Technical Article

Low Power, Big Impact: Low-power Ethernet PHYs for Building Automation

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The use of Ethernet (Institute for Electrical and Electronics Engineers [IEEE] 802.3) in building automation is growing, enabling smart buildings that use enhanced sensor and control networks to manage environmental systems (such as lighting and heating, ventilation and air conditioning), access control, security systems, safety systems and even preventive maintenance monitoring. New construction routinely provisions for building automation networks with dedicated Category 5 Enhanced (Cat5e) cabling, Ethernet switches and routers. Even existing building stock is being retrofitted to accommodate networked sensors and controls.

Retrofitting is challenging for two reasons:

- The need to provide power to locations that were not originally provisioned for power.
- Installation space constraints, as most retrofitted buildings were not originally designed to accommodate sensors and controllers in walls, ceilings and floors.

While many commercial and industrial buildings were originally designed to accommodate the easy reconfiguration of internal spaces, a sensor and controller technology that supports ease of power distribution and offers small form factors makes it more feasible to retrofit these buildings with Ethernet-based automation.

Meet the industry's smallest, lowest-power Ethernet PHY

Learn more about the DP83825I low-power 10-/100-Mbps Ethernet PHY transceiver.

Deploying Ethernet in Building Automation

The use of Ethernet in building automation is growing for several reasons.

First, as a mature networking technology, it offers a well-developed ecosystem of hardware and software that enables engineers to quickly develop solutions that are plug-and-play. It sits at the base of the Open Systems Interconnection model, and thus supports the use of standards-based data communications for aggregation, transmission, exchange, processing and storage.

Second, Ethernet enables the integration of products from different vendors, avoiding proprietary interfaces.

Third, Ethernet offers faster data speeds than most existing point-to-point or bus-oriented communication protocols. This is relevant for three reasons:

- Many sensors operate at low data rates and thus can be serviced by a single controller entity that aggregates their slower data streams into a single high-speed data stream that is dumped onto the network, reducing the number of physical connections needed to bring the data to a centralized management and operations center.
- Faster data speeds mean faster response times to events detected at the sensor end, which is critical for safety-related systems (fire, smoke, carbon dioxide, gas detection, etc.), security and access control.
- Higher data rates have expanded the deployment of certain types of sensors – most notably video cameras for surveillance. IP network cameras (IPNCs) have replaced analog-based closed-circuit television camera technology, which used analog image sensors, along with analog transmission systems that depended on dedicated coaxial cabling. IPNCs generate fully digitized video streams and have built-in network protocol engines that allow their connection to a 100BASE-TX network using Cat5e cables.

Combined Power and Networking

An additional factor that has enabled the broader deployment of IPNCs is the expansion of the IEEE 802.3 standard to include Power over Ethernet (PoE). IEEE 802.3at-2009 and IEEE 802.3bt introduced provisions to the standard that support power transmission over Cat5e. As described in the standards, Alternative A uses the active data pairs to transmit power, while Alternative B makes use of the spare twisted pairs, thereby separating data and power.

Most IPNCs currently use 100BASE-TX, which uses two pairs of Cat5e twisted-pair cabling, leaving the spare pairs available for power. The standards define two entities that sit at opposite ends of the cable. The power sourcing equipment (PSE) is responsible for power delivery to the powered device (PD) at the other end of the cable. The standards define four different types of use scenarios, which correspond to four levels of maximum power delivery capability. Table 1 summarizes the types.

Table 1. PoE Types and Power Delivery Specifications

Parameter	802.3at Type 1	802.3at Type 2	802.3bt Type 3	802.3bt Type 4
Power available at the PD (W)	12.95	25.5	51	71
Maximum PSE power (W)	15.4	30	60	100
PSE voltage range (V)	44-57	50-57	50-57	52-57
PD voltage range (V)	37-57	42.5-57	42.5-57	41.1-57
Maximum current (mA)	350	600	600 per pair	960 per pair
Maximum cable resistance per pair (Ω)	20	12.5	12.5	12.5

As you can see from the table, each type supports a finite power budget available at the PD. Thus, using power-efficient devices in the PSE and PD is critical.

System Example

Figure 1 illustrates an example building automation network with PoE. This example shows a combination of a sensor controller and an IPNC attached to a network switch, which is also a power injector. In the language of the standard, it is the PSE. The sensor controller and IPNC at the other ends of the link are the PDs. Incorporating physical layers (PHYs) in each of the PDs handles the Ethernet communications.

Given that the purpose of PoE is to enable the deployment of sensors (such as an IPNC) to locations that may not have available power, or in which it would be difficult to provision power, it is important that the PHY consume as little as possible of the power budget. From Table 1, you can see that a Type 1 PoE link would have a power budget of 12.95 W at the PD end. There will be some loss in the power conversion and conditioning block, leaving less than 12.95 W available to the application circuit. A PHY should consume only a few hundred milliwatts or less, leaving the vast majority of the power for the sensor node or IPNC.

