ACF Controllers Push Power Adapters To Higher Efficiency Using Silicon Only

Silanna Semiconductor's SZ1110 and SZ1130 devices are active clamp flyback (ACF) PWM controllers that integrate an adaptive digital PWM controller and three high-voltage components—an active-clamp FET, active-clamp gate driver and a startup regulator. This level of integration facilitates designing efficient, high-power-density adapters with low BoM cost to satisfy power-hungry mobile phones, tablets, notebooks and video game consoles. Flyback designs based on the SZ1110 and SZ1130 are capable of over 94% efficiency, and efficiency is flat across both line (universal, 90 to 265 Vac input) and load ranges (Fig. 1).

"Less than a year ago we launched the SZ1101, the world's first Active Clamp Flyback Controller, to an incredible customer and industry response," said Mark Drucker, CEO of Silanna Semiconductor. "This expansion into higher power and smaller form factors speaks to our core power density leadership. Silanna Semiconductor delivers ac-dc solutions with the highest power density and efficiency while simultaneously delivering the greatest value and reduced BoM costs."

The 33-W SZ1110 and 65-W SZ1130 ACF controllers provide the same output power ratings as the SZ1101 and ACF SZ1105 controllers that Silanna introduced last year. However, the new controllers deliver significant increases in efficiency and power density. For example, while the SZ1105 delivered over 93% efficiency and over 20 W/in^3 power density at the full 65-W output power, the SZ1130 can push efficiency over 94.5% with 27.5 W/in^3 power density at 65 W (uncased in both examples). According to the company, this new level of performance is approximately 50% above the closest state-of-the-art competitor in terms of power density (Fig 2).

When asked what changes in controller design enabled the higher levels of performance achieved by the SZ1110 and SZ1130, Ahsan Zaman, director of marketing, said "Improvements in efficiency and power density are primarily coming from enhancements in the digital controller which allow more optimal operation. These include internal active clamp FET operation and proprietary modes of operation, such as burst mode for light-load operating conditions, and adaptive quasi-resonant (QR) valley switching mode for medium to heavy load operating conditions."

Zaman added that the better controller operation also lowers EMI, which in turns allows use of a smaller filter on the input. The smaller filter contributes to better efficiency and power density.

Zaman also noted there were other enhancements in the new controllers such as more comprehensive fault protections and better recovery behaviors, greater ESD ratings, and lower output voltage ripple etc. "These changes were made based on customer feedback and market requirements," he said. Key differences between the new controllers and their predecessors are summarized in the table. Also see Fig. 3.*

The SZ1110 and SZ1130 devices provide the ease-of-design of a simple flyback controller with all the benefits of an ACF design, including recycling of the leakage inductance energy of the flyback transformer and limiting the primary FET drain voltage spike during the turn-off events. Employing Silanna's OptiMode digital control architecture, the SZ1110 and SZ1130 adjust the device's mode of operation on a cycle-by-cycle basis to maintain high efficiency, low EMI, fast dynamic load regulation and other key power supply parameters in response to varying line voltage and load.

"Unlike conventional ACF designs, tight tolerances of the clamp capacitor and leakage inductance values are not required for proper operation of the circuit in high volume production," said Zaman. "The SZ1110 and SZ1130 are well-suited for high efficiency and high power density ac-dc power adapters. The devices are designed for up to 33 W (SZ1110) and 65 W (SZ1130) output power, including USB-PD and Quick Charge applications."

SZ1110 and SZ1130-based ac-dc power supplies easily meet the stringent DoE and CoC efficiency and no-load standby power requirements, according to Silanna.

Other features of the controllers include:

- Operation at a switching frequency up to 146 kHz
- Self-tuning valley-mode switching (VMS)
- Multi-mode operation (burst mode, quasi-resonant and VMS)

- 6-dB EMI margin
- OTP, OVP, OCP, OPP and output short-circuit protections
- <50-mW no-load power consumption
- 16-pin SOIC package

Customers can see demonstrations of the ACF controllers in the online demo room at www.powerdensity.com. Pricing and sample information is also available on that page.

