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Solutions for a world in motion

Actuator controls

AUMATIC AC 01.1/ACExC 01.1

Foundation Fieldbus

Fieldbus Foundation

Manual

Device integration Fieldbus

Read operation instructions first

- Observe safety instructions.

Purpose of the document:

This document is intended to support the system integrator in integrating the fieldbus interface into the DCS.

Reference documents:

- Operation instructions (assembly, operation, commissioning) for actuator
- (Operation and setting) manual AUMATIC AC 01.1/ACExC 01.1 Foundation Fieldbus
  Can be downloaded from the Internet (www.auma.com) or ordered directly from AUMA (addresses from page 82).

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1. Safety instructions

1.1. General notes on safety

Standards/directives

AUMA products are designed and manufactured in compliance with recognised standards and directives. This is certified in a declaration of incorporation and a declaration of conformity.
The end user or the contractor of the plant must observe national laws and regulations regarding assembly, electrical connection, and commissioning on site.
This includes in particular the fulfilment of the requirements in standards and directives for potentially explosive areas, such as e.g. EN 60079-17 “Inspection and maintenance of electrical installations in hazardous areas (other than mines) (IEC 60079-17:2002)”.
This includes, in particular the observance of the applicable configuration directives for fieldbus applications.

Safety instructions/ warnings

All personnel working with this device must be familiar with the safety and warning instructions in this manual and observe the instructions given. Safety instructions and warning signs on the device must be observed to avoid personal injury or property damage.

Qualification of staff

Assembly, electrical connection, commissioning, operation, and maintenance must be carried out exclusively by suitably qualified personnel authorised by the end user or contractor of the plant.
Prior to working on this product, the staff must have thoroughly read and understood these instructions and, furthermore, know and observe officially recognised rules regarding occupational health and safety.
Work performed in potentially explosive atmospheres is subject to special regulations which have be observed. The end user or contractor of the plant are responsible for respect and control of these regulations, standards, and laws.

Commissioning

Prior to commissioning, it is important to check that all settings are in compliance with the requirements of the application. Incorrect settings might present a danger to the application, e.g. cause damage to the valve or the installation.
The manufacturer will not be held liable for any consequential damage. Such risk lies entirely with the user.

Safe operation

Prerequisites for safe and smooth operation:

- Correct transport, proper storage, mounting and installation, as well as careful commissioning.
- Exclusively operate the device if it is in perfect condition while observing these instructions.
- Immediately inform about any faults and damage and allow for corrective measures.
- Observe recognised rules for occupational health and safety.

Protective measures

The end user or the contractor are responsible for implementing required protective measures on site, such as enclosures, barriers, or personal safety equipment for the staff.

Maintenance

Any device modification requires the consent of the manufacturer.

1.2. Range of application

AUMA actuator controls are exclusively designed for the operation of AUMA actuators.

Other applications require explicit (written) confirmation by the manufacturer.

The following applications are not permitted, e.g.:

- motor activation
- pump activation

No liability can be assumed for inappropriate or unintended use.

Observance of these operation instructions is considered as part of the device's designated use.

1.3. Warnings and symbols

The following references and symbols are used in these instructions:

NOTICE

Potentially hazardous situation. Failure to observe this warning may result in property damage.

Information

The term **Information** preceding the text indicates important notes and information.

For assembly, operation, and commissioning, observe the additional safety and warning instructions of the reference documents (page 2).

Symbol for CLOSED

Symbol for OPEN

Via the menu to parameter
Describes the path within the menu to the parameter. By using the push buttons of the local controls you may quickly find the desired parameter in the display.

Description of the parameter settings/indications
Describes the setting/viewing possibilities of a parameter.

Step by step
Provides a detailed description of each step for setting/viewing the parameter.

2. General information regarding Foundation Fieldbus

For the exchange of information among automation systems and between automation systems and the connected distributed field devices, the use of serial fieldbus systems as communication system is state-of-the-art. Thousands of applications have proved impressively that, in comparison with conventional technology, cost savings of up to 40 % in wiring, commissioning, and maintenance are achieved by using fieldbus technology. While in the past the fieldbus systems used were often manufacturer specific and incompatible with other bus systems, the systems employed today are almost exclusively open and standardized. This means that the user does not depend on individual suppliers and can choose within a large product range the best product at the most competitive price.

Historical development

In 1992, an international group, the ISP (Interoperable Systems Project) was founded with the intention to create an internationally uniform fieldbus standard for use in hazardous environments. At the same time, the manufacturers and users of the French FIP (Flux Information Process; previously: Factory Instrumentation Protocol) established the international user organisation WorldFIP. Together with the FIP North America, they were a strong counterweight to the ISP consortium. In 1994, for technical, economic, and political reasons, the ISP and the WorldFIP merged to form the Fieldbus Foundation. The aim of the Fieldbus Foundation was and is to create a single, international fieldbus standard for hazardous environments which will find widespread use as IEC standardised fieldbus. The website of the Fieldbus Foundation is www.fieldbus.org.

