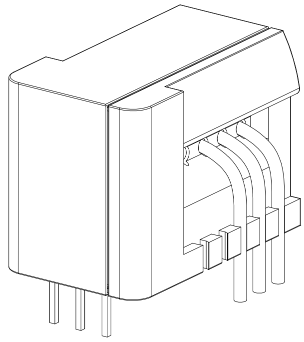
Current Transducer CAS 25-NP/SP2

I_{PN} = 25 A

For the electronic measurement of current: DC, AC, pulsed..., with galvanic separation between the primary and the secondary circuit.



Features

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

Special feature

- Configuration with 3 primary conductors positioned to meet higher insulation distance.

Advantages

- Very low temperature coefficient of offset
- Very good d*v*/d*t* 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: 1997
- UL 508: 2010
- IEC 61010-1: 2010
- IEC 62109-1: 2010.

Application Domain

- Industrial.

Absolute maximum ratings

Parameter	Symbol	Unit	Value
Supply voltage	U_C	V	7
Primary conductor temperature	T_B	°C	110
Maximum primary current	$I_{P\ max}$	A	$20 \times I_{PN}$
ESD rating, Human Body Model (HBM)	U_{ESD}	kV	4

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

UL 508:Ratings and assumptions of certification

File # E189713 Volume: 2 Section: 1

Standards

- CSA C22.2 NO. 14 - 10 INDUSTRIAL CONTROL EQUIPMENT - Edition 11 - Revision Date 2011/08/01
- UL 508 STANDARD FOR INDUSTRIAL CONTROL EQUIPMENT - Edition 17 - Revision Date 2010/04/15.

Parameter	Symbol	Unit	Value
Primary involved potential		V AC/DC	600
Max surrounding air temperature	T_A	°C	85
Primary current	I_P	A	0 to 25
Secondary supply voltage	U_C	V DC	7
Output voltage	V_{out}	V	0 to 5

Conditions of acceptability

When installed in the end-use equiment, consideration shall be given to the following:

1 - These devices must be mounted in a suitable end-use enclosure.

2 - The terminals have not been evaluated for field wiring.

3 - CAS series shall be used in a pollution degree 2 environment.

4 - Low voltage circuits are intended to be powered by a circuit derived from an isolating source (such as a transformer,optical isolator,limiting impedance or electro-mechanical relay) and having no direct connection back to the primary circuit (other than through the grounding means).

Marking

Only those products bearing the UL or UR Mark should be considered to be Listed or Recognized and covered under UL's Follow-Up Service.Always look for the Mark on the product.

Insulation coordination

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC insulation test 50/60 Hz/1 min	U_d	kV	4.2	
Impulse withstand voltage 1.2/50 µs	$\hat{U}_W$	kV	7.6	
Partial discharge extinction rms voltage @ 10 pC	U_e	V	1000	
Clearance (pri. - sec.)	d_{Cl}	mm	8.2	Shortest internal distance through air (Note [1])
Creepage distance (pri. - sec.)	d_{Cp}	mm	8.2	Shortest internal path along device body (Note [1])
Creepage distance (pri. .- sec.)	d_{Cp}	mm	11	Shortest external path along device body
Case material	-	-	V0 according to UL 94	
Comparative tracking index	*CTI*		600	
Application example	-	-	1000 V CAT II PD2	Reinforced insulation, non uniform field according to IEC 62109-1
Application example	-	-	600 V CAT III PD2	Basic insulation, non uniform field according to EN 50178, EN 61010

Note: [1] Inside device enclosure providing protection IP5x.

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		

Electrical data

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

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal rms current	I_{PN}	A		25		
Primary current, measuring range	I_{PM}	A	-85		85	
Number of primary turns	N_P	-		1,2,3		
Supply voltage	U_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	G_{th}	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 × I_{PN}) referred to primary	I_{OM}	A	-0.1		0.1	
Output noise current spectral density 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 to 10 % of I_{PN}	t_{ra}	μs			0.3	R_L = 1 kΩ di/dt = 68 A/μs
Step response time to 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	