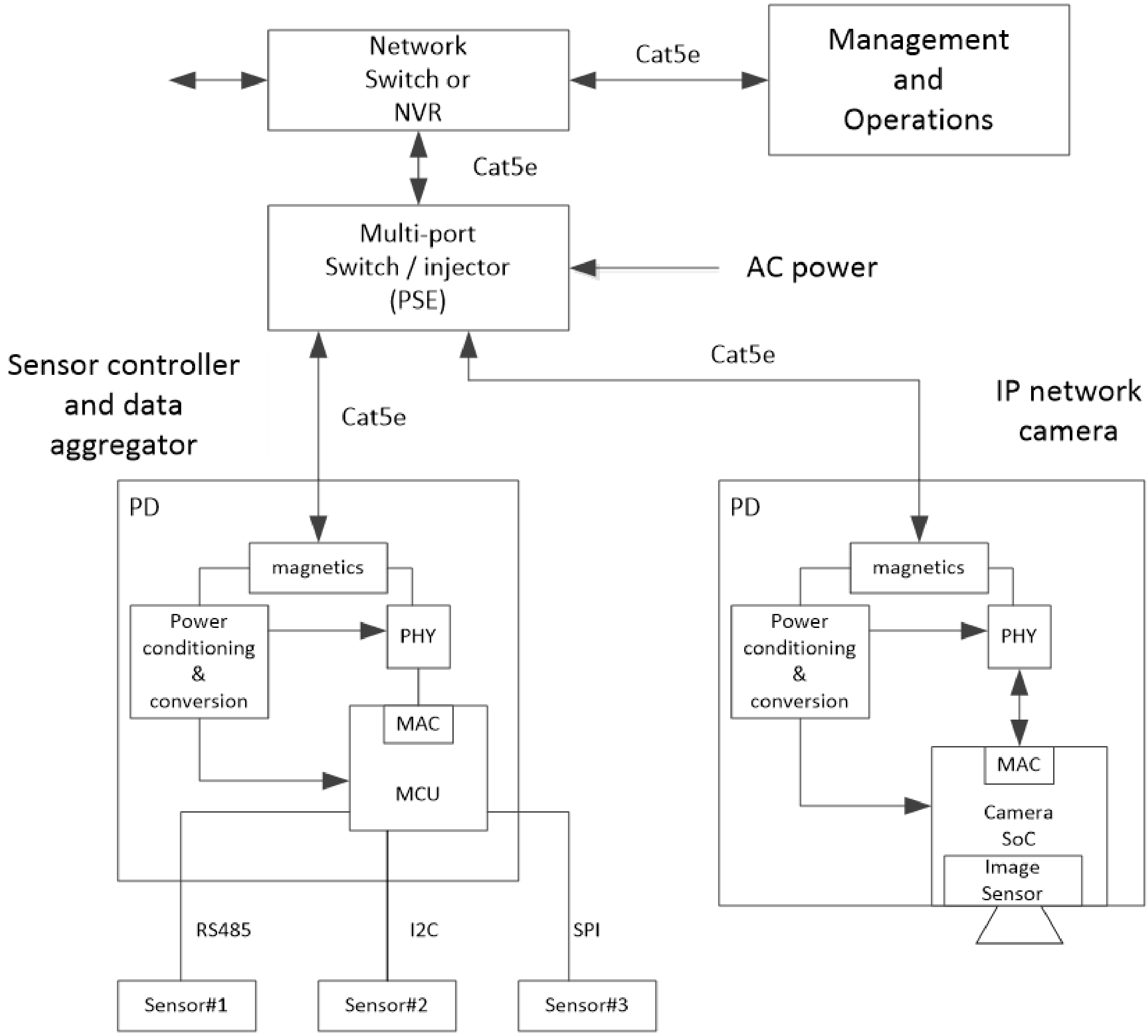

Figure 1. Example of a Building Automation Network Topology

The DP83825I 10-/100-Ethernet PHY offers a compact, low-power connectivity solution for building automation components such as sensor controllers, lighting controllers and IPNCs. It consumes only 135 mW at 100 Mbps and is available in a 24-pin, 3-mm-by-3-mm, quad flat no-lead package, making it one of the smallest 10/100 PHYs in the industry. With integrated termination resistors in the medium dependent interface and medium access control (MAC) interface, as well as a low-pin-count reduced media-independent Interface to the MAC, the DP83825I enables system designers to achieve a small solution size and allocate more board space and power to the application circuit.

Additional Resources

- Download the DP83825I data sheet or order the DP83825I evaluation module.
- Check out our portfolio of industrial and automotive Ethernet PHYs.
- Explore our differentiated solutions for building automation.
- Develop cost-optimized Ethernet designs with the EMC-compliant 10/100Mbps Ethernet PHY reference design with IEEE802.3at Type-1 (≤ 12.95 W) PoE-PD.