



# CSR-25-HBW

±25A HIGH-BANDWIDTH CURRENT SENSOR

HIGH-PERFORMANCE SOLUTIONS FOR  
CONTROL DEVELOPMENT AND TESTING



# CSR-25-HBW

±25A HIGH-BANDWIDTH CURRENT SENSOR

“ A very convenient product, simultaneously usable as a fast precision sensor and a debug/monitoring probe.



## GENERAL DESCRIPTION

CSR-25-HBW is a versatile isolated current sensor tailored for power conversion systems. This sensor enables the measurement and monitoring of AC and DC currents in a broad range of applications, including very fast switching converters using SiC or GaN.

Based on Anisotropic Magneto Resistive (AMR) technology, CSR-25-HBW uses two internal sensors and a special compensation circuit, resulting in outstanding voltage rejection over a broad range of  $dV/dt$  conditions, ranging from few  $kV/\mu s$  to  $> 100 kV/\mu s$ .

Thanks to a response time  $< 260 ns$  and an attenuation of typ. 3 dB at 1.5 MHz, this sensor guarantees the precise tracking of non-sinusoidal current waveforms up to typically 500 kHz.

With a nominal sensitivity of 0.2V/A, this sensor covers a measurement range of  $\pm 25 A$  (rms) with a  $\pm 5V$  output. Current measurement inputs are available using both laboratory plugs (banana) and wire terminals. The signal output is provided as a differential pair on the RJ45 connector.

CSR-25-HBW sensors are best suited for use with imperix controllers, which provide the necessary  $\pm 15V$  power supply over the RJ45 connector. They are nonetheless compatible with any other acquisition system using the adequate pinout.

## KEY FEATURES AND SPECIFICATIONS

- Auto-configuration with B-Box 4 (1-wire link)
- $\pm 25 A_{RMS}$  measurement range
- 260 ns response time (typ.)
- 1.5 MHz amplitude bandwidth
- Outstanding CMTI over wide range of  $dV/dt$
- Selectable bandwidth (1.5 MHz or 150 kHz)
- $\pm 0.02 A$  offset (typ.) with factory calibration available on B-Box 4
- $\pm 0.4\%$  gain error (typ.) with factory calibration available on B-Box 4
- $\pm 4.8 kV$  isolation from primary to secondary (60 s)
- Up to  $550 V_{RMS}$  permanent working voltage
- Self-powered from imperix controllers ( $\pm 15V$ )

## TYPICAL APPLICATIONS

- High-performance current control (bandwidth, precision)
- Monitoring, scoping, debug
- System identification

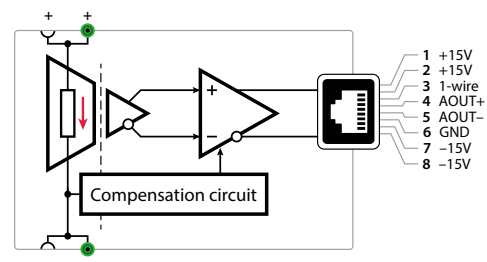
## BENEFITS

The large bandwidth and outstanding voltage rejection of CSR-25-HBW sensors enable very detailed measurements for both control and visualization purposes. With imperix B-Box 4 – which supports oversampling up to 20 Msps – this permits capturing the finest details of current waveforms, often making extra and costly laboratory equipment (e.g. current probes and oscilloscopes) dispensable.

Furthermore, CSR-25-HBW sensors deliver precise and accurate measurements. Indeed, they offer a calibrated performance of typically  $\pm 0.4\%$  gain error and  $\pm 0.02 A$  offset. B-Box 4 users can even benefit from factory calibration parameters, available through an automated sensor identification mechanism, also embedded inside of the RJ45 link (1-wire).

On the practical side, these sensors are truly plug-&-play and thus, very easy to use. Thanks to their high  $dV/dt$  rejection, they can be placed virtually anywhere in the circuit, including directly at the switching node of modern converters. Thanks to their large isolation ratings, safety is not a concern either.