User organisation

The Fieldbus Foundation is an independent non-profit organisation. The mission is to develop and support a global, uniform fieldbus infrastructure for automation tasks – the Foundation Fieldbus. Members include users and manufacturers of field devices and automation systems. The Fieldbus Foundation contains various workshops which are responsible, among others, for technical support, marketing, and support of the members. Website of the Fieldbus Foundation: www.fieldbus.org.

Certification of the devices

The Fieldbus is an open bus standard which enables devices of different manufacturers to be integrated in one system and, if required, interchanged (interoperability). This is only feasible when all devices exactly meet the specification. If the devices are approved by Fieldbus Foundation, this implies a guarantee for the user and manufacturer that those devices comply with the specification.

2.1. Performance features

The Foundation Fieldbus provides a broad spectrum of services and functions compared to other fieldbus systems:

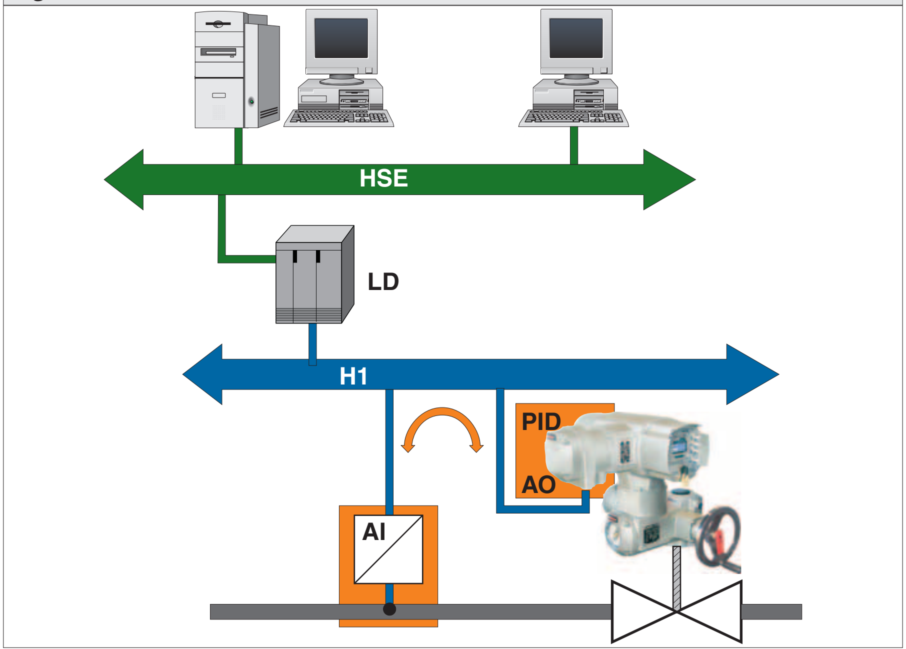
- Bus-powered field devices
- Line or tree topology
- Deterministic (predictable) dynamic behaviour
- Distributed data transfer (DDT)
- Standardised block model for uniform device interfaces (interoperability, interchangeability)
- Trend functions and alarm treatment
- Flexible extension options based on device descriptions
- Intrinsic safety for use in hazardous areas (option)

Decentralised process data processing

The distributed data transmission within the Foundation Fieldbus network enables individual field devices to independently perform automation tasks via standardised function blocks. If a field device contains e.g. the PID function block, it is able to independently control a process variable. This automation decentralisation from the automation to the field level relieves the central process control.

Typical Foundation Fieldbus structure:

Figure 1



HSE	FF bus based on high speed Ethernet		Actuator controls with function blocks:
H1	FF bus based on H1	PID	Process controller
LD	Linking device	AO	Analogue output (valve setpoint)
		AI	Analog Input (e.g. flow rate measured by sensor)

2.2. Layered communications model

The structure of Foundation Fieldbus is based on the ISO/OSI reference model (**I**nternational **S**tandards **O**rganisation - **O**pen **S**ystems **I**nterconnection). This model consists of 7 layers. Foundation Fieldbus just uses three layers:

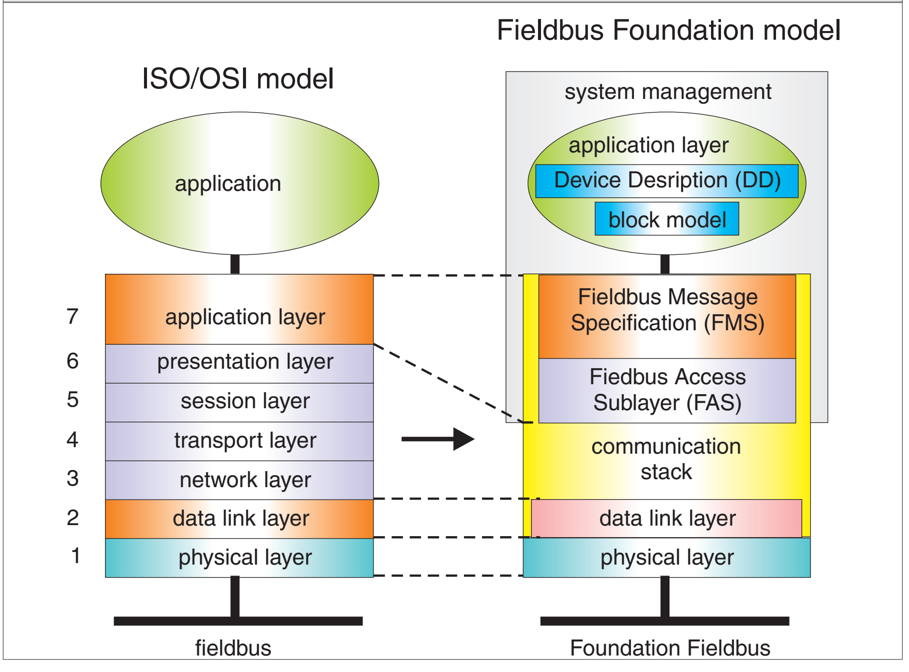
- Layer 1: Physical layer
- Layer 2: Data link layer
- Layer 7: Application layer

