From Device to Platform: EPC23108/109/110/11 100 V Integrated GaN Power Stages Simplify Multi-Axis Motor Drive Design

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OVERVIEW

Multi-axis robots, drones, surgical robots, and precision motion platforms are driving low-voltage motor drives toward higher power density, smaller form factors, faster dynamic response, and more complex control interfaces. In these systems, the difficulty of power-stage design is no longer limited to selecting a switch with lower $R_{DS(on)}$. Engineers must also handle gate drive, dead time, fault response, current sensing, thermal margin, EMI / dv/dt, and the wiring complexity of multi-axis systems at the same time.

The 100 V (EPC23108, EPC23109, EPC23110 and EPC23111) integrated GaN power-stage IC family addresses these system constraints by integrating the high-side / low-side eGaN FETs, gate driver, level shifting, control interface, and protection logic into a single power stage. Together with the EPC91128–EPC91131 three-phase BLDC / PMSM inverter evaluation platforms, engineers can evaluate different current ratings, PWM interfaces, and thermal boundaries across a recommended 14–80 V operating range, with 48 V as the typical condition. The core value is to shorten the path from device selection to system validation: GaN's high frequency, high power density, and fast protection capabilities are already packaged into a motor-drive platform that can be evaluated directly.

SYSTEM CONSTRAINTS IN LOW-VOLTAGE HIGH-PERFORMANCE MOTOR DRIVES ARE CHANGING

In robotics and drone systems, the design bottleneck for motor drives rarely depends on a single parameter. Instead, multiple system constraints often converge: limited space, weight sensitivity, high thermal density, complex wiring, increasing axis count, and shorter fault-response windows. A multi-axis surgical robot can easily reach more than a dozen axes; a humanoid forearm may integrate dozens of motors; and small-to-mid-sized drones must reserve every gram possible for payload and flight endurance.

This means low-voltage motor drives have reached a stage where full power-stage integration is needed. Engineers care about whether the power stage can be made smaller, whether the drive and protection chain is reliable, whether the PWM interface can connect easily to existing controllers, whether dead time is controllable, whether fault shutdown is fast enough, whether the sensing chain is complete, and whether the platform can be replicated quickly across multi-motor systems. The positioning of EPC231xx is built around these questions: reduce the matching burden of discrete power stages and provide a compact starting point for three-phase drives.

EPC231XX: INTEGRATED GAN POWER STAGES FOR 100 V BLDC / PMSM DRIVES

The EPC231xx family includes EPC23108, EPC23109, EPC23110, and EPC23111, targeting 100 V BLDC / PMSM motor drives. The series adopts the ePower™ Stage IC format and integrates the high-side / low-side eGaN FETs, gate drive, level shifting, and control and protection functions into the same power stage (Table 1).

In terms of current rating and application orientation, EPC23108 / EPC23109 target higher current capability and are suitable as the basis for higher-power three-phase drives. EPC23110 / EPC23111 target lower-current, higher-frequency motor-drive applications. In real device selection, C_{OSS}, target switching frequency, thermal conditions, and continuous / pulsed current limits should be assessed as one set of constraints. Beyond current capability, the more important difference among the four devices is the control interface: EPC23108 / EPC23110 correspond to the complementary PWM route, while EPC23109 / EPC23111 correspond to the single PWM + enable route.

The significance of this product segmentation is that engineers can select a device directly according to system architecture. If the controller already has mature 6-PWM outputs and the ability to optimize dead time online, the complementary PWM route is appropriate. If the system is more constrained by multi-axis wiring, interface count, and assembly complexity, single PWM + enable is a more suitable starting point.

