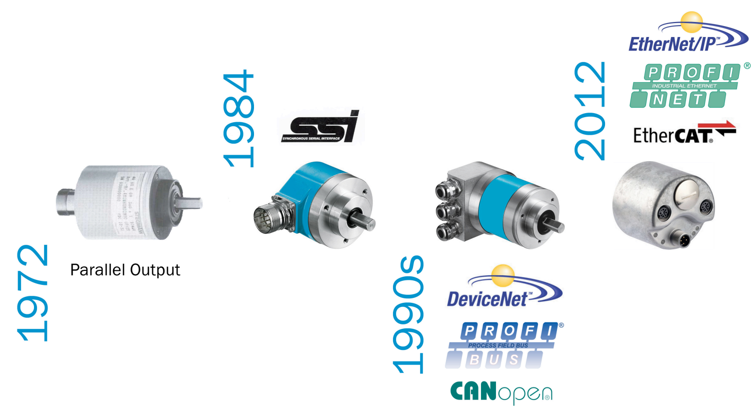
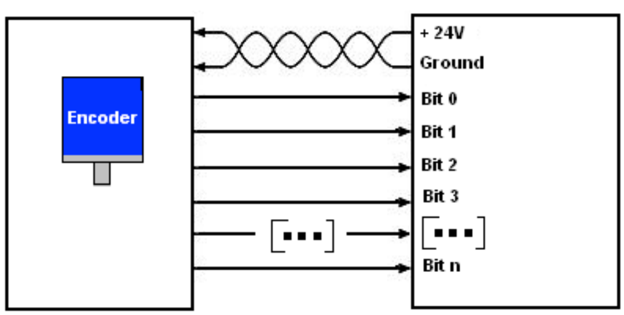
Absolute Encoder Evolution: Three Absolute Advantages for OEMs

The evolution of absolute encoders has been driven by changing application demands and new communication platforms. Today, advancements in highly precise positioning capabilities and communication network technology saves costs, simplifies systems, and increases flexibility for OEMs and end users alike.



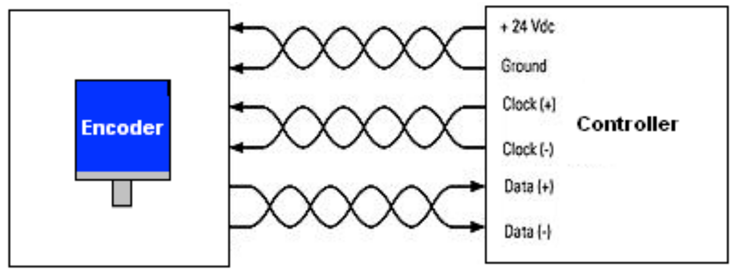
The Absolute Encoders Evolution

In the past, the type of absolute encoders on the market was limited, the resolution was low and the price was high. The output signal from absolute encoders consisted of parallel wires for each data bit. For the first encoders on the market, resolutions were limited by the technology of the code discs. Therefore, the number of wires in a cable of this system was not an issue.



As encoder technology improved, the resolution drastically increased, allowing for incredibly precise measurement. When implemented in the traditional parallel output methodology, these higher resolutions require more wires in the cable. Several issues are immediately evident in this scenario, including cable costs, installation time and opportunities for errors during commissioning. In addition, the information from the encoder is limited to positional information. Typically, no diagnostics or configuration capabilities are possible on these encoders. Each of these issues grows exponentially as the need for resolution, positioning accuracy, and ultimately application control increases.

In 1984, Stegmann GmbH developed “Synchronous Serial Interface” (SSI) communication for absolute encoder position data. This advancement used a simpler design for data transmission. However, the controller hardware became more complex compared with a parallel output. A clock pulse train from a SSI controller was sent to the input of the encoder (the number of clock pulses depended on the number of bits to be transmitted). One bit of encoder data was transmitted to the controller for each clock pulse received.



In this design, instead of a separate wire for each data bit, only two pairs of wires were used: one for the clock signals from the controller, and other for data transmission from the encoder.

The data was not limited to a specific number of words, and number of bits used has no affect on the connectivity hardware, but it does need to match the specific SSI controller. The serial communication greatly reduced the wiring that was once required for position data, cutting costs and installation time.

