AUTOMOTIVE CURRENT TRANSDUCER FLUXGATE TECHNOLOGY
CAB 500-C/SP5

Introduction

The CAB family is for battery monitoring applications where high accuracy and very low offset are required.
It offers galvanic separation between primary circuit (high voltage) and the secondary circuit (12 V system).

Features

- Transducer using Fluxgate technology
- Unlimited over-current capability
- Panel mounting
- Unipolar +12 V battery power supply
- Output signal: High speed CAN (500 kpbs)
- Configurable internal digital low-pass frequency filter
- Configurable CAN speed
- Configurable CAN ID.

Special feature

- Connector type: Tyco AMP 1473672-1.

Advantages

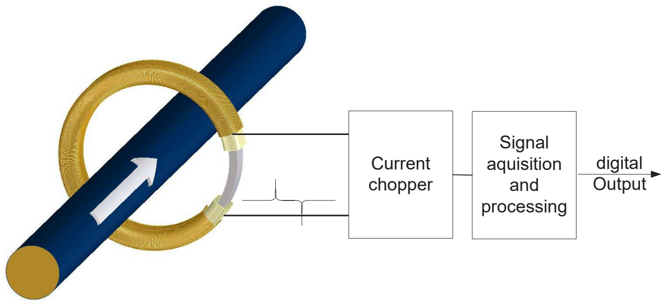
- Offset below 10 mA
- High overall accuracy
  −0.1 % error at room temperature (Typ.)
  −0.5 % error over temperature range (±3δ)
- Full galvanic separation.

Automotive applications

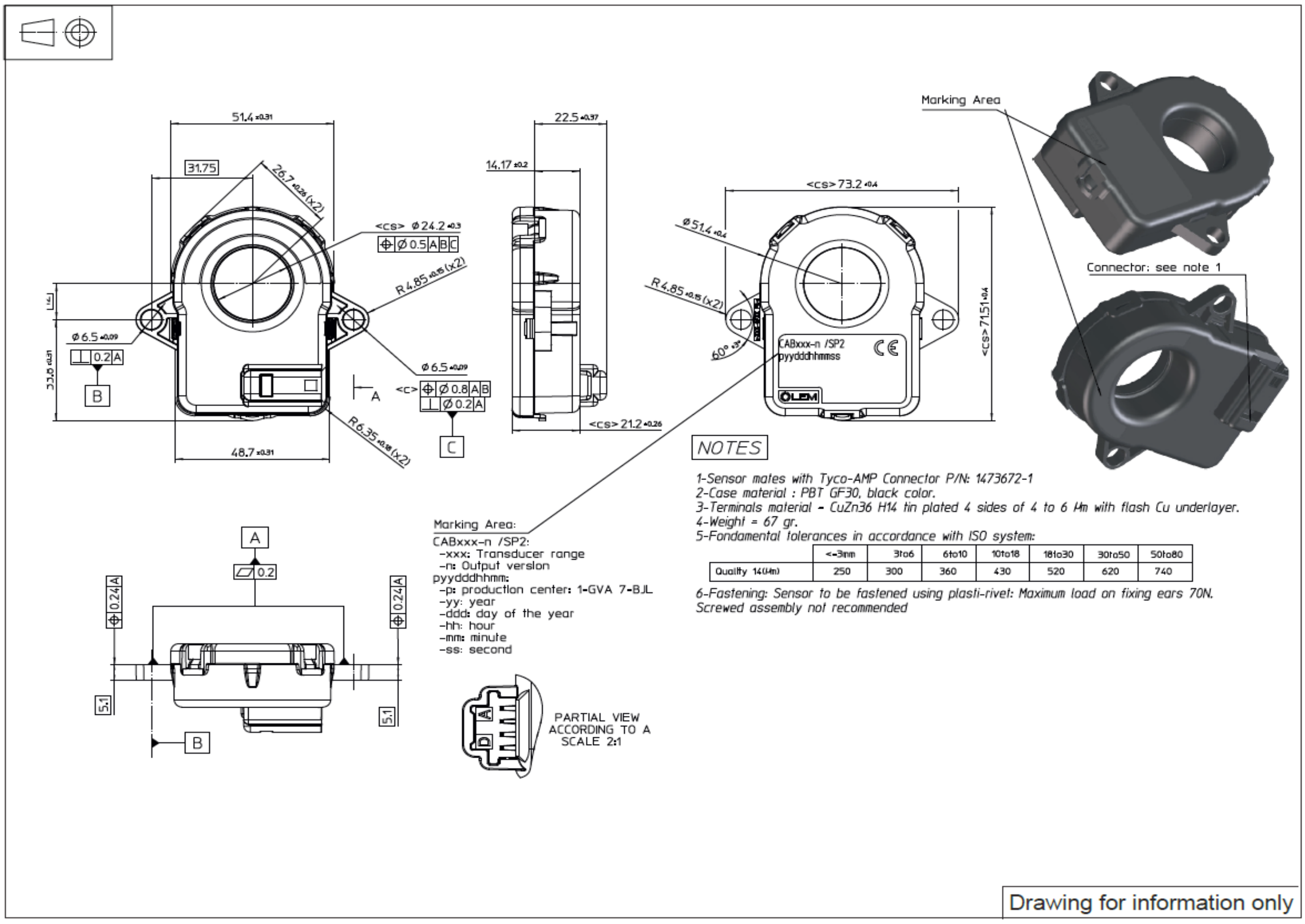
- Hybrid and electric vehicle battery pack
- Conventional lead-acid batteries
- Accurate current measurement for battery management applications (SOC, SOH, SOF, etc…).

