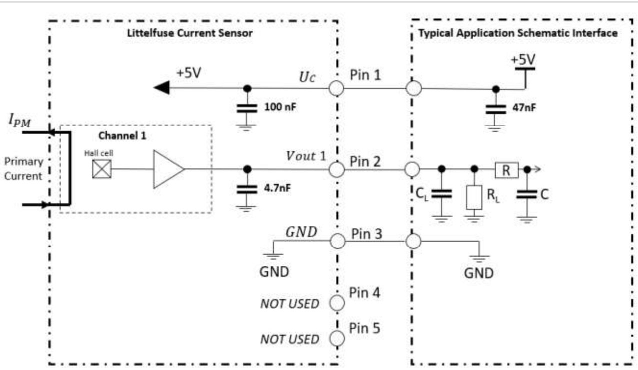
Current Sensor

CH1B02xM

Description

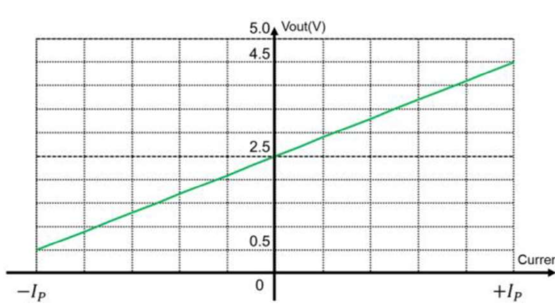
Littelfuse CH1B02xM current sensor is an open-loop Hall Effect device which provides a ratiometric output signal proportional to the magnetic flux density generated by a C-core concentrator. The sensor is offered in three configurations: standard connector, standard connector with cable retainer, and with CPA equipped connector.

Typical Application Diagram



- CL: 1 - 4.7nF EMC protection (optional).
- RC Low pass filter (optional).
- RL > 10 KΩ.

Output Characteristics



Features

- Analog ratiometric output
- +5V DC unipolar power supply
- Operating temp. range: -40°C ... +125°C
- Open-loop Hall effect
- ASIL-QM
- Current measurement: up to ±1500A

Applications

- Inverter
- Starter Generator
- DC/DC Converter
- AC/DC Converter

Benefits

- High accuracy, non-intrusive solution
- Low thermal offset drift
- Low thermal sensitivity drift

Mechanical Characteristics

- Case Material: PBT-GF30, UL94-V0
- Mass: 60.5 g ± 5%
- Busbar: Cu-ETP
- Protection degree: IP4X (IEC 60529)

Mating Connector

- CH1B020M / CH1B021M

  Molex DuraClik 5-way – info pg.3-4

- CH1B022M

  Tyco 4-way with CPA – info pg.5

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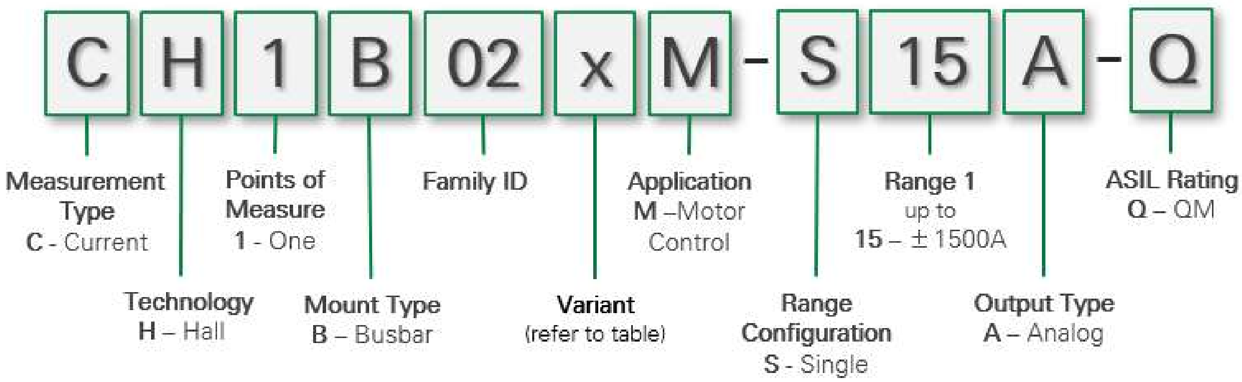
Littelfuse Current Sensor P/N Convention



Product Variants

Part Name	Config	Ref. Image
CH1B020M	Standard	
CH1B021M	Cable Retainer	
CH1B022M	CPA Connector	

Current Range Definition

Littelfuse offers customized calibration ranges.

