
Overall accuracy @ T_A = 85°C	X_G	% of I_{PN}			3.9	
Accuracy	X	% of I_{PN}			0.8	
Accuracy @ T_A = 85°C	X	% of I_{PN}			2.7	

Electrical data CAS 25-NP

At T_A = 25°C, V_C = + 5 V, N_P = 1 turn, R_L = 10 kΩ, unless otherwise noted.

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current rms	I_{PN}	A		25		
Primary current, measuring range	I_{PM}	A	-85		85	
Number of primary turns	N_P	-		1,2,3		
Supply voltage	V_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$15 + \frac{I_P\,(mA)}{N_S}$	$20 + \frac{I_P\,(mA)}{N_S}$	N_S = 1731 turns
Output voltage	V_{OUT}	V	0.375		4.625	
Output voltage @ I_P = 0 A	V_{OUT}	V		2.5		
Electrical offset voltage	V_{OE}	mV	-6.25		6.25	100% tested V_{OUT} - 2.5 V
Electrical offset current referred to primary	I_{OE}	A	-0.25		0.25	100% tested
Temperature coefficient of V_{OUT} @ I_P = 0 A	TCV_{OUT}	ppm/K		±6.5	±60	ppm/K of 2.5 V - 40°C .. 85°C
Theoretical sensitivity	Gth	mV/A		25		625 mV/ I_{PN}
Sensitivity error	ε_G	%	-0.7		0.7	100% tested
Temperature coefficient of **G**	TCG	ppm/K			±40	- 40°C .. 85°C
Linearity error	ε_L	% of I_{PN}	-0.1		0.1	
Magnetic offset current (10 x I_{PN}) referred to primary	I_{OM}	A	-0.1		0.1	
Output current noise (spectral density) rms 100 Hz .. 100 kHz referred to primary	i_{no}	µA/Hz½		150		R_L = 1 kΩ
Peak-peak output ripple at oscillator frequency **f** = 450 kHz (typ.)	-	mV		10	40	R_L = 1 kΩ
Reaction time @ 10 % of I_{PN}	t_{ra}	µs			0.3	R_L = 1 kΩ di/dt = 68 A/µs
Response time @ 90 % of I_{PN}	t_r	µs			0.3	R_L = 1 kΩ di/dt = 68 A/µs
Frequency bandwidth (± 1 dB)	BW	kHz	200			R_L = 1 kΩ
Frequency bandwidth (± 3 dB)	BW	kHz	300			R_L = 1 kΩ
Overall accuracy	X_G	% of I_{PN}			1.8	
Overall accuracy @ T_A = 85°C	X_G	% of I_{PN}			3.5	
Accuracy	X	% of I_{PN}			0.8	
Accuracy @ T_A = 85°C	X	% of I_{PN}			2.5	

Electrical data CAS 50-NP

At T_A = 25°C, V_C = + 5 V, N_P = 1 turn, R_L = 10 kΩ, unless otherwise noted.

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current rms	I_{PN}	A		50		
Primary current, measuring range	I_{PM}	A	-150		150	
Number of primary turns	N_P	-		1,2,3		
Supply voltage	V_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$15 + \frac{I_P\,(mA)}{N_S}$	$20 + \frac{I_P\,(mA)}{N_S}$	N_S = 966 turns
Output voltage	V_{OUT}	V	0.375		4.625	
Output voltage @ I_P = 0 A	V_{OUT}	V		2.5		
Electrical offset voltage	V_{OE}	mV	-5.8		5.8	100% tested V_{OUT} - 2.5 V
Electrical offset current referred to primary	I_{OE}	A	-0.46		0.46	100% tested
Temperature coefficient of V_{OUT} @ I_P = 0 A	TCV_{OUT}	ppm/K		±6	±60	ppm/K of 2.5 V - 40°C .. 85°C
Theoretical sensitivity	Gth	mV/A		12.5		625 mV/ I_{PN}
Sensitivity error	ε_G	%	-0.7		0.7	100% tested
Temperature coefficient of **G**	TCG	ppm/K			±40	- 40°C .. 85°C
Linearity error	ε_L	% of I_{PN}	-0.1		0.1	
Magnetic offset current (10 x I_{PN}) referred to primary	I_{OM}	A	-0.1		0.1	
Output current noise (spectral density) rms 100 Hz .. 100 kHz referred to primary	i_{no}	μA/Hz½		300		R_L = 1 kΩ
Peak-peak output ripple at oscillator frequency **f** = 450 kHz (typ.)	-	mV		5	20	R_L = 1 kΩ
Reaction time @ 10 % of I_{PN}	t_{ra}	μs			0.3	R_L = 1 kΩ di/dt = 100 A/μs
Response time @ 90 % of I_{PN}	t_r	μs			0.3	R_L = 1 kΩ di/dt = 100 A/μs
Frequency bandwidth (± 1 dB)	BW	kHz	200			R_L = 1 kΩ
Frequency bandwidth (± 3 dB)	BW	kHz	300			R_L = 1 kΩ
Overall accuracy	X_G	% of I_{PN}			1.7	
Overall accuracy @ T_A = 85°C	X_G	% of I_{PN}			3.4	
Accuracy	X	% of I_{PN}			0.8	
Accuracy @ T_A = 85°C	X	% of I_{PN}			2.5	

