

Isolated power modules with IsoShield™ technology cut solution size by as much as 70%



Cole Neswold, product marketing engineer

- Integrated transformer modules deliver three times the power density for space-constrained applications such as electric vehicle (EV) traction inverters and data center power-supply units (PSUs).
- Advanced isolation provides 250V/ns common-mode transient immunity for harsh environments.

Expectations of EV performance continue to evolve, requiring engineers to support high battery voltages and faster-switching FETs while reducing vehicle weight, improving efficiency, and providing galvanic isolation to protect systems from transients and noise in harsh environments with extreme temperatures, vibration, and electromagnetic interference (EMI).

Meanwhile, AI computing demands require greater power density in data centers, with designers tasked to pack more power into smaller spaces while facing similar isolation challenges in multi-kilowatt PSUs, backup battery units (BBUs), and server racks. Traditional inductor-inductor-capacitor resonant converter and flyback designs require transformers that consume precious board space and height. Discrete transformer-based designs also add unwanted electrical effects that reduce noise immunity and increase design complexity.

Isolated power modules using TI's proprietary IsoShield™ packaging technology address these constraints by integrating transformers, switching devices and passive components to meet isolation requirements while reducing size by as much as 70% compared to existing solutions. [Figure 1](#) shows the power module with this proprietary integrated transformer technology.

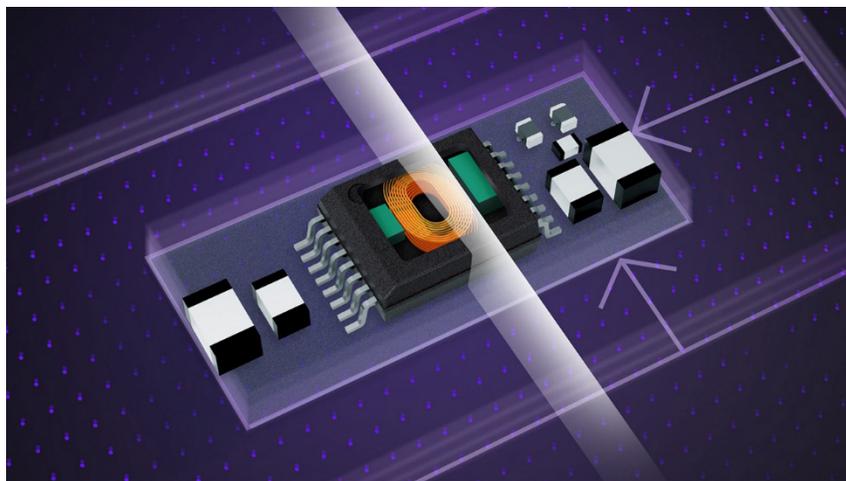


Figure 1. The UCC34141-Q1 with IsoShield technology in a 5.85mm-by-7.50mm-by-2.65mm package

How Increased Power Density Reduces Solution Size

Traditional isolated power designs make choosing between power delivery and board space difficult. Transformers must fit in compact spaces, while providing isolation between 800V battery systems and 12V or 3V control circuits. EV designers and data center engineers need to maximize power density while minimizing weight and space requirements.

Power modules with IsoShield packaging technology integrate the transformer, typically the largest component on a printed circuit board (PCB). While other devices can achieve similar levels of performance with a significant

amount of external circuitry, IsoShield technology enables extremely small packages while still providing sufficient power. For example, the mid-voltage [UCC34141-Q1](#) and low-voltage [UCC33420-Q1](#) DC/DC modules provide 1.5W of isolated output power in 5.85mm-by-7.50mm-by-2.65mm and 4mm-by-5mm-by-1mm packages, respectively.

The UCC34141-Q1 reduces bias-supply solution area 70% compared to discrete flyback solutions and >35% compared to existing integrated transformer solutions. These reductions deliver 333% and 150% higher power density, respectively.

[Figure 2](#) visualizes the solution area reduction associated with moving from flyback on the left to a fully integrated solution, the UCC34141-Q1, on the right.

