

# Optocouplers in Industrial Communication

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## White Paper

Industrial communication includes data monitoring and processing, diagnostic and sensing, as well as visualization. Optocouplers are used to maintain data integrity—eliminating ground loop current and common mode noise. Various technologies and communication buses allow the user to select the appropriate optocoupler according to his specific requirements such as speed, switching specifications, or security. Sales of fieldbus systems in Europe are projected to rise from their 2001 level of \$170.2 million to \$420.0 million in 2008 (Frost & Sullivan), across all networking levels. The hierarchy (Figure 1) of industrial networking includes:

- Enterprise Level (Ethernet PCs, Servers, Gateways)
- Control Level (High performance Ethernet (HSE), Ethernet, ProfiNet)
- Device Level (Profibus DP, DeviceNet)
- Sensor Level (CANbus, Remote I/O)

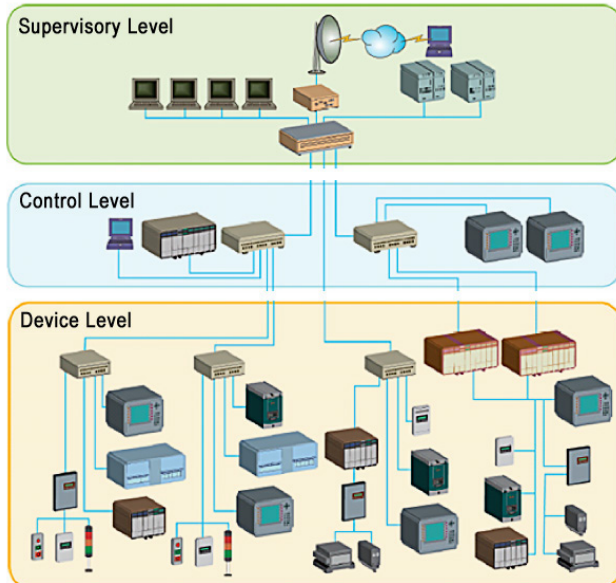


Figure 1. Industrial Networking Hierarchy

Smart sensors are used within industrial systems resulting in a change of communication at the device level, thus creating a more complex information exchange. Due to increased miniaturization, a sensor becomes a small PC with memory and networking capability. This allows sophisticated feedback and more accurate information by onboard calibration to compensate for nonlinearity, and offset temperature-related errors. These advantages and the new flexibility create a success story for smart sensors, and boost overall industrial communication. More intelligence is added in the form of programmable logic controllers (PLCs). These are used to control and handle the information flow on the lower network protocol layers (OSI), especially at the sensor and device level.

Fieldbus is another area with an expected growth rate as it also benefits from the use of smart sensors. Fieldbus is often used to connect these individual programmable logic controllers. Among the most popular are Profibus, DeviceNet, Interbus, and CANbus. In Europe, Profibus appears to be the market leader, while in the US, DeviceNet is number one.

To achieve signal integrity, optocouplers are used on interface cards from slow RS232 or CANbus to high speed RS485 interfaces. To optimize space consumption often multi-channel packages are preferred. Bi-directional communication channels help to further reduce board space.

Requirements for isolators are often expressed in “speed” or “MBd.” More valuable for designers are the switching related specifications such as propagation delay and pulse width distortion. DeviceNet specifies relatively slow data rates (125 kBaud, 250 kBaud and 500 kBaud) requiring less than 40ns propagation delay. CANbus specifies 125kBit/s for low speed and 1Mbit/s for high speed with no sharp requirement on propagation delay. Profibus transmits in the 12MBd range and specifies a total PWD delay for the isolator, transceiver and connection. To meet overall requirements, the isolator needs to be less than 8ns. Emerging technologies such as capacitive and magnetic isolators often advertise faster speeds of up to 100MBd, but the limitation for communication speed comes from pulse width distortion (PWD). Established isolators in the market, such as opto/magnetic or capacitive couplers, do provide a PWD as low as 2ns, which sets the maximum speed in asynchronous data communication that can be effectively used without additional components to 50MBd. This is what optocouplers provide today.

New generations of transceivers are offering lower supply voltages, especially in the control area where noise is not a problem. Supply voltage in the range of 3V is now becoming standard. The availability of 3V isolators permit designers to eliminate one supply and save costs.

The new generation of optocouplers optimized for communication applications is measured by its flexibility of supply voltage and overall board space consumption. Avago Technologies is the only optocoupler manufacturer that offers multi-channel and bi-directional

optocouplers, as well as a series of digital optocouplers that operate at both 3V and 5V, to serve these market trends. This technology leadership is based on a breakthrough in LED technology that allows back-emitting LEDs. These can be positioned directly on the isolation material, respective to the output IC, reducing the physical size of the LED-isolation-photodiode unit and allowing up to 4 channels per package. Board space savings can be at least 75%, depending on the chosen package.

In the future, Ethernet-based communications will become more important. ProfiNet is currently being promoted in Europe; EtherCat is another open standard. Both allow data rates up to 100 Mbit/s. Isolation today is done with transformer technology inherited from computing Ethernet. Optocouplers have not yet found their place and are challenged by new speed requirements. Going forward, the usage of high speed optocouplers is probable, as are optical fiber-based solutions. Avago Technologies has just released a new high speed (125MBd) fiber optic transceiver for industrial Ethernet based on 650nm LED technology for 1mm polymer optical fiber (POF) and 200um plastic cladded fiber (PCF). This new transceiver offers ease of use, as well as the best noise immunity and galvanic isolation.

Industrial Ethernet and established field buses will co-exist for at least the next 10-15 years. Optocouplers will continue to provide isolation, guarantee signal integrity, and play a key role in industrial communication for the coming years.

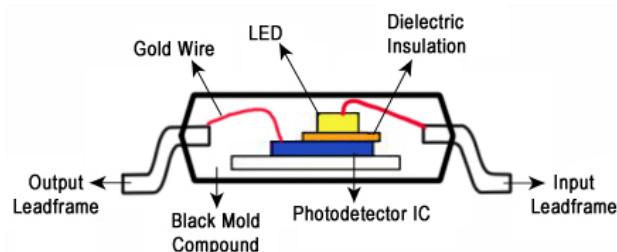


Figure 2. New Optocoupler type ACSL-6xx0

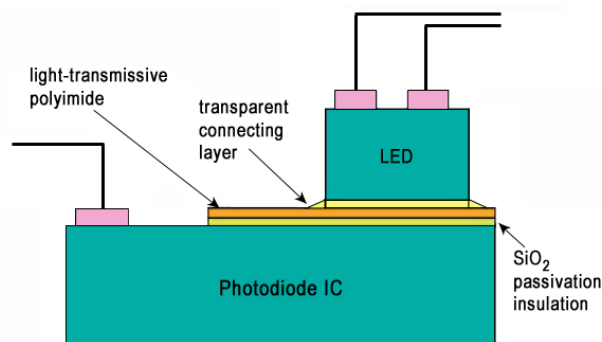


Figure 3. LED technology breakthrough

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