TLx5572 three-phase evaluation boards user guide

XENSIV™ current sensors

About this document

Scope and purpose

This document describes the XENSIV™ TLx5572 three-phase evaluation boards (EVAL_TLX5572_3PH_3V, EVAL_TLX5572_3PH_5V), which use Infineon's magnetic current sensor with an external current rail (eCR) for industrial and consumer applications.

The evaluation board is intended solely for customer evaluation and testing purposes. It is not a commercial product and must not be used for series production. Therefore, the board is not designed to meet industrial specifications and is intended to operate at room temperature only.

Intended audience

This document is intended for customers who plan to use XENSIV™ TLx5572 in current sensing applications.

About this product group

Target applications

- Server power supply units (PSU)
- Battery powered tools
- Service robots and drones
- e-Bikes and e-Scooters
- General purpose motor drive
- Photovoltaic

Product family

Infineon's XENSIV™ current sensors deliver precise AC and DC current measurements with internal current rail packages and support measurements of currents up to several kiloamperes with external current rail packages.

Evaluation board

This board is used during design, for evaluation and measurement of characteristics, and proof of datasheet specifications.

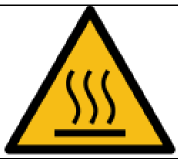
Note: Printed circuit board (PCB) and auxiliary circuits are not optimized for final customer design. Boards do not necessarily meet safety, electromagnetic interference (EMI), and quality standards (for example, UL, CE) requirements.

Table of contents

Safety precautions

Note: *Please note the following warnings regarding the hazards associated with development systems.*

Safety precautions

	**Warning:** *The DC link potential of this board is up to 1000 VDC. When measuring voltage waveforms by oscilloscope, high voltage differential probes must be used. Failure to do so may result in personal injury or death.*
	**Warning:** *The evaluation or reference board is connected to the grid input during testing. Hence, high-voltage differential probes must be used when measuring voltage waveforms by oscilloscope. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.*
	**Warning:** *Remove or disconnect power from the drive before you disconnect or reconnect wires, or perform maintenance work. Wait five minutes after removing power to discharge the bus capacitors. Do not attempt to service the drive until the bus capacitors have discharged to zero. Failure to do so may result in personal injury or death.*
	**Caution:** *The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.*
	**Caution:** *Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.*
	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*
	**Caution:** *A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.*
	**Caution:** *The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.*

1 The board at a glance

The XENSIV™ TLx5572 evaluation board is designed to enable familiarization with the TLx5572 current sensor for design support and evaluation purposes.

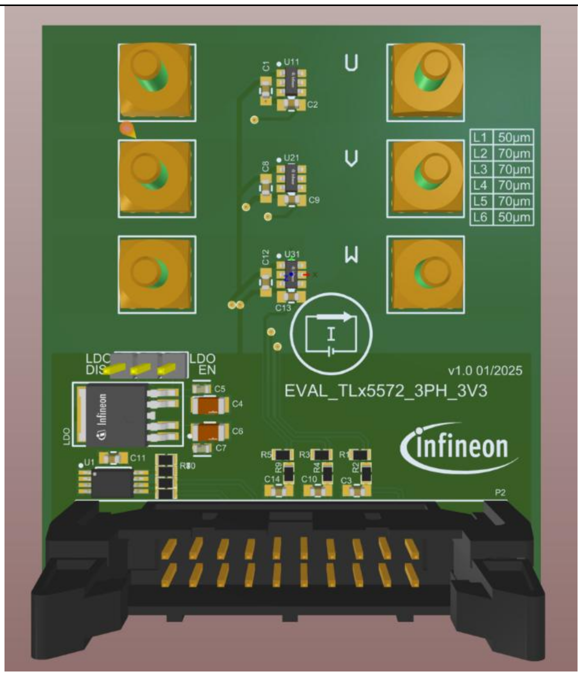


Figure 1 XENSIV™ TLx5572 three-phase evaluation board

1.1 Block diagram

The device measures the magnetic field using a tunnel magnetoresistance (TMR) bridge. The TMR bridge output signal is fed into the first amplification stage via an operational transconductance amplifier (OTA).

The OTA output is then processed by a differential amplifier, which generates the signal at the AOUT pin. Infineon applies temperature compensation, pre-calibration, and trimming to the sensor.

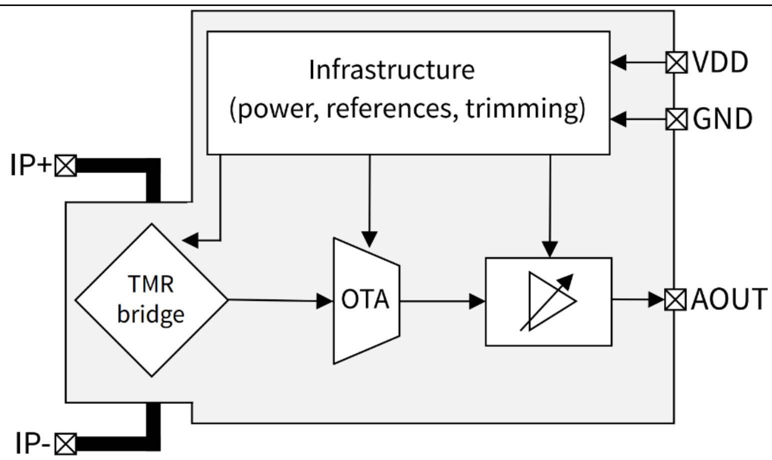


Figure 2 Block diagram of the XENSIV™ TLx5572 evaluation board

1.2 Main features

The main features are:

- Three XENSIV™ TLx5572 sensors, for testing in three-phase systems
- Shunt replacement

1.3 Board parameters and technical data

Table 1 Evaluation board overview for 3.3 V variant

Product	**TLx5572-AE12E1**
Package	PG-SOT23-6-4
Supply voltage	3.3 V
Evaluation board name	EVAL_TLX5572_3PH_3V
Evaluation board order number	SP006042517
Insertion method name	Lateral insertion 90° bend on Inlay PCB
Full-scale	165 A
Typical transfer factor of the external current rail	72 µT/A
Typical sensor sensitivity	8.2 mV/A
Output mode	Single-ended AOUT only
External current rail width	2.5 mm
External current rail thickness	0.28 mm

Table 2 Evaluation board overview for 5 V variant

Product	**TLx5572-AE08E1**
Package	PG-SOT23-6-4
Supply voltage	5 V
Evaluation board name	EVAL_TLX5572_3PH_5V
Evaluation board order number	SP006042510
Insertion method name	Lateral insertion 90° bend on Inlay PCB
Full-scale	165 A
Typical transfer factor of the external current rail	72 µT/A
Typical sensor sensitivity	13.1 mV/A
Output mode	Single-ended AOUT only
External current rail width	2.5 mm
External current rail thickness	0.28 mm

2 System and functional description

2.1 Commissioning

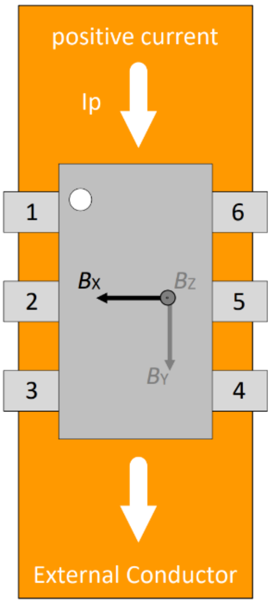
Supply the voltage via pin 16 (VS, low-dropout (LDO) regulator input). To enable the onboard LDO, pin 19 Enable (EN) must be connected to the same supply voltage. For a 3.3 V LDO output, VS must be 3.6 V, and for a 5 V LDO output, VS must be 5.5 V. See Figure 7 for the complete pinout of the evaluation board connector.

2.2 Description of the functional blocks

The board consists of three XENSIV™ TLx5572 current sensors to accurately sense AC and DC currents. It includes an onboard LDO to provide a stable supply voltage to the sensors. For additional details on XENSIV™ TLx5572 sensor, see the datasheet.

2.3 Sensing structure layout

The sensor detects the magnetic field component directed from pin 5 to pin 2. The magnetic field at the sensing element is considered positive when it is directed from pin 5 to pin 2. A current flowing through an external conductor generates a corresponding positive magnetic field.



TLx5572 is sensitive to fields in **Bx**

Fieldvector **Bx** points from pin 5 to pin 2

A **positive current Ip** flowing in an external conductor
in **direction** from pin1 to pin3
will lead to a **voltage increase** at the **AOUT** pin

