SAM DAVIS, Editor-in-Chief, PET

IC Duo Produces Power Source Equipment Controller for 12 Isolated PoE Ports

Power over Ethernet (PoE) systems employ a Power Source Equipment (PSE) controller that sends power and data to a Powered Device (PD). A pair of ICs combine to produce a 12-port PSE controller that creates an isolated environment consistent with PoE specifications.

THE LTC4270 and LTC4271 from Linear Technology form an isolated 12-port Power Source Equipment (PSE) controller for use in Power over Ethernet (PoE) systems. The 12 independent PSE ports send power and data to the Powered Device (PD). In contrast with traditional approaches, it is a simpler, lower component count design, reducing board space and lowering system costs.

As shown in *Fig. 1*, The LTC4271 provides a digital interface to the PSE host, while the LTC4270 provides the high voltage isolated Ethernet interface; the two ICs are then bridged by inexpensive Ethernet transformers. Power for the LTC4271 is obtained from a ground-referenced 3.3V supply, allowing a direct interface with an I^2C data connection. In contrast, the traditional approach has been to use a "floating" 48V (nominal) with no ground reference, which requires six opto-couplers to support the I^2C interface. This transformer-isolated communication protocol and proprietary isolation scheme yields a more robust design than traditional approaches.

The output of each port operates like the traditional PoE system (For information on Power over Ethernet, see the sidebar, "Up-To-Date Power Over Ethernet). As shown in *Fig. 1*, there are center-tapped Ethernet transformers on the send and receiving end of the cable that carries both the data and power for the DC-DC converter that supplies power to the PD. Each port configuration is similar. This duplicates the traditional approach for one port, but the two-chip PSE can power 12-ports and can deliver/manage up to 90W on each port.

This two-chip configuration implements an IEEE 802.3at compliant PSE design, requiring only an external power

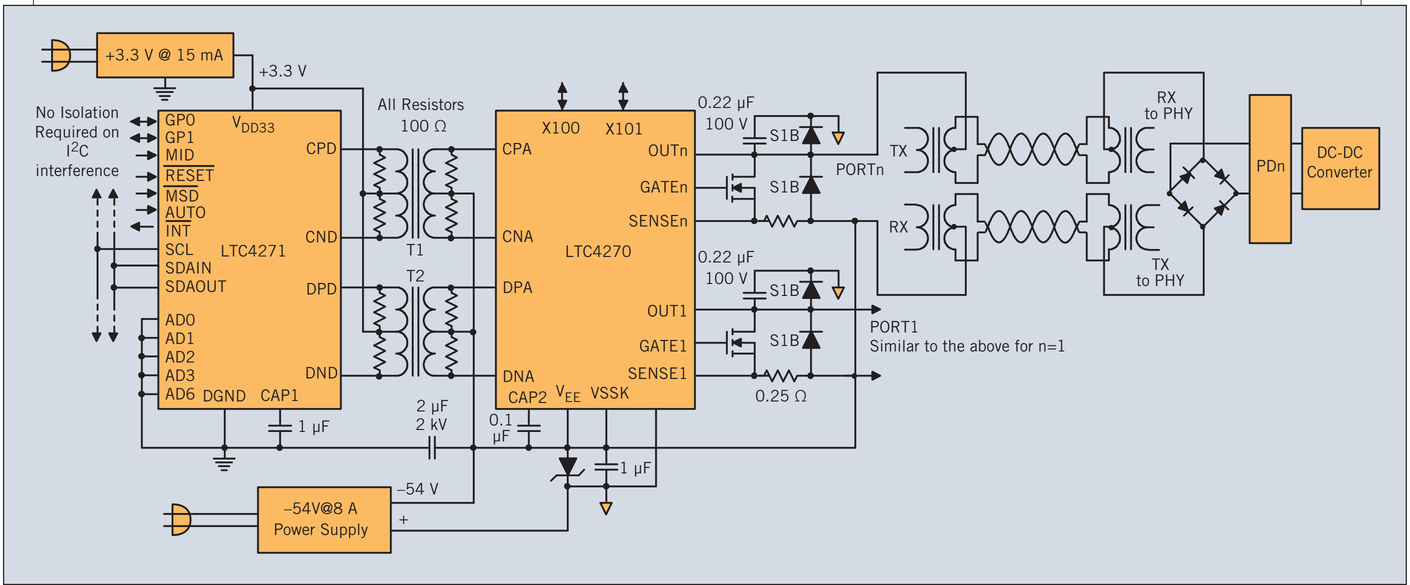


Fig. 1. PSE configuration using the LTC4270 and LTC4271 produces 12 isolated ports for powering PDs. Each of the 12 ports outputs data and power to the associated PD, which are transformer-coupled similar to that for PORTn, and n=1 to 12.

