XFC technologies

Distributed clocks – Shifting accuracy to the I/O level
In a normal, discrete control loop, actual value acquisition occurs at a certain time (input component), the result is transferred to the control system (communication component), the response is calculated (control component), the result is communicated to the set value output module (output component) and issued to the process (controlled system).

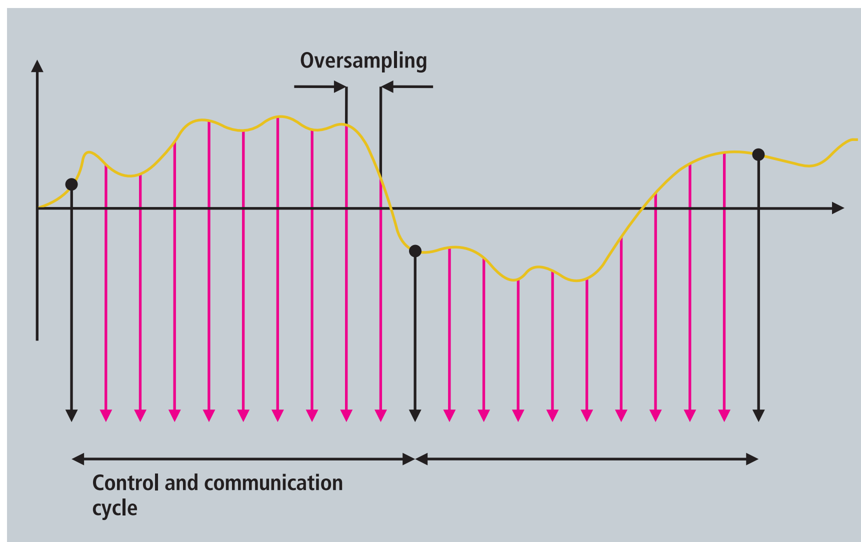
The crucial factors for the control process are: minimum response time, deterministic actual value acquisition (i. e. exact temporal calculation must be possible), and corresponding deterministic set value output. At what point in time the communication and calculation occurs in the meantime is irrelevant, as long as the results are available in the output unit in time for the next output, i. e. temporal precision is required in the I/O components, but not in the communication or the calculation unit.

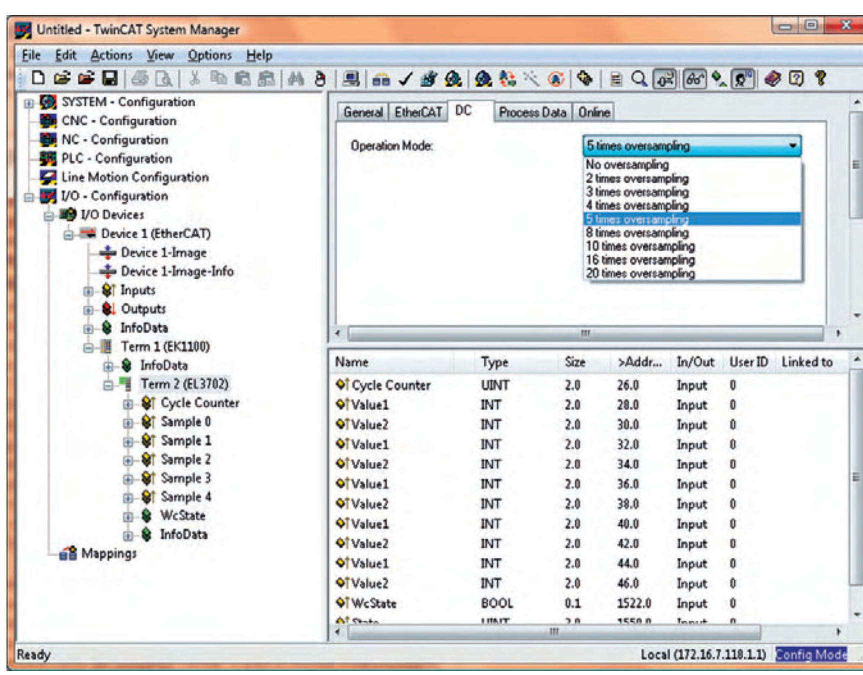
The distributed EtherCAT clocks therefore represent a basic XFC technology and are a general component of EtherCAT communication. All EtherCAT devices have their own local clocks, which are automatically and continuously synchronised with all other clocks via the EtherCAT communication. Different communication run-times are compensated, so that the maximum deviation between all clocks is generally less than 100 nanoseconds. The current time of the distributed clocks is therefore also referred to as system time, because it is always available across the whole system.