**For more background on the SZ1101 and SZ1105, see "Fully Integrated Active Clamp Flyback Controller Extends Benefits To 60-W AC Adapters," How2Power Today, May 2019.*

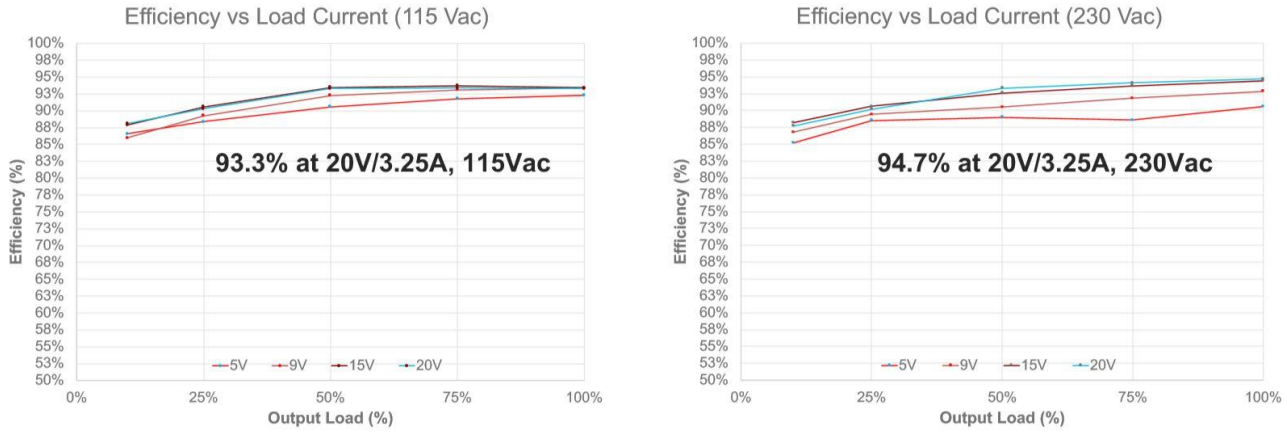

Fig. 1. With 230-Vac input, an adapter design based on either the SZ1110 or SZ1130 active clamp flyback controller can achieve >94.5% efficiency using an all-silicon design (no GaN FETs).