Naming Examples:

Type Name	Current Range
CH1B02xM-S02A-Q	±200 A
CH1B02xM-S04A-Q	±400 A
CH1B02xM-S06A-Q	±600 A
CH1B02xM-S08A-Q	±800 A
CH1B02xM-S10A-Q	±1000 A
CH1B02xM -S12A-Q	±1200 A
CH1B02xM -S15A-Q	±1500 A

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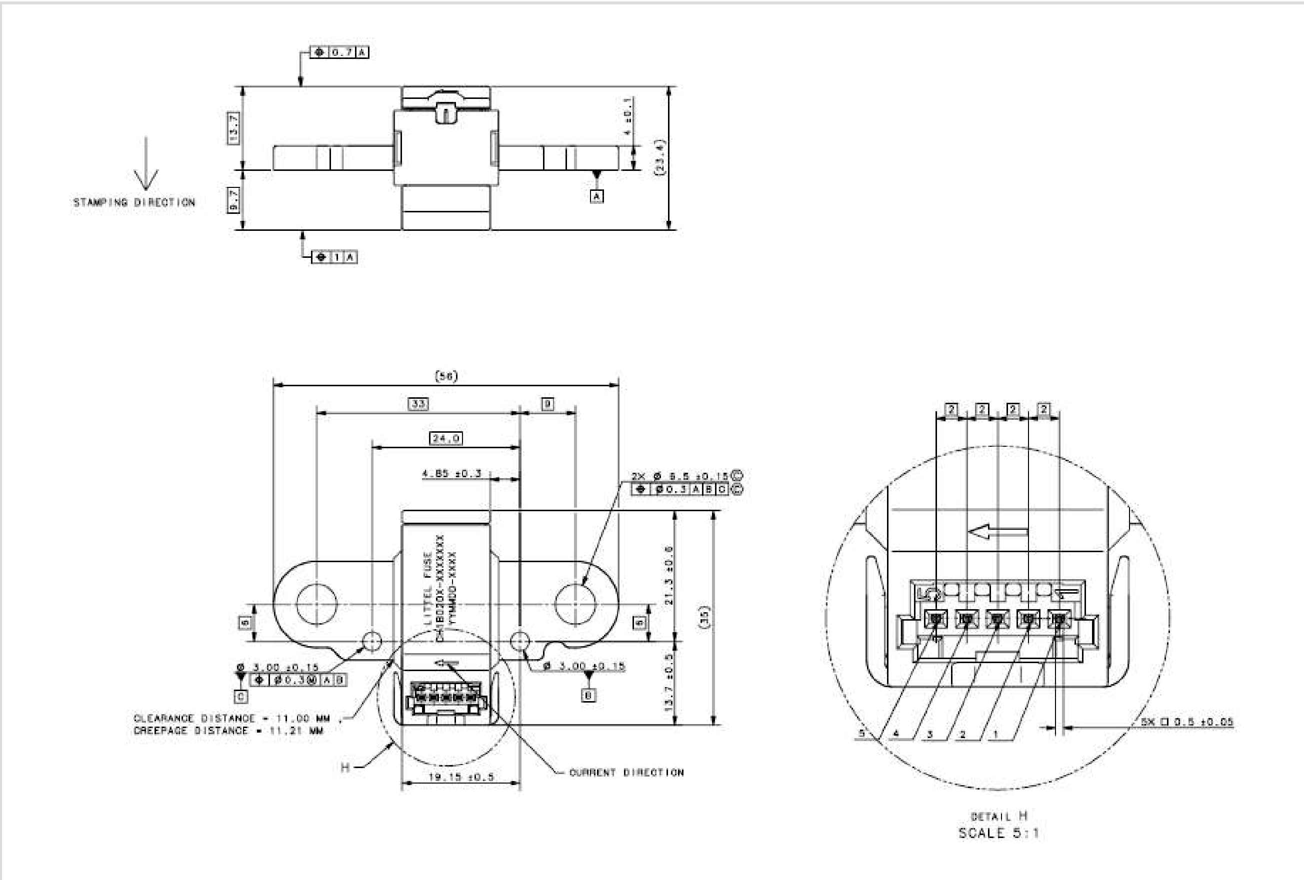
Current Sensor Dimensions (in mm)

CH1B020M



Remark

$V_{out} > V_o$, when I_p flows in the positive direction (see current direction arrow on drawing).

