Drives with PROFIBUS and PROFINET move the world
Presentation agenda

- Introduction to PROFIdrive
- Core aspects of PROFIdrive
- Mapping to PROFIBUS and PROFINET
- Device development and certification test
- Benefits for manufacturers and end users
Introduction to PROFIdrive

No Automation without drive technology

- Drive technology is a fundamental requirement for all automation tasks.

- The tasks performed and the related requirements are heavily dependent on the particular application.

- The range of applications includes …

  - … Motors with fixed and variable speed, such as pumps, fans and compressors, and drives for transport tasks

  - … Single-axis positioning for applications, such as moving, resetting, and positioning

  - … Applications with multi-axis interpolation for packaging, printing, and milling
PI supplies comprehensive and harmonized base technologies

- **PROFIBUS und PROFINET**
  - Approved and innovative

- **PROFIdrive**
  - Vendor-neutral

- **PROFIsafe**
  - Safe

- **PROFIenergy**
  - Thrifty
Interoperability – Premise for good communication

- Modern drive products are usually equipped with a digital drive interface (fieldbus interface)

- Using PROFIBUS or PROFINET all drive functions on any drive are controllable
  - On / Off, rotational direction
  - Setting of speed, position, torque
  - Parametrization of drive functions
  - Diagnosis and supervision

- Communication can be realized in a flexible way
  - The protocol to control the device can be freely selected and fits best to the product
  - Simple retrofit of existing products

- Interoperability only to products of the same manufacturer
  - No manufacture independent Interoperability
How PROFIdrive came about

PROFIdrive is the standard profile for drive technology that relies on the PROFIBUS and PROFINET communication systems. It creates multiple benefits not only for the device and system manufacturers but also for integrators and end users.

- 1991 Focus on variable speed drives exclusively on PROFIBUS.
- 2002 New functionality of PROFIBUS
  - DPV1 acyclic services
  - DPV2 clock cycle synchronization
- 2005 PROFINET mapping added
- 2006 PROFIsafe integrated
- 2007 PROFIdrive becomes international standard IEC 61800-7
Principles

Concept of
- Integrating standard drive and "motion control" functionality with PLC sequencing logic.
- Distribution of Application processes across the devices
  - Motor-current control
  - Speed control
  - Position control
  - Path interpolation
  - Logic control

The communication system provides the link between the distributed processes, making use of dedicated services such as
- Cyclic IO
- Acyclic services
- Clock synchronization
- Profile-based Slave-to-Slave communication
Structure of the profile

The main part 1 of the profile describes those functions that are separate from the communication system.
- Part 2 describes using of PROFIBUS
- Part 3 describes using of PROFINET

Scalable communication performance
- From a basic fieldbus to a system-wide Ethernet network
  - Same application view
  - Without any changes needing to be made to the automation system
PROFIdrive base model

The general automation concept of PROFIdrive

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Data model and data flow in a drive
Device behavior – State machine

General state machine of a PROFIdrive drive
PROFIdrive Parameter Model

Profile parameters
- Same parameters for all drives
- Drive identification
- Fault buffer
- Drive control
- Device identification
- Process data configuration
- List of all parameters

Manufacturer-specific parameters
- Complex devices can add up to well over 1000
- Provide manufacturers with maximum flexibility
- Manufacturer specific control and monitoring

Parameter access
- Acyclic access
- 256 axes per drive can be accessed
- Up to 65,535 parameters per axis
- Up to 65,535 array elements per parameter
- Value, descriptions and associated text elements
PROFIdrive Base mode parameter access

Controller/Supervisor (Client) → Communication system → DO parameter manager (Server)

Parameter Request → Write parameter request to PAP → Parameter Request

Error or Response not Yet available → Read parameter response from PAP → Error or Response not Yet available

Read parameter response from PAP → Parameter Response

PAP: Parameter access point

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**Diagnosis**

**PROFIdrive diagnostic functions**

- **Drive**
  - Drive exception state
  - Transitions
  - Mapping of warnings onto fault classes
  - Mapping of actual fault situation onto fault classes

- **Warning mechanism**
  - Provides specific actual state
  - Shows actual state

- **Fault buffer mechanism**
  - Records state transitions
  - Shows history of state transitions and does fault acknowledge

- **Fault classes mechanism**
  - PROFIdrive fault classes
  - Standard diagnosis mechanism
  - Standard alarm mechanism

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Diagnosis

- Drive exception state
- Transitions
- Warning mechanism: Provides specific actual state
- Fault buffer mechanism: Records state transitions
- Optional: Shows actual state
- Shows history of state transitions and does fault acknowledge

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<td>Add. Value</td>
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Fault Codes:
- PNU947
- PNU946
- PNU948
- PNU949
Drive technology is a fundamental requirement for all automation tasks.