In addition to cutting cable costs, the ability to add data bits without adding more cabling hardware allowed transmission error date along with the normal position information. In general, there is no slave recognition in an SSI network from the master. Error bits can ensure that a slave device is connected and working properly – something that was not included in a parallel network.

Programmability was also introduced on some SSI encoders, allowing for configuration that was previously not possible. These configuration settings included changing the resolution based on the specific application need, setting the zero or offset position electrically reducing the installation time on a machine, and the ability to consolidate a variety of encoders to one part number.

Because of its flexibility and durability in an industrial setting, SSI is an industry standard today and can be applied in a wide range of applications. Some typical applications include monitoring the position of a crane winch and the angle of a robotic arm, determining the direction of an AGV steering wheel, and many others.

Introduction of the Fieldbus in Industrial Encoders

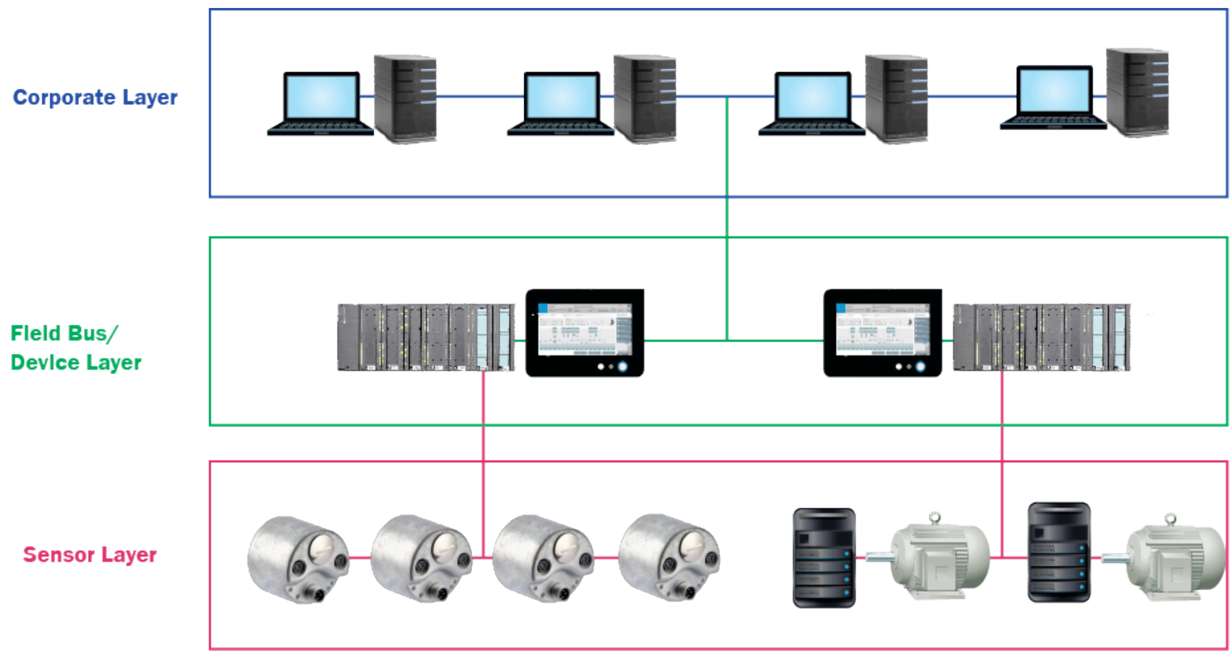
SSI is limited to a master/slave architecture or point to point system, and more complex machines and facilities benefit from an organized system using PLCs, HMIs, and networks instead of a separate master for each encoder or other device. Industrial fieldbuses or networks were introduced to meet this need. At Minneapolis-based SICK, the three most common fieldbus protocols, DeviceNet, Profibus, and CANopen, were added to the ATM60 absolute encoder line, launched in the 1990s. In these environments, a fieldbus protocol allows the user to connect and group encoders and other devices to one or more controllers or network interface cards.

The fieldbus protocols are organized into network topologies like tree, star, line, and branch. Because devices can be connected using these differing structures, the amount and length of cabling required decreases as same set of cables are shared between devices.