As is the case for many other bus systems, layers three to six are not used. Layer 7 is subdivided into a Fieldbus Access Sublayer (FAS) and a Fieldbus Message Specification (FMS). The Communication Stack covers the tasks of layers 2 and 7.
The special feature of Foundation Fieldbus is the device-dependent application layer, placed above the 7th layer. Whereas the actual application process is not determined for the ISO/OSI model, the Fieldbus Foundation defines a special application layer. This layer contains a block model with function block and a device description (DD). Depending on which blocks are implemented in the block model of a device, users can access a variety of services.

Thus, the Foundation Fieldbus specification consists of 3 main function elements:

- Physical layer
- Communication stack
- Application layer

Figure 2



2.3. Physical layer

The lowest bus level, the physical layer, complies with the IEC 61158-2 standard. This layer specifies the physical connection to the fieldbus network and how to solve communication tasks.
Foundation Fieldbus uses two systems for the communication. For communicating and for directly connecting the field devices, the low speed H1 version is implemented; the fast HSE version, based on Ethernet, is used within the control system.

2.3.1 H1 bus

The following summary provides a brief overview of the features and functions of the H1 bus. For more details, refer to the various Application Guides of the Fieldbus Foundation (e.g. AG 140, AG 163).

- Data transfer: Manchester coding
- Data transfer rate 31.25 kbit/s (default setting, cannot be modified).
- Requirements for flawless communication: Sufficient power supply for the field devices, i.e. minimum 9 volts for each device. Software tools are available for network planning, calculating the resulting currents and terminal voltage on the basis of the network topology, of the resistivity, and the supply voltage.
- Field device connection via H1 version. The Foundation Fieldbus power supply unit is connected to the bus line in the same way (parallel) as a field device. Field devices powered by supply sources other than the bus must be additionally connected to their own supply sources.
- The maximum power consumption of current consuming devices within the H1 version must be lower than the electric power supplied by the Foundation Fieldbus power supply unit.
- Network topologies: Line topology; when using junction boxes, also star, tree or a combination of different topologies.
- Device connection: Often via short spurs to enable connection/disconnection of the devices without interrupting communication to other users.
- Maximum length of a spur: 120 m, depending on the number of spurs used as well as the number of devices per spur.
- Maximum length of an H1 segment without repeater: 1,900 m.
- Maximum length of an H1 segment using maximum 4 repeaters:
  5 x 1,900 m = 9.5 km.
  All spurs from the field devices to the junction box have to be included in the total length calculation.
- Number of bus users per segment: In non-intrinsically safe areas: Max. 32, in explosion-hazardous areas, this number is reduced to significantly fewer devices (due to power supply limitations).
  Based on the available H1 bandwidth, the typical number of devices per segment is max. 10 – 14 devices per segment.
- Fieldbus cable: Type A (recommended), only this type is specified for the maximum cable length of 1,900 m.
- Termination: Two terminators per bus segment, typically one at each end of the longest fieldbus line.
- Bus cable shielding: If shielded cables are used (recommended), the shield may only be grounded at one single point within the segment (typically near the Foundation Fieldbus power supply).

2.3.2 High Speed Ethernet (HSE)

HSE is based on standard Ethernet technology. The required components are therefore widely used and are available at comparatively low costs. The HSE data transfer speed runs at 100 Mbit/s and can be equipped with both copper cables and optical fibre cables.
The Ethernet operates by using random (not deterministic) CSMA bus access.
This method cannot be applied to all automation applications because, sometimes, real-time capability is required. The extremely high transmission rate enables the HSE to respond sufficiently fast when the bus load is low and only few devices are connected. With respect to process automation demands, real-time requirements are met in any case.
If the bus load must be reduced due to the multitude of connected devices, or if several HSE sub-networks are to be combined to create a larger network, Ethernet switches must be used. A switch reads the target address of the data packets that must be forwarded and then passes the packets on to the associated sub-network. This way, the bus load and the resulting bus access time can be controlled as to adapt it ideally to the respective requirements.

