



CSR-40-HBW

±40A HIGH-BANDWIDTH CURRENT SENSOR

HIGH-PERFORMANCE SOLUTIONS FOR
CONTROL DEVELOPMENT AND TESTING



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“A versatile sensor, usable as both a fast control measuring element and a precision probe for waveform monitoring.”



GENERAL DESCRIPTION

The CSR-40-HBW is an isolated, high-bandwidth and high-accuracy current sensor, specifically engineered for the demands of modern power electronic systems. It is designed to precisely control and monitor both AC and DC currents across a wide range of use cases, including very high-speed switching converters based on SiC or GaN semiconductors.

Featuring a rapid response time of 180 ns and a typical signal bandwidth of 3 MHz, this sensor ensures accurate tracking of complex current waveforms up to typically 1 MHz. Furthermore, it offers exceptional common-mode voltage rejection performance across the entire frequency range.

The device supports a nominal measurement range of ±40A (rms) with a sensitivity of 0.1 V/A. Its current inputs are available via both laboratory banana plugs and wire terminals, allowing for flexible integration into various setups. The output signal is provided as a differential pair on the RJ45 connector.

Ideally, CSR-40-HBW sensors are used together with imperix controllers because they provide the necessary ±15V power supply on 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)
- ±40A_{RMS} measurement range
- 180 ns response time (typ.)
- 3 MHz bandwidth
- Outstanding CMTI over wide range of dV/dt
- Selectable bandwidth (3 MHz or 300 kHz)
- ±0.015 A typ. offset with factory calibration available on B-Box 4
- ±0.25 % max. gain error with factory calibration on B-Box 4
- ±6.0 kV isolation from primary to secondary (60 s)
- Up to 1060V_{RMS} permanent working voltage
- Self-powered from imperix controllers (±15V)

TYPICAL APPLICATIONS

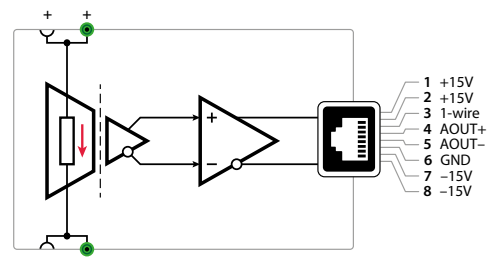
- High-performance current control (bandwidth, precision)
- Monitoring, scoping, debug
- System identification

BENEFITS

Combining high bandwidth with outstanding voltage rejection, the CSR-40-HBW is perfectly suited for both real-time control and signal visualization. Used together with imperix B-Box 4 – which can sample signals up to 20 Msps – the sensor is able to capture every detail of current waveforms. This performance level often eliminates the need for expensive external laboratory equipment, such as high-end current probes and oscilloscopes.

Additionally, CSR-40-HBW sensors are designed for precise and accurate results, offering a calibrated performance with a maximum ±0.25 % gain error and a typical ±0.015 A offset. B-Box 4 users can benefit from factory calibration parameters, which are retrieved via a 1-Wire interface integrated into the RJ45 link. The same communication interface also facilitates the automated sensor identification. From a practical standpoint, these sensors offer a true plug-&-play experience and are exceptionally 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. High isolation ratings further guarantee safe operation across different applications.

SIMPLIFIED SCHEMATIC



RELATED PRODUCTS

Sensor	Type	Range	BW	CMTI	Production
VSR-500-HBW	Differential	±500V _{pk}	3 MHz	very high	Active
VSR-1000-ISO	Isolated	±1000V _{pk}	100 kHz	very high	Active
CSR-25-LNO	Isolated	±25 A _{RMS}	1.5 MHz	very high	Active
CSR-40-HBW	Isolated	±40 A _{RMS}	3 MHz	very high	Active
DIN-800V	Isolated	±800V _{pk}	100 kHz	medium	NRND
DIN-50A	Isolated	±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 ¹	–	±40	–	A _{RMS}
Maximum measurable current, peak value	$I_{MAX,pk}$	Before clipping ²	–	±56	–	A _{pk}
ESD Human Body Model	V_{ESD_HBM}		–	±2000	–	V
Power supply voltage	±V _{CC}		±12	±15	±18	V

INSULATION CHARACTERISTICS

Parameter	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Dielectric withstand test voltage	V _{TEST}	60s, AC, type test	–	4200	–	V _{rms}
Maximum working voltage	V _{IOWM}	OVCII, PD2, basic isolation	–	1700	–	V _{RMS}
		OVCII, PD2, reinforced isolation	–	1060	–	V _{RMS}