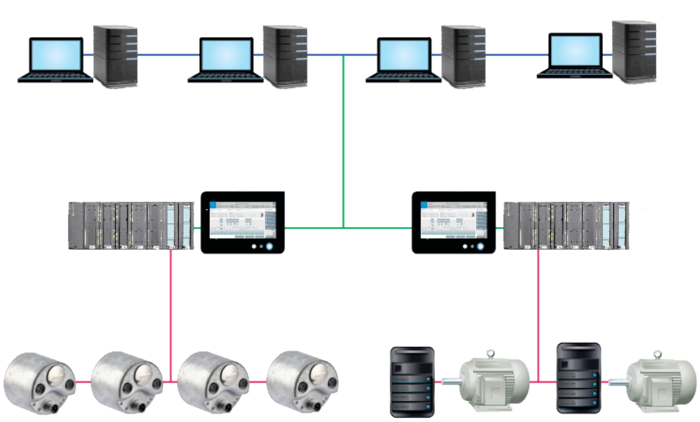
In addition to organizing and grouping encoders and other devices, the amount of data from the encoder has been expanded, making each encoder smarter. Instead of error bits, specific diagnostic attributes can be integrated into the encoders. The ATM60s, for example, offer temperature diagnostics and acceleration values, giving more information to the user, cutting troubleshooting and downtime.

The configuration or settings of the encoder can be set from a Programming Logic Controller (PLC), or other central control systems. The resolution, for example, is one of the configurations that can be programmed. This reduces the variants of encoders necessary in a machine or a stock room, consolidating the numerous resolutions and other attributes to one encoder part number.

Modern Networks using Industrial Ethernet



The development of all of the above-mentioned protocols has led to the introduction of a new generation of industrial Ethernet technology. Traditionally, fieldbuses use a layered network. One layer with sensors and simple I/O modules in the control network; a second layer of controllers, HMIs in a fieldbus or device level network; and the third layer is typically Ethernet in the corporate network. The trend in factory automation is to integrate all levels of a network into a single Ethernet-based system.



Benefits of using Industrial Ethernet

Industrial Ethernet builds on the basic benefits of fieldbus systems, and also expands the amount of information from the encoder. In some cases, it increases speed, and can simplify a network installation.

Diagnose problems before they occur

In general, industrial Ethernet interfaces allow for even more data flexibility than before. SICK's AFS/AFM60 encoders with Ethernet/IP, EtherCAT, and PROFINET, for example, offer more diagnostic functions than any other encoder currently on the market. Data, such as temperature, velocity, and acceleration can obviously give information regarding the encoder itself, but these diagnostic attributes also allow users to look beyond the encoder for the first time. The AFS/AFM60s also keep track of runtime, and number of revolutions. If a machine needs oiling or upkeep after a certain amount of time, the runtime attribute allows for more consistent maintenance, decreasing the likelihood of unexpected downtime.

Increase speed for motion applications

Using industrial Ethernet can also increase the speed of the system in some cases. One potential challenge in moving to an Ethernet-based system is the use of TCP in a time-critical motion control application. TCP ensures reliable data transmission by establishing connections before sending data packets. This greatly minimizes the risk of dropped or corrupted packets, but without time stamping, the overhead does not make this transmission ideal for real-time applications.

The EtherCAT protocol found in the AFS/AFM60 family can be the solution in motion control application. These encoders offer very fast cycle times and deterministic data allowing for real time data transfers. The ability to use real-time data is perfect for motion control applications, where precise motion positioning is critical.

Simplify your network – and keep it running with network redundancy

Network installation can also be simplified using industrial Ethernet. The Ethernet base used for all of the different protocol variations work with standard Ethernet components like routers, switches, hubs, and access points. The AFS/AFM60s, with an Industrial Ethernet interface, all use embedded switches, which increase the variations for topologies while reducing external switching components for line or ring setups. The Ethernet/IP AFS/AFM60s are equipped with device level ring (DLR) capability for use in industrial control applications with a ring topology. DLR-enabled devices greatly reduce the need for external switching components, making the system cost less to implement and are fault-tolerant. In a motion monitoring system, if an encoder detects a break in the communications ring, and is DLR enabled, the DLR functionality within the device provides an alternate path for the data to travel, allowing the network to recover quickly and incur little or no downtime.

Conclusion

The evolution of absolute encoders has created many process improvements in an industrial setting. As the number of machine builders embracing absolute measurement encoders grows, the evolving encoder technology advances precise positioning capabilities, saves costs, simplifies systems, and increases flexibility. These benefits along with easy integration into the end user's control network, makes these encoders ideal for OEMs.

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