

# AUTOMOTIVE CURRENT TRANSDUCER

## DHAB S/24



### Introduction

The DHAB family is best suited for DC, AC, or pulsed currents measurement in high power and low voltage automotive applications. It contains galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The DHAB family gives you a choice of having different current measuring ranges in the same housing (from  $\pm 20$  up to  $\pm 600$  A).

### Features

- Open Loop transducer using the Hall effect sensor
- Low voltage application
- Unipolar + 5 V DC power supply
- Primary current measuring range up to  $\pm 75$  A for range 1 and  $\pm 500$  A for range 2
- Maximum rms primary admissible limited by the busbar, the magnetic core or the ASIC temperature  $T^\circ < + 150^\circ\text{C}$
- Operating temperature range:  $- 40^\circ\text{C} < T^\circ < + 125^\circ\text{C}$
- Output voltage: fully ratiometric (in sensitivity and offset) 2 measuring ranges to have a better accuracy.

### Advantages

- Good accuracy for high and low current range
- Good linearity
- Low thermal offset drift
- Low thermal sensitivity drift
- Hermetic package.

### Automotive applications

- Battery Pack Monitoring
- Hybrid Vehicles
- EV and Utility Vehicles.

### Principle of DHAB Family

The open loop transducers use an Hall effect integrated circuit.

The magnetic flux density **B**, contributing to the rise of the Hall voltage, is generated by the primary current  $I_p$  to be measured.

The current to be measured  $I_p$  is supplied by a current source i.e. battery or generator (Fig. 1).

Within the linear region of the hysteresis cycle, **B** is proportional to:

$$B(I_p) = \text{constant}(a) \times I_p$$

The Hall voltage is thus expressed by:

$$V_H = (R_H/d) \times l \times \text{constant}(a) \times I_p$$

Except for  $I_p$ , all terms of this equation are constant. Therefore:

$$V_H = \text{constant}(b) \times I_p$$

The measurement signal  $V_H$  amplified to supply the user output voltage or current.