Device	Load Current	Maximum Input Voltage	Typical $R_{DS(on)}$	Control Interface	Evaluation Board
EPC23108	35 A	100 V	5.2 mΩ	Independent HS / LS inputs; suitable for complementary PWM / dual PWM control	**EPC91128**
EPC23109	35 A	100 V	5.2 mΩ	Single PWM + enable; internal fixed dead time	**EPC91129**
EPC23110	20 A	100 V	8.7 mΩ	Independent HS / LS inputs; suitable for complementary PWM / dual PWM control	**EPC91130**
EPC23111	20 A	100 V	8.7 mΩ	Single PWM + enable; internal fixed dead time	**EPC91131**

Table 1: EPC231xx Product Family Quick Comparison

CONTROL AND PROTECTION: SHORTENING THE FAULT-RESPONSE CHAIN AND RELEASING PWM MODULATION FREEDOM

This generation of EPC231xx control and protection features focuses on shortening the fault-response chain and enabling greater freedom for complex PWM modulation. The series uses active-low fault / shutdown signals. Under a fault condition, the active-low fault signal immediately disables PWM command to the power GaN FETs through a hardware path.

This immediate PWM disable capability has practical significance for motor-drive systems. Robot joints, drone motors, and high-dynamic precision motion platforms need to cut off abnormal energy paths as quickly as possible under fault conditions, preventing the fault state from continuing to accumulate. Integrating the fault-response path into the power stage and redundant hardware path helps reduce the design burden on control electronics during safety assessment.

Another key capability is 100% duty-cycle operation. EPC231xx high-side and low-side PWM pulses are not time-limited; provided supply conditions are met, the devices support continuous 100% on-time. This provides a foundation for more complex modulation methods such as discontinuous PWM and flat-bottom PWM. In some operating conditions, these methods may reduce switching losses or improve system energy consumption, extending the value of GaN from high-speed switching into control strategy and system efficiency.

EPC91128–EPC91131: TURNING DEVICE CAPABILITY INTO A THREE-PHASE INVERTER PLATFORM

EPC91128–EPC91131 are evaluation platforms built around three-phase BLDC / PMSM motor drives. They bring the EPC231xx power stage, three-phase inverter, sensing chain, protection circuits, and controller interface onto one board, allowing engineers to evaluate complete system behavior directly.

The four evaluation boards have a recommended input range of 14–80 V, with 48 V as a typical application condition. The board size is approximately 81 x 75 mm. The platform integrates three-phase current sensing, three-phase voltage sensing, DC bus voltage sensing, temperature sensing, housekeeping power, encoder / Hall sensor interface, over-current protection, and UVLO. For engineers, this means current capability, temperature rise, protection behavior, and control-interface performance can be observed under real three-phase motor-drive conditions. System boundaries can be measured directly on the board, rather than inferred from device curves.

The platform connects to controllers through a 40-pin controller interface and can work with Microchip, Texas Instruments, STMicroelectronics, Renesas, and general-purpose controller interface boards. Engineers can therefore evaluate the GaN power stage within a familiar MCU / DSP control ecosystem, while the power board, sensing chain, and protection circuits are already prepared.

This is especially important for robotics and drone teams. In many cases, the control-algorithm capability is already in place; the bottleneck is stable integration of the power stage, sensing, protection, thermal design, and controller interface into a compact system. EPC91128–EPC91131 move this part of system validation to a stage where engineers can run a motor shortly after receiving the board (Figure 1).