## SIMPLIFIED SCHEMATIC



## RELATED PRODUCTS

| Sensor       | Type         | Range             | BW      | CMTI      | Production |
|--------------|--------------|-------------------|---------|-----------|------------|
| VSR-500-HBW  | Differential | $\pm 500 V_{pk}$  | 3 MHz   | very high | Active     |
| VSR-1000-ISO | Isolated     | $\pm 1000 V_{pk}$ | 100 kHz | very high | Active     |
| CSR-25-HBW   | Isolated     | $\pm 25 A_{RMS}$  | 1.5 MHz | very high | Active     |
| DIN-800V     | Isolated     | $\pm 800 V_{pk}$  | 100 kHz | medium    | NRND       |
| DIN-50A      | Isolated     | $\pm 50 A_{pk}$   | 200 kHz | medium    | NRND       |

# TECHNICAL SPECIFICATIONS

## ABSOLUTE MAXIMUM RATINGS

| Parameter                              | Symbol        | Test conditions              | Min. | Typ. | Max. | Unit      |
|--|---------------|------------------------------|------|------|------|-----------|
| Maximum tolerable input current        | $I_{MAX,RMS}$ | Long term, thermally limited | –    | ±25  | –    | $A_{RMS}$ |
| Maximum measurable current, peak value | $I_{MAX,pk}$  | Before clipping              | –    | ±50  | –    | $A_{pk}$  |
| ESD Human Body Model                   |               |                              | –    | ±8   | –    | kV        |
| Power supply voltage                   | $\pm V_{CC}$  |                              | ±12  | ±15  | ±18  | V         |

## INSULATION CHARACTERISTICS

| Parameter                                 | Symbol     | Test conditions                  | Min. | Typ. | Max. | Unit      |
|---|------------|----------------------------------|------|------|------|-----------|
| Maximum repetitive peak isolation voltage | $V_{IORM}$ | 60s, AC                          | –    | 4.8  | –    | $kV_{pk}$ |
| Maximum working voltage                   | $V_{IOWM}$ | OVCII, PD2, basic isolation      | –    | 1100 | –    | $V_{RMS}$ |
|   |            | OVCII, PD2, reinforced isolation | –    | 550  | –    | $V_{RMS}$ |

## ELECTRICAL CHARACTERISTICS

| Parameter                         | Symbol         | Test conditions                          | Min. | Typ.  | Max. | Unit      |
|-----------------------------------|----------------|--|------|-------|------|-----------|
| Nominal input current range, RMS  | $I_{NOM,RMS}$  |  | –    | ±25   | –    | $A_{RMS}$ |
| Nominal input current range, peak | $I_{NOM,pk}$   |  | –    | ±35   | –    | $A_{pk}$  |
| Nominal sensitivity               | G              | Load resistance $R_L = 5\text{ k}\Omega$ | –    | 200.0 | –    | $mV/A$    |
| Sensitivity error                 | $G_E$          | Disregarding calibration data            | –    | –     | ±3.5 | %         |
|                                   | $G_{E,Calib}$  | On B-Box 4 with calibration data enabled | –    | –     | ±0.4 | %         |
| Input-referred offset             | $I_O$          | Disregarding calibration data            | –    | ±90   | ±270 | $mA$      |
|                                   | $I_{O,Calib}$  | On B-Box 4 with calibration data enabled | –    | ±20   | ±60  | $mA$      |
| Measurement bandwidth             | $f_{3dB,High}$ | Selector set to HIGH bandwidth           | –    | 1.5   | –    | MHz       |
|                                   | $f_{3dB,Low}$  | Selector set to LOW bandwidth            | –    | 150   | –    | kHz       |
| Response time                     |                |  | 250  | 260   | 280  | ns        |
| Input-referred noise, RMS         | $I_{N,high}$   | 100 Hz - 1.5 MHz                         | –    | 31    | –    | $mA$      |
|                                   | $I_{N,low}$    | 100 Hz - 150 kHz                         | –    | 14    | –    | $mA$      |
| Input series resistance           | $R_{IN}$       |  | –    | 3.5   | 5.0  | $m\Omega$ |
| Output impedance, differential    | $R_{OUT}$      |  | 19.8 | 20    | 20.2 | $\Omega$  |
| Output short-circuit current      | $I_{SC}$       |  | –    | ±37   | –    | $mA$      |
| Power consumption                 | $P_{DD}$       |  | –    | 0.41  | –    | W         |

