Current Transducer IT 700-S ULTRASTAB

I_{PM} = 700 A

For ultra-high precision measurement of current: DC, AC, pulsed..., with galvanic separation between primary and secondary.

Features

- Closed loop (compensated) current transducer using an extremely accurate zero flux detector
- Electrostatic shield between primary and secondary circuit
- 9-pin D-Sub male secondary connector
- Status signal to indicate the transducer state
- LED indicator confirms normal operation.

Advantages

- Very high accuracy
- Excellent linearity
- Extremely low temperature drift
- Wide frequency bandwidth
- High immunity to external fields
- No insertion losses
- Low noise on output signal
- Low noise feedback to primary conductor.

Applications

- Feed back element in high performance gradient amplifiers for MRI
- Feedback element in high-precision, high-stability power supplies
- Calibration unit
- Energy measurement
- Medical equipment.

Standards

- EN 61000-6-2: 2005
- EN 61000-6-3: 2007
- EN 61010-1: 2010.

Application Domains

- Industrial
- Laboratory
- Medical.

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Insulation coordination

Parameter	Symbol	Unit	Value	Comment
Rated insulation RMS voltage, basic insulation	U_{Nm}	V	1000	IEC 61010-1 conditions - over voltage cat III - pollution degree 2
Rated insulation RMS voltage, reinforced insulation	U_{Nm}	V	300	IEC 61010-1 conditions - over voltage cat III - pollution degree 2
Rated insulation RMS voltage, basic insulation	U_{Nm}	V	1000	EN 50178 conditions - over voltage cat III - pollution degree 2
Rated insulation RMS voltage, reinforced insulation	U_{Nm}	V	600	EN 50178 conditions - over voltage cat III - pollution degree 2
RMS voltage for AC insulation test, 50/60 Hz, 1 min	U_d	kV	4.6	Between primary and secondary + shield
		V DC	200	Between secondary and shield
		V DC	500	Between secondary and status output
Impulse withstand voltage 1.2/50 µs	U_{Ni}	kV	8.5	
Clearance (pri. - sec.)	d_{Cl}	mm	9	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm	9	Shortest path along device body
Comparative tracking index	CTI	V	600	

If insulated cable is used for the primary circuit, the voltage category could be improved with the following table (for single insulation) (IEC 61010-1 standard):

Cable insulated (primary)	Category
HAR03	1750 V CAT III
HAR05	1850 V CAT III
HAR07	1950 V CAT III

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	10		50	
Ambient storage temperature	$T_{A\,st}$	°C	−20		85	
Relative humidity	RH	%	20		80	Non-condensing
Dimensions						See drawing page 8
Mass	m	kg		0.8		

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Electrical data

At T_A = 25 °C, ± U_C = ± 15 V, unless otherwise noted (see Definition of typical, minimum and maximum values paragraph in page 4).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary continuous direct current	$I_{P N DC}$	A	−700		700	
Primary nominal RMS current	$I_{P N}$	A			495	
Primary current, measuring range	$I_{P M}$	A	−700		700	
Measuring resistance Over operating current, temperature and supply voltage range	R_M	Ω	0		2.5	See graph page 5
Secondary current	I_S	A	−0.4		0.4	
Turns ratio	N_P/N_S			1:1750		
Resistance of secondary winding	R_S	Ω		20		
Primary withstand peak current (maximum) [1]	$\hat{I}_{P max}$	kA	−3.5		3.5	@ pulse of 100 ms
Supply voltage	U_C	V	±14.25	±15	±15.75	
Current consumption	I_C	mA			80	Add I_S for total current consumption
RMS noise voltage 0 ... 10 Hz [2]	U_{no}	ppm			0.05	
RMS noise voltage 0 ... 100 Hz [2]					0.5	
RMS noise voltage 0 ... 1 kHz [2]					1	
RMS noise voltage 0 ... 10 kHz [2]					3	
RMS noise voltage 0 ... 50 kHz [2]					6	
Re-injected RMS noise on primary bus bar		µV			5	0 ... 50 kHz
Electrical offset current + self magnetization + effect of earth magnetic field [2]	$I_{O E}$	ppm	−50		50	
Temperature coefficient of $I_{O E}$ [2]	$TCI_{O E}$	ppm/K	−0.5		0.5	10 °C ... 50 °C
Offset stability [2]		ppm/month	−0.5		0.5	
Linearity error [2]	ε_L	ppm	−3		3	
Delay time to 90 % of the final output value for $I_{P N DC}$ step	$t_{D 90}$	µs			1	di/dt of 100 A/µs
Frequency bandwidth (±1 dB)	BW	kHz	0	50		Small-signal bandwidth, 0.5 % of $I_{P M}$
Frequency bandwidth (±3 dB)	BW	kHz	0	100		Small-signal bandwidth, 0.5 % of $I_{P M}$