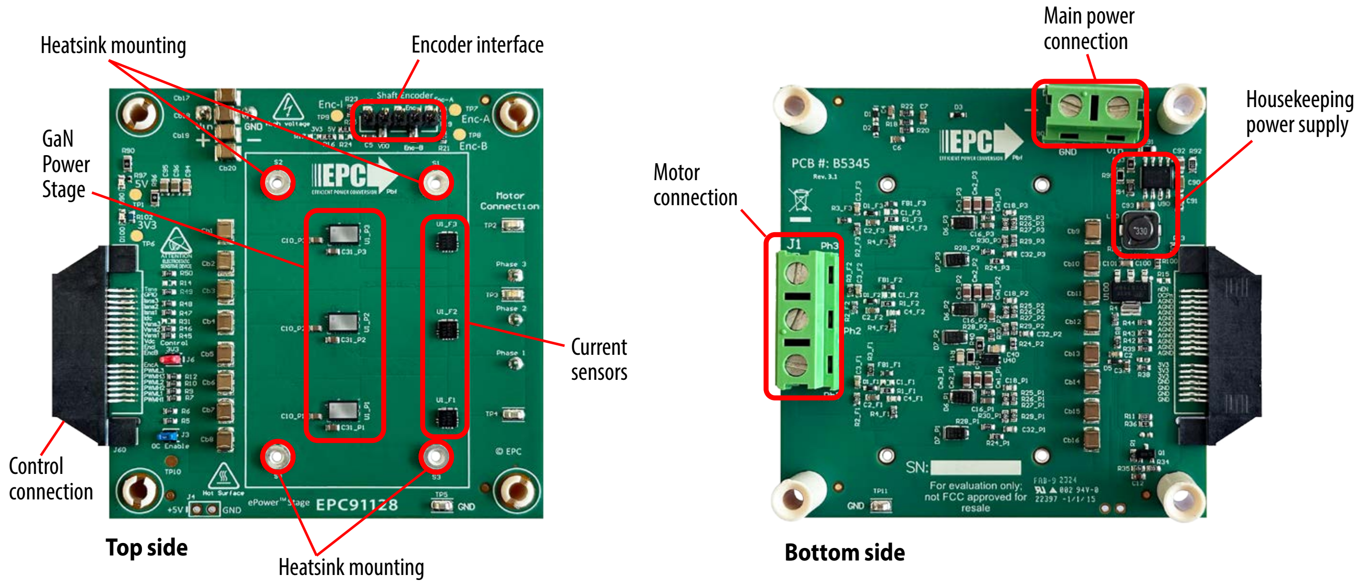

*Figure 1: Main functional sections of the EPC91128–EPC91131 evaluation boards, including the GaN power stage, main power connection, control connection, current sensors, encoder / Hall interface, and housekeeping power supply. Source: **EPC91128–EPC91131 Quick Start Guide**.*

