AUTOMOTIVE CURRENT TRANSDUCER
HABT 100-V

Introduction

The HABT 100-V current transducer is attached on the battery cable (or bus-bar) of a vehicle. It provides to a controller (ECU) the actual value of current flowing in the cable and the ambient temperature. The current value is provided by a voltage signal. Temperature is given by an NTC thermistor. The transducer is linked to the BCM (Body Control Module) with the car harness. The electrical connection is made with a waterproof connector. The output voltage $\mathbf{V}_{OUT}$ is fully ratiometric with the supply voltage $\mathbf{V}_d$.

Features

- Open Loop transducer using the Hall effect
- Unipolar + 5 V DC power supply
- Primary current measuring range up to ± 100 A
- Maximum rms primary current limited by the cable, the magnetic core or the ASIC temperature T° < + 150°C
- Operating temperature range: - 30°C < T° < 90°C
- Output voltage: full ratiometric (in sensitivity and offset)
- Temperature measurement by embedded NTC.

Advantages

- Excellent accuracy
- Very good linearity
- Very low thermal offset drift
- Very low thermal sensitivity drift
- Current & Temperature measurement
- No insertion losses.

Automotive applications

- Battery monitoring
- HEV application
- EV application.

Principle of HABT 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 $\mathbf{I}_P$ to be measured.
The current to be measured $\mathbf{I}_P$ 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:

$$\mathbf{B}\ (\mathbf{I}_P) = \text{constant (a)} \times \mathbf{I}_P$$

The Hall voltage is thus expressed by:

$$\mathbf{V}_H = (R_H/d) \times \mathbf{I} \times \text{constant (a)} \times \mathbf{I}_P$$

Except for $\mathbf{I}_P$, all terms of this equation are constant. Therefore:

$$\mathbf{V}_H = \text{constant (b)} \times \mathbf{I}_P$$

The measurement signal $\mathbf{V}_H$ amplified to supply the user output voltage or current.

