



CAB-A/I 1000 APPLICATION NOTES

INFORMATION IN THIS DOCUMENT SHOULD BE USED AS REFERENCE, THEY ARE NOT GUARANTEED VALUES

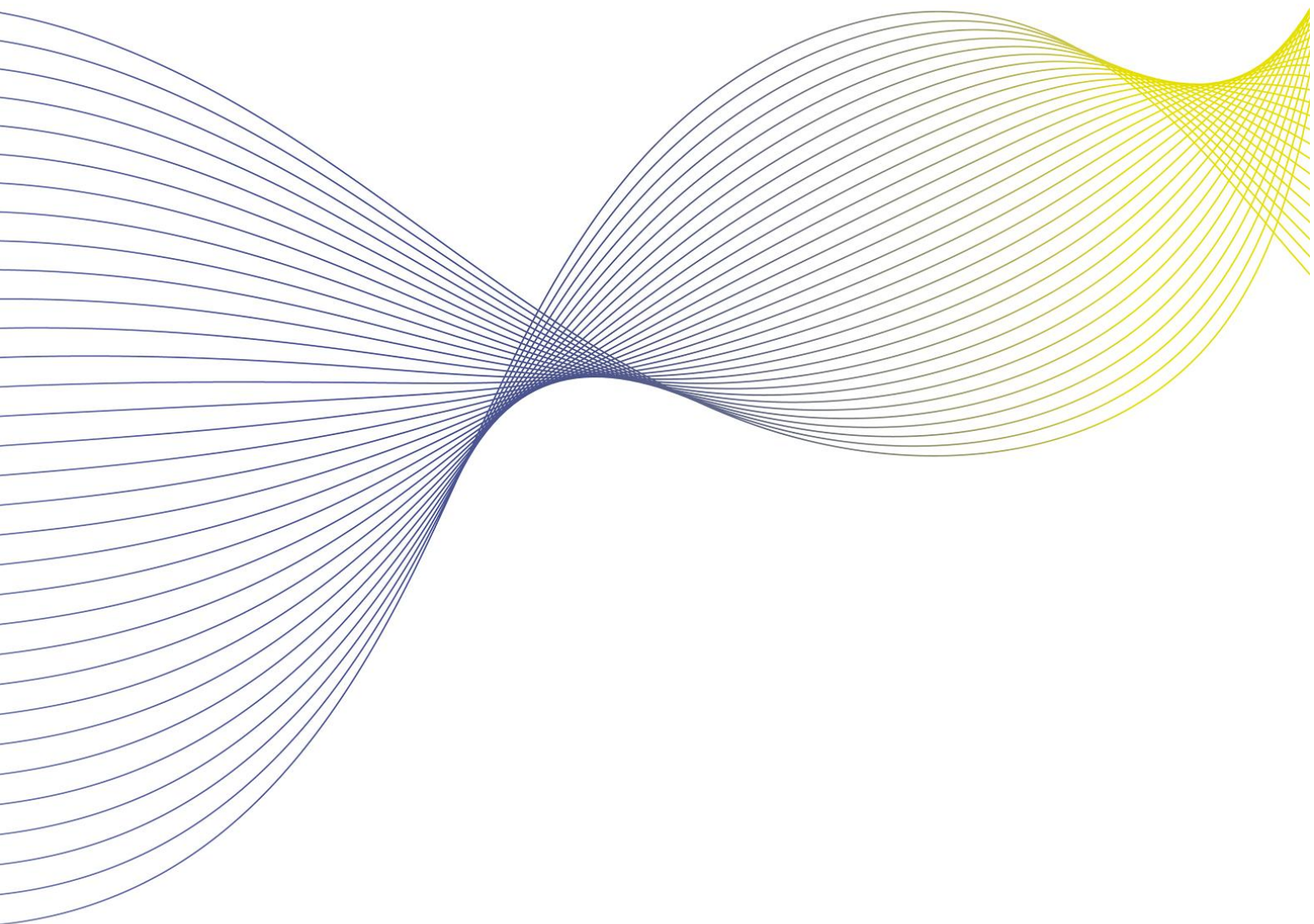


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Revision history

Rev	Date	Who	Change and updates
0	21/Sept/2026	FYN	Creation

Document confidentiality level: indicate with a cross (X)		
	Level 1	Secret
	Level 2	Confidential
X	Level 3	Restricted
	Level 4	Public

1 Clarification

The information in this document is provided for reference only and does not represent guaranteed values.

2 Abbreviation

Abbreviation	Description	Comment
BMS	Battery Management System	
CAN	Controller Area Network	
CRC	Cyclic Redundancy Check	
CSM	Current Sensor Module	
ECU	Electronic Control Unit	
ESD	Electrostatic Discharge	
LSB	Least Significant Bit	
MSB	Most Significant Bit	
UDS	Unified Diagnostic Services	
BDU	Battery dis	
UV	Under Voltage	
OV	Over Voltage	
OT	Over Temperature	
OC	Over Current	

3 Naming Rules

CAB-X 1000 αβγ

CAB: LEM CAB series

X: Application category, where:

- X=I indicates industrial applications;
- X=A indicates automotive applications.

α: Product variant, where:

- α=0: 12 V, panel mounting;
- α=2: 12 V, busbar mounting;
- α=6: 24 V, panel mounting;
- α=8: 24 V, busbar mounting.

β: Reserved digit

γ: Indicates the CAN ID, for example:

- γ=0 means the CAN ID is 3C0;
- γ=1 means the CAN ID is 3C1; and so on.

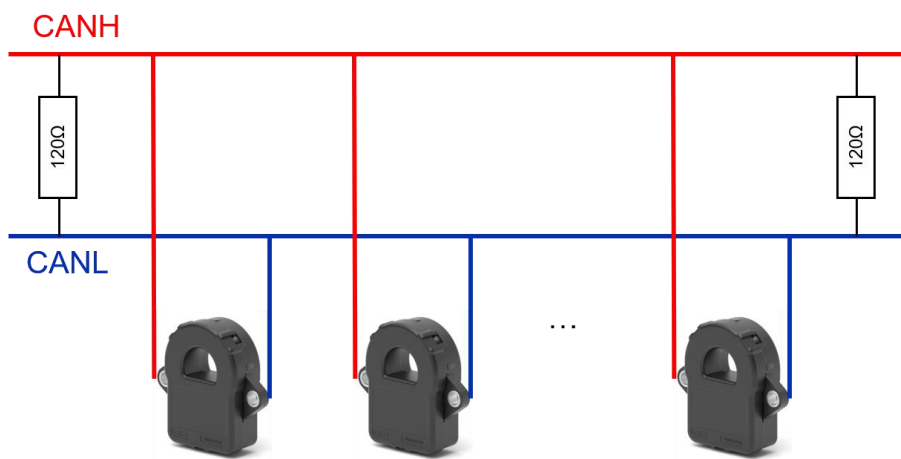
4 CAN interface

The CAB-A/I 1000 series provide digital communication functionality via a CAN bus interface.

