AUTOMOTIVE CURRENT TRANSDUCER FLUXGATE TECHNOLOGY

CAB-A 1000-0XX; CAB-A 1000-2XX; CAB-A 1000-6XX; CAB-A 1000-8XX



Introduction

The CAB-A family is specially engineered for the DC current measurement on 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 (low voltage).

Features

- Fluxgate transducer technology
- Unipolar +12V / +24 V battery power supply
- Output signal: High speed CAN (500 kbps)
- Unlimited over-current capability
- History error storage function
- Panel / busbar mounting
- Plug & play with standard CAB family.

Advantages

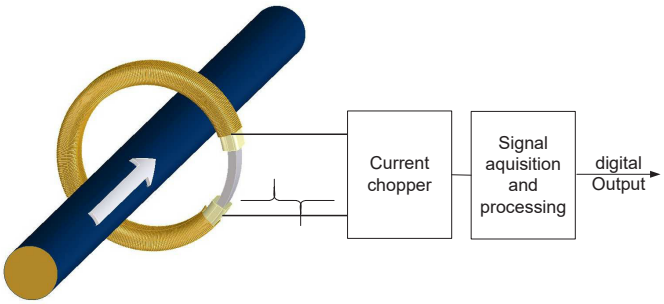
- Low offset 50 mA
- High accuracy 0.5 % at −40 °C to 85 °C
  0.8 % at 85 °C to 105 °C
- Wide ambient temperature range
- Full galvanic separation
- Good magnetic anti-interference performance
- Compatible with 1500 V applications following IEC60664-1 standard.

Automotive applications

- Electric and hybrid vehicle battery pack
- Electric and hybrid vehicle battery / power disconnect unit
- Electric and hybrid vehicle X-in-1 powertrain
- 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 ±Bmax 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.



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Safety



Caution

If the device is used in a way that is not specified by the manufacturer, the protection provided by the device may be compromised.
Always inspect the electronics unit and connecting cable before using this product and do not use it if damaged.
Mounting assembly shall guarantee the maximum primary conductor temperature, fulfill clearance and creepage distance, minimize electric and magnetic coupling, and unless otherwise specified can be mounted in any orientation.



Caution, risk of electrical shock

This transducer must be used in limited-energy secondary circuits SELV according to IEC 61010-1, in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the manufacturer's operating specifications.

Use caution during installation and use of this product; certain parts of the module can carry hazardous voltages and high currents (e.g. power supply, primary conductor).
Ignoring this warning can lead to injury and or/or cause serious damage.

This transducer is a build-in device, whose hazardous live parts must be inaccessible after installation.
This transducer must be mounted in a suitable end-enclosure.
Besides make sure to have a distance of minimum 30 mm between the primary terminals of the transducer and other neighboring components.

