How utilizing EtherCAT benefits industrial applications with faster real-time measurements

The Challenge

As the focus on costs continues to impact throughout industry there is a growing need to provide faster real-time measurements in industrial applications.

There are already a number of different systems in use based on standard Ethernet known from the office communication, but these are often inefficient since a large proportion of the available bandwidth is unavailable.

There are two reasons for this ineffectiveness:

- One is that only small amounts of data are being transmitted at any one time.
- In addition the messages originate when the client or master device in the system requests the data. This means that standard Ethernet operates as a half-duplex information system.

The Solution

To overcome the problem research was undertaken by Beckhoff Automation GmbH to develop a fieldbus system that could operate in real-time by challenging the low bandwidth of standard Ethernet protocols.

The outcome was EtherCAT (Ethernet Control Automation Technology), a high-performance, industrial communication protocol that extends the IEEE 802.3 Ethernet standard enabling data to be transferred with predictable timing and precise synchronization.

The development of EtherCAT means that Ethernet packets are no longer received, interpreted, processed and copied at every device. The EtherCAT protocol still transports data directly within a standard Ethernet frame without changing its basic structure.

However, EtherCAT slave devices can read the data addressed to them while the frame passes through the device node. Input data can also be inserted at the same time resulting in delays of only a few nanoseconds. Because EtherCAT frames comprise data from many devices that are operating in both send and receive modes, the usable data rate increases to over 90%. This enables the full-duplex features of 100BaseTX to be fully utilized with effective data rates of >100 Mbit/s being achieved.

Advantages

Another advantage of EtherCAT is that it supports the entire CANopen family and the Sercos drive profile. This helps users to easily configure EtherCAT networks to the specific application by modifying predefined basic profiles.

In addition EtherCAT can support almost any topology making it suitable for a wide range of applications with the standard switch-based Ethernet star topology included. This makes it a very flexible system in terms of wiring and different cables can easily be used. Thus the complete bandwidth of an Ethernet network can readily be used in combination with switches or media converters.

Gateway modules

To maximize effectiveness in gathering real-time measurements by utilizing EtherCAT, HBM has introduced its CX27 gateway module as part of its established QuantumX system. The CX27 features an EtherCAT connection comprising a one-off module/channel setup for isochronous data traffic. This enables the setting and configuring of individual channels via EtherCAT for both channel configuration (SDO) and as a method of assigning process data (PDO).

QuantumX CX27

To help users, configuration is easily achieved using either the EtherCAT Studio, based on the König PA system, or TwinCAT, which utilizes Beckhoff's methods. Configuration can also be done by using the supplied QuantumX System CD or by downloading the appropriate software from HBM's Internet site. Finally users can also use a network scan or information stored in the EEPROM to configure the device. This gives users a great deal of flexibility for easily configuring the CX27.

Key considerations

An important consideration when simultaneous actions are demanded in widely distributed processes is that the timing of all the nodes in the network are synchronized exactly.
This is achieved by transmitting the timing from the master clock to all slave clocks, and aligned to compensate for any delay offset, by using the distributed clocks synchronization method (IEEE 1588).

In an EtherCAT grouping, the master clock is in a slave device, as the master should deliberately be mapped by standard components. All the nodes can then be synchronized with an error of less than 1 ms.

In the CX27 there is an option in the Device Description File (DDF) that activates or deactivates distributed clocks; the default is set for distributed clocks as activated. When the distributed clocks are activated, the timing master forwards the time to the QuantumX slave and this distributes the timing to the modules. Using distributed clocks is useful when measurements need to be performed in parallel via Ethernet and use the same time stamp as a reference.

Using HBM’s CX27 as an EtherCAT slave permits high channel counts or high sampling rates. Up to 199 time-synchronized signals, with a maximum sampling rate of 1,200 Hz or 30 channels with a sampling rate of 4,800 Hz can be achieved on the fieldbus system with the powerful, modular QuantumX data acquisition system.

Conclusion

EtherCAT is a very high performance, easy to deploy, open application layer protocol for Ethernet applications and its inclusion in HBM’s CX27 ensures that users can take full advantage of the synchronization capabilities while using the complete bandwidth for any suitable application. This would be particularly valuable where a large number of measuring modules needs to be synchronized.

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