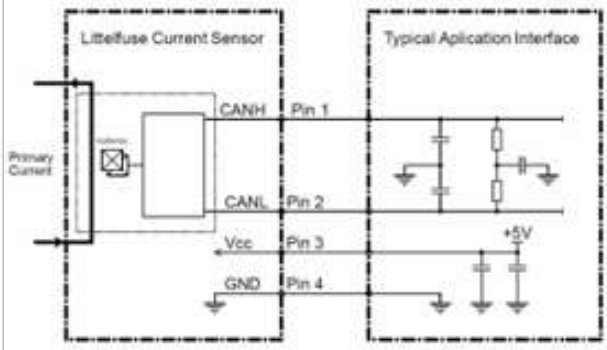
Current Sensor
CH1B032B

General Description

Littelfuse current sensor CH1B032B utilizes open-loop Hall effect technology to provide a ratiometric output signal proportionate to the magnetic flux density generated by c-core. The sensor offers digital output for ASIL C integration.

Typical Application Diagram



* Application CAN network shall have bus terminator with 120Ω. Split termination technique is recommended .

Features

- Open-loop Hall effect
- Busbar isolated measurement
- Unipolar +5V DC power supply
- Operating ambient temperature range:
  - -40 °C < T < +85 °C
- Digital output: CAN 2.0B with diagnostics, AUTOSAR E2E Profile 1A implemented.
- Over range current detection
- Very high accuracy obtained through multiple Hall sensor output combinations
- Digital signal output: Channel CAN: ±1500A

Benefits

- High sensing accuracy
- Low thermal offset drift
- Low thermal sensitivity drift
- Non-intrusive solution
- Redundant architecture for functional safety

Applications

- Battery management system

Mechanical Characteristics

- Plastic housing: PBT-GF30
- Busbar: Cu-ETP
- Mass: 105g ± 5g
- Pin definition: GND, Vcc, CANL, CANH

Mating Connector

- SUMITOMO 4-Way

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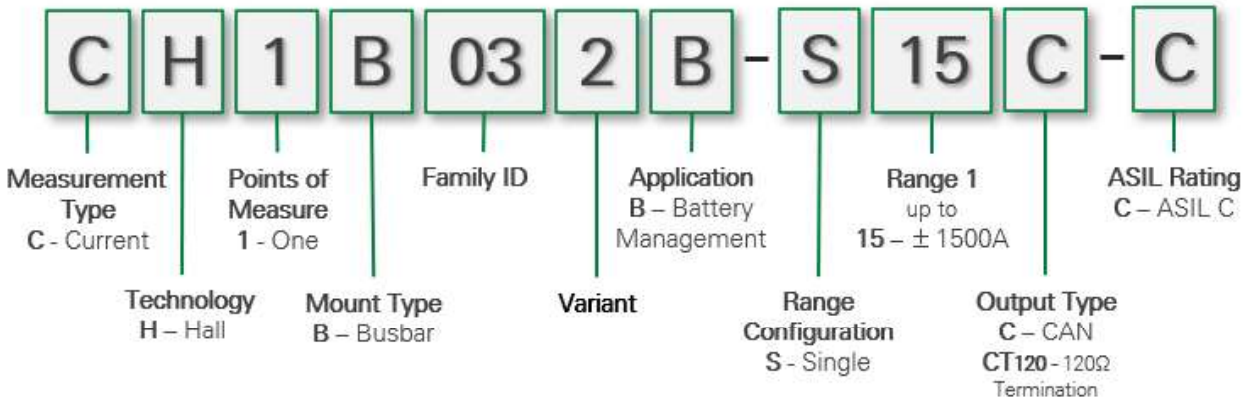
Littelfuse Current Sensor P/N Convention



Current Range Definition

Littelfuse offers customized calibration ranges. The definition below lists common calibration options.