Typical performance characteristics

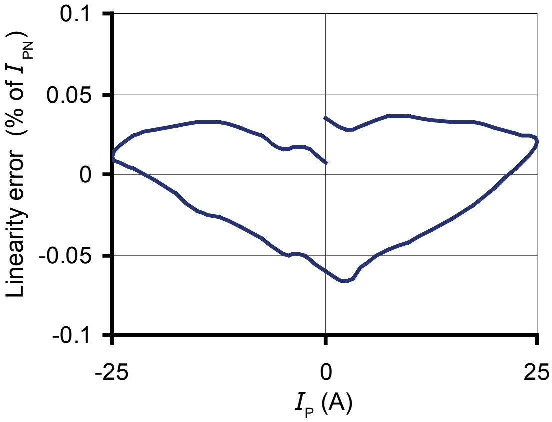


Figure 1: Linearity error

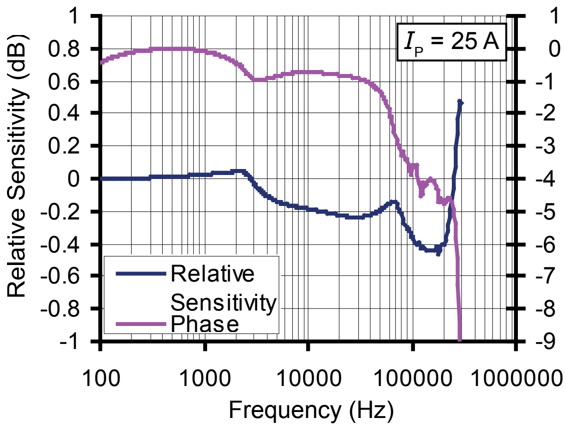


Figure 2: Frequency response

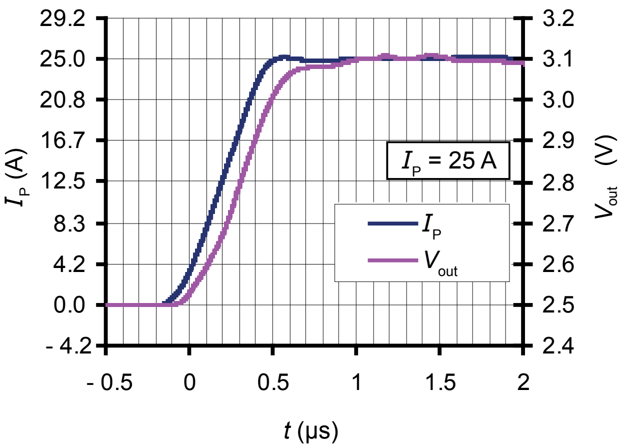


Figure 3: Step response

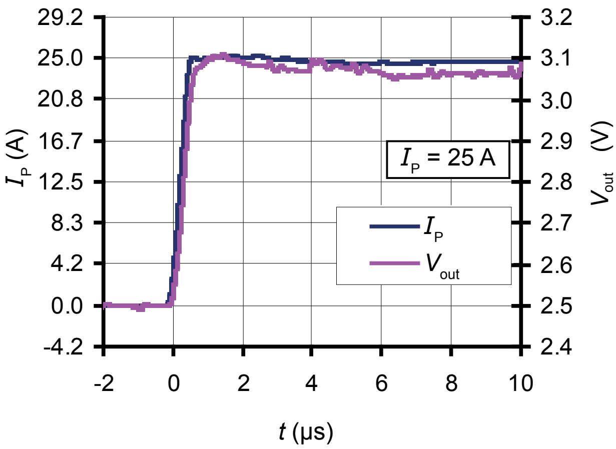


Figure 4: Step response

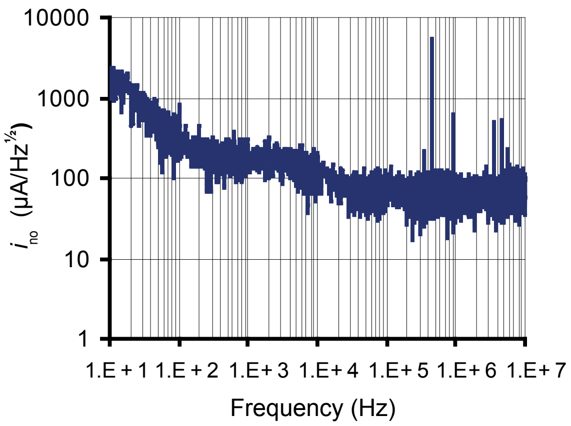


Figure 5: Input referred noise

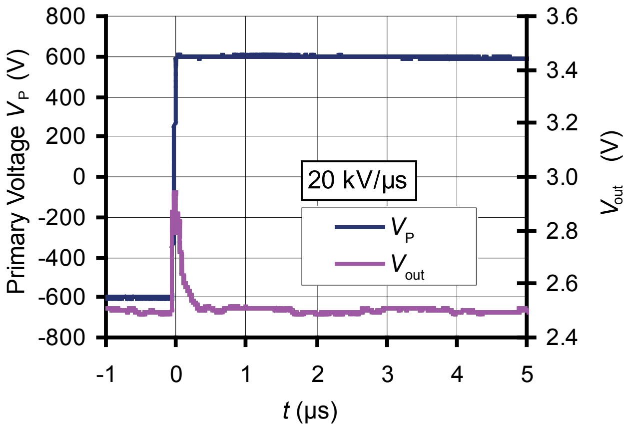


Figure 6: dv/dt

Maximum continuous DC primary current

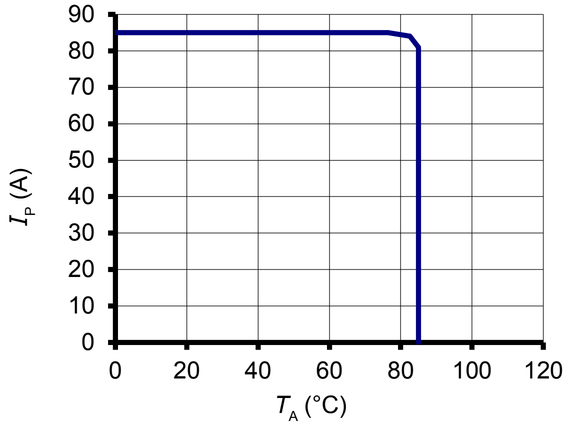


Figure 7: I_P vs T_A

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 T_j <125 °C
- Primary conductor temperature <110 °C
- Resistor power dissipation < 0.5 × rated power

Frequency derating

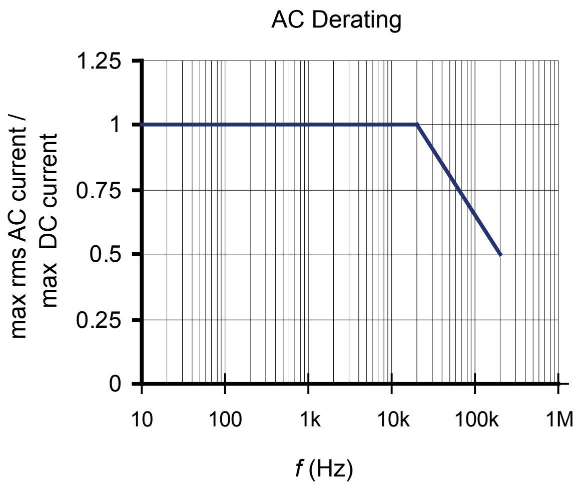


Figure 8: Maximum RMS AC primary current / maximum DC primary current vs frequency

Performance parameters definition

Ampere-turns and amperes

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

$\Theta_P = N_P \cdot I_P$ (At)

Where N_P is the number of primary turn (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 data-sheet 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:
$V_{out} = G \cdot \Theta_P$ + 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:

$\Theta_P = N_P \cdot I_P$	: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 $\pm I_{PN}$.

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}.

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

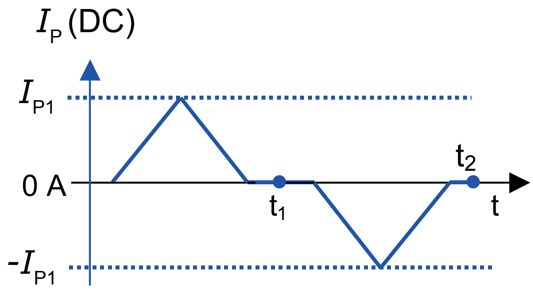


Figure 9: Current cycle used to measure magnetic and electrical offset (transducer supplied)

Performance parameters definition (continued)

Electrical offset

The electrical offset voltage 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 9.

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 V_{OT} of the electrical offset voltage 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).