2.3.3 Connection between H1 and HSE

To connect the comparatively slow H1 segments to the HSE network, linking devices are required (refer to figure 1).
The linking device adapts the data transfer rates and the data telegrams of both networks while considering the direction of transmission. This way, powerful and widely branched networks can be installed in larger plants.

2.3.4 Data transmission and power supply

Within the Foundation Fieldbus network, a device transmitting data typically varies its power consumption by ±10 mA at 31.25 kbit/s to generate a typical ± 0.5 V voltage change at a power supply with 50 Ohm impedance. This voltage change is modulated onto the 9 – 32 V DC H1 power supply.

2.4. Communication stack

The field devices used with Foundation Fieldbus are capable of independently assuming automation tasks, i.e.:
- Each controlling field device can directly exchange data with other devices (e.g. reading measuring values, forwarding control values).
- All field devices send and receive data at pre-defined points in time.
- It is ensured that two or more devices never access the bus simultaneously.

To meet these requirements, the Foundation Fieldbus needs a central communication control system (Link Active Scheduler = LAS).

2.4.1 Link Active Scheduler - LAS

A field device performing the Link Active Scheduler (LAS) function controls and schedules the bus communication. It controls all bus activities by means of various data telegrams that it sends to the available devices. Since the LAS also continuously polls unassigned device addresses, it is possible to connect devices during operation and to integrate them in the bus communication.

Devices which can be used as LAS are called Link Master Devices. Basic devices do not have LAS capacity.

In a redundant system containing several link master devices, only one link master takes over the LAS task. If the active LAS device fails, another link master device will take over (fail operational design).
The LAS continuously transmits and updates the live list.

If a device is removed from or added to the list, the LAS transmits this change to all link master devices (broadcast message). This way, all link masters maintain a copy of the current live list so that they can become the LAS without any loss of information.

2.4.2 Communication control

The communication services of the FF specification use scheduled and unscheduled data transmission. Time-critical tasks, such as the control of process variables, are exclusively performed by scheduled services, whereas programming and diagnostic functions are carried out using unscheduled communication services.

Scheduled data transmission

To solve communication tasks in time and without access conflicts, all time-critical tasks are based on a strict transmission schedule. This schedule is created by the Foundation Fieldbus system operator during the configuration of the FF system.
The LAS periodically broadcasts a synchronisation signal (TD: Time Distribution) on the fieldbus so that all devices have exactly the same time information. In scheduled transmission, the point in time and the sequence of data telegrams are exactly defined.

This is why it is called a deterministic system.

For each task to be executed, a certain time frame is scheduled.
Based on this schedule, a transmission list is generated which defines when a specific field device is prompted to send its data. Upon receipt of a special trigger telegram (CD: Compel Data), the respective device (publisher) broadcasts the data in the buffer of all devices which are configured to receive this data (subscriber).
This type of transmission is therefore called the “Publisher/subscriber” method.

Unscheduled data transmission

Device parameters and diagnostic data must be transmitted when needed, i.e. on request. The transmission of this data is not time-critical. For such communication tasks, the Foundation Fieldbus offers the unscheduled data transmission.
Permission for a certain device to use the fieldbus for unscheduled communication tasks is granted by the LAS device, provided that no scheduled data transmission is active.
Every device may use the bus as long as required until it either returns the bus access (token), or until the maximum granted time to use the token has elapsed.
Unscheduled transmission offers two data transfer methods: “Client/Server” to adapt device setting, configuration, and upload/download of diagnostic data as well as ‘Report Distribution’ to send alarms.

2.4.3 Services

The Fieldbus Access Sublayer (FAS) and the Fieldbus Message Specification (FMS) layer form the interface between the data link layer and the user application (refer to figure 2). The services provided by the FAS and FMS are invisible for the user. However, performance and functionality of the communication system considerably depend on these services.

Fieldbus Access Sublayer (FAS)

FAS services create Virtual Communication Relationships (VCR) which are used by the higher-level FMS layer to execute its tasks. VCRs describe different types of communication processes and enable faster processing of the associated activities. Foundation Fieldbus communication use the three different VCR types as follows (table 1).

Table 1

Client/Server	Report Distribution	Publisher/Subscriber
User communication	Events, alarms, trends	Transmitting process data
Setpoint changes Change in operation mode and device data Upload/download Adapting alarm values Remote diagnostics	Send process alarms to user console Transferring trend data for long term data logging.	Transfer process values from sensors and other devices

The publisher/subscriber VCR type is used to transmit the input and output data of function blocks. As described above, scheduled data transmission is based on this type of VCR.

The Client/Server VCR type is the basis for operator initiated requests, such as setpoint changes, adaptations and change of control parameters, diagnostics, device upload, and download, etc.

Report Distribution is used to send alarms or event notifications to the operator consoles or similar devices. Client/Server and Report Distribution data transmission is unscheduled, due to the fact that the time of transmission cannot be foreseen and therefore not be scheduled.

Fieldbus Message Specification (FMS)

FMS provides the services for standardised communication. Data types that are communicated via the fieldbus are assigned to certain communication services. For uniform and clear assignment, object descriptions are used. Object descriptions contain definitions of all standard transmission message formats as well as application-specific data. Special, predefined communication services are available for each object type.