Mating Connector

- Molex DuraClik 5-Way – ISL Version
- Housing 5W, Black: 5601230501
- Retainer 5W Gray: 5601250500
- Terminal: 5601240101

Pinout

Pin No.	Signal	Description
1	VCC	+5V Power supply
2	OUTPUT 1	Channel 1 OUT
3	GND	Ground
4	OUTPUT 2	Channel 2 OUT
5	NO CONN	Not Connected

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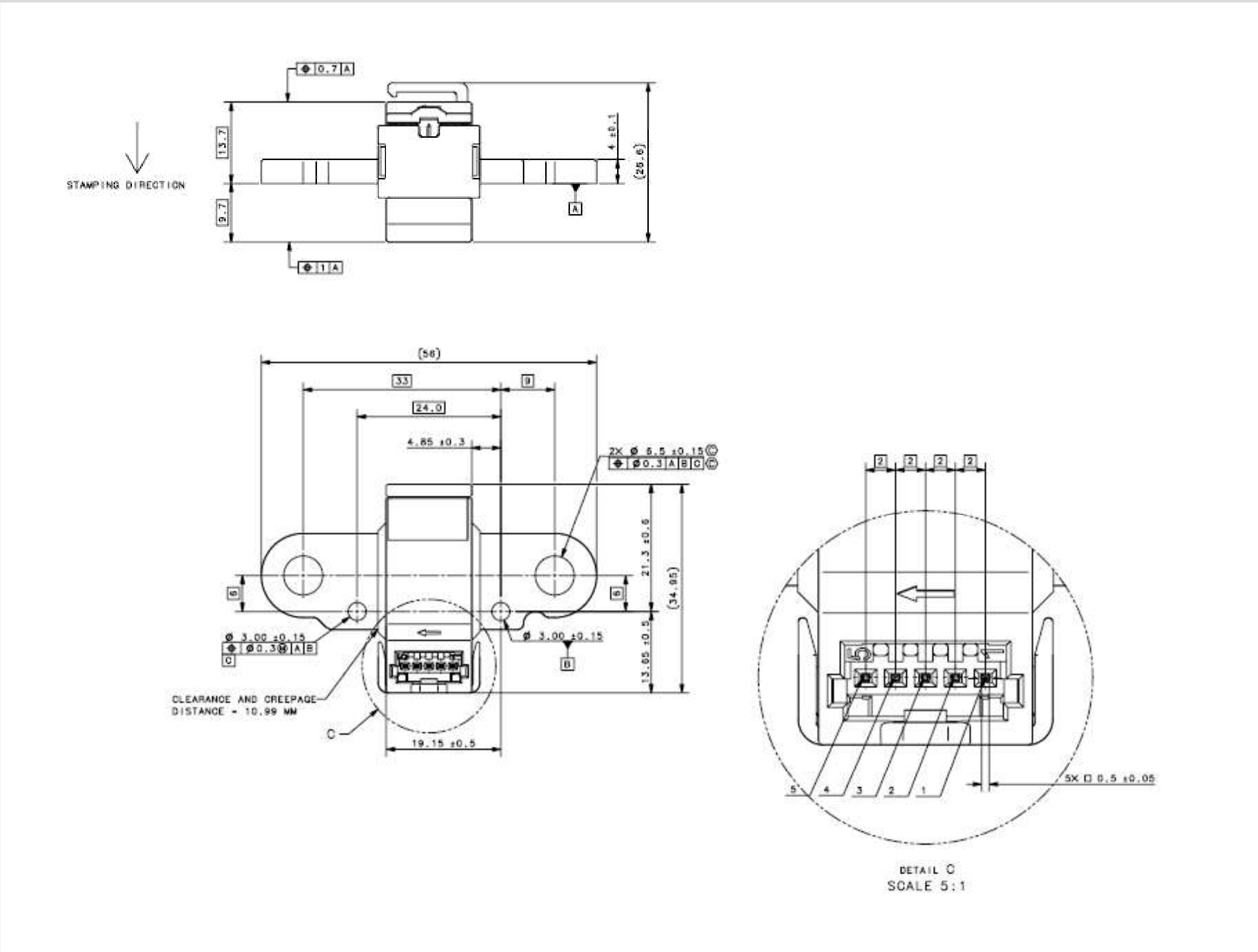
Current Sensor Dimensions (in mm)

CH1B021M



Remark

$V_{out} > V_o$, when I_p flows in the positive direction (see current direction arrow on drawing).

