Power Architecture Promises Higher Efficiency And Smaller Size For AC-DC Converters

Eggtronic's QuarEgg+ is a proprietary power architecture that significantly improves the efficiency and reduces the size of ac-dc converters that would traditionally have used active clamp flyback (ACF) and quasi-resonant (QR) topologies. According to the company, the new architecture will maximize the performance, minimize the form factor and improve the reliability of ac-dc power schemes in applications ranging from fast chargers and adapters for mobile devices and laptops to power supplies for loudspeakers and smart home assistants.

QuarEgg+, which targets ac-dc converter designs below 100 W, is the first in a series of power conversion architectures that make up the Eggtronic EcoVoltas family. Specifically developed to deliver smaller, higher efficiency power conversion, this family of proprietary technologies will help engineers to meet performance, cost, size, weight and sustainability goals. EcoVoltas solutions are said to boost the performance of FET switching devices, whether they are based on silicon or wide-bandgap materials such as GaN or SiC. They also drive down no-load "vampire" power and reduce the overall bill of materials (BoM) (Fig. 1).

By offering superior performance to conventional ACF and QR converters, QuarEgg+ enables power converters that have up to five times lower losses and are two times smaller than traditional silicon converters and have up to two times lower losses and are 30% smaller than previous GaN converters, says the vendor (Fig. 2).

QuarEgg+ operates with zero voltage switching (ZVS) under all load conditions to give very flat light-load-to-full-load efficiency curves. Efficiencies are up to 95% at full load and up to 92% at light load. Power consumption is further reduced thanks to the ultra-low standby power of less than 18 mW. Elimination of a high-voltage, high-side clamping MOSFET minimizes component count and improves reliability, while smooth rising edges and soft switching reduces EMI to simplify filtering requirements.

In discussing the differences between QuarEgg+ and the conventional QR topology, Lorenzo Ferrari, a researcher and designer at Eggtronic, observes, "The standard QR flyback is a quasi-resonant topology, meaning that it is capable of low voltage switching in some working conditions, especially when running at low input voltage and when running at 50%+ of nominal load, synchronizing the switching activity with one of the first valleys in the switching waveform. When running at high Vin, low Vout and medium to low loads, a QR flyback is basically a hard-switching highly inefficient topology."

In contrast "QuarEgg+ is a true ZVS topology in that it achieves zero voltage switching in every working condition. This is possible because Quaregg does not rely on a passive uncontrolled phenomena like spurious valleys (as in QR), but rather it uses an active mechanism to force ZVS," says Ferrari.

As Fig. 1 shows, Eggtronic's application circuit contains a small MOSFET and an auxiliary winding. In operation, the controller syncs on a primary-side crest in the switching waveform (if available), as shown in Fig. 3. When the crest is detected, the controller generates a pulse via the aux MOSFET and aux winding.

When this happens, a small amount of energy is taken from the secondary side and transmitted across the transformer to the primary side. This energy is later used to turn on the body diode of the primary-side switch, causing the drain voltage to resonate to 0 V. At this point, the controller can turn on the primary-side switch in ZVS. Note that there is some deadtime programmed into this sequence to give the primary-side MOSFET time to reach O V.

What's described above and shown in Fig. 1 is an implementation of the QuarEgg+ architecture with secondary-side control. This approach was mainly chosen to allow integration of control functions. However, the company can also implement the QuarEgg+ architecture with primary-side control, if the application warrants it.

To help speed the development of ac-dc applications built on QuarEgg+ technology, Eggtronic will be offering both GaN-based and silicon-based QuarEgg+ products with power outputs of 35 W, 45 W and 60 W with output options that include USB PD, fixed voltage and CC CV. In other words, the company will design and manufacture complete power supply designs for customers.

However, Eggtronic will also provide the components and tools for customers to develop their own QuarEgg+ based power supplies. To that end it offers integrated power controllers, a range of proprietary magnetic components, development boards, and comprehensive technical support.

Discussing the new architecture, Igor Spinella, Eggtronic's CEO and founder comments, "Thanks to EcoVoltas QuarEgg+ technology, designers of low-power ac-dc power conversion applications can now address the most stringent performance, size and cost criteria while contributing to sustainability goals by driving down power use and associated emissions." For more information, see the [website](#) or contact support@eggtronic.com.

