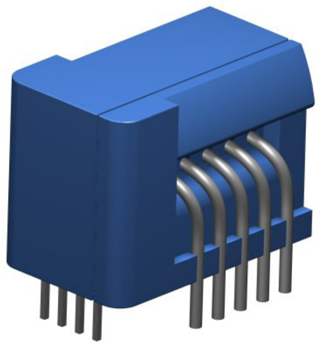
Current Transducer CKSR 75-NP

I_{PN} = 75 A

Ref: CKSR 75-NP

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
- Compact design for PCB mounting.

Special feature

- Dedicated 5 primary conductors configuration.

Advantages

- Very low temperature coefficient of offset
- Very good dv/dt immunity
- Reduced height
- Reference pin with two modes: Ref IN and Ref OUT
- Extended measuring range for unipolar measurement.

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
- Solar inverters.

Standards

- IEC 60950-1: 2006
- IEC 61010-1: 2010
- IEC 61326-1: 2012
- UL 508: 2010.

Application Domain

- Industrial.

Absolute maximum ratings

Parameter	Symbol	Unit	Value
Maximum supply voltage	$U_{C\ max}$	V	7
Maximum primary conductor temperature	$T_{B\ max}$	°C	110
Maximum primary current	$I_{P\ max}$	A	20 × $I_{P\ N}$
Maximum ESD rating, Human Body Model (HBM)	$U_{ESD\ max}$	kV	4

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	4.1	
Impulse withstand voltage 1.2/50 µs	$\hat{U}_W$	kV	7.5	
Partial discharge extinction RMS voltage @ 10 pC	U_e	V	1000	
Clearance (pri. - sec.)	d_{Cl}	mm	7.5	Shortest internal distance through air [1)]
Creepage distance (pri. - sec.)	d_{Cp}	mm	7.5	Shortest internal path along device body [1)]
Clearance (pri. - sec.)	d_{Cl}	mm	6.1	When mounted on PCB with recommended layout
Creepage distance (pri. - sec.)	d_{Cp}	mm	6.1	When mounted on PCB with recommended layout
Case material	-	-	V0 according to UL 94	
Comparative tracking index	CTI		600	
Application example	-	-	300 V CAT III PD2	Reinforced insulation, non uniform field according to IEC 61010-1
Application example	-	-	600 V CAT III PD2	Basic insulation, non uniform field according to IEC 61010-1

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		105	[1)]
Ambient storage temperature	T_S	°C	−55		105	
Mass	m	g		9		

Note: [1)] The working conditions have direct impact on the temperature of primary conductor. At any cases, the temperature of conductor must below 110 °C according to absolute maximum ratings in page 2.

Electrical data CKSR 75-NP

At T_A = 25 °C, U_C = +5 V, N_P = 1 turn, R_L = 10 kΩ internal reference unless otherwise noted (see definition of typ, Min, Max. paragraph in page 5).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal rms current	I_{PN}	A		75		Apply derating according to fig. 13
Primary current, measuring range	I_{PM}	A	−180		180	At 25 °C
Number of primary turns	N_P			1,2,3,4,5		
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 = 966 turns
Reference voltage @ I_P = 0 A	V_{ref}	V	2.495	2.5	2.505	Internal reference
External reference voltage	V_{ref}	V	0		4	
Output voltage	V_{out}	V	V_{ref}−1.125		V_{ref}+1.125	@ I_{PM}
Output voltage @ I_P = 0 A	V_{out}	V		V_{ref}		
Electrical offset voltage	V_{OE}	mV	−0.725		0.725	100 % tested $V_{out} - V_{ref}$
Electrical offset current referred to primary	I_{OE}	mA	−116		116	100 % tested
Temperature coefficient of V_{ref}	TCV_{ref}	ppm/K		±5	±50	Internal reference
Temperature coefficient of V_{out} @ I_P = 0 A	TCV_{out}	ppm/K			±4	ppm/K of 2.5 V −40 °C … 105 °C (at ±6 Sigma)
Theoretical sensitivity	G_{th}	mV/A		6.25		468.5 mV/I_{PN}
Sensitivity error	ε_G	%	−1		1	100 % tested
Temperature coefficient of G	TCG	ppm/K	−40		40	−40 °C … 105 °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 rms current noise (spectral density) 100 Hz … 100 kHz referred to primary	I_{no}	µA/Hz½		20		R_L = 1 kΩ
Peak-peak output ripple at oscillator frequency f = 450 kHz (typ.)	-	mV			10	R_L = 1 kΩ
Reaction time @ 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}			1.2	
Overall accuracy @ T_A = 105 °C	X_G	% of I_{PN}			1.6	
Accuracy	X	% of I_{PN}			1	