Type Name	Littelfuse P/N	Current Range Out 1	Current Range Out 2
CH1B032B-**S07C-C**	25245-00-01	**±700 A**	N/A
CH1B032B-**S15C-C**	not released	**±1500 A**	N/A

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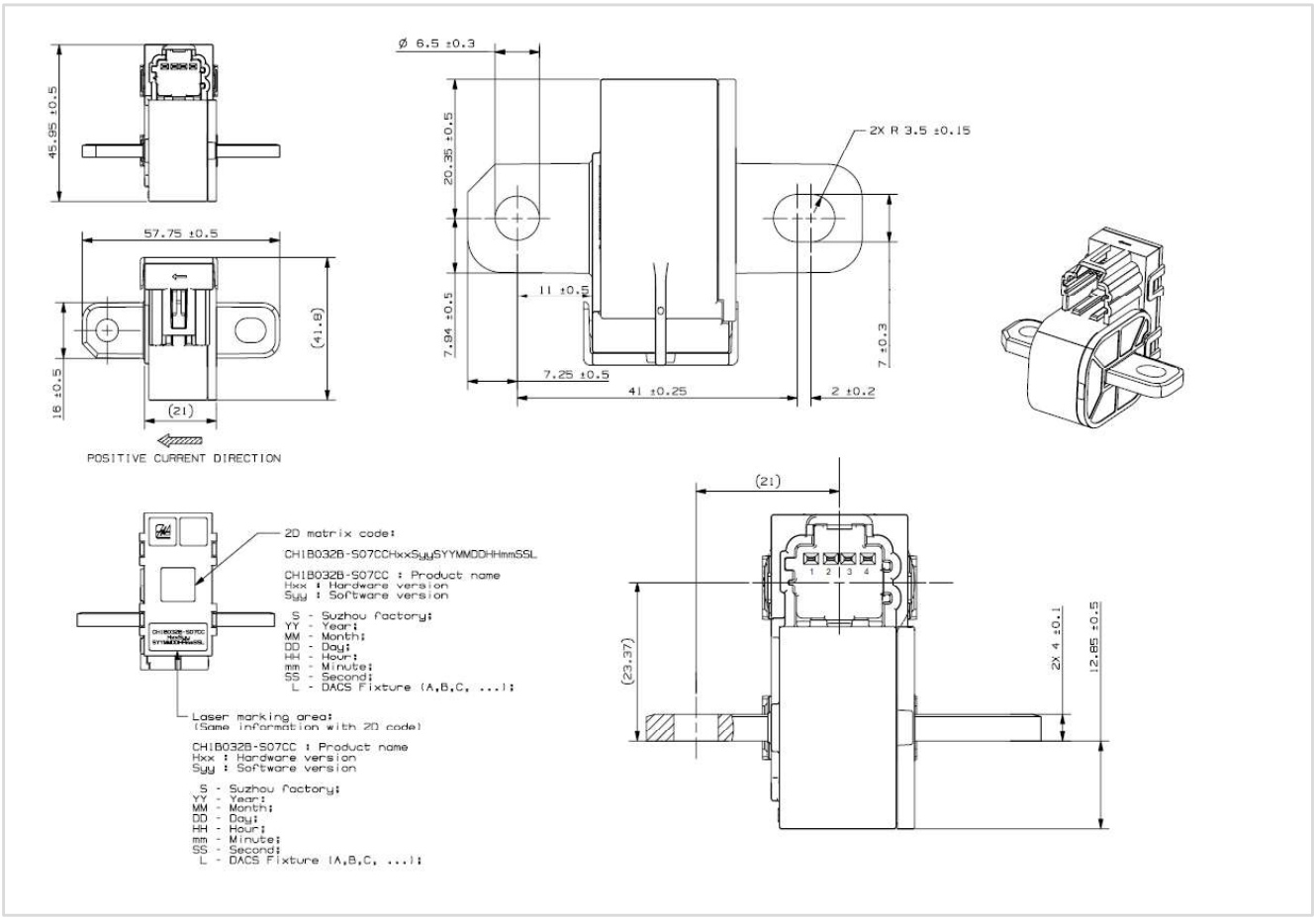
Current Sensor Dimensions (in mm)