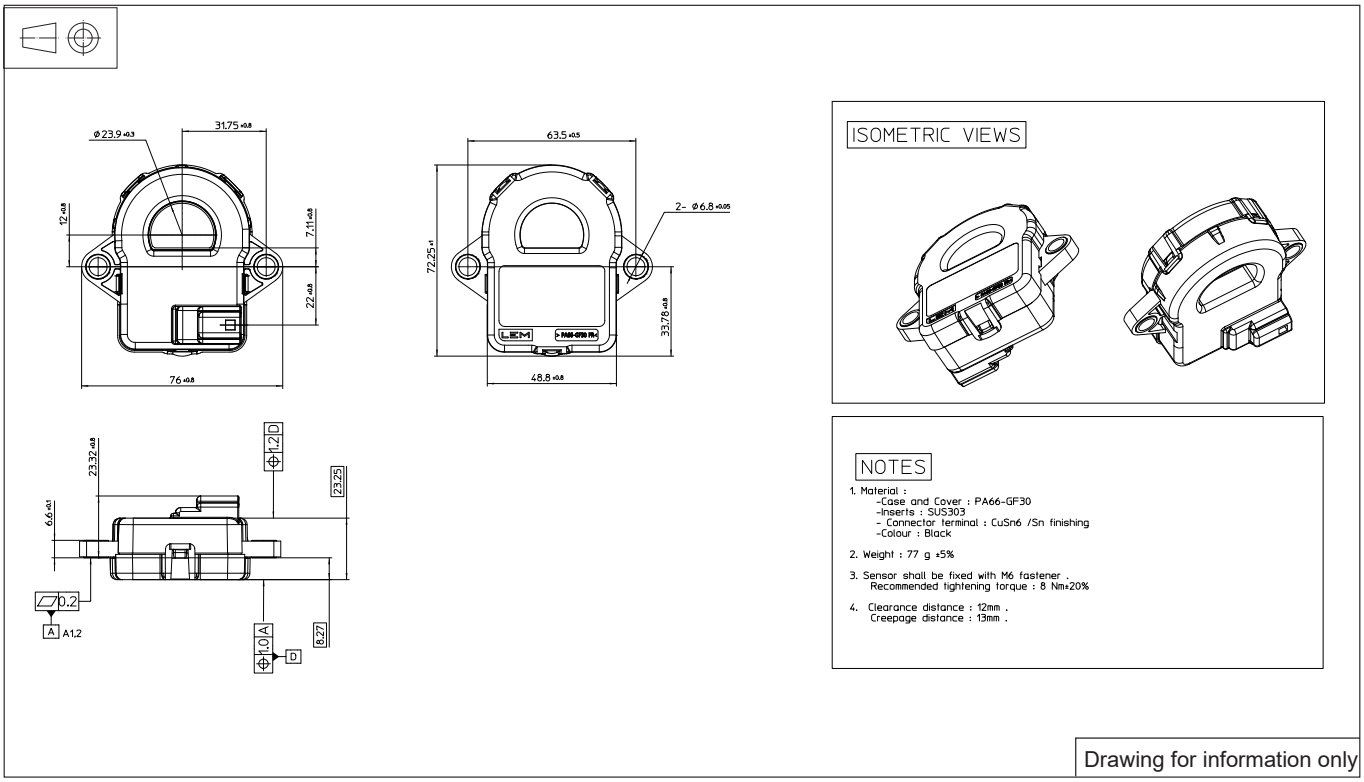
This transducer is a built-in device, not intended to be cleaned with any product. Nevertheless if the user must implement cleaning or washing process, validation of the cleaning program has to be done by himself.



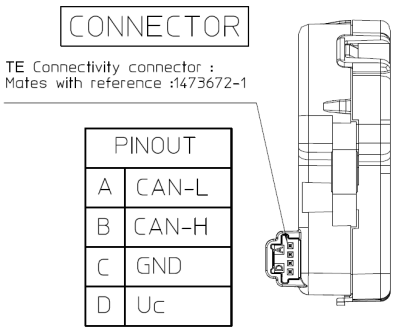
ESD susceptibility
The product is susceptible to be damaged from an ESD event and the personnel should be grounded when handling it.

Do not dispose of this product as unsorted municipal waste. Contact a qualified recycler for disposal.
Although LEM applies utmost care to facilitate compliance of end products with applicable regulations during LEM product design, use of this part may need additional measures on the application side for compliance with regulations regarding EMC and protection against electric shock. Therefore LEM cannot be held liable for any potential hazards, damages, injuries or loss of life resulting from the use of this product.

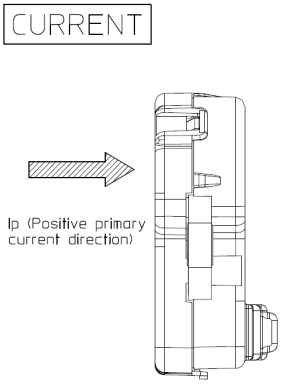
Dimensions (in mm. General geometrical tolerance 1.5; General linear tolerance ±0.5)



