TECHNICAL ARTICLE

Integrating high-precision current sensing

Meet the XENSIV™ TLx4971 current sensor series in 300-mil package

In the realm of power electronics, the push for higher power density and efficiency is relentless. For developers and system integrators, this creates a specific challenge: how to measure high currents accurately without introducing significant losses or consuming excessive board space. Accurate current sensing is fundamental to the control loop of any power conversion system, directly influencing efficiency and reliability.

To address these challenges, Infineon has expanded its current sensor portfolio with the XENSIV™ TLx4971 current sensor series. This new coreless magnetic current sensor is housed in a compact 300-mil package, designed specifically to meet the rigorous demands of automotive and industrial current sensing applications. By combining proprietary temperature and stress compensation with a robust coreless architecture, the TLx4971 offers a streamlined solution for engineers seeking optimal current measurement performance with minimal development effort.

1. Redefining accuracy in magnetic current sensing

The primary metric for any current sensor is accuracy over the lifespan of the product. Drift caused by temperature fluctuations or mechanical stress can lead to inefficiencies in power supplies or, worse, safety-critical faults in automotive traction inverters.
The XENSIV™ TLx4971 sets a new high standard for coreless magnetic sensors, achieving a total error rate of just 0.7 percent over temperature and lifetime. This level of precision is not accidental; it is the result of Infineon’s proprietary back-end calibration process.

1.1. Eliminating sensor drift in harsh environments

During manufacturing, Infineon calibrates each sensor to minimize errors associated with temperature and lifetime drift. For a developer, this means the sensor you design into your schematic today will perform consistently five or ten years from now, even in harsh thermal environments. This long-term stability allows you to tighten safety margins in your control algorithms, ultimately delivering more performance out of the system without compromising reliability.

1.2. Flexible current ranges

To support a wide variety of applications without requiring complex reconfiguration, the XENSIV™ TLx4971 current sensor series is available in six pre-programmed current measurement ranges:

- 16 A
- 20 A
- 30 A
- 35 A
- 40 A
- 50 A

This pre-programming allows for a true "plug-and-play" approach. You select the range that matches your application's nominal current, ensuring you utilize the full output voltage swing for the best Signal-to-Noise Ratio (SNR) when feeding into your microcontroller’s Analog-to-Digital Converter (ADC).

2. The engineering advantage of coreless current sensor design

Traditional magnetic current sensors often rely on magnetic cores (flux concentrators). While effective, cores introduce weight, size constraints, and the physical phenomenon of magnetic hysteresis. Hysteresis can cause the sensor to retain a magnetic "memory" after a high-current pulse, leading to offset errors that degrade measurement accuracy. Furthermore, magnetic cores can saturate at high currents, causing sensor blindness and potentially compromising the control system.
The XENSIV™ TLx4971 current sensor series utilizes a coreless magnetic sensor design, which fundamentally eliminates both hysteresis and saturation effects.

2.1. Differential sensing principle

A common concern with coreless magnetic sensors is susceptibility to stray magnetic fields – a frequent issue in dense power stages where high-current traces are routed closely together. The XENSIV™ TLx4971 current sensor mitigates this through a robust differential sensing principle.

The chip incorporates two separate Hall effect elements that measure the magnetic field gradient generated by the current flowing through the integrated current rail. Because external stray fields typically affect both Hall elements equally, the differential measurement effectively cancels out this common-mode interference. This ensures that the sensor reports only the current you intend to measure, providing superior stray-field robustness that simplifies PCB layout design and component placement.

3. Optimized for high-voltage integration

Integrating components into high-voltage environments requires careful attention to electrical isolation and thermal management. The XENSIV™ TLx4971 current sensor addresses these needs with a robust 300-mil package design.

3.1. Isolation and safety

For applications involving high voltage, such as 800 V EV architectures or industrial inverters, safety is paramount. The XENSIV™ TLx4971 package offers:

- Electrical isolation: Up to 1.5 kV isolation voltage.
- Clearance and creepage: A distance of 8 mm, meeting IEC stringent standards for high-voltage separation.

These specifications allow the sensor to be used in both reinforced and basic isolation configurations, giving you flexibility in how you architect your safety barriers.

3.2. Minimizing power loss

Every milliohm of resistance in the current path generates heat and reduces overall system efficiency. The XENSIV™ TLx4971 features an integrated current rail with a typical insertion resistance of only 550 µΩ. This ultra-low resistance minimizes power dissipation, which is critical for maintaining high efficiency in designs like On-Board Chargers (OBC) or photovoltaic (PV) inverters. It also simplifies PCB thermal management, as less heat is generated at the current sensing point.

4. System protection, reliability and fast shutdown capability

Protecting expensive power stages – such as Silicon Carbide (SiC) MOSFETs or IGBTs – is a critical function of the current sensor. In the event of a short circuit or overcurrent fault, milliseconds matter.
The XENSIV™ TLx4971 sensor incorporates built-in Overcurrent Detection (OCD) with two dedicated OCD pins. These pins provide a separate, fast hardware signal directly to the microcontroller or gate driver, bypassing the slower analog signal path.

This dual-path architecture enables a rapid response to fault conditions. If an overcurrent event occurs, the sensor signals the gate driver to shut down the power stage immediately. This fast reaction time helps prevent

catastrophic failure of the power switches, protecting the hardware investment and ensuring the long-term reliability of the system.

5. Accelerating development with modifiable resources

We understand that reducing development time is a key success indicator for engineers. To facilitate easy integration, Infineon provides comprehensive support for the XENSIV™ TLx4971.

5.1. Evaluation boards for rapid prototyping

To help you validate performance quickly, we offer an evaluation board TLE4971 EVAL 50A optimized for 3-phase applications. The board accommodates three sensors (one for each phase) and is rated for 50 A current flow. This allows you to test the sensor's thermal performance, signal integrity, and OCD functionality in a representative environment before committing to a final PCB layout.

5.2. Customization via EEPROM programming

While the sensors come pre-programmed for convenience, the integrated EEPROM allows for further customization if your application requires it. You can modify sensitivity settings and other parameters to fine-tune the sensor to your specific system requirements, offering a balance between off-the-shelf simplicity and custom flexibility.

6. Applications in automotive and industrial sectors

The robust design and high precision of the XENSIV™ TLx4971 make it an ideal candidate for a wide range of demanding applications.

Automotive Applications:

- On-Board Chargers (OBC): Enabling efficient AC/DC conversion for EV charging.
- DC/DC Converters: Monitoring current flow for stable voltage regulation.
- Traction Inverters: Providing precise feedback for motor control.

Industrial Applications:

- Photovoltaic (PV) Inverters: Ensuring maximum power point tracking (MPPT) accuracy.
- Industrial Drives: Offering reliable control for automation motors.
- Power Supply Units (PSU): Maintaining efficiency in server and telecom power supplies.
- DC Fast Chargers: Managing high-power delivery safely.

Conclusion

The XENSIV™ TLx4971 represents a significant step forward in coreless magnetic current sensing. By combining high precision, robust stray-field immunity, and integrated overcurrent protection features, it addresses the core challenges faced by developers in the power electronics space. Whether you are designing the next generation of electric vehicles or high-efficiency industrial drives, the TLx4971 offers the performance and reliability needed to bring your project to successful completion with minimal development effort.
For detailed specifications, parameters, reference designs, and to order the evaluation board, please visit the XENSIV™ TLx4971 300 mil PG products.

Explore the full XENSIV™ TLx4971 current sensor series here.