Overall accuracy

The overall accuracy at 25 °C X_G is the error in the $-I_{PN}$ .. $+I_{PN}$ range, relative to the rated value I_{PN}.
It includes:

- the electrical offset V_{OE}
- the sensitivity error ε_G
- the linearity error ε_L (to 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 I_{PN}.

Response and reaction times

The response time t_r and the reaction time t_{ra} are shown in figure 10.
Both depend on the primary current di/dt. They are measured at nominal ampere-turns.

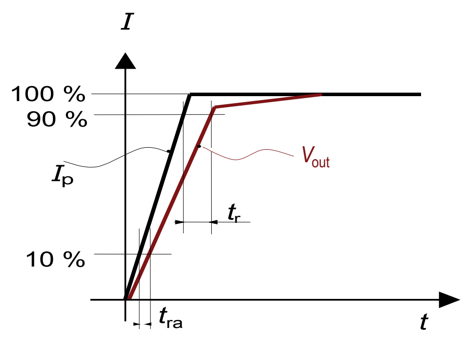


Figure 10: Response time t_r and reaction time t_{ra}

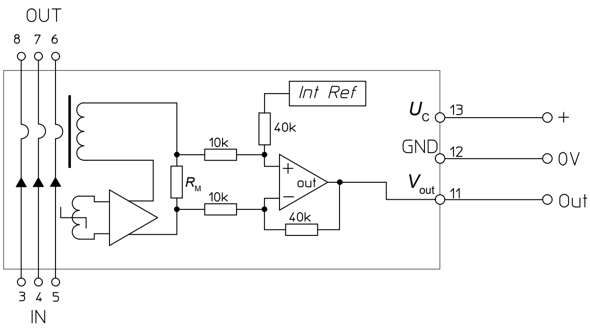


Figure 11: Test connection

Application information

Filtering and decoupling

Supply voltage U_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 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 V_{out} and reference 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).

Total Primary Resistance

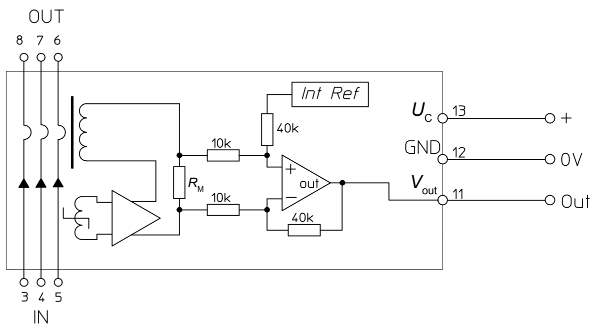
The primary resistance is 0.72 mΩ per conductor

In the following table, examples of primary resistance according to the number of primary turns.

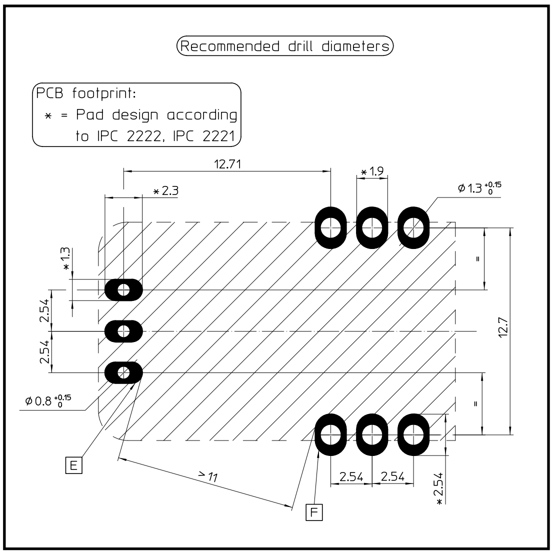
Number of primary turns	Primary resistance R_P [mW]	Recommended connections
1	0.24	8 7 6 OUT IN 3 4 5
2	1.08	8 7 6 OUT IN 3 4 5
3	2.16	8 7 6 OUT IN 3 4 5

Output V_{out}

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



CAS 25-NP/SP2, PCB footprint



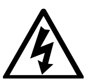
Assembly on PCB

- 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 25-NP/SP2 (in mm. General linear tolerance ±0.25 mm)

	d_{Cl}	d_{Cp}
A-B	12.4 mm	12.4 mm
C-D	8.2 mm	8.2 mm
E-F	11 mm	11 mm

Connection