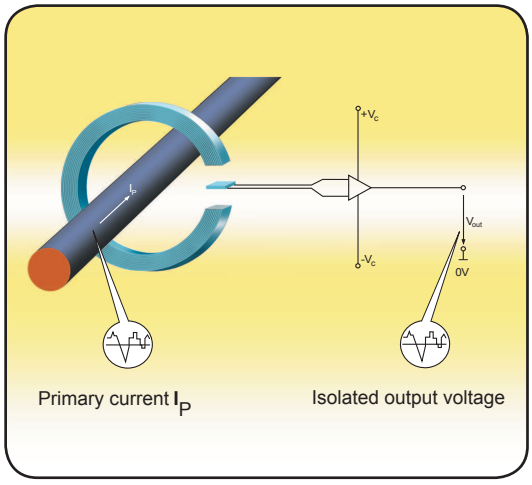
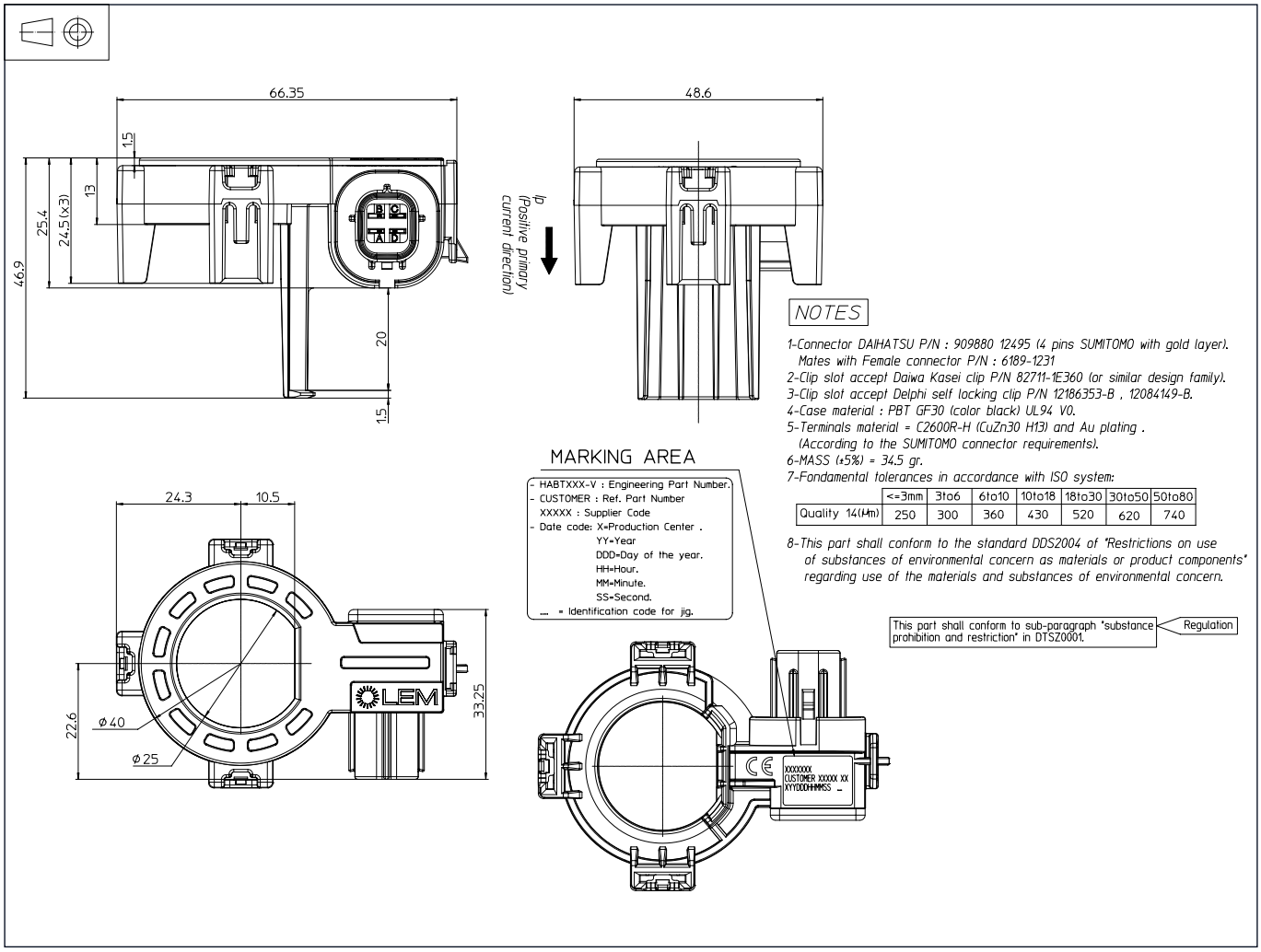


Fig. 1: Principle of the open loop transducer

HABT 100-V

Dimensions HABT 100-V (in mm. 1mm = 0.0394 inch)



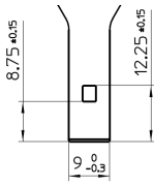
	<=3mm	3to6	6to10	10to18	18to30	30to50	50to80
Quality 14(µm)	250	300	360	430	520	620	740

Bill of materials

- Plastic case — PBT GF 30
- Magnetic core — Iron silicon alloy
- Pins — Gold plated

Mass — < 35 g

"Clip" shape recommendation (Thickness = 1.4 mm)



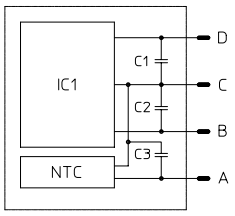
Clip reference :

Daiwa Kasei
82711-1E360
(or similar)

Remark

$V_{OUT} > \frac{V_c}{2}$ when I_P flows in the direction of the arrow.