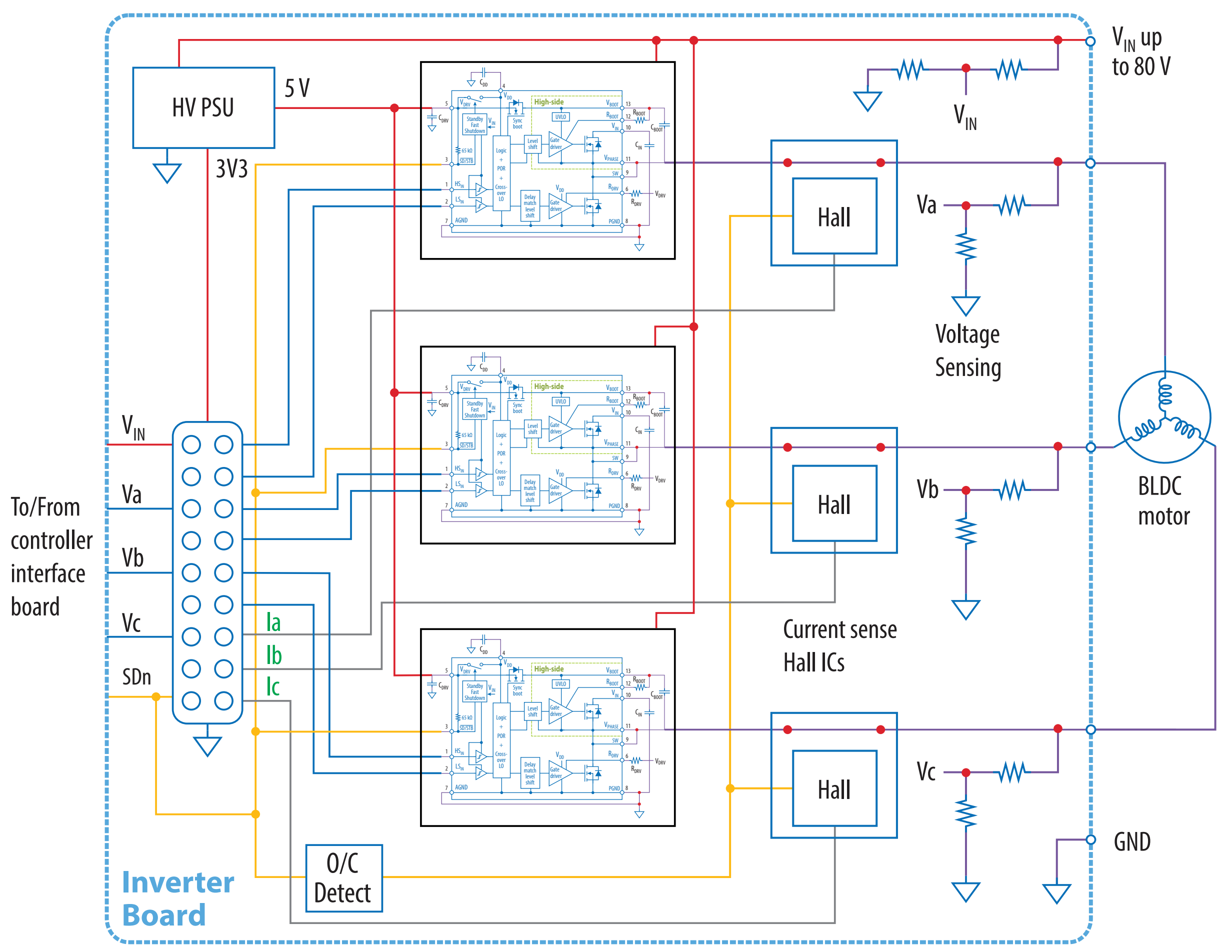

*Figure 2: Complementary PWM functional block diagram of EPC91128 / EPC91130 in a BLDC drive application, showing the connection relationships among the three-phase power stage, Hall current sensing, phase voltage / DC bus voltage sensing, O/C detect, and controller interface. Source: **EPC91128–EPC91131 Quick Start Guide**.*

Platform Capability	Specification	Engineering Significance
Input voltage	Recommended 14–80 V; typical 48 V	Covers common low-voltage buses in robotics, drones, and compact battery-powered platforms
Board size	81 × 75 mm, including connectors	Compact size supports integration into multi-axis drive systems and space-constrained robot joints
Switching frequency	20–150 kHz; typical 100 kHz	Supports high-frequency validation, helping reduce passive component size and improve dynamic response
dv/dt	Below 10 V/ns; adjustable through resistor selection	Reduces motor noise, torque ripple, and EMI, improving system controllability
Sensing chain	Three-phase current, three-phase voltage, DC bus voltage, and temperature sensing	A complete sensing chain allows engineers to evaluate current, thermal, and protection boundaries directly
Protection functions	OCP and input supply UVLO; SDn / OCDn are both active low	Hardware-level fast shutdown shortens the fault-response chain
Controller interface	40-pin; compatible with Microchip, TI, ST, Renesas, and general-purpose interface boards	Lowers the development barrier from power-stage evaluation to control-ecosystem adaptation
Position feedback interface	Shaft encoder / Hall sensors, supporting 3.3 V / 5 V	Directly supports BLDC motor drives and multi-axis motion-control scenarios

Table 2: EPC91128–EPC91131 Platform Capability Overview

ENGINEERING SELECTION PATH

1. Start with current rating: for higher continuous / pulsed current, begin with EPC91128 / EPC91129; for lower-current and higher-frequency orientation, begin with EPC91130 / EPC91131.
2. Then select by control interface: choose EPC91128 or EPC91130 when 6-PWM / complementary PWM control resources are already available; choose EPC91129 or EPC91131 when multi-axis wiring and interface count are the main constraints.
3. Recheck the thermal boundary: use the official validation data at 48 V, 100 kHz, and 50 ns dead time as a starting point, then reassess margin based on heatsink use, ambient temperature, and the target duty profile.
4. Enter system validation: retest current sensing, OCP / UVLO, fault response, and temperature rise under the target controller, target motor, and target thermal structure (Table 2).

