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PoE PD Power SoC Manages Remote Device Power

A powered-device controller IC for PoE systems has four on-chip dc-dc converters plus a high-voltage, high-speed isolation barrier interface that allows it to manage both primary and isolated secondary power.

Augmenting the move to Power-over-Ethernet (PoE), the AS18x4 family of controller ICs from Akros Silicon integrates the company's "GreenEdge™" high-voltage, high-speed-isolation and power-conversion technology for powered devices (PD). The power-supply system-on-a-chip (SoC) family includes a Type 1- (IEEE® 802.3af, 13 W) and Type 2- (IEEE® pre-802.3at, 25.5 W)-compliant PD controller with four dc-dc converters, resulting in a complete power-management solution that boasts the industry's smallest footprint and requires only a few external components.

THE OLD WAY

To understand the importance of this new IC family we have to trace the PoE evolution. Ethernet-controlled electronic devices require both data connectivity and a dc power source. In the past, Ethernet-controlled devices have had data connectivity, but the power source for the remote device relied on the electric utility's ac power to produce the required dc operating voltage (*Fig. 1*).

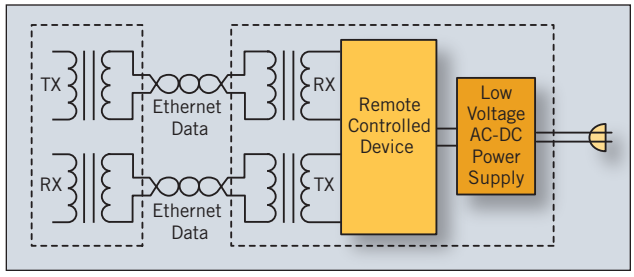

Fig. 1. Before PoE, the power source for the remote Ethernet device used the electric utility's ac power to produce its dc operating voltage.

THE NEW WAY

The demand for greater system capabilities led to the development of PoE standards that define the requirements associated with providing and receiving power over existing Ethernet cabling. The standards specify the protocol for delivering a nominal 48 Vdc over unshielded twisted-pair cables (such as Cat 5 and Cat 5e). It can be used with powered devices like VoIP phones, wireless access points (WAPs), IP cameras, and point-of-sale terminals.

As defined in the original IEEE 802.3af standard, a PoE configuration employs two main system functions, as shown in *Fig. 2*. The Power Sourcing Equipment (PSE) consists of a 48-Vdc (nominal) power supply with control circuitry that sends 48 Vdc over existing Ethernet cables to the remote PD. The PD employs a controller that accepts this nominal 48 Vdc (minus a voltage loss due to cable and connector resistance) and Ethernet input data. Upon initial connection of the Ethernet cable to the PD, the PSE and PD go through an IEEE-defined signaling exchange that must be success-

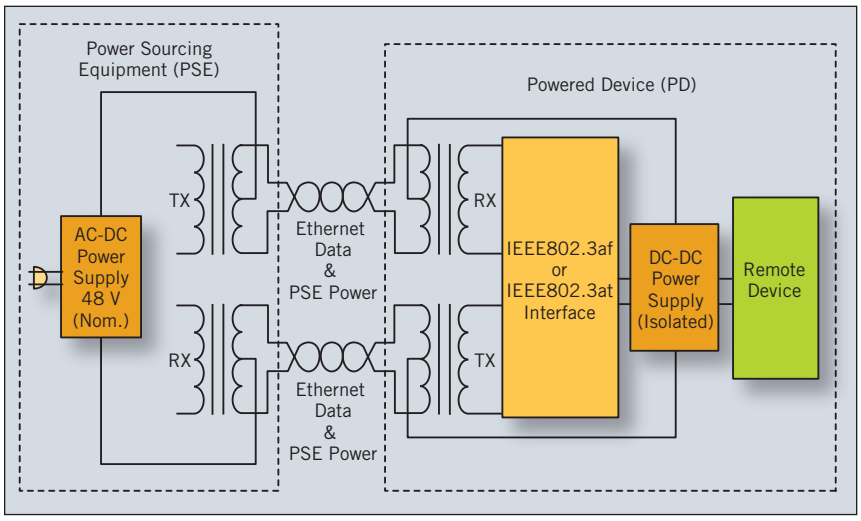

Fig. 2. According to the IEEE 802.3af and IEEE 802.3at standards, the remote PD receives power from the PSE (minus the cable loss), while using existing Ethernet cabling for data transmission.

fully completed by both ends before the PD can supply power to the rest of the client platform and processing of Ethernet packet data can begin.

PoE has several advantages:

- It simplifies system installation because it uses existing data cable lines.
- The powered device can be easily relocated to another Ethernet system.
- Elimination of the ac power source provides a safer installation.
- Powered devices can be shut down or reset remotely.
- Evolving applications for PoE drove development of the new IEEE802.3at Standard for 25-W power delivery, compared with l3 W defined in the original IEEE802.3af Standard introduced in 2003.

