Transmit power safely with PoE tech

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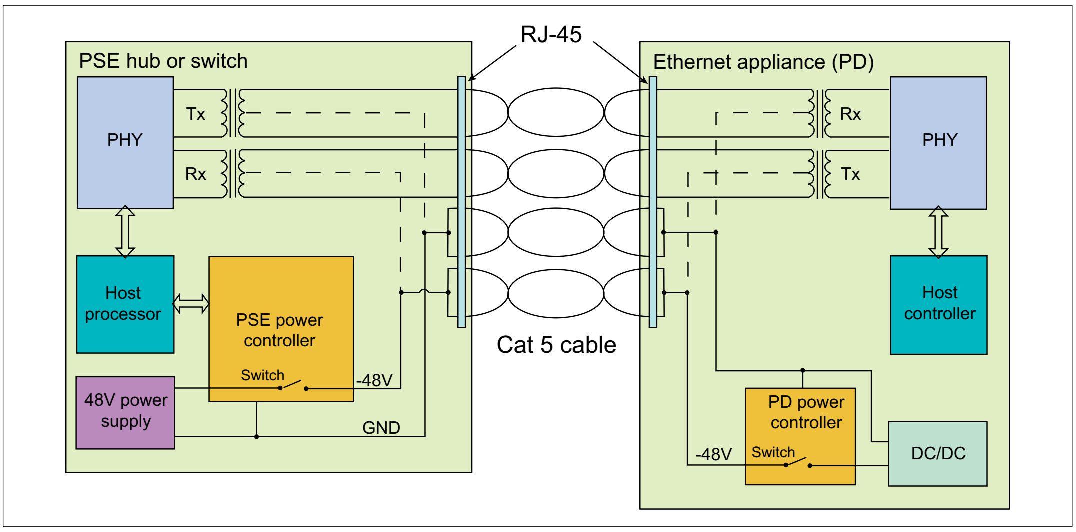

Figure 2: A simple one-port PoE system comprises a PSE, which is a hub or a switch shown on the left-hand side, and the PD, which is on the right side and the end application side.

PoE is a technology of transferring power and data using a LAN cable. It allows safe and reliable power transmission—15W with 48V—for telecom applications over existing Cat5, Cat5e and Cat6 cables. For example, it can be used to power IP phones, WLAN access points, network cameras and various other network terminals in the allowed power range of 13W, as measured by the powered device side. PoE is also known as power-over-LAN and is based on the IEEE 802.3af standard.

More PoE equipment continues to emerge due to the ease-of-use of existing standard Cat5 cable infrastructures. Hence, no modification or tampering with existing Ethernet infrastructures is needed.

The PoE technology has many benefits. For example, only one set of wires is brought to your appliances, thus simplifying installation and saving space. It also allows continued service during power outage by using the same centralized UPS that backs up the network.

There is also no need to pay an expensive electrician or to delay installation to meet the electrician's schedule, thus saving time and money. Furthermore, the appliance can be easily moved to wherever you can lay a LAN cable. Since there are no mains voltages present anywhere, it's safe. Using a UPS can guarantee power to their clients during mains-power failures.

The Simple Network Management Protocol infrastructure can be used to monitor and control the appliance, and the data transfer to and from the appliance. Hence, the appliances can be managed, shut down or reset remotely in a centralized manner.

802.3af standard

Modern Ethernet networks and traditional telephone systems have much in common. Both typically send data or voice over an unshielded twisted pair cable, usually using a form of star network. The difference between the two is that traditional phones are powered from the same wire as the data or the voice wires. Meanwhile, Ethernet devices require a local power source.

The 802.3af standard has changed all this by allowing the central switch to provide 48V DC of up to 13W through the RJ-45 connector. This standard addresses all of the issues in supplying power to devices via Ethernet cabling.

Simply put, the standard defines the functional and electrical characteristics of two optional power entities: the power device (PD) and the power sourcing equipment (PSE). This is to be used for the PHY layers defined in the standard. The standard is about how these devices or entities can supply and draw power using the same generic cabling, as used for data transmission.