Performance parameters definition

Ampere-turns and amperes

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

$\Theta_P = N_P I_P$ (At)

Where N_P 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 datasheet is written in terms of primary current instead of current linkages. However, the ampere-turns (At) 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:

$V_{out} = G\,\Theta_P + \varepsilon$

In which ε =

$V_{O\,E} + V_{O\,T}(T_A) + \varepsilon_G \cdot \Theta_P \cdot G + \varepsilon_L(\Theta_{P\,max}) \cdot \Theta_{P\,max} \cdot G + TCG \cdot (T_A - 25) \cdot \Theta_P \cdot G$

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)
$V_{O\,E}$	:the electrical offset voltage (V)
$V_{O\,T}(T_A)$	:the temperature variation of V_O at temperature T_A (V)
G	:the sensitivity of the transducer (V/At)
ε_G	:the sensitivity error
$\varepsilon_L(\Theta_{P\,max})$	:the linearity error for $\Theta_{P\,max}$

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

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, minimum and maximum values are determined during the initial characterization of the product.

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

Magnetic offset

The magnetic offset current $I_{O\,M}$ 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.
$I_{O\,M}$ depends on the current value I_{P1} ($I_{P1} > I_{P\,N}$).

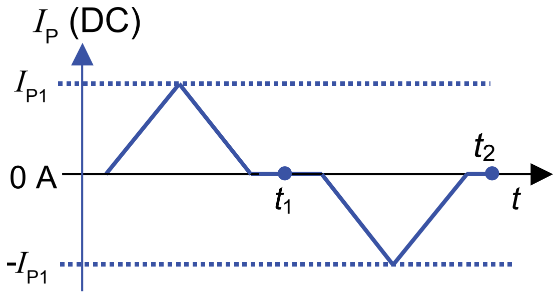


Figure 1: Current cycle used to measure magnetic and electrical offset (transducer supplied)

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 1.

Using the current cycle shown in figure 1, 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_{OT} is the variation of the electrical offset from 25 °C to the considered temperature:

Note: the transducer has to be demagnetized prior to the ap-

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

plication of the current cycle (for example with a demagnetization tunnel).

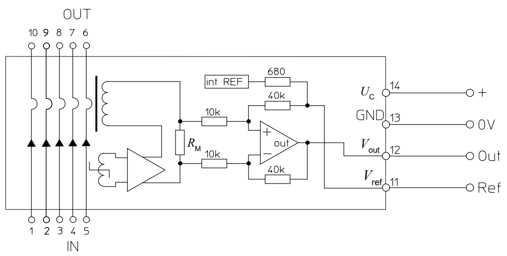


Figure 2: Test connection

Overall accuracy

The overall accuracy at 25 °C X_G is the error in the $-I_{PN} \ldots +I_{PN}$ 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 3.

Both depend on the primary current di/dt. They are measured at nominal ampere-turns.

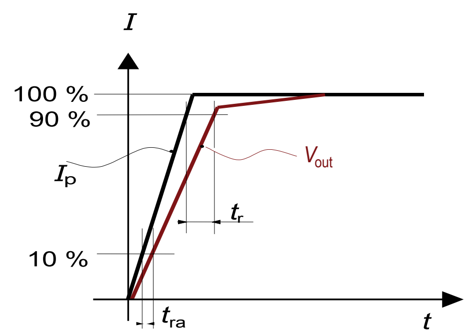


Figure 3: Response time t_r and reaction time t_{ra}

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 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).

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 Rf = 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.

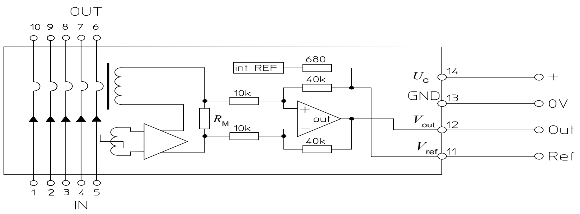
Total Primary Resistance

The primary resistance is 0.72 mΩ per conductor.