Mating Connector

- Molex DuraClik 5-Way – ISL Version
- Housing 5W, Black: 5601230501
- Retainer 5W Gray: 5601250500
- Terminal: 5601240101

Pinout

Pin No.	Signal	Description
1	VCC	+5V Power supply
2	OUTPUT 1	Channel 1 OUT
3	GND	Ground
4	OUTPUT 2	Channel 2 OUT
5	NO CONN	Not Connected

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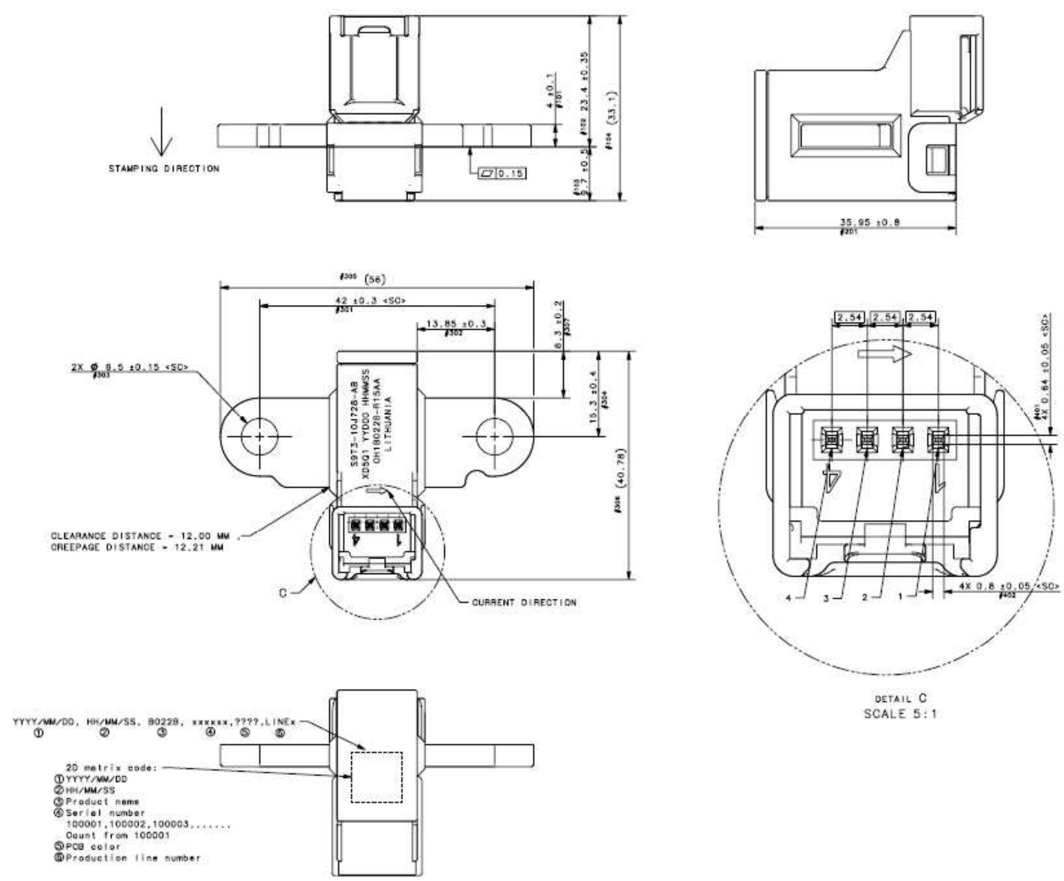
Current Sensor Dimensions (in mm)

CH1B022M



Remark

$V_{out} > V_o$, when I_p flows in the positive direction (see current direction arrow on drawing).

Mating Connector

- TE 4-Way – Generation Y
- Housing with CPA: 2035360-2
- Terminal: 1924955-1

Pinout

Pin No.	Signal	Description
1	VCC	+5V Power supply
2	OUTPUT 1	Channel 1 OUT
3	OUTPUT 2	Channel 2 OUT
4	GND	Ground

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Absolute Maximum Ratings (non-operating)

Parameter	Symbol	Min	Typ.	Max	Units	Comments
Maximum Supply Voltage	U_{CMAX}	-0.3		10	V	
Maximum Output Current	I_{CMAX}	-10		10	mA	
Ambient Storage Temperature	T_{ST}	-40		+125	$°C$	
Insulation Resistance	R_{INS}	500			MΩ	500V DC, 60s
Dielectric voltage	I_{LEAK}			1	mA	2.5 kV AC, 50Hz, 1min
Creepage distance	D_{CREE}		12.21		mm	
Clearance	D_{CLEA}		12		mm	
Comparative tracking index	CTI		0 PLC		-	UL746A

Mechanical Product Properties

Parameter	Symbol	Level	Standard	Comments
Flammability Class		V0	UL94	
Protection Degree		IP 4X	IEC 60529	

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Common Characteristics in Normal Range

