AN6625

Application note

Easily develop a compact and efficient motor control solution leveraging GaN technology with GANSPIN1102

Introduction

The evolution of power electronics is driving an increasing demand for solutions that are more efficient, more compact, and more reliable. In this context, GaN technology is emerging as one of the most attractive options for applications where the goal is not only to improve electrical efficiency, but also to reduce system size and simplify integration. Compared with traditional silicon MOSFETs, GaN devices offer faster switching times, lower dynamic losses, and higher power density, all of which are particularly valuable in modern converter architectures.

Thanks to their wide-bandgap nature and highly efficient device structure, GaN transistors can achieve significantly lower $R_{DS(on)}$ values than comparable silicon solutions while maintaining a very small footprint. This characteristic directly translates into lower conduction losses, which is especially important in motor-drive systems operating at elevated current levels. In compact inverter designs, where thermal headroom is often limited, reducing conduction losses is a key factor not only for improving overall system efficiency but also for reducing heat generation, limiting local temperature rise, and improving reliability. For this reason, the attractive combination of low on-resistance and compact device size offered by GaN technology, is an increasingly relevant option in motor control applications that require high efficiency, reduced power dissipation, and a small form factor.

The gradual market adoption of GaN is supported by several factors. On one hand, the maturity of technology and package solutions has improved device robustness and reliability; on the other hand, the growing demand for compact and highly efficient solutions has accelerated interest in this technology. The result is a rapidly expanding ecosystem of devices and architectures optimized to exploit GaN advantages in a practical and industrially relevant way.

Within this context, GANSPIN1102 is an integrated solution designed for high power-density motor control applications. The device combines two GaN FETs, the gate driver, and the support capacitors in a single package, enabling an extremely compact and design-friendly approach.

While GaN technology brings clear advantages in terms of efficiency, compactness, and power density, it also introduces some design challenges that must be carefully addressed. In particular, the very fast switching behavior of GaN devices makes the PCB layout, the power loop, and the gate-drive loop especially critical. If these loops are not properly optimized, parasitic inductances can lead to voltage overshoots, ringing, and increased electromagnetic interference, potentially degrading both performance and reliability. In low-voltage motor-control applications, these aspects become even more relevant because high current levels amplify the impact of parasitics and switching transients.

GANSPIN1102 has been designed to ease these integration challenges. Its highly integrated structure, compact package, and optimized internal layout help minimize parasitic elements and simplify the external PCB design. By embedding the GaN FETs, gate driver, and support capacitors into a single power stage, the device reduces the complexity of the gate-drive and power paths, making it easier to achieve robust behavior and good switching performance even in compact inverter layouts.

