SERCOS interface extends PC Control

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Overview

PC based control
- Advantages
- Requirements

Synchronization between SERCOS^{i} and PC

Position lag as a major quality factor

SERCOS^{i} and PC complement each other

SERCOS^{i} and other I/Os
- SERCOS^{i} I/O devices
- SERCOS^{i} in combination with other fieldbus systems

TwinCAT and SERCOS^{i}

Summary

PC based Control – General Advantages

High performance – low costs

- Performance and costs from the desktop world

Standard operating systems

- e.g. Windows® NT/2000/CE

Communication features “for free”

- Standard protocols (e.g. TCP/IP)
- Standard interfaces (e.g. Ethernet, USB, Firewire)

Combination of control and HMI software on one platform

Additional third-party solutions possible and available

- Hardware extensions (e.g. frame grabber)
- Software extensions (e.g. CAE / CAM)

Requirements for PC control

SERCOS interface

SERCOS interface extends PC based control

A PC

Required features for PC control

- Data persistence (On-off behavior of a legacy PLC)
- Industrial parts and especially industrial housings

Interface to external I/O

- Access to fieldbus systems
- PC interfaces available for control software

“Soft” or “Hard” Real-time

- Real-time quality (max. latency) depends on application
- OS features versus real-time extensions

Cyclic driven control software (e.g. Soft-PLC)

- Debugging of “running” applications
- Online change features

Special Requirements for Motion Control

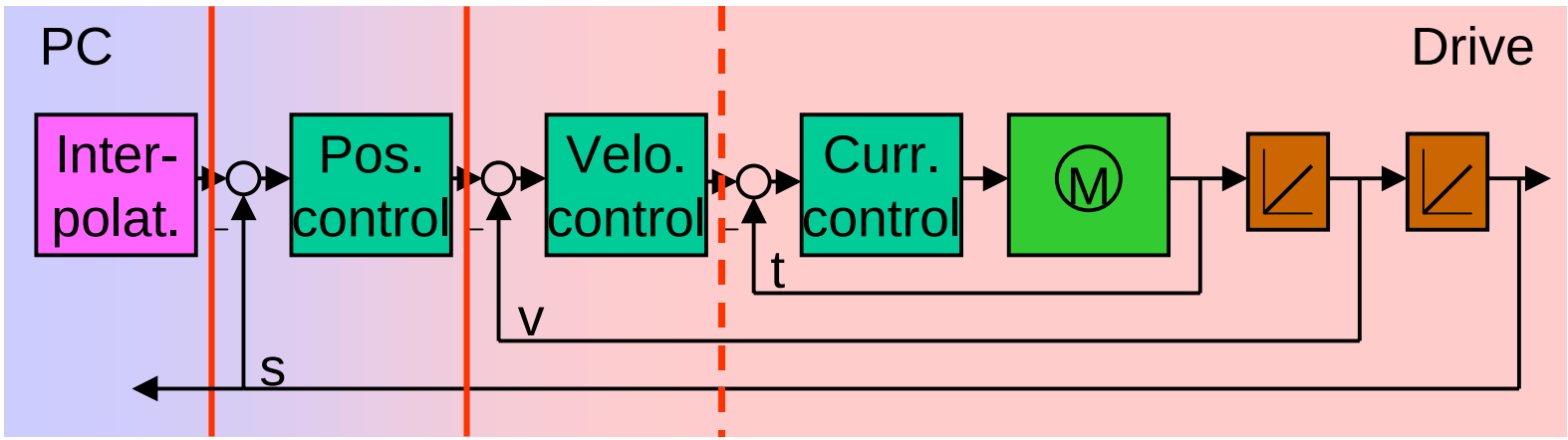
SERCOS interface extends PC based control

"Hard" real-time

- Typical cycle time: 0.5 – 4 ms (position control)
- Latency below 100 µs

Floating point features in real-time environment

Synchronization between software task (PC) and current control (Drive)



Synchronization between SERCOS^{i} and PC (1)

By design SERCOS^{i} supports synchronization between bus and drive cycle

SERCOS^{i} real-time requirements and PC possibilities

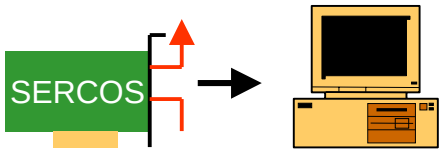
- Latency of SERCOS^{i} MST (JTSCYC) < 5 µs
- Latency of Windows NT real-time extensions > 5 µs

