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Microinverter Reference Platform Taps GaN BDS To Deliver High Efficiency

Eggtronic's 500-W solar microinverter reference platform, which was jointly developed with Renesas Electronics, combines Eggtronic's EPIC2ACO01 EPIC mixed-signal controller technology with Renesas' TP65B110HRU bidirectional GaN switch (BDS). It demonstrates a high-efficiency architecture that supports microinverter OEMs and system manufacturers in developing next-generation solar microinverters and power conversion applications (see Figs. 1 and 2).

The reference platform achieves 96.1% average efficiency under CEC standards and 95.9% under EU standards, validating the performance potential of a single-stage dc-ac topology enabled by advanced digital control and wide-bandgap semiconductors (Fig. 3).

As photovoltaic (PV) module output continues to increase beyond 400 W, microinverter manufacturers must continuously optimize efficiency, thermal performance, component integration, and overall system cost. Many established architectures—whether based on interleaving, multi-stage topologies, or advanced GaN implementations—involve design tradeoffs between complexity, power density, and cost that require careful engineering balance.

The reference design demonstrates how semiconductor-level innovation, combining intelligent mixed-signal control and high-performance bidirectional GaN switching devices, can enable OEMs to explore alternative architectures that optimize efficiency and power density while maintaining system reliability.

At the core of the platform is Eggtronic's proprietary EPIC mixed-signal controller EPIC2ACO01. The controller executes patented variable frequency modulation (VFM) and current-mode strategies designed to maintain zero-voltage switching (ZVS) across the full load range. This single-stage approach minimizes BOM cost, switching losses, reduces reactive power circulation, and maintains low THD (<3%, compliant with IEEE 1547 standards), while enabling operation at switching frequencies up to 1 MHz—significantly reducing the size of magnetic components.

Igor Spinella, CEO of Eggtronic, notes the challenge of switching at such a high frequency, saying, "You must be realy accurate on dead-time or you kill the bidirectional switch." He adds that Eggtronic's controller performs very well in this regard. This creates an opening for many inverter developers who don't have the resources to develop their own controllers. "There are some excellent ASICs from leading companies but they are not readily available. Our reference design has a very high performance and cost effective controller."

However, there are also other distinctions between ASIC-based controllers and Eggtronic's "hybrid" style controller, which combines analog peripherals with a digital core. Unlike other digital controllers, which require very high clocks speeds to close the current loop fast, EPIC can close the loop independently from the core, with zero latency.

As Spinella explains, "EPIC is Eggtronic's mixed-signal controller platform for advanced power conversion applications. It is designed to fill the gap between traditional ASICs and digital controllers."

He adds, "ASICs can offer low cost and strong performance for specific applications and operating points, but they provide limited flexibility and are difficult to adapt when complex control laws are required. Digital controllers, on the other hand, offer high flexibility, but achieving high-performance real-time control often requires significant computational capability, increasing both cost and power consumption."

"EPIC combines the advantages of both approaches, dynamically creating virtual ASICs to avoid the need for expensive cores. It is supported by web-based software tools that allow users to configure behavior and functionalities through a GUI. It offers performance superior to ARM M4-based microcontrollers at a fraction of the cost. This enables advanced real-time control at very high frequency, while maintaining flexibility, efficiency, and cost-effectiveness," says Spinella.

The platform leverages Renesas' TP65B110HRU bidirectional GaN switch, integrated in a common-drain configuration suitable for cycloconverter-based ac switching. The device's low on-resistance and fast switching characteristics enable high-frequency operation and reduced conduction losses, supporting compact and thermally optimized designs. According to Spinella, the TP65B110HRU outperformed several other BDSs on the market.

"This reference platform highlights how advanced digital control combined with high-performance devices like these bidirectional GaN HEMTs can support OEM partners in developing efficient and compact microinverter solutions," says Spinella. "Our objective is to provide enabling semiconductor technologies that help established and emerging manufacturers accelerate innovation while optimizing overall system performance."

The ERD00718 500-W microinverter reference design is available for evaluation by qualified OEM and system manufacturer customers. For more information, see the AC DAB Cycloconverter and TP65B110HRU pages.

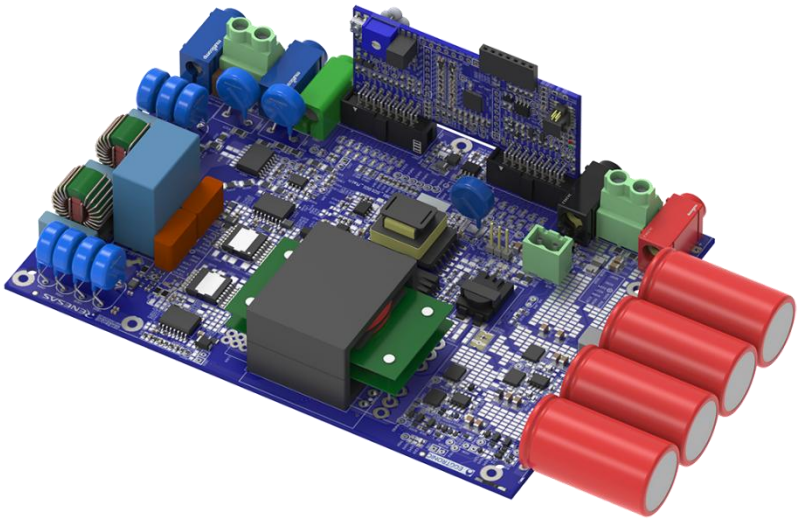

Fig. 1. Based on the SolarEgg single-stage DAB cycloconverter architecture, the ERD00718 500-W microinverter reference design incorporates the EPIC2ACO01 controller, optimized for this topology, together with Renesas' TP65B110HRU bidirectional GaN device. An eval board is pictured here.