MOSFET, diodes and sense resistor per port. Its 80V-rated port outputs dissipate less power than PSEs with on-chip MOSFETs that have higher on-resistance (and higher power dissipation). When using external MOSFETs and a single port fails, the others' ports will continue to function, which increases system reliability.

Advanced power management includes prioritized fast shutdown of preselected ports, bit per-port voltage and current readback, 8-bit DAC-programmable current limits and 7-bit programmable overload current limits. Its 1 MHz I^2C interface allows a host controller to digitally configure the PSE or query port readings. Other features include 12-bit current monitoring ADCs per-port and field-upgradeable firmware. "C" libraries are available to reduce engineering costs and improve time-to-market.

HIGHER GRADES

All grades of the LTC4270/LTC4271 family offer advanced fourth generation PSE features, including per-port current monitoring, global temperature and V_{EE} monitoring, port current policing, one second current averaging and four general purpose input/output pins.

Three grades support the range of power levels:

- A-grade LTC4270/LTC4271 chipset extends PoE power delivery capabilities to LTPoE++™ levels, a proprietary specification allowing delivery of up to 90W for LTPoE++ compliant PDs. The A-grade chipset also incorporates all B- and C-grade features.
- The B-grade LTC4270/LTC4271 is a fully IEEE-compliant Type 2 PSE supporting autonomous detection, classification and powering of Type 1 and Type 2 PDs. The B-grade chipset also incorporates all C-grade

UP-TO-DATE POWER OVER ETHERNET (POE)

THE IEEE'S POE STANDARD states that all data terminal equipment (DTE) may receive power over existing cabling used for Ethernet data transmission. The Standard defines the requirements associated with providing and receiving power over the existing cabling.

According to the Standard, a device that provides power to the network is known as a PSE, or power sourcing equipment, whereas a device that draws power from the network is a PD, or powered device. Most PDs require both data connectivity and a power supply. The Standard defines the interface between the PSE and PD as it relates to controlled operation.

Using the existing cabling to supply power to the PD eliminates the need for an ac adapter or other ac-supplied power for the PD.

Among the reasons for going to PoE:

- Only one set of wires is required per PD, which simplifies installation.
- You can easily move appliances to wherever you can lay a LAN cable.
- There are no ac utility voltages required anywhere near the PD, which can greatly reduce cost and improve safety.
- Appliances can be shut down or reset remotely, so there is no need for a reset button or power switch.

The original PoE spec, known as 802.3af, allowed power loads up to 13W. It was not adequate for some requirements, so the IEEE released a new standard, known as 802.3at or PoE+, increasing the voltage and current requirements to provide up to 25W.

PSEs come in two types: Endpoints (typically network switches or routers), which provide data and power; and Midspans, which provide power but pass through data. Midspans are typically used to add PoE capability to existing non-PoE networks. PDs are typically IP phones, wireless access points, security cameras, and similar devices.

Common Ethernet data connections consist of two or four twisted pairs of copper wire (CAT-5 cable), transformer-coupled at each end to avoid ground loops. Fig. 2 shows a typical PoE installation that uses the data cable pairs and isolation transformers. Because Ethernet pairs are transformer-coupled at each end, you can apply DC power to the center tap of the isolation transformer without upsetting the data transfer. The center-tap of the transformers associated with the PD provides a DC output to power the associated DC-DC converter.

To avoid damaging legacy data equipment that does not expect to see DC voltage, the PoE spec defines a protocol that determines when the PSE may apply and remove power. Valid PDs are required to have a specific 25kΩ common mode resistance at their input. When such a PD is connected to the cable, the PSE detects this signature resistance and turns on the power. When the PD is later disconnected, the PSE senses the open circuit and turns power off. The PSE also turns off power in the event of a current fault or short circuit.

After detecting a PD the PSE optionally looks for a classification signature that tells the PSE the maximum power the PD will draw. The PSE can use this information to allocate power among several ports, to police the current consumption of the PD, or to reject a PD that will draw more power than the PSE can supply. The classification step is optional; if a PSE chooses not to classify a PD, it must assume that the PD is a 13W (full 802.3af power) device.

features.

