SERCOS goes Ethernet

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Bosch Rexroth Corporation
1986 • VDW/ZVEI “Digital Drive Interface” task force founded.
1990 • Release of the initial SERCOS interface Specification.
  • IGS, the SERCOS interface Organization, founded.
  • 1st testing laboratory at the Univ. of Darmstadt.
1993 • SERCON410 ASIC developed.
1994 • SERCOS North America founded.
1995 • 1st edition of IEC 61491 approved.
1998 • SERCOS Japan founded.
  • European Standard EN 61491 approved.
1999 • SERCON816 ASIC developed.
2003 • Ethernet-based SERCOS III announced.
2005 • First SERCOS III product released.
Who Started SERCOS?

The VDW/ZVEI Working Group

- ABB
- AMK
- AEG
- BAUMULLER
- INDRA
- INDREX
- BOSCH
- SIEMENS
- GILDEMEISTER
What Were the Working Group’s Goals?

- Open Interface Between Drives & Motion Controls
- Technology Independent
- Multi-Axes Synchronous Operation
- High Speed
- High Resolution
- Economically Practical
- Standardize as Much as Possible!
- Internal Data & Diagnostic Access
- Features & Aids for Troubleshooting
Who is SERCOS Today?
What Does SERCOS Mean?

SErial
Real-time
COmmunication
System
- Unidirectional Fiber Optic Ring
- 16 Mbit/s data rate
- Sub-microsecond synchronization
- Over 1.75M installed nodes
- Over 50 Controls Suppliers
- Over 30 Drive Supplies
- 20 year history
Synchronization with SERCOS

Machines with master drive and mechanical synchronization elements

Machines with decentralized drives synchronized via motion networks
SERCOS Applications Today

Gear Grinding
Camshaft Grinding
High-speed Free-form Milling

Wood working
Packaging Machines
Printing Machines
One Important Key: Standardized Parameters & Profiles

<table>
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<tr>
<th>IDN:</th>
<th>S-0-0036</th>
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<tbody>
<tr>
<td>Name:</td>
<td>Velocity Command Value</td>
</tr>
<tr>
<td>Attribute:</td>
<td>4 bytes, signed integer, 1 DP</td>
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<tr>
<td>Unit:</td>
<td>RPM</td>
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<tr>
<td>Minimum:</td>
<td>$-2^{31}$</td>
</tr>
<tr>
<td>Maximum:</td>
<td>$+2^{31} - 1$</td>
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<td>Operation Data</td>
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- S-0-0038 Positive Velocity Limit Value
- S-0-0039 Negative Velocity Limit Value
- S-0-0040 Velocity Feedback Value
- S-0-0043 Velocity Polarity Parameter
- S-0-0092 Bipolar Torque Limit Value
- S-0-0124 Standstill Window
- S-0-0155 Friction Torque Compensation
The SERCOS Success Story

- Well-defined standard
  - Profiles and control architectures are defined – not only physical & protocol layers
  - Comprehensive diagnostic features
  - License-free – Anybody may implement SERCOS
  - IEC 61491 standard since 1995
  - The only international & world-wide accepted digital drive interface standard
  - Thorough Conformance testing and development tools available

- Widely used
  - over 50 control manufacturers – over 30 drive manufacturers
  - Other field bus systems are usually dominated by one or very few control manufacturers
  - More than 1.75 Million nodes installed
- Tried & true SERCOS real-time communication now on Ethernet.
- Application-level compatibility to SERCOS-II.
- Direct Drive-to-Drive Cross Communication.
- Control-to-Control communication.
- Standard IP Communication for startup & diagnostics.
- Standard IP communication during real-time operation
- SERCOS Safety
- Increase data transfer rate for data amount/node count/cycle time.
- Hardware redundancy
- Hot Plugging
SERCOS III Basics

- Fast Ethernet (Full-Duplex)
- Standard Ethernet-Telegrams
- Line Topology
- Ring-Topology
- Cyclic Real-Time Data Transfer
- Cost optimized Topology: no Switches or Hubs
- I/O Device Support

CAT5e

Baud rate: 100 Mbit/s
Cycle time: 31.25 µs … 65 ms
SERCOS III New Features

Baud rate: 100 Mbit/s
Cycle time: 31.25 µs … 65 ms

Hot-Plug Device
SERCOS III New Features

Baud rate: 100 Mbit/s
Cycle time: 31.25 µs ... 65 ms

Directly connect IP devices on the SERCOS-III Slave
SERCOS III New Features

- World Wide Access
- Local Service on the Machine

PC1

Ethernet (Office)

IP

Master

PC2

I/O

PC3
SERCOS-III Cross Communications

Direct cross communications between masters (C2C, Controller-to-Controller)

Direct cross communications between Slave-Devices (CC, Cross Communications)

Example: Cross Communication between Slave-Devices S5 and S6 effected via SERCOS Network over masters M1 & M2
- Ratified as an IEC tentative standard with 96% acceptance (IEC/PAS 62410)
- Official Standard (IEC 61784/61158) planned for 2007 (together with the remaining Real-time Ethernet Protocols)
SERCOS III PCI-Card for Master & Slave (Automata)
A1 Industrial-PC (Automata)
SERCOS III Slave implementation w/ netX (Hilscher)
SERCOS III Communications Module (Hilscher)
SERCANS III, active PCI-Card (Bosch Rexroth)
IndraDrive C (Bosch Rexroth)
IndraControl L (Bosch Rexroth)
IndraMotion MLD (Bosch Rexroth)
IndraMotion MLC (Bosch Rexroth)
...
SERCOS III ...
- Ties the trusted SERCOS Technology to Ethernet
- Uses the simple and proven Synchronization Mechanism and Profile of the existing SERCOS
- Provides a painless transition from SERCOS I/II to III
- Based on inexpensive and flexible standard hardware
- Covers all existing and future requirements of a communication system for Motion Control applications (C2C, Safety, I/O)
- Approved as an IEC (IEC/PAS 62410 Ed.1) tentative standard and is a part of the future IEC 61784/61158 & IEC 61800 standards
SERCOS III – Ethernet-based Real-time Communications for Motion, Safety & I/O

SERCOS International: Stuttgart Germany: www.SERCOS.de
SERCOS North America (FL): www.SERCOS.com