Optocouplers in Industrial Communication

By Alexander Jaus, Avago Technologies

White Paper

Industrial communication includes data monitoring and processing, diagnostic and sensing as well as visualization. To maintain data integrity against group loop current or common mode noise, optocouplers are used to eliminate both problems. Various technologies and communication buses allow the user to select according to their 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)

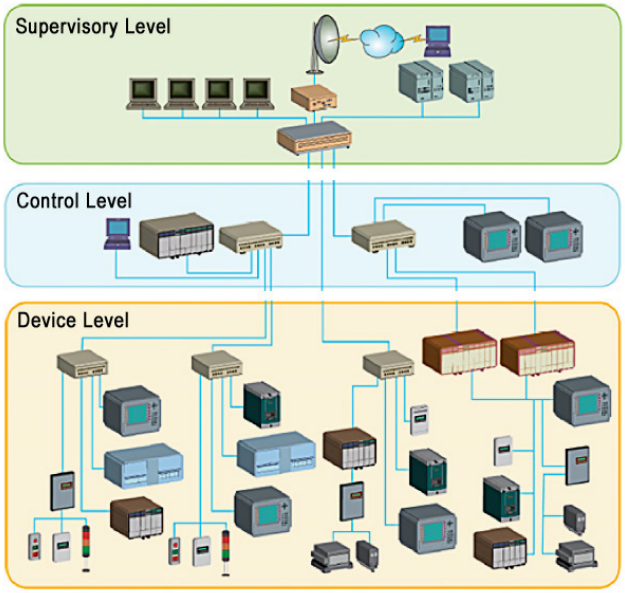

Figure 1. Industrial Networking Hierarchy

Smart sensors are used within industrial systems causing a change of communication at the device level, moving towards 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 nonlinearity, and offset or temperature related errors. These advantages and the new flexibility result in a success story of smart sensors and boost industrial communication overall. More intelligence is added in the form of programmable logic controllers (PLC's). 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 smart sensors. Fieldbus is often used to connect these individual programmable logic controllers together. Among the most popular are Profibus, DeviceNet, Interbus, and CANbus with regional emphasis. 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 is 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 then 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, 6ns or less. 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 transceiver generations are showing the trend towards lower supply voltages, especially in the control area where noise is not a problem. Supply voltage in the range of 3V is becoming standard now. The availability of 3V isolators give designers a chance to eliminate one supply and save costs.

The new generation of optocouplers optimized for communication applications are measured by their 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 operates at both 3V and 5V, to serve these market trends. This technology leadership is based on a breakthrough in LED technology that allows so called back-emitting LED's. 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. Depending on the package chosen, the board space saving for the customers can be 75% and higher.

In the future Ethernet based communications will become more important. ProfiNet is currently promoted in Europe, EtherCat is another open standard, and 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 well as 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) that offers ease of use, 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.

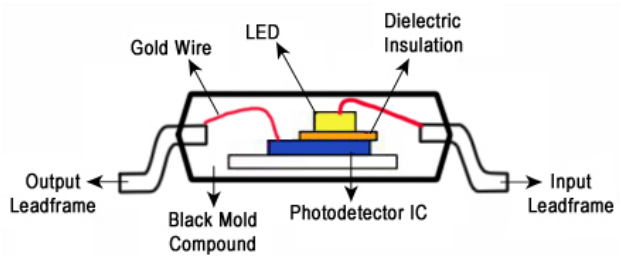

Figure 2. New Optocoupler type ACSL-6xx0

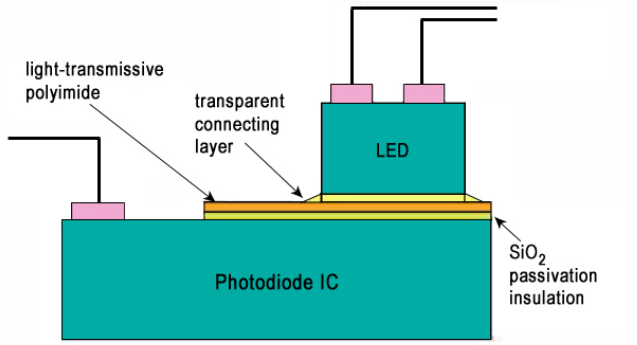

Figure 3. LED technology breakthrough

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

AV02-0561EN - July 6, 2007