XFC components

Implementation of the XFC technologies described above requires full support for all hardware and software components involved in the control system, including fast, deterministic communication and I/O and control hardware. A significant part of XFC are the software components responsible for fast processing of the control algorithms and optimised configuration of the overall system.

Beckhoff offers a special XFC product range based primarily on four categories: EtherCAT as fieldbus, EtherCAT Terminals as I/O system, IPCs as hardware platform, and TwinCAT as higher-level software. All components are based on open standards, which means that any engineer or programmer can develop very fast control solutions with high performance based on standard components (i. e. without special hardware).

I/O component – EtherCAT Terminals with XFC technology

Standard EtherCAT Terminals already offer full support for XFC technology. Synchronisation of the I/O conversion with the communication or – more precisely – with the distributed clocks is already standard in EtherCAT and is therefore supported by all terminals.

Newly developed XFC terminals offer additional special features that make them particularly suitable for fast or high-precision applications:

- digital EtherCAT Terminals with very short T_{ON} /T_{OFF} times, or analog terminals with particularly short conversion times
- EtherCAT Terminals with time stamp latching at the exact system time at which digital or analog events occur. Output of digital or analog values can occur at exactly predefined times.
- Terminals with oversampling enable actual value acquisition or set value output with significantly higher resolution than the communication cycle time.

Communication component – EtherCAT fully utilised

With high communication speed and usable data rates EtherCAT offers the basic prerequisites for XFC. However, speed is not everything. The option of using the bus to exchange several independent process images arranged according to the control application enables parallel application of XFC and standard control technology. The central control system is relieved of time-consuming copying and mapping tasks and can fully utilise the available computing power for the control algorithms.

The distributed EtherCAT clocks that form the temporal backbone of the XFC technologies are available in all communication devices without significant additional effort.

The crucial point of XFC is the option of integrating all I/O components directly in the EtherCAT communication, so that no subordinate communication systems (sub bus) are required. In many XFC terminals the AD or DA converter is connected directly to the EtherCAT chip, so that delays are avoided.

I/O component – EtherCAT Terminals with XFC technology

Communication component – EtherCAT fully utilised

Control component – High-performance Industrial PCs

Central control technology can be particularly advantageous if it can run faster and more powerful control algorithms than would be the case with many distributed small controllers. Modern Industrial PCs offer significantly more processing power and memory at lower cost than the sum of a large number of small controllers.

The latest general PC technology innovations can also be used to good effect for control technology. Fast dual core processors are ideal for running the operator interface of the machine in parallel with the control tasks. Large caches available with modern CPUs are ideal for XPC technology, because fast algorithms run in the cache and can therefore be processed even faster.

An important factor for short XFC cycle times is the fact that the CPU is not burdened with complex process data copying tasks needed by traditional fieldbuses with their DPRAM-based central boards. EtherCAT process data communication can be handled entirely by the integrated Ethernet controller (NIC with bus master DMA).

Software component – TwinCAT automation suite

TwinCAT as high-performance automation suite fully supports the XFC technologies while retaining all the familiar features. The real-time implementation of TwinCAT supports different tasks with different cycle times. Modern Industrial PCs can achieve cycle times of 100 µs or less without problem. Several (different) fieldbuses can be mixed. The associated allocations and communication cycles are optimised according to the fieldbus capabilities. The EtherCAT implementation in TwinCAT makes full use of the communication system and enables application of several independent time levels. It uses distributed clocks. Different time levels enable coexistence of XFC and normal control tasks in the same system, without the XFC requirements becoming a "bottleneck".

A new option specially designed for XFC enables inputs to be read during independent communication calls and outputs to be sent directly after the calculation. Due to the speed offered by EtherCAT the inputs are read "just" before the start of the control tasks, followed by immediate distribution of the outputs. The resulting response times are faster than the fieldbus cycle time in some cases.

Special TwinCAT extensions facilitate handling of the new XFC data types (time stamp and oversampling). PLC blocks enable simple analysis and calculation of the time stamps. The TwinCAT scope can display the data picked up via oversampling according to the allocated oversampling factor and enables precise data analyses.

Control component – High-performance Industrial PCs

Software component – TwinCAT