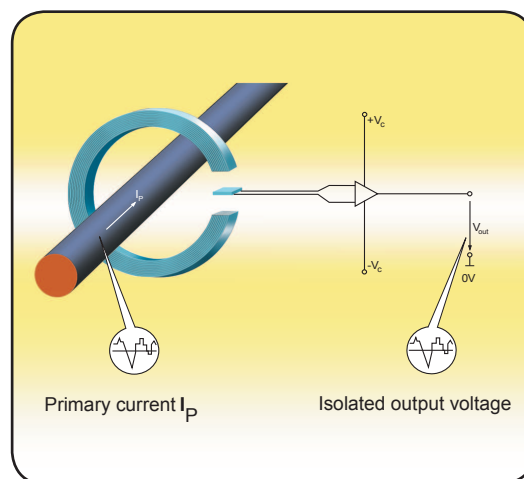
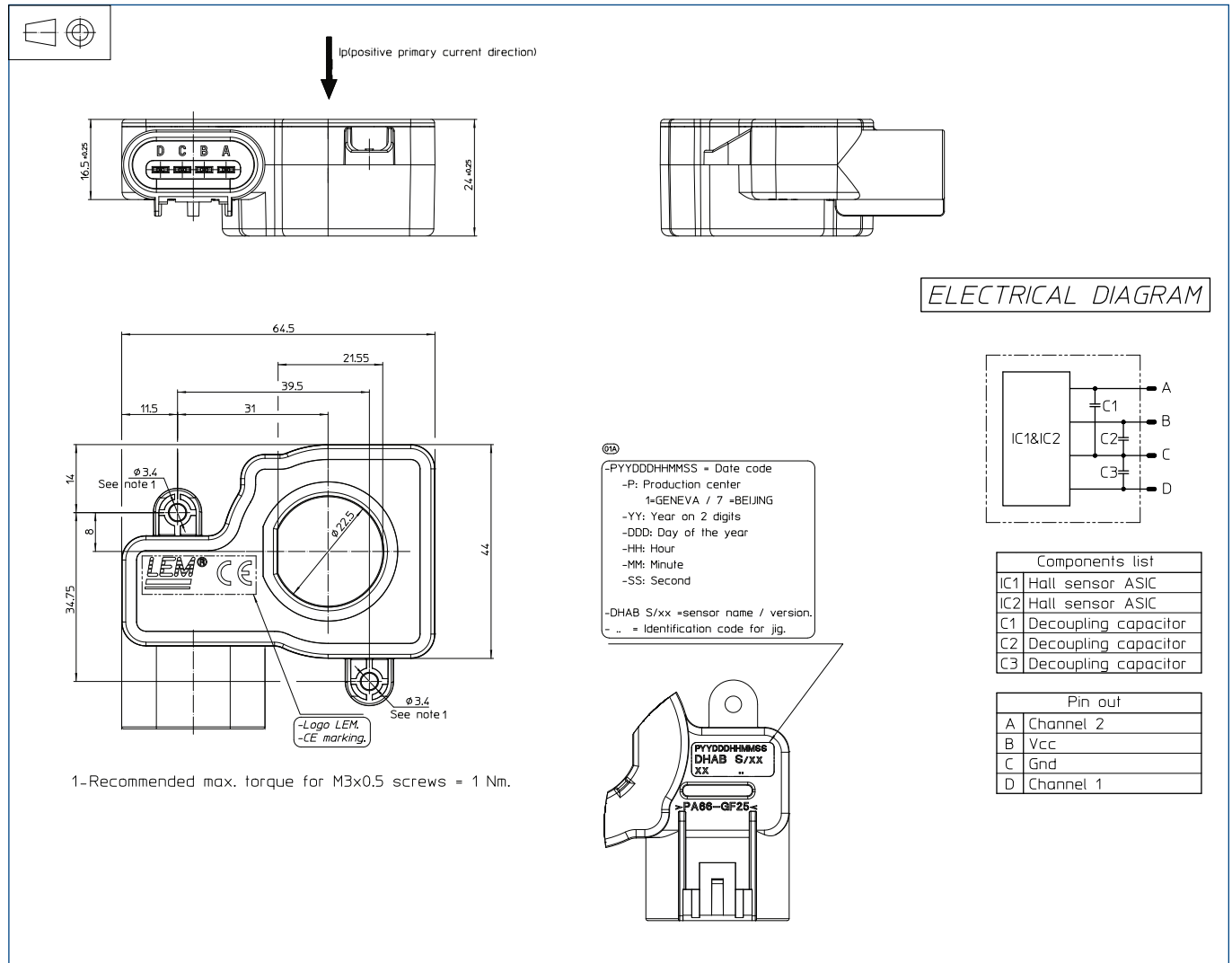


Fig. 1: Principle of the open loop transducer

## DHAB S/24

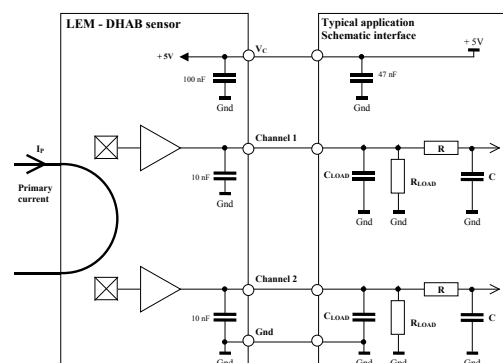
### Dimensions DHAB S/24 (in mm.)



### Bill of materials

- Plastic case
  - Magnetic core
  - Pins
  - Mass
- >PA66-GF25<
- Channel 1: FeNi alloy
- Channel 2: FeSi alloy
- Brass tin plated
- 69.5 g

### System architecture (example)



$R_L > 10 \text{ k}\Omega$  optional resistor for signal line diagnosis

$C_L < 100 \text{ nF}$  EMC protection

RC Low pass filter EMC protection (optional)

## DHAB S/24

### Absolute maximum ratings

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Supply voltage	V <sub>C</sub>	V			8.5	
Over voltage					14	1 min
Reverse voltage			-14			1 min @ T <sub>A</sub> = 25°C
Output voltage (Analog)	V <sub>OUT</sub>	V			8.5	
Output over voltage (Analog)		V			14	1 min @ T <sub>A</sub> = 25°C
Continuous output current	I <sub>OUT</sub>	mA	-10		10	
Output short-circuit duration	T <sub>E</sub>	min			2	
Ambient storage temperature	T <sub>S</sub>	°C	-40		125	