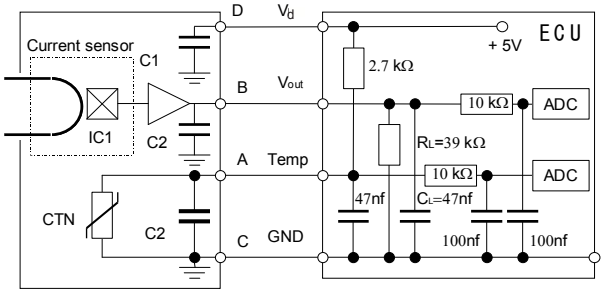
System architecture



Components list	
IC1	Hall sensor ASIC
C1	Capacitor
C2, C3	Capacitors
NTC	Thermistor

Pin out	
D	DC supply voltage (5V)
C	Ground
B	Output signal
A	Temperature signal

System architecture (example)



HABT 100-V

Absolute maximum ratings

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Nominal supply voltage	V_d	V	4.5	5	5.5	
Supply continuous over voltage					8.5	
Reverse voltage			-14			1 min @ T_A = 25°C
Over voltage					14	2 min
Continuous output voltage	V_{OUT}	V			14	1 min @ T_A = 25°C
Continuous output current	I_{OUT}	mA	-10		10	
Output short-circuit duration	T_C	min			2	
Isolation resistance	R_{IS}	MΩ	10			DC 500 V
Ambient storage temperature	T_S	°C	-40		100	

