

TYCO ELECTRONICS eDIGEST

A series of technology briefs spanning Tyco Electronics' product portfolio

Connectors: Addressing Interconnect Design Challenges in Power over Ethernet Applications

A new version of an integrated RJ45 connector with power magnetics allows for easier migration to Power over Ethernet (PoE). The new design provides customers with the flexibility to incorporate a multi-port connector onto their board that integrates the IEEE 802.3af PoE silicon controller. The integrated connector was designed from the ground up to meet the changing industry, customer and regulatory requirements enabled by the IEEE 802.3af and mandated by the reduction of hazardous substances (RoHS).

There are a number of reasons why the traditional modular jack (RJ45) has been revisited. Some of these reasons will be clear to most designers, but some are either new or only obvious to those involved with leading-edge hardware designs.

One of the first drivers for design efforts was the ratification of the IEEE 802.3af PoE specification in June of 2003. This clears the way for standardization of product detection and power delivery for up to 13W/port on existing Ethernet connections. For fast Ethernet systems (10/100Mbps), the power can be supplied either on the two unused pairs of a four pair cable, or on the two data pairs by utilizing specially designed magnetics. For gigabit Ethernet systems, data is usually supplied on pairs 1 and 2.

For existing systems or new systems that do not have sufficient space, power, or cooling capacity, a mid-span supply (MSE) can be utilized. Mid-span power introduction brings about special signal integrity issues that will be discussed later in this article. This approach, however, has been proven to be quite successful for fast Ethernet systems.

New LAN switch designs incorporate additional features to provide PoE functionality inherently without the need for a mid-span solution. Next generation switches are focusing on higher port density – 24 to 48 ports per switch is common –

The Signal Integrity Problem:

Since RJ45s with isolation magnetics are used only at the sourcing and receiving end of a system, they have been considered part of a device, and have been allowed to have relaxed electrical requirements. Though all components between these devices are controlled by the more stringent requirements of EIA568/Category 5E requirements, the magnetics assemblies have not. As customers migrate to Gigabit Ethernet, the poor crosstalk performance has made it difficult to design robust systems, and virtually impossible to implement a mid-span POE solution. It is for these reasons that the performance of RJ45s with integrated magnetics must be improved.

and faster transmission speeds. Currently available methods to include the PoE functionality in these switches are discrete solutions or PoE DIMM boards. The key component in these two options is the silicon power management controller.

Today, various silicon suppliers are offering products for both the power sourcing function (PSE) or powered device (PD) products. These include, but are not limited to Linear Technology, Maxim, PowerDSine and Texas Instruments.

Tyco Electronics provides a product that incorporates various features for a flexible, high performance product. The goal was to provide a product to meet the emerging requirements of power delivery, while exceeding existing electrical performance attributes.



The first decision was to eliminate the existing soldered footprint and switch to a press-fit product. This eliminates costly wave soldering, and provides an easier migration to the European RoHS requirements for July 2006. The second was to provide the press-fit connector with a footprint that allows for easy migration between a magnetics only system, a PoE Enabled System (PoE devices separated from RJ45), and a PoE

Integrated system (PoE devices integrated into RJ45 assembly). This combination frees the designer to create one board for a traditional system or one that incorporates power delivery.

Once these decisions were made, the difficult part of effective packaging became the leading challenge. The goal was to provide a part that combined reduced crosstalk, magnetics suitable for the higher current needs of PoE, LEDs, a high level of EMI containment, while still fitting into existing sheet metal designs. To accomplish this, a variety of unique features have been incorporated into the design.

The first area of packaging was to implement a modular magnetics/RJ45 package that would outperform existing product, while providing the ability to use different core configurations for different applications. Existing magnetics/RJ45 assemblies typically have significantly higher crosstalk than standalone RJ45 jacks for Category5E applications. Most suppliers quote values that are in the range of 11dB or more above allowable Cat5E limits. As more designers migrate toward 1000BaseT products, this level of performance is becoming harder to achieve. By combining extensive computer modeling and a unique magnetics assembly, it was possible to improve the crosstalk performance by a minimum of 6dB and in some cases, as much as 12dB. This provides a product that more closely performs like other components in a typical channel, thereby simplifying the job of the designer.

Improved performance is certainly a desirable feature of a product, but if the assembly cannot be integrated into a system and successfully pass EMI testing, the product is of no

use. It is exactly for this reason that Tyco Electronics designed the SFP and XFP family of products and used them in the shielding design. The design objective was to improve

What do the magnetics do?

The magnetics perform a variety of necessary functions. The first is to provide the necessary DC isolation mandated by IEEE802.3 and IEC60950. The second is to provide common mode EMI suppression, and the third is to allow introduction of DC power for PoE applications.

EMI performance by a minimum of 6dB over currently acceptable product. This goal is even a greater challenge as systems utilize multiple-gigabit backplanes and serial uplinks. It is quite common to mix 1 and 10Gbps serial I/O links on a product that has up to 48 RJ45 ports. Additionally, many of the gigabit physical layers

(PHYs) have 125Mhz clock signals. This and other high-speed noise sources within a system can provide a considerable challenge to pass EMI testing.