The data terminal equipment powering is intended to provide a 10Base-T, 100Base-TX or 1,000Base-T device with a single interface to both the data it requires and the power to process these data.

Earlier PoE implementations will not conflict with 802.3af, and the available power levels are expected to address future applications. We are already seeing discussion on 30W power transmission.

To meet the 802.3af standard, the PSE output voltage needs to

Figure 1a: Shown is an endpoint PoE implementation, with the end application hooked up to the switch.

Figure 1b: Shown is the mid-span implementation of PoE, wherein the power is inserted to the network.

be 44-57V; the maximum output current in normal mode is 350mA; and the continuous output power is around 15.4W.

For the PD end, which is the client, the input voltage through your PD needs to be 37-57V. The average input power is 12.95W, and the input inrush current is 400mA. The following are the other specifications:

- PSE output voltage: 44-57V;
- PSE maximum output current in normal mode: 350mA;
- PSE continuous output power: 15.4W;
- PD input voltage: 37-57V;
- PD input average power: 12.95W;
- PD input inrush current: 400mA.

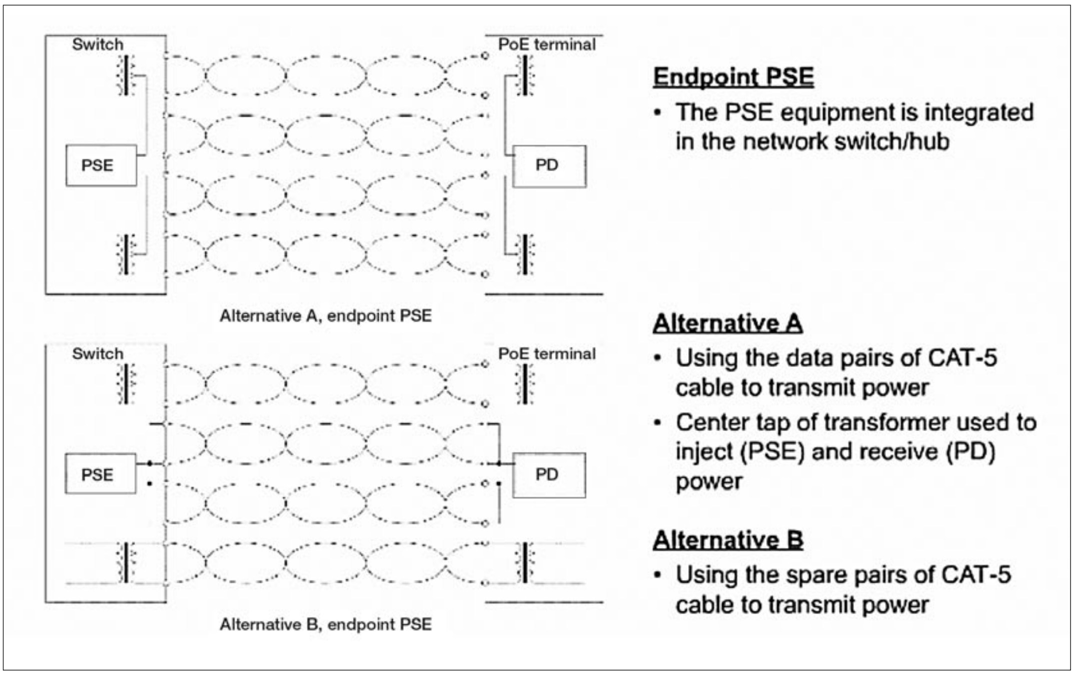

Figure 3: The alternative A architecture uses the actual data pairs of Cat5 LAN cable to transmit power. Meanwhile, the alternative B option makes use of spare wires, with designers transmitting power on a spare pair.

Alternative architectures

Two particular implementations are defined. One is the endpoint, which is applicable to a PoE-enabled switch (**Figure 1a**). Note that the end application is hooked up to your switch, and it derives power from the switch.