Time stamp data types
Process data is usually transferred in its respective data format (e. g. one bit for a digital value or one word for an analog value). The temporal relevance of the process record is therefore inherent in the communication cycle during which the record is transferred. However, this also means that the temporal resolution and accuracy is limited to the communication cycle.

Time stamped data types contain a time stamp in addition to their user data. This time stamp – naturally expressed in the ubiquitous system time – enables provision of temporal information with significantly higher precision for the process record. Time stamps can be used for inputs (e. g. to identify the time of an event occurred) and outputs (e.g. timing of a response).

Oversampling data types
Process data is usually transferred exactly once per communication cycle. Conversely, the temporal resolution of a process record





Oversampling settings in the TwinCAT System Manager directly depends on the communication cycle time. Higher temporal resolution is only possible through a reduction in cycle time – with associated practical limits.

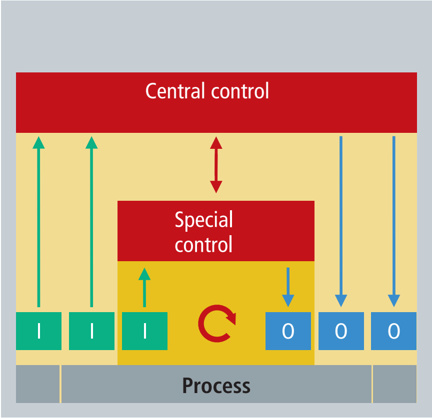
Oversampling data types enable multiple sampling of a process record within a communication cycle and subsequent (inputs) or prior (outputs) transfer of all data contained in an array. The oversampling factor describes the number of samples within a communication cycle and is therefore a multiple of one. Sampling rates of 200 kHz can easily be achieved, even with moderate communication cycle times.

Triggering of the sampling within the I/O components is controlled by the local clock (or the global system time), which enables associated temporal relationships between distributed signals across the whole network.

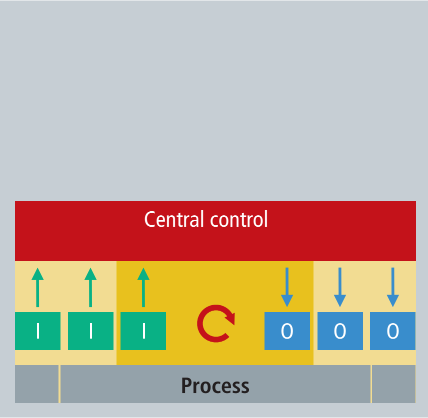
Very short cycle times – Optimised I/O communication

Very fast physical responses require suitably short control cycle times in the associated control system. A response can only take place once the control system has detected and processed an event.

The traditional approach for achieving cycle times in the 100 µs range relies on special separate controllers with their own, directly controlled I/Os. This approach has clear disadvantages, because the separate controller has only very limited information about the overall system and therefore cannot make higher-level decisions. Reparameterisation options (e. g. for new workpieces) are also limited. Another significant disadvantage is the fixed I/O configuration, which generally cannot be expanded.



Subordinate special control
(limited process image)



Fast central control
(complete process image)

XFC Performance data

Extreme short control cycle time
- 100 µs (min. 50 µs)
- new performance class for PLC application: control loops with 100 µs

Extreme fast I/O response time
- 85 µs (min. ~ 50 µs)
- Deterministic synchronised input and output signal conversion leads to low process timing jitter.
- Process timing jitter is independent of communication and CPU jitter.
- new performance class for PLC application: control loops with 100 µs

Signal oversampling
- multiple signal conversion in one control cycle
- hard time synchronisation through distributed clocks
- for digital input/output signals
- for analog input/output signals
- support of analog I/O EtherCAT Terminals
  - ► up to 200 kHz signal conversion
  - ► down to 5 µs resolution
- application
  - ► fast signal monitoring
  - ► fast function generator output
  - ► signal sampling independent of cycle time
  - ► fast loop control

Signal time stamping (10 ns resolution)
- extreme time measurement for digital single shot events: resolution: 10 ns, accuracy: < 100 ns
- exact time measurement of rising or falling edges of distributed digital inputs
  - ► exact timing of distributed output signals, independent of control cycle
  - ► time stamping data: resolution 10 ns, accuracy < 100 ns

Distributed-Clocks
- distributed absolute system synchronisation for CPU, I/O and drive devices
- resolution: 10 ns
- accuracy: < 100 ns