The new Tyco Electronics Mag 45 PoE connector utilizes a variety of carefully designed and connected internal and external shields to provide the backbone of the EMI performance. When combined with the improved electrical performance of the connector and the magnetics assemblies it provides the necessary EMI improvement. To confirm the performance, Tyco Electronics has designed and built a reference board with a gigabit PHY to compare existing and new product performance. Testing has shown the desired product improvement, and customer results have supported this.

Obviously, the first question is ‘why add PoE into the mod jack?’ The main reason why adding PoE capability to the mod jack makes sense is the ability to use the Auto Mode of the jack so that once it is placed on the board, it is allowed to run by itself. This results in a significant reduction in board level components, simplification of the bill of materials, and frees up valuable board space. For those who wish to have additional control, but still have the part reduction and board benefits, the product can be controlled in the Enhanced Mode. Enhanced Mode control allows control over power delivered, prioritization of ports, remote diagnostics, and compatibility with non-802.3af standard products.

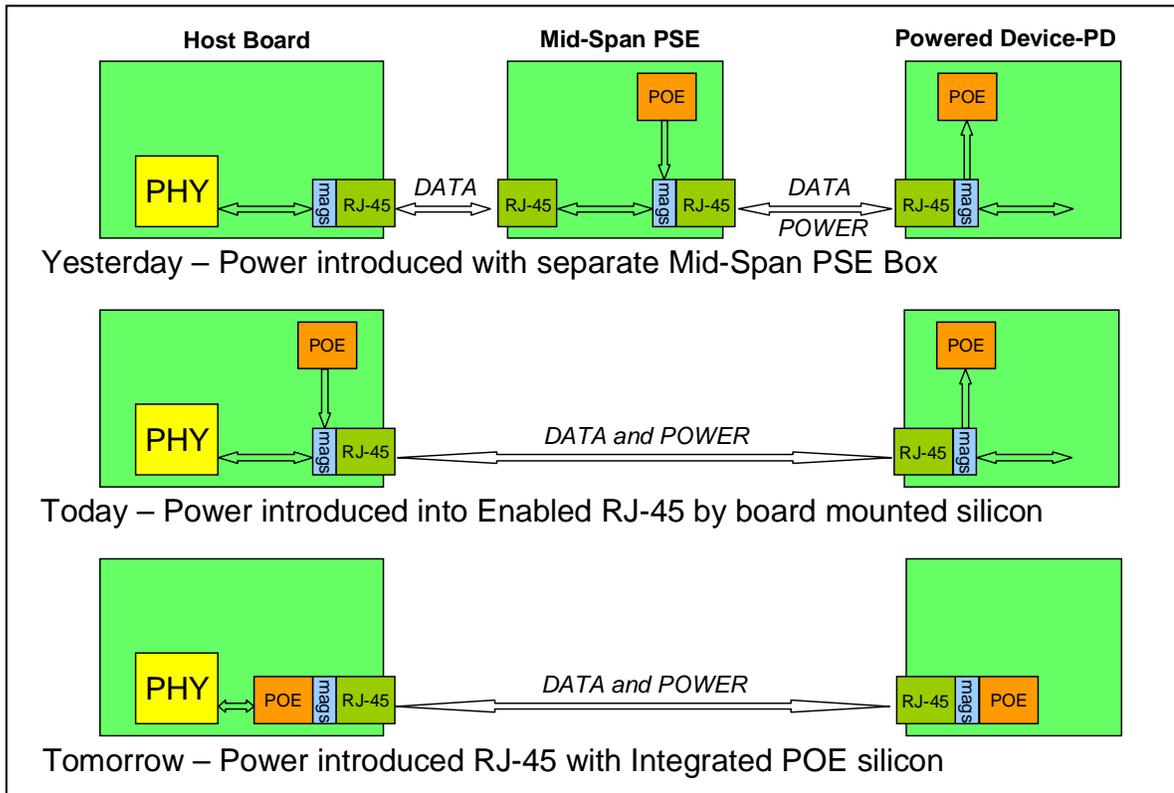
For those who want PoE, but do not wish to have it integrated, the ability to provide an ‘Enabled’ solution is key. To provide this, it is necessary to bring the two PoE leads from the magnetics center taps of each RJ45 to the host board. The pins on the integrated assembly that are used for communication and power can now be used for the center tap-to-host board attachment. This allows for signal, Virtual Device Driver, and LED lines to remain identical for each of the three design options.

A number of difficulties arise when attempting to integrate the PoE silicon into the stacked RJ45 form factor. The first is space. Since there are a number of components that must be placed in close proximity to power sourcing silicon, the component density is very high. The second is providing necessary isolation, and the third is to provide a way to exhaust heat generated by the silicon and associated sensing diodes and resistors.

If it is decided to use a fully integrated solution, sufficient airflow is required to help assure that the system is cool enough to allow full power delivery. For a fully populated, 48 port system, testing has determined that a laminar airflow of 200 LFM is required so

that the product functions acceptably. Thermal registers integrated within the assembly provide feedback in fully configured systems communicating the potential need for power limitation or port shutdown.

A number of major suppliers are either already supplying PoE capable LAN switch products, or plan to supply PoE capable products in the near future. To support this need, Tyco Electronics provides products for 10/100 and 10/100/1000 applications in a magnetics only, PoE enabled, and fully integrated systems.



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