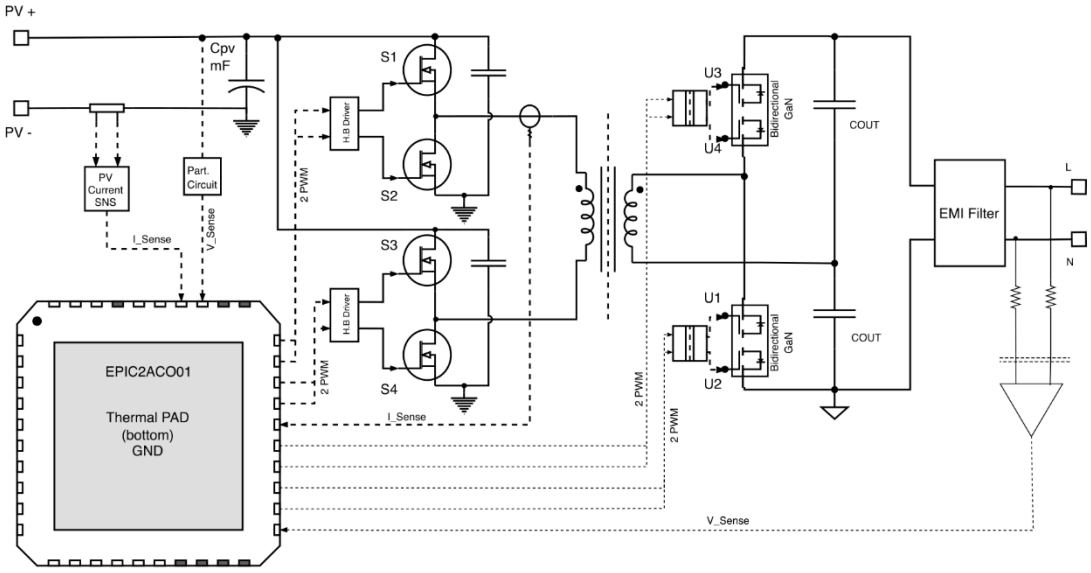

Fig. 2. At its core, SolarEgg employs an advanced single-stage DAB cycloconverter architecture for direct dc-ac conversion. The topology integrates a primary low-voltage full-bridge, a secondary high-voltage half-bridge based on bidirectional GaN devices, and a high-frequency isolation transformer. The EPIC controller's proprietary variable frequency modulation enables zero-voltage switching across all power devices, minimizing reactive power and switching losses. The result is a highly efficient, flat efficiency curve across the full operating range, outperforming conventional fixed-frequency solutions.

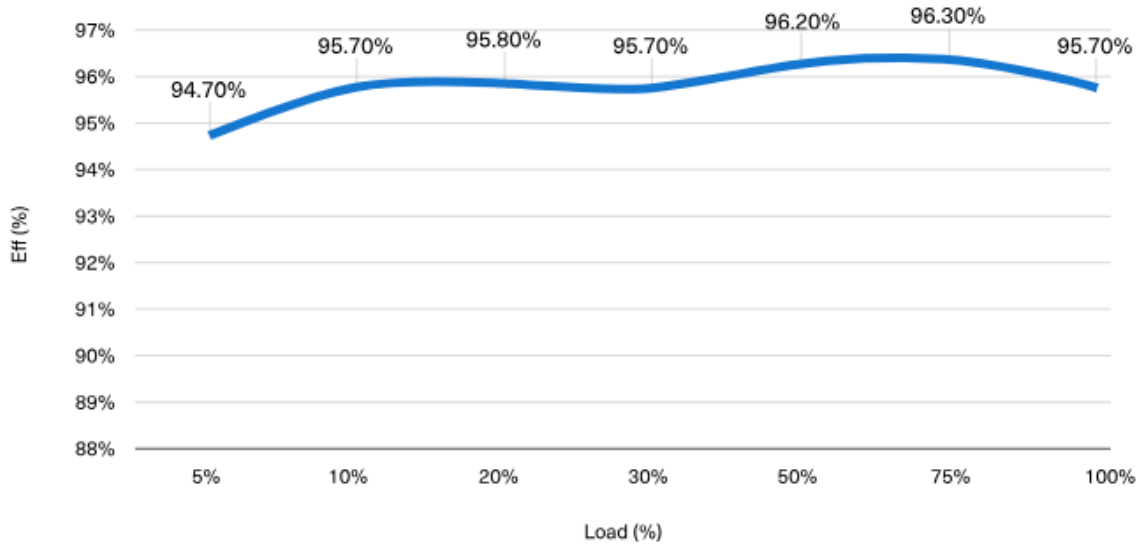

Fig. 3. Efficiency of the 500-W microinverter reference design with 35-Vdc input and 240-Vac output.