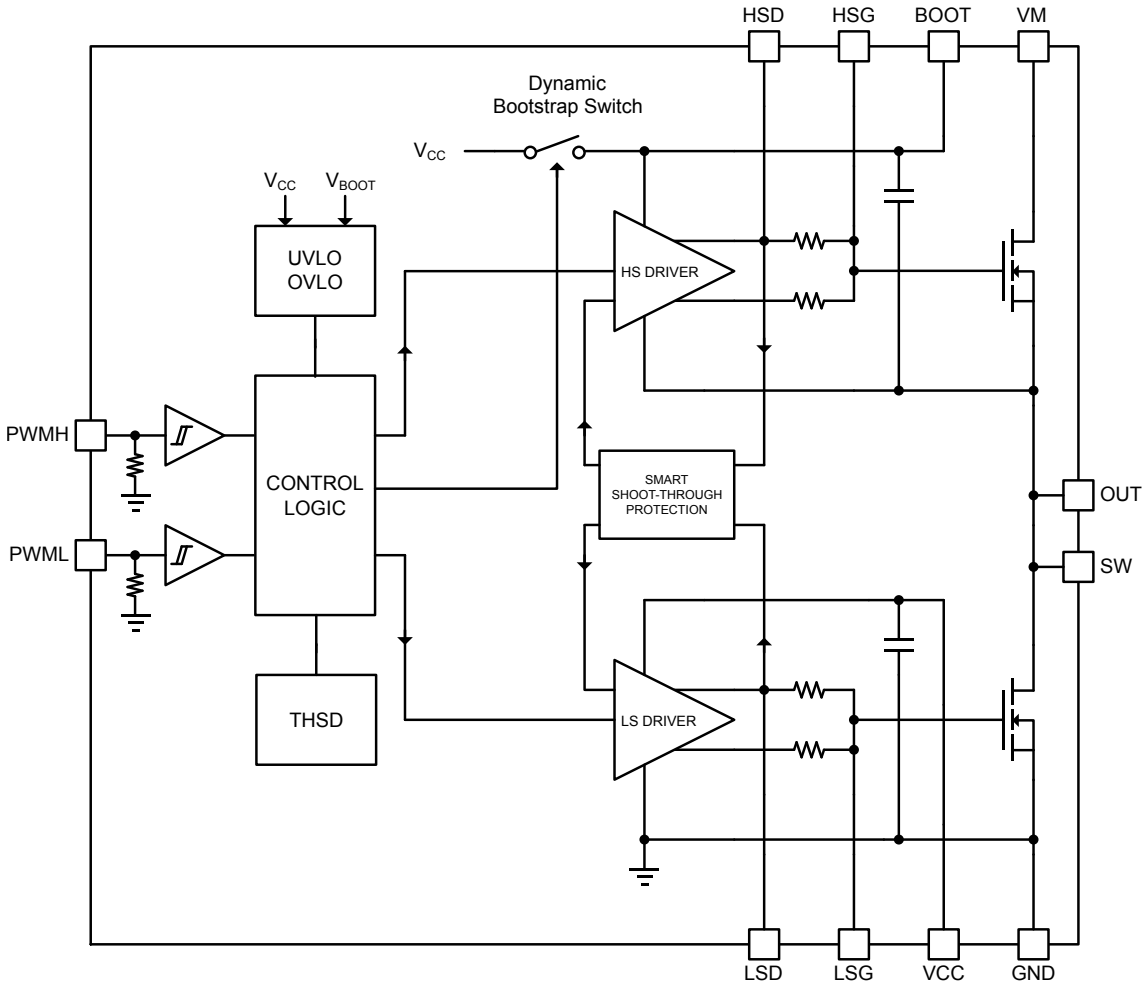
The purpose of this application note is therefore to show how GaN technology, and GANSPIN1102 in particular, can effectively address the needs of modern motor control systems. After a brief introduction to the technology and its benefits, the document presents the main product features and the experimental results related to thermal behavior, optimized layout, and switching waveforms. Taken together, these elements demonstrate how a compact, efficient, and motion-control-ready three-phase inverter can be realized.

1 Overview of GANSPIN1102

GANSPIN1102 is a 100 V GaN half-bridge module designed for compact and efficient motor control applications. The device integrates two GaN FETs, a gate driver, and support capacitors. It comes in a very small package. This design simplifies the system, optimizes the bill of materials, and reduces the overall footprint.

The product is available in a 5 × 6.5 mm LGA package, with an additional top-side cooling option (GANSPIN1102E). This architecture makes the solution well suited for high-power-density three-phase inverter designs, especially where available space is limited.