4.1 CAN termination resistor

For reliable communication with an external ECU, proper CAN bus termination is critical. Incorrect termination is a common cause of communication errors, signal reflections, and instability. The following table lists the termination resistor configuration for the CAB series.

A 120 Ω CAN termination resistor is recommended at the customer system application level.



4.2 Message data layout

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	CSM_BAT_CURRENT							
	MSB							
Byte 1	CSM_BAT_CURRENT							
Byte 2	CSM_BAT_CURRENT							
Byte 3	CSM_BAT_CURRENT							
								LSB
Byte 4	ERROR_INFORMATION							ERROR_INDICATION
	MSB						LSB	
Byte 5	PRODUCT_NAME							
	MSB							
Byte 6	PRODUCT_NAME							
								LSB
Byte 7	SW_REVISION							
	MSB							LSB

For the complete CAN message definition, including signal physical definitions, encoding details, and error descriptions, please refer to the official public datasheet.

4.3 Cybersecurity assumptions

To ensure that the CAB-A1000 series application complies with vehicle network cybersecurity requirements, the following conditions are assumed to be fulfilled by the user:

- The CAB sensor shall be connected to the private CAN bus network of the external ECU.
- The network provider shall ensure the integrity and robustness of the private CAN bus.

For more detailed information, please refer to the official Cybersecurity Manual.

4.4 Internal error

The CAB-X 1000 series sensor provides comprehensive self-diagnostic functions. When an internal diagnostic abnormality is detected, an internal error is reported. The main internal errors are classified as shown below.

- Hardware fault (MCU, internal circuit, etc)
- NTC temperature measurement fault

5 Power supply

This section clarifies the power status indication, presents power consumption under different operating conditions including primary current and temperature, and provides power-related information for CAB system power supply design.

5.1 Power supply range

5.1.1 CAB-X 1000 0xx and CAB-X 1000 2xx Series

The CAB-X 1000 0xx and CAB-X 1000 2xx series are designed for standard 12 V systems, with a tolerated supply voltage range of [8, 18] V. The sensor sets and clears the overvoltage and undervoltage warning flags under the following conditions.

- Overvoltage flag set (sensor reports an overvoltage fault): 18.8 V
- Overvoltage flag cleared (sensor reports no overvoltage fault): 18.5 V
- Undervoltage flag set (sensor reports an undervoltage fault): 7 V
- Undervoltage flag cleared (sensor reports no undervoltage fault): 7.3 V
- Communication stops during continuous sensor operation: 6.5 V
- Communication stops during initial sensor power-up: 6.8 V

5.1.2 CAB-X 1000 6xx and CAB-X 1000 8xx Series

The CAB-X 1000 6xx and CAB-X 1000 8xx series are designed for standard 24 V systems, with a tolerated supply voltage range of [18, 32] V. The sensor sets and clears the overvoltage and undervoltage warning flags under the following conditions.

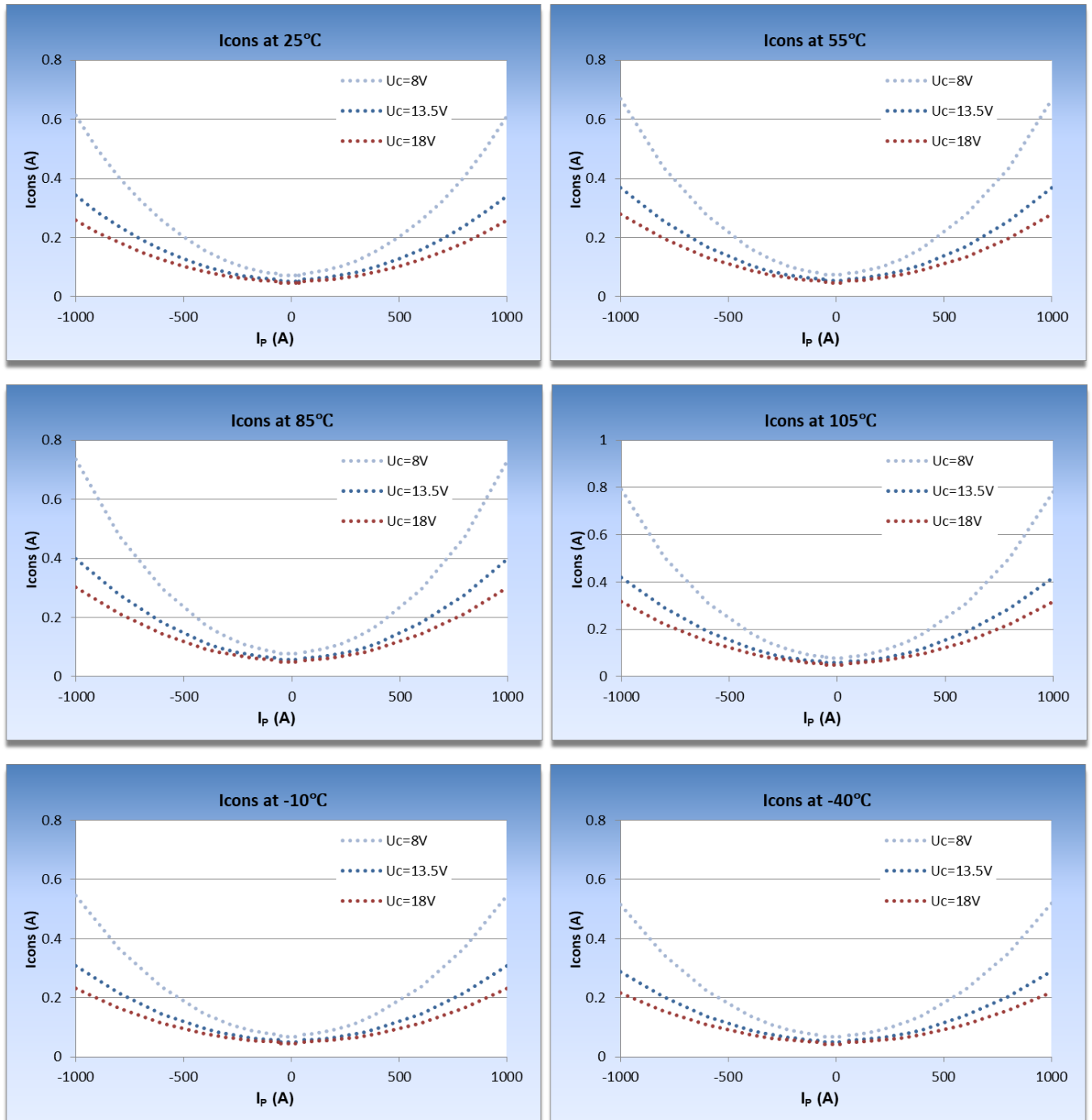
- Overvoltage flag set (sensor reports an overvoltage fault): 34 V
- Overvoltage flag cleared (sensor reports no overvoltage fault): 33 V
- Undervoltage flag set (sensor reports an undervoltage fault): 17 V
- Undervoltage flag cleared (sensor reports no undervoltage fault): 17.5 V
- Communication stops during continuous sensor operation: 16 V
- Communication stops during initial sensor power-up: 16.5 V