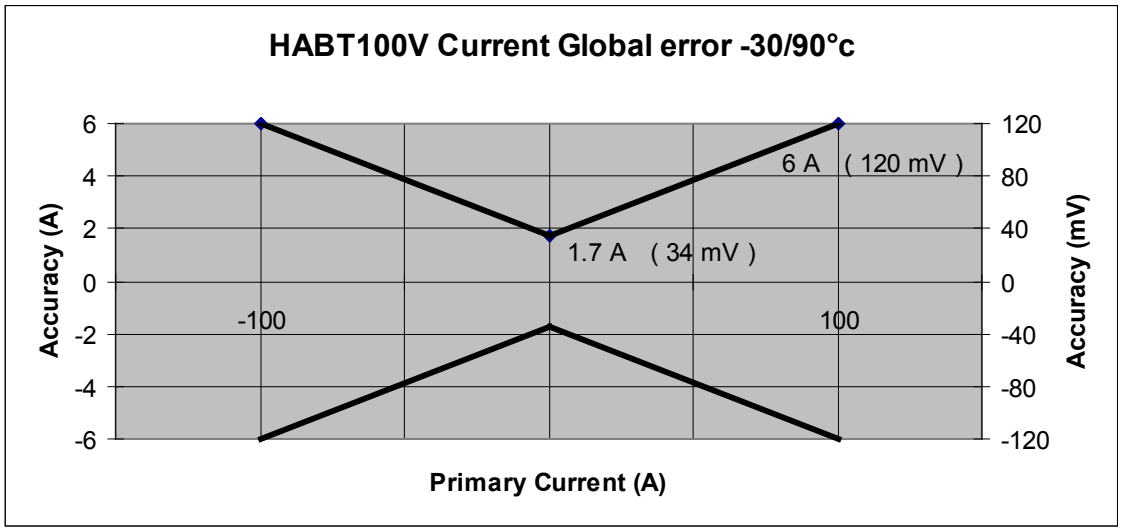
Operating characteristics

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Supply voltage	V_d	V	4.5	5	5.5	
Continuous output current	I_{OUT}	mA	-1		1	
Sensitivity error	ε_G	%		± 0.5		
Load resistance	R_L	KΩ	4.7	10		
Capacitive loading	C_L	nF		10	100	
Ambient operating temperature	T_A	°C	-30		90	
Output voltage (diagnostic detection open ground)	V_{OUT}	V	4.7			
Output voltage (diagnostic detection open V_d)	V_{OUT}	V			0.2	
Performance Data						
Current consumption (High output impedance)	I_C	mA	7.5			@ T_A = 25°C
					10	Over temperature
Linearity error	ε_L	%	-0.5		0.5	Up to 80 A
			-2		2	Up to 100 A
Overall accuracy @ I = 0 A @ - 30 to 90°C	X_G	A	-1.7		1.7	V_{OUT} = ± 34 mV @ V_d = 5 V ± 0.05 V
Overall accuracy @ I = 100 A @ - 30 to 90°C			-6		6	V_{OUT} = ± 120 mV @ V_d = 5 V ± 0.05 V
Sensitivity	G	mV/A	20			
Global offset current	I_O	mA	-400		400	@ T_A = 25°C
Electrical offset current	I_{OE}	mA	-300		300	@ T_A = 25°C
Magnetic offset current	I_{OM}	mA		110		@ T_A = 25°C
Primary current, measuring range	I_{PM}	A	-100		100	
Output voltage @ I_P = 0	V_{OUT}	V		V_d/2		
Resolution		mV		2.5		
Output internal resistance	R_{OUT}	Ω		1		@ T_A = 25°C
					10	Over temperature
Response time to 90 % of I_{PN} step [1]	t_r	ms			1.1	
Power up time				25	200	
Setlling time after overload					25	
Negative temperature coefficient resistance	R_{NTC}	KΩ	2.178	2.2	2.222	Accuracy ± 1 % @ T_A = 25°C
B 25/85 constant			3485	3520	3555	Accuracy ± 1 %
Output clamping voltage low	V_{sz}	%V_d	5.1	6	6.9	
Output clamping voltage high			92.1	93	93.9	
Temperature accuracy		°C	-2		2	- 40/90°C power off

Note: [1] With internal filter adjusted at 500 Hz.