TWO PWM INTERFACES: A TRADE-OFF BETWEEN CONTROL FREEDOM AND MULTI-AXIS DEPLOYMENT EFFICIENCY

EPC91128 and EPC91130 use six PWM inputs to drive a three-phase motor. This route is suitable for systems that already have a mature complementary PWM control architecture. It is also suitable for applications that require greater control freedom, online dead-time adjustment, or fine management of high-side and low-side switching behavior.

EPC91129 and EPC91131 use three single PWM inputs plus one enable signal, with fixed dead time embedded inside the device. For multi-axis systems, the value of this interface is direct: it reduces the number of control lines, lowers wiring complexity, and improves assembly and maintenance efficiency. When a system scales from one motor to more than a dozen or even dozens of motors, provides clear advantages in volume, weight, connector count, and wiring complexity.

Consequently, the 6-PWM and single-PWM + enable interfaces are not merely high-end versus low-end configurations; they represent distinct system-design philosophies::

- 6 PWM inputs: suitable for systems that prioritize control freedom, already have mature controller output resources, and require flexible dead-time management.
- Single PWM + enable: suitable for systems that prioritize multi-axis integration, simplified wiring, interface determinism, and rapid deployment.

In robot arms, humanoid forearms, surgical robots, and compact drones, interface count and wiring space are often as critical as power density.

