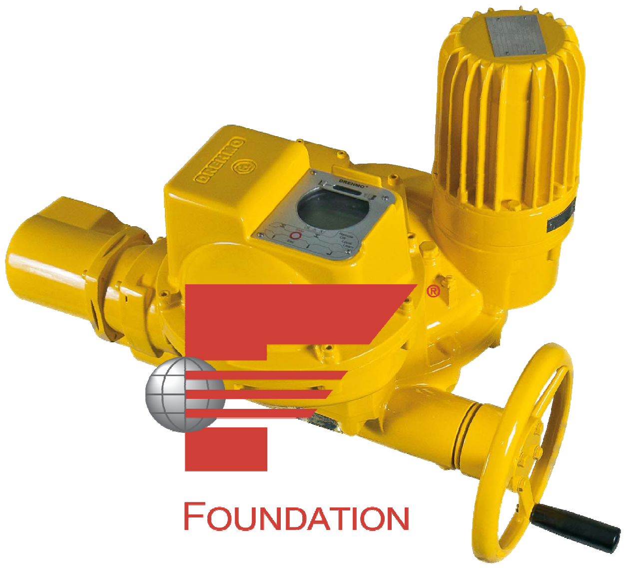
DREHMO
VALVE ACTUATORS

A member of the AUMA Group

Complementary operating manual

Foundation Fieldbus



Operation and servicing instructions

Part. no: 179810
Revision: 1.0
Date: 04/10/2018

Keep this manual for future reference.
These operating manual is only valid in connection with the operating manual for i-matic.

Important information

Notes:

- Please read operation instructions first!
- This manual must be kept for future use.

Purpose of the document:

This document contains information for commissioning, operation and maintenance staff. It is intended to support interoperability with DCS, local device operation and setting modifications.

Reference documents:

This operating manual has to be used in conjunction with the operating manual for i-matic actuators (from version 1.x)!
Available via internet at www.drehmo.com.

Table of contents

1 Safety instructions

1.1 General information on safety

Standards/ directives

DREHMO products are designed and manufactured in compliance with recognized standards and directives.
The end user and contractor must sure about all legal requirements, regulations, guidelines, national regulations and recommendations with respect to assembly of the electrical connection, commissioning and operation at the installation. For example these include configuration guidelines for fieldbus applications.

Safety instructions-/ warnings

All personnel, who works with here described device, must be familiar and keep with safety and warning instructions to avoid personal injury or property damage.

Qualification

Only qualified personnel authorized by end user or contractor are allowed to work with DREHMO products. Prior working the personnel must read and understood this manual as well as know and respect recognized rules regarding occupational health and safety. In explosive atmospheres has to be observe special regulations. The end user and contractor of the plant are responsible to keep and respect these special regulations.

Commissioning

Prior commissioning has to check that all settings meet their application requirements. Incorrect settings can cause hazards to persons or equipment. The manufacturer will not liable for any consequential damage. Such risk lies entirely with the staff.

Operation

Requirements for safe and correct operation:

- Observe recognized rules regarding occupational health and safety.
- Report any faults and damage and eliminate it by a qualified staff.
- Operate DREHMO products only in a perfect condition and in compliance with this manual.
- Correct transport, proper storage, positioning and assembly as well as careful commissioning.
- Observe national regulations

Protective measures

The end user or contractor is responsible for all necessary protective measures on site, for example enclosures, barriers or protective equipment for the staff.

Changes Changes on DREHMO devices only permitted by the approval of the manufacturer.

Maintenance The maintenance instructions must be observed, otherwise a safe operation of the device is no longer guaranteed.

1.2 Range of application

DREHMO actuators are designed for the operation of industrial valves such as valves, gate valves, butterfly valves and ball valves. Other applications require an explicit consult with the manufacturer. The manufacturer will not liable for incorrect use and resulting possible damage. The risk is lying with the user. Intended use includes the observance of these operating manuals.

