

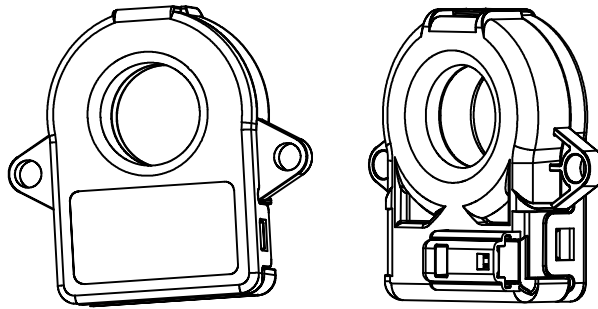
## FR1C H00 Series

### AUTOMOTIVE CURRENT SENSOR FLUXGATE TECHNOLOGY

Model Number:

FR1C 300 H00

FR1C 500 H00



The FR1C series 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

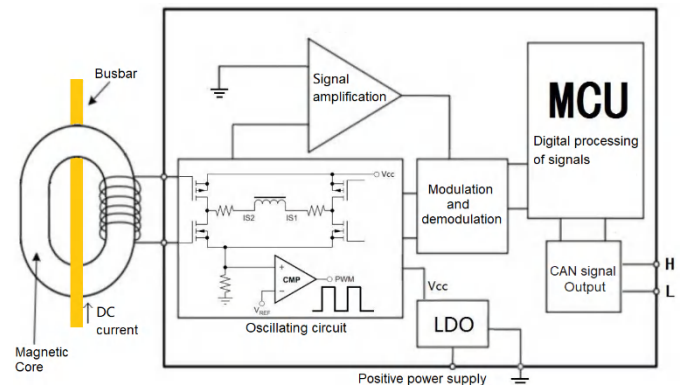
- ✧ Current sensor using Fluxgate technology
- ✧ Overcurrent detection mechanism
- ✧ Panel mounting
- ✧ Unipolar +12V battery power supply
- ✧ Output signal: High speed CAN (up to 500 kbps)
- ✧ Configurable internal digital low-pass frequency filter
- ✧ Configurable CAN speed/CAN ID
- ✧ UL508 compliant
- ✧ Ingress Protection - IP42 level.

#### Principle of Fluxgate Sensors

A low-frequency fluxgate current sensor 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 sensors 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 canceled.

#### Automotive applications

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



## FR1C H00 Series

### Safety usage instructions

The use of sensors must comply with the ISO16750 and CISPR 25 standards.

Sensors must be placed in electronic or electrical equipment that meets application standards and safety requirements according to the instructions.

**Caution, risk of electrical shock!**



When sensors are working, certain parts may be subjected to dangerous voltages (such as the primary busbar and power supply), ignoring these can lead to damage and serious danger.

Sensors are built-in devices, and after installation, their conductive parts must be ensured not to be touched by the outside world. If necessary, a protective shell or shielding cover can be added. The main power supply must be able to be disconnected.

### Absolute maximum ratings (not operating)

| Parameter                  | Symbol | Unit | Specification |
|----------------------------|--------|------|---------------|
| Supply voltage             | $V_C$  | V    | +18           |
| Primary busbar temperature | $T_B$  | °C   | 105           |

✗ Using beyond the above limits may cause permanent damage to the sensor.

✗ Long term exposure to the above limit environment may reduce the reliability of the product.

### Environmental and mechanical characteristics

| Parameter                     | Symbol | Unit | Min | Typical | Max | Conditions |
|-------------------------------|--------|------|-----|---------|-----|------------|
| Ambient operating temperature | $T_A$  | °C   | -40 |         | 85  |            |
| Storage temperature           | $T_S$  | °C   | -40 |         | 105 |            |
| Mass                          | $m$    | g    |     | 78      |     |            |

### Insulation coordination

| Parameter                          | Symbol    | Unit | Specification | Conditions          |
|------------------------------------|-----------|------|---------------|---------------------|
| Clearance                          | $d_{Cl}$  | mm   | 7             |                     |
| Creepage Distance                  | $d_{Cp}$  | mm   | 7.2           |                     |
| Plastic case                       |           |      | UL94-V0       |                     |
| 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                           |           |      | IP 42         |                     |

## FR1C H00 Series

### Electrical data

#### FR1C 300 H00

✖ Unless otherwise specified, the following data testing environment is based on conditions  $T_A = 25^\circ\text{C}$ ,  $V_C = +13.5\text{V}$ .