## OFFSET

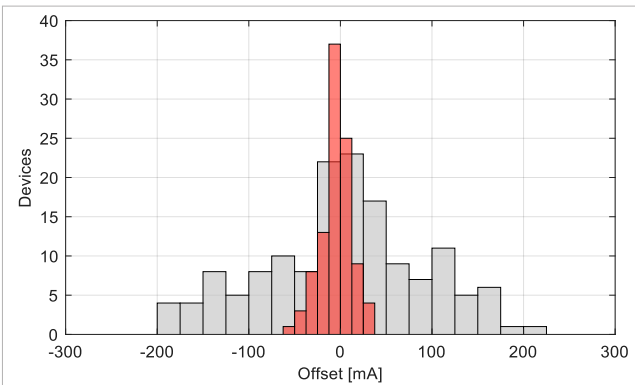


Fig. 1. Statistical distribution of input-referred offset (grey: uncalibrated, red: calibrated).

## SENSITIVITY ERROR

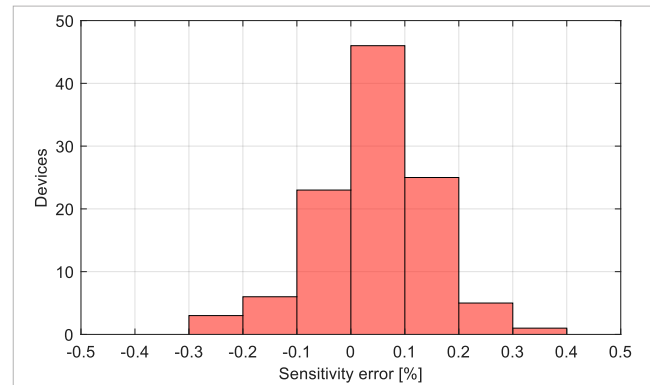


Fig. 2. Statistical distribution of sensitivity error (calibrated).

# TYPICAL CHARACTERISTICS

## RIPPLE CURRENT TRACKING

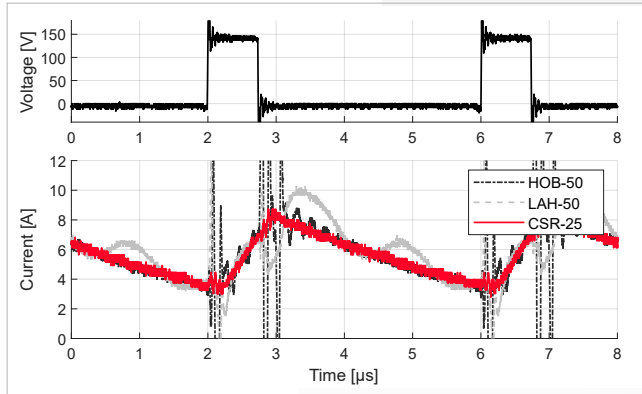


Fig. 3. Tracking performance comparison of CSR-25-HBW sensor against competing solutions.  $F_{SW} = 250$  kHz.