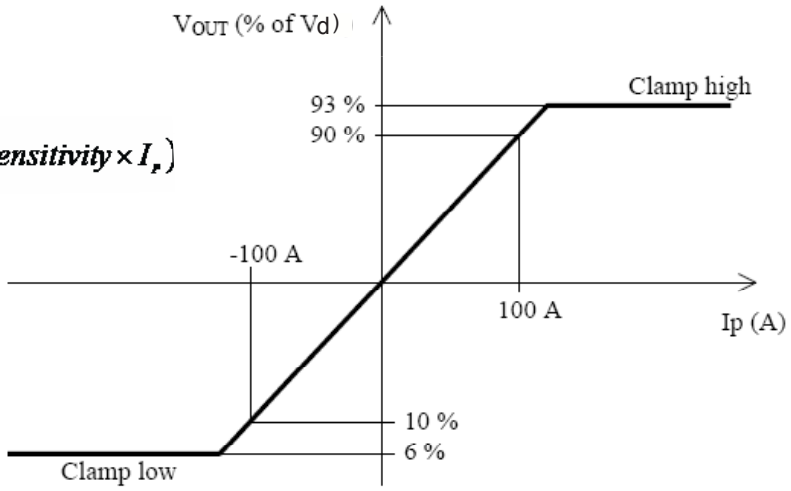
HABT 100-V

Global Error



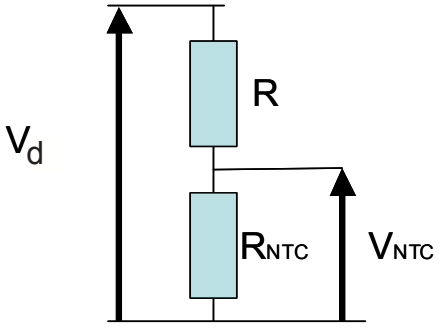
Output and clamping

$$V_{out} = \frac{V_d}{5} \times (2.5 + Sensitivity \times I_p)$$

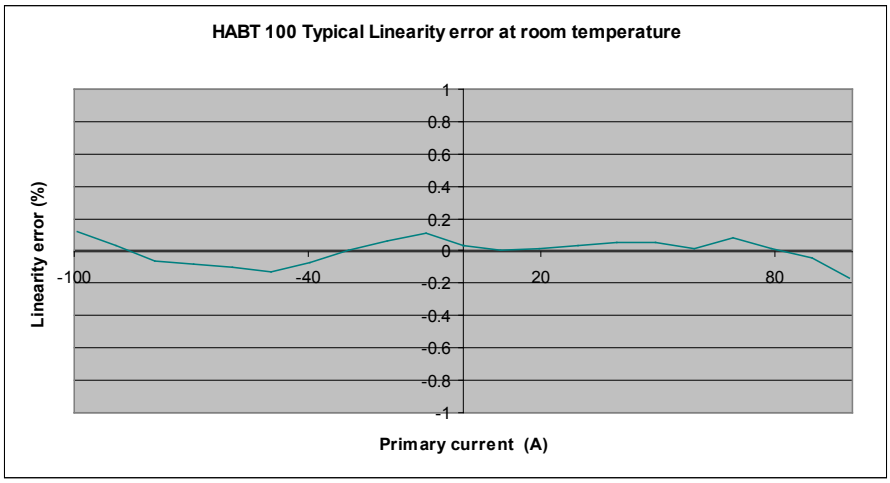


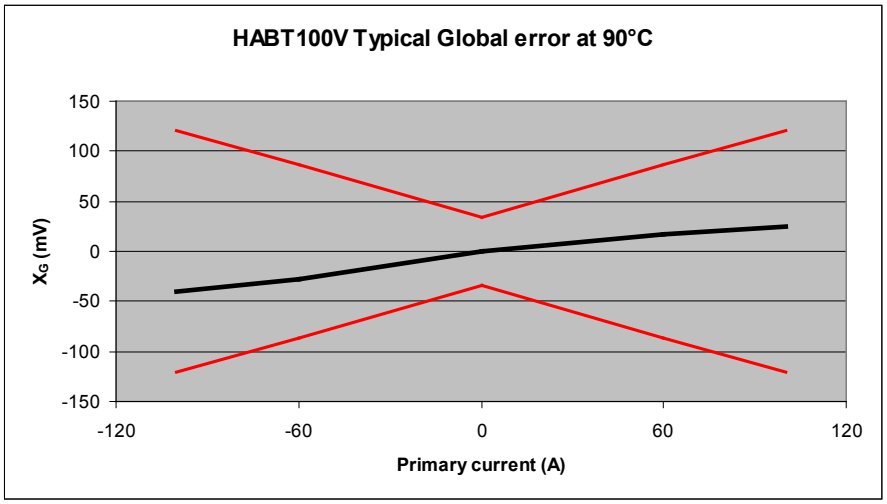
Temperature output

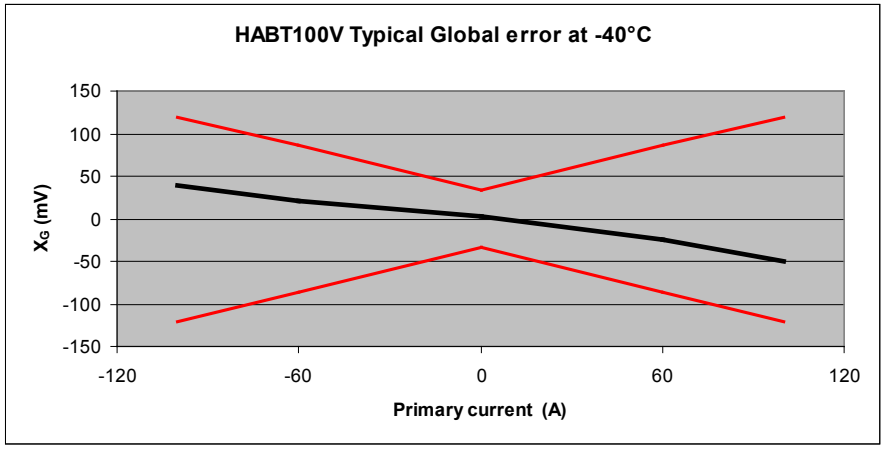
T°C = 3520/ (Ln (R_{NTC}/2200) + 3520/298.15) - 273.15
R_{NTC} = R x V_{NTC} / (V_d - V_{NTC})