| Parameter                                    | Symbol          | Unit                  | Min  | Typical            | Max | Conditions                        |
|----------------------------------------------|-----------------|-----------------------|------|--------------------|-----|-----------------------------------|
| Primary nominal RMS current                  | $I_{PN}$        | A                     |      | $\pm 300$          |     |                                   |
| Primary current, measuring range             | $I_{PM}$        | A                     | -400 |                    | 400 |                                   |
| Supply voltage                               | $V_C$           | V                     | 8    | 13.5 <sup>1)</sup> | 16  |                                   |
| Current consumption @ $I_{PN}=0\text{A}$     | $I_C$           | mA                    |      | 30                 |     | @ $V_C = +13.5\text{V}$           |
| Current consumption @ $I_{PM}=500\text{A}$   | $I_C$           | mA                    |      | 160                |     | @ $V_C = +13.5\text{V}$           |
| Temperature coefficient of G                 | $TCG$           | ppm/ $^\circ\text{C}$ |      | 20                 |     |                                   |
| Electrical offset current                    | $I_{OE}$        | mA                    | -10  |                    | 10  | @ $I_{PN} = 0\text{A}$            |
| Linearity error 0... $I_{PN}$                | $\varepsilon_L$ | %                     | -0.1 |                    | 0.1 |                                   |
| Accuracy @ $I_{PN}$                          | $X$             | mA                    | -60  |                    | 60  |                                   |
| Output noise                                 | <i>Noise</i>    | dB                    | -10  |                    | 10  |                                   |
| Output frequency of CAN signal <sup>2)</sup> |                 | Hz                    |      | 100                |     | Depends on the filter implemented |
| Start-up time                                | $t_{start}$     | ms                    |      | 150                |     |                                   |
| Setting time after overload                  |                 | ms                    |      | 20                 |     |                                   |

Notes: 1) For the classical 12 V Lead-acid battery system, the mean value of battery voltage becomes to 13.5 V during charging

2) Output frequency depends on the emission period of the frame without digital filter.

## FR1C H00 Series

### Electrical data

#### FR1C 500 H00

✖ Unless otherwise specified, the following data testing environment is based on conditions  $T_A = 25^\circ\text{C}$ ,  $V_C = +13.5\text{V}$ .

| Parameter                                    | Symbol          | Unit                  | Min  | Typical            | Max | Conditions                        |
|----------------------------------------------|-----------------|-----------------------|------|--------------------|-----|-----------------------------------|
| Primary nominal RMS current                  | $I_{PN}$        | A                     |      | $\pm 500$          |     |                                   |
| Primary current, measuring range             | $I_{PM}$        | A                     | -600 |                    | 600 |                                   |
| Supply voltage                               | $V_C$           | V                     | 8    | 13.5 <sup>1)</sup> | 16  |                                   |
| Current consumption@ $I_{PN}=0\text{A}$      | $I_C$           | mA                    |      |                    | 30  | @ $I_{PN}=0\text{A}$              |
| Current consumption@ $I_{PM}=500\text{A}$    | $I_C$           | mA                    |      |                    | 160 | @ $I_{PM}=500\text{A}$            |
| Temperature coefficient of G                 | $TCG$           | ppm/ $^\circ\text{C}$ |      | 20                 |     |                                   |
| Electrical offset current                    | $I_{OE}$        | mA                    | -10  |                    | 10  | @ $I_{PN}=0\text{A}$              |
| Linearity error 0... $I_{PN}$                | $\varepsilon_L$ | %                     | -0.1 |                    | 0.1 |                                   |
| Accuracy @ $I_{PN}$                          | $X$             | mA                    | -60  |                    | 60  |                                   |
| Output noise                                 | <i>Noise</i>    | dB                    | -10  |                    | 10  |                                   |
| Output frequency of CAN signal <sup>2)</sup> |                 | Hz                    |      | 100                |     | Depends on the filter implemented |
| Start-up time                                | $t_{start}$     | ms                    |      | 150                |     |                                   |
| Setting time after overload                  |                 | ms                    |      | 20                 |     |                                   |

Notes: 1) For the classical 12 V Lead-acid battery system, the mean value of battery voltage becomes to 13.5 V during charging

2) Output frequency depends on the emission period of the frame without digital filter.