Figure 3 Sensing structure overview

3 System design

3.1 Schematics

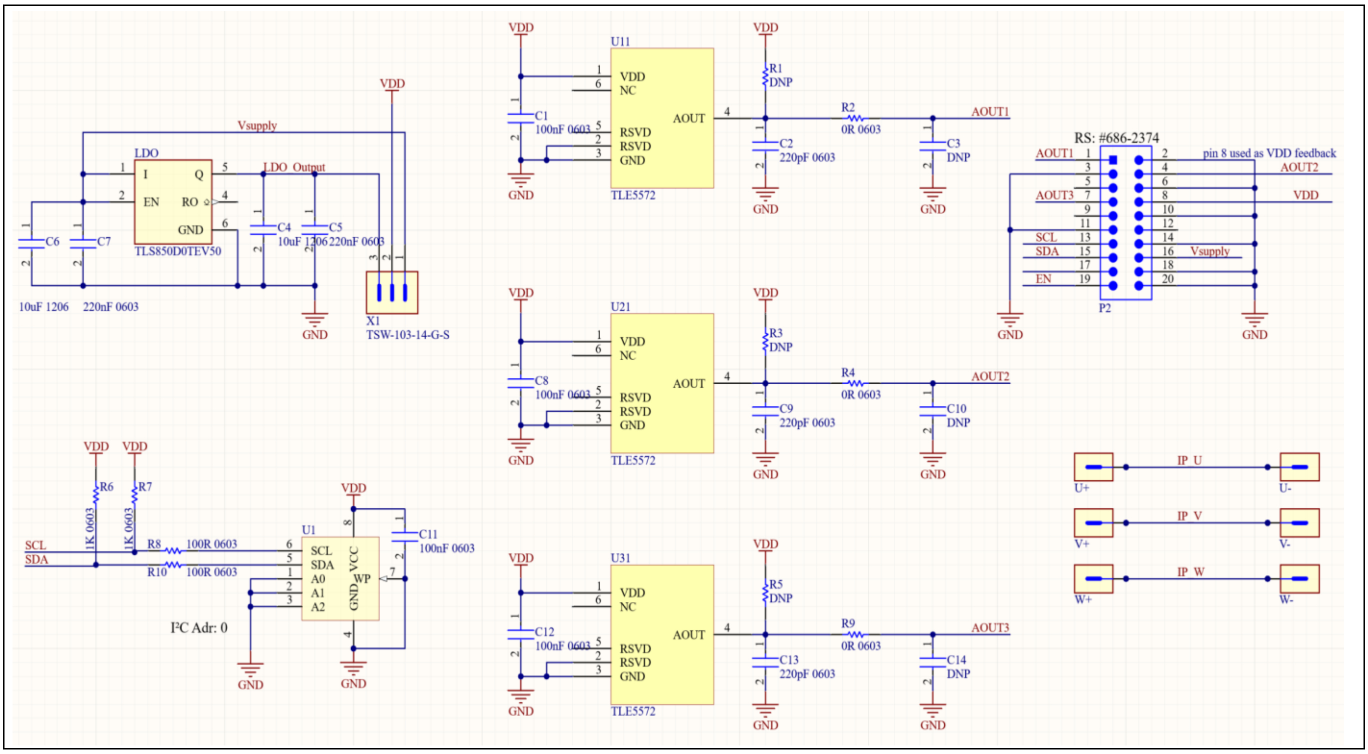


Figure 4 **XENSIV™ TLx5572 evaluation board schematic**

To suppress the high-frequency noise and meet the EMC (electromagnetic compatibility) and ESD (electrostatic discharge) requirements, the design includes the following capacitors:

- A 100 nF bypass capacitor connected to the supply voltage (VDD) pins of the sensors
- A 220 pF bypass capacitor connected to the output pins of the sensors

An LDO is implemented to supply the sensors with a stable voltage.

3.2 Layout

The XENSIV™ TLx5572 evaluation board consists of six layers. Layers two, three, four, and five are designed to carry the high current sensed by the sensors. Further details are shown in Figure 5.

#	Name	Material	Type	Weight	Thickness
	Top Overlay		Overlay		
	Top Solder	Solder Resist	Solder Mask		0.02mm
1	L1_Top		Signal	1oz	0.05mm
	Dielectric 1	PP-006	Prepreg		0.16mm
2	L2	CF-004	Signal	1oz	0.07mm
	Dielectric1	FR-4	Prepreg		0.125mm
3	L3		Signal	1oz	0.07mm
	Dielectric4	FR-4	Core		0.24mm
4	L4		Signal	1oz	0.07mm
	Dielectric10	FR-4	Prepreg		0.125mm
5	L5	CF-004	Signal	1oz	0.07mm
	Dielectric 2	PP-006	Prepreg		0.16mm
6	L6_Bot		Signal	1oz	0.05mm
	Bottom Solder	Solder Resist	Solder Mask		0.02mm
	Bottom Overlay		Overlay		

Figure 5 Layer stack-up of the evaluation board

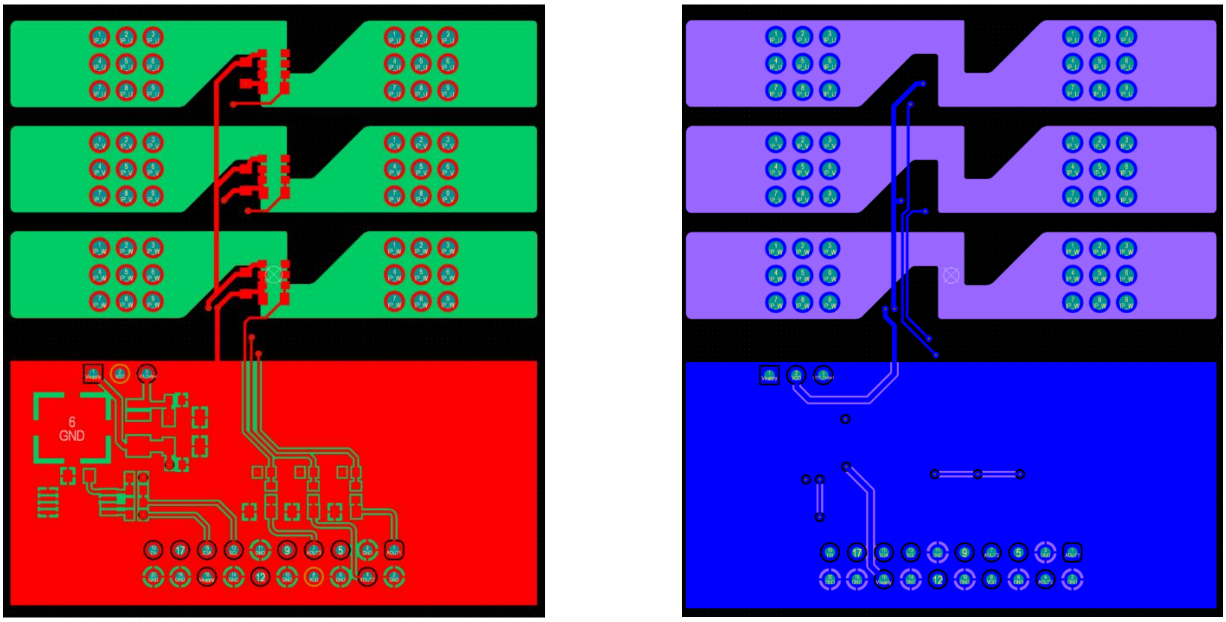


Figure 6 Evaluation board PCB layout: External current rails (green on layer 2, purple on layer 1), top layer (left, red) and bottom layer (right, blue).

Ground planes are used to protect the signal tracks and reduce parasitic inductive coupling. In addition, the external current rail is also routed through layers 3 and 4.