Object descriptions are collected together in a structure called object dictionary.

2.5. Application layer

An important criterion for a fieldbus system to be accepted by the market is the interoperability of the devices. Interoperability means the capability of devices of different manufacturers to communicate with each other. In addition, it must be ensured that a device from one manufacturer can be substituted with that of another.
This requires an open protocol specification which defines uniform device functions and application interfaces. Other network users and application programs can use these interfaces to access the functions and parameters of the field devices. The Foundation Fieldbus meets these requirements by means of standardised function blocks and device descriptions.

2.5.1 Block model

Foundation Fieldbus assigns all functions and device data to three different types of blocks:

- Resource block
- One or several function blocks
- Several transducer blocks.

The assignment depends on the device function type.

Resource block

The resource block describes characteristics of a fieldbus device, e.g. device name, manufacturer, serial number, hardware and firmware version, etc.

Function blocks

Function blocks describe the device functions and define how these can be accessed. The schedules of the scheduled data transmission are based on these function blocks. Each block (including the pertaining input and outputs) has a definite task. Each device is equipped with at least one function block.
The FF specification has defined standard function blocks which can be used to describe all basic functions. They are listed below:

- AI: Analog Input
- AO: Analog Output
- DI: Discrete Input
- DO: Discrete Output
- PID: Proportional/Integral/Derivative

Transducer blocks

Transducer blocks expand the complexity and the application options of a device. Their data enables the input and/or output parameters of a function block to be influenced. Measuring and positioning data can be calibrated and reset, characteristics can be linearised or physical units can be reset using additional process data.

Further objects

Besides the three block types, the following additional objects are defined within the block model:
Link objects define the links between different function blocks within the field devices as well as across the fieldbus network.
Alert objects allow reporting alarms and events on the fieldbus.
Trend objects allow trending function block data for access and analysis by higher-level systems.
View objects are predefined groups of data and block parameter records that can be used to group and display the parameters according to their tasks: Process control, configuration, maintenance, additional information.

2.5.2 Device descriptions

During start-up and maintenance as well as when performing diagnostic functions, an open communication system must ensure that higher-level control computers or control systems can access all field devices and that respective controls are available.
The device descriptions (DDs) contain the necessary information to fulfill these requirements. They provide information needed to understand the meaning of the device data and display them correctly on the operator console.

2.5.3 System management

The system management of each device has the following tasks:

- Synchronisation of relevant device activities, i.e. according to the predefined transmission schedule.
- Cyclic processing of the transmission list (LAS only) within the predefined schedule.

Further tasks performed by the system management:

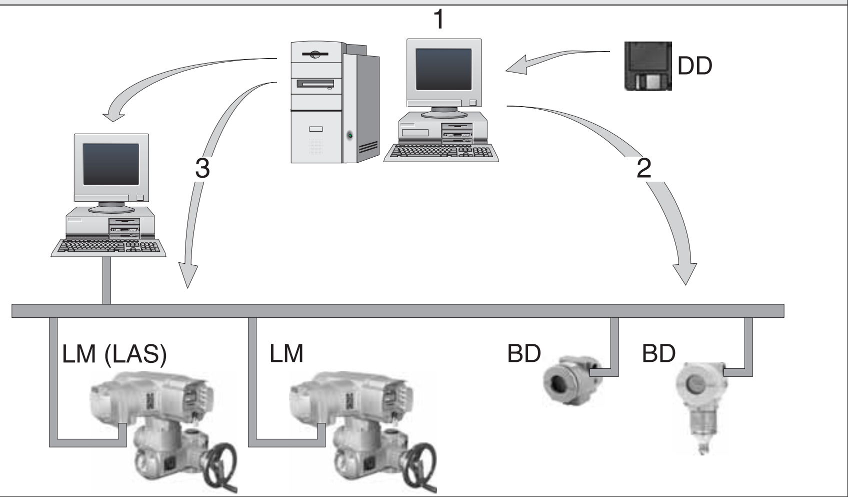
- Automatic assignment of LAS function to another Link Master if the active LAS fails.
- Synchronisation of time information
- Automatic address assignment for new devices within the communication network

The automatic assignment of a provisional device address allows the assignment of a clear and unambiguous device address during commissioning while communication is active. For this address assignment procedure, special default addresses are reserved allowing to access the new devices which are not yet configured. A new device is integrated into the communication network after assigning a device tag as well as a new, unambiguous and final bus address. The default address used is then available again for the assignment of further devices still due to be configured.

2.5.4 System configuration

Scheduled communication as well as all fieldbus devices must be configured before their first start-up (figure 4). This requires a configuration tool, e.g. the NI-FBUS Configurator by National Instruments.