Notes:
[1] Single pulse only, not AC. The transducer may require a few seconds to return to normal operation when autoreset system is running.
[2] All ppm figures refer to full-scale which corresponds to a secondary current (I_S) of 0.4 A.

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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 the product.

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.

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Overload protection - Electrical specification - Status

The overload occurs when the primary current I_P exceeds a trip level such that the fluxgate detector becomes completely saturated and, consequently, the transducer will switch from normal operation to overload mode.
This trip level is guaranteed to be greater than 110 % of $I_{P N DC}$ and its actual value depends on operating conditions such as temperature and measuring resistance.
When this happens, the transducer will automatically begin to sweep in order to lock on the primary current again and the measuring can resume when the primary current returns in the nominal range between $-I_{P N DC}$ and $+I_{P N DC}$.
In overload mode, the secondary current generated is a low frequency triangle waveform between −0.4 A and 0.4 A.

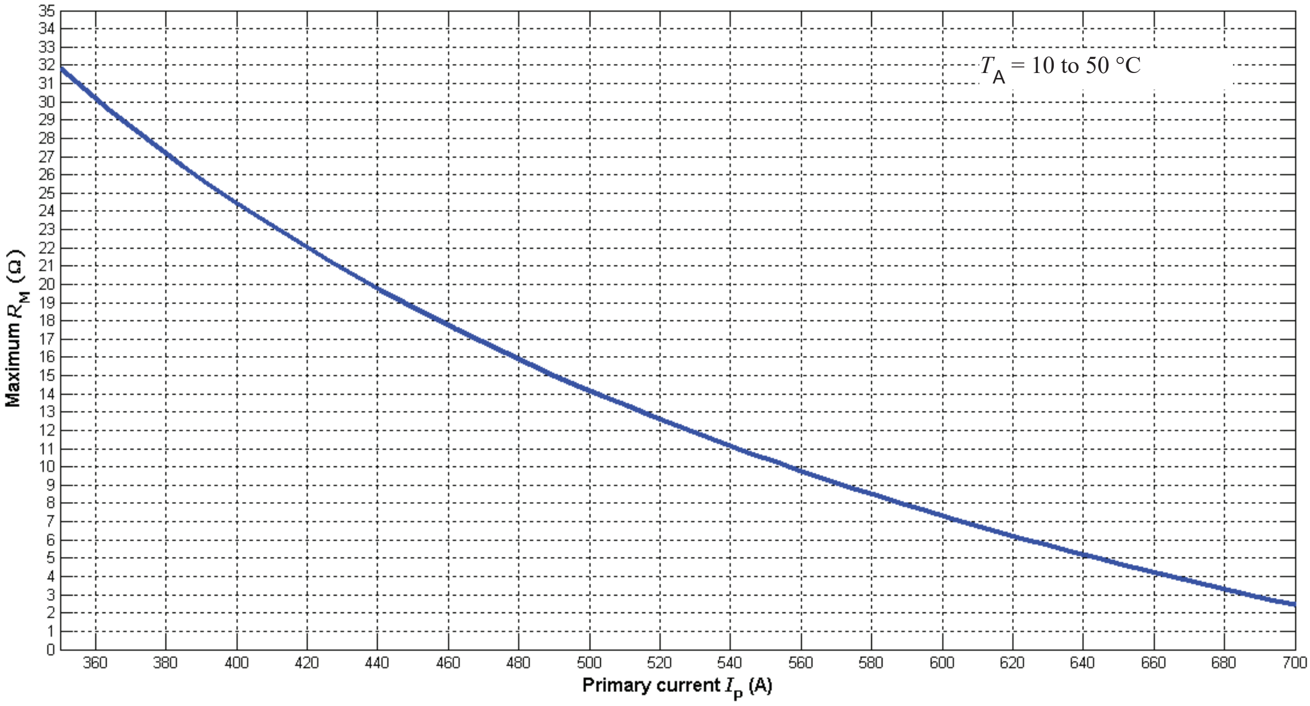
Under these conditions:

- The contact (normal operation status) between pin 3 and 8 (of the D-sub connector) switches off, this contact becomes open.
- The green LED indicator (normal operation status) turns off.