- Timer of SERCOS^{i} chip used for MST
- Synchronization between SERCOS^{i} timer and real-time OS or extension required
  - PLL (phase locked loop) mechanism
  - SERCOS^{i} synchronizes PC
  - PC synchronizes SERCOS^{i}

Synchronization between SERCOS^{i} and PC (2)

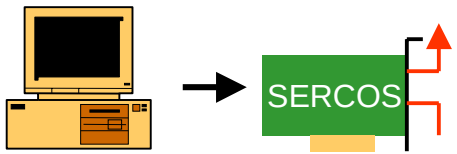
SERCOS interface extends PC based control

SERCOS synchronizes PC



- Advantages
  - SERCOS^{i} cycle time as accurate as quartz
- Disadvantages
  - Only one time-“master” possible
  - Special real-time OS / OS extension required

PC synchronizes SERCOS



- Advantages
  - PC is able to synchronize multiple fieldbus systems
  - PC can be a member of a global synchronization group
- Disadvantages
  - PLL mechanism must be supported by SERCOS^{i} master

Position Lag as a major Quality Factor

Position lag is the difference between nominal and actual position of an axis

The position lag produces in multi axis environments geometry faults

<u>Possible steps to minimize the position lag:</u>

- **Decreasing the control cycle time** *decreases* the position lag in all phases
- **Velocity feed forward** is a mechanism to *avoid* position lag during phases of **constant** velocity
- **Acceleration feed forward** is a mechanism to *avoid* position lag during phases of **changing** velocity

Effect of Position Control Cycle Time

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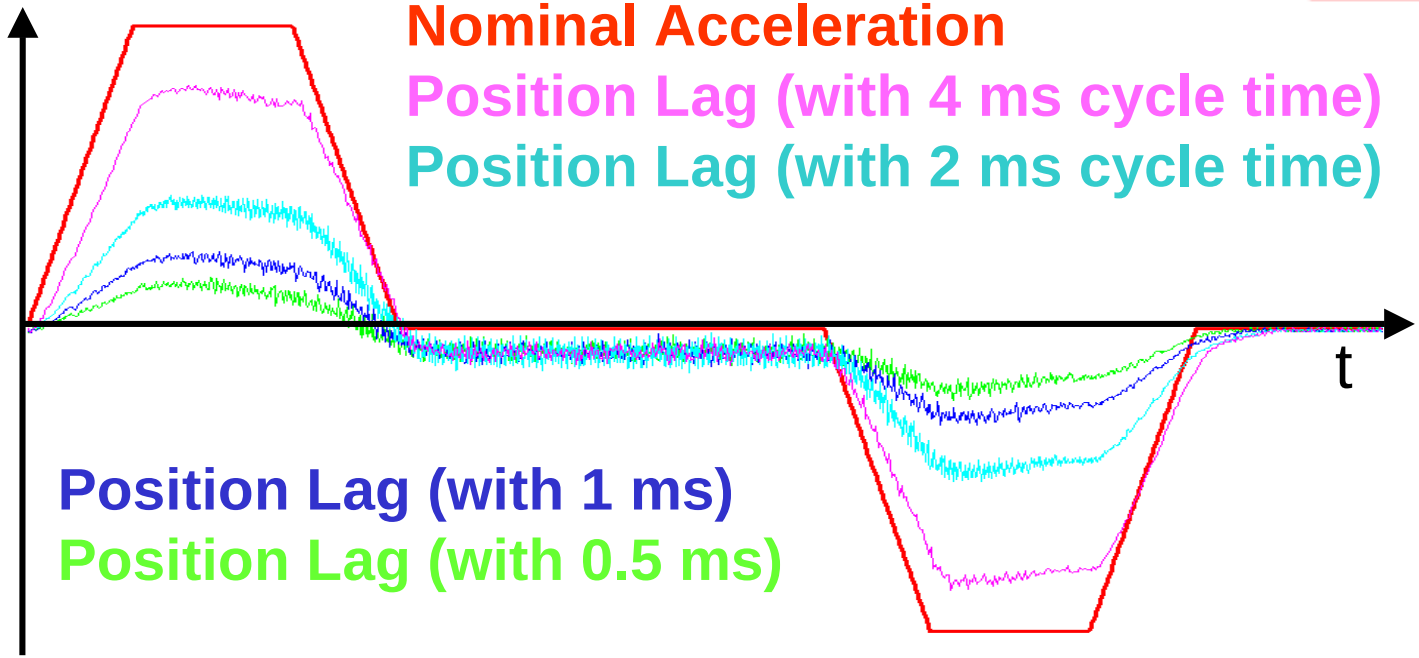