3.3 Bill of materials

Table 3 Bill of materials

Quantity	Designator	Value	Comment	Footprint
3	U11, U21, U31	TLx5572	TMR current sensor	PG-SOT23-6-4
1	LDO	TLS850D0TEV50	Low-dropout linear voltage regulator, fixed output voltage 3 V	PG-TO252-5
1	P2	61202022821	WR-BHD box header with long lever, male, pitch 2.54 mm, THT, straight, 20p	–
1	U1	M24C01	M24C02-WDW6TP	8-TSSOP
6	U-, U+, V-, V+, W-, W+	Header 1 9p	Threaded shank M3 full plain pin-plate, 9 pins	–
1	X1	TSW-103-14-G-S	Through hole .025 SQ post header, 2.54 mm pitch, 3 pin, vertical, 5.7 A, 550 V	–
7	C1, C3, C8, C10, C11, C12, C14	100 nF	Capacitor	C0603
3	C2, C9, C13	220 pF	Capacitor	C0603
2	C4, C6	10 µF	Capacitor	C1206
2	C5, C7	220 nF	Capacitor	C0603
3	R1, R3, R5	DNP	Optional pull-ups resistor	–
3	R2, R4, R9	0 Ω	Filter option	–
2	R6, R7	1 kΩ	Resistor	R0603
2	R8, R10	100 Ω	Resistor	R0603

3.4 Connector details

Table 4 Evaluation board connector pinout

Pin number	Pin name	Pin function
1	AOUT1	Analog output voltage of sensor 1
4	AOUT2	Analog output voltage of sensor 2
7	AOUT3	Analog output voltage of sensor 3
8	VDD	Supply voltage, connected to each sensor on the VDD pin. This voltage is generated onboard by the LDO
13	SCL	Clock for communication with the external EEPROM on Infineon's evaluation boards
15	SDA	Data link for communication with the external EEPROM on Infineon's evaluation boards
16	VS	External supply voltage of the evaluation board for LDO
19	EN	LDO enable. It must be connected to VS if the evaluation board is used as a standalone
2,3,6,10,11,14,18,20	GND	Ground connection
5,9,12,17	Not connected	Not connected

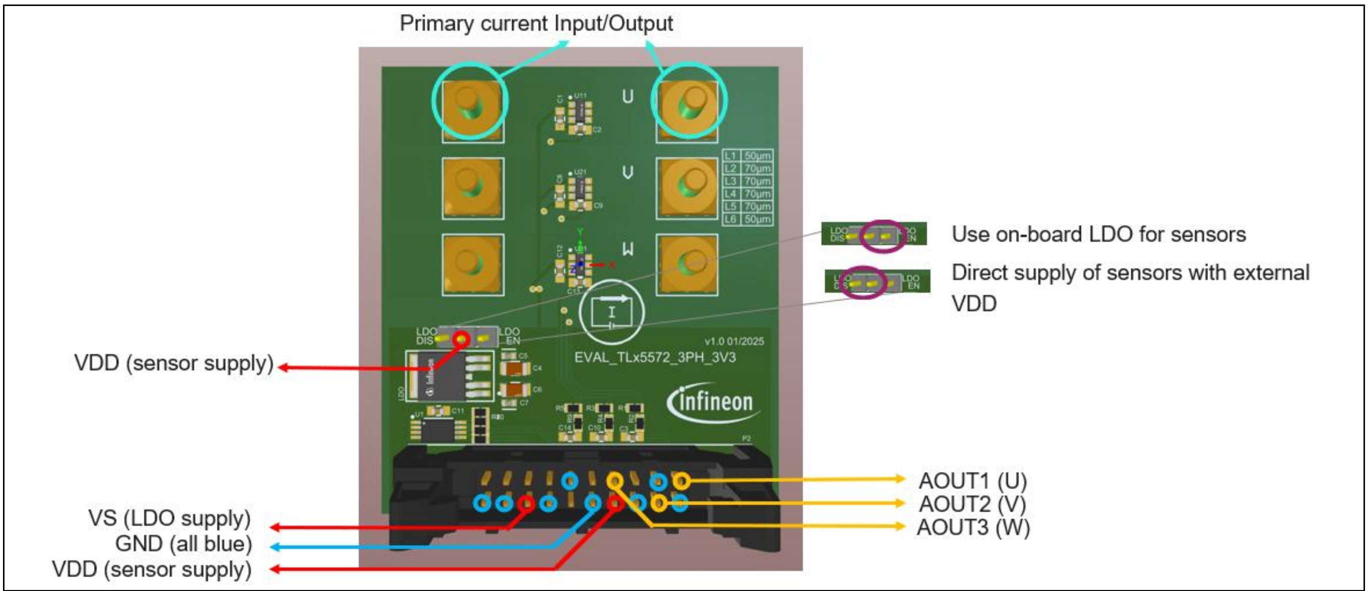


Figure 7 Pinout

4 System performance

4.1 Test points

Measure the output voltage of the three sensors from the evaluation board connector. See Figure 7 for the complete pinout of the evaluation board connector.