### Operating characteristics

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Supply voltage	V <sub>C</sub>	V	4.5	5	5.5	
Output current (Analog)	I <sub>OUT</sub>	mA	- 1		1	
Current consumption	I <sub>C</sub>	mA		15	20	@ V <sub>C</sub> < 3.5 V
Power up inrush current					40	
Load resistance	R <sub>L</sub>	KΩ	10			
Capacitive loading	C <sub>L</sub>	nF	1		100	
Ambient operating temperature	T <sub>A</sub>	°C	-10		65	High accuracy
			-40		125	Reduced accuracy

### Channel 1

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Primary current	$I_{P \text{ channel 1}}$	A	-75		75	
Calibration current	$I_{CAL}$		60		60	@ $T_A = 25^{\circ}\text{C}$
Offset voltage <sup>1)</sup>	$V_O$	V		2.5		@ $V_C = 5 \text{ V}$
Sensitivity <sup>1)</sup>	$G$	mV/A		26.7		@ $V_C = 5 \text{ V}$
Resolution		mV		2.5		@ $V_C = 5 \text{ V}$
Output clamping voltage min <sup>1)</sup>	$V_{SZ}$	V	0.24	0.25	0.26	@ $V_C = 5 \text{ V}$
Output clamping voltage max <sup>1)</sup>			4.74	4.75	4.76	@ $V_C = 5 \text{ V}$
Output internal resistance	$R_{OUT}$	$\Omega$		1	10	
Frequency bandwidth	$BW$	Hz			80	@ -3 dB
Power up time		ms		25	110	
Setting time after over load		ms			25	

### Channel 2

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Primary current	I <sub>P channel 2</sub>	A	-500		500	
Calibration current	I <sub>CAL</sub>		-500		500	@ T <sub>A</sub> = 25°C
Offset voltage <sup>1)</sup>	V <sub>O</sub>	V		2.5		@ V <sub>C</sub> = 5 V
Sensitivity <sup>1)</sup>	G	mV/A		4		@ V <sub>C</sub> = 5 V
Resolution		mV		2.5		@ V <sub>C</sub> = 5 V
Output clamping voltage min <sup>1)</sup>	V <sub>SZ</sub>	V	0.24	0.25	0.26	@ V <sub>C</sub> = 5 V
Output clamping voltage max <sup>1)</sup>			4.74	4.75	4.76	@ V <sub>C</sub> = 5 V
Output internal resistance	R <sub>OUT</sub>	Ω		1	10	
Frequency bandwidth	BW	Hz			80	@ -3 dB
Power up time		ms		25	110	
Setting time after over load		ms			25	

**Note:** <sup>1)</sup> The output voltage  $V_{OUT}$  is fully ratiometric (concerning offset, sensitivity and clamping) and is dependent on the supply voltage  $V_C$  relative to the following formula:

$$I_P = \left( V_{OUT} - \frac{V_C}{2} \right) \times \frac{1}{G} \times \frac{5}{V_C} \quad \text{with } G \text{ in } (V/A)$$