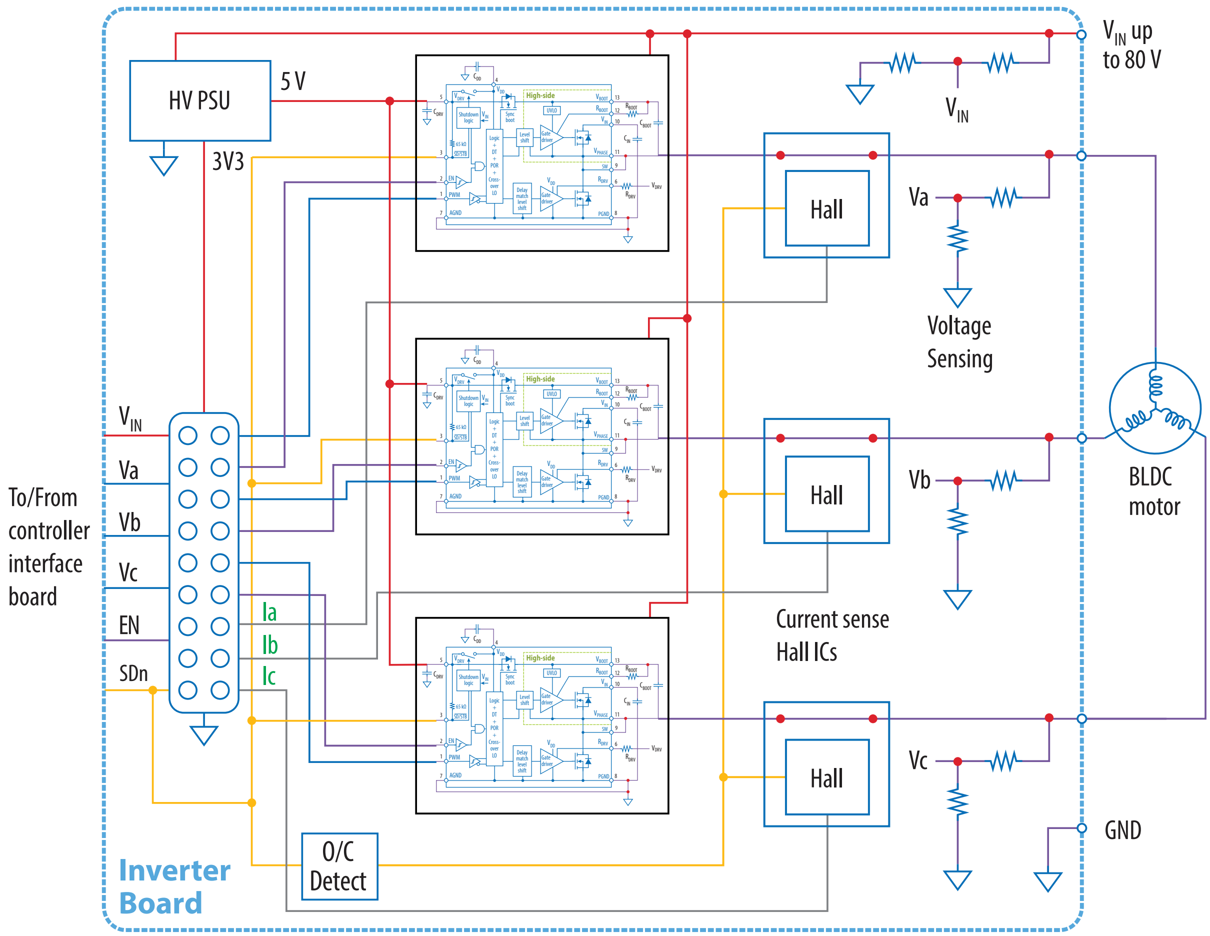

Figure 3: Single PWM + enable functional block diagram of EPC91129 / EPC91131 in a BLDC drive application. Compared with th complementary PWM route, this interface is better suited to systems that emphasize multi-axis wiring simplification and control-interface determinism. Source: ***EPC91128–EPC91131 Quick Start Guide****.*

HOW TO CHOOSE AMONG THE FOUR EVALUATION BOARDS

EPC91128, EPC91129, EPC91130, and EPC91131 can be selected along three dimensions: target current rating, control-interface type, and switching-frequency / C_{OSS} requirements.

EPC91128 / EPC91129 target higher current capability and are suitable for BLDC / PMSM drives that require higher continuous and pulsed current. EPC91128 uses 6-PWM inputs and fits systems that emphasize control freedom; EPC91129 uses 3 PWM + enable and fits multi-axis systems that need to reduce wiring and control-interface count (Figure 3).

EPC91130 / EPC91131 target lower current levels, but their lower C_{OSS} makes them better suited to higher-switching-frequency, lower-current motor applications. EPC91130 corresponds to 6-PWM input, while EPC91131 corresponds to 3 PWM + enable.

From a protection perspective, all four boards integrate independent three-phase OCP and implement fast shutdown through active-low shutdown. The switching-frequency range is 20–150 kHz, with 100 kHz as a typical evaluation condition. Engineers can choose the starting platform according to motor power, controller resources, wiring constraints, thermal conditions, and target switching frequency (Table 3).

Evaluation Board	Corresponding Device	Validation Conditions	Natural Convection / No Heatsink	Natural Convection / With Heatsink	Pulsed Current Capability
EPC91128 / EPC91129	EPC23108 / EPC23109	48 V_{DC}, 100 kHz PWM, 50 ns dead time, 3 kW motor	15 A_{RMS} steady-state	20 A_{RMS} steady-state	29 A_{RMS} impulsive current with heatsink
EPC91130 / EPC91131	EPC23110 / EPC23111	48 V_{DC}, 100 kHz PWM, 50 ns dead time, 3 kW motor	10–11 A_{RMS} steady-state	15 A_{RMS} steady-state	18–18.7 A_{RMS} impulsive current with heatsink