4.2 Test results

4.2.1 Connections for calibration

1. Choose the LDO for stabilized 3.3 V at VDD

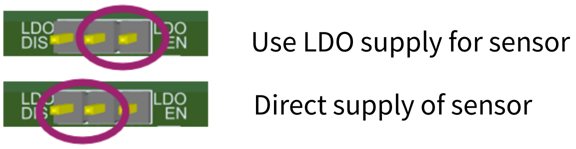


Figure 8 Supply selection: Onboard LDO vs. external VDD

   a) Recommended: Sensor supply via LDO
   - Place the jumper on LDO_EN

   b) Direct supply of the sensor (expert use only, V_{QC} and full-scale range will change)
   - $V_{DD} = 3.3\ V\ or\ 5\ V$
   - Place the jumper on LDO_DIS

2. Connect VS and GND

   a) Set $V_S = V_{DD} + 0.3\ V$ (for example, 3.6 V for 3.3 V board version)

   b) Observe $V_{DD}\ = 3.3\ V\ or\ 5\ V$

   c) Observe $V_{Aout}\ at\ (I_{primary}\ = 0\ A) = \frac{V_{DD}}{2} = V_{QC}\ = 1.65\ V\ or\ 2.5\ V$

3. Connect Current terminals

   a) Supply $I_{primary}$ through the terminals (observe the sign convention on the board)

   b) Observe that $(V_{Aout} - V_{QC}\ )$ changes proportionally with $I_{primary}$

4.2.2 First estimation of 3.3 V board version

$$Average\_Sensitivity_{TLx5572-EvalBoard-3.3\ V} = \sim 8.2\ \frac{mV}{A}$$

Equation 1 Average sensitivity for 3.3 V board

$$V_{QC\ nominal\ 3.3\ V} = \frac{V_{DD}}{2} = 1.65\ \mathrm{V}$$

Equation 2 Nominal output voltage at 0 mT for 3.3 V board

$$Current_{measured} = \frac{1}{Sensitivity_{TLx5572-EvalBoard-3.3\,V}} * (V_{Aout} - V_{QC}) = \frac{1}{8.2}\frac{A}{mV} \times (1.95\text{ V} - 1.65\text{ V}) = \sim 42.7\text{ A}$$

Equation 3 Measurement example for a 300 mV reading

4.2.3 First estimation of 5 V board version

$$Average\_Sensitivity_{TLx5572-EvalBoard-5\,V} = \sim 13.1\ \frac{mV}{A}$$

Equation 4 Average sensitivity for 5 V board

$$V_{QC\,nominal\ 3.3\,V} = \frac{V_{DD}}{2} = 2.5\ V$$

Equation 5 Nominal output voltage at 0 mT for 5 V board

$$Current_{measured} = \frac{1}{Sensitivity_{TLx5572-EvalBoard-3.3\,V}} \times (V_{Aout} - V_{QC}) = \frac{1}{13.1}\frac{A}{mV} \times (2.85\text{ V} - 2.5\text{ V}) = \sim 26.7\text{ A}$$

Equation 6 Measurement example for a 350 mV reading

4.2.4 Offset and sensitivity calibration

Single-point sensitivity calibration for each phase:

- Offset compensation
  - Measure $V_{QC} = V_{Aout}$ at $(I_{primary} = 0)$
- Sensitivity compensation
  - Pulse $I_{primary} = 25\ A$ to minimize self-heating

(It is recommended to use approximately 20% of the full-scale range to achieve a good balance between self-heating and accuracy.)

- Measure V_{Aout} at $(I_{primary} = 25\ A)$
- Calculate $Sensitivity_{TLx5572-EvalBoard} = \frac{V_{Aout} - V_{QC}}{I_{primary}}$ in $\frac{mV}{A}$ for this specific board

Use the parameters V_{QC} and $Sensitivity_{TLx5572-EvalBoard}$ for the calculation of the actual current:

$$I_{primary_{measured}} = \frac{1}{Sensitivity_{TLx5572-EvalBoard}} \times (V_{Aout} - V_{QC})$$

Equation 7 Calibrated measurement

4.2.5 Sensitivity calculation

The sensitivity depends on multiple factors.

An estimate of your board design is provided below.

$$Sensitivity_{TLx5572} = gain_{currentrail} \times gain_{TLx5572}$$

Equation 8 System sensitivity calculation

$$\mathrm{Sensitivity}_{\mathrm{TLx5572\ 3.3\ V\ S3}} = 75\ \frac{\mathrm{uT}}{\mathrm{A}} \times \frac{109\ \mathrm{mV}}{\mathrm{mT}} = \sim 8.2\ \frac{\mathrm{mV}}{\mathrm{A}}$$

Equation 9 Average system sensitivity for 3.3 V variant

$$Sensitivity_{TLx5572\ 5\ V\ S4} = 75\ \frac{uT}{A} \times \frac{174\ mV}{mT} = \sim 13.1\ \frac{mV}{A}$$

Equation 10 Average system sensitivity for 5 V variant

From Equation 8, Equation 9, and Equation 10,

$gain_{currentrail}$ – Can be obtained through simulation (using tools offered on the Infineon website).

$gain_{TLx5572}$ – Defined by the datasheet parameter sensitivity (subject to part-to-part variation).

4.2.6 Measurement notes for error calculation

- Sensor = TLE5572-AE12E1-R-E0001
- VDD = 3.3 V
- Full-scale range = 165 A
- Five boards were observed (each has three sensors U, V, and W)
- Offset calibrated at 0 A
- Sensitivity calibrated at 25 A

$$Current\ Error = \frac{\mathrm{V_{Aout}}}{\mathrm{Sensitivity}} - Primary\ current$$

Equation 11 Current error formula

- Sensitivity for offset compensation = Estimated sensitivity
- Sensitivity compensation = Sensitivity obtained at 25 A

$$\mathrm{Error}\ (\%) = \frac{\mathrm{Current\ Error}}{\mathrm{Full\text{-}scale\ Range}}$$

Equation 12 Error referred to full scale range

4.2.7 Importance of calibration

Calibration ensures that the sensor accurately measures the magnetic field, which is critical in applications where even small errors can have significant consequences. Calibration helps to identify and correct offset errors caused by inherent sensor characteristics or environmental factors, thereby improving data reliability. By adjusting the sensor output to match a known reference value, calibration eliminates these offset errors. It can compensate for non-linearity in the sensor response, which occurs when the output is not directly proportional to the input.