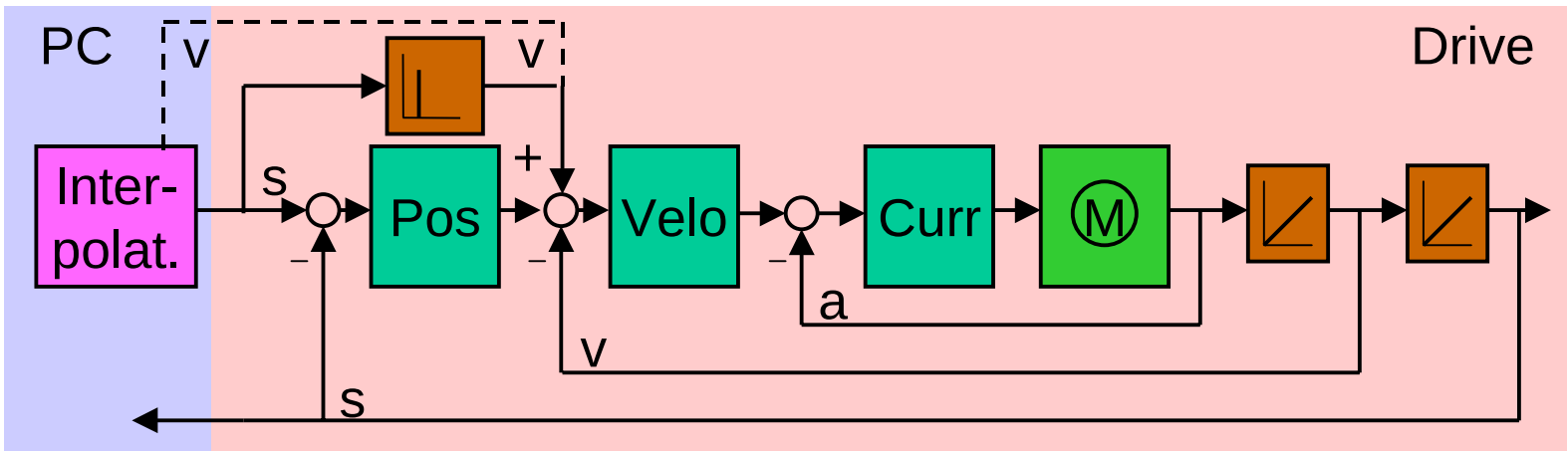

Effect of Acceleration Feed Forward

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