Typical performance characteristics CAS 6-NP

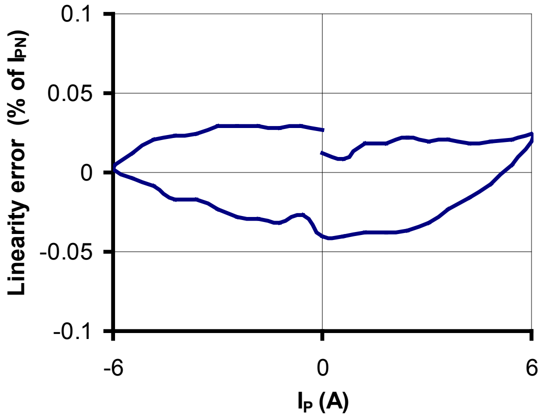


Figure 1: Linearity error

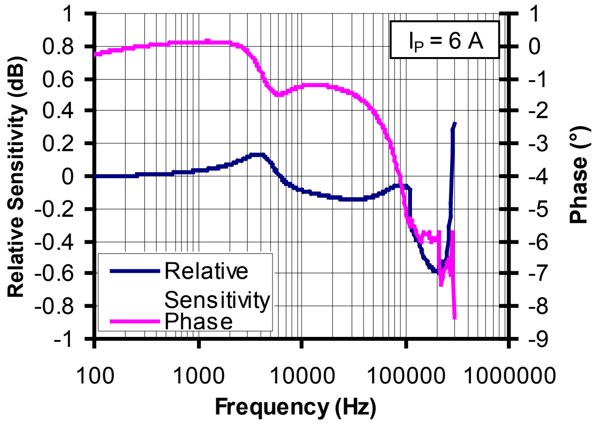


Figure 2: Frequency response

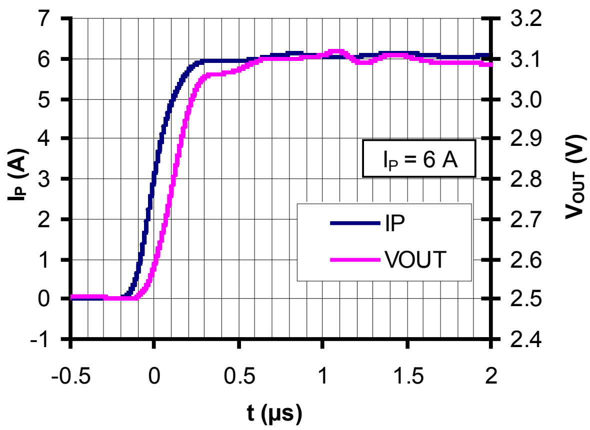


Figure 3: Step response

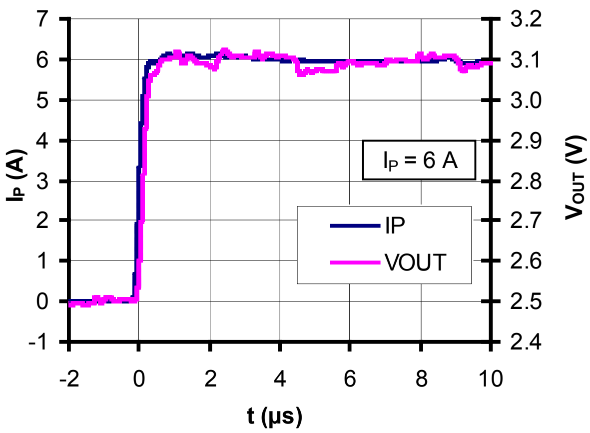


Figure 4: Step response

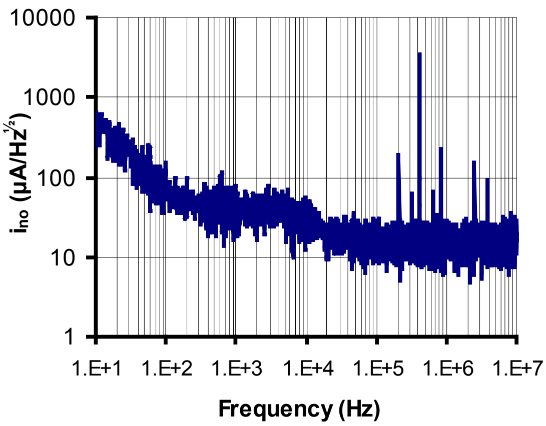


Figure 5: Input referred noise

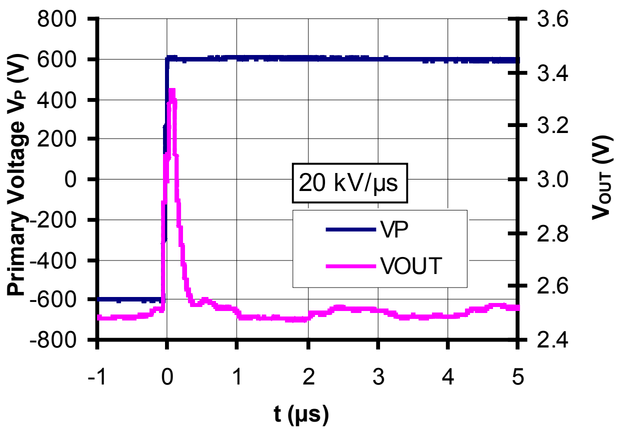


Figure 6: dv/dt