Figure 1. GANSPIN1102 block diagram

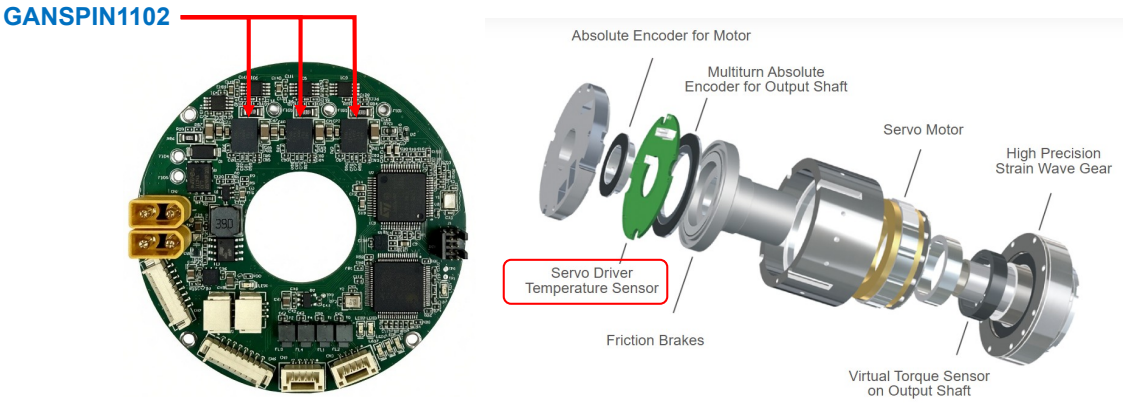


This high-performance driver features a typical $R_{DS(on)}$ of 2.4 mΩ, supports an operating voltage of up to 80 V continuously and 100 V transiently, and can switch at frequencies of up to 5 MHz. It offers independent control inputs for high-side and low-side operation. The typical propagation delay is 20 nanoseconds. The typical delay matching is 1 nanosecond for precise timing. In addition, it includes UVLO, OVLO, and thermal shutdown protection, smart shoot-through protection, and a dynamic bootstrap switch

1.1 GANSPIN1102 in robotics

GANSPIN1102 is a natural fit for advanced robotics, where space, efficiency, and power density are key requirements. The device is particularly suitable for integration in humanoid robot joints, such as shoulders, elbows, hips, and knees, where power and control functions must be concentrated in a very limited volume.

Figure 2. Example of robotic joint solution based on GANSPIN1102



The dedicated thermal evaluations for robotics show that the device, thanks to its availability in a bottom-side cooling and top-side cooling package, can be used across a wide power range while maintaining good performance even in demanding ambient conditions. This makes GANSPIN1102 an attractive solution for high-integration motorized joints.

Figure 3. Example of GANSPIN1102 (bottom-side cooling) output power (T_{amb} = 85 °C, R_{thJA} = 39 °C/W, V_{SUPPLY} = 48 V, modulation index 90%)