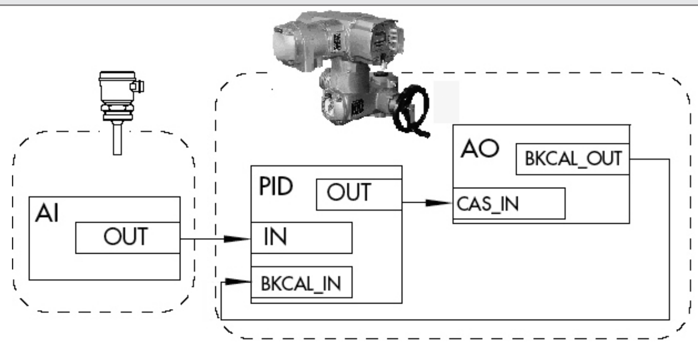
Figure 4



1 Configuration device
2 Configurating basic devices
3 Configurating LAS and link master

Prior to the actual commissioning, the Device Description (DD) for all devices to be configured must be installed in the configuration tools. The configuration software must either be able to access the device descriptions in the predefined libraries, or the device descriptions must be downloaded via external data carriers.
The configuration software helps to determine how and with which devices the measurement and control tasks of a plant are processed by connecting the function blocks of the field devices. This task can be performed using a graphical user interface. For this, just connect the inputs and outputs of the corresponding block symbols and define the block behaviour.
Figure 3 shows an example for a filling level control. The sensor output value is connected to a PID function block. This block can be provided e.g. by actuator controls. The subsequent analogue output acts on the actuator positioner for filling level control.

Figure 3



Filling level sensor with function block:
AI Analog Input (filling level)

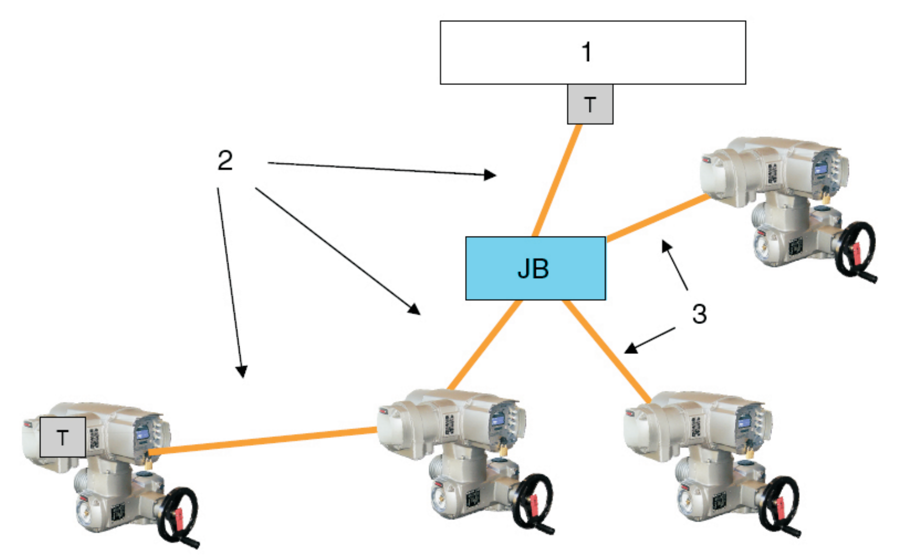
Actuator controls with function blocks:
PID Process controller
AO Analog Output

2.6. Topology

Several structures are available for Foundation Fieldbus:

Point-to-point topology, whereby only one device is connected to each line.
Bus with **spurs**; for this structure, the fieldbus devices are connected to the bus segment via spurs.
Line topology; for this structure, the fieldbus cable of a segment is led from device to device and connected to the terminals of each fieldbus user. Due to the AUMA plug/socket connector, installations with AUMA actuators implementing this topology can easily and individually be disconnected from the network without impairing the availability of the remaining segment.
Tree topology; for this structure, the devices of one fieldbus segment are connected to a common junction box via separate fieldbus cables. The maximum spur length must be observed when implementing this topology.
It is furthermore possible to combine the topology options mentioned.

Figure 5



1 DCS	3 Spurs
2 Trunk	JB Junction box

Spurs or tee connectors are possible for Foundation Fieldbus.
The possible fieldbus line length is determined by the type of cable, the cross section, and the type of the bus supply.

Cable length = trunk length + total spur length
Maximum length = 1,900 metres with cable type A

By using up to four repeaters, a maximum of 5 x 1,900 m = 9,500 m can be achieved.
A terminator is to be installed at both ends of the main trunk.

Table 3

Number of devices	Permissible spur length
The number of devices possible on a fieldbus depends on the power consumption of devices, the type of cable used, the use of repeaters, etc. For details please refer to Physical Layer Standard	Permissible spur length for one device per spur - any further device reduces the permissible spur length by 30 metres
25 – 32	1 m
19 – 24	30 m
15 – 18	60 m
13 – 14	90 m
1 – 12	120 m

For details regarding the different topology options, please refer to the Application Guides published by Fieldbus Foundation:
AG-140 31.25 kbit/s Wiring and Installation
AG-163 31.25 kbit/s Intrinsically Safe Systems
AG-170 Function Block Capabilities in Hybrid/Batch Applications
AG-181 System Engineering Guidelines

Bus cables

Various types of fieldbus cables can be applied for Foundation Fieldbus. The following table lists the cable types specified by the IEC/ISA 61158-2 Physical Layer Standard.
Type A is the preferred fieldbus cable. This cable should be used in new installations. However, other cable types may be used for the fieldbus wiring (e.g type B, C, and D). Their disadvantage is the reduced cable length; therefore, their use is not recommended.