The other application or implementation is called the mid span (**Figure 1b**). Designers or users can appreciate that in between the switch and their end application, there is a port for the mid span. This is where power is inserted to their network. In turn, the powered devices that are hooked up to this mid span will get its power from it.

To illustrate how a PoE system works, consider the block diagram of a simple one-port PoE system (**Figure 2**). It comprises a PSE, which is a hub or a switch shown on the left-hand side, and the PD, which is on the right side and the end application side. The PD side would typically drive applications such as IP phones or Web cameras. From the left, the PSE provides power via data lines or spare lines that would go through the Cat5 cable and then to the Ethernet appliance side (PD). Designers would extract this power (through a center tap transformer, if data lines are used) before feeding this through the PD, such as the Freescale MCZ34670.

Figure 3 shows the two options for endpoint PSE application. The alternative A architecture uses the actual data pairs of Cat5 LAN cable to transmit power. The power is, in fact, superimposed on the data pairs. In 802.3af, powering is implemented using the secondary winding center taps of the transmitter and receiver transformers at each end of the link. Meanwhile, the alternative B option makes use of spare wires, with designers transmitting power on a spare pair.

In summary, there are two options for inserting or extracting power. One is the use of a data pair, where you superimpose power on top of the data. The second is the use of spare pairs to transmit power.

The mid-span configuration is very useful because it allows power supply to be external to the Ethernet. Moreover, it provides data and power on the twisted pair linked segment without burdening each port with the Ethernet equipment when you need to provide power. Thus, this allows the addition of PoE to your older systems without replacing switches or hubs.

The current specification only allows power in two of the four wire pairs in the Cat cable. For the endpoint applications, we considered using the data pair or the spare pair. In the standard for the mid span applications, however, PSEs are restricted to using only the spare pair of the Cat5 wires. Thus, the PD extracts power from the PSE using the spare pair.

PSE, PD operation

Detecting and powering PoE devices require PSE power sourcing to work out, identify or distinguish between a PoE and a non-PoE device. This prevents the use of powering devices that are not PoE-compliant, and do not need or do not want to be sent power. For obvious safety reasons, this also prevents you from blowing up devices that are not PoE-compliant.

For a safe and reliable operation of PoE systems, the 802.3af standard mandates that the PSE determine whether or not to supply power to the PD by applying test voltages. The test voltages are used to determine the load characteristics of the PD. The load characteristics of the PD are called the PD detection signature. The PSE reads the PD detection signature to determine whether to supply power and how much power to supply. If it doesn't see the signature in the device or the client end, it does not deliver power from the network to that particular device.

The important functions of the PSE are to identify the PDs that are enabled to receive power, to provide required power levels and to remove power when the PD is disconnected from the link. The detection mechanism is an extremely important function of the PSE to circumvent the application of power to various devices that can be plugged into the eight-position modular jack.

Signature detection

What makes a valid signature? The detection impedance of the resistor that is attached to the power devices is all that's required for valid detection. The detection impedance requires only one transistor with a value of 23.75-26.25kΩ. We use a resistor called Rsig that is attached to the Rsig pin of our device. It draws current that is close to what is expected of a valid impedance, thus minimizing power consumption. The tolerance for such a resistor is very tight, between 23.75kΩ and 26.25kΩ. You also need to consider the serial resistance of the diode.

To understand the standard's power interface, the power device connected to the Ethernet keyboard goes through a series of steps that must be compliant with the standard. Otherwise, no power will be sent to your PD.

The power-sourcing end provides a voltage of 2-10V. This feeds the PDs, and this voltage range is good enough to detect a valid signature from your resistor (e.g. a nominal 25kΩ). Once this voltage detects the presence of that signature, it increases its power to 15-20V. Here, it measures the particular class of required power. Upon successful signature detection and classification, it ramps up its power for normal operation. Because it's for a telecom application, it's 48V. We have a voltage of 37-57V for normal application.

The MCZ34670 combines a power interface port for IEEE 802.3af PD and a high-performance current-mode switching regulator. It can be used for applications such as wireless access points, Web cameras and IP phones.