Mating Connector

- Mating connector:
  - Housing:
    SUMITOMO 6098-8501 (Stellantis)
    SUMITOMO 6098-9908 (Ford)
    SUMITOMO 6098-8443 (GM)
  -Terminals (Tin plated):
    SUMITOMO 8240-0629 (Stellantis)
    SUMITOMO 8240-0627 (Ford)
- SUMITOMO connector meets GMW 3191

Pinout

Pin No.	Signal	Description
1	CANH	CAN High
2	CANL	CAN Low
3	Vcc	+5V power supply
4	GND	Ground

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Absolute Maximum Ratings (non- operating)

Parameter	Symbol	Min	Typ.	Max	Units	Comments
Maximum Supply Voltage	V_{ccMAX}	-6		5.5	V	1 min
Maximum Supply Current	I_{CMAX}			150	mA	
Max. Voltage to CAN	U_{OUT}			6	V	without ASIC damage
Max. Current to Output Pin	I_{OUT}			1	mA	without ASIC damage
Storage Temperature	T_{ST}	-40		+125	$°C$	
Insulation Resistance	R_{INS}	500			MΩ	800V DC, 60s
Dielectric Strength	I_{LEAK}			1	mA	2.5 kV AC, 50Hz, 1min
Creepage Distance	D_{CREE}		17		mm	
Electrical Clearance	D_{CLEA}		15.6		mm	
Comparative tracking index	CTI		PLC3			

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Common Characteristics (normal range)

Parameter	Symbol	Min.	Typ.	Max.	Units	Comments
Supply Voltage	V_{cc}	4.75	5	5.25	V	
Current consumption	I_{C_OP}		55	150	mA	
Operating Ambient Temperature	T_A	-40		+85[1]	°C	
Power-on Time	t_{on}			350	ms	

Digital Signal

Parameter	Symbol	Min.	Typ.	Max.	Units	Comment
CAN Protocol Type		CAN 2.0B				
CAN Frame Type		Standard (11bit ID)				
CAN Message Period	T_{CAN}		10		ms	
CAN Baud Rate	F_{CAN}		500		kbps	
Current signal Resolution per LSB			50		mA	
CAN Byte Order		Motorola (Big-endian)				
CAN Message ID	ID_{CAN}	0x3C0				
CAN Termination[3]		not populated				CAN termination resistor can be populated upon request
CAN Data E2E protection		AUTOSAR Profile 1A				
CAN AUTOSAR Data ID	$ID_{AUTOSAR}$	0xF3CF				Customer selectable

[1] Applicable operating temperature depending on RMS current flow and current frequency.
Busbar temperature shall not exceed 105 °C see Heat Rise & Continuous Current Performance. BMS busbar cooling concept to be reviewed.
[3] Note: part naming ending with "CT" for CAN termination populated

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CAN Message Mapping

CAN frames may be customized per customer request. Table below is provided as a typical example.

Signal name	Length (bits)	Byte Order	Value Type	Factor*	Offset* (units)	Minimum (units)	Maximum	Unit
CRC8	8	Big-endian	Unsigned	1	0	0	255	-
Counter	4	Big-endian	Unsigned	1	0	0	15	-
Current signal	18	Big-endian	Unsigned	0.05	-800.00	-800.00	+800.00	A
VCC signal	10	Big-endian	Unsigned	0.01	0	4.50	5.50	V
Temperature signal	9	Big-endian	Unsigned	1	-45	-45	+150	°C
DTC	5	Big-endian	Unsigned	1	0	0	31	-

* To convert to a physical value the following formula shall be used: physical value = (raw value * factor) + offset

CAN Bit Table

	Bit number							
Byte number	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte0	7	6	5	4	3	2	1	0
	(msb*)	CRC8						(lsb*)
Byte1	15	14	13	12	11	10	9	8
	not used				(msb)	Counter		(lsb)
Byte2	23	22	21	20	19	18	17	16
	(msb)	Current signal						
Byte3	31	30	29	28	27	26	25	24
	Current signal							
Byte4	39	38	37	36	35	34	33	32
	Current Signal	(lsb)	not used					
Byte5	47	46	45	44	43	42	41	40
	(msb)	VCC signal						
Byte6	55	54	53	52	51	50	49	48
		(lsb)	(msb)	Temperature signal				
Byte7	63	62	61	60	59	58	57	56
			(lsb)	(msb)	DTC			(lsb)