## DHAB S/24

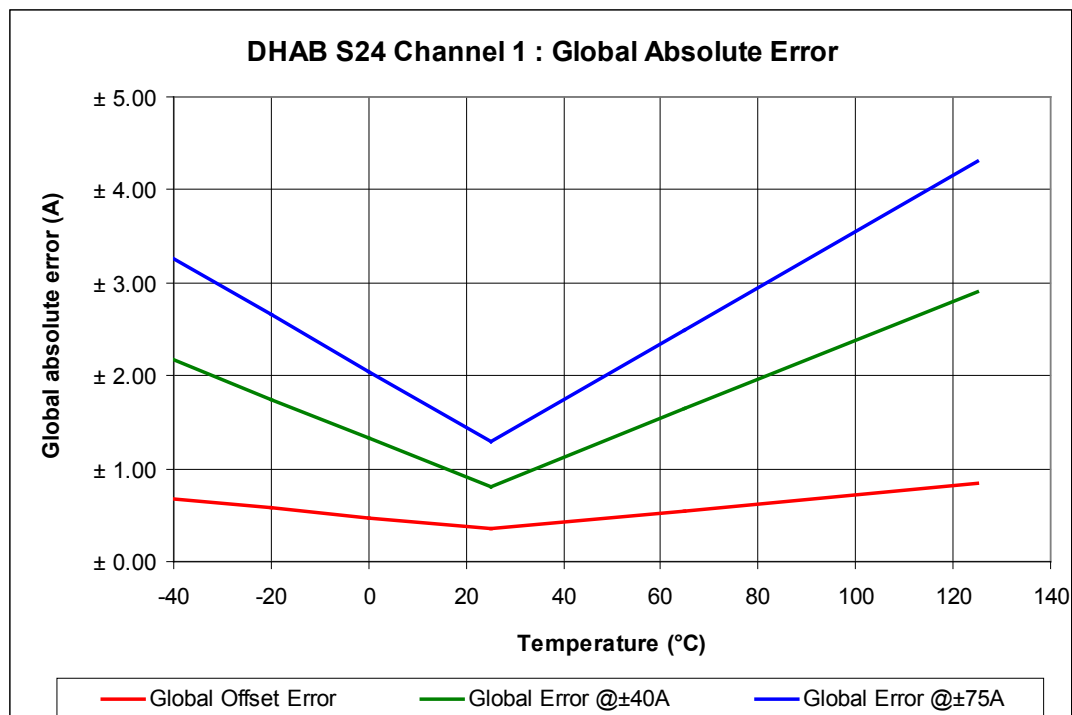
### ACCURACY

#### Channel 1

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Electrical offset current	I <sub>OE channel 1</sub>	mA		± 100		@ T <sub>A</sub> = 25°C
Magnetic offset current	I <sub>OM channel 1</sub>	mA		± 100		@ T <sub>A</sub> = 25°C
Global offset current	I <sub>O channel 1</sub>	mA	- 350		350	@ T <sub>A</sub> = 25°C
			- 550		550	@ - 10°C < T° < 65°C
			- 850		850	@ - 40°C < T° < 125°C
Sensitivity error	ε <sub>G</sub>	%		± 0.5		@ T <sub>A</sub> = 25°C
				± 2		@ - 10°C < T° < 65°C
				± 3.5		@ - 40°C < T° < 125°C
Linearity error	ε <sub>L</sub>	%		± 0.5		off full range

#### Global Absolute Error (A)

Channel 1	Global Absolute Error (A)					
Temperature	-40	-20	0	25	65	125
Global Offset Error	$\pm 0.68$	$\pm 0.58$	$\pm 0.48$	$\pm 0.35$	$\pm 0.55$	$\pm 0.85$
Global Error @±40A	$\pm 2.17$	$\pm 1.75$	$\pm 1.33$	$\pm 0.80$	$\pm 1.64$	$\pm 2.90$
Global Error @±75A	$\pm 3.25$	$\pm 2.65$	$\pm 2.05$	$\pm 1.30$	$\pm 2.50$	$\pm 4.30$