Parameter	Symbol	Min	Typ.	Max	Units	Comments
Supply Voltage	U_C	4.75	5	5.25	V	
Current Consumption	I_C		11	15	mA	Single channel only
Current Consumption	I_C		22	30	mA	w/ Dual or Redundant channel
Operating Ambient Temperature	T_A	-40		+125[1]	$°C$	
Output Voltage	V_{out}	$V_{out} = (U_C/5) \times (V_O + I_p \times S_{th})$			V	
Output Offset Voltage	V_o		2.5		V	U_C= 5V, $I_p = 0\ A$
Clamping Voltage Lower	V_{CL}		0.3		V	U_C = 5V, $T_A = 25$ °C
Clamping Voltage Upper	V_{CU}		4.7		V	U_C = 5V, $T_A = 25$ °C
Power-on Time	t_{po}			1	ms	
Response Time	t_r		2	6	us	
Frequency Bandwidth	BW	40			KHz	@-3dB
Phase Shift	$\Delta\varphi$		-4		°	@DC to 1KHz
Supply Capacitance	C_{SUP}	47	100		nF	Capacitors need to be located near supply pin
Load Capacitance	C_L		2.2		nF	
Load Resistance	R_L		25		kΩ	
Linearity Error	$\mathcal{E}_L$		±0.8		%FS	U_C = 5V, over temp
Offset Error	$\mathcal{E}_O$		±15		mV	U_C = 5V, T_A= 25°C, I_A= 0A
Sensitivity Error	$\mathcal{E}_S$		±1		%	U_C = 5V, over temp

[1] Practical operating ambient temperature depending on RMS current profile. Maximum permissible busbar surface temperature: ≤ 150°C.

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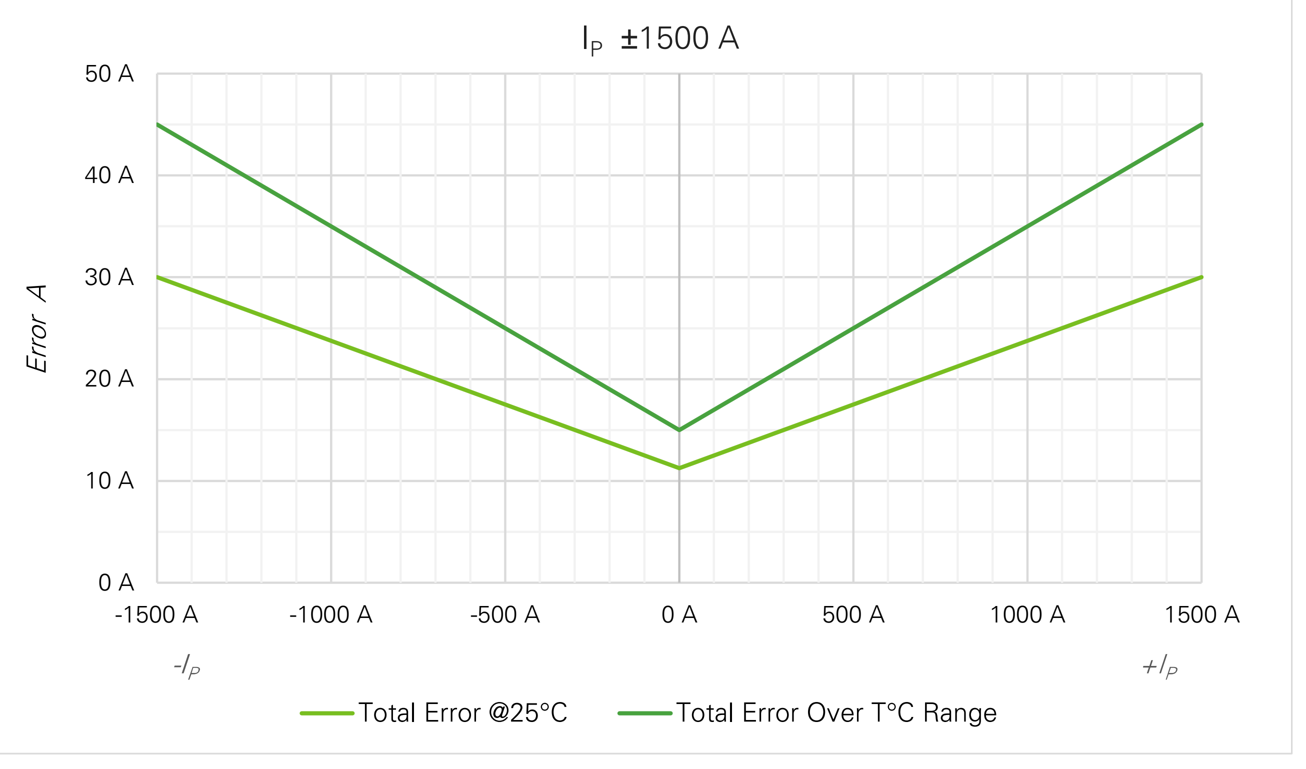
Littelfuse offers customized calibrations.
Performance data below is applicable for a ±1500A calibration.