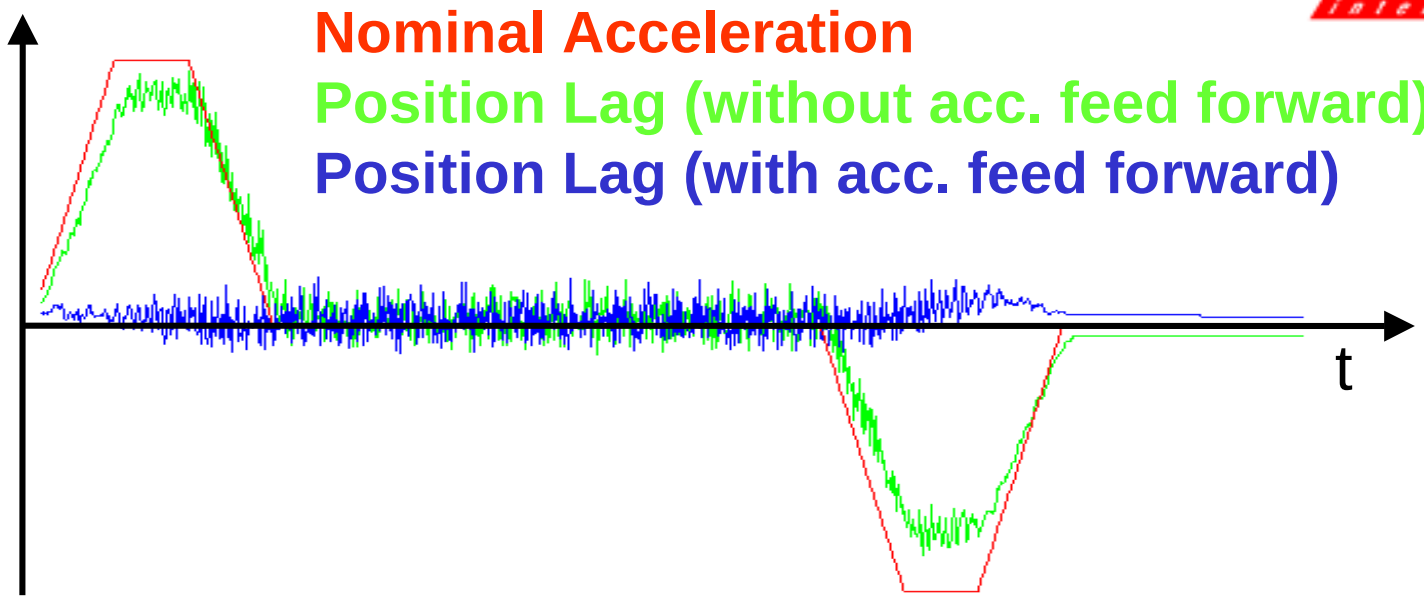
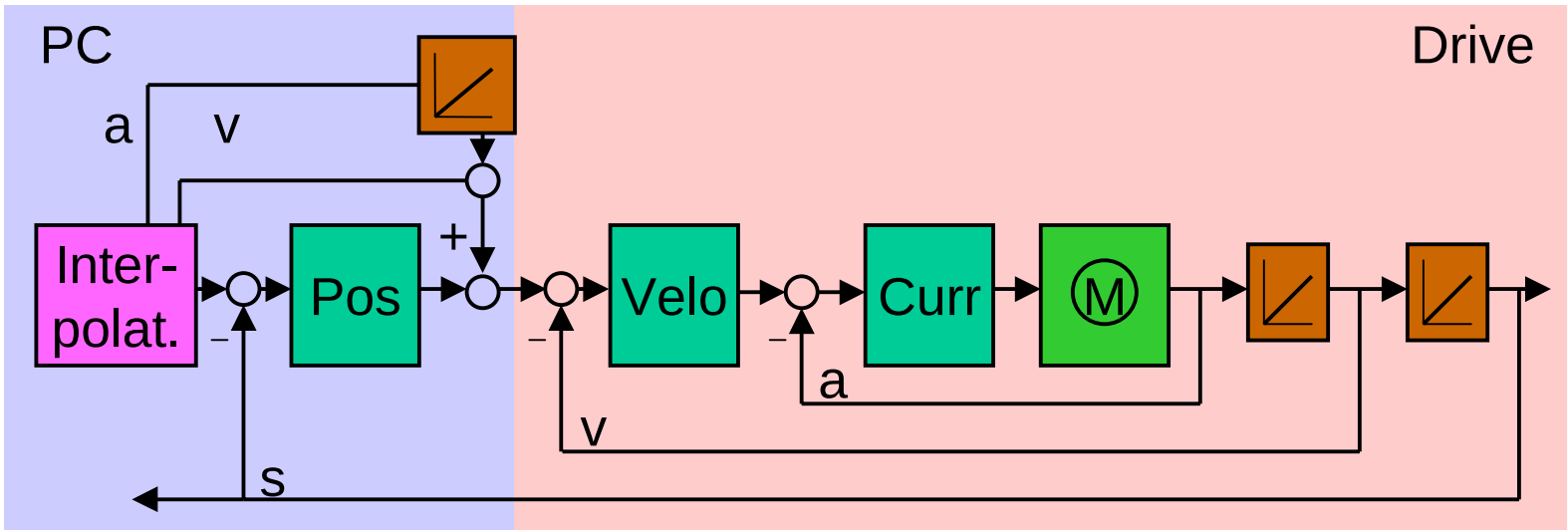
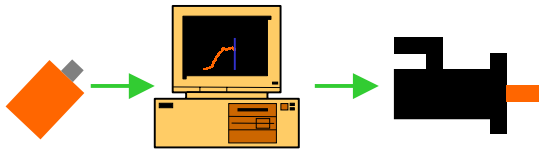