Connector definition

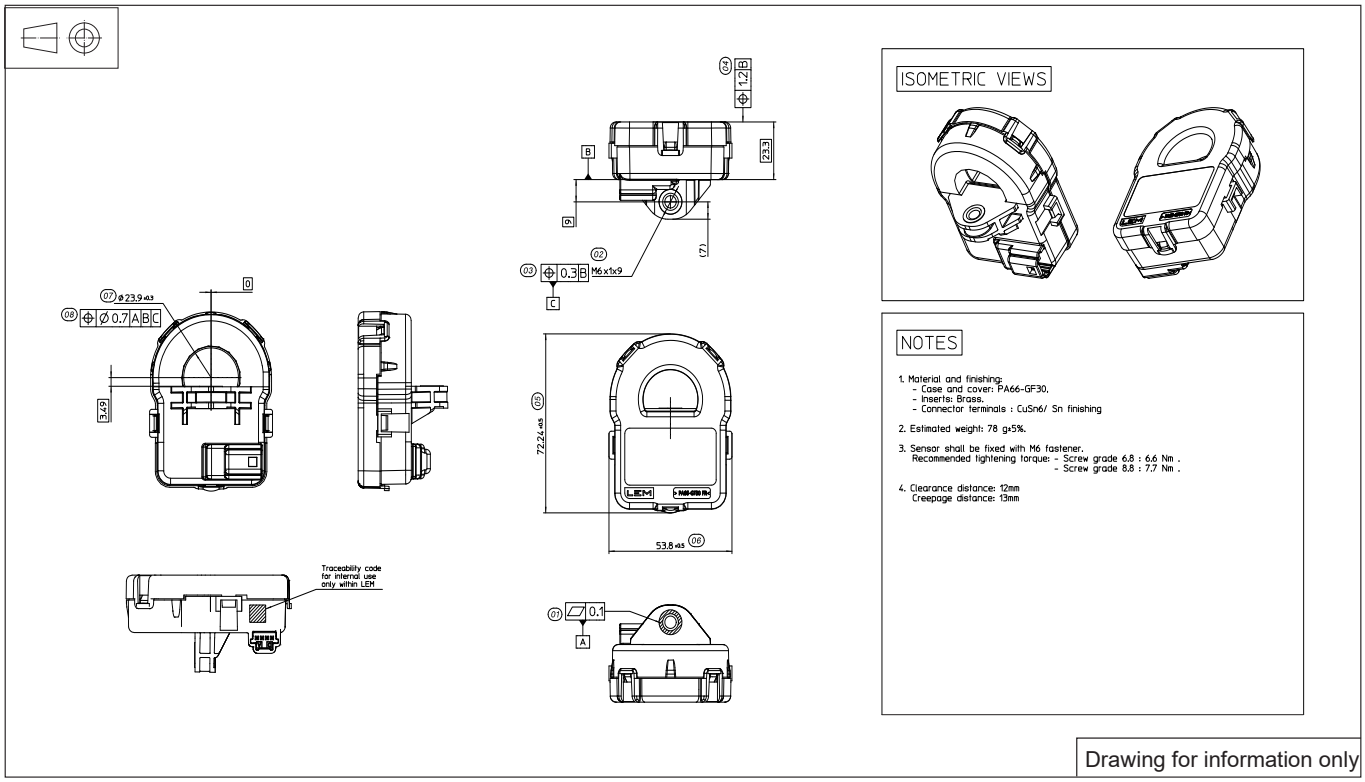


Primary current direction

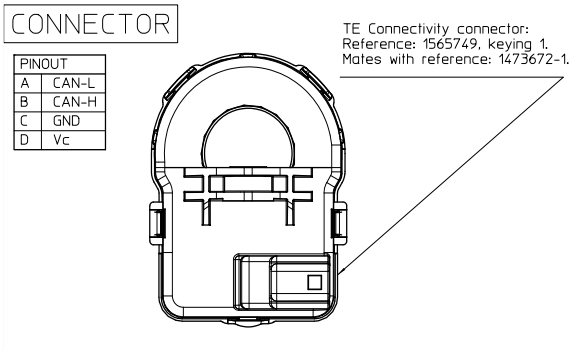


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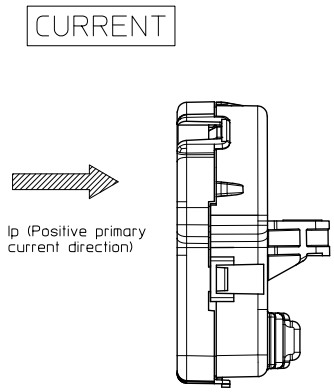
Dimensions (in mm. General geometrical tolerance 1.5; General linear tolerance ±0.5)



Connector definition



Primary current direction



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Physical summary

CAB-A 1000 series	Plastic	Mass	Mounting recommendation		
			Mounting	Screw	Torque
CAB-A 1000-00x	PA66-GF30	77.0 g ± 5 %	Panel	M6	Screw grade 6.8: 8 N·m
CAB-A 1000-60x					
CAB-A 1000-20x		78.0 g ± 5 %	Busbar	M6	Screw grade 6.8: 6.6 N·m Screw grade 8.8: 7.7 N·m
CAB-A 1000-80x					

Laser marking

Designation	Datecode	2D matrix content	Text marking area
CAB-A 1000-xxx[1)]	P = Production center ID YY = Last two digit of the year DDD = Day number of the year CC = Machine ID HH = Hour MM = Minute SS = Second J = Machine jig ID	PYYDDDCCHHMMSSJ70.G4.60.xxx[1)].0	

Note: [1)] "xxx" mean sensor variants' ID.