Typical performance characteristics CAS 15-NP

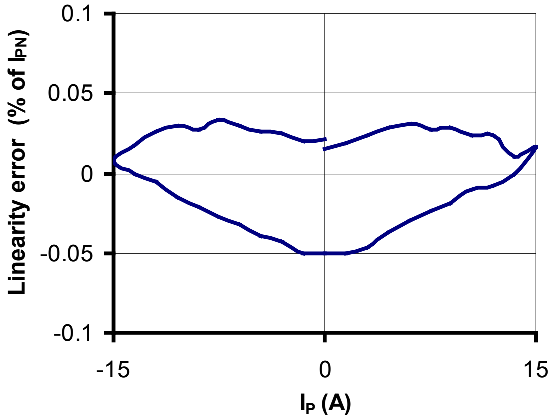


Figure 7: Linearity error

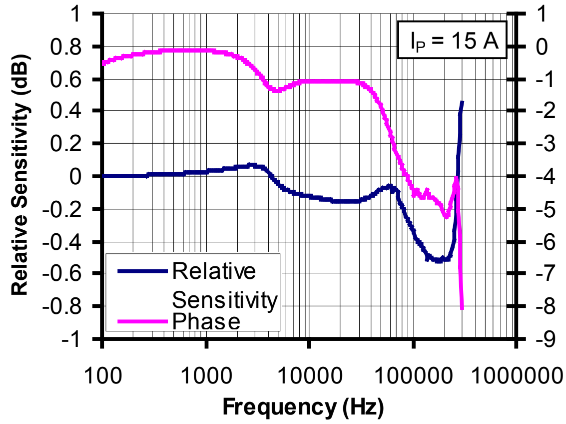


Figure 8: Frequency response

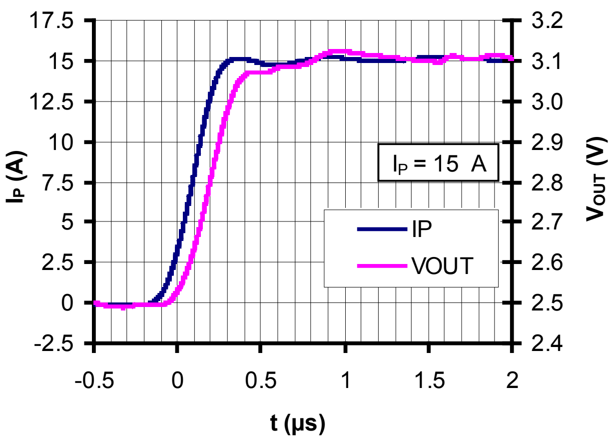


Figure 9: Step response

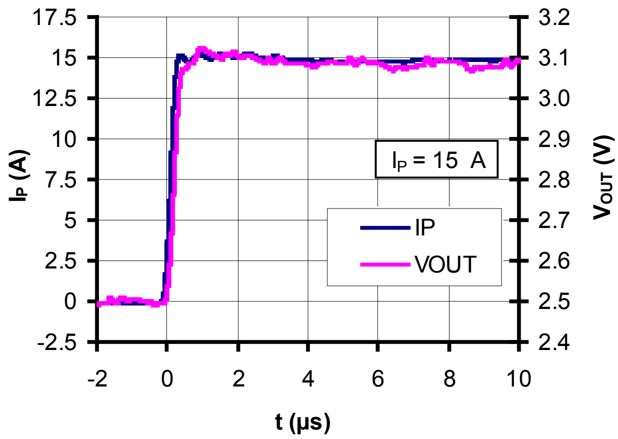


Figure 10: Step response

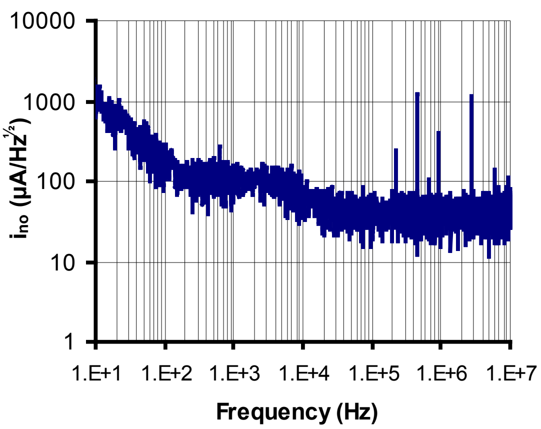


Figure 11: Input referred noise

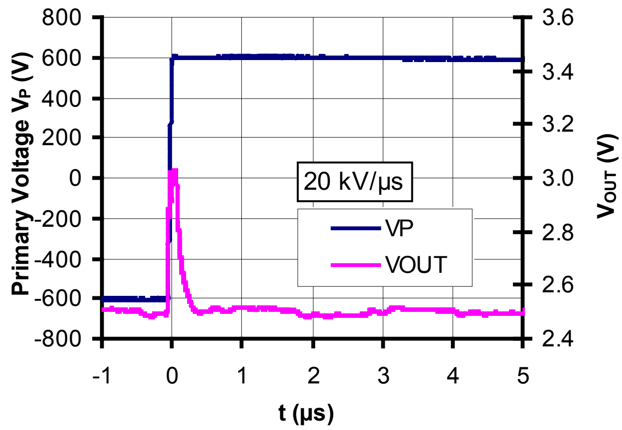


Figure 12: dv/dt