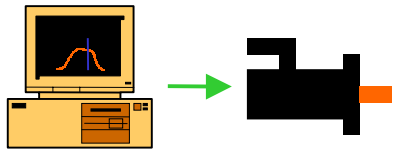
Position Control by SERCOS^{i} versus by PC

SERCOS^{i} for “unknown” motion profiles

- Short position control cycle
- Setpoint velocity differentiated (required for velocity feed forward)



PC for “known” motion profiles



- Setpoint position, velocity and acceleration of each interpolation step are “known”
- Optimal feed forward values predictable (velocity and acceleration)

SERCOS^{i} and PC complement each other

SERCOS interface extends PC based control

High quality motion control combined with high performance and huge memory

- Different kinds of position generating methods possible
  - Point-to-Point
  - Interpolation
  - Electronic gears
  - CAM applications
  - Flying saw algorithms
- Combinations of different position generating methods
  - Cyclic or PLC-driven changes of position generating methods
  - Smooth transitions calculated by PC (acceleration steps avoidance)

New applications outside the machine tool world possible

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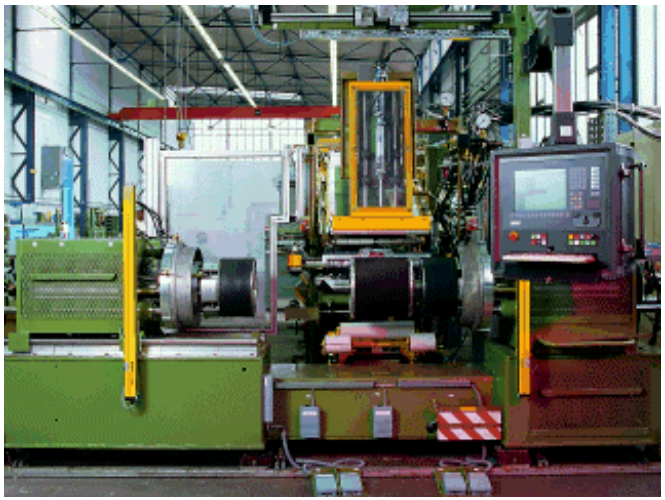
50 Axis and more…

SERCOS interface extends PC based control



Tire manufacturing machine

Packaging machine

Laminate press machine

Feeder for press machines

SERCOS^{i} and other I/Os

Motion control is not everything...

- General control applications have much more digital and analogue I/Os than machine tool applications
- Most general control applications are PLC driven – not CNC driven (IEC 61131 versus DIN 66025)
- Several control tasks with different priorities and cycle times share I/Os

Solutions:

- SERCOS^{i} I/O devices
- SERCOS^{i} in combination with other fieldbus systems

SERCOS^{i} I/O Devices

Advantages:

- One fieldbus type for everything
- Small applications require only one master card
- Deterministic I/O update

Disadvantages:

- No support of different priorities and cycle times
- Limited device variety (today)

Introduction: **Beckhoff bus coupler BK7500**

- Covers all major signal types (digital, analog, incremental, thermo coupler, serial, custom signals)
- Designed for SERCOS^{i} interface I/O specification
- Support of Service Channel
- Add-on to a well known, successful I/O system