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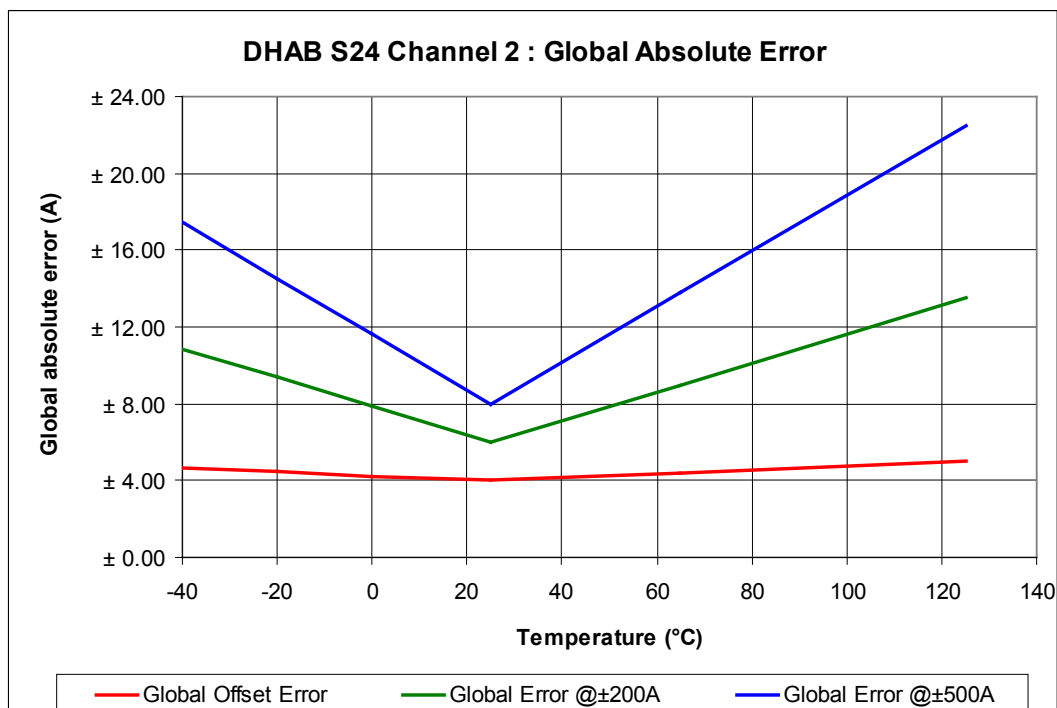
### ACCURACY

#### Channel 2

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Electrical offset current	I <sub>OE channel 2</sub>	A		± 0.8		@ T <sub>A</sub> = 25°C
Magnetic offset current	I <sub>OM channel 2</sub>	A		± 2.8		@ T <sub>A</sub> = 25°C
Global offset current	I <sub>O channel 2</sub>	A	- 4.		4	@ T <sub>A</sub> = 25°C
			- 4.4		4.4	@ - 10°C < T° < 65°C
			- 5		5	@ - 40°C < T° < 125°C
Sensitivity error	ε <sub>G</sub>	%		± 0.5		@ T <sub>A</sub> = 25°C
				± 2		@ - 10°C < T° < 65°C
				± 3.5		@ - 40°C < T° < 125°C
Linearity error	ε <sub>L</sub>	%		± 0.5		off full range

#### Global Absolute Error (A)

Channel 2	Global Absolute Error (A)					
Temperature	-40	-20	0	25	65	125
Global Offset Error	$\pm 4.65$	$\pm 4.45$	$\pm 4.25$	$\pm 4.00$	$\pm 4.40$	$\pm 5.00$
Global Error @ $\pm 200\text{A}$	$\pm 10.88$	$\pm 9.38$	$\pm 7.88$	$\pm 6.00$	$\pm 9.00$	$\pm 13.50$
Global Error @ $\pm 500\text{A}$	$\pm 17.43$	$\pm 14.53$	$\pm 11.63$	$\pm 8.00$	$\pm 13.80$	$\pm 22.50$



## DHAB S/24

### PERFORMANCES PARAMETERS DEFINITIONS

#### Output noise voltage:

The output voltage noise is the result of the noise floor of the Hall elements and the linear  $I_c$  amplifier gain.

#### Magnetic offset:

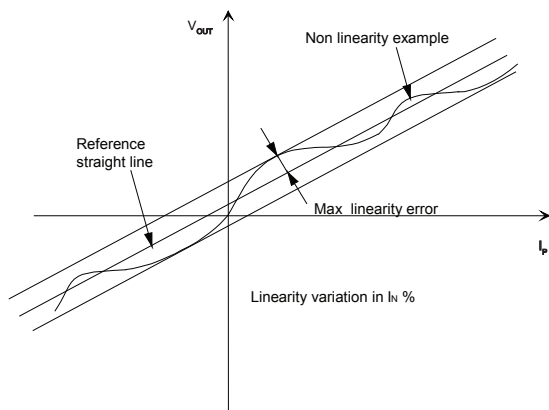
The magnetic offset is the consequence of an over-current on the primary side. It's defined after an excursion of  $I_{P \max}$ .