Typical performance characteristics CAS 25-NP

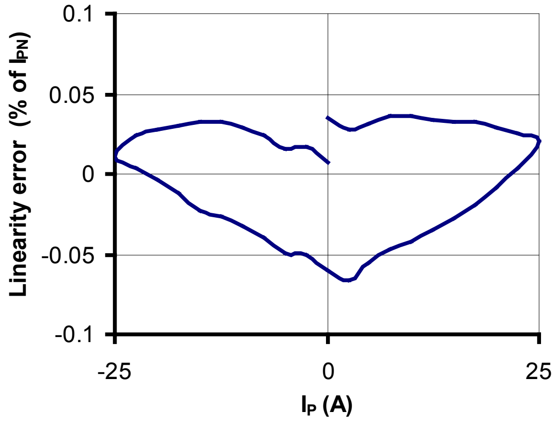


Figure 13: Linearity error

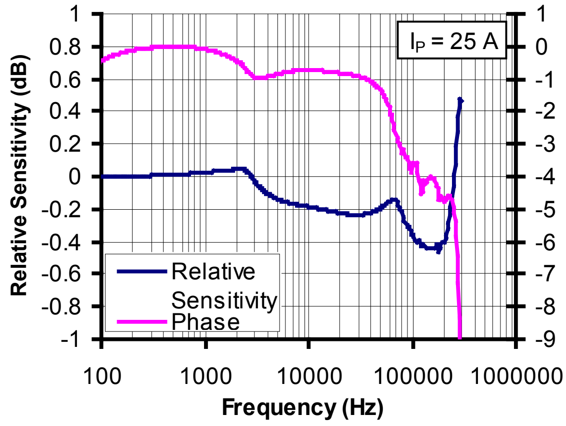


Figure 14: Frequency response

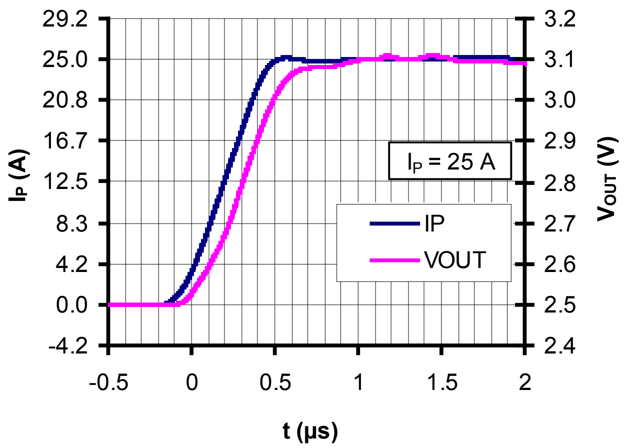


Figure 15: Step response

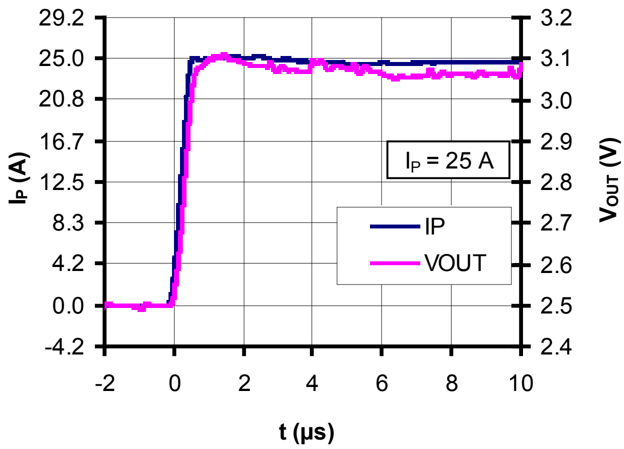


Figure 16: Step response

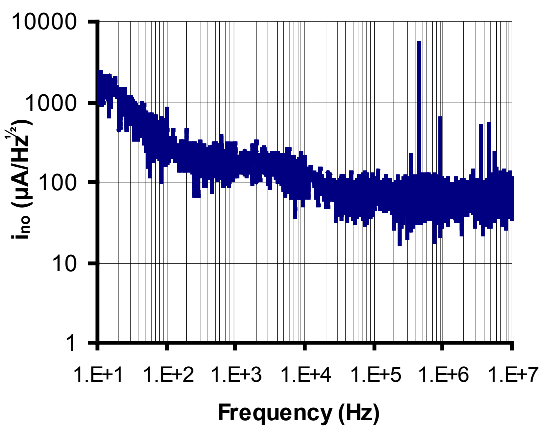


Figure 17: Input referred noise

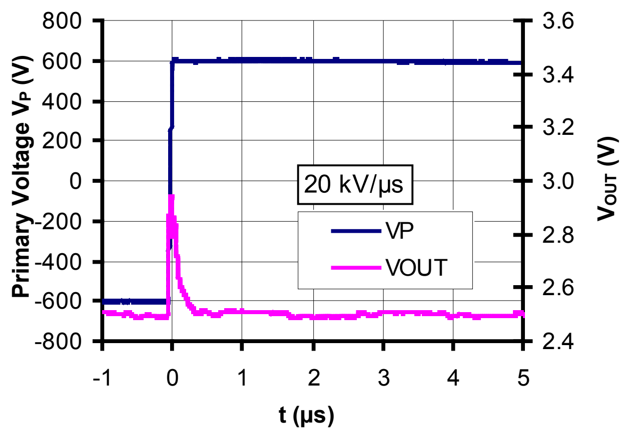


Figure 18: dv/dt