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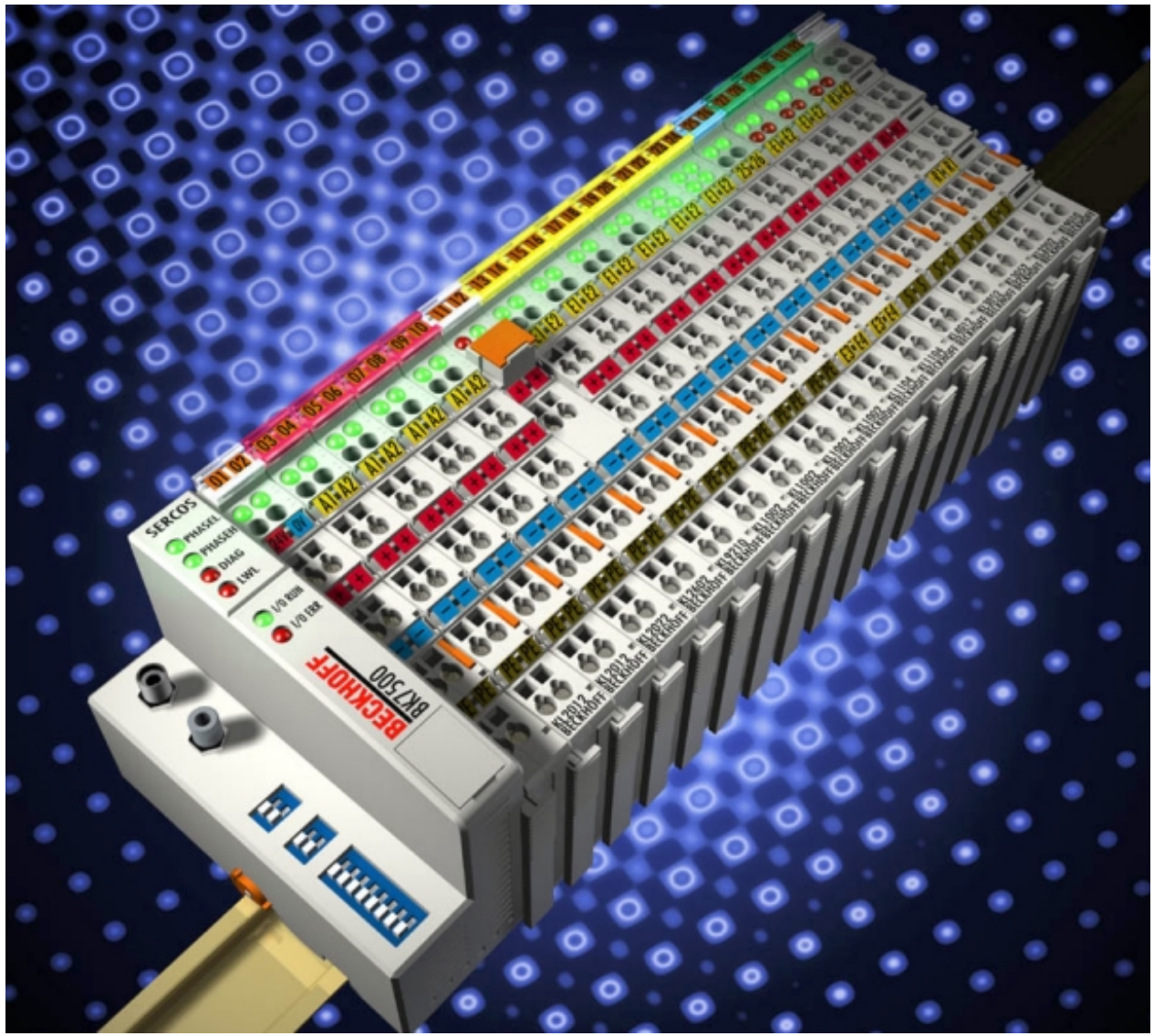
SERCOS^{i} Bus Coupler BK7500

SERCOS interface extends PC based control



2,4,8 and 16 MBaud

SERCOS^{i} I/O specification

Signal types:

- Digital
- Analogue
- Incremental
- Thermo C.
- Serial
- PWM
- Custom

SERCOS^{i} and other Fieldbus Systems

SERCOS interface extends PC based control

Advantages:

- Freedom to choose the best technology and best devices for the application requirements
- Broad variety of available devices
- Independent priorities and cycle times
- Adaptation to end-user requests and infrastructure

Disadvantages:

- At least two master cards
- Different types of technology, cabling and storekeeping

TwinCAT and SERCOS^{i} interface (1)

SERCOS interface extends PC based control

Features of TwinCAT:

- Full featured general control system
- PC with Windows® NT/2000 OS
- Real-time extension (cycle time as low as 50 µs possible)
- IEC 61131-3 PLC system
- Motion Control part supports several position generating types (e.g. electronic gear, CAM, Interpolation…)

I/O Subsystem of TwinCAT:

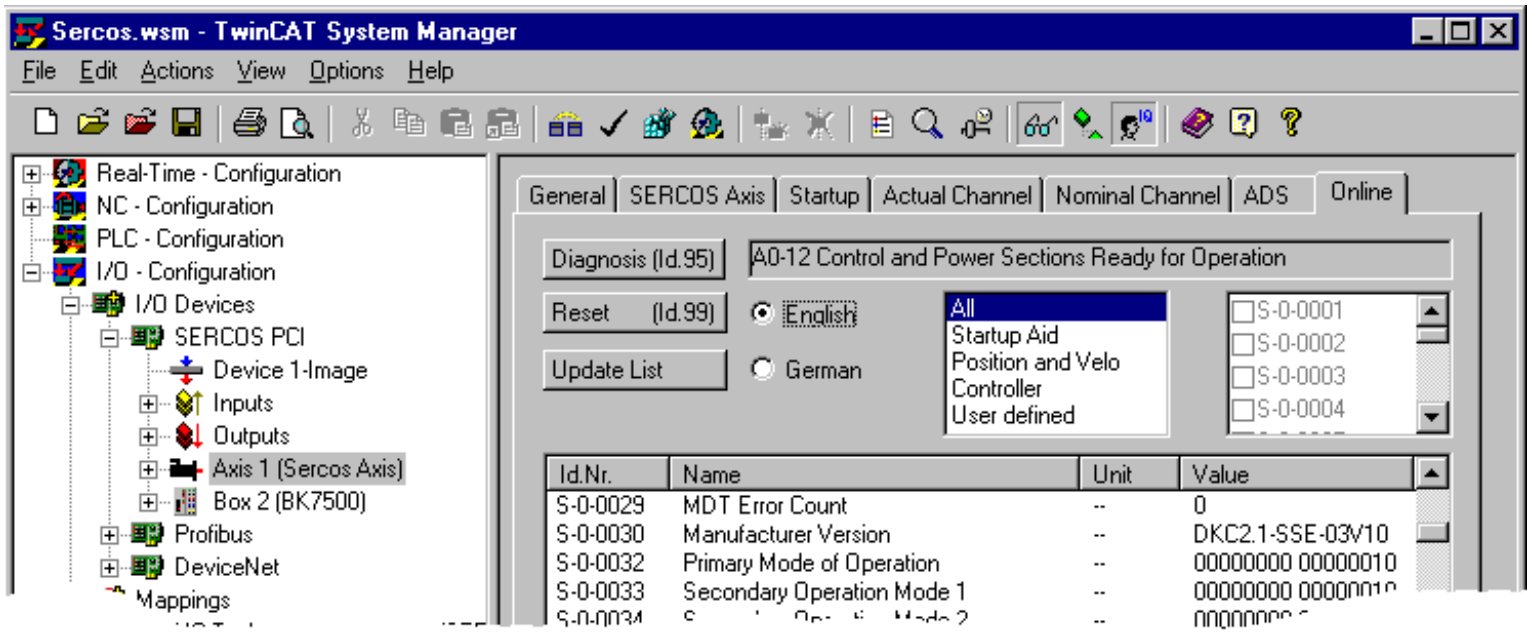
- Abstraction layer between physical and logical I/Os
- Support of all major fieldbus systems
- Synchronous and asynchronous relationships between software tasks and fieldbus systems
- 1 to 1, 1 to many, many to 1 and many to many combinations possible
- Unique configuration for all different fieldbus systems

TwinCAT and SERCOS^{i} interface (2)

SERCOS interface extends PC based control

SERCOS^{i} support in TwinCAT:

- Different master cards supported (ISA, PCI)
- Synchronization between SERCOS^{i} and TwinCAT real-time extension
- Access to all SERCOS^{i} identifiers through generic communication method (ADS) from “anywhere”
- Combination with other fieldbus systems “by design”



Summary

SERCOS interface extends PC based control

- SERCOS^{i} interface in combination with PC based control systems enables high quality motion control applications
- Best control mode selectable, depending on application
- SERCOS^{i} I/O devices and SERCOS^{i} in combination with other fieldbus systems available
- End-users require unique and consistent interfaces for configuration and programming

All we need is a PC, SERCOS^{i} and something like TwinCAT!