Figure 9 shows the relationship between current (A) and error (%)for uncalibrated sensors. Figure 10 shows data for fifteen sensors after offset compensation when there is no current flowing through the external current rail. The error value converges to 0%. Figure 11 shows data after both offset and sensitivity calibration at 25 A. The values are more closely clustered around the minimum error.

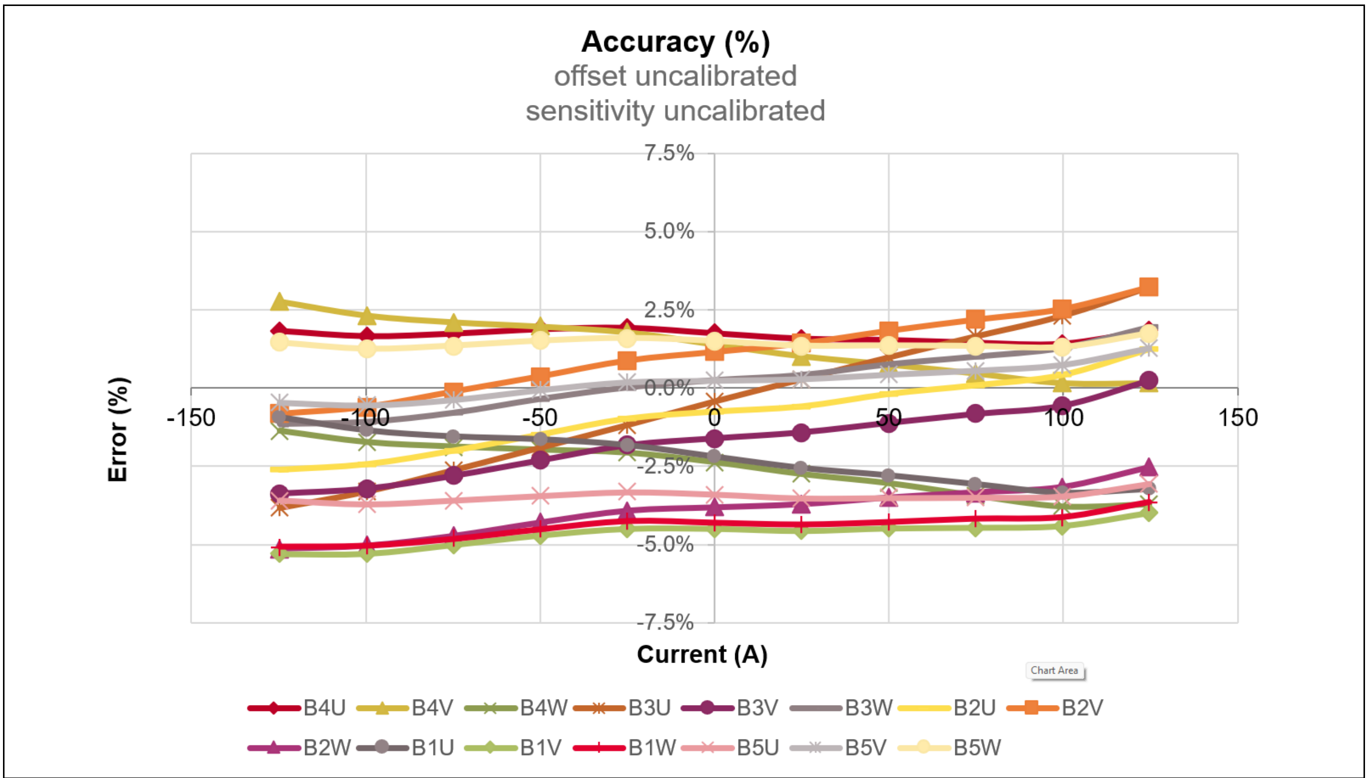


Figure 9 **Summary for fifteen sensors without offset and sensitivity calibration**