- The C-grade chipset is a fully autonomous 802.3af Type 1 PSE solution. The C-grade chipset autonomously supports detection, classification and powering of Type 1 PDs. As a Type 1 PSE, two event classification is prohibited and Class 4 PDs are automatically treated as Class 0 PDs.

The higher levels of LTPoE++ delivery impose additional layout and component selection constraints. The higher current can cause a higher voltage drop in the cable, so a higher minimum PSE output voltage must be used. And, the higher current means the cable environment must specified to avoid cable temperatures in excess of 75°C. This can be accomplished by reducing the standard IEEE cable bundle size (100 cables per bundle) to a smaller size.

With the LTC4271's AUTO pin set high, settings of the LTC4270's XI01 and XI00 pins determine the maximum deliverable power. PDs requesting more than the available power limits are not powered.

CURRENT LIMITS

The LTC4270/LTC4271 ports include two current limiting thresholds (I_{CUT} and I_{LIM}), each with a corresponding timer. Setting the I_{CUT} and I_{LIM} thresholds depends on several factors: the class of the PD, the voltage of the main supply (V_{EE}), the type of PSE (Type 1 or Type 2), the sense resistor (0.5Ω or 0.25Ω), the SOA (safe operating area) of the MOSFET, and whether or not the system is required to enforce class current levels.

The I_{LIM} current limiting circuit is always enabled and actively limits port current. I_{CUT} is typically set to a lower value than I_{LIM} to allow the port to tolerate minor faults with-

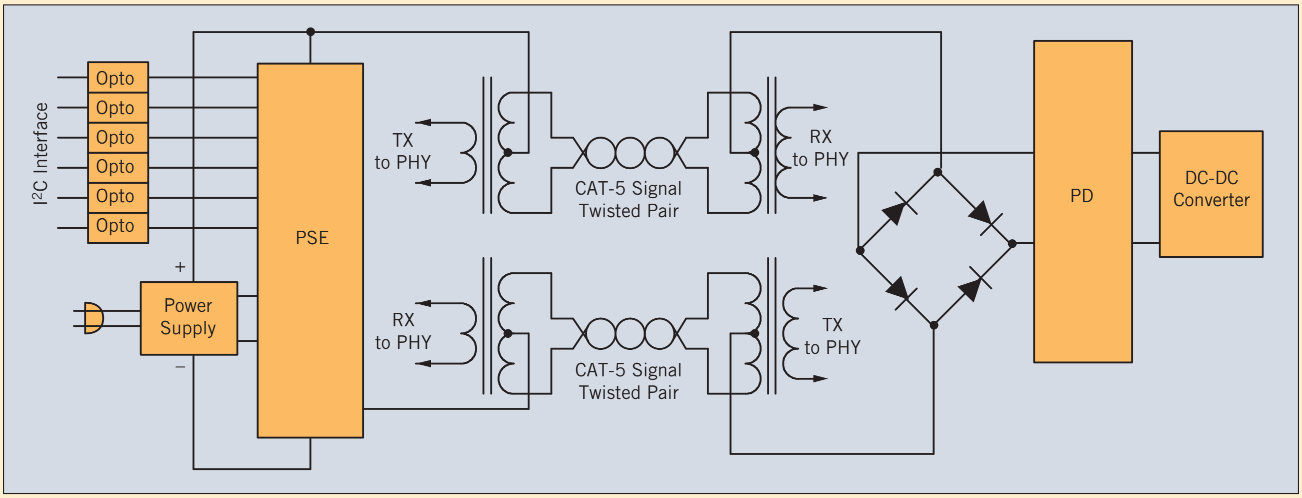


Fig. 2. The traditional approach to Power over Ethernet was to employ the existing data cables to also provide power (nominal 48V) to a dc-dc converter that supplies power for the PD. This requires opto-couplers for the I²C data interface.

802.3AT

The newer 802.3at standard supersedes 802.3af and brings several new features:

- A PD may draw as much as 25.5W. Such PDs (and the PSEs that support them) are known as Type 2. Older 13W 802.3af equipment is classified as Type 1. Type 1 PDs work with all PSEs; Type 2 PDs may require Type 2 PSEs to work properly.
- The Classification protocol is expanded to allow Type 2 PSEs to detect Type 2 PDs, and allow Type 2 PDs to determine if they are connected to a Type 2 PSE. Two versions of the new Classification protocol are available.
- Fault protection current levels and timing are adjusted to reduce peak power in the MOSFET during a fault; this allows the new 25.5W levels to be reached using the same MOSFETs as older 13W designs.