HABT 100-V


HABT 100 Typical Linearity error at room temperature
Linearity error (%)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-100
-40
20
80
Primary current (A)


HABT100V Typical Global error at 90°C
XG (mV)
150
100
50
0
-50
-100
-150
-120
-60
0
60
120
Primary current (A)


HABT100V Typical Global error at -40°C
XG (mV)
150
100
50
0
-50
-100
-150
-120
-60
0
60
120
Primary current (A)

HABT 100-V

PERFORMANCES PARAMETERS DEFINITIONS

Output noise voltage:

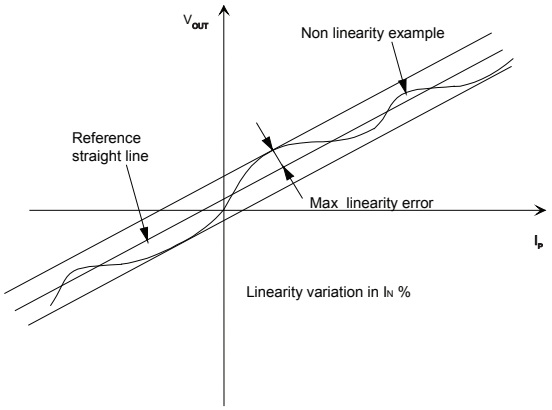
The output voltage noise is the result of the noise floor of the Hall elements and the linear $\mathbf{I}_C$ amplifier gain.

Magnetic offset:

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

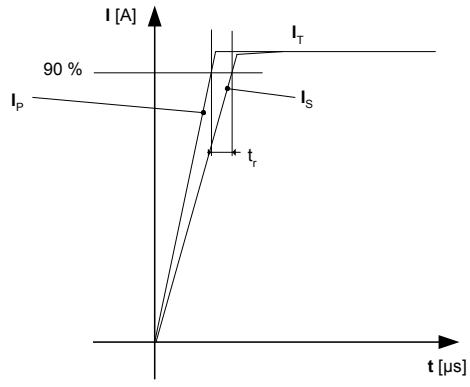
Linearity:

The maximum positive or negative discrepancy with a reference straight line $\mathbf{V}_{OUT} = f(\mathbf{I}_P)$.
Unit: linearity (%) expressed with full scale of $I_{P\ max}$.
Linearity is measured on cycle + $\mathbf{I}_P$, O, - $\mathbf{I}_P$, O, + $\mathbf{I}_P$ 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:

Theorical value or usual accuracy recorded during the production.

Sensitivity:

The Transducer's sensitivity **G** is the slope of the straight line $\mathbf{V}_{out} = f(\mathbf{I}_P)$, it must establish the relation:
$\mathbf{V}_{out}(\mathbf{I}_P) = \mathbf{V}_d/5\ (\mathbf{G} \times \mathbf{I}_P + 2.5)$ (*)

(*) 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 $\mathbf{I}_{OT}$ is a maximum variation the offset in the temperature range:
$\mathbf{I}_{OT} = \mathbf{I}_{OE}$ max - $\mathbf{I}_{OE}$ min
The Offset drift $\mathbf{TCI}_{OEAV}$ is the $\mathbf{I}_{OT}$ 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 $\mathbf{G}_T$ is the maximum variation (in ppm or %) of the sensitivity in the temperature range:
$\mathbf{G}_T$ = (Sensitivity max - Sensitivity min) / Sensitivity at 25°C.
The sensitivity drift $\mathbf{TCG}_{AV}$ is the $\mathbf{G}_T$ 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 $\mathbf{V}_O$ is $\mathbf{V}_d/2$ at $\mathbf{V}_d$ = 5 V. So, the difference of $\mathbf{V}_O$ -$\mathbf{V}_d/2$ 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.