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The range of applications includes …

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- … Single-axis positioning for applications, such as moving, resetting, and positioning

- … Applications with multi-axis interpolation for packaging, printing, and milling
Application Classes

- Standard drive (Class 1)
- Standard drive with technological function (Class 2)
- Positioning drive (Class 3)
- Central motion control (Classes 4 and 5)
- Decentralized automation with synchronized processes and electronic shafts (Class 6)
Standard drive (Class 1)

PROFIdrive application class 1

- Drive
  - Open Loop Speed Ctrl, or Closed Loop Speed Ctrl.
- M
- Encoder (optional)

Automation

Technology

Speed setpoint

Speed actual value

- Drive
  - Open Loop Speed Ctrl, or Closed Loop Speed Ctrl.
- M
- Encoder (optional)

- Drive
  - Open Loop Speed Ctrl, or Closed Loop Speed Ctrl.
- M
- Encoder (optional)
Standard drive with distributed technology (Class 2)

PROFIdrive application class 2
Positioning drive (Class 3)

**PROFIdrive application class 3**

Control (PLC/NC)

- Positioning Control Word
- Positioning Status Word

Drive

- Interpolation + Position Control + Speed Control

Encoder

M

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Isochronous mode for what?

... Isochronous mode assures a bus cycle with 1 μs accuracy

All drive application processes are synchronized to the bus cycle ...

... allowing high performance and high precision motion control applications!

Fieldbus cyclic data exchange is precisely synchronized based on the PLC master clock.

Setpoint and actual values of all devices connected to the bus are sampled resp. transferred at the same time (< 1 μs accuracy)
Example of a machine using isochronous drives

Distributed automation system based on isochronous applications:
- Cam dis
- Electronic gear box
- Flying saw
Central motion control (Class 4 and 5)

Control (PLC/NC)
- Technology
- Interpolation, Position Control

Speed Setpoint + ...
Clock
Actual Position + ...

Drive
- Closed Loop Speed Control*

Encoder

M

Drive
- Closed Loop Speed Control*

Encoder

M

Drive
- Closed Loop Speed Control*

Encoder

M

*) Closed Loop Speed Control operates clock synchronous to PLC application

PROFIdrive application class 4 and 5
Standard drive with distributed technology (Class 6)

PROFIdrive application class 6
### Telegram for Standard drive (Class 1)

#### Standard Telegram 1:

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<tr>
<th>PZD number</th>
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**Standard telegram 3: n set interface, 32 bit, with one sensor**

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**Standard telegram 4: n set interface, 32 bit, with two sensors**

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Integration of PROFIsafe

- Optional one common control for safety and standard control
- Control of safety functions
- Drive Profile Safety-telegram (cyclic)
- Drive Profile Standard-telegram (cyclic)
- Drive Profile Additional safety info (cyclic)
- e.g. speed setpoint
- Drive Based Safety Prozess
- Drive Control Prozess

- Safety application
  - PROFIsafeDriver
- User application, Motion Control
- Drive Profile Interface
- Drive Control
- Inverter
- G
- M

- Safety State Machine
- Drive based Safety Functions
- State Machine
- Setpoint channel
- Drive Profile Interface
- PROFIsafe driver
- Drive Safety Interface
- Coordination
**PROFIdrive Conformity test**

- The products (test samples) undergo automated testing based on script descriptions
- Test steps are recorded automatically in the product test log
- Quality system and accreditation procedures ensure a consistent level of test quality
**Benefits...**

**...for device and system manufacturers**

- Cost-effective thanks to only one communication technology for drives, control, I/O, and B&B
- Highly flexible thanks to integrated technology for the entire drive spectrum
- Functional security thanks to independent certification
- International acceptance thanks to IEC standardization and recommendation by end-user organizations such as OMAC
- Fit for the future on the basis of PROFIBUS and PROFINET

**...integrators and end users**

- Cost-effective thanks to a single bus technology, reduced training requirement and high impact
- Reduction in costs thanks to lower installation overheads and system-wide application programs
- Flexibility in terms of the adaptation of drive equipment
- User-friendly thanks to the interoperability and interchangeability of devices built by different manufacturers
- Investment security thanks to IEC standardization
- Fit for the future thanks to the position of PROFIBUS and PROFINET as market leaders

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