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Product variants summary

CAB-A 1000 series	UCLEM	Power supply	Casing version	CAN ID
CAB-A 1000-000	70.G4.60.000.0	12V	Panel	0x3C0
CAB-A 1000-001	70.G4.60.001.0			0x3C1
CAB-A 1000-002	70.G4.60.002.0			0x3C2
CAB-A 1000-003	70.G4.60.003.0			0x3C3
CAB-A 1000-004	70.G4.60.004.0			0x3C4
CAB-A 1000-200	70.G4.60.200.0		Busbar	0x3C0
CAB-A 1000-201	70.G4.60.201.0			0x3C1
CAB-A 1000-202	70.G4.60.202.0			0x3C2
CAB-A 1000-203	70.G4.60.203.0			0x3C3
CAB-A 1000-204	70.G4.60.204.0			0x3C4
CAB-A 1000-600	70.G4.60.600.0	24V	Panel	0x3C0
CAB-A 1000-601	70.G4.60.601.0			0x3C1
CAB-A 1000-602	70.G4.60.602.0			0x3C2
CAB-A 1000-603	70.G4.60.603.0			0x3C3
CAB-A 1000-604	70.G4.60.604.0			0x3C4
CAB-A 1000-800	70.G4.60.800.0		Busbar	0x3C0
CAB-A 1000-801	70.G4.60.801.0			0x3C1
CAB-A 1000-802	70.G4.60.802.0			0x3C2
CAB-A 1000-803	70.G4.60.803.0			0x3C3
CAB-A 1000-804	70.G4.60.804.0			0x3C4

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Absolute ratings (not operating)

Parameter	Symbol	Unit	Specification	Conditions
Load dump over-voltage	U_C	V	35	400 ms, R_i = 0.5 Ω
Over-voltage	U_C	V	24	1 min
Reverse polarity	U_C	V	−24	1 min
Minimum supply voltage	$U_{C\,min}$	V	7	CAN communication available
Maximum supply voltage	$U_{C\,max}$	V	24	
Ambient storage temperature	$T_{A\,st}$	°C	−40 /+85	
Creepage distance	d_{Cp}	mm	13	busbar hole
Clearance	d_{Cl}	mm	12	busbar hole
Withstand voltage	U_d	kV	5	50 Hz,1 min
Insulation resistance	R_{INS}	MΩ	1000	1500 V
IP Level			IP 40	

Characteristics in nominal range

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical Data						
Supply voltage	U_C	V	8	13.5	18	−1000 A ≤ I_P ≤ 1000 A
RMS current consumption	I_C	mA		65	85	I_P = 0 A, U_C = 13.5 V, T = 25 °C
				350	500	I_P = ±1000 A, U_C = 13.5 V, T = 25 °C
Ambient operating temperature	T_A	°C	−40		+105	
Performance Data						
Primary current nominal	$I_{P\,N}$	A	−1000		1000	
Primary current clamping		A	−1050		1050	1050 A
Time to first frame		ms		100		CAN frame
Linearity error	ε_L	%		±0.1		T_A = 25 °C
Total error	ε_{tot}	%		±0.5		−40 °C ≤ T_A ≤ 85 °C
				±0.8		85 °C ≤ T_A ≤ 105 °C
Offset		mA		±50		-40 °C ≤ T_A ≤ 105 °C
Frequency bandwidth	BW	Hz		20		With periodic CAN message @10ms

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Absolute ratings (not operating)

Parameter	Symbol	Unit	Specification	Conditions
Load dump over-voltage	U_C	V	58	300 ms, R_i = 1 Ω
Over-voltage	U_C	V	36	1 min
Reverse polarity	U_C	V	−32	1 min
Minimum supply voltage	$U_{C\,min}$	V	17	CAN communication available
Maximum supply voltage	$U_{C\,max}$	V	36	
Ambient storage temperature	$T_{A\,st}$	°C	−40 /+85	
Creepage distance	d_{Cp}	mm	13	busbar hole
Clearance	d_{Cl}	mm	12	busbar hole
Withstand voltage	U_d	kV	5	50 Hz,1 min
Insulation resistance	R_{INS}	MΩ	1000	1500 V
IP Level			IP 40	

