Technical Article

Get More from Your GaN-based Digital Power Designs with a C2000 Real-time MCU

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Gallium nitride (GaN) field-effect transistors (FETs) provide drastically improved switching losses and higher power density over silicon-carbide and silicon-based FETs, respectively. These traits can be particularly helpful in high-switching-frequency applications such as digital power converters, where they can help reduce the size of the magnetics.

Designers in the power electronics industry need new technologies and methods to increase performance in GaN systems. C2000™ real-time microcontrollers (MCUs) can help address design challenges when developing modern power-conversion systems using GaN technology.

The benefits of C2000 real-time MCUs

The adaptability of a digital controller like a C2000 MCU benefits complex topologies and control algorithms such as zero voltage switching, zero current switching or inductor-inductor-capacitor-resonant DC/DC power supplies with hybrid hysteresis control.

A C2000 MCU enables benefits such as:

- **Complex, time-critical calculation processing.** C2000 MCUs have an advanced instruction set that drastically reduces the number of cycles required for complex math calculations. This reduction in calculation time makes it possible to increase the control-loop frequency without increasing the MCU's operating frequency.
- **Precise control.** The high-resolution pulse-width modulator (PWM) in a C2000 MCU enables 150-ps resolution, while built-in analog comparators and a configurable logic block help safely handle error conditions.
- **Software and peripheral scalability.** As system requirements change, the C2000 platform enables the scaling of real-time MCU features up or down while maintaining software investments to achieve faster time to market. A low-cost C2000 MCU such as the TMS320F280025C, for example, enables real-time processing and control in a small-server power supply while maintaining code compatibility with the TMS320F28379D, which is a popular device in higher frequency multiphase systems.

Read the white paper

Discover how C2000 real-time MCUs and GaN FETs work together to meet power density challenges.

Addressing GaN switching challenges with C2000 MCUs

As I mentioned earlier, driving higher switching frequencies enables a reduction in the size of the magnetics in switching converters, but this reduction can introduce a number of control challenges. For example, in a totem-pole power factor correction topology, reducing the size of the inductor can cause an increased current spike at the zero-crossing point and increase dead-band-induced third-quadrant losses as well. These effects combine to increase the total harmonic distortion (THD) and reduce efficiency.

To address these issues, C2000 real-time MCUs have feature-rich PWMs to enable soft-starting algorithms that smooth out current spikes and achieve better THD. The C2000 MCU also has extended instruction sets, floating-point unit and trigonometric math unit, that can drastically reduce the time required to calculate parameters such as the PWM's on time. This time reduction also increases the control-loop frequency, which along with the 150-ps resolution of the PWM helps reduce third-quadrant losses.

Interfacing C2000 MCUs with TI GaN technology

A C2000 MCU, digital isolation device and GaN FET are all that are necessary to interface the devices, as shown in Figure 1.

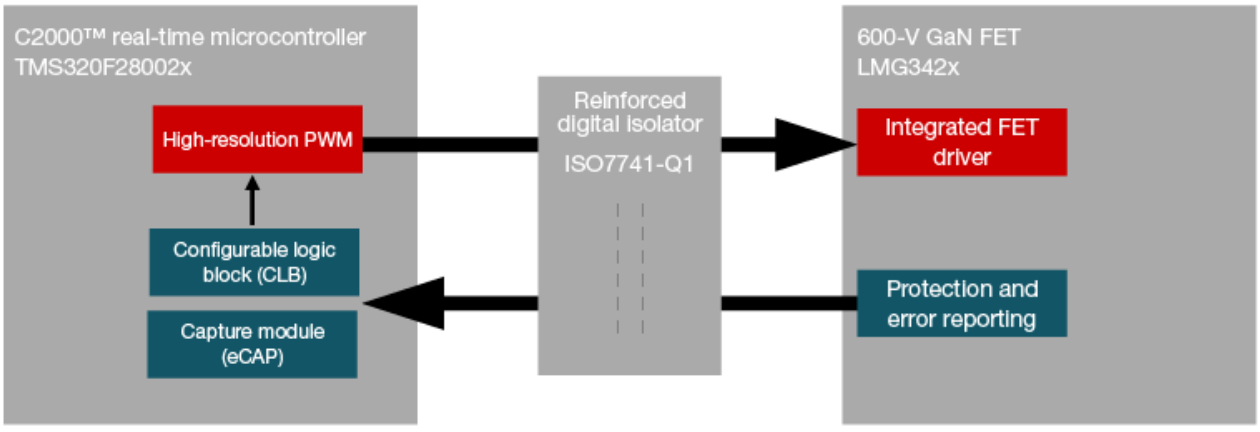

Figure 1. Interfacing a C2000 MCU, digital isolator and 600-V GaN FET

A reinforced digital isolator helps suppress transient noise and protects the C2000 MCU. The C2000 MCU provides precise control output using its high-resolution PWM and configurable logic block and enhanced-capture modules to capture all of the GaN FET's safety, temperature and error-reporting features without the use of external glue logic. The integrated driver in a 600-V GaN FET reduces system design concerns caused by inductive ringing. Combining these devices eliminates the need for external components, reducing overall costs.

Learn more about the advanced features of TI's GaN FETs in the technical article, "How GaN FETs with integrated drivers and self-protection will enable the next generation of industrial power designs."

Conclusion

TI C2000 real-time MCUs and GaN FETs work in harmony to provide a flexible and simple solution for modern digital power systems, while still providing cutting-edge features that enable power-dense and efficient digital power systems. Our fully tested and documented reference designs help accelerate development of high-efficiency and high-density digital power systems.

Additional resources

- Read the white paper, Achieve Power-Dense and Efficient Digital Power Systems by Combining TI GaN FETs and C2000 Real-Time MCUs
- Check out these reference design, Bidirectional High-Density GaN CCM Totem Pole PFC Using C2000 MCU.
- Read the application report, "Does GaN Have a Body Diode? – Understanding the Third Quadrant Operation of GaN."
- Learn more about the capabilities of the configurable logic block in the TI training, "C2000 Configurable Logic Block (CLB) Introduction."
- Read the technical article, "Meeting 3 server power supply design trends with a real-time MCU" and learn about the F28003x MCU family.

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