* (msb) – most significant bit of the signal; (lsb) – least significant bit of the signal

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CAN DTC

DTC	Error name	Error description
Bit56	Overrange	If bit=1 Overrange detected, Primary current exceeds ±750A. If bit=0: No overrange detected.
Bit57	General Sensor Error	If bit=1: Critical Error. Loss of ORD or Accuracy limits detection function(s). If bit=0: No general sensor error.
Bit58	Current Reading Accuracy Error	If bit=1: Current sensor reading is outside of safety goal accuracy limits. If bit=0: Current sensor reading is within safety goal accuracy limits.
Bit59	CAN Communication Error	If bit=1: Current sensor encountered CAN communication error more than 10 times in a row. If bit=0: No CAN communication error occurred in the last 10 frames.
Bit60	Power Supply Voltage Error	If bit=1 Power supply voltage is out of specification (>5.25V or <4.75V). If bit=0: Power supply voltage is within specification (≥4.75V or ≥ 5.25V).

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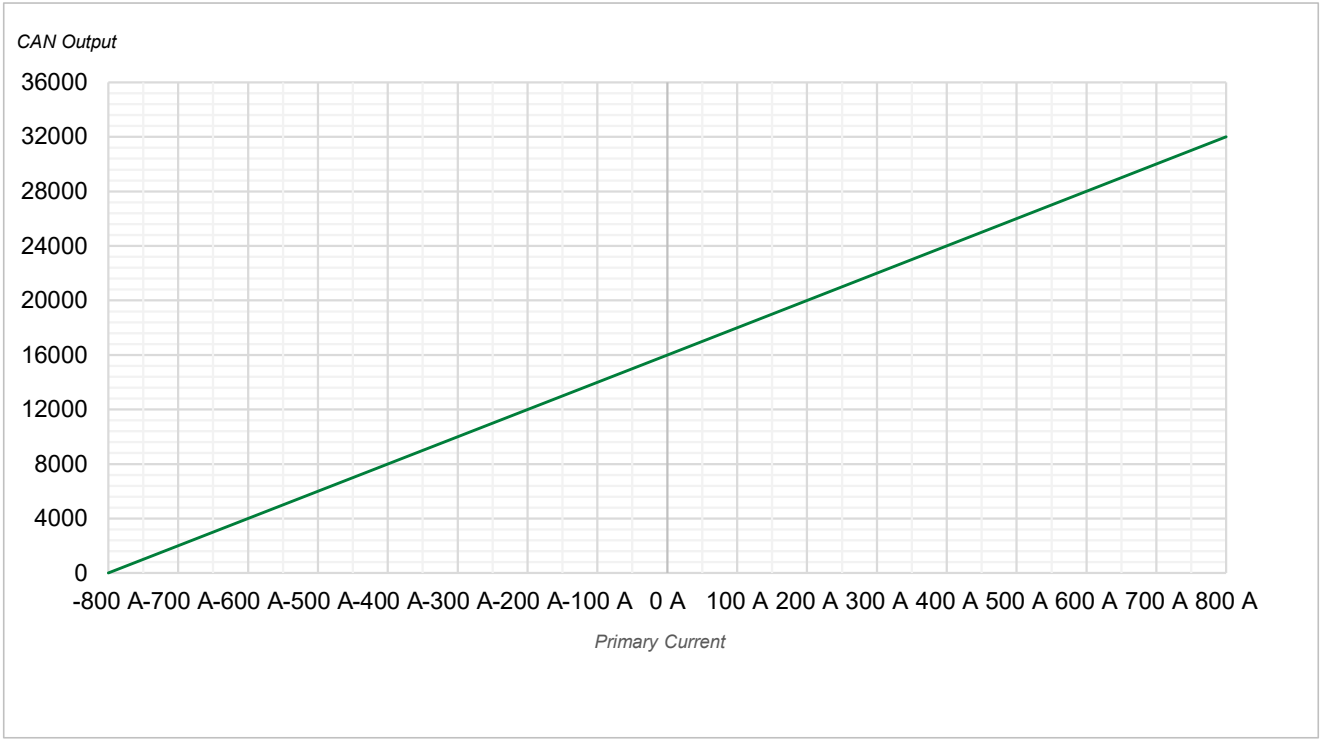
CAN Output Transfer Function