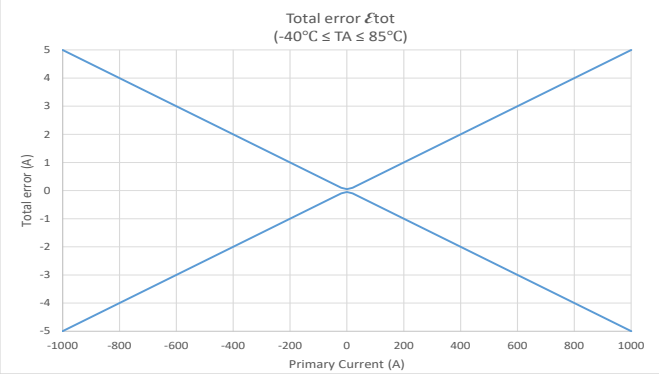
Characteristics in nominal range

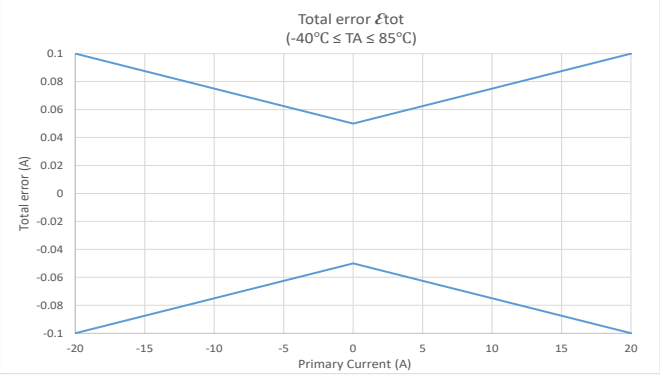
Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical Data						
Supply voltage	U_C	V	18	24	32	−1000 A ≤ I_P ≤ 1000 A
RMS current consumption	I_C	mA			50	I_P = 0 A, U_C = 24 V, T = 25 °C
					350	I_P = ±1000 A, U_C = 24 V, T = 25 °C
Ambient operating temperature	T_A	°C	−40		+105	
Performance Data						
Primary current nominal	$I_{P\,N}$	A	−1000		1000	
Primary current clamping		A	−1050		1050	
Time to first frame		ms		100		CAN frame
Linearity error	ε_L	%		±0.1		T_A = 25 °C
Total error	ε_{tot}	%		±0.5		−40 °C ≤ T_A ≤ 85 °C
				±0.8		85 °C < T_A ≤ 105 °C
Offset		mA		±50		−40 °C ≤ T_A ≤ 105 °C
Frequency bandwidth	BW	Hz		20		With periodic CAN message @10ms

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Total error

Total error from −40 °C to 85 °C:
Performances are considered with average value over 10 CAN frames (100 ms)



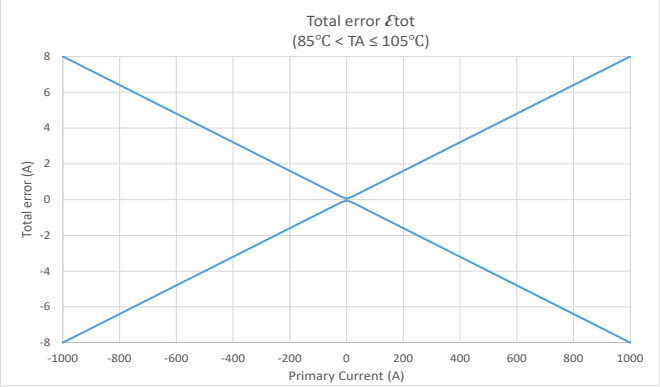


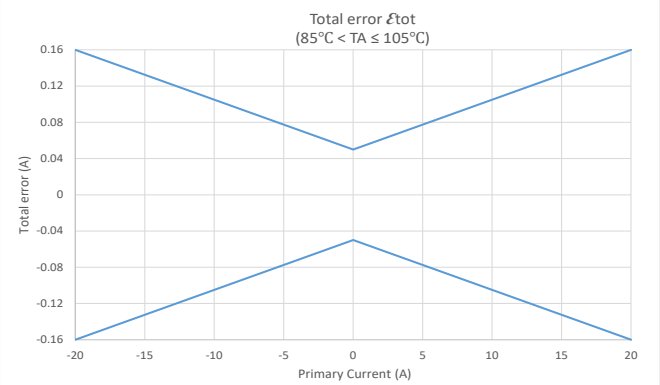
I_P	Total error limit ($-40\ °C \le T_A \le 85\ °C$)		Comment
(A)	(A)	(%)	
−1000	±5.0	±0.5	
−20	±0.1	±0.5	
0	±0.05	-	Not applicable
20	±0.1	±0.5	
1000	±5.0	±0.5	