Even during the process of creating the IEEE PoE+ 25.5W specification, it became clear that there was a significant and increasing need for more than 25.5W of delivered power. This led to the LTPoE++ specification provides reliable detection and classification extensions to the existing IEEE PoE protocols that are backward compatible and interoperable with existing Type 1 and Type 2 PDs. LTPoE++ provides mutual identification between the PSE and PD.

out current limiting.

Per the IEEE specification, the LTC4270/LTC4271 allow the port current to exceed I_{CUT} for a limited period of time before removing power from the port, whereas it will actively control the MOSFET gate drive to keep the port current below I_{LIM}. In addition, the chipset automatically sets I_{LIM} to 425mA during inrush at port turn-on, and then switches to the programmed I_{LIM} setting after the inrush. To maintain IEEE compliance, I_{LIM} should be kept at 425mA for all Type 1 PDs, and 850mA if a Type 2 PD is detected. I_{LIM} is automatically reset to 425mA when a port turns off.

OPERATING MODES

The user can set each of the LTC4270/LTC4271's 12 independent ports to operate in one of four modes:

In manual mode, the port waits for instructions from the host system before taking any action. It runs a single detection or classification cycle when commanded to by the host, and reports the result in its Port Status register. The host system can command the port to turn on or off the power at any time. This mode is available for hardware and system design verification and integration. It is not recommended for use in normal operation.

In semi-auto mode, the port repeatedly attempts to detect and classify any PD attached to it. It reports the status of these attempts back to the host, and waits for a command from the host before turning on power to the port. The host must enable detection (and optionally classification) for the port before detection starts.

AUTO pin mode operates the same as semi-auto mode except it automatically turns on the power to the port if detection is successful. AUTO pin mode autonomously sets the I_{CUT} and I_{LIM} values based on the class result. This operational mode is only valid if the AUTO pin is high.

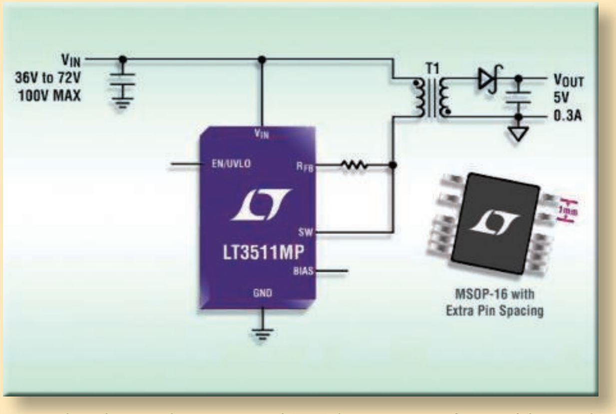
In shutdown mode, the port is disabled and will not detect or power a PD.

Regardless of operating mode, the LTC4270/LTC4271 will remove power automatically from any port that generates a current limit fault. It also automatically removes power from any port that generates a disconnect event, if disconnect detection is enabled. The host controller may also command the port to remove power at any time.

NEWproducts

No-Opto 100V Isolated Monolithic Flyback Regulator

LINEAR TECHNOLOGY Corporation announces a new high reliability (MP-grade) version of the LT3511, a high voltage isolated monolithic flyback regulator that operates over a -55°C to 150°C junction temperature range. This device simplifies the design of an isolated DC/DC converter since it needs no optocoupler, third winding or signal transformer for feedback, as the device's output voltage is sensed from the primary-side flyback signal. The LT3511 operates over a 4.5V to 100V input voltage range, has a 240mA, 150V onboard power switch and delivers up to 2.5 watts, making it well suited for a wide variety of telecom, datacom, automotive, industrial and medical applications.



The LT3511 operates in a boundary mode, a current-mode control switching scheme, resulting in +/-5% typical regulation over the full line, load and temperature range. Boundary mode, also known as critical conduction mode (CrCM), permits the use of a smaller transformer compared to equivalent continuous conduction mode designs. The output voltage is easily set by two external resistors and the transformer turns ratio. Several transformers identified in the data sheet can be used for numerous applications. Additional features include an onboard low dropout regulator for IC power, undervoltage lockout and output voltage temperature compensation. The high level of integration results in a simple, clean, tightly regulated solution for isolated power delivery.

The LT3511MPMS is available in a small MSOP-16 package with 4 pins removed for additional high voltage pin spacing. Pricing starts at $8.95 each in 1000-piece quantities.

Linear Technology
Milpitas, CA
http://www.linear.com