{CAN_Output} = ({Primary_Current} - {Offset}) / {Factor}
{Primary_Current} = {CAN_Output Decimal} * {Factor} + {Offset}

Primary Current	Factor	Offset	CAN Output Value DEC	CAN Output Value HEX
800	0.05	-800	32000	7D00
100	0.05	-800	18000	4650
0	0.05	-800	16000	3E80
-100	0.05	-800	14000	36B0
-800	0.05	-800	0	0

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ISO 26262 ASIL

Safety Goal	FSR	ASIL	Safe State	FTTI
Current sensor to provide overrange	Current sensor shall report overrange to BCU over the digital communication line via E2E message when peak current magnitude exceeds the ability for the sensor to report a valid reading.	ASIL-C	Current sensor reports to BPCM via CAN DTC message failure mode: Incapability to report overrange event.	6.5 s
Current sensor to provide current value	Current sensor shall accurately report current over the digital communication line via E2E message.	ASIL-C	Current sensor reports to BPCM via CAN DTC message failure mode: Current measurement is outside of the accuracy limits.	6.5 s

Safety Goal: Current Sensor to Provide Overrange

Primary Current I_M (A)	Overrange Event Report
[-∞, -750], [+750, +∞]	Yes
[-750, -700], [+700, +750]	Yes/No
[-700, +700]	No

Safety Goal: Current Sensor to Provide Current Value

Primary Current I_p (A)	ASIL-C Redundant Signal, Global Error (A) (−40 °C ≤ T_A ≤ +85 °C, Vcc = 5V)
[-700, -100], [+100, +700]	± 4% * I_P
[-100, +100]	4 A