## FR1C H00 Series

### CAN Output specification

#### Software Version

#### Applicable: FR1C 300 H00

- CAN protocol 2.0 B
- Bit order: big endian (Motorola)
- CAN oscillator tolerance: 0.27 %
- No sleep mode capability
- 120 ohms termination resistor to be added externally, internal CAN impedance = 4.8 kohm

| Message Description       | CAN ID | Name       | Data Length (Nb bytes) | Type of frame | Message launch type           | Signal description                                               | Signal name         | Start bit | Length |
|---------------------------|--------|------------|------------------------|---------------|-------------------------------|------------------------------------------------------------------|---------------------|-----------|--------|
| Return Current $I_P$ (mA) | 0x3C2  | FR1C_IP    | 8                      | Standard      | Cyclic message period 10±1 ms | $I_P$ Value:<br>80000000H=0mA<br>7FFFFFFFH=-1mA<br>80000001H=1mA | CSM_BAT_CURRENT     | 24        | 32     |
|                           |        |            |                        |               |                               | Error indication (1 bit)<br>0 = Normal 1 = Failure               | ERROR_INDICATION    | 32        | 1      |
|                           |        |            |                        |               |                               | Error information (7 bits)                                       | CSM_FAIL            | 33        | 7      |
|                           |        |            |                        |               |                               | CAB (16 bits)                                                    | PRODUCT_NAME        | 48        | 16     |
|                           |        |            |                        |               |                               | Software Revision (8 bit)                                        | SW_Revision         | 56        | 8      |
| Start/Stop CAN TX         | 0x6F0  | TX_Control | 8                      | Standard      | Asynchronous received message | Set to 0x02                                                      | PCI                 | 0         | 8      |
|                           |        |            |                        |               |                               | 0x28 (Stop CAN) /<br>0x29 (Start CAN)                            | BS                  | 8         | 8      |
|                           |        |            |                        |               |                               | Set to 0x02                                                      | STmin               | 16        | 8      |
|                           |        |            |                        |               |                               | Set to 0xFFFF FFFF                                               | VACANT_DATA_5 BYTES | 56        | 40     |

#### Error Management

| Failure Mode                                       | $I_P$ Value  | Error Indication | Error Information |
|----------------------------------------------------|--------------|------------------|-------------------|
| Memory Error                                       | 0x FFFF FFFF | 1                | 0x40              |
| Overcurrent Detection<br>$I_P >$ Approximate 580 A | 0x FFFF FFFF | 1                | 0x41              |
| Fluxgate has no oscillation for more than 20 ms    | 0x FFFF FFFF | 1                | 0x42              |
| 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<br>DAC Threshold                  | 0x FFFF FFFF | 1                | 0x4A              |
| Hardware default<br>Reference voltage              | 0x FFFF FFFF | 1                | 0x4B              |

## FR1C H00 Series

### Software Version

#### Applicable: FR1C 500 H00

- CAN protocol 2.0 B
- Bit order: big endian (Motorola)
- CAN oscillator tolerance: 0.27 %
- No sleep mode capability
- 120 ohms termination resistor to be added externally, internal CAN impedance = 4.8 kohm