Table 3: Official Thermal Performance and Current Validation Data

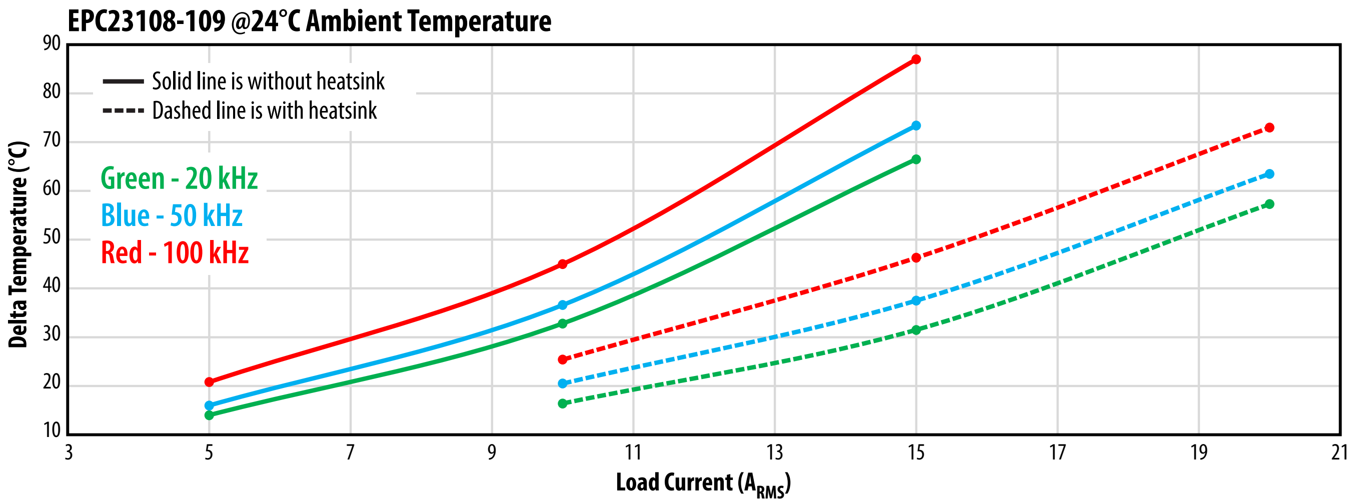

Figure 4: Steady-state thermal performance of EPC91128 / EPC91129 at 20 kHz, 50 kHz, and 100 kHz. Solid lines indicate operation without heatsink; dashed lines indicate operation with heatsink. Source: EPC91128–EPC91131 Quick Start Guide.