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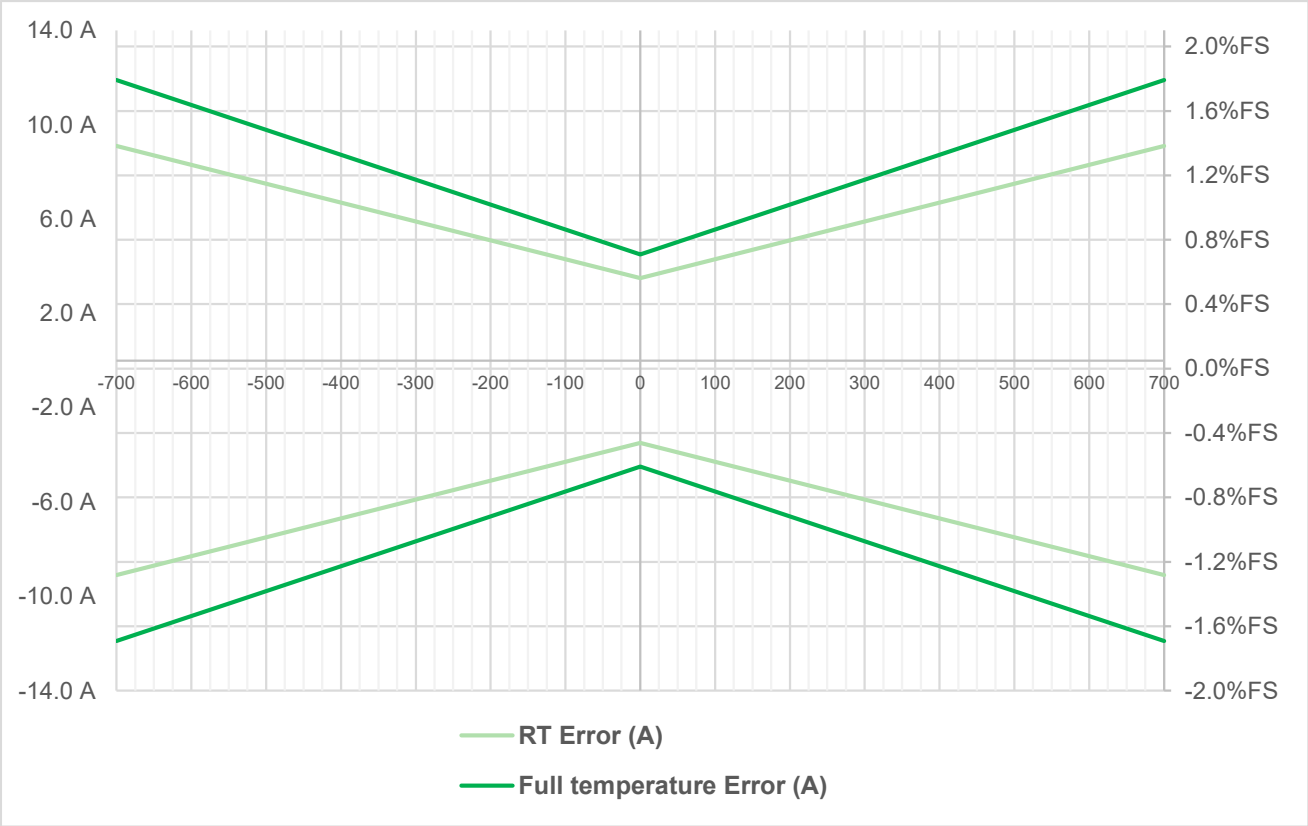
Digital Measuring High Current Range: ±700A

Parameter	Symbol	Min	Typ.	Max	Units	Comments
Measuring Current	I_P	-700		+700	A	

Global Error over temperature ±700 A, after reliability tests, specified at 3 sigma



Primary Current $\pm I_P$	Total Error @25°C 4.75V ≤ Vcc ≤ 5.25V	Total Error @25°C 4.75V ≤ Vcc ≤ 5.25V	Total Error @Trange −40 °C ≤ T_A ≤ +85°C 4.75V ≤ Vcc ≤ 5.25V	Total Error @Trange −40 °C ≤ T_A ≤ +85°C 4.75V ≤ Vcc ≤ 5.25V
(A)	(A)	(% of full scale)	(A)	(% of full scale)
+700	± 9.1	± 1.3%	± 11.9	± 1.7%
0	± 3.5	± 0.5%	± 4.5	±0.64%
-700	± 9.1	± 1.3%	± 11.9	±1.7%

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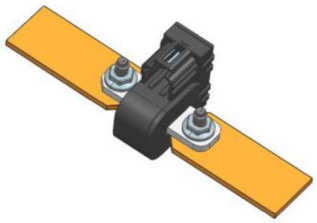
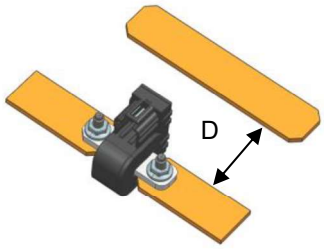
Setup Recommendation

Busbar Mounting:



- Mount with ISO M6 serrated flange screw or bolt, or with M6 fastener screw or bolt combined with lock washer.
- Assembly torque: 7N·m ± 10%
- It is recommended to pre-tighten mounting fasteners both sides of the integral busbar prior to applying final assembly torque.
- Recommended mating busbar cross section: 3x20mm

Adjacent Busbar Spacing:



- The distance between sensor busbar and adjacent busbar is recommended to be more than: 20 mm @ 500 A
- Adjacent busbar should not pass directly above or below current sensor housing.
- Busbar layout should be reviewed with Littelfuse for compatibility.