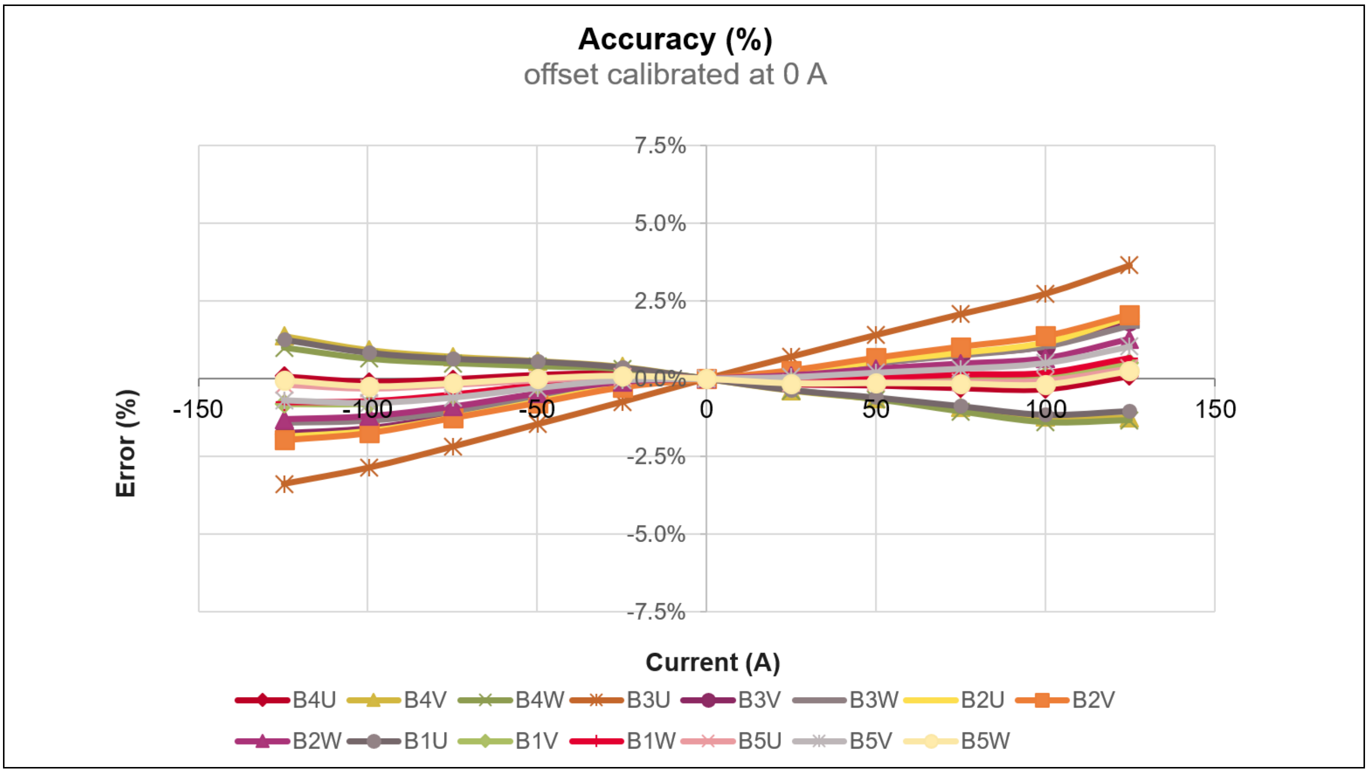


Figure 10 Summary for fifteen sensors after offset compensation at 0 A

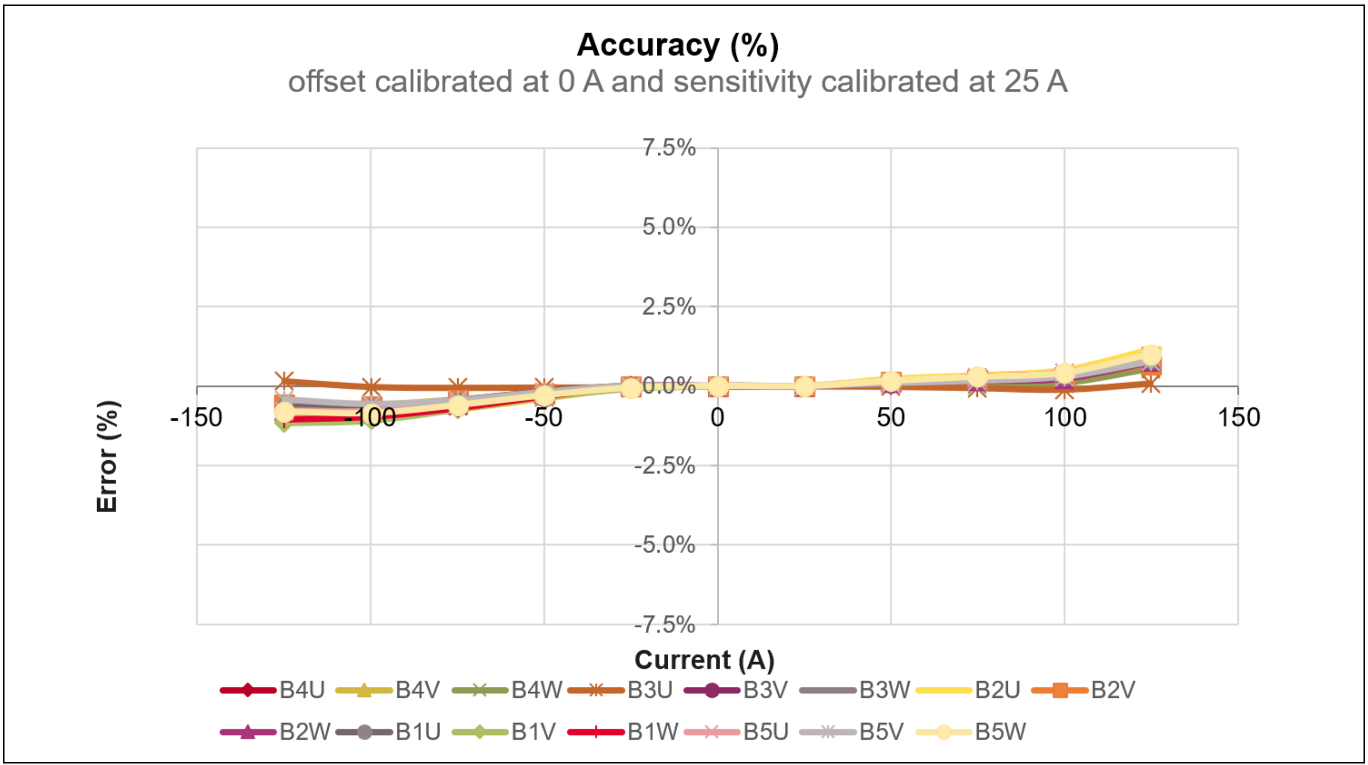


Figure 11 Summary for fifteen sensors after offset compensation at 0 A and sensitivity calibration at 25 A

4.2.8 Sensitivity distribution

Table 5 presents the calculated sensitivity values for fifteen sensors, along with the corresponding sensitivity distribution.