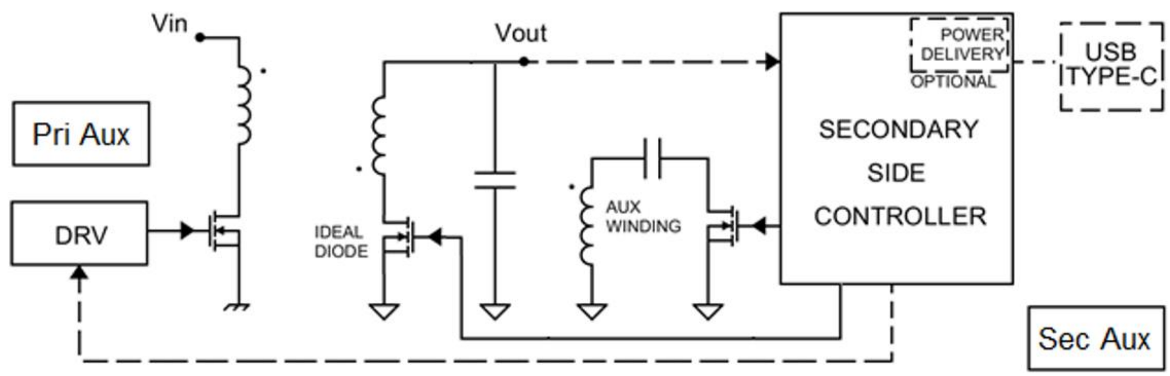
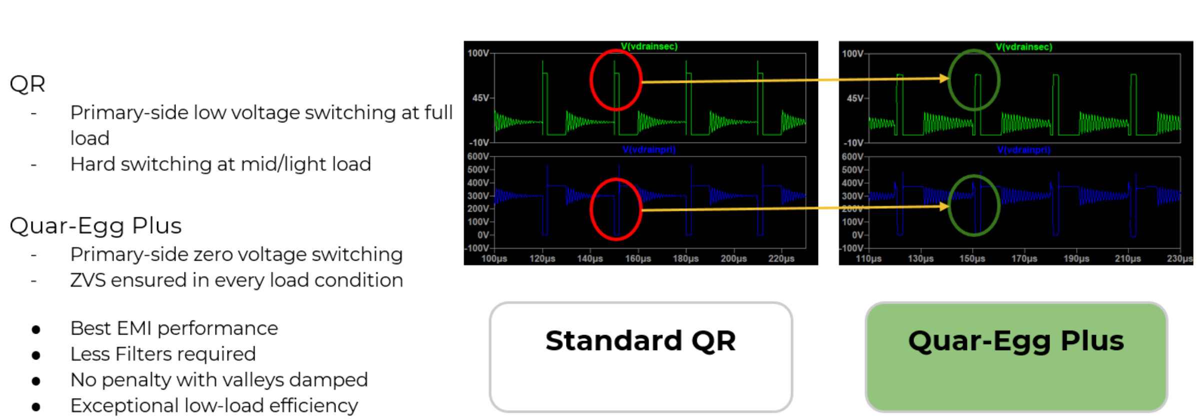


Fig. 1. QuarEgg+ is a modified flyback architecture. The single-chip implementation of this architecture employs a secondary-side controller that drives the primary-side MOSFET power switch, performs secondary-side synchronous rectification and USB Type-C control of power delivery. This proprietary architecture is offered as an alternative to conventional QR and active clamp flyback architectures, providing flatter efficiency and lower standby power.



(a)

Comparison for 45W Power Delivery

KPI	Quasi-Resonant	Quar-Egg Plus	Active Clamp
Peak efficiency [%]	90.0%	94.5%	93.5%
Light Load (1W) efficiency [%]	83%	92%	86%
Power Density (module) [W / inch³]	18	25	24
# active components	1xHV, 1xLV	1xHV, 1xLV + 1x(small)LV	2xHV, 1xLV
Relative cost	1	1	1.5

(b)

Fig. 2. Forced ZVS operation under all load conditions is said to be the key to this architecture's high efficiency. In standard QR switching, with high input voltage and at medium to light loads, ZVS is typically lost as operation changes to hard switching. (a) Meanwhile with active clamp switching, transients tend to degrade efficiency at light load. The chart in (b) compares the efficiency of QR, active clamp, and QuarEgg+ architectures in a typical 45-W PD adapter application.

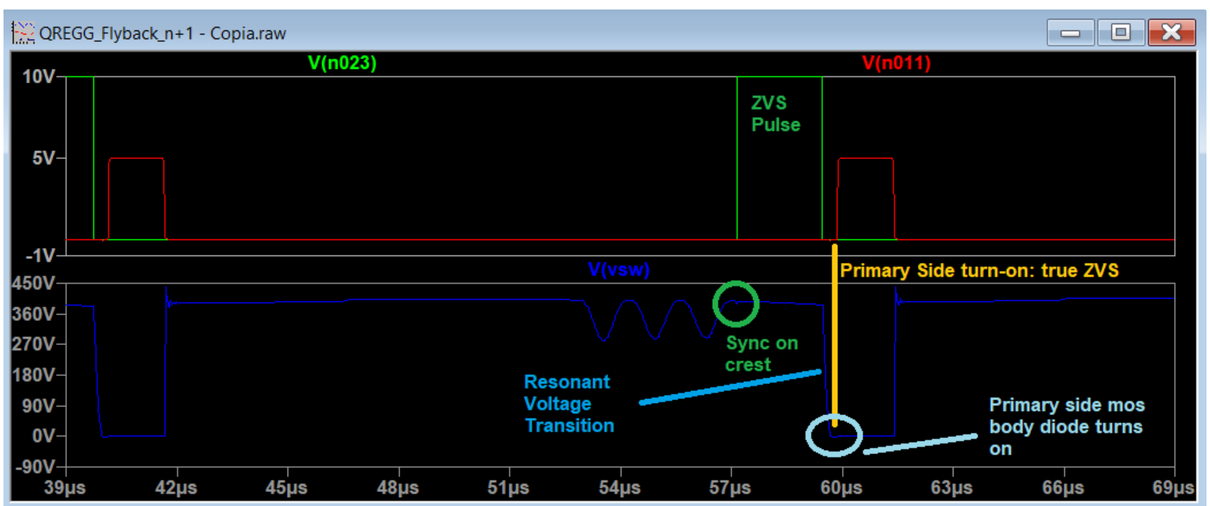


Fig. 3. By sensing the crest of the switching waveform, and then transmitting a pulse via the aux winding to turn on the primary MOSFET's body diode, the controller forces V_{DS} of the power switch to 0 V. In this way, the power switch can predictably be turned on with zero volts on the drain, ensuring ZVS under all operating conditions. Note that in the measurements shown here, ZVS is achieved while operating from a high input voltage (the EU grid voltage) and low output voltage (5 V)—a condition in which a standard QR flyback would typically be hard switching.