Handling

- Handling of sensors should be minimized by maintaining parts within packaging until point of assembly.
- Contact with sensor terminals should be avoided.
- To avoid potential damage, adherence to ESD handling best practices is recommended.
- Dropped parts should be scrapped regardless of evidence of external damage.

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Heat Rise & Continuous Current Performance

This test is started from 85°C ambient temperature. Heat rise could be verified by other primary current value.

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Validation Test Specification

Test Groups	Reference	Test Condition
Environmental		
Low Temperature Storage	ISO 16750-4 §5.1.1.1	24h @ -40C
High Temperature Storage	ISO 16750-4 §5.1.2.1	48h @ 125C
Low temperature operating endurance		48 hours @ -40C, continuous monitoring
Temperature Hum Cycle (THC)		@ -10C / 65C / 93% RH 240 h, continuous monitoring
High Temp Humidity Endurance (HTHE)		85C / 85%RH 1000 hours (250 h interim check). 5.0 V , Ip = 0A
High Temp operating endurance		1300hr @ 85C (250 h interim check). Power supply off.
Powered Thermal Cycle	ISO16750-4 §5.3.1	300 cycles @ -40/125C, total 500h continuous monitoring
Thermal shock	ISO16750-4 §5.3.2	300 cycles @ -40/125C, 30min dwell time
Mechanical		
Random Vibration		Category: V2-200k-mi Vibration Profile: Per CS.00056 Duration: 16 hrs. per axis continuous monitoring
Mechanical Shock	ISO 16750-3 §4.2.2.2	50g, 11ms, 60 shocks 100g, 11ms, 24 shocks continuous monitoring
Chemical exposure test		Coolant additive acc to CS.00054
Handling drop		Test Height: 1 meter
Electrical		
Supply Voltage Range		Functional Behaviors M1.
Immunity to Short Circuits in the Supply Voltage Input and Load Output Lines		Post test function check behavior M1.
Immunity to Short Circuits in I/O Signal Lines		All signal input and output lines shall be tested by short circuiting the individual lines to ground and to +5 V for at least 5 s (CS.00054 section 5.5.2) Post test function check behavior M1
Over Current Withstand		Apply and measure target current 1400A for 100s. Return current to zero, continuing to measure, and rest for 100s. Total cycle time is 200s.
EMC		
ESD Handling Test		Functional behavior M1, Post ESD Injection.
ESD Operating Test		Functional behavior M1 for CAN
CISPR25 Conducted RF Emissions – (Voltage on Supply Lines)		Lines taken out of current probe during testing PIN1 CANH, and PIN2 CANL(Differential line).
CISPR25 Conducted RF Emissions – (Current on all Lines in Harness)		Lines taken out of current probe during testing PIN3 VREF, and PIN4 RTN.

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CISPR25 Radiated Emissions		ALSE method
Radiated Immunity: BCI		Levels to test L1 (required functional status M1), L2 (required functional status M2).
Radiated Immunity: ALSE		Level to test L2 (required functional behavior M1)
Magnetic Field Immunity		Functional behavior M1
Transient Immunity of I/O or Sensor Lines – Coupling Clamp (CCC)		Functional behavior M2. Sensor is powered by +5V
Transient Immunity of I/O or Sensor Lines – Direct Capacitive Coupling (DCC)		Functional behavior M2. Sensor is powered by +5V
Connector		
Connector Drop Test	USCAR-2, 5.4.8.2	Samples shall meet the Acceptance Criteria of section 5.1.8, Visual Inspection. Components shall not be displaced from their shipping position
Extraction Force - With Primary and Secondary Locks	SAE/USCAR-2, 5.4.1.3 B	Check the extraction force
Voltage Drop	USCAR-2, 5.3.2	Check the voltage drop of connector pin.
Polarization Feature Effectiveness	USCAR-2, 5.4.4.3.7	Check whether there is any damage to the test sample and whether there is contact between the male and female terminals under three incorrect assembly conditions.
Connector-to Connector Audible Click - Pre-Moisture Conditioning	SAE/USCAR-2, 5.4.7.3	Connector locking sonde level check before aging
Connector-to Connector Audible Click - Post Moisture Conditioning	SAE/USCAR-2, 5.4.7.3	Connector locking sonde level check after aging
CPA Disengagement	SAE/USCAR-2, 5.4.5.2.3 B	(Lock to preset) After 2 cycles without terminal