5.2 Current consumption

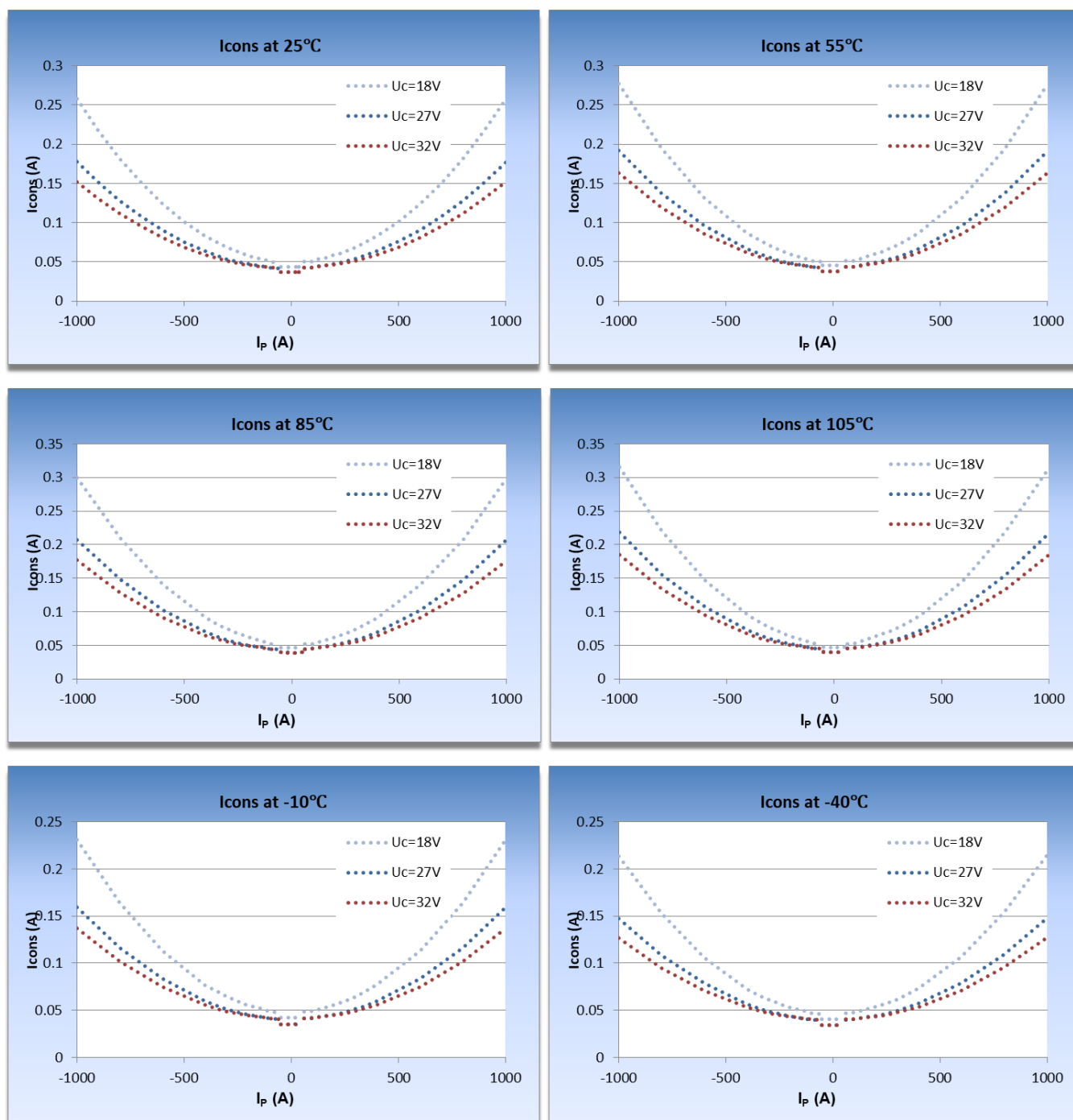
The CAB-X 1000 series sensor is based on fluxgate technology. Its power consumption is affected by the primary current, supply voltage, and ambient temperature.

In the figures below, the horizontal axis represents the primary current and the vertical axis represents sensor power consumption. The different curves show the influence of different supply voltages.

5.2.1 CAB-X 1000 0xx and CAB-X 1000 2xx Series



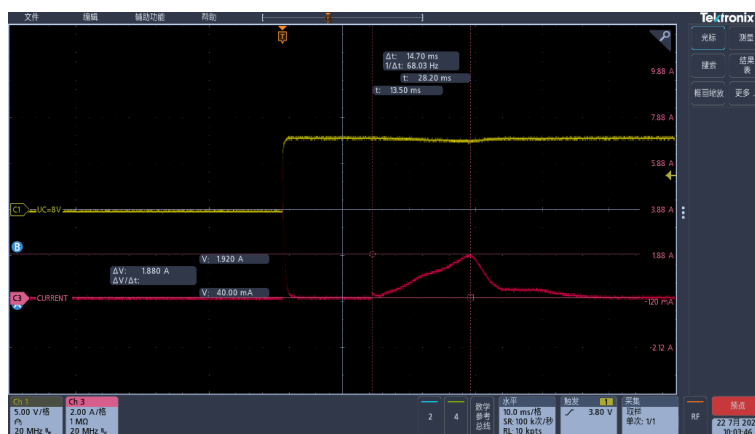
5.2.2 CAB-X 1000 0xx and CAB-X 1000 2xx Series



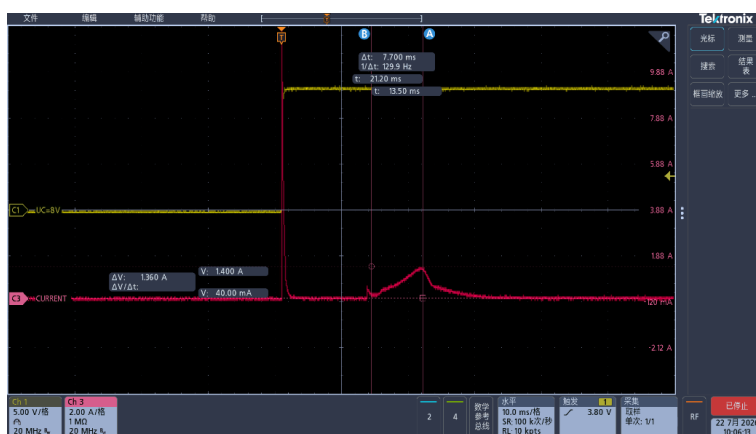
5.3 Inrush current

The CAB-X 1000 series sensor is based on fluxgate technology. During power-up, the supply source charges the coil, resulting in a short-duration high current consumption at the microsecond level. After power-up, the current consumption at typical supply voltages is provided in the attachment.