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Nominal input current range, RMS	$I_{NOM,RMS}$	Long term, thermally limited ¹	–	±40	–	A _{RMS}
Nominal input current range, peak	$I_{NOM,pk}$	Before clipping ²	–	±56	–	A _{pk}
Nominal sensitivity	G	Load resistance R _L = 5 kΩ	–	100.0	–	mV/A
Sensitivity error	G _E	Disregarding calibration data, T = 25 °C	–	±0.55	±1.1	%
	G _{E,Calib}	On B-Box 4 with calibration data enabled, T = 25 °C	–	±0.07	±0.25	%
Input-referred offset	I _O	Disregarding calibration data, T = 25 °C	–	±25	±75	mA
	I _{O,Calib}	On B-Box 4 with calibration data enabled, T = 25 °C	–	±15	±45	mA
Measurement bandwidth	f _{3dB,High}	Selector set to HIGH bandwidth	–	3.0	–	MHz
	f _{3dB,Low}	Selector set to LOW bandwidth	–	300	–	kHz
Response time	t _{resp}		–	180	–	ns
Input-referred noise, RMS	I _{N,high}	100 Hz - 3.0 MHz	–	38.2	–	mA
	I _{N,low}	100 Hz - 300 kHz	–	36.6	–	mA
Input series resistance	R _{IN,B}	Using banana connectors	–	2.9	–	mΩ
	R _{IN,W}	Using wire terminals	–	1.8	–	mΩ
Output impedance, differential	R _{OUT}		19.8	20.0	20.2	Ω
Output short-circuit current	I _{SC}		–	±37	–	mA
Power consumption	P _{DD}		–	0.52	–	W

OFFSET

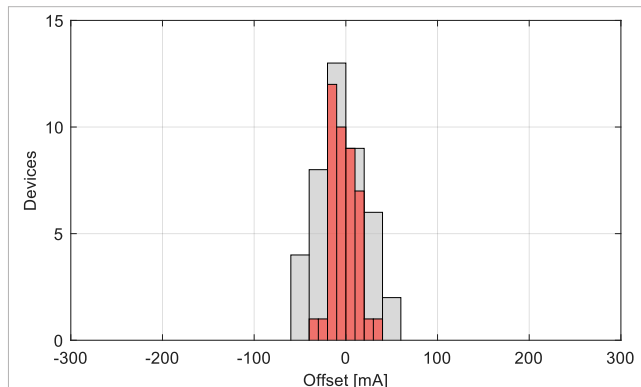


Fig. 1. Statistical distribution of input-referred offset (grey: uncalibrated, red: calibrated).

SENSITIVITY ERROR

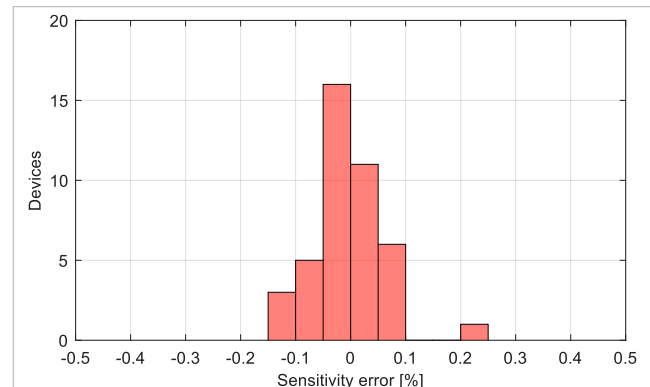


Fig. 2. Statistical distribution of sensitivity error (calibrated).

¹ Rating applies to a single sensor under natural convection. For side-by-side DIN-rail mounting, derate accordingly - see details under "Thermal performance" on page 4.

² The max. measurable peak current corresponds to the nominal peak current rating; no additional margin above this value.

TYPICAL CHARACTERISTICS

RIPPLE CURRENT TRACKING AT $F_{SW} = 200 \text{ KHZ}$

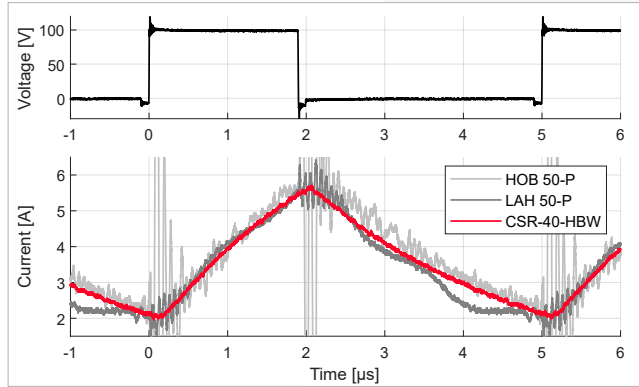


Fig. 3. Current ripple comparison with competing solutions.