Typical performance characteristics CAS 50-NP

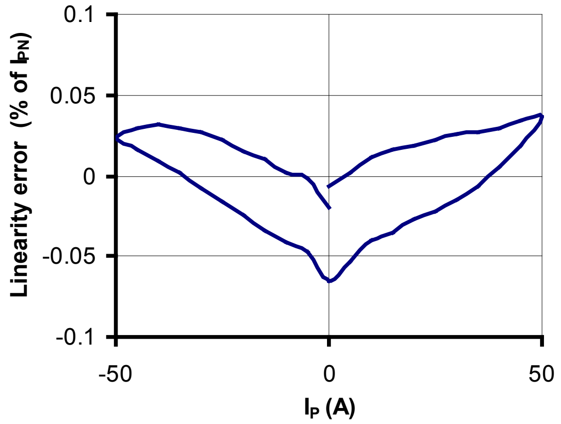


Figure 19: Linearity error

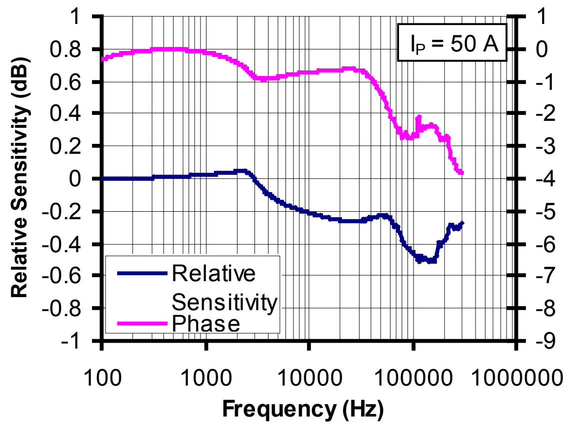


Figure 20: Frequency response

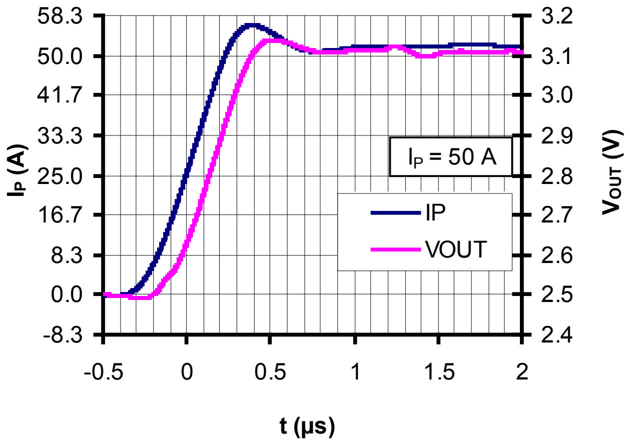


Figure 21: Step response

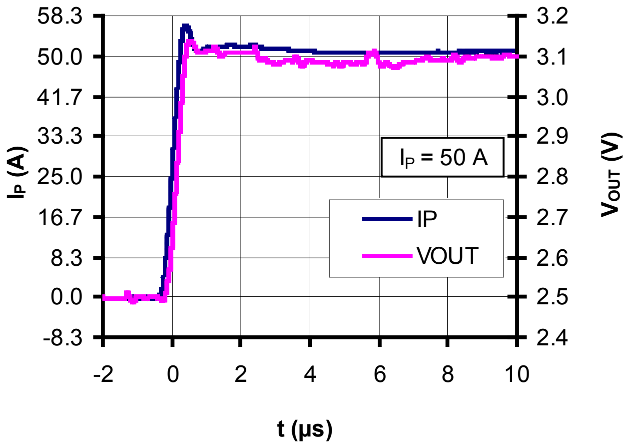


Figure 22: Step response

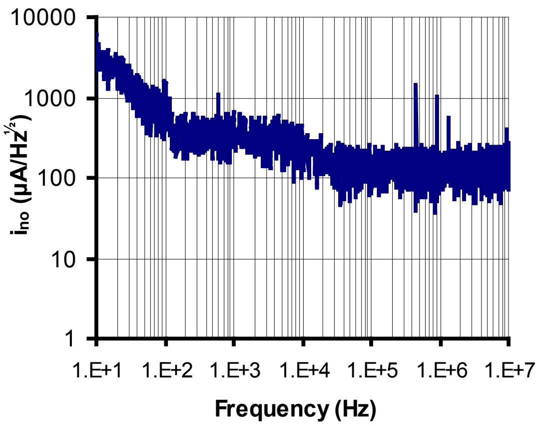


Figure 23: Input referred noise

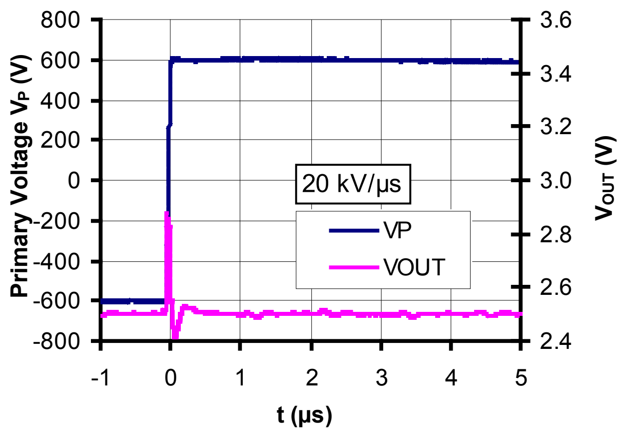


Figure 24: dv/dt