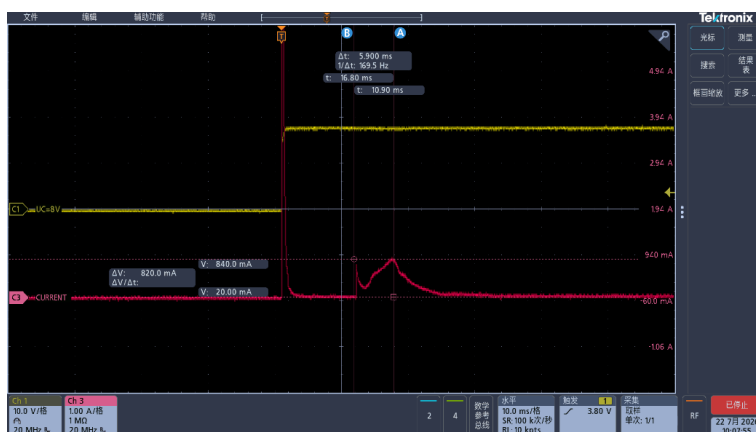
- At a supply voltage of 8 V, the maximum current consumption is approximately 1.88 A and lasts for 14.7 ms.



- At a supply voltage of 13.5 V, the maximum current consumption is approximately 1.36 A and lasts for 7.7 ms.



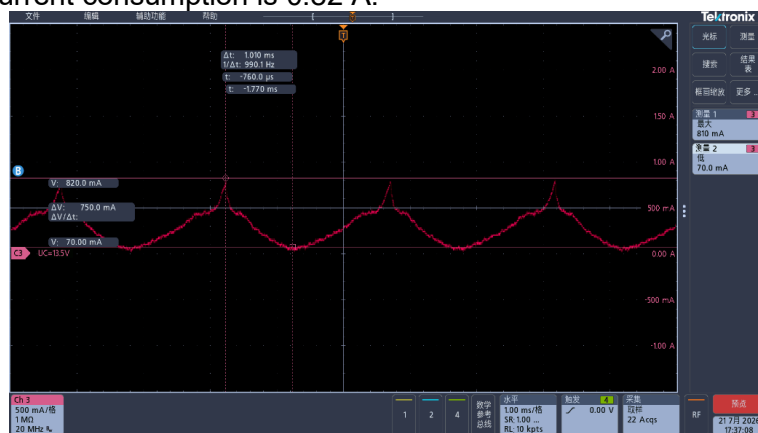
- At a supply voltage of 18 V, the maximum current consumption is approximately 0.82 A and lasts for 10.9 ms.



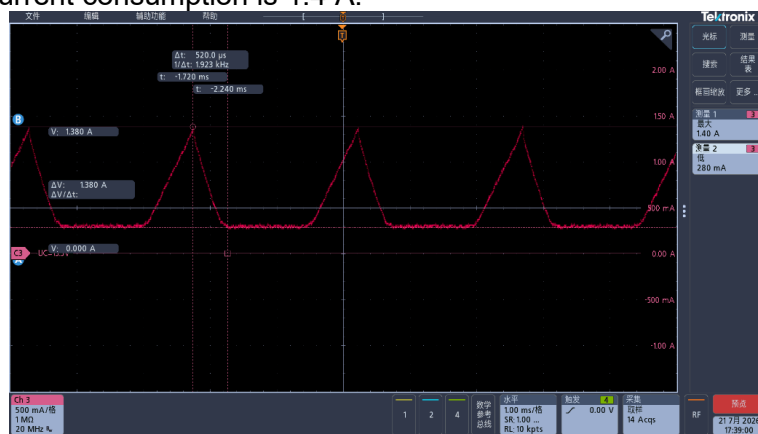
5.4 Input peak current

The CAB-X 1000 series sensor is based on fluxgate technology. During fluxgate oscillation, additional current is consumed at a specific frequency synchronized with the sensor's fluxgate oscillation. Therefore, LEM recommends that customers reserve sufficient margin when designing the power supply.

- When the sensor operates normally with a 13.5 V supply voltage and a primary current of $I_p = 1000$ A, the maximum peak current consumption is 0.82 A.



- When the sensor operates normally with an 8 V supply voltage and a primary current of $I_p = 1000$ A, the maximum peak current consumption is 1.4 A.



6 Measurement range

The measurement range of the CAB-X 1000 series sensor is 1000 A. When the primary current exceeds 1000 A, the sensor output behaves as shown below. The measurement capacity of the sensor is approximately 1400 A to 1500 A, and may vary slightly between individual sensors.

Primary current (A)	Sensor Output (A)	Remark
900	900	The sensor outputs the actual measured value.
1000	1000	The sensor outputs the actual measured value.
1050	1050	The sensor output is clamped at 1050 A.
1100	1050	The sensor output is clamped at 1050 A.
1200	1050	The sensor output is clamped at 1050 A.
1400	1050	The sensor output is clamped at 1050 A.
1425	0x FFFF FFFF	Invalid value when primary current exceeds sensor measurement capacity.
1500	0x FFFF FFFF	Invalid value.

7 Single busbar scenario

The CAB-X 1000 series sensor is based on fluxgate technology and has been optimized to improve immunity to external magnetic field interference. However, during customer installation, additional magnetic interference introduced by the return busbar shall still be carefully controlled.

7.1 Return busbar test notes

Test environment: room temperature

Busbar dimensions used in the test:

- 22 mm (width) × 4 mm (thickness)

Error calculation method:

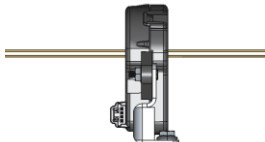
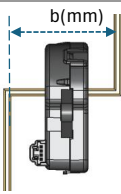
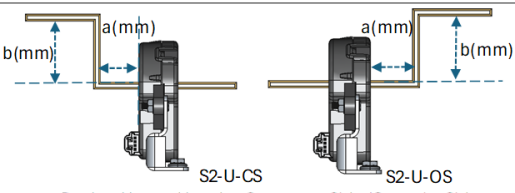
- $\Delta I = I_{\text{Sensor}} - I_P$
- $\Delta I \% = \frac{I_{\text{Sensor}} - I_P}{I_P} \cdot 100\%$