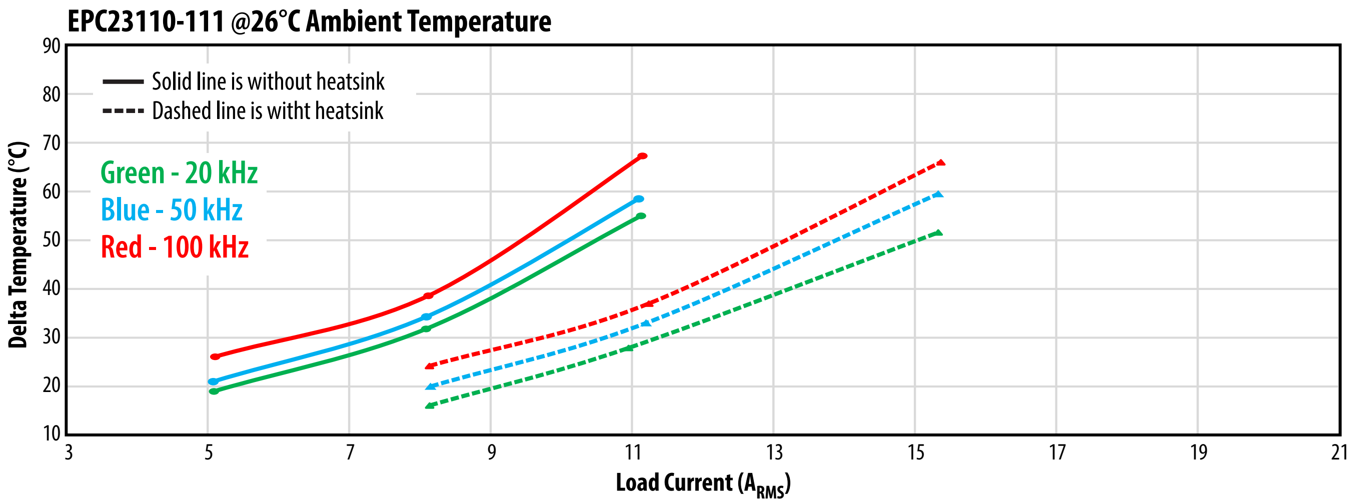

Figure 5: Steady-state thermal performance of EPC91130 / EPC91131 at 20 kHz, 50 kHz, and 100 kHz. Solid lines indicate operation without heatsink; dashed lines indicate operation with heatsink. Source: EPC91128–EPC91131 Quick Start Guide.

WHAT THIS MEANS FOR ROBOTICS, DRONES, AND PRECISION MOTION CONTROL

The combination of EPC231xx and EPC91128–EPC91131 directly addresses several tightening system constraints in low-voltage high-performance motor drives.

The most immediate constraint is size and weight. Robot joints, dexterous hands, surgical robot end effectors, and drone propulsion systems leave less and less space for the power stage. Integrated GaN power stages compress the board area occupied by discrete devices, gate drivers, protection circuits, and external matching components, while the single PWM + enable interface also reduces control-line count and connector volume in multi-axis systems. When a system scales from one motor to dozens of motors, saving 2–3 control lines per axis quickly accumulates into a wiring and weight advantage.

Protection response speed is also critical. High-dynamic motion-control systems have short tolerance windows for abnormal states. Active-low fault / shutdown and hardware-level immediate PWM disable complete abnormal shutdown inside the power stage, reducing the burden of external protection logic.

A frequently underestimated constraint is the system-level validation of high-frequency operation and thermal boundaries. GaN's high-frequency capability can help shrink passive components and improve dynamic response, but whether these advantages can be realized under the target thermal condition and target current must be tested in a real three-phase motor-drive environment. EPC91128–EPC91131 provide exactly that test environment: the current capability and temperature-rise data at 48 V, 100 kHz, and different thermal configurations give engineers a usable baseline (Figures 4 and 5).

THE COMPETITIVE DIMENSION OF GaN MOTOR DRIVES IS CHANGING

In 100 V motor drives, the competitive focus for GaN has moved to the level of system-design complexity. The industry has already seen the single-point performance advantage; the real question is how engineers can actually use it. For robotics, drone, and precision motion-control manufacturers, the factors that truly affect adoption speed are whether the complete power stage is easy to validate, easy to protect, easy to control, easy to cool, and easy to replicate across multi-axis systems.

A single IC manages the power stage, while one board completes three-phase system validation. Engineers do not need to rebuild already-validated links repeatedly.

For engineering teams, this compresses the cycle from obtaining a GaN device to generating system-level data on the target motor. This matters even more when the system must be replicated across more than a dozen axes: a platformized starting point is much faster than a discrete-build starting point.

CONCLUSION

EPC231xx and EPC91128–EPC91131 form a system-level solution for low-voltage high-performance motor drives, covering the full path from power-stage selection to three-phase inverter platform validation. After receiving the evaluation board, engineers can directly validate current capability, temperature rise, and protection behavior under 48 V / 100 kHz conditions, while accumulating system data on the target controller and target motor.

As humanoid robots, drones, surgical robots, and precision motion platforms continue moving toward higher axis count, smaller form factors, and faster dynamic response, the emergence of 100 V integrated GaN power stages as the standard starting point for multi-axis drives will depend on the depth of validation and ecosystem coverage established in real-world systems. EPC231xx and EPC91128–EPC91131 are EPC's first platform-level offering in this direction.

RESOURCE LINKS

- EPC23108 product web page
- EPC23109 product web page
- EPC23110 product web page
- EPC23111 product web page
- EPC91128 / EPC91129 evaluation board product web page and design files
- EPC91130 / EPC91131 evaluation board product web page and design files