A NEWER WAY

Now that we have described the basics of PoE, we can fill in the details of the AS18x4 IC family. *Fig. 3* shows a block diagram of the AS1834, a member of the AS18x4 family of PD controllers. The IC includes an internal isolation barrier that also allows the transfer of management and control information between the primary and secondary sides of the chip.

Users can implement four different voltage outputs on the AS18x4, each configured per the system/application voltage and power requirements. The fourth voltage output (Vout_4) may be configured as either a buck or boost converter, allowing source voltages higher than the primary voltage (Vout_1).

Power-supply design features of the AS18x4 include:

- Integrated (low external-component count) capabilities for power-efficient topologies, such as isolated synchronous flyback and forward converters.
- Improved power-supply efficiency (light load to full load) by minimizing switching losses with digital control of timing edges.
- Automatic adaptation to a broad range of external components in the primary power-control loop, leading to reduction in design times and improved design portability.
- Replacing traditionally slow analog-feedback loops employing unreliable optocouplers with fast, isolated, digital-feedback designs.
- Digital speed for fast power-transient response to deal with modern "green" designs that demand fast turn-on and turn-off of power supplies based on application needs.

The number of required voltage sources in a PoE-PD platform is similar to many embedded microprocessor-based

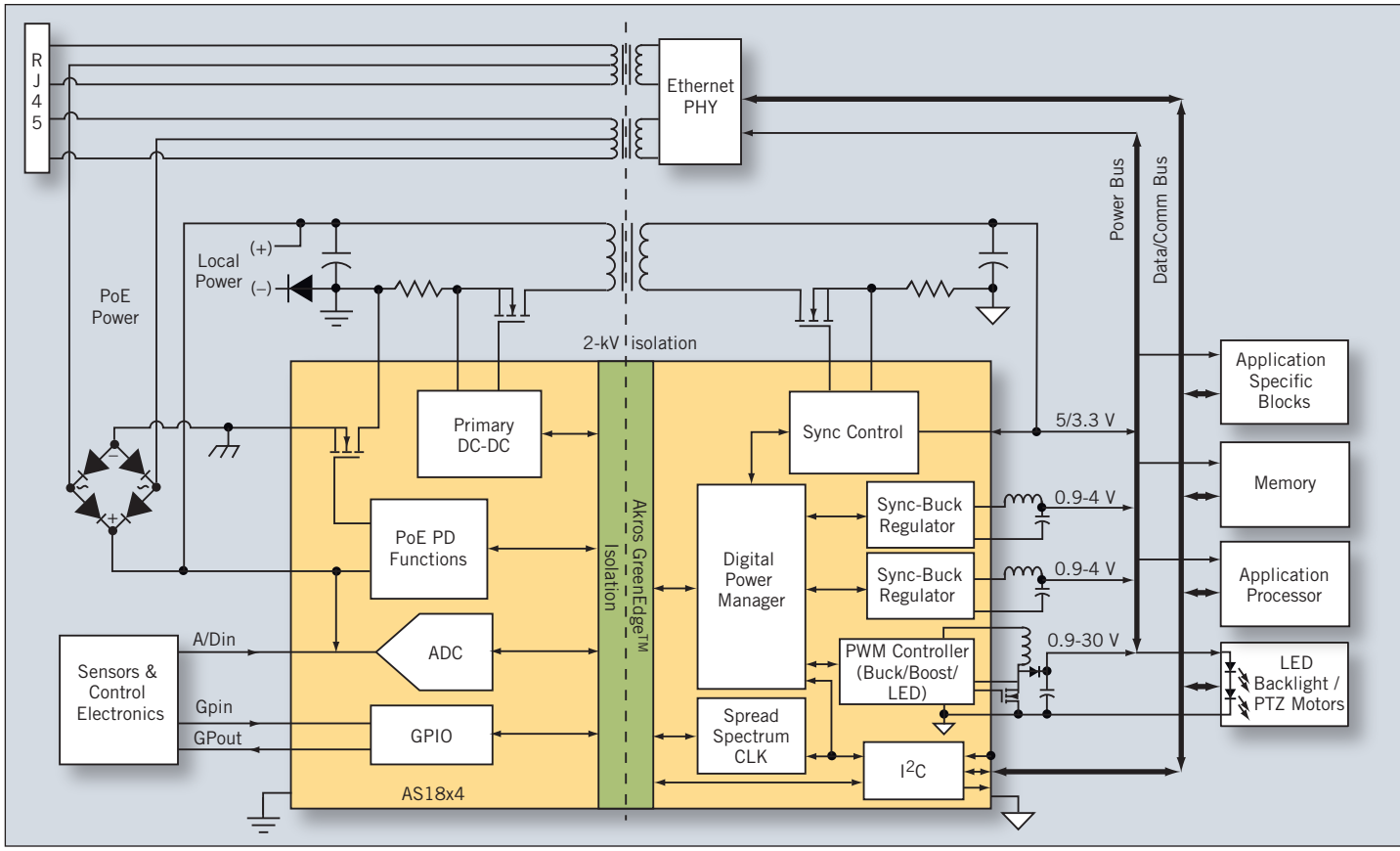

Fig. 3. The Akros AS1834 includes an internal isolation barrier that enables high-speed data transfer between its primary and secondary sides, which provides PD power management.