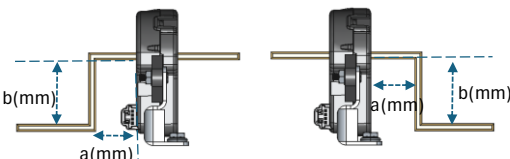
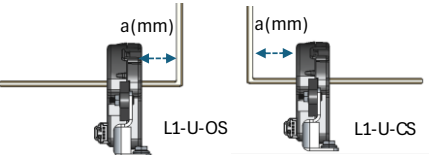
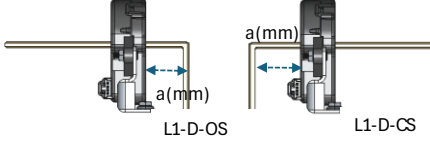
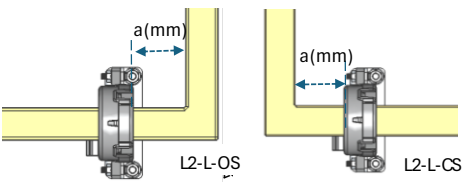
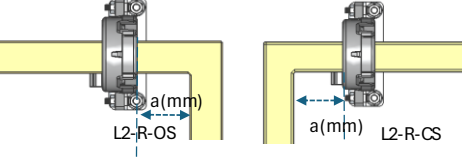
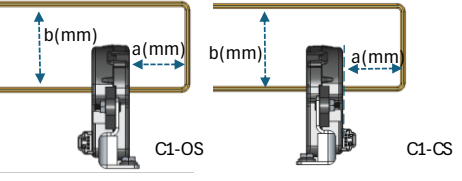
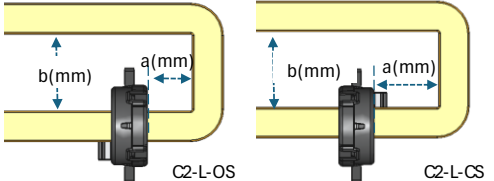
where the sensor measurement is the current measured by the sensor, and the reference measurement is the current measured by the LEM high-precision reference source (LEM ITZ2000), which is used as the comparison benchmark.

Note: Due to the complexity of actual installation environments, this test cannot cover all possible scenarios. Sensor performance in the final system shall be verified through actual system-level testing.

7.2 Recommended busbar shapes

When integrating the CAB-X 1000 series sensor, LEM recommends that customers refer to the table below.

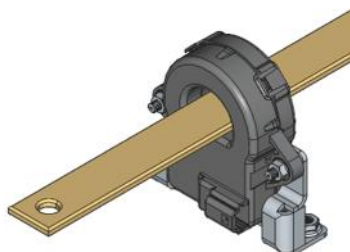
No	Description	Code	Remarks	Illustration
7.2.1	Straight Busbar	N/A	Best performance. Sensor accuracy meets the datasheet specification.	
7.2.2	S-shape busbar	S1	$b \geq 40 \text{ mm}$ Sensor centered Sensor accuracy meets the datasheet specification	
		S2-U	$a \geq 5 \text{ mm}$ $b \geq 5 \text{ mm}$ Sensor accuracy meets the datasheet specification	

No	Description	Code	Remarks	Illustration
		S2-D	$a \geq 5 \text{ mm}$ $b \geq 5 \text{ mm}$ Sensor accuracy meets the datasheet specification	 S2-D-CS S2-D-OS Busbar Downward bend at Connector Side / Opposite Side
7.2.3	L-shape busbar	L1-U	$a \geq 5 \text{ mm}$ Sensor accuracy meets the datasheet specification	 L1-U-OS L1-U-CS Busbar Upward bend at Connector Side / Opposite Side
		L1-D	$a \geq 5 \text{ mm}$ Sensor accuracy meets the datasheet specification	 L1-D-OS L1-D-CS Busbar Downward bend at Connector Side / Opposite Side
		L2-L	$a \geq 5 \text{ mm}$ Sensor accuracy meets the datasheet specification	 L2-L-OS L2-L-CS Busbar left bend at Connector Side / Opposite Side
		L2-R	$a \geq 5 \text{ mm}$ Sensor accuracy meets the datasheet specification	 L2-R-OS L2-R-CS Busbar right bend at Connector Side / Opposite Side
7.2.4	C-shape busbar	C1	$a \geq 10 \text{ mm}$ $b \geq 30 \text{ mm}$ Sensor accuracy meets the datasheet specification	 C1-OS C1-CS Busbar at Connector Side / Opposite Side
		C2-L	$a \geq 10 \text{ mm}$ $b \geq 30 \text{ mm}$ Sensor accuracy meets the datasheet specification	 C2-L-OS C2-L-CS Busbar left bend at Connector Side / Opposite Side

No	Description	Code	Remarks	Illustration
	C-shape busbar	C2-L	$a \geq 10 \text{ mm}$ $b \geq 30 \text{ mm}$ Sensor accuracy meets the datasheet specification	C2-R-OS U2-R-CS Busbar right bend at Connector Side / Opposite Side
7.2.5	U-shape busbar	U1	$b \geq 5 \text{ mm}$ $c \geq 40 \text{ mm}$ Sensor centered Sensor accuracy meets the datasheet specification	U1-U U1-D Busbar Upward/Downward bend
		U2	$b \geq 5 \text{ mm}$ $c \geq 40 \text{ mm}$ Sensor centered Sensor accuracy meets the datasheet specification	U2-L U2-R Busbar left bend/right bend

7.2.1 Straight busbar

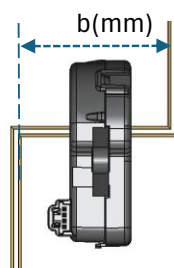
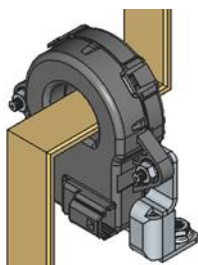
Under this ideal configuration, the CAB-X 1000 series sensor meets the datasheet specifications.