HABT 100-V

Immunity to conducted disturbance test		
Immunity to signal line transients	ISO 7637-3 (1995)	Operating Class C
Immunity to bulk current injection (BCI)	ISO 11452-4 (2005)	60 mA Class C, 100 mA Class C, 200 mA Class C
Resistance to impulse transient		Operating Class C
Immunity to radiated disturbance tests		
Immunity to audio frequency magnetic field	ISO / DIS 11452-8 (2006)	Operating Class A
Resistance to electrostatic discharge tests		
Resistance to electrostatic discharges, equipment not supplied	IEC 61000-4-2 (2001) C = 150 pF; R = 330 Ohms	± 4 kV Contact discharge: Class A ± 8 kV Contact discharge: Class B ± 15 kV Air discharge: Class B
Resistance to electrostatic discharges, equipment supplied	ISO 10605 (2001)	± 4 kV Contact discharge: Class A ± 8 kV Contact discharge: Class B ± 4 kV Air discharge: Class A ± 8 kV Air discharge: Class A ± 15 kV Air discharge: Class B ± 25 kV Air discharge: Class D
Electrical tests		
Engine starting voltage test	DTSC7001G § 5-1	6 to 8 V, 1 Hz
Voltage dips tests	DTSC7001G § 5-2	1, 5, 10, 15 and 20 ms
Reversed power connection test	DTSC7001G § 5-3	13 V/1 min
Environmental tests		
Low T°C storage test	DTSC7000G § 5-3	Not powered, - 40°C, 96 ± 2H
Low T°C operation test	DTSC7000G § 5-4	- 30°C, 192H, powered
High T° storage test	DTSC7000G § 5-5	No powered, 100°C ± 3.96H
High T° operation test	DTSC7000G § 5-6	+90°C ±3, 192H, powered
Temperature cycle test	DTSC7000G § 5-7	30 cycles, 90°C to -30°C, operational 5H and non operational 1 H (180H)
Thermal shock	DTSC7000G § 5-8	-40°C/+90°C with 2000H(30 min + 30 min) no powered
Temperature humidity cycle test	DTSC7000G § 5-9	
Constant humidity test	DTSC7000G § 5-10	+60°C/90% rH, 96H, powered
Vibration in temperature	DTSC7000G § 5-11	Resonnance point detection 3g, 5 to 200 Hz, sweep 10 min, 4+2+2 H
Impact test	DTSC7000G § 5-12	Free fall @ 1 m, 3 times for each 5 planes, 15 times for connector plane on concrete
Dew condensation test	DTSC7000G § 5-13	2H @ -5°C and 10 Min @ 85% rH @ 35°C no operational
Salt spray test	JIS Z 2371	Test according to JIS Z 2371. Leave transducers for 300H at ambient temperature of 35 ± 3°C
Dipping test		Storage temperature 80± 3°C, storage time 1H mini water temperature 25 ± 10°C Dip depth: 100 mm dipping time 1 min No water immersion into inside of connector
Spray frost test	JIS D 0203 R2e	Spray frost Conform to JIS D 0203 R2e
Vibration durability		Ambient temperature 80 ± 3°C, Frequency 20 to 200 Hz, Sweep time: 2 min, Acceleration 43.12m/s^2, Time: 3 hours for each directions (top/bottom, left/right front/back), Power voltage 5 ± 2 V, measured current: 50 to - 100 A
Chemical proof test		Chemical temperature: 25±10°C Dipping time: 1 min Exposenal temperature: 80 ± 3°C exposal time: 1H min Chemical name: Gasoline, engine, oil, brake oil, anti-freeze fluid. Torque converter oil. Washer fluid. Battery fluid. CRC. WÀX WAX remover. PS. Oil.