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Total error

Total error from 85 °C to 105 °C:
Performances are considered with average value over 10 CAN frames (100 ms)





I_P	Total error (85 °C < T_A ≤ 105 °C)		Comment
(A)	(A)	(%)	
−1000	±8.0	±0.8	
−20	±0.16	±0.8	
0	±0.05	-	Not applicable
20	±0.16	±0.8	
1000	±8.0	±0.8	

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External magnetic field influences

The CAB-A 1000 Family delivers accurate current measurement. However, to ensure its proper functioning and to ensure the current measurement accuracy, it is necessary to comply with rules for setting up in the BMS environment. Thus, some conditions must be respected during the design of the environment of the transducer:

- Primary busbar centering
- Busbar shape
- Contactors position

LEM's recommendations can be found in the application notes available on request. Please contact LEM support team to ensure that your busbars design fits with LEM's design guideline.

Current ripple influences

Current ripples on the high voltage DC lines could be induced during power conversion from devices like DC/DC, inverter, on-board charger, and so on.

Current ripples not only negatively impact on the health of li-ion batteries, but also could cause malfunctions of the CAB transducer. The failure mode can manifest itself as a disturbed current measurement due to aliasing effect, leading to internal error when the threshold is exceeded. The malfunctions can be automatically recovered when the ripple current disappears.

Normally the ripple current should be measured and minimized during vehicle system design and development. For proper function of the CAB transducer, the acceptable maximum value of the ripple current should be checked. Please contact LEM support team on the reference values, LEM's recommendations can be found in the application notes available on request.

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CAN output specification

- CAN protocol 2.0B
- Bit order: big endian (Motorola MSB)
- CAN oscillator tolerance: ±0.27 %
- No sleep mode capability
- 120 Ω termination resistor to be added externally

Products	Message name	Description	CAN ID [1]	CAN speed	Length	Type	Period
CAB-A 1000-xxx	CAB-A 1000_IP	Primary current I_P message	-	500 kbps	8 Bytes	Standard	10 ± 1 ms

Note: 1) Refer to Product variants summary

Signal description	Signal name	Start bit	Length
Physical value to represent I_P 80000000H=0 mA, 7FFFFFFFH=−1 mA, 80000001H=1 mA Logical value to represent error stauts FFFFFFFFH: invalid value, FFFFFFFEH: initial value	CSM_BAT_CURRENT	24	32
Error indication: 0=Normal 1=Failure	ERROR_INDICATION	32	1
Error information	ERROR INFORMATION	33	7
Product name: “CABA”	PRODUCT_NAME	48	16
Software revision	SW_REVISION	56	8

Error Management

Failure Mode	I_P Value	Error Indication	Error Information
Memory Error [1]	0x FFFF FFFF	1	0x40
Over-current detection [1]	0x FFFF FFFF / I_P	1	0x41
Over-temperature error [1]	I_P	1	0x44
Supply under-voltage error [1]	0x FFFF FFFF	1	0x54
Supply over-voltage error [1]	0x FFFF FFFF	1	0x55
Internal common error [1]	0x FFFF FFFF / I_P	1	0x60
No error	I_P	0	0x64