7.2.2 S shape busbar

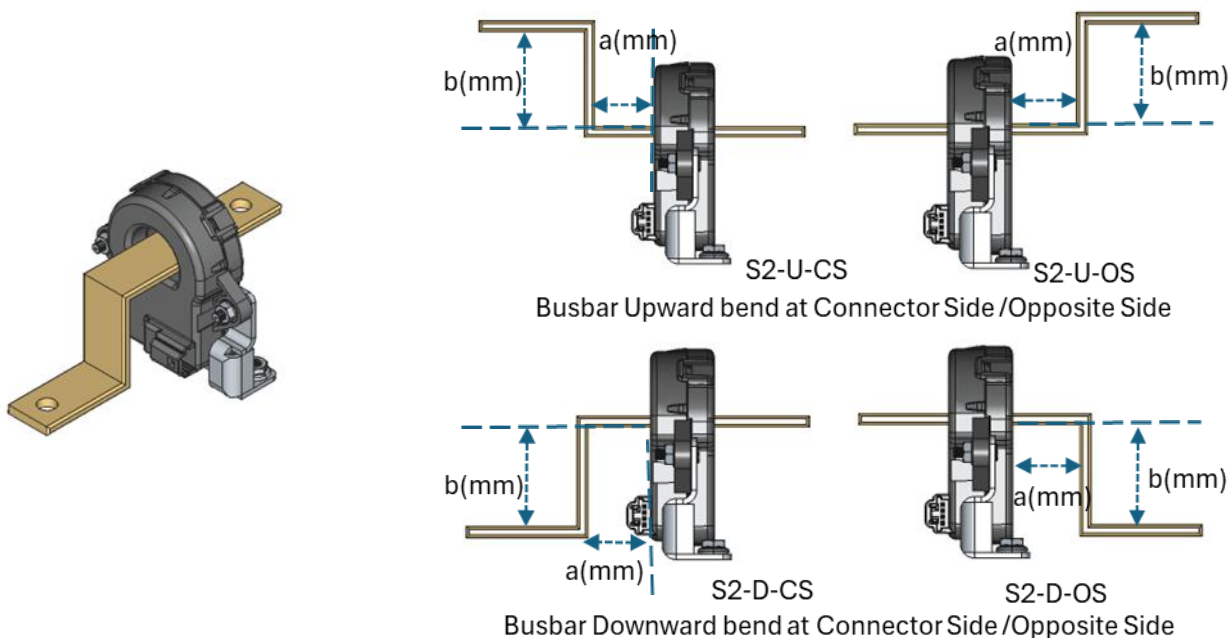
7.2.2.1 S1 shape Busbar

For the S1 shape busbar, when $b \geq 40 \text{ mm}$ and the sensor is installed at the center, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.



7.2.2.2 S1 shape Busbar

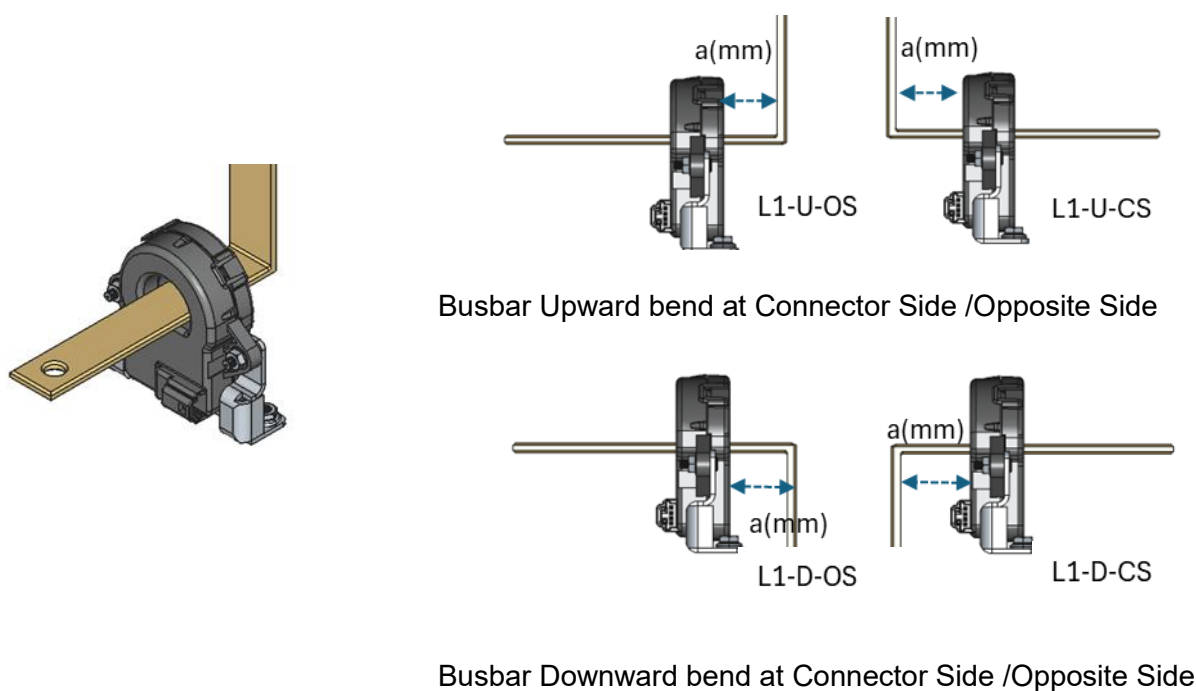
For the S2 shape busbar, when $a \geq 5 \text{ mm}$, $b \geq 5 \text{ mm}$, and the sensor is installed at the center, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.



7.2.3 L shape busbar

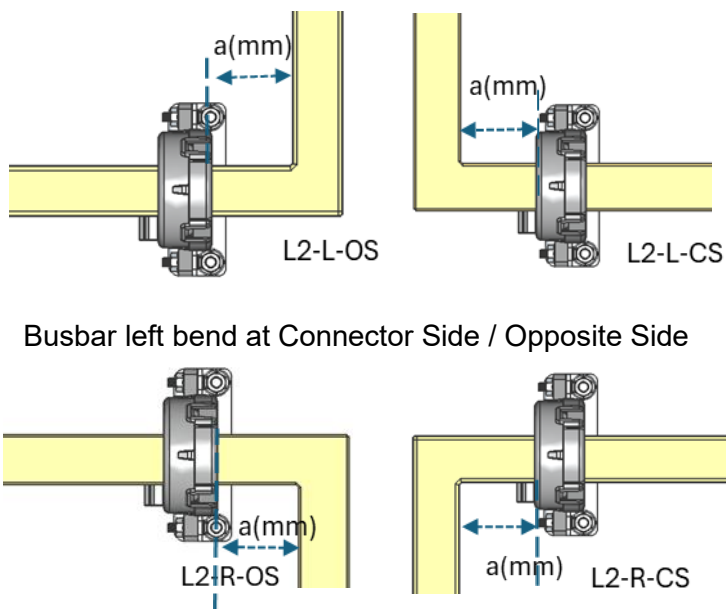
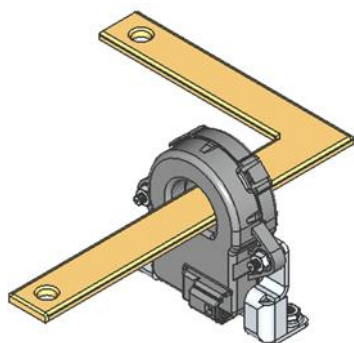
7.2.3.1 L1 shape busbar

For the L1 shape busbar, when **$a \geq 5 \text{ mm}$** , the performance of the CAB-X 1000 series sensor meets the datasheet requirements.