Maximum continuous DC primary current

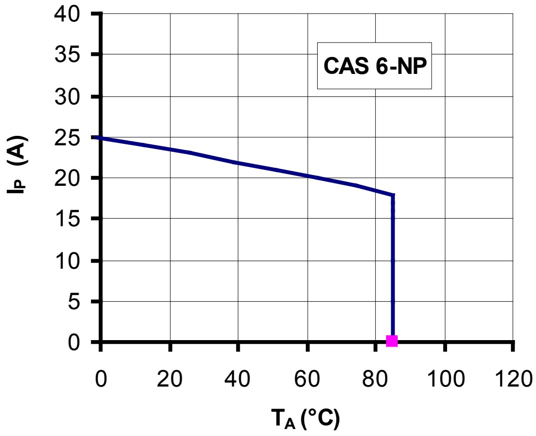


Figure 25: I_P vs T_A for CAS 6-NP

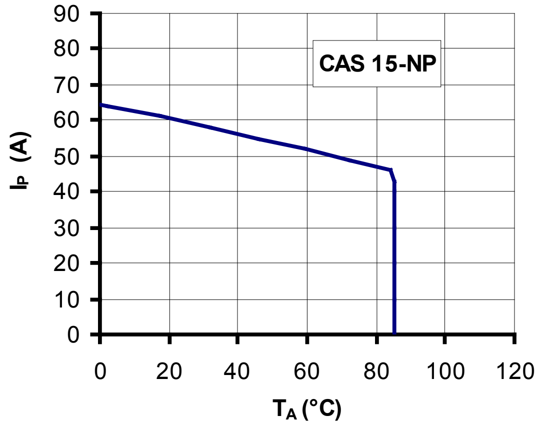


Figure 26: I_P vs T_A for CAS 15-NP

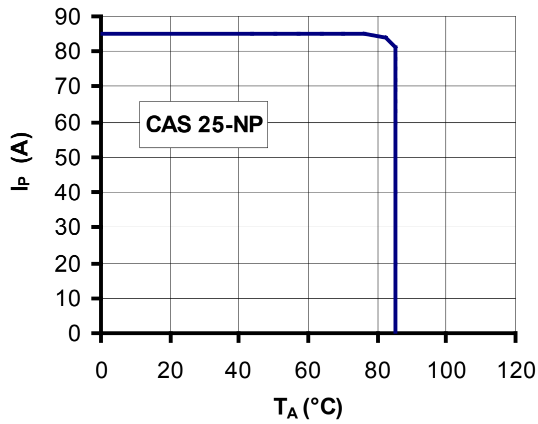


Figure 27: I_P vs T_A for CAS 25-NP

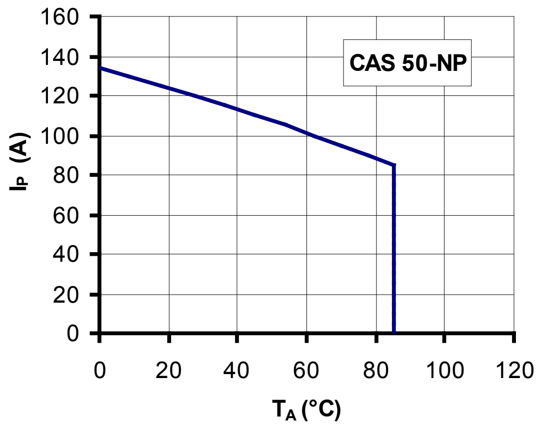


Figure 28: I_P vs T_A for CAS 50-NP

The maximum continuous DC primary current plot shows the boundary of the area for which all the following conditions are true:

- $I_P < I_{PM}$
- Junction temperature Tj < 125 °C
- Primary conductor temperature < 110 °C
- Resistor power dissipation < 0.5 x rated power

Frequency derating

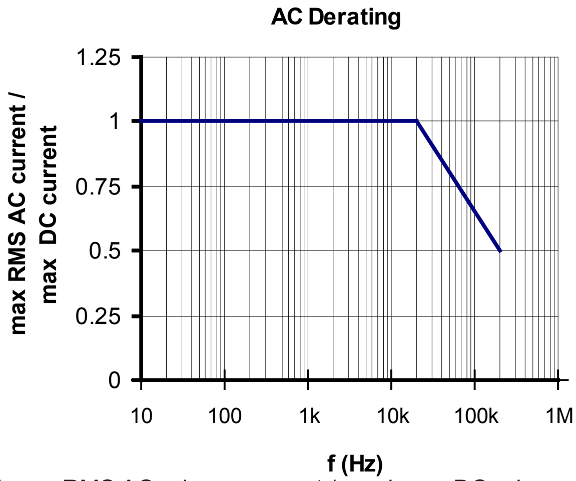


Figure 29: Maximum RMS AC primary current / maximum DC primary current vs frequency

Performance parameters definition

Ampere-turns and amperes

The transducer is sensitive to the primary current linkage Θ_P (also called ampere-turns).

$$\Theta_P = N_P I_P \text{(At)}$$

Where $N_P I_P$ the number of primary turn (1, 2 or 3 depending on the connection of the primary jumpers)

Caution: As most applications will use the transducer with only one single primary turn ($N_P = 1$), much of this datasheet is written in terms of primary current instead of current linkages. However, the ampere-turns (A-t) unit is used to emphasis that current linkages are intended and applicable.

Transducer simplified model

The static model of the transducer at temperature T_A is:
$V_{OUT} = G\ \Theta_P$ + error

In which error =

$$V_{OE} + V_{OT}(T_A) + \varepsilon_G \cdot \Theta_P \cdot G + \varepsilon_L(\Theta_{Pmax}) \cdot \Theta_{Pmax} \cdot G + TCG \cdot (T_A - 25) \cdot \Theta_P \cdot G$$

With:	$\Theta_P = N_P I_P$	:the input ampere-turns (At) Please read above warning.
	$\Theta_P$max	:the maxi input ampere-turns that have been applied to the transducer (At)
	V_{OUT}	:the secondary voltage (V)
	T_A	:the ambient temperature (°C)
	V_{OE}	:the electrical offset voltage (V)
	$V_{OT}(T_A)$	:the temperature variation of V_O at temperature T_A (V)
	G	:the sensitivity of the transducer (V/At)
	ε_G	:the sensitivity error
	$\varepsilon_L(\Theta_{Pmax})$	:the linearity error for Θ_{Pmax}

This model is valid for primary ampere-turns Θ_P between $-\Theta_{Pmax}$ and $+\Theta_{Pmax}$ only.

Sensitivity and linearity

To measure sensitivity and linearity, the primary current (DC) is cycled from 0 to I_P, then to $-I_P$ and back to 0 (equally spaced I_P/10 steps).
The sensitivity G is defined as the slope of the linear regression line for a cycle between ± I_{PN}.

The linearity error ε_L is the maximum positive or negative difference between the measured points and the linear regression line, expressed in % of I_{PN}.

Magnetic offset

The magnetic offset current I_{OM} is the consequence of a current on the primary side ("memory effect" of the transducer's ferro-magnetic parts). It is included in the linearity figure but can be measured individually.
It is measured using the following primary current cycle.
I_{OM} depends on the current value I_{P1}.

$$I_{OM} = \frac{V_{OUT}(t_1) - V_{OUT}(t_2)}{2} \cdot \frac{1}{Gth}$$

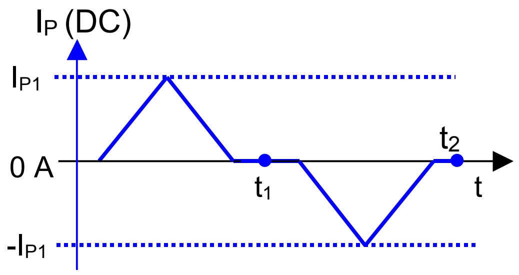


Figure 30: Current cycle used to measure magnetic and electrical offset (transducer supplied)

Performance parameters definition (continued)

Electrical offset

The electrical offset voltage $\mathbf{V}_{OE}$ can either be measured when the ferro-magnetic parts of the transducer are:

- completely demagnetized, which is difficult to realize,
- or in a known magnetization state, like in the current cycle shown in figure 30.