platforms that include a processor, DRAM/SRAM, Flash memory and I/O, each with different voltage and power requirements. For a VoIP phone, there is often a display that may demand a unique voltage, whereas a pan-tilt-zoom (PTZ) camera will have multiple motors as well as low-voltage electronic power needs. Typical numbers for PD platforms are up to four unique voltages. By integrating four flexible dc-dc outputs in one power SoC, including digital isolation, the AS18x4 product family simplifies PoE PD system design while delivering benefits of power-system efficiency and intelligent management.

FAMILY MEMBERS

Members of the AS18x4 family are listed in the *Table*. The AS1824 and AS1844 have hardware (pin-controlled) functions, whereas system CPU software control is also included in AS1834 and AS1854 functionality via an integrated I^2C interface. Software control provides seamless bidirectional digital communication across the 2,000-V isolation barrier to enable monitoring and control of the high-voltage primary from a secondary-side interface, such as a CPU bus and GPIO interfaces. This also enables the system microprocessor to monitor the health of each PD in the network.

REMOTE POWER MANAGEMENT

In the enterprise, VoIP phones don't need the typical 6.5 or 13 W allocated to them under IEEE802.3af. They can be reduced to a much lower standby power and quickly ramp up to their active power level upon the initiation of a call or other wake-up event. For example, a PSE supporting 50 VoIP phones does not have to support simultaneous full power usage of all 50 phones. If the PSE can reallocate the power to any port that needs it, it can reduce the power supply by two to four times, depending on statistical usage pattern of the VoIP phones in that environment.

Similarly, IP cameras working in low light, generating high-definition IP video streams of a rapidly-moving object might only require its maximum 25-W allocation during a midnight alarm condition, likely when the VoIP phone usage is minimal. So power from VoIP ports can be reallocated to the IP camera ports at night time.

An example of a new platform feature enabled by the AS18x4 family is intelligent allocation and energy management through the use of its on-chip isolated a/d converter (ADC), which can provide live monitoring of the network. The PoE voltage monitored by the ADC can be communicated to the Ethernet switch network manager to determine actual cable loss, which then can remotely manage the PSE to change its PD power allocation based on the measured PD power consumption and cable loss. This also allows the PSE power supply to operate near peak efficiency. This dynamic allocation also allows all ports to continually obtain their required power.

AS18x4 FAMILY OF PoE PD CONTROLLERS

PART NUMBER	TYPE 1 PD	TYPE 2 PD	H/W MODE	S/W MODE	POWER IN (W)
AS1824	X		X		13
AS1834	X		X	X	13
AS1844	X	X	X		13/25
AS1854	X	X	X	X	13/25

The ADC can also operate with environmental sensors. For example, if the light level at a remote device is too low, the AS18x4 can change the dimming adjustment on the PD's LCD display panel. The high frequency PWM circuit of the on-chip LED driver enables this dimming capability.

EMC MANAGEMENT

In a PoE platform, any common-mode noise can spread into the Ethernet's twisted-pair cable, which shows up as conducted or radiated emissions. Therefore, controlling the behavior of the PD's dc-dc converters is critical to the managing EMI.

A robust EMI solution involves both the primary- and secondary-side dc-dc converters, ideally with deterministic clock-management and power-design techniques. This maximizes the ability of the PD platform to attain the proper spectral power margin for any FCC test. Another key requirement for PoE systems is immunity to overvoltage and surge events by inductive coupling of lightning that can cause power-line surge voltages.

EMC management design features of the AS18x4 include:

- Integrated primary-side dc-dc converters with reduced EM emission for FCC Class B-compliant applications.
- Managed capabilities for primary and secondary system-level clocking using the on-chip spread-spectrum-circuit's randomization and external synchronization capabilities.
- Multi-phase switched-PWM clocking for secondary buck-converter noise reduction.
- Integrated designs that provide very fast low-impedance paths for surge events, enabling superior system-level surge protection.
- Pre-tested solutions that meet IEC 61000-4-2/3/4/5/6, IEC 60950, and FCC requirements for surge EMC compliance.

The capabilities of this IC family represent a step forward as PoE applications continue to grow and expand into enterprise areas beyond its present commercial and industrial base. As always, market forces are driving the need to provide more features, often in a smaller footprint, and sometimes at a lower cost. To this end, the AS18x4 family is said to offer up to a 75% reduction in power system board area, as well as more than a 25% reduction in the power system's bill of materials (BOM), leading the way for the next-generation of cost-effective and intelligent PoE appliance designs.