Parameter	Symbol	Min	Typ.	Max	Units	Comments
Primary Current	I_p	-1500		+1500	A	
Sensitivity	S_{th}		1.33		mV/A	U_C = 5 V

Total Error



Primary Current $\pm I_P$	Sensitivity	Total Error @25°C		Total Error @Trange	
A	mV/A	%	A	%	A
+1500 A	1.33	±2.00 %	±30.00 A	±3.0 %	±45.0 A
0	1.33	±0.75 %	±11.25 A	±1.0 %	±15.0 A
-1500 A	1.33	±2.00 %	±30.00 A	±3.0 %	±45.0 A

*Error in current (A) = Total Error % ** I_p

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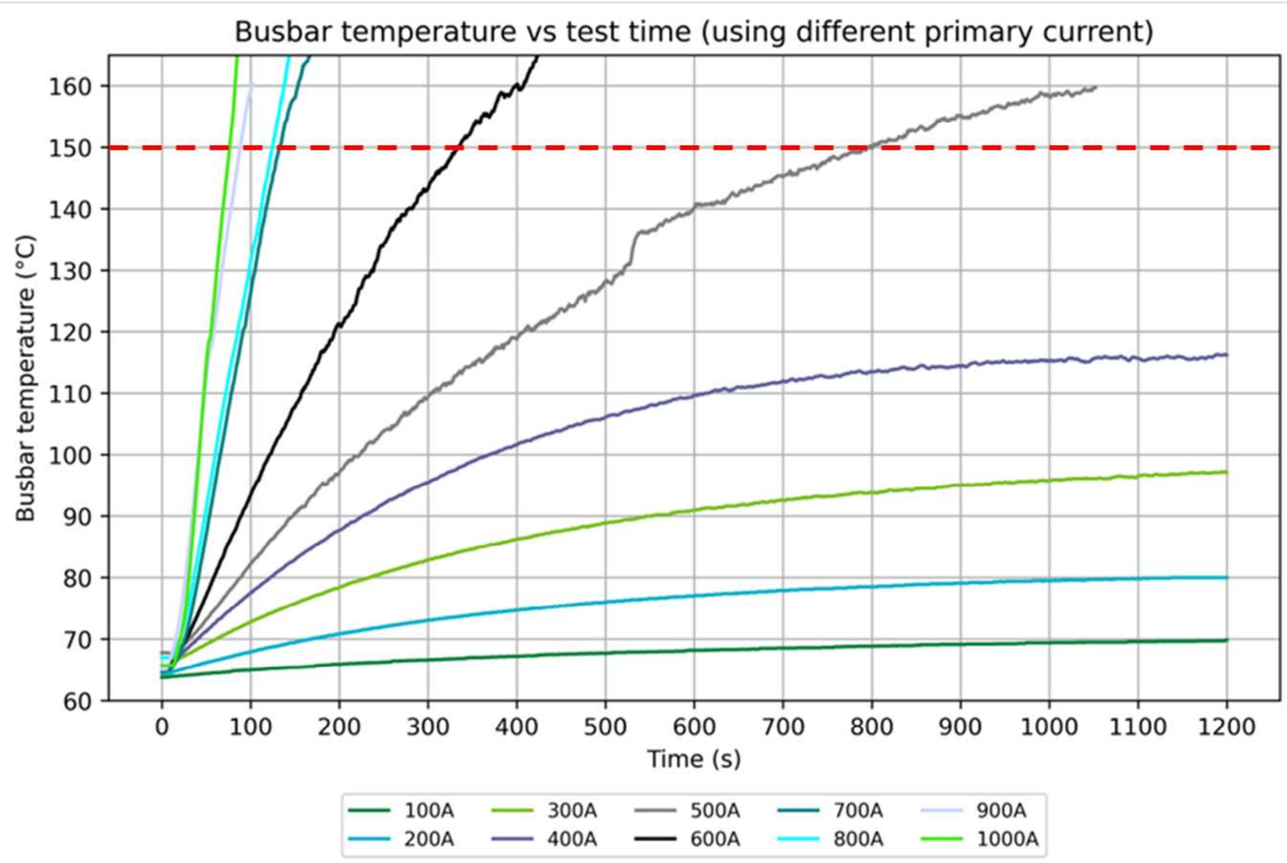
Continuous Current Performance (Busbar Heat Rise)



Test Conditions:
Ambient temperature: 65 °C, without cooling
Temperature monitoring: Record 1 data point per second. Test stopped when Temperature is stabilized at 150°C.