Table 2

	Type A (Reference)	Type B	Type C	Type D
Cable design	Twisted conductor pair	One or multiple twisted conductor pairs, overall shield	Multiple twisted pairs, not shielded	Multiple non-twisted pairs, not shielded
Conductor cross-section (nominal)	0.8 mm² (AWG 18)	0.32 mm² (AWG 22)	0.13 mm² (AWG 26)	1.25 mm² (AWG 16)
Loop impedance (DC current)	44 Ω/km	112 Ω/km	264 Ω/km	40 Ω/km
Wave resistance at 31.25 kHz	100 Ω ± 20 %	100 Ω ± 30 %	not specified	not specified
Wave attenuation at 39 kHz	3 dB/km	5 dB/km	8 dB/km	8 dB/km
Capacitve asymmetry	2 nF/km	2 nF/km	not specified	not specified
Group delay distortion (7.9 – 39 kHz)	1.7 µs/km	not specified	not specified	not specified
Degree of shield coverage	90 %	not specified	not specified	not specified
Recommended network expansion (incl. spur line)	1,900 m	1,200 m	400 m	200 m

3. Commissioning

3.1. Introduction

The AUMATIC with Foundation Fieldbus is commissioned via the fieldbus network. This includes both device tag and device address setting as well as the function block application configuration and network configuration.

3.2. Function blocks of the AUMATIC

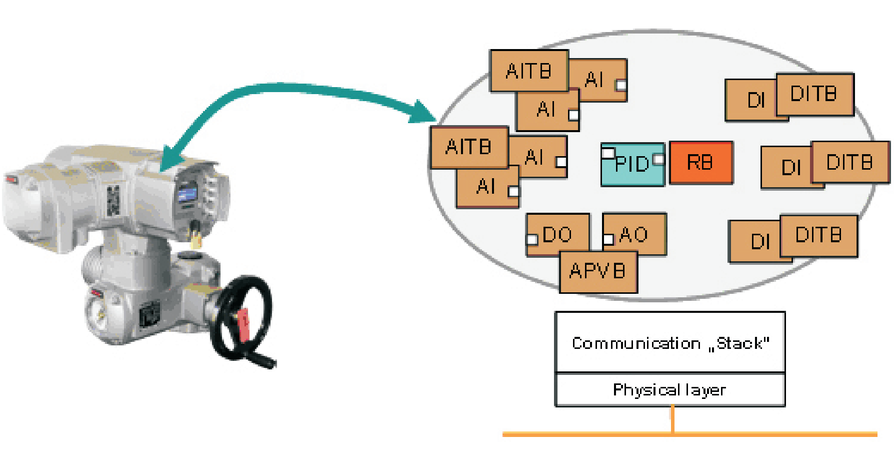
Input and output parameters of function blocks can be connected to perform the automation task via Foundation Fieldbus.
The AUMATIC contains the following function blocks:

Table 4

No.	Abbreviation	Description
1	RB	Resource Block
4	AI	Analog Input function block
2	AITB	Analog Input Transducer Block
3	DI	Discrete Input function block
3	DITB	Discrete Input Transducer Block
1	AO	Analog Output function block
1	DO	Discrete Output function block
1	APVB	Advanced Positioner Valve Basic transducer block

Each discrete input function block is connected to a discrete input transducer block.
Two analog input function blocks are connected to one common analog input transducer block. The discrete output and the analog output function block also have a common transducer block (APVB).
No transducer blocks are required for the PID function block or the resource block.

Figure 6



3.2.1 Operation commands

Electric operation via Foundation Fieldbus of an actuator with AUMATIC can be performed via the Analog Output function block (AO) for setpoint operation commands or, alternatively, via the Discrete Output function block (DO) for OPEN - STOP - CLOSE commands.
Both function blocks are connected to the Advanced Positioner Valve Basic transducer block (APVB). The APVB converts the Foundation Fieldbus data received via DO or AO into signals to change the actuator position.

