

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/µs to > 100kV/µs.

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

With a nominal sensitivity of 0.2 V/A, this sensor covers a measurement range of  $\pm 25$ A (peak) with a  $\pm 5$ V 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  $\pm 15$ V 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)
- $\pm 25 A_{pk}$  measurement range
- 260 ns response time (typ.)
- 2 MHz amplitude bandwidth
- Outstanding CMTI over wide range of dV/dt
- · Selectable bandwidth (1.5MHz or 150kHz)
- ±0.2A offset (typ.) factory calibration available on B-Box 4
- $\bullet \pm 0.6\%$  gain error (typ.) factory calibration available on B-Box 4
- ±4.8kV isolation from primary to secondary (60s)
- Up to 550V<sub>RMS</sub> permanent working voltage
- Self-powered from imperix controllers (±15V)

#### TYPICAL APPLICATIONS

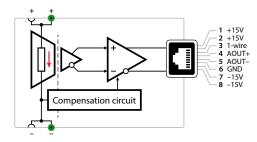
- High-performance current control (bandwidth, precision)
- Monitoring, scoping, debug
- System identification

#### **BENEFITS**

The large bandwidth and outstanding voltage rejection of CSR-50-HBW sensors enable very detailed measurements for both control and vizualisation purposes. With imperix B-Box 4 – which supports oversampling up to 20Msps – 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 an uncalibrated performance of typically  $\pm 0.6\%$  gain error and  $\pm 0.2\mathrm{A}$  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	Туре	Range	BW	CMTI	Production
VSR-500-HBW	Differential	$\pm 500V_{pk}$	3 MHz	very high	Active
VSR-1000-ISO	Isolated	±1000V <sub>pk</sub>	100 kHz	very high	Active
CSR-25-HBW	Isolated	$\pm 25A_{pk}$	1.5 MHz	very high	Active
DIN-800V	Isolated	$\pm 800  V_{pk}$	100 kHz	medium	NRND
DIN-50A	Isolated	$\pm 70A_{pk}$	200 kHz	medium	NRND

## **TECHNICAL SPECIFICATIONS**

## ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test conditions	Min.	Тур.	Max.	Unit
Maximum tolerable input current		Short term, any terminals	-	tbd	-	A <sub>RMS</sub>
		Long term, banana connectors	-	24	-	A <sub>RMS</sub>
		Long term, terminal blocks	-	40	-	A <sub>RMS</sub>
Maximum repetitive peak isolation voltage	$V_{IORM}$	60s, AC	-	4.8	-	$kV_{RMS}$
Maximum working voltage	$V_{\text{IOWM}}$	OVCII, PD2, basic isolation	-	1100	-	$V_{RMS}$
		OVCII, PD2, reinforced isolation	-	550	-	$V_{RMS}$
ESD Human Body Model			-	±8	-	kV
Power supply voltage	±V <sub>CC</sub>		±12	±15	±18	V

## **ELECTRICAL CHARACTERISTICS**

Parameter		Symbol	Test conditions	Min.	Тур.	Max.	Unit
Nominal input current, linear range		I <sub>NOM</sub>		-	±50	-	$A_{pk}$
Maximum measurable current, peak value		I <sub>MAX</sub>		-		-	$A_{pk}$
Nominal sensitivity		G	Load resistance $R_L = 5 k\Omega$		100.0		mV/A
Sensitivity error		$G_{E}$			±0.8		%
Input-referred offset		Io	Disregarding calibration data		±65	350	mA
Measurement bandwidth		f <sub>3dB,High</sub>	Selector set to HIGH bandwidth	-	1.5	-	MHz
		f <sub>3dB,Low</sub>	Selector set to LOW bandwidth	-	150	-	kHz
Group delay			50 Hz	250	260	280	ns
Voltage rejection ratio			50 Hz		tbd		dB
			20 kHz		tbd		dB
			1 MHz		tbd		dB
Input-referred noise			100Hz-100kHz		60		uA/√Hz
			HIGH bandwidth		tbd		$mA_RMS$
			LOW bandwidth		tbd		$mA_{RMS}$
Input series resistance		R <sub>IN</sub>			3.5	5.0	mΩ
Output impedance, differential		R <sub>OUT</sub>		9,9	10	10.1	Ω
Power consumption		$P_{DD}$			210		mW

## **TYPICAL CHARACTERISTICS**

## RIPPLE CURRENT TRACKING

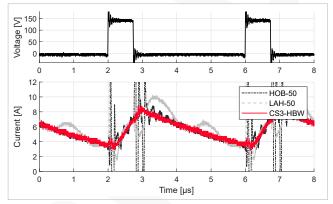


Fig. 1. Tracking performance comparison of CSR-25 sensor against competing solutions.  $F_{SW} = 250 \text{ kHz}$ .