Principle of Fluxgate Transducers

A low-frequency fluxgate transducer is made of a wound core which saturates under low induction. A current chopper switches the winding's current to saturate the magnetic core alternatively at $\pm B$ max with a fixed frequency. Fluxgate transducers use the change of the saturation's point symmetry to measure the primary current. Due to the principle of switching the current, all offsets (electric and magnetic) are cancelled.

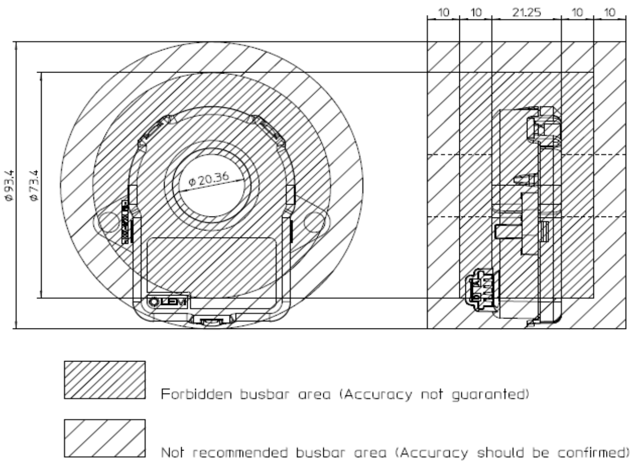


Dimensions CAB 500-C series (in mm)



Mechanical characteristics

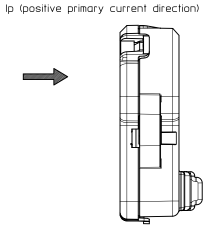
- Plastic case PBT GF 30
- Magnetic core Nanocrystalline
- Mass 67 g
- Electrical terminal coating Tin plated.



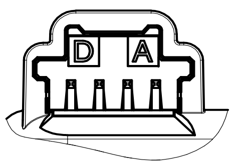
Mounting recommendation

- Connector type Tyco-AMP P/N: 1 473672-1

Connection



Pin Out	
A	CAN-L
B	CAN-H
C	GND
D	U_C



Absolute maximum ratings (not operating)

Parameter	Symbol	Unit	Specification	Conditions
Load dump overvoltage	U_C	V	32	400 ms
Over-voltage	U_C	V	24	1 minute
Reverse polarity	U_C	V	−50	1 minute
Minimum supply voltage	$U_{C\ min}$	V	6	continuous, not measuring
Maximum supply voltage	$U_{C\ max}$	V	18	continuous, not measuring
Creepage distance	d_{Cp}	mm	7.2	
Clearance	d_{Cl}	mm	6.95	
RMS voltage for AC insulation test	U_d	KV	2.5	50 Hz,1 min
Insulation resistance	R_{INS}	MΩ	500	500 V - ISO 16750-2
IP Level			IP41	