#### Linearity:

The maximum positive or negative discrepancy with a reference straight line  $V_{OUT} = f(I_P)$ .

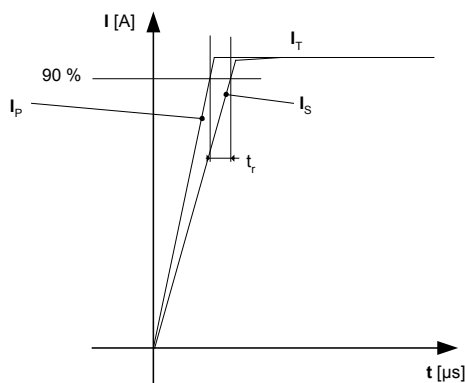
Unit: linearity (%) expressed with full scale of  $I_{P \max}$ .

Linearity is measured on cycle +  $I_P$ , 0, -  $I_P$ , 0, +  $I_P$  without magnetic offset (average values used)



#### Response time (delay time) $t_r$ :

The time between the primary current signal and the output signal reach at 90 % of its final value



#### Typical:

Theoretical value or usual accuracy recorded during the production.

#### Sensitivity:

The Transducer's sensitivity  $G$  is the slope of the straight line  $V_{out} = f(I_P)$ , it must establish the relation:

$$V_{out}(I_P) = V_C/5 (G \times I_P + 2.5) (*)$$

(\*) For all symetrics transducers.

#### Offset with temperature:

The error of the offset in the operating temperature is the variation of the offset in the temperature considered with the initial offset at 25°C.

The offset variation  $I_{OT}$  is a maximum variation the offset in the temperature range:

$$I_{OT} = I_{OE \max} - I_{OE \min}$$

The Offset drift  $TCI_{OEAV}$  is the  $I_{OT}$  value divided by the temperature range.

#### Sensitivity with temperature:

The error of the sensitivity in the operating temperature is the relative variation of sensitivity with the temperature considered with the initial offset at 25°C.

The sensitivity variation  $G_T$  is the maximum variation (in ppm or %) of the sensitivity in the temperature range:

$$G_T = (Sensitivity \max - Sensitivity \min) / Sensitivity \text{ at } 25^\circ C.$$

The sensitivity drift  $TCG_{AV}$  is the  $G_T$  value divided by the temperature range.

#### Offset voltage @ $I_P = 0$ A:

Is the output voltage when the primary current is null. The ideal value of  $V_O$  is  $V_C/2$  at  $V_C = 5$  V. So, the difference of  $V_O - V_C/2$  is called the total offset voltage error. This offset error can be attributed to the electrical offset (due to the resolution of the ASIC quiescent voltage trimming), the magnetic offset, the thermal drift and the thermal hysteresis.

#### Environmental test specifications

Name	Standard	Conditions
Thermal shocks	GM &5.5.5 (IEC 60068 Part 2-14)	T° - 40°C + 125°C / 300 cycles not connected. Criteria: $\epsilon_c < 3\%$ @ 25°C
Power temperature	GM &5.5.6 (IEC 60068 Part 2-14 Nb)	T° -40 + 125°C/595 cycles, supply voltage = 5 V Criteria: $\epsilon_c < 3\%$ @ 25°C
Temperature humidity cycle test	GM &6.18.1 (IEC 60068 2-38)	T° -10 + 65°C/10 cycles, supply voltage = 5 V Criteria: $\epsilon_c < 3\%$ @ 25°C
Mechanical tests		
Vibration test	GM &6.6.2 (IEC 60068 2-64)	Acceleration 30m/s <sup>2</sup> , 25°C, frequency 20 to 1000 Hz/8h each axis
Drop test	GM &6.10 (IEC 60068 2-32)	Drop 1m, 2 falls/part, 1 part/axis, 3 axes, criteria: relative sensitivity error 3%
EMC Test		
Rms voltage for AC isolation test	GM &6.4-13 (IEC 60068 2-38)	
Bulk current injection immunity	ISO 11452-4	Criteria B
Electrostatic discharge immunity test		2 KV, Criteria B