7.2.3.2 L2 shape busbar

For the L2 shape busbar, when $a \geq 5 \text{ mm}$, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

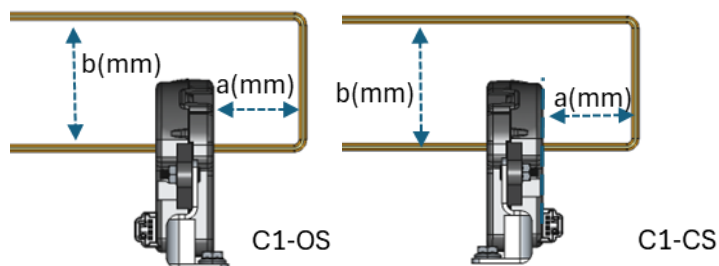
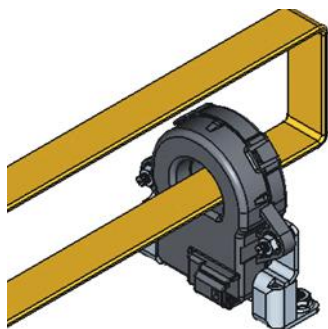


Busbar left bend at Connector Side / Opposite Side

Busbar right bend at Connector Side / Opposite Side

7.2.4 C shape busbar

7.2.4.1 C1 shape Busbar



Busbar at Connector Side / Opposite Side

Busbar at Connector Side

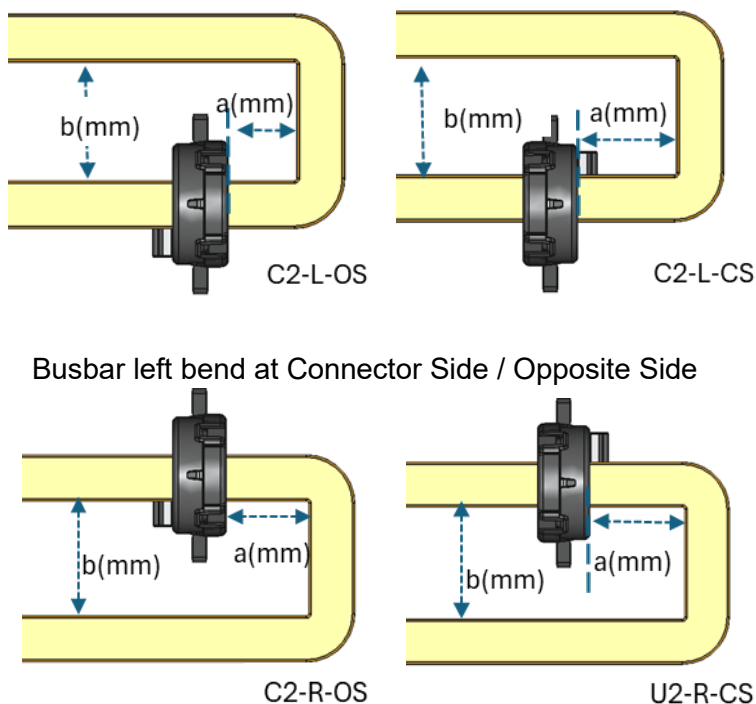
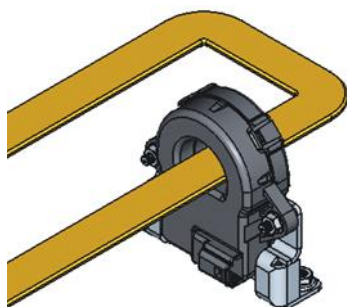
When $b \leq 30 \text{ mm}$ and $a \leq 10 \text{ mm}$ under $I_p > 875 \text{ A}$, the sensor error may reach approximately 1.2%.

For all other conditions, when $a \geq 10 \text{ mm}$, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

Busbar at Opposite Side

When $a \geq 10 \text{ mm}$, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

7.2.4.2 C2 shape Busbar



Busbar left bend at Connector Side / Opposite Side

Busbar right bend at Connector Side / Opposite Side

Busbar left bend at Connector Side

When $b \leq 30$ mm and $a \leq 5$ mm under $I_p > 875$ A, the sensor error may reach approximately 0.7%.

For all other conditions, when $a \geq 5$ mm and $b \geq 30$ mm, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

Busbar left bend at Opposite Side

When $a \geq 5$ mm and $b \geq 30$ mm, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

Busbar right bend at Connector Side

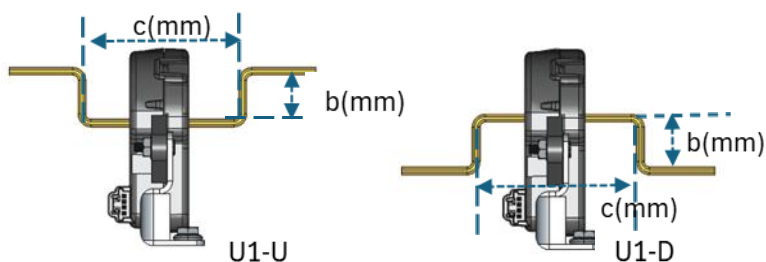
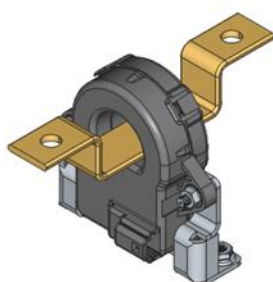
When $a \geq 5$ mm and $b \geq 30$ mm, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

Busbar right bend at Opposite Side

When $a \geq 5$ mm and $b \geq 30$ mm, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

7.2.5 U shape busbar

7.2.5.1 U1 shape Busbar



Busbar Upward/Downward bend

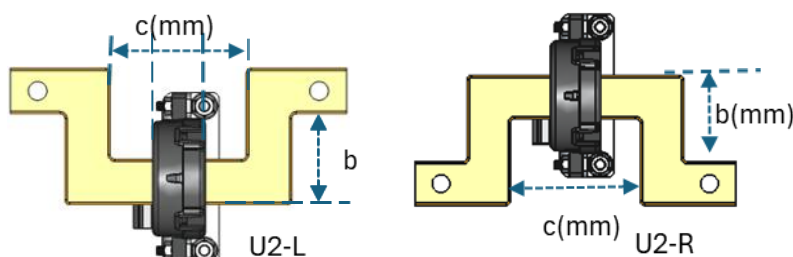
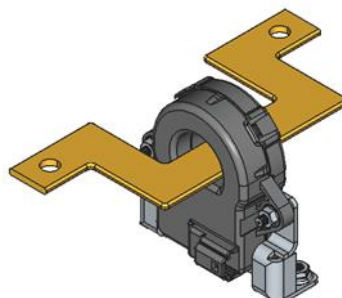
Busbar Upward

When $b \geq 5 \text{ mm}$ and $c \geq 40 \text{ mm}$, and the sensor is placed at the center, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

Busbar Downward

When $b \geq 5 \text{ mm}$ and $c \geq 40 \text{ mm}$, and the sensor is placed at the center, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

7.2.5.2 U2 shape Busbar



Busbar left bend/right bend

Busbar at left bend

When $b \geq 5 \text{ mm}$ and $c \geq 40 \text{ mm}$, and the sensor is placed at the center, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