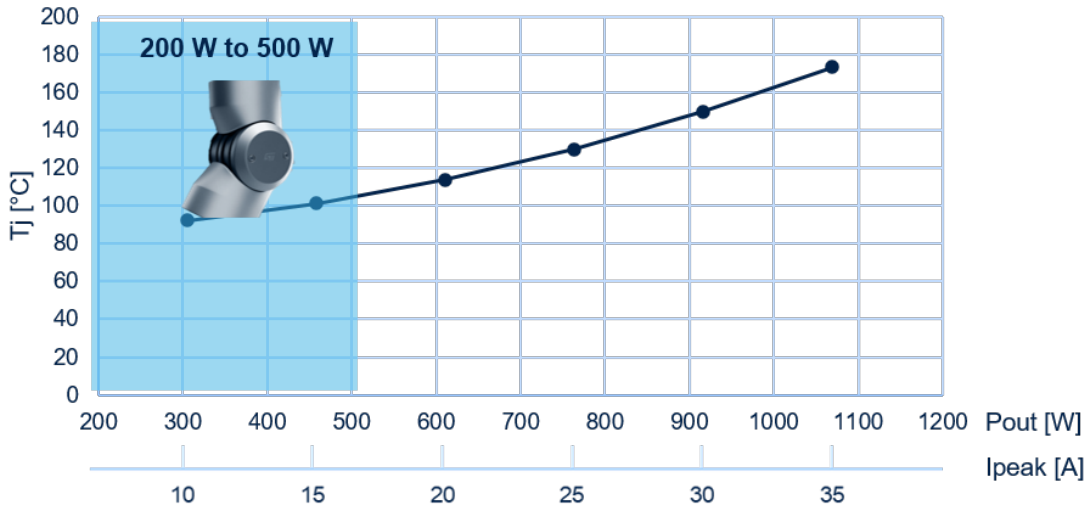
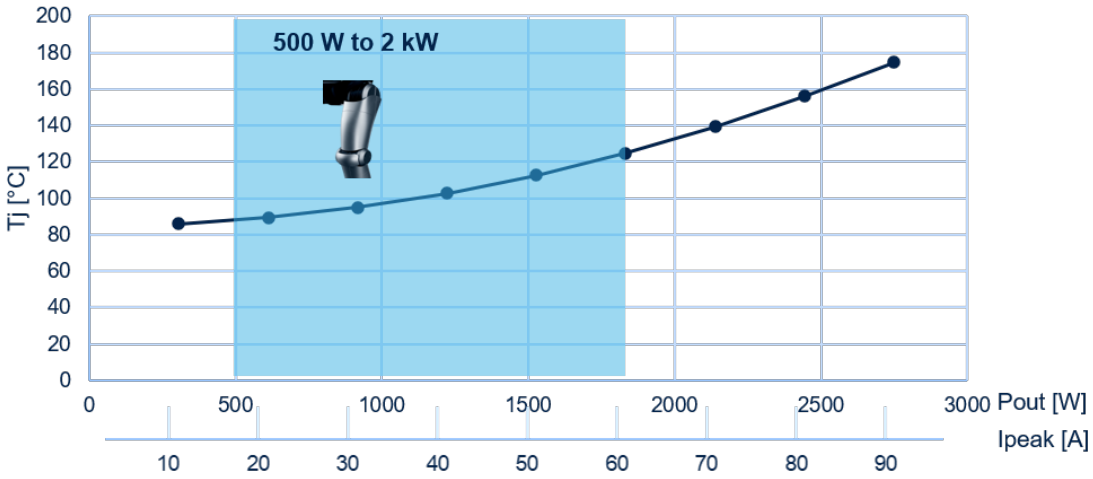


Figure 4. Example of GANSPIN1102E (top-side cooling) output power (T_{amb} = 85 °C, $R_{thIA, Heatsink}$ = 6 °C/W, V_{SUPPLY} = 48 V, modulation index 90%)



2 Main Advantages of GANSPIN1102

2.1 Low conduction losses and favourable thermal behavior

The GaN transistors embedded into the GANSPIN1102 offer a typical $R_{DS(on)}$ of 2.4 mΩ, which is a key factor in limiting conduction losses. In motor-control applications, this means that power dissipation is lower during normal operation. This also reduces the thermal burden for the entire system. This benefit is clearly reflected in the thermal measurements reported in Figure 3, Figure 4 and Figure 5.

Figure 3 and Figure 4 summarize the thermal performance of the device dissipating the heat through a well-designed PCB. The graphs show the progression of ΔT as current increases under different test conditions. The results indicate that temperature rise remains well controlled even at high load levels, confirming the suitability of the solution for compact, high-power-density motion control applications. It is also important to note that the temperature variation resulting from increasing the PWM frequency from 20 kHz to 100 kHz is limited (Figure 5). This result can be achieved because of the excellent dynamic performance of the GANSPIN1102 and its effective dead-time control, as detailed in Section 2.2: Low switching losses.

Figure 6 provides thermal images of the device under high-current operating conditions. The images highlight how the low conduction losses contribute to maintaining an acceptable thermal profile, even in demanding scenarios.

Figure 5. Thermal performance of GANSPIN1102 (bottom side cooling): delta temperature versus output current for different switching frequency conditions at 48 V bus voltage.