Using the current cycle shown in figure 30, the electrical offset is:

$$V_{OE} = \frac{V_{OUT}(t_1) + V_{OUT}(t_2)}{2}$$

The temperature variation $\mathbf{V}_{OT}$ of the electrical offset voltage $\mathbf{V}_{OE}$ is the variation of the electrical offset from 25°C to the considered temperature:

$$V_{OT}(T) = V_{OE}(T) - V_{OE}(25°C)$$

Note: the transducer has to be demagnetized prior to the application of the current cycle (for example with a demagnetization tunnel).

Response and reaction times

The response time tr and the reaction time tra are shown in figure 31.
Both depend on the primary current di/dt. They are measured at nominal ampere-turns.

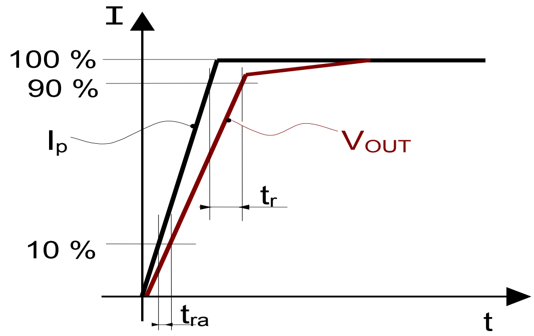


Figure 31: Response time t_r and reaction time t_{ra}

Overall accuracy

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

- the electrical offset $\mathbf{V}_{OE}$
- the sensitivity error ε_G
- the linearity error ε_L (to $\mathbf{I}_{PN}$)

The magnetic offset is part of the overall accuracy. It is taken into account in the linearity error figure provided the transducer has not been magnetized by a current higher than $\mathbf{I}_{PN}$.

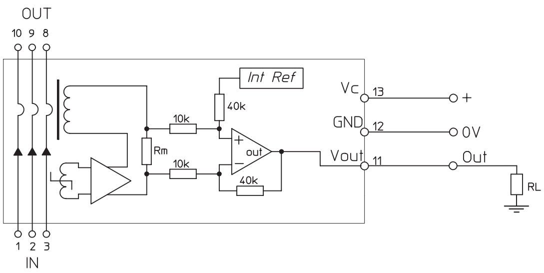


Figure 32: Test connection

Application information

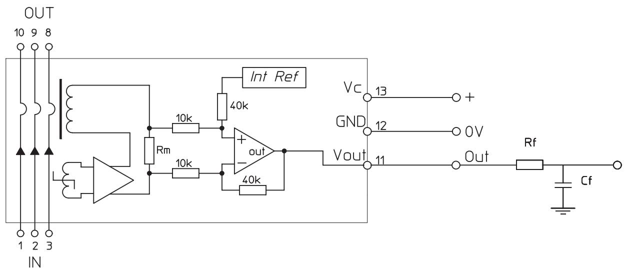
Filtering and decoupling

Supply voltage V_C

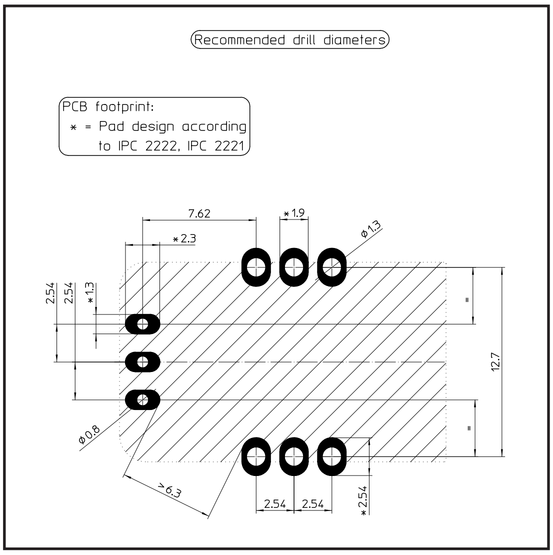
The fluxgate oscillator draws current pulses of up to 30 mA at a rate of ca. 900 kHz. Significant 900 kHz voltage ripple on $\mathbf{V}_C$ can indicate a power supply with high impedance. At these frequencies the power supply rejection ratio is low, and the ripple may appear on the transducer output $\mathbf{V}_{OUT}$ and reference $\mathbf{V}_{REF}$. The transducer has internal decoupling capacitors, but in the case of a power supply with high impedance, it is advised to provide local decoupling (100 nF or more, located close to the transducer).

Output V_{OUT}

The output $\mathbf{V}_{OUT}$ has a very low output impedance of typically 2 Ohms; it can drive 100 pF directly. Adding series Rf = 100 Ohms allows much larger capacitive loads. Empirical evaluation may be necessary to obtain optimum results. The minimum load resistance on $\mathbf{V}_{OUT}$ is 1 kOhm.



CAS Series, PCB footprint



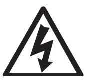
Assembly on PCB

- Recommended PCB hole diameter 1.3 mm for primary pin
  0.8 mm for secondary pin
- Maximum PCB thickness 2.4 mm
- Wave soldering profile maximum 260°C for 10 s
  No clean process only.

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 (eg. primary busbar, 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.

Dimensions CAS Series (in mm. General linear tolerance ± 0.25 mm)

	Clearance	Creepage
A-B	7.7 mm	7.7 mm

Connection