1.3 Warnings and notes

Serious bodily injury or property damage can occur at non-observance of the warnings. Qualified personnel must be thoroughly familiar with all warnings in this manual.
For highlight safety-relevant procedures in this manual, the following notes are marked with a pictogram.

Note	**Note** This is general information for the user.
Info	**Information** This notice inform the user that non-observance can result in damage.
Warning	**Warning** This notice inform the user that non-observance can possible result in personal injury and property damage.
Danger	**Danger** This notice inform the user that non-observance can result in serious personal injury and property damage.

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.

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

This fieldbus is an open fieldbus standard which enables devices of different manufacturers to be integrated in one system and, if required, ensures their interchangeability (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.

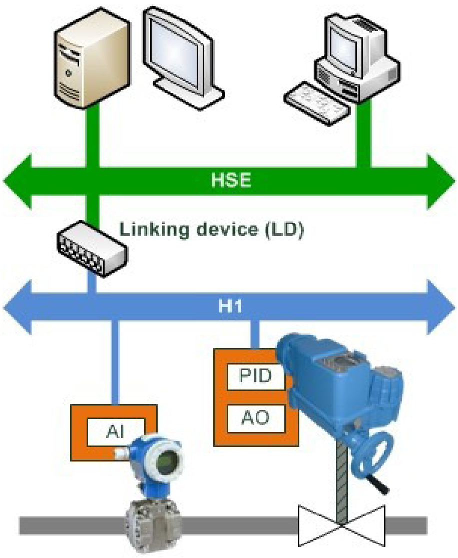


Figure 1: typical Foundation Fieldbus structure

HSE	FF Bus based on High-Speed-Ethernet
H1	FF Bus based on Low Speed Bus
LD	Linking device
PC	Power Conditioner (FF H1 power supply)
	Actuator controls with function blocks:
PID	Process controller
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 (International Standards Organisation - Open Systems Interconnection). 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

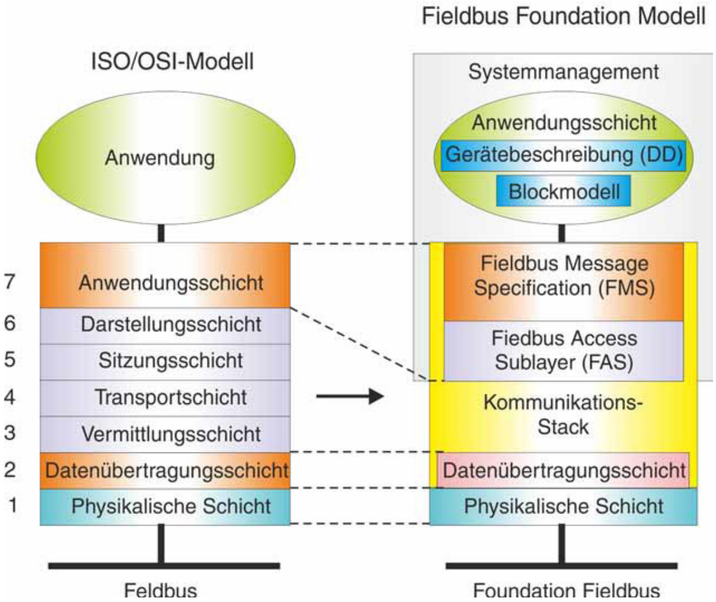


Figure 2: Compare OSI model vs. FF model

2.3 Physical layer

The lowest bus level, the physical layer, is based on IEC standard 61158-2. This layer defines how the physical connection to the fieldbus network as well as the data transmission is to be performed.
Foundation Fieldbus uses two systems for the communication. The low H1 version for communication and direct connection of the field devices, the fast HSE version based on Industrial Ethernet within the DCS and for connecting Remote Operations Management (ROM) systems.

2.3.1 H1 Bus

The following summary gives a brief overview of the features and functions of the H1 bus. For detailed information, refer to the various Application Guides of the Fieldbus Foundation (e.g. AG-140, AG-163, AG-