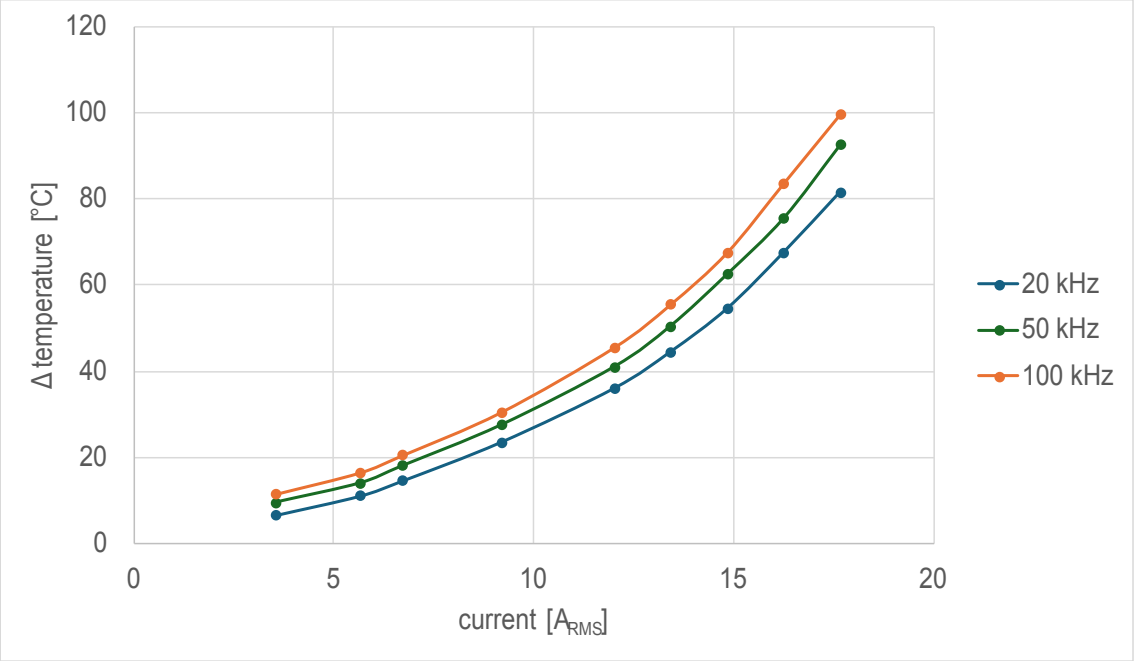
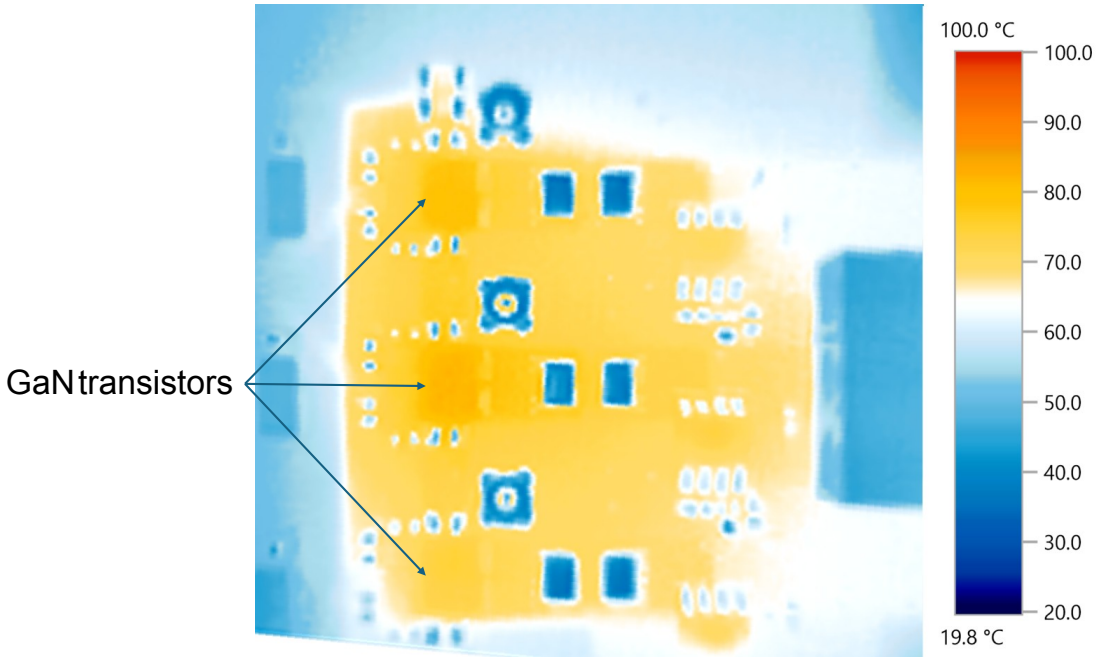