## RIPPLE CURRENT TRACKING

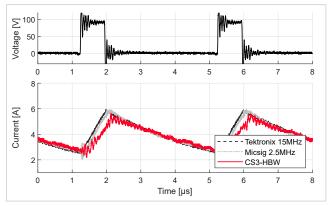


Fig. 2. Tracking performance comparison of CSR-25 sensor against laboratory current probes. F<sub>SW</sub> = 250 kHz

#### TRANSIENT VOLTAGE REJECTION, 20% RINGING

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Fig. 3. Voltage rejection performance of CSR-25 against competing solutions. GaN-based converter with 20% voltage ringing.

#### TRANSIENT VOLTAGE REJECTION, 20% RINGING

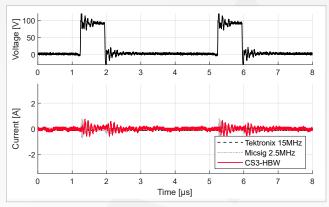


Fig. 5. Voltage rejection performance of CSR-25 against laboratory current probes. GaN-based converter with 20% voltage ringing.

## RESPONSE TO A CURRENT STEP

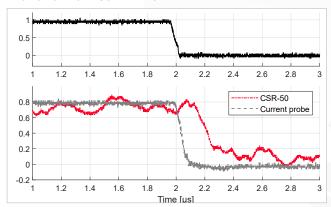


Fig. 4. Transient response to a current step.

#### **OFFSET**



Fig. 6. Statistical distribution of offset.

## SENSITIVITY ERROR



Fig. 7. Statistical distribution of sensitivity error.

## **CALIBRATION**

The CSR-25-HBW sensors contain an EEPROM, which contains calibration information that can be read from the B-Box 4. This EEPROM is accessible over a 1-wire communication link present on pin 4 of the RJ45 connector.

#### **FACTORY PARAMETERS**

The following information is written into the EEPROM during the factory test:

Parameter	Value	User access from B-Box 4
Sensor model	CSR-25-HBW	Read only
Revision number	vvvv.w	Read only
Nominal sensitivity	0.1 [V/A]	Read only
Calibrated sensitivity	x.yyy [V/A]	Read / write
Nominal offset	0.0 [mA]	Read only
Calibrated offset	0.zzz [A]	Read / write
Calibration date	dd.mm.AAAA	Read / write

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



Fig. 8. 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.

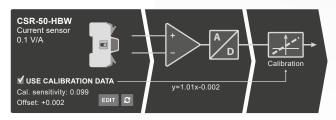


Fig. 9. Relevant section of the "analog I/O" configuration in Cockpit.

#### **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/O" configuration tab.
- Select the correct channel.
- · Click on the "edit" button, as shown in Fig. 10.

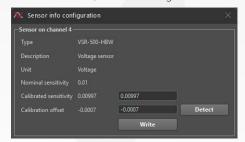


Fig. 10. Editing the calibration data in imperix Cockpit.

#### **MECHANICS**

#### **MECHANICAL SPECIFICATIONS**

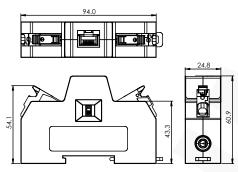


Fig. 11. Dimensions of the CSR-25-HBW sensors.

#### 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 surfac-

es are flat, preventing any risk of damage to stranded wires.

### **SAFETY PRECAUTIONS**

#### **ENVIRONMENTAL CONDITIONS**

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

Table 1. Rated environmental conditions

#### **RELATED DOCUMENTATION**

#### **PRINT**

• B-Box 4 Datasheet

#### ONI INF

- Sensor calibration with B-Box 4 link
- Analog I/O configuration on B-Box 4 link
- Architecture and operation of B-Box 4 link
- ullet Over-current and over-voltage protection link
- Advanced sampling techniques link

## **REVISION HISTORY**

- 22.09.25: Preliminary version
- 10.10.25: Typographic corrections

## 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 topics. Our products are designed to accelerate the implementation of laboratory-scale power converters and facilitate the derivation of high-quality experimental results.





This product must be used in electronic equipment / environment with respect to applicable safety requirements and in accordance with the manufacturer's operating instructions.
Caution! Never open the product. Risk of electric shock!

## NOTE

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