Characteristics in nominal range

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical Data						
Supply voltage [1]	U_C	V	8	13.5	16	
Current consumption @ I_P = 0 A	I_C	mA		40	45	@U_C = 13.5 V, CAN acknowledge, T °C Range
Current consumption @ I_P = 500 A	I_C	mA		140	160	@U_C = 13.5 V, CAN acknowledge, T °C Range
Ambient operating temperature	T_A	°C	−40		85	Temperature range with accuracy guaranteed ±3 sigma
Performance Data						
Primary nominal DC or RMS current	$I_{P\ N}$	A	−500		500	
Current clamping value		A	−530		530	
Voltage clamping value max		V		18		When U_C increases
				17.35		When U_C decreases
Voltage clamping value min		V		7.75		When U_C increases
				7.27		When U_C decreases
Linearity error	ε_L	%		0.1		at room temperature
Gain drift		ppm/°C		70		
Output noise		mA		±10		
Frequency bandwidth [2]	BW	Hz		100		depends on the filter implemented[2]
Start-up time	t_{start}	ms		150		
Setting time after over load		ms		20		

Note: [1] Performances are considered with average value over 10 CAN frames (100 ms).
[2] Bandwidth depends on emission period of the frame without digital filter

Accuracy - Enhanced Performances in Typical Application

PHEV and EV systems may use different technologies of batteries. One very important parameter that may influence the stability of the SOC is the temperature.
The battery temperature affects vehicle performance, reliability, safety and life-cycle cost.
The CAB 500-C family is qualified between −40 °C to 85 °C but the sensor shows a better accuracy in a restricted temperature range in order to deliver a very accurate current measurement.
As shown in the picture below, the recommended and desired operating temperature range is between 15 °C to 35 °C, in this range the CAB 500-C family has a very good accuracy, please refer to the table 1

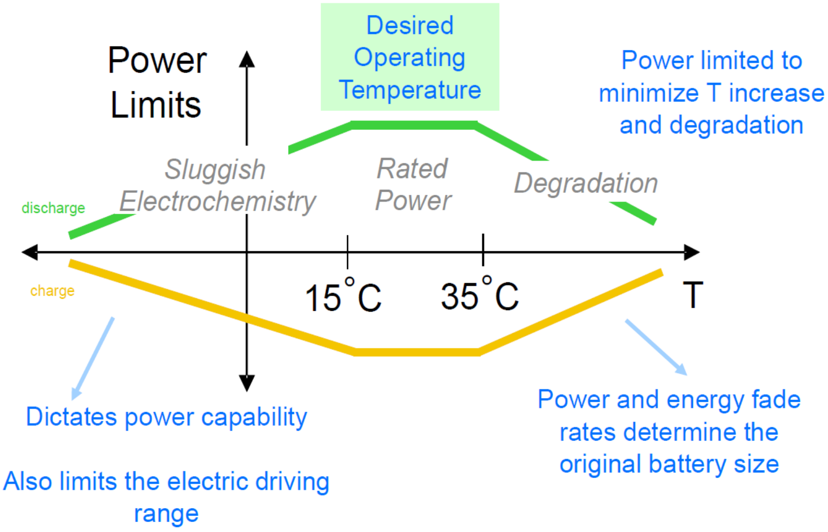


Figure 1 – Temperature impacts for battery life

Absolute Accuracy Table

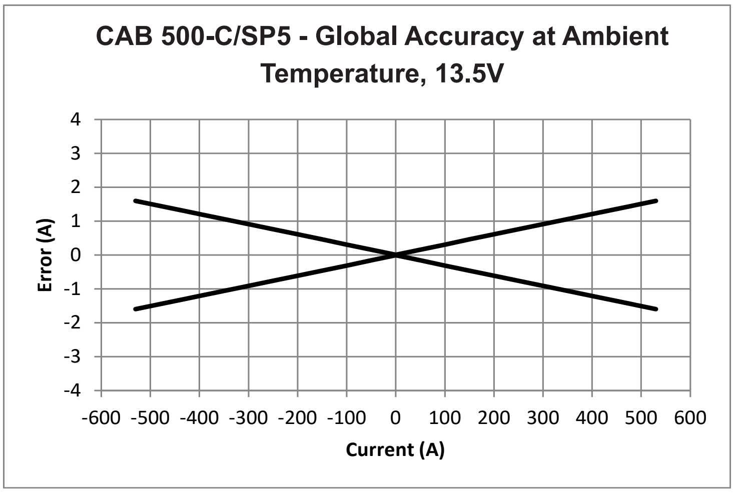
Operating parameter valid for T_A = −40 °C to +85 °C & 11 V < U_C < 15 V