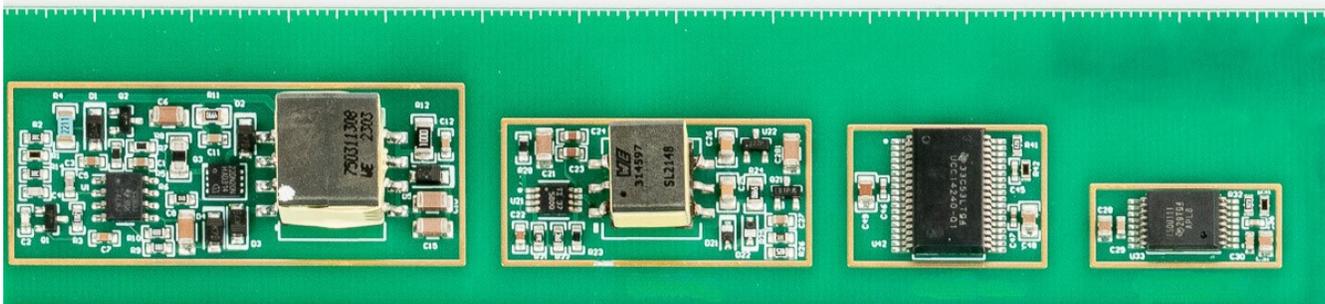


Figure 2. Top view of the evolution of isolated bias-supply solutions

Solution height is equally important. Integrating the transformer eliminates the tallest component on the board, enabling a solution that is less than one-fourth the height. The UCC34141-Q1 measures 2.65mm high, and the UCC33420-Q1 is 1mm high.

Integration and small size typically raise concerns about thermal performance and EMI, but DC/DC modules with IsoShield technology dispel these worries. These devices improve thermal performance by as much as 30% compared to previous modules – and in 54% smaller packages. These modules only need small, inexpensive EMI filtering to pass Comité International Spécial des Perturbations Radioélectriques (CISPR) 32 Class B and CISPR 25 Class 5 requirements.

Enhanced system durability and reliability

Power-supply reliability and high performance in noisy and harsh environments are important to ensure safe system operation. Devices with IsoShield technology are designed to provide reliable performance through four types of immunity:

- Common-mode transient immunity (CMTI): The modules feature <math><3\text{pF}</math> of parasitic capacitance across the primary and secondary windings of the integrated transformer, enabling a CMTI of 250V/ns for the UCC34141-Q1 and UCC33421-Q1. [Figure 3](#) is an output waveform of the UCC33421-Q1 under a >250V/ns voltage strike.