Max voltage pin 3 and pin 8, off-State	100 V
Max current pin 3 and pin 8, on-State	1000 mA
On-State resistance pin 3 and pin 8:	50 mΩ (typ)

TO ENSURE A SAFE RECOVERY FROM SATURATION, THE MAXIMUM BURDEN RESISTOR ALLOWED IS 2.5 Ω.

Maximum measuring resistor versus primary current



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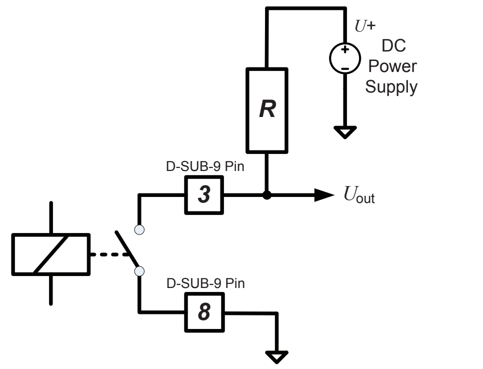
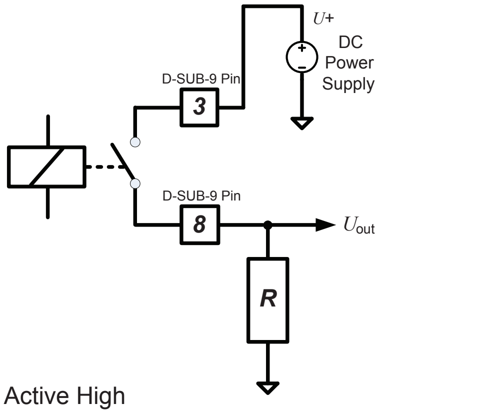
Status/Interlock port wiring

Example of application
Status/Interlock port wiring



U_{out} is Active Low
→ U_{out} switches to GND when the transducer is OK (Normal operation).
→ U_{out} switches to U+ when the transducer is not OK (Overload mode or supply fault).

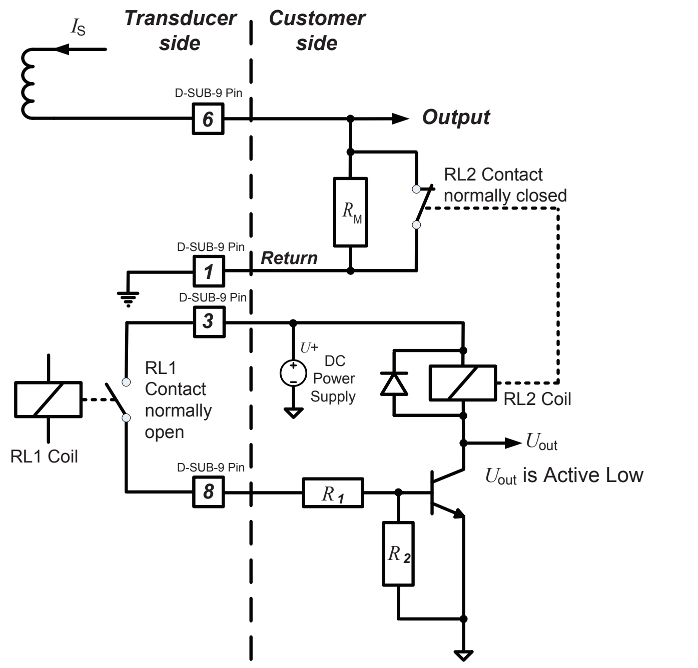


U_{out} is Active High
→ U_{out} switches to U+ when the transducer is OK (Normal operation).
→ U_{out} switches to GND when the transducer is not OK (Overload mode or supply fault).