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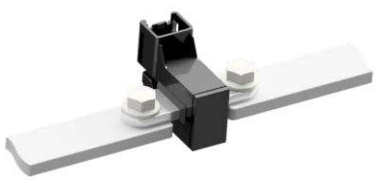
Recommendations for Use

Setup Recommendation

Mounting and spacing recommendations are common for all component family members listed in this datasheet. Example shown is CH1B022M.

Busbar Mounting:	**Adjacent Busbar Spacing:**
	
▪ Mount with ISO M6 serrated flange screw or bolt, or with M6 fastener scew 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: 5x20mm	▪ The distance between sensor busbar and adjacent busbar is recommended to be more than: - 20 mm @ 1500 A - 10 mm @ 1000 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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Validation Test Specification

Group / Test	Reference	Test Condition
Environmental		
Low Temperature Operation	ISO 16750-4	24h; @-40 °C, power supply(continuous monitoring: offset (Vout and Vcc) at 1s intervals, zero primary current
High Temperature Operating Endurance (HTOE)	ISO 16750-4	96 h; power supply continuous monitoring: offset (Vout and Vcc),at 30ms intervals @ 125 °C, zero primary current
Temperature Step Test	ISO 16750-4: 2010 Section 5.2	20°C -> Tmin -> Tmax -> 20°C. Temperature step: 5 °C. Dwell time: TBD. Check DUT functionality at Umin, Unom, Umax at each temperature step.
High Temperature / High Humidity Endurance (HTHE)	IEC 60068-2-78	1000h, 85°C / 85% RH, power supplied (continuous monitoring Vcc) at 30ms intervals, zero primary current. Intermediate functional test at room temp at 500hrs.
Powered Thermal Cycle Endurance	ISO16750-4 §5.3.1 EN 60068-2-14, test Nb	125 cycles. 1000 h. DUT powered on, continous monitoring Vout and Vcc at 30ms intervals. Intermediate functional test at room temp at 500hrs.
Thermal Shock	ISO16750-4 §5.3.2 EN 60068-2-14	1000 h, −40 °C (30 min soak) / 125 °C (30 min soak), shift time ≤ 30s, 1000 cycles, with connectors installed. Intermediate functional test at room temp at 500hrs.
Composite Temperature /Humidity Cyclic	ISO 16750-4 §5.6.2.3 IEC 60068-2-38	10 cycles. Total duration 240h. Temperature: +65°C. DUT monitoring at 30ms intervals.
Dewing Test	ISO 16750-4:2010 Section 5.6.2.4 Test 3	5 cycles. Total duration 30 hours. Temperature: +80°C. DUT powered on, continous monitoring of Vout and Vcc at 30ms intervals.
Ingress Protection		
Dust	IEC 60529	per IEC 60529
Mechanical		
Mechanical Shock	ISO 16750-3 §4.2.2.2	(500 m·s-2; 11 ms) 10 shocks per axe Half sinusoidal pulse. Continuous monitoring: offset(Vout and Vcc) at 1ms intervals, zero primary current.
Vibration in Temperature	ISO 16750-3 § 4.1.2.4 Test Ⅳ, passenger car, sprung masses	22 hours for each axis. RMS acceleration value of 96,6 m/s2. Continuous monitoring: offset(Vout and Vcc) at 30ms intervals, zero primary current. Temperature cycling from Tmin to Tmax.
Free Fall	ISO 16750-3 § 4.3	Test direction: ±X, ±Y, ±Z axis (6 directions), one sample per each axis; Drop floor: steel plate; Drop height: 1 meter. Temperature:+23 ℃ ± 5 °C.
Electrical		
Noise	Littelfuse VS	Sweep from DC to 1MHZ.
Power-on Time	Littelfuse VS	Vdd min to 90%Vout
Overvoltage	ISO 16750-2 §4.3	+6V for 60s
Output Short Circuit to Supply	ISO16750-2 §4.10	'VDC: 5 V; Connect all terminals to GND except for B+ terminal of connector; Connect all terminal to B+ except for GND terminal of connector.
Reverse Supply Voltage	ISO 16750-2 §4.7.2	-0.3V for 60s
Response Time	Littelfuse VS	90%Primary current to 90%Vout

Continued next page

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Validation Test Specification (continued)