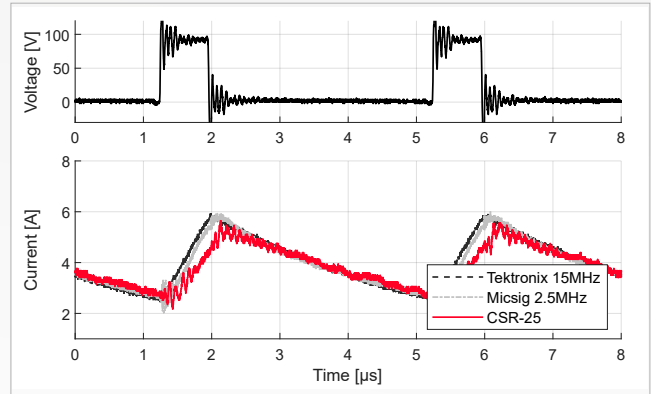


Fig. 4. Tracking performance comparison of CSR-25-HBW sensor against laboratory current probes.  $F_{SW} = 250$  kHz

## TRANSIENT VOLTAGE REJECTION, 20% RINGING

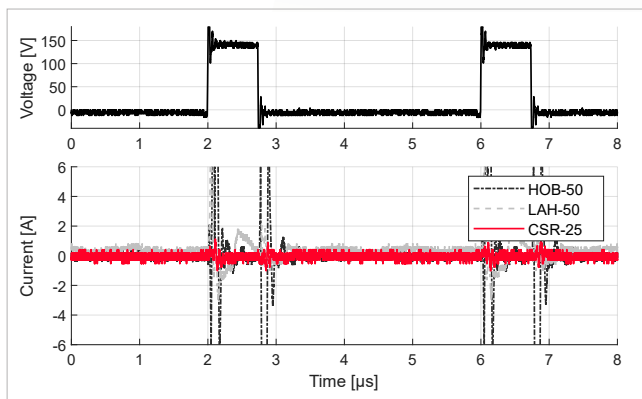


Fig. 5. Voltage rejection performance of CSR-25-HBW against competing solutions. GaN-based converter with 20% voltage ringing.

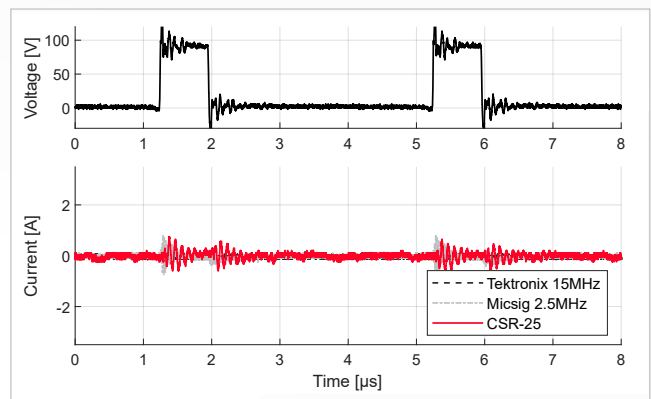


Fig. 6. Voltage rejection performance of CSR-25-HBW against laboratory current probes. GaN-based converter with 20% voltage ringing.

## RESPONSE TO A CURRENT STEP

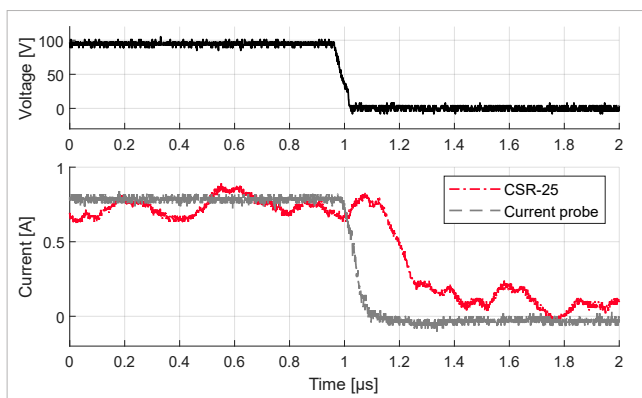


Fig. 7. Transient response to a current step.