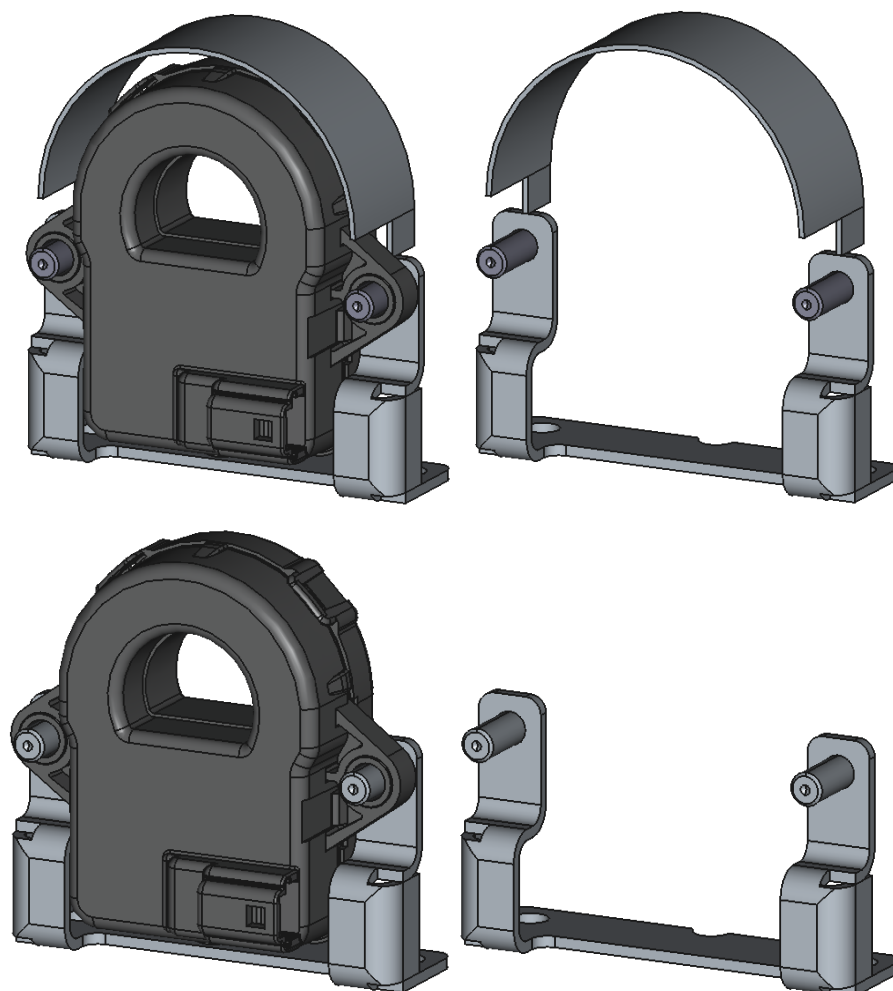
Busbar at right bend

When $b \geq 5 \text{ mm}$ and $c \geq 40 \text{ mm}$, and the sensor is placed at the center, the performance of the CAB-X 1000 series sensor meets the datasheet requirements.

7.3 Nearby ferromagnetic objects

7.3.1 Installation bracket

The CAB-X 1000 series sensor has been specifically optimized through magnetic design to ensure good compatibility with mounting brackets. Two typical mounting bracket configurations are recommended below. Mounting brackets can be made of either steel or stainless steel.



7.3.2 Steel plate

In BDU installation environments, if a steel plate (magnetically permeable material) is located above the CAB series sensor, the sensor accuracy may be affected. LEM recommends maintaining the following installation clearances.

- Single-busbar application: distance between the steel plate above and the sensor ≥ 10 mm.
- Multi-busbar application: distance between the steel plate above and the sensor ≥ 30 mm.

7.4 Relay position

LEM recommends maintaining **a minimum distance of 20 mm** between the CAB-X 1000 series sensor and the relay. As the level of magnetic interference generated by relays can vary depending on the relay design, accuracy validation is recommended after integration into the customer system to ensure the required measurement performance is achieved.

8 Current ripple

The CAB-X 1000 series sensor operates based on fluxgate technology, with a fluxgate operating frequency of approximately 400 Hz.

To avoid potential measurement interference, customers should avoid ripple current frequencies on the primary busbar that are close to the fluxgate fundamental frequency and its 2nd and 3rd harmonics and so

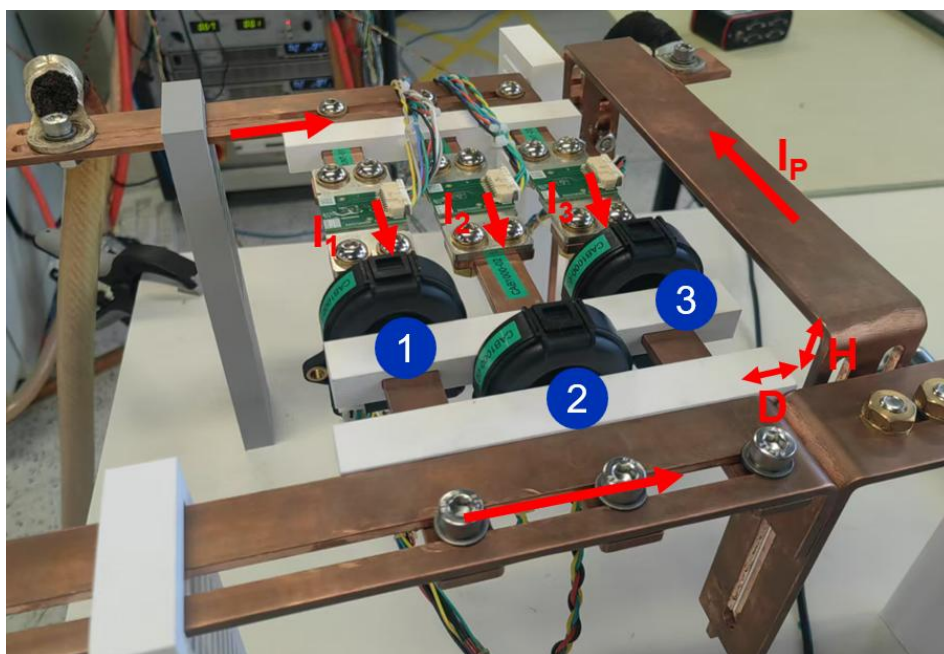
on, especially when the ripple current amplitude exceeds 50 A RMS. Otherwise, the sensor accuracy may be affected.

9 Multi-busbar scenario

The CAB-X 1000 series sensor has been specifically optimized for multi-busbar applications to provide excellent immunity to magnetic cross-talk. It is well suited for applications such as electric trucks, electric buses, and heavy-duty electric construction equipment.

The figure below shows a typical multi-busbar application

- Three current sensors (①, ②, and ③) are installed on three separate branches, respectively.
- The distance between two sub-branches is 30 mm
- The thickness of the white spacer is 20 mm.
- The current flowing through the main busbar (far right) is the sum of the currents in the three branch circuits: $I_P = I_1 + I_2 + I_3$



Based on engineering experience, the magnetic field generated by the main busbar has the greatest impact on Sensor ③. As a result, the vertical separation (H) and horizontal distance (D) between the main busbar and Sensor ③ should be carefully optimized to minimize accuracy degradation.

When $D \geq 30$ mm, the accuracy of all CAB-X 1000 series sensors in each branch can meet the specifications stated in the datasheet.