Group / Test	Reference	Test Condition
Insulation and Dielectric Voltage		
Insulation Resistance	ISO 16750-2 §4.12.2	Perform insulation resistance test ,then perform a CL-THC-Temperature / Humidity cycle test, at last perform insulation resistance test again; record the min value, test point: connector wires to busbar, samples shall remain 0.5h at room temperature after Composite temperature/humidity cyclic test: 1000V DC, 60s
Dielectric Withstand Voltage	IEC 60664; Part 1	Perform dielectric withstand voltage test ,then perform a CL-THC-Temperature / Humidity cycle test, at last perform dielectric withstand voltage test again; record the max value ;samples shall remain 0.5h at room temperature after Composite temperature/humidity cyclic test, 'test point: connector wire to busbar: 2.5 kV AC, 50Hz, 1min.
EMC		
Bulk Current Injection (BCI)	ISO 11452-4 Annex E.1.1, Table E.1 GMW3097; From 1 to 400 MHz.	Refer to EMC Test Plan - *EMC-8057*
Radiated Electromagnetic Immunity (ALSE)	ISO 11452-2	Refer to EMC Test Plan - *EMC-8057*
Radiated Emissions	CISPRR25 (2008) Table 9	Refer to EMC Test Plan - *EMC-8057*
ESD Handling	ISO 10605 §7	Refer to EMC Test Plan - *EMC-8057*
Connector		
Terminal Push-out Force	GMW3191:2012 §4.5.2	Apply rearward pulling force to dislodge the terminal out of the header. Speed 50± 10mm/min. Record the peak force required to displace the terminal 0.20 mm. Afterwards, connectors conditioned by being exposed to 95% to 98% RH at +40 °C for 6 hours. Push / pull tests shall be performed immediately following removal of the headers from the temperature/humidity chamber. Terminal width 0.5 mm and 0.5 mm (< 0.8 mm)
Connector to Connector Engagement Force	GMW3191:2012 §4.2.8/ USCAR25	Insert TPA into connector body at a uniform rate of (50 ± 10) mm/minute. Record peak force and graph force versus distance from initial position of TPA to connector body to final engaged position.
Locked Connector Disengagement Force	GMW3191:2012 §4.2.18	Pull the mated connectors apart at a rate of (50 ± 10) mm/minute. Record the force at which the connectors disengage.
Unlocked Connector Disengagement Force	GMW3191:2012 §4.2.19	Pull the mated connectors apart at a rate of (50 ± 10) mm/minute. Record the force at which the connectors disengage.
Other		
Phase Shift Test	Littelfuse VS	

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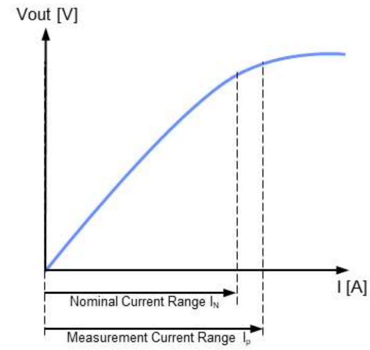
Performance Parameter Definitions

Output Voltage (V_{OUT})

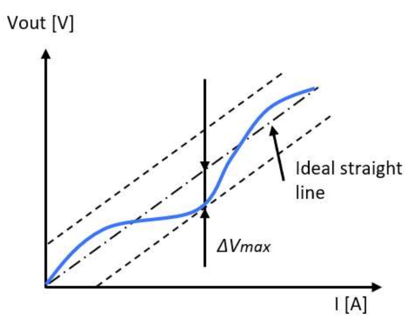
$$V_{out} = (V_{CC}/5) \times (2.5 + I_p \times S)$$

Primary current definition (I_N, I_p)



Linearity error (ε_L)

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



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

V_{FS}: full scope output voltage

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)

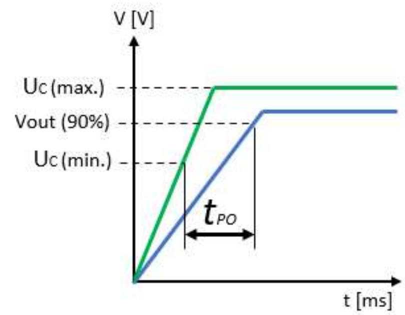
The sensor sensitivity error is the drift of sensor's ideal sensitivity.

$$\varepsilon_S = \pm \frac{S - S_{th}}{S_{th}} \times 100\%$$

S_{th}: theory sensitivity

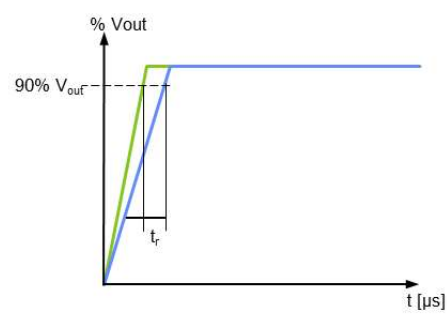
Power-on time (t_{po})

The Power-on time is the duration from Uc (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 are 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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