## THERMAL PERFORMANCE

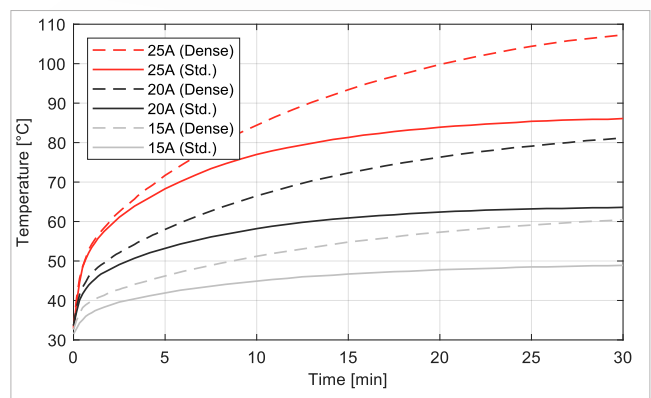


Fig. 8. Internal temperature rise over time.

The curves illustrate the internal temperature rise at the surface of the sensing chip for various current levels.

- "Dense" curves represent a worst-case scenario: sensors mounted side-by-side on a DIN rail with identical loads (mutual heating).
- "Std." curves show a standalone sensor operating independently under natural convection (still air).

Measurements were conducted at 25°C ambient. To ensure reliability, the internal surface temperature must not exceed 110°C.

## MECHANICAL SPECIFICATIONS

### DIMENSIONS

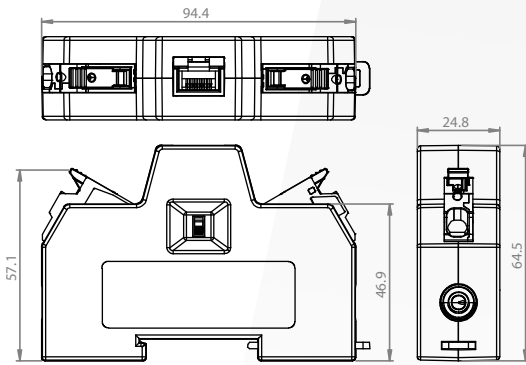


Fig. 9. Dimensions of the CSR-25-HBW sensors.

### AUTO-IDENTIFICATION AND CALIBRATION

The CSR-25-HBW sensors embeds an EEPROM, which contains information on the sensor type as well as its calibration parameters. This data can be read from B-Box 4 and enable the auto-identification. The EEPROM is accessible over a 1-wire communication link present on pin 3 of the RJ45 connector.

#### FACTORY PARAMETERS

The following table lists the stored parameters. During factory testing, the offset and the sensitivity are calibrated.

| Parameter              | Value      | User access from B-Box 4 |
|------------------------|------------|--------------------------|
| Sensor type            | CSR-25-HBW | Read only                |
| Nominal sensitivity    | 0.2 [V/A]  | Read only                |
| Calibrated sensitivity | 0.2 [V/A]  | Read / write             |
| Calibrated offset      | 0 [A]      | Read / write             |

Table 1. Information stored in the EEPROM

#### CALIBRATION PROCEDURE

If the user wishes to update the calibration data present inside the EEPROM, this can be done by clicking the "edit" button in Cockpit:

- Switch from the "Projects" view to the "Targets" view.
- Select the correct target (if not already the case).
- Navigate to the "Analog I/Os" configuration tab.
- Select the correct channel.
- Click on the "edit" button, as shown in Fig. 12.

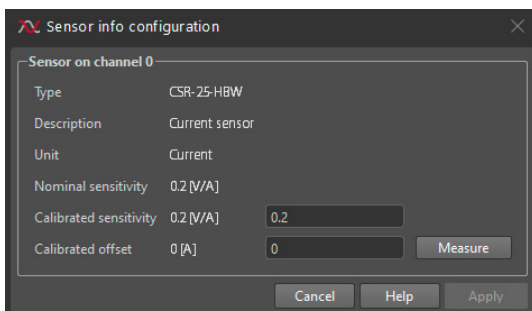


Fig. 10. Editing the calibration data in imperix Cockpit.

### MOUNTING INSTRUCTIONS

CRS-25-HBW sensors are designed to be mounted on 35mm DIN rails. To correctly mount the device:

- Pull the black spring-type locker out.
- Place the sensor on the rail.
- Push back the spring-type locker.