Figure 6. Thermal images of GANSPIN1102 under high-current operating conditions (20 A).

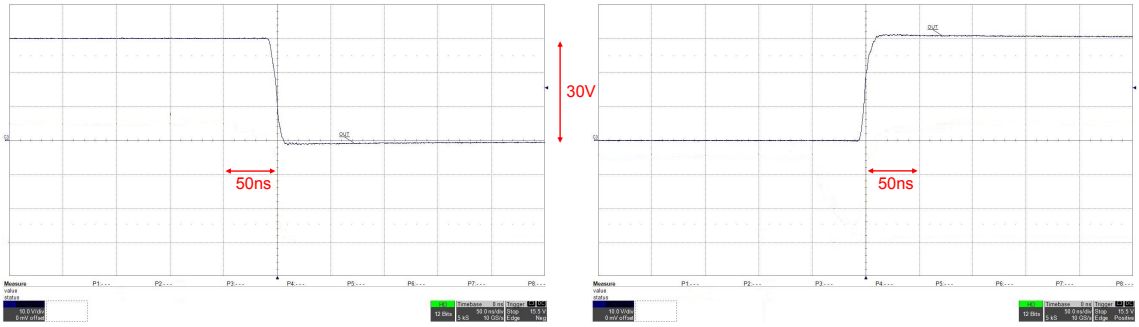


2.2 Low switching losses

GANSPIN1102 is designed to switch in a quickly and well-controlled way. Its fast transition behavior reduces dynamic losses and helps improve overall converter efficiency. In practical terms, this means that the device can support efficient operation while keeping the switching behavior well managed, avoiding overshoots or ringing that could negatively affect EMC performance.

The measured waveforms in Figure 7 show this capability. The output waveforms exhibit very fast rising and falling edges, with short rise and fall times that are consistent with efficient switching operation and no anomalous spikes or oscillations at the end of the transitions. These results demonstrate that the device is able to support low dynamic losses while maintaining a clean and well-defined transition behavior.

Figure 7. Output switching waveforms of GANSPIN1102 with very short rise and fall times.

