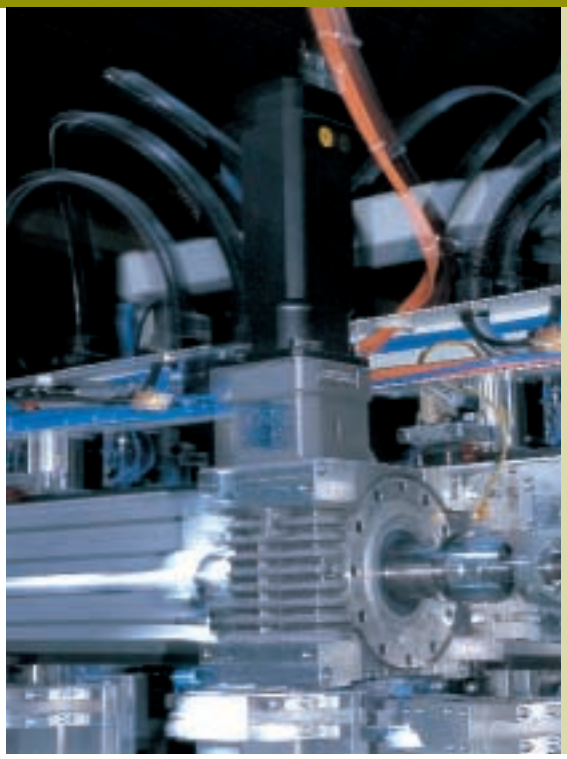
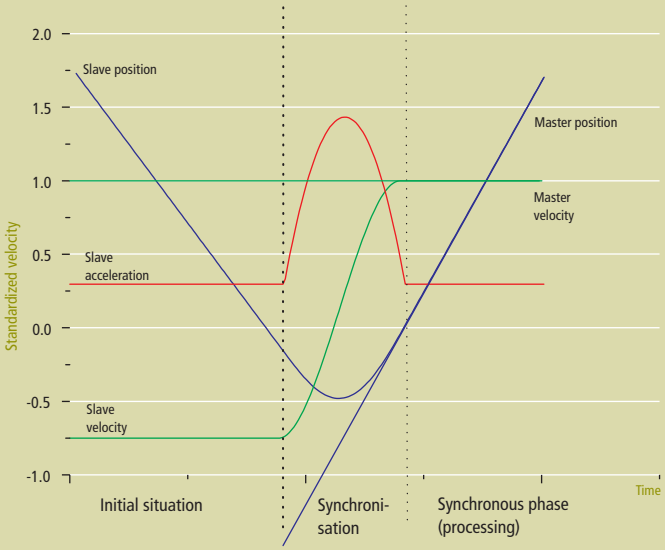
Flying Saw – non-stop

The TwinCAT system from Beckhoff includes powerful motion control blocks ranging from electronic gearing to cam plates. The TwinCAT Flying Saw NC module has been extended with new functionalities that enable synchronization with a master in motion, without restrictions regarding the initial dynamics of the slave. This functionality - in combination with the flexible PLC function blocks - significantly increases system effectiveness and performance.





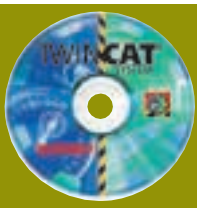
Scope of a synchronisation.

Faster and faster cycle times are being demanded. This also applies to the flying saw. The flying saw functionality is defined as the synchronization of a slave axis with a master axis in motion, and the movement of the slave axis synchronous with the master – with parameterizable gearing factor – during the machining process. The synchronous motion with the master axis enables machining of a workpiece even during transport. Previously, the TwinCAT Flying Saw required the slave axis to stop at the start of the process, with subsequent synchronization with the master axis with maximum dynamics. The new functionality enables synchronization with a moving master, without restriction on the initial dynamics of the slave. For many applications, this provides significantly more degrees of freedom, since at the time of the coupling the slave axis is already executing a previous travel command with positive or negative velocity and acceleration. Once non-cyclic machining of the workpiece during the synchronous phase has been completed, the slave is uncoupled from the master, decelerated and returned to the starting position. The starting position does not necessarily have to be reached, since a new synchronization can directly follow an enable command for the machining of the next workpiece. For a cyclic slave axis, the next cycle can be started with a new synchronous position after each completed machining process. The gearing factor of the master/slave coupling can have any value not equal to zero.

PLCopen-compliant function blocks

For convenient programming of this functionality, two function blocks that comply with the PLCopen standards are available in the TwinCAT NC motion control library. The modularization of the functionality within function blocks enables appropriate solutions to be realized easily for a variety of requirements:

- MC_GearInVelo: synchronization with fixed gearing factor
- MC_GearInPos: synchronization to the specified position with fixed gearing factor



The set value profiles of the axes involved are calculated by the NC of the TwinCAT system and issued to the axes. The PLC calculates the required specifications such as the coupling position. Furthermore, the PLC controls and monitors the complete process, consisting of coupling (synchronization), synchronous movement, uncoupling and repositioning.
The flexibility of this solution is increased further through the specification of boundary conditions. The motion requirements are thus already considered during the calculation of the set value profile, and not only controlled later during execution. The slave axis motion, for example, can be restricted in such a way that only positive values for velocity – e. g. for the processing of film – are permitted. Travel across the end positions and exceeding of a set maximum velocity during the synchronization phase can also be monitored and prevented. In addition, the slave motion is also determined – within the specified dynamic limits (maximum values for velocity, acceleration, deceleration and jerk) – so that an optimum set value profile is generated.

Flexible motion functions

For determining the set position of the slave, the NC calculates a motion function depending on the master position. A 5th order polynomial is best suited for compliance with the specified boundary conditions, although some of its features may not necessarily be desirable. Based on the above-mentioned conditions, an attempt will be made to find an optimum solution for the respective requirements. The advantage of realizing position coupling (cam plate) is that the coupling is only calculated once and is then available as a flexible motion function with real-time capability. This motion function enables run time-optimized calculation, independent of the future master motion. A change in master dynamics automatically leads to consistent adaptation of the slave dynamics.