### WIRING INSTRUCTIONS

Beware of the limited current-carrying capacity of the 4 mm (banana) connectors. Their rating (24A) is similar to that of most laboratory cables. For higher-current applications, use the wire terminals.

Do not use wire sleeves with the wire terminals. Their internal surfaces are flat, preventing any risk of damage to stranded wires.

### DISABLING CALIBRATION INFORMATION

By default, the B-Box 4 uses calibration parameters in order to improve the accuracy of the retrieved measurement. If, for any reason, the user wishes to bypass this behaviour, calibration can be disabled in the analog I/O configuration of the B-Box 4:

- Directly on B-Box 4, select the "analog I/O" configuration menu. Select the desired channel, and then "disable" in the relevant screen:

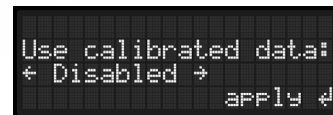


Fig. 11. Status message on the OLED screen of the B-Box 4.

- In Cockpit, uncheck the "USE CALIBRATION DATA" checkbox in the "analog I/O" tab of the "target" configuration.

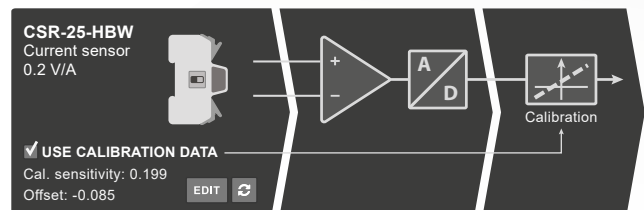


Fig. 12. Relevant section of the "analog I/O" configuration in Cockpit.

## RELATED DOCUMENTATION

### PRINT

- Datasheet of the B-Box 4 – [link](#)

### ONLINE

- Sensor auto-identification on B-Box 4 – [link](#)
- Analog I/O configuration on B-Box 4 – [link](#)
- Architecture and operation of B-Box 4 – [link](#)
- Over-current and over-voltage protection – [link](#)
- Advanced sampling techniques – [link](#)

## ENVIRONMENTAL CONDITIONS

| Parameter                               | Value  |
|---|--|
| System voltage                          | 300V, OVC II, PD2  |
| Operating conditions (IEC/EN 60721-3-3) | Climate conditions for operation class 3K3:<br>– Temperature range: 0°C to +40°C<br>– Relative humidity: < 95%, no condensation<br>– Atmospheric pressure: 70KPa to 106KPa |
| Storage conditions (IEC/EN 60721-3-1)   | Climate conditions for storage class 1K3:<br>– Temperature range: -25°C to +55°C<br>– Relative humidity: < 95%, no condensation<br>– Atmospheric pressure: 70KPa to 106KPa |
| IP rating                               | IP 20  |
| Protection class                        | Class II   |

Table 2. Rated environmental conditions

## PINOUT

| Pin | Pair | Color         | Description                    |
|-----|------|---------------|--------------------------------|
| 1   | 2    | orange stripe | +15 V                          |
| 2   | 2    | orange solid  | +15 V                          |
| 3   | 3    | green stripe  | 1-WIRE data                    |
| 4   | 1    | blue solid    | Positive input / current input |
| 5   | 1    | blue stripe   | Negative input / ground        |
| 6   | 3    | green solid   | GND                            |
| 7   | 4    | brown stripe  | -15 V                          |
| 8   | 4    | brown solid   | -15 V                          |

Table 3. Pinout of the RJ45 connector.

## REVISION HISTORY

- **22.09.25**: Preliminary version
- **30.03.26**: Added details on offset, sensitivity error and thermal aspects.

## CONTACT

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## ABOUT US

Imperix develops high-end control equipment and prototyping hardware for power electronics, motor drives, smart grids, and related applications. Our products are designed to accelerate the implementation of laboratory-scale power converters and facilitate the acquisition of high-quality experimental results.

## NOTE

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