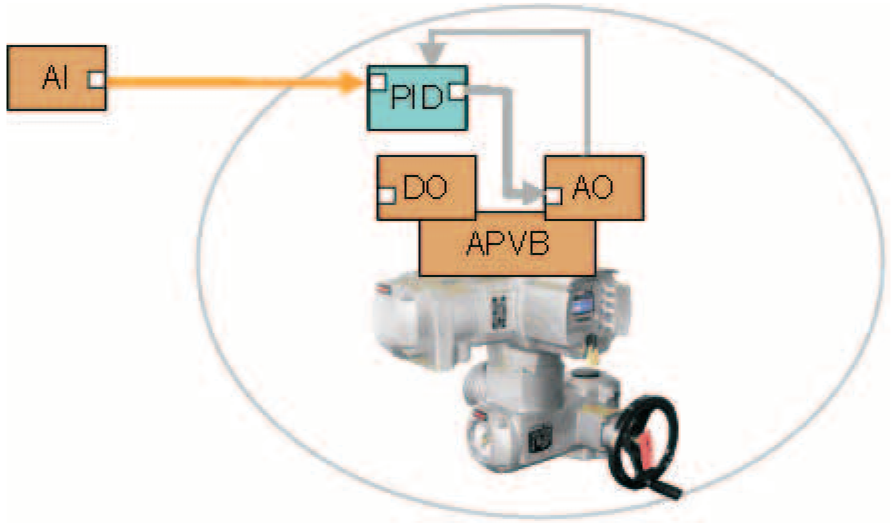
Information

If the actuator is driven via the AO for setpoint operation commands, the DO must be set to Out_of_Service (OOS); if the actuator is driven via the DO for the OPEN - STOP - CLOSE commands, the AO must be set to Out_of_Service (OOS).

Operation commands via the analog output function block

The integral PID function block can be used as controller function block to reduce the number of required external VCRs. This is not imperative. The PID function block can be activated within another external device, e.g. the DCS; however, an additional VCR is then required for feedback from the AO to the PID.

Figure 7



The AO function block accepts setpoints between 0 and 100 %.
A setpoint of 0% signifies that the actuator fully closes, a setpoint of 100 % signifies that the actuator fully opens.

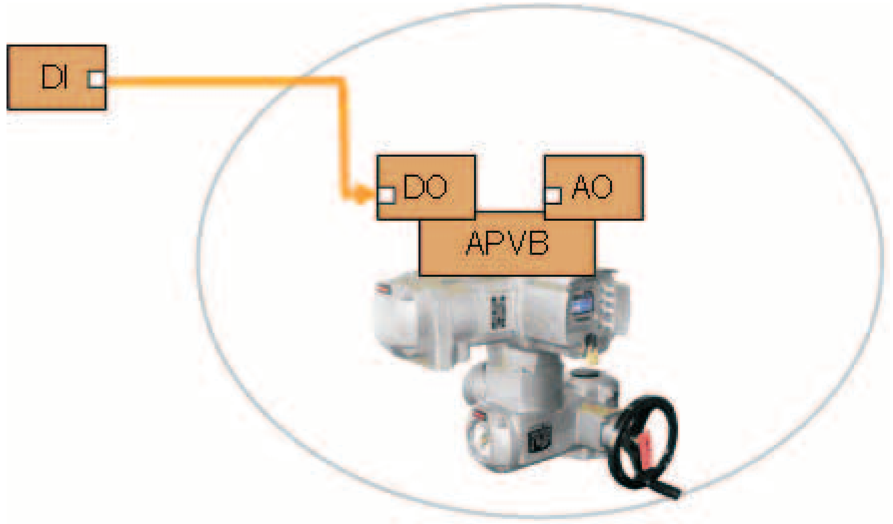
Operation commands via the discrete output function block

The operation commands of the DO function block are coded as follows:

Table 5

Discrete state	Operation command	Description
0	CLOSE	Run CLOSE
1	OPEN	Run OPEN
2	STOP	Actuator stops
3	STOP	Actuator stops
4	Intermediate pos.1	Actuator directly runs to intermediate position 1
5	Intermediate pos.2	Actuator directly runs to intermediate position 2
6	Intermediate pos.3	Actuator directly runs to intermediate position 3
7	Intermediate pos.4	Actuator directly runs to intermediate position 4
8	Intermediate pos.5	Actuator directly runs to intermediate position 5
9	Intermediate pos.6	Actuator directly runs to intermediate position 6
10	Intermediate pos.7	Actuator directly runs to intermediate position 7
11	Intermediate pos.8	Actuator directly runs to intermediate position 8

Figure 8



3.2.2 Feedback signals from the AUMATIC

The AUMATIC is able to signal its status by means of several different function blocks.
The Analog Input function blocks (AI) are used to transmit analogue data, the Discrete Input function blocks (DI) are used to transmit binary information.

Feedback signals via the analog input function blocks

The AUMATIC is equipped with 4 analog input function blocks:

- AIFB_1 is used to transmit an external 0 – 20 mA input signal and is connected to the first analogue input, identified by ANIN1+ and ANIN1– on the wiring diagram (option).
- AIFB_1 is also used to transmit an external 0 – 20 mA input signal and is connected to the second external analogue input, identified by ANIN2+ and ANIN2– on the wiring diagram (option).
- AIFB_3 is used to transmit the actual actuator position.
- AIFB_3 is used to transmit the actual actuator torque (option).

There are to Analog Input Transducer Blocks (AITB), both each connected to two Analog Input Function Blocks (AIFB).

Feedback signals via the discrete input function blocks

The AUMATIC is equipped with 3 discrete input function blocks:
Each Discrete Input Function Block (DIFB_1, DIFB_2 and DIFB_3) has its own Discrete Input Transducer Block (DITB_1, DITB_2, DITB_3).
Each function block may transmit up to 8 configurable binary signals. Configuration of these binary signals is defined in the associated Discrete Input Transducer Blocks (DITB_x).