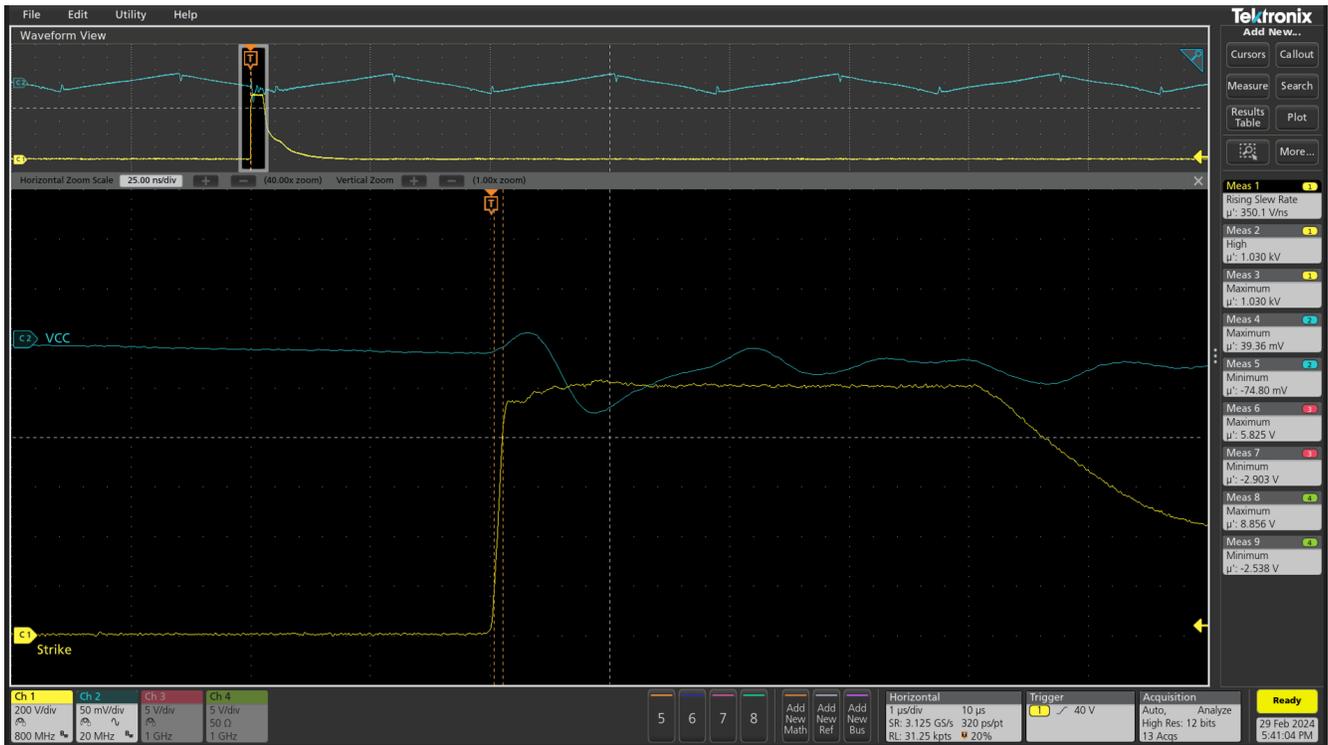


Figure 3. UCC33421-Q1 output waveform during a >250V/ns voltage strike

- Radiated immunity: An injected electromagnetic noise test with a transverse electromagnetic cell on the UCC34141-Q1 shows continuous operation at a >100V/m noise level through a frequency range from 10MHz to 1GHz. The UCC34141-Q1 meets the CISPR 25 standard and exceeds the International Electrotechnical Commission 61000-4-3 standard without needing to add metal exposure or an EMI filter.
- Magnetic immunity: The UCC34141-Q1 operates reliably near strong magnetic fields. In applications, these fields may generate from the busbar in a traction inverter or magnetics in medical equipment such as an MRI or X-ray machine. Power modules with IsoShield technology can operate with >100mT of field strength.
- Vibration immunity: Strong and frequent vibrations are typical in EV applications. Thanks to their small size and low profile, devices with IsoShield technology can reduce the torque and stress on solder joints and PCB pads >90% compared to discrete transformers, which reduces the possibility of transformer failures caused by vibration. [Figure 4](#) illustrates the solution height reduction of the devices, which contributes directly to vibration immunity.

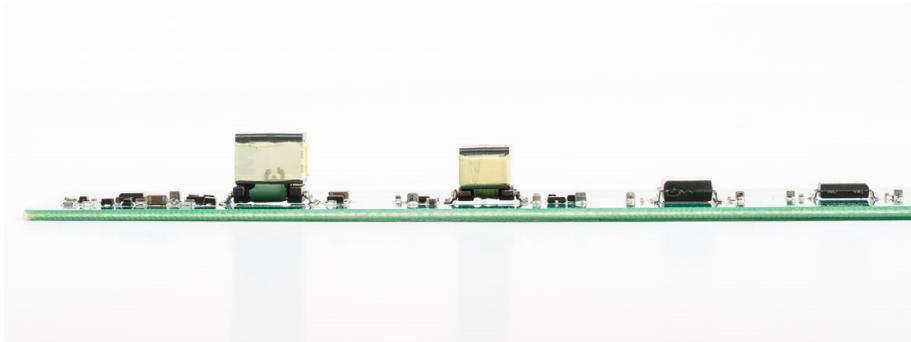


Figure 4. Side view of the evolution of isolated bias-supply solutions

Accelerated design cycles

Transformers are among the most difficult to select, source and design, requiring trade-offs between catalog and custom designs. Custom designs require significant specifications for windings (how many, how to route, how much loss); core (size, shape, material, loss); inductance (leakage, coupling, parasitics); and packaging.

Bias-supply modules that integrate the transformer, switching FETs and other passive components eliminate these issues, reducing the amount of component selections and design considerations. This is extremely valuable in data center applications given the rapid design and deployment of PSUs, BBUs and server racks to meet rising market demands.

Conclusion

Devices with IsoShield technology help eliminate the typical trade-offs associated with engineering higher power, higher performance and higher reliability. The ability to repurpose 70% of your previous bias-supply solution gives you the opportunity to add extra features or sensors to the system, increase redundancy, or design a higher-power-density solution.

Additional resources

- Evaluate the UCC34141-Q1 by ordering the [evaluation module](#).
- Check out the [Design priorities in EV traction inverters](#) white paper.
- Download the [Data center reference design for HVDC 30kW PSU](#) (PMP23630) to get started.

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