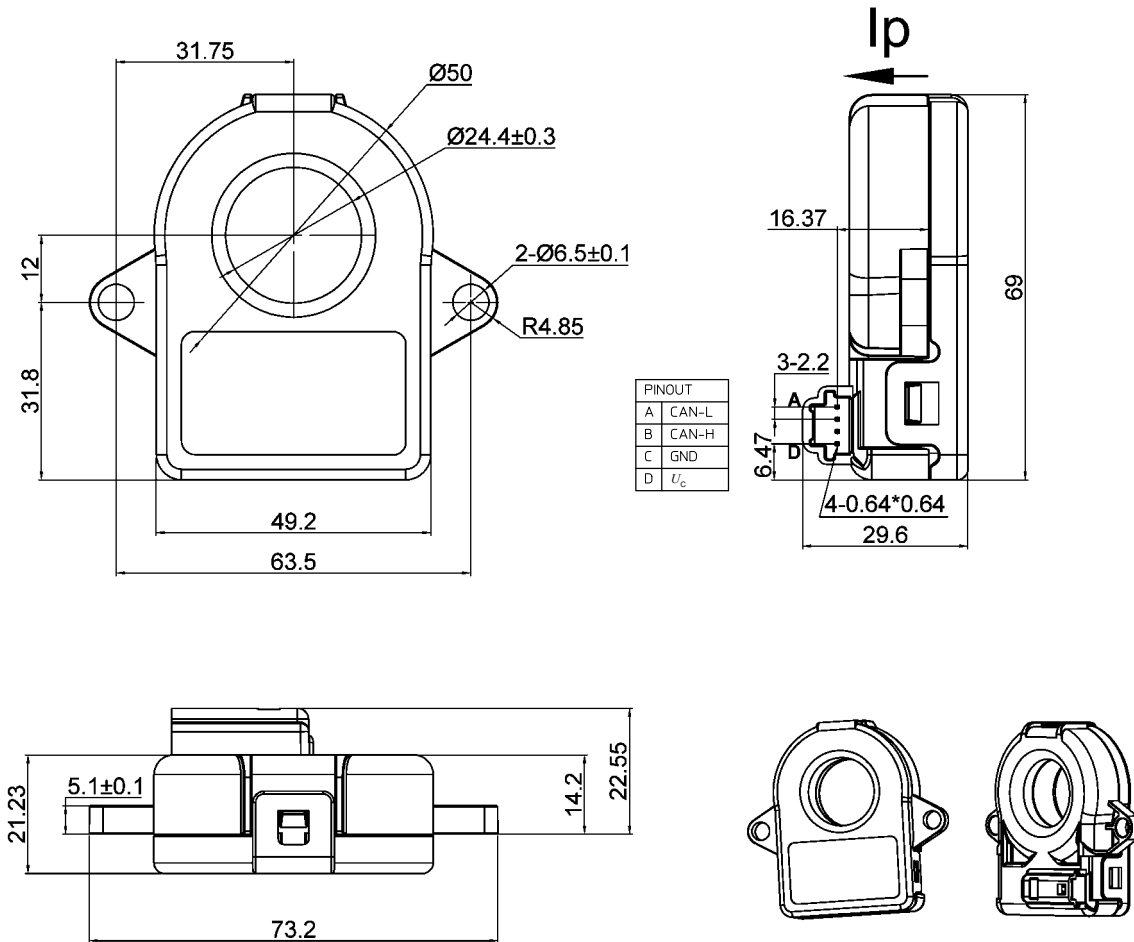
| Message Description       | CAN ID | Name       | Data Length (Nb bytes) | Type of frame | Message launch type           | Signal description                                               | Signal name         | Start bit | Length |
|---------------------------|--------|------------|------------------------|---------------|-------------------------------|------------------------------------------------------------------|---------------------|-----------|--------|
| Return Current $I_P$ (mA) | 0x3C2  | FR1C_IP    | 8                      | Standard      | Cyclic message period 10±1 ms | $I_P$ Value:<br>80000000H=0mA<br>7FFFFFFFH=-1mA<br>80000001H=1mA | CSM_BAT_CURRENT     | 24        | 32     |
|                           |        |            |                        |               |                               | Error indication (1 bit)<br>0 = Normal 1 = Failure               | ERROR_INDICATION    | 32        | 1      |
|                           |        |            |                        |               |                               | Error information (7 bits)                                       | CSM_FAIL            | 33        | 7      |
|                           |        |            |                        |               |                               | CAB (16 bits)                                                    | PRODUCT_NAME        | 48        | 16     |
|                           |        |            |                        |               |                               | Software Revision (8 bit)                                        | SW_Revision         | 56        | 8      |
| Start/Stop CAN TX         | 0x6F0  | TX_Control | 8                      | Standard      | Asynchronous received message | Set to 0x02                                                      | PCI                 | 0         | 8      |
|                           |        |            |                        |               |                               | 0x28 (Stop CAN) / 0x29 (Start CAN)                               | BS                  | 8         | 8      |
|                           |        |            |                        |               |                               | Set to 0x02                                                      | STmin               | 16        | 8      |
|                           |        |            |                        |               |                               | Set to 0xFFFF FFFF                                               | VACANT_DATA_5 BYTES | 56        | 40     |

### Error Management

| Failure Mode                                       | $I_P$ Value  | Error Indication | Error Information |
|----------------------------------------------------|--------------|------------------|-------------------|
| Memory Error                                       | 0x FFFF FFFF | 1                | 0x40              |
| Overcurrent Detection<br>$I_P >$ Approximate 580 A | 0x FFFF FFFF | 1                | 0x41              |
| Fluxgate has no oscillation for more than 20 ms    | 0x FFFF FFFF | 1                | 0x42              |
| 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              |

## FR1C H00 Series

Dimensions (in mm. 1 mm = 0.0394 inch)



### Mechanical characteristics

- ✧ General tolerance:  $\pm 0.5$  mm
- ✧ Connector type: Tyco AMP 1473672-1
- ✧ Primary hole:  $\Phi 24.2$  mm through hole
- ✧ Plastic housing material: PBT+ GF30%
- ✧ Mounting screw: M6, torque max 3 Nm
- ✧ Recommended fastening torque: 2.1 N•m ( $\pm 10\%$ )
- ✧ Mass: 78g $\pm 5$ g

### Remarks

- ✧ I<sub>p</sub> are in the same direction, when IP flows in the direction of arrow.
- ✧ Temperature of the primary conductor should not exceed 105°C.
- ✧ The test busbar should be located in the middle of the installation hole as much as possible.
- ✧ Strong magnet away from sensor.

This is a standard model. For different applications (measurement, secondary connections...), please contact CHIPSENSE.