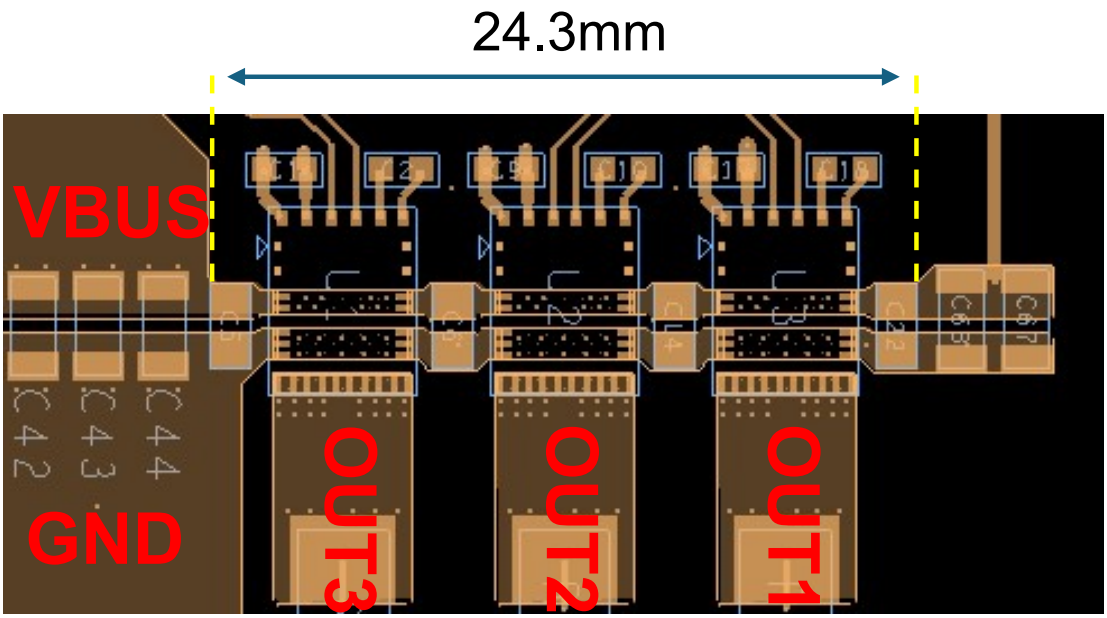


2.3 Compact size and optimized layout

Another major advantage of GANSPIN1102 is its high level of integration, which enables very compact board layouts. This is especially important in motor-control systems, where the available space is often limited by mechanical constraints.

The layout example shown in Figure 8 illustrates how a three-phase inverter can be implemented in a very small area while preserving a functional arrangement of the power and signal sections. A compact layout also helps minimize parasitic inductances, which is beneficial for both electrical performance and system robustness.

Figure 8. **Optimized board layout enabling the integration of a three-phase inverter in a very small space.**



3 Conclusions

GaN is one of the most promising technologies in modern power electronics, and its value becomes particularly evident in low-voltage motor control applications where high currents are involved. In this operating range, where even small differences in on-resistance have a strong impact on efficiency and thermal behaviour, the use of GaN transistors with very low $R_{DS(on)}$ is a major advantage.

In this context, the compact and highly integrated architecture of GANSPIN1102, enables a substantial reduction in conduction losses while preserving a very small footprint. This is especially valuable in compact inverter designs, where thermal headroom is limited and efficient heat management is essential like in the humanoid robot joints.

The experimental results presented in this application note confirm that the device can sustain demanding operating conditions while maintaining a favourable thermal profile, compact layout, and fast switching behavior. Taken together, these features make GANSPIN1102 a perfect fit for high power density motor control solutions.

Revision history

Table 1. **Document revision history**

Date	Version	Changes
11-Nov-2026	1	Initial release.

Contents

1 **Overview of GANSPIN1102** 2
1.1 GANSPIN1102 in robotics 2
2 **Main Advantages of GANSPIN1102** 5
2.1 Low conduction losses and favourable thermal behavior 5
2.2 Low switching losses 6
2.3 Compact size and optimized layout 6
3 **Conclusions** 8
Revision history 9
List of tables 11
List of figures 12

List of tables

Table 1. Document revision history 9

List of figures

Figure 1. GANSPIN1102 block diagram . . . 2
Figure 2. Example of robotic joint solution based on GANSPIN1102 . . . 3
Figure 3. Example of GANSPIN1102 (bottom-side cooling) output power (T_{amb} = 85 °C, R_{thIA} = 39 °C/W, V_{SUPPLY} = 48 V, modulation index 90%) . . . 3
Figure 4. Example of GANSPIN1102E (top-side cooling) output power (T_{amb} = 85 °C, $R_{thIA, Heatsink}$ = 6 °C/W, V_{SUPPLY} = 48 V, modulation index 90%) . . . 4
Figure 5. Thermal performance of GANSPIN1102 (bottom side cooling): delta temperature versus output current for different switching frequency conditions at 48 V bus voltage. . . . 5
Figure 6. Thermal images of GANSPIN1102 under high-current operating conditions (20 A). . . . 6
Figure 7. Output switching waveforms of GANSPIN1102 with very short rise and fall times. . . . 6
Figure 8. Optimized board layout enabling the integration of a three-phase inverter in a very small space. . . . 7

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