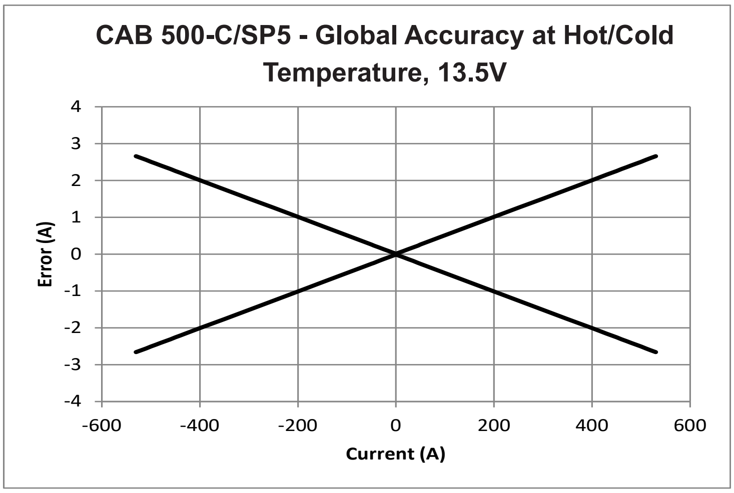
Primary Current	Symbol	Unit	Temperature					
			−40 °C	0 °C	15 °C	25 °C	55 °C	85 °C
100 A	X_G	%	0.5	0.4	0.3		0.4	0.5
350 A								
450 A								
500 A								

(1) All the parameters expressed in the table are determined during initial characterization and given at ±3δ

(2) The accuracy of the sensor is guaranteed in the conditions given in the application notes ANE_120504 & ANE_14032017

Global Accuracy Graph





External Magnetic Field Influences

The CAB 500-C family uses a very accurate technology and offers to the customer the current measurement needed to the application.

In order to respect this accuracy, some conditions must be respected during the design of the environment of the sensor:

- Primary busbar centering
- Bus-bar shape
- Contactors position

LEM's recommendations can be found in the application notes available on request.

Can output specification

- CAN protocol 2.0B
- Bit order: big endian (Motorola)
- CAN oscillator tolerance: 0.27 %
- No sleep mode capability
- 120 ohm termination resistor to be added externally, internal CAN impedance = 2.4Kohm

Message Description	CAN ID	Name	Data Length (Nb bytes)	Type of frame	Message launch type	Message launch type	Signal Description	Start bit	End bit
Return Current IP (mA)	0x3C2	CAB500_IP	8	Standard	Cyclic message every 10ms	I_P Value: 80000000H = 0 mA, 7FFFFFFFH = −1 mA, 80000001H = 1 mA	IP_VALUE	0	31
						Error Info (1 bit) 0=Normal 1=Failure	ERROR_INDICATION	32	32
						CSM-FAIL (7 bits)	ERROR_INFO	33	39
						CAB500 (16 bits)	SENSOR_NAME	40	55
						Software Revision (8 bit)	SW_Revision	56	63

Note: Refer to the Application Note ANE_26022018 for the customization features.

Error Management

Failure Mode	I_P Value	Error Indication	Error Information
Memory Error	0x FFFF FFFF	1	0x40
Overcurrent Detection IP > 580A	0x FFFF FFFF	1	0x41
Fluxgate has no oscillation for more than 20ms	0x FFFF FFFF	1	0x42
Clock derivation	0x FFFF FFFF	1	0x44
Supply voltage is out of range	0x FFFF FFFF	1	0x46
Hardware default ADC channel	0x FFFF FFFF	1	0x47
New Data not available	0x FFFF FFFF	1	0x49
Hardware default DAC Threshold	0x FFFF FFFF	1	0x4A
Hardware default Reference voltage	0x FFFF FFFF	1	0x4B