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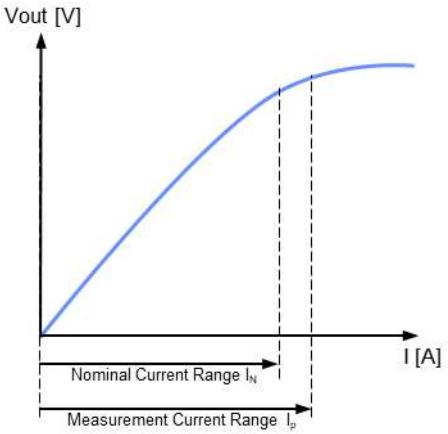
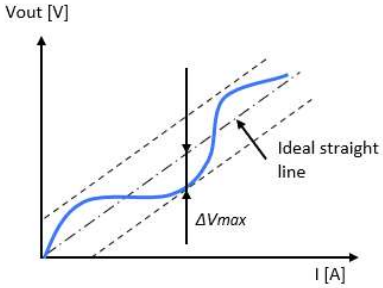
Performance Parameter Definitions

Primary current definition (I_N, I_p)



Linearity error (ε_L)

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



$$\varepsilon_L = \pm \frac{\Delta V_{max}}{V_{FS}} \times 100\%$$

Offset error (ε_O)

The voltage drift of the measured sensor output V_{out} at 0A compared to the ideal value 2.5V (@V_c = 5V) is called the total offset voltage error. This offset error can be attributed to the electrical offset, magnetic offset and related drift over temperature.

$$\varepsilon_O = \pm \frac{V_{out} - V_O}{V_{FS}} \times 100\%$$

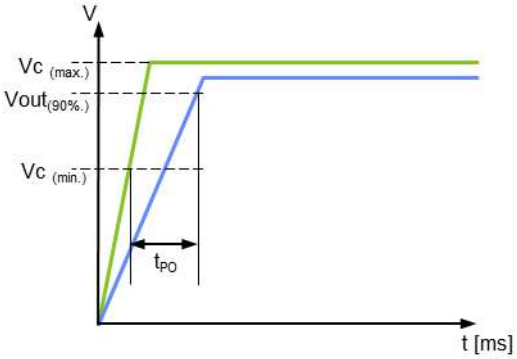
Sensitivity error (ε_S)

The sensor sensitivity error is the drift of sensor's ideal sensitivity.

$$\varepsilon_S = \pm \frac{G - G_{th}}{G_{th}} \times 100\%$$

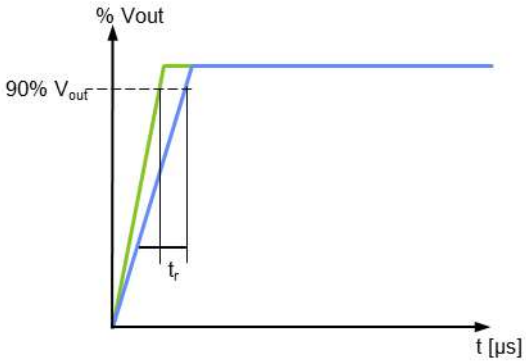
Power-on time (t_{po})

The Power-on time is the duration from V_{DD}(min.) to 90% of Vout.



Response time (t_r)

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



Typical minimum and maximum values

Typical minimum and maximum values get determined during initial product characterization. Typical values representing the normal of statistical ±1σ interval (68.27% probability).
Minimum and maximum values representing the Gaussian distribution boundaries of the ±3σ interval (99.73% probability).

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Contact

Custom electrical and environmental specifications can be designed to meet any need, please contact Littelfuse Engineering for details.

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