Circuit diagram for using R_M > 2.5 Ω

This circuit ensures a safe recovery from saturation when using R_M > 2.5 Ω. It allows the transducer to recover normal operation in case R_M is greater than 2.5 Ω and an overload is detected by the transducer.

Example of application
Circuit diagram for using R_M> 2.5 Ω



Contact RL1 (Pins 3 and 8)	Contact RL2	U_{out}	Description
Closed	Open	Low (switches to GND)	The transducer is OK (Normal operation)
Open	Closed	High (switches to U+)	The transducer is not OK (Overload mode or supply fault)

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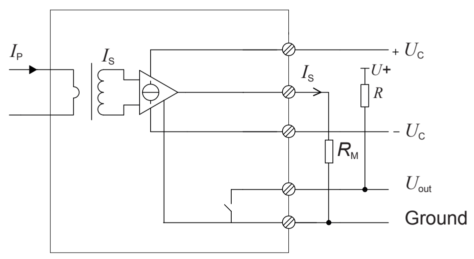
Performance parameters definition

The schematic used to measure all electrical parameters is shown below:



Transducer simplified model

The static model of the transducer at temperature T_A is:

$$I_S = N_P/N_S \cdot I_P + \text{error}$$

In which

$$\text{error} = I_{OE} \text{ at } 25\ °C + I_{OT}\,(T_A) + \varepsilon_L \cdot I_{PM} \cdot N_P/N_S$$

Where,

$$I_{OT}\,(T_A) = TCI_{OE} \cdot |T_A - 25\ °C| \cdot I_{PM} \cdot N_P/N_S$$

- I_S : secondary current (A)
- N_P/N_S : turn ratio
- I_P : primary current (A)
- I_{PM} : primary current, measuring range (A)
- T_A : ambient operating temperature (°C)
- I_{OE} : electrical offset current (A)
- I_{OT} : temperature variation of I_{OE} at T_A (A)
- ε_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:

$$\varepsilon = \sqrt{\sum_{i=1}^{N} \varepsilon_i^2}$$

Linearity

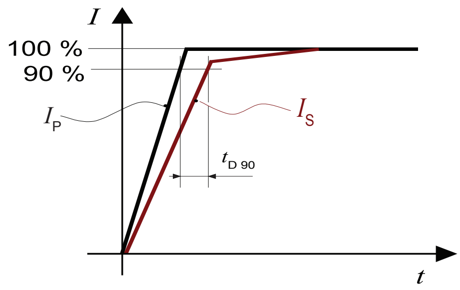
To measure linearity, the primary current (DC) is cycled from 0 to I_{PM}, then to $-I_{PM}$ and back to 0 (equally spaced I_{PM}/10 steps). The linearity error ε_L is the maximum positive or negative difference between the measured points and the linear regression line, expressed in parts per million (ppm) of full-scale which corresponds to the maximum measured value.

Electrical offset

The electrical offset current I_{OE} is the residual output current when the input current is zero.
The temperature variation I_{OT} of the electrical offset current I_{OE} is the variation of the electrical offset from 25 °C to the considered temperature.

Delay time

The delay time $t_{D\,90}$ is shown in the next figure.
It depends on the primary current di/dt and it's measured at nominal current.