Table 5 Sensitivities of all sensors and their deviation from the average value

Sensor	Sensitivity (mV/A)	Sensitivity deviation (mV/A)	Part-to-part sensitivity error (%)
B1U	7.941071	−0.193	−2.4
B1V	8.098112	−0.036	−0.4
B1W	8.104997	−0.030	−0.4
B2U	8.223202	0.089	1.1
B2V	8.281970	0.147	1.8
B2W	8.190713	0.056	0.7
B3U	8.517842	0.383	4.7
B3V	8.238523	0.104	1.3
B3W	8.225054	0.091	1.1
B4U	8.042626	−0.092	1.1
B4V	7.932452	−0.202	−2.5
B4W	7.934044	−0.200	−2.5
B5U	8.069961	−0.065	−0.8
B5V	8.163232	0.029	0.4
B5W	8.053991	−0.081	−1.0

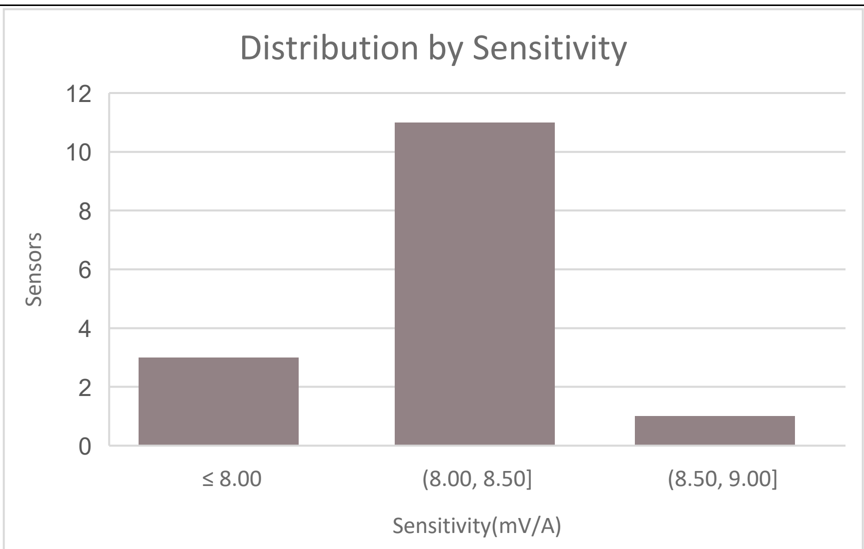


Figure 12 Sensitivity distribution

The sensitivity of all fifteen sensors was evaluated and shown in a distribution chart (Figure 12). Eleven sensors exhibited sensitivities between 8 mV/A and 8.5 mV/A. Three sensors showed sensitivities below 8 mV/A, while one sensor had a sensitivity between 8.5 mV/A and 9 mV/A.

5 Related resources

- XENSIV™ current sensor family webpage
- XENSIV™ Current Sensor Simulation Tool
- XENSIV™ current sensors developer community

References

[1] Infineon Technologies AG: *XENSIV™ TLx5572 current sensors datasheet;* Available online

[2] Infineon Technologies AG: *XENSIV™ TLE4972 and TLE4973 current sensors: Sensing structure design application note;* Available online

[3] Infineon Technologies AG: *AN123820: XENSIV™ TLx5572 current sensors in three-phase applications application note*; Available online

Glossary

AC
alternating current (AC)

CE
European Conformity (CE)

TMR
tunnel magnetoresistance (TMR)

OTA
operational transconductance amplifier (OTA)

DC
direct current (DC)

EMC
electromagnetic compatibility (EMC)

VDD
supply voltage to sensor (VDD)

VS
supply voltage to LDO (VS)

EMI
electromagnetic interference (EMI)

ESD
electrostatic discharge (ESD)

PCB
printed circuit board (PCB)

SCL
serial clock (SCL)

SDA
serial data (SDA)

UL
Underwriters Laboratories (UL)

DNP
do not populate (DNP)

EN
enable (EN)

Revision history

Document revision	Date of release	Description of changes
1.00	2026-07-08	Initial release

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Safety & Operating Instructions:
Customer shall check the Evaluation Board for any physical damage which may have occurred during transport. If customer detects any damages or defects in the Evaluation Board, customer shall not connect the Evaluation Board to a power source. Customer shall contact Infineon for further support. If customer observes unusual operating behavior during the evaluation process, customer shall immediately shut off the power supply to the Evaluation Board and consult Infineon for support.
Customer shall not touch the Evaluation Board during operation and keep a safe distance.
Customer shall not touch the Evaluation Board after disconnecting the power supply, several components may still store electrical voltage and can discharge through physical contact. Several parts, like heat sinks and transformers, may still be very hot. Allow the components to cool before touching or servicing.
The electrical installation must be completed in accordance with the appropriate safety requirements.