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

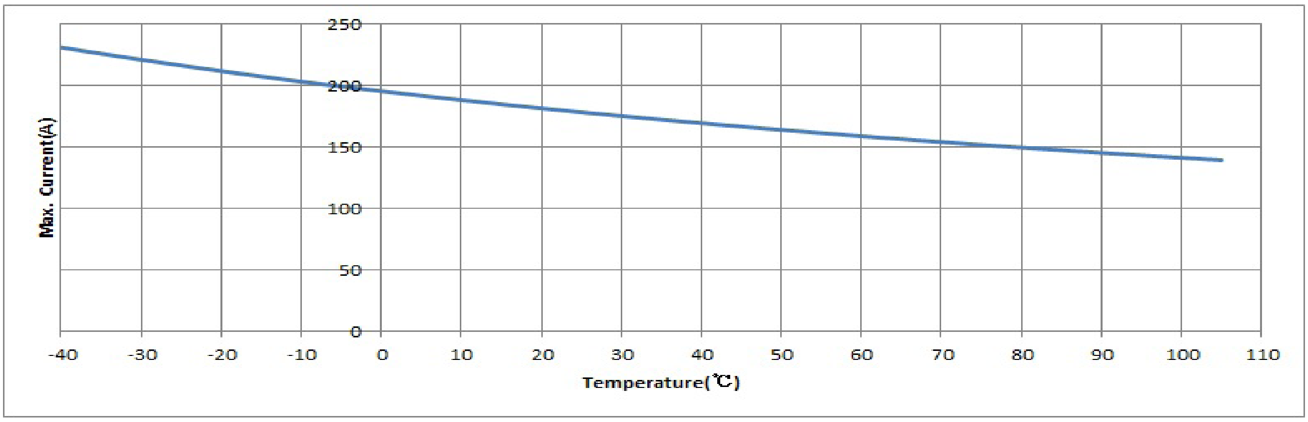
Reference V_{ref}

Ripple present on the reference output can be filtered with a low value of capacitance because of the internal 680 Ohm series resistance. The maximum filter capacitance value is 1 µF.



Measurement range

The winding resistance have direct impact on the measurement range. The measurement range vs. temperature as follows:



External reference voltage

If the Ref pin of the transducer is not used it could be either left unconnected or filtered according to the previous paragraph "Reference V_{ref}".

The Ref pin has two modes Ref IN and Ref OUT:

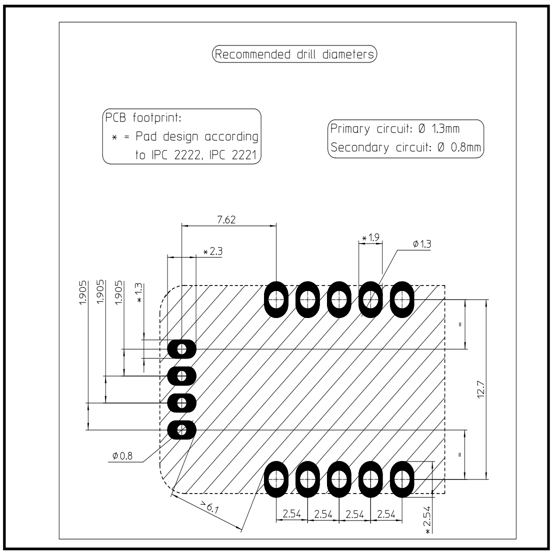
- In the Ref OUT mode the 2.5 V internal precision reference is used by the transducer as the reference point for bipolar measurements; this internal reference is connected to the Ref pin of the transducer through a 680 Ohms resistor. it tolerates sink or source currents up to ±5 mA, but the 680 Ohms resistor prevents this current to exceed these limits.
- In the Ref IN mode, an external reference voltage is connected to the Ref pin; this voltage is specified in the range 0 to 4 V and is directly used by the transducer as the reference point for measurements.
  The external reference voltage V_{ref} must be able:

- either to source a typical current of $\frac{Vref - 2.5}{680}$, the maximum value will be 2.2 mA typ. when V_{ref} = 4 V.

- or to sink a typical current of $\frac{2.5 - Vref}{680}$, the maximum value will be 3.68 mA typ. when V_{ref} = 0 V.

The following graphs show how the measuring range of each transducer version depends on the external reference voltage value V_{ref}.

PCB footprint



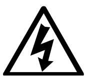
Assembly on PCB

● 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 (in mm, general linear tolerance ±0.25 mm)

Connection