Test	Test standard	Procedure
		Environmental test
Shipping/Storage Temperature Exposure	ISO16750-4	164 hrs, −40 °C / +85 °C, power off, slope 0.6 °C/min
Low Temperature Operating Endurance		120 hrs, −40 °C, power on
High Temperature Operating Endurance		85 °C, 4752 hrs, power on caracterization before and after test only at 25 °C and U_C nom
Powered Thermal Cycle Endurance	ISO16750-4	540 cycles/100 min: −40 °C (20 min), +85 °C (20 min), slope 4 °C/min : 900 hrs caracterization before and after test only at 25 °C and U_C nom
Thermal Shock		−40 °C (20 min soak) / 85 °C (20 min soak) , 1000 cycles, with connectors => 667 h (28 days)
Thermal Humidity Cycle	IEC 60068-2-38	240 hrs, −10 °C /+65 °C , 93 % humidity caracterization before and after test only at 25 °C and U_C nom
High Temperature and Humidity Endurance	IEC60068-2-67	85 °C, 85 % humidity, 1000 hrs caracterization before and after test only at 25 °C and U_C nom Performance after test : offset < 20 mA, Global error < 3000 mA
Vibration		Class 1 5 Hz to 1000 Hz (table 6-10), 20 h / axis, 3 axis+ −40 °C / + 85°C during 8 hours and 25 °C during 12 h. (Fig.6-2) Characterization before and after test only at 25 °C and Vcnom
Mechanical Shock	ISO16750-3	500 m/s^2, 10 each direction (60 total) Half sine pulse Characterization before and after test only at 25 °C and $U_C$nom
Package Drop		With final packaging 1 m, 1 bottom, 4 bottom edge, 4 bottom corner => total 9 drops. 1 meter on concrete floor.
Handling Drop	ISO16750-3	1 fall in one direction for each sensor, from 1 meter on concrete floor. caracterization before and after test only at 25 °C and U_C nom
Dust (and other solid intrusion)	ISO20653	IP category: 4
Water Intrusion	ISO20653	IP category: 1
Dew formation test	IEC60068-2030	
Mixed Flowing Gas	IEC60068-2-60	
Salt Fog	ISO16750-4	96 h @ 35 °C 5 % of salt water solution caracterization before and after test only at 25 °C and U_C nom
Chemical exposure - outside cabin compartment	ISO16750-5	24 h / fluid; see PV test report for list of fluids

Test	Test standard	Procedure
EMC test		
CISPR 25 Conducted RF Emissions-Voltage on Supply Lines	CISPR25	Narrow band : 0.15 to 108 (MHz) Wide band : 0.15 to 200 (MHz)
CISPR 25 Conducted RF Emissions-Current on all Lines in Harness	CISPR25	Narrow band : 0.15 to 108 (MHz) Wide band : 0.15 to 200 (MHz)
CISPR 25 Radiated Emissions	CISPR25	30 to 1000 (MHz)
Bulk Current Injection (BCI) Test	ISO 11452-4	According to ISO 11452-4
ALSE with a Ground Plane	ISO 11452-2	According to ISO 11452-2
Transient Disturbances Conducted along Supply Lines	ISO 7637-2	According to ISO 7637-2
Transient Disturbances Conducted along I/O or Sensor Lines	ISO 7637-3	According to ISO 7637-3
Handling Test	ISO10605	Test method: IEC 61000-4-2 (2008) pins: ±4 kV case: ±8 kV
Operating Test	IEC 61000-4-2	Test method: IEC 61000-4-2 (2008) Indirect contact discharge: ±8 kV Air discharge: ±20 kV
Impulse Noise Test		±2 kV noise simulator, on each lines
Fast Transient Noise Test		±2 kV fast transient simulator, on each lines

Test	Test standard	Procedure
		Electrical test
Supply Voltage Range		8 V to 16 V; from −40 °C to 105 °C
Supply Voltage Ripple	SAE J1113-2	According to SAE J1113-2
Supply Voltage Drop Out		Supply voltage drop from 11 V to 0 V and return to 11 V. Drop duration increase from 10us to 1ms (sensor functionnal) and from 1 ms to 2 s (sensor not damaged)
Supply Voltage Dips		Supply voltage dips from 11 V to dip voltage and return to 11 V. Dip voltage are 5.5 V, 5 V, 4.5 V, 4 V,3.5 V and 3 V. Dips duration for each levels are 100 us-1 ms (sensor functionnal) and 1 ms - 500 ms (sensor not damaged)
Slow decreases and increase	ISO 16750-2 (2004)	According to ISO 16750-2 (2004)
Defective Regulation (Full-Fielded Alternator)		24 V, 1 minute
Jump Start		18 V, 60 minutes, @ 65 °C
Load Dump		32 V, 400 ms; 5 pulses
Reverse Supply Voltage	ISO16750-2	−16 V, 1 minute
Immunity to Short Circuits in the Supply Voltage Input and Load Output Lines		
Immunity to Short Circuits in I/O Signal Lines		