Note: 1) See Application Note

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Applicable standards

Test	Standard	Procedure
CHARACTERIZATION AT 25 °C (Initial and final)	LEM CO.60.09.014.0	Total error; Linearity error
CHARACTERIZATION IN TEMPERATURE RANGE (Initial and final)	LEM CO.60.09.014.0	Total error; Linearity error
Environmental test		
Low temperature storage	ISO 16750.4-2023	Temperature −40 °C, duration 24 h, power off
High temperature storage	ISO 16750.4-2023	Temperature 105 °C, duration 96 h, power off
Low temperature operation	ISO 16750.4-2023	Temperature −40 °C, duration 24 h, power on
Thermal shock	ISO 16750.4-2023	T_{min} = −40 °C, T_{max} = 85 °C, exposure time 20 min, transition time < 30 s, 300 cycles, no power supply
Humid heat cycle	ISO 16750.4-2023	Composite temperature / humidity cyclic test, 10 cycles, power on
Steady-state temperature-humidity endurance	IEC 60068-2-78-2025	Equivalent to T = 85 °C, RH = 85 %, duration 1000 h, power on, monitoring
Temperature cycle endurance	ISO 16750.4-2023	T_{min}= -40 °C, T_{max}= 105 °C, exposure time 30 min, change rate 4 °C/min, 690 cycles, monitoring
High temperature operating endurance	ISO 16750.4-2023	T = 105 °C, duration 977 h, power on, monitoring
Salt spray	IEC 60068-2-11-2021	Salt concentration 5 ± 1 %, PH 6.5~7.2, 48 h
Condensation test	ISO 16750.4-2023	Type A, cycle numbers 3, twice functional check every cycle
Temperature cycle random vibration	ISO 16750.3-2023	Busbar version: acceleration 57.9 m/s², temperature -40 °C~105 °C, X/Y/Z axis, 32 h/axis, power on Panel version: acceleration 57.9 m/s², temperature -40 °C~105 °C, X/Y/Z axis, 32 h/axis, power on
Mechanical shock	ISO 16750.3-2023	Pulse shape half-sinusoidal, acceleration 500 m/s², duration 6 ms, shock numbers 10 per direction, 6 directions, power on
Free fall	ISO 16750.3-2023	2 falls per DUT, drop height 1 m on concrete ground or steel plate, X/Y/Z axis, 2 directions by axis
Cross section checking on PCBA	IPC-A-610J-2024	-

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Test	Standard	Procedure
Electrical test		
Direct current supply voltage	ISO 16750.2-2012	$U_{S\,min}$ = 8 V, $U_{S\,max}$ = 18 V
Reversed voltage	ISO 16750.2-2012	Case 2, U_A = -24 V, Duration : 60 s
Over-voltage	ISO 16750.2-2012	24 V, 1 min, @ 25 °C
Superimposed alternating voltage	ISO 16750.2-2012	$U_{S\,max}$ =18 V 1) U_{PP} = 6 V, 15 Hz ~ 30 kHz 2) U_{PP} = 1 V, 30 kHz ~ 200 kHz
Slow decrease and increase of supply voltage	ISO 16750.2-2012	$U_{S\,max}$ = 18 V, $U_{S\,min}$ = 8 V Sequence: 0 V -> $U_{S\,max}$ (1 min) -> $U_{S\,min}$ (1 min) -> 0 V
Momentary drop in supply voltage	ISO 16750.2-2012	$U_{S\,min}$ = 8 V, $U_{S\,min}$ to 4.5 V
Reset behavior at voltage drop	ISO 16750.2-2012	$U_{S\,min}$ = 8 V
Starting profile	ISO 16750.2-2012	Test Level I / II / III / IV
Load dump	ISO 16750.2-2012	Pulse B U_A = 13.5 V, U_S* = 35 V, U_S = 101 V, R_i = 0.5 Ω, T_d = 400 ms, 10 pulses at 1 min intervals
Ground reference and supply offset	ISO 16750.2-2012	Offset voltage = 1.0 V±0.1 V
Open circuit test	ISO 16750.2-2012	Single line / multiple line interruption, Opening duration : 10 s
Short circuit protection	ISO 16750.2-2012	Signal circuits, $U_{S\,max}$ = 32 V, CAN H/L to GND or $U_{S\,max}$
Withstand voltage	ISO 16750.2-2023	5 kV AC, 50 Hz, 60 s
Insulation resistance	ISO 16750.2-2023	1500 V DC for 60 s Resistance criteria: > 1000 MΩ