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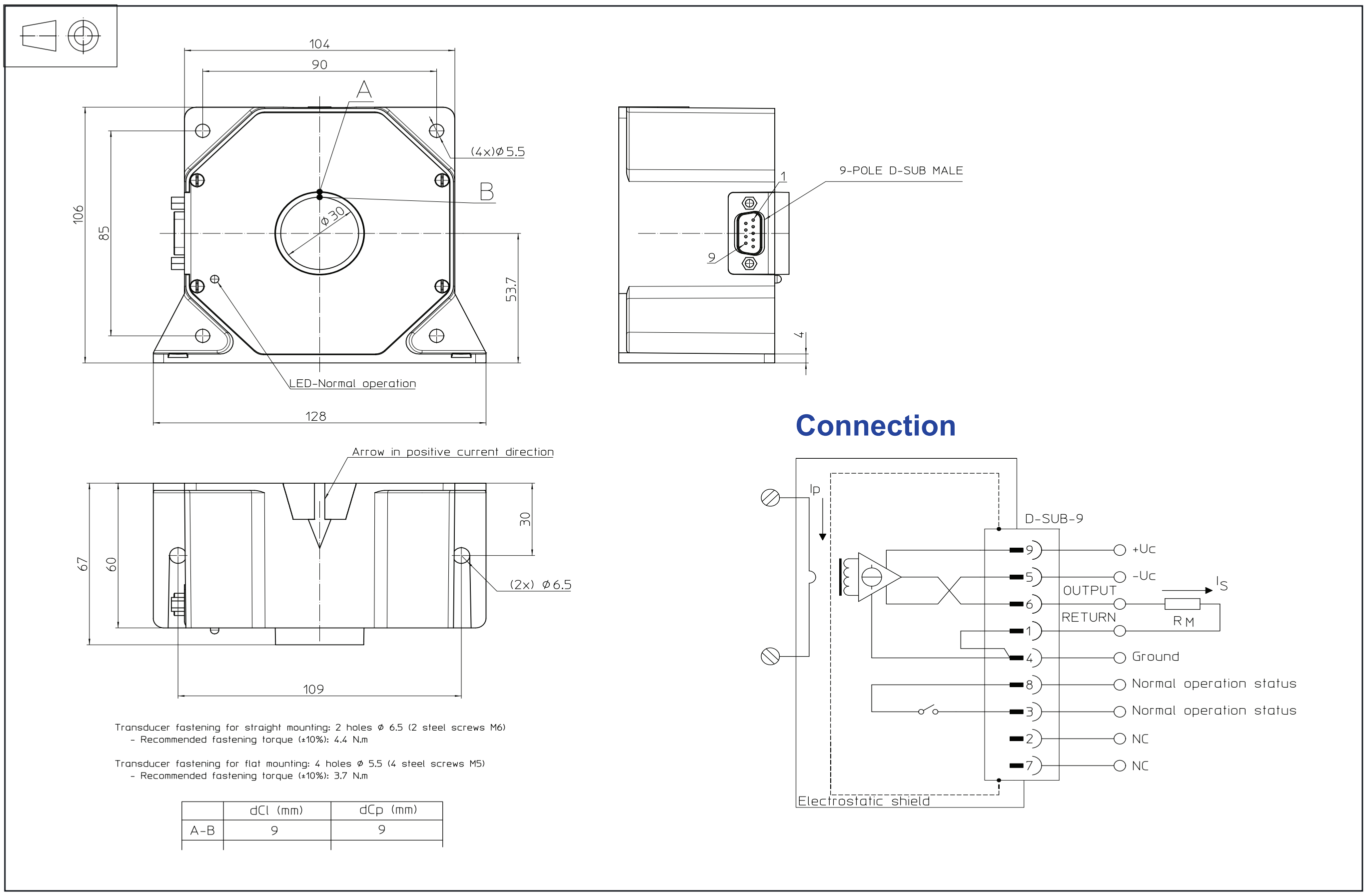
Dimensions (in mm)



Connection

- Normal operation status (Pins 3 and 8)
  Normal operation means: - ±15 V (± U_C) present
  - zero detector is working
  - compensation current ≤ 110 % of $I_{P\,N\,DC}$
  - green LED indicator is lit.

Contact (Pins 3 and 8)	Description
Closed	The transducer is OK (Normal operation)
Open	The transducer is not OK (Overload mode or supply fault)

Remarks

- I_S is positive when I_P flows in the direction of the arrow.
- We recommend that a shielded output cable and plug are used to ensure the maximum immunity against electrostatic fields.
- Pin 4 should be connected to cable and connector shield to maintain lowest output noise.
- Temperature of the primary conductor should not exceed 50 °C.

Mechanical characteristics

- General tolerance ±0.5 mm
- Transducer fastening
  - Straight mounting: 2 holes Ø 6.5 mm, 2 x M6 steel screws
  - Recommended fastening torque 4.4 N·m
  - Flat mounting: 4 holes Ø 5.5 mm, 4 x M5 steel screws
  - Recommended fastening torque 3.7 N·m
- Connection of secondary connector: on D-SUB-9, UNC 4-40
- All mounting recommendations are given for a standard mounting. Screws with flat and spring washers.
- Primary through hole Ø ≤ 30 mm
- 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: https://www.lem.com/en/file/3137/download/.

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