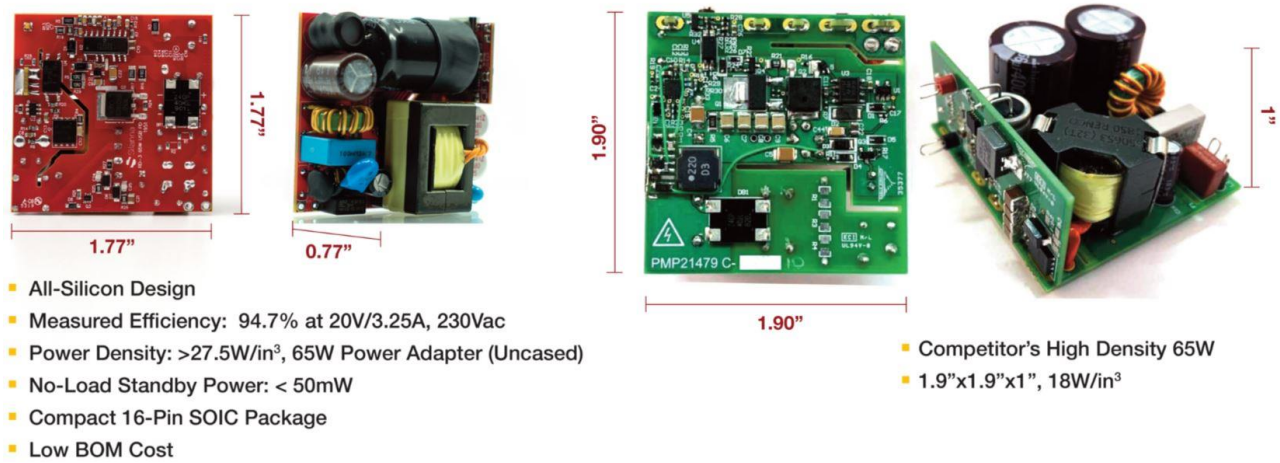

Fig. 2. The 65-W SZ1130 ACF controller is said to implement a power adapter design with approximately 50% higher power density and 30% smaller volume than the best performing ACF controller, all silicon solution from a competitor.

Table. Comparing performance and features of the new SZ1110/SZ1130 controllers with the existing SZ1101/SZ1105 controllers.

Performance/ features	SZ1101/SZ1105	SZ1110/SZ1130
Fault mode protections	Hiccup with OTP latch, Latch mode fault recovery	Hiccup (all faults), Hiccup with OTP latch, and Latch-mode fault recovery
Output overvoltage protection	No dedicated pin on the IC	Dedicated pin on the IC
EMI	Low	Further reduced by forced frequency jitter at high line
Light-load efficiency	High	Further improved by enhanced burst mode operation
Output voltage ripple	Low	Further reduced (removed oscillation when transitioning from burst mode to QR mode and vice versa)
ESD improvement	Most pins are rated for 2 kV HBM except some, which are rated for 1 kV HBM	2 kV HBM on all pins, except 3 UHV pins (CLAMP, SW, BOOT_CL)
External overtemperature protection (OTP) accuracy	Uses internal pull up resistor for NTC resistor (±12% accuracy)	Enables an external pull-up resistor for NTC resistor, which improves OTP accuracy
Fault recovery timer	160-ms wait time between self-restart attempts	640-ms wait time between self-restart attempts

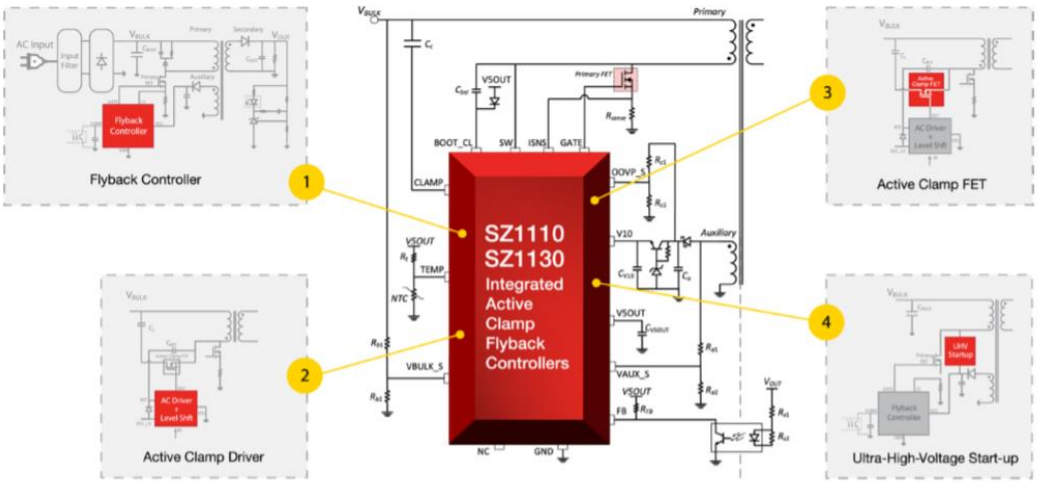

Fig. 3. Like their predecessors, the SZ1101 and SZ1105, the new 33-W SZ1110 and 65-W SZ1130 ACF controllers simplify the design of ACF converters by integrating four key functions—the flyback controller, active clamp driver, active-clamp FET and high-voltage startup circuitry—but have enhancements which enable higher efficiency and power density, more comprehensive fault protections, and other improvements in performance.