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Test	Standard	Procedure
Electrical test		
Direct current supply voltage	ISO 16750.2-2012	$U_{S\,min}$ = 18 V, $U_{S\,max}$ = 32 V
Reversed voltage	ISO 16750.2-2012	Case 2, U_A = -36 V, Duration : 60 s
Over-voltage	ISO 16750.2-2012	36 V, 1 min, @ 25 °C
Superimposed alternating voltage	ISO 16750.2-2012	$U_{S\,max}$ =32 V 1) U_{PP} = 6 V, 15 Hz ~ 30 kHz 2) U_{PP} = 1 V, 30 kHz ~ 200 kHz
Slow decrease and increase of supply voltage	ISO 16750.2-2012	$U_{S\,max}$ = 32 V, $U_{S\,min}$ = 18 V Sequence: 0 V -> $U_{S\,max}$ (1 min) -> $U_{S\,min}$ (1 min) -> 0 V
Momentary drop in supply voltage	ISO 16750.2-2012	$U_{S\,min}$ = 18 V, $U_{S\,min}$ to 9 V
Reset behavior at voltage drop	ISO 16750.2-2012	$U_{S\,min}$ = 18 V
Starting Profile	ISO 16750.2-2012	Test level I / II / III
Load dump	ISO 16750.2-2012	Pulse B U_A = 27 V, U_S* = 58 V, U_S = 202 V, R_i = 1 Ω, T_d = 300 ms, 10 pulses at 1 min intervals
Ground reference and supply offset	ISO 16750.2-2012	Offset voltage = 1.0 V±0.1 V
Open circuit test	ISO 16750.2-2012	Single line / multiple line interruption, Opening duration: 10 s
Short circuit protection	ISO 16750.2-2012	Signal circuits, $U_{S\,max}$ = 32 V, CAN H/L to GND or $U_{S\,max}$
Withstand voltage	ISO 16750.2-2012	5 kV AC, 50 Hz, 60 s
Insulation resistance	ISO 16750.2-2012	1500 V DC for 60 s Resistance criteria: > 1000 MΩ

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Test	Standard	Procedure
EMC test		
Conducted emission - voltage method	CISPR 25-2021	Frequency = 9 kHz to 108 MHz, Class 3, FM band class 4
Conducted emission - current method	CISPR 25-2021	Frequency = 9 kHz to 245 MHz, Class 3, FM band class 4
Low frequency electromagnetic emission	CISPR 25-2021	Frequency = 150kHz~30MHz
Radiated emission - ALSE method	CISPR 25-2021	Frequency = 100 kHz to 6 GHz, Class 3, FM band class 4
Voltage transient emission	ISO 7637.2-2011	Fast pulse: +50 V, -75 V, Slow pulse: +25 V, -50 V
Conducted transient immunity (Transient Disturbance conducted along supply line)	ISO 7637.2-2011	12V version: Pulse 1: -150 V, 5000 pulses Pulse 2a: +112 V, 5000 pulses Pulse 2b: +10 V, 10 pulses Pulse 2c: -50 V, 10 pulses Pulse 3a: -220 V, 1 h Pulse 3b: +150 V, 1 h 24V version: Pulse 1: -600 V, 5000 pulses Pulse 2a: +112 V, 5000 pulses Pulse 2b: +20 V, 10 pulses Pulse 2c: -50 V, 10 pulses Pulse 3a: -300 V, 1 h Pulse 3b: +300 V, 1 h
Conducted transient immunity (Transient Disturbance conducted along I/O lines)	ISO 7637.3-2016	Fast a(CCC): -200 V, 10 min Fast b(CCC): +200 V, 10 min Slow +(ICC): +20 V, 20 min Slow -(ICC): -20 V, 20 min
Bulk current injection	ISO 11452.4-2020	Frequency 100 kHz to 400 MHz, DBCI method 150 mm / 450 mm, CBCI method 150 mm / 450 mm / 750 mm, Level 200 mA
Radiated immunity	ISO 11452.2-2019	80~800 MHz: CW / AM and H / V, 100 V/m, 0.8~3.4 GHz: CW / PM1 and H / V, 150 V/m, 3.4~6 GHz: CW / PM1 and H / V, 150 V/m, 1.2~1.4 GHz: CW / PM2 and H / V, 300 V/m, 2.7~3.2 GHz: CW / PM2 and H / V, 300 V/m
Magnetic field immunity	ISO 11452.8-2015	Level IV
Portable transmitter immunity	ISO 11452.9-2021	Level II
ESD immunity - handling mode	ISO 10605-2023	Enclosure: contact: ±6 kV / ±8 kV, air: ±15 kV / ±25 kV, Pins: contact: ±6 kV / ±8 kV, 3 times / level, 150 pF / 330 Ω
ESD immunity - power-on mode	ISO 10605-2023	Enclosure: contact: ±4 kV / ±6 kV / ±8 kV, air: ±6 kV / ±8 kV / ±15 kV, Harness coupling board（Indirect discharge）: ±8 kV / ±15 kV, 3 times / level, 330 pF / 330Ω

Cybersecurity

The integrator shall ensure that this product is integrated, configured, and operated in accordance with the instructions provided in this Cybersecurity Manual. For more detail, please take contact with your LEM's support.

With restrictive access, the Cybersecurity manual is available.
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