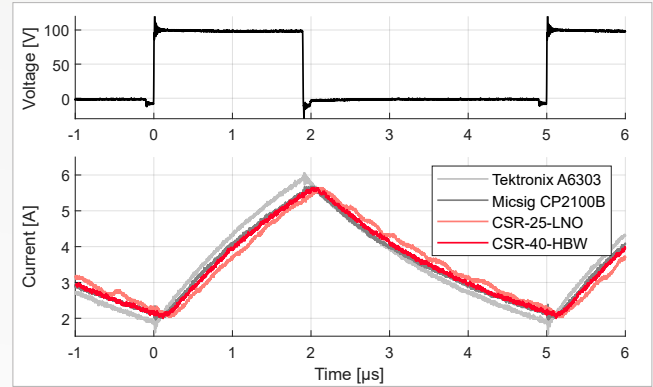


Fig. 4. Current ripple comparison with laboratory current probes.

TRANSIENT VOLTAGE REJECTION

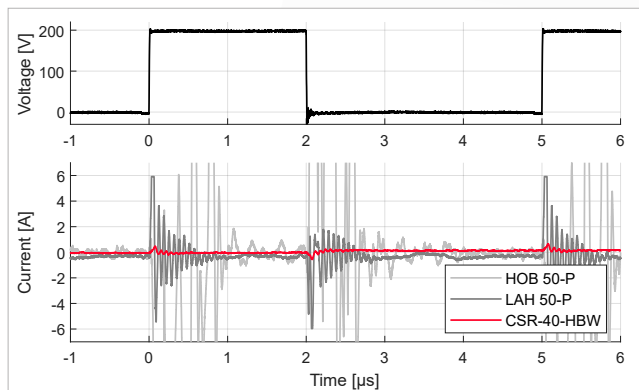


Fig. 5. Voltage rejection comparison with competing solutions.

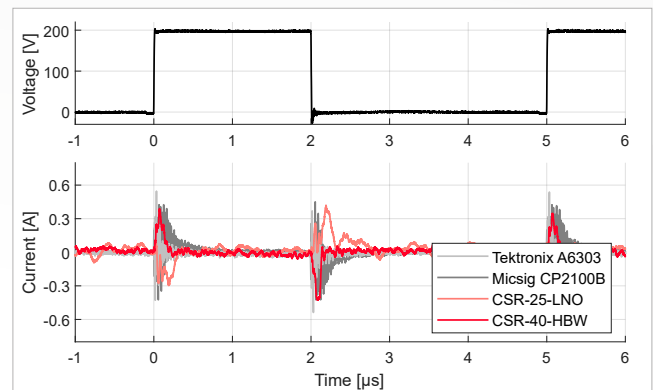


Fig. 6. Voltage rejection comparison with laboratory current probes.

RESPONSE TO A CURRENT STEP OF $I_{STEP} = 10 \text{ A}$

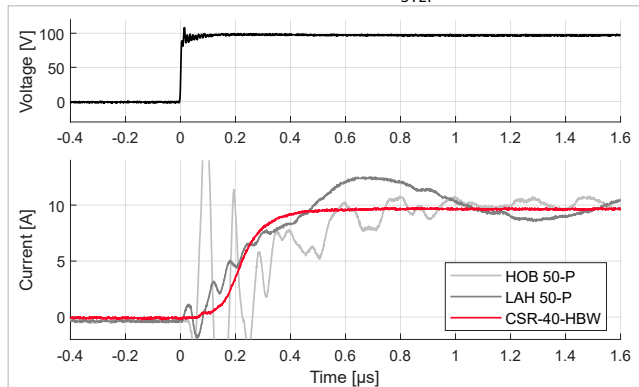


Fig. 7. Step response comparison with competing solutions.

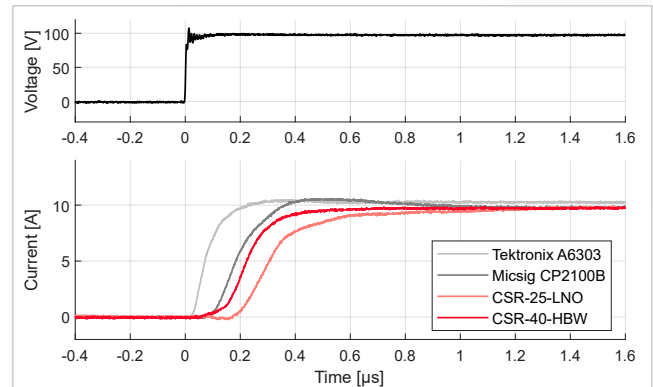


Fig. 8. Step response comparison with laboratory current probes.

THERMAL PERFORMANCE

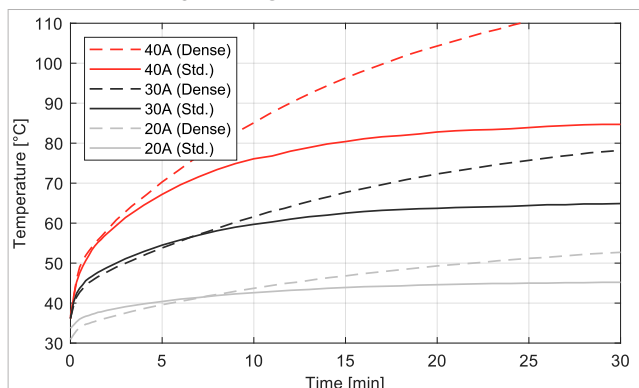


Fig. 9. Internal temperature rise over time.

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.

Note: At the full $\pm 40 \text{ A}$ rating with dense, side-by-side mounting, this limit is exceeded during long-term operation; derate the current or increase spacing in such configurations.

MECHANICAL SPECIFICATIONS

DIMENSIONS

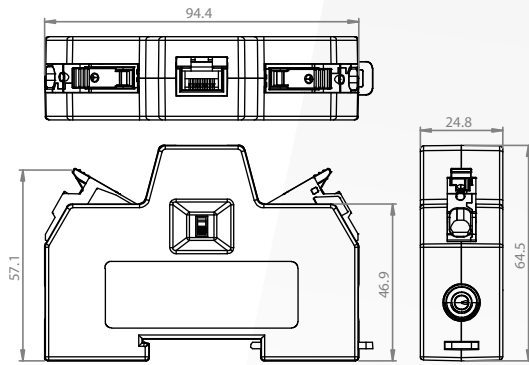


Fig. 10. Dimensions of the CSR-40-HBW sensors.

AUTO-IDENTIFICATION AND CALIBRATION

The CSR-40-HBW sensor 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-40-HBW	Read only
Nominal sensitivity	0.1 [V/A]	Read only
Calibrated sensitivity	0.1 [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. 13.

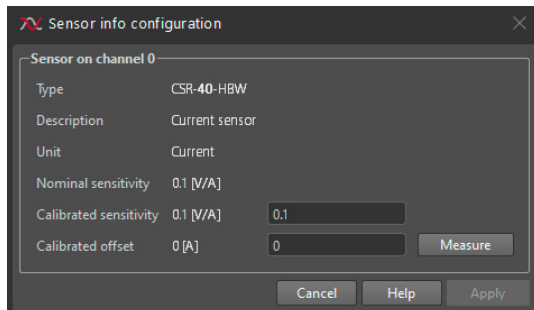


Fig. 11. Editing the calibration data in imperix Cockpit.

MOUNTING INSTRUCTIONS

CSR-40-HBW sensors are designed to be mounted on 35 mm 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, or to use the full scale of the sensor, 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:

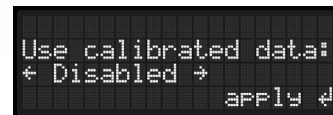


Fig. 12. Status message on the OLED screen of the B-Box 4.

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

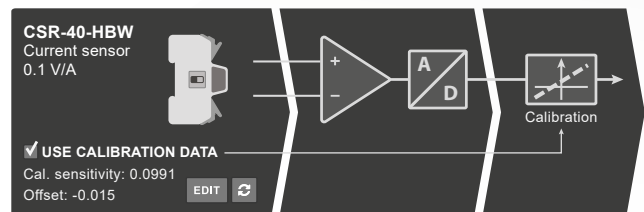


Fig. 13. Relevant section of the "analog I/O" configuration in Cockpit.

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 (IEC/EN 61010-1)	300V, 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 2. Rated environmental conditions

PINOUT

Pin	Pair	Color	Description
1	2	orange stripe	+15V
2	2	orange solid	+15V
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	-15V
8	4	brown solid	-15V

Table 3. Pinout of the RJ45 connector.

REVISION HISTORY

- 23.09.26: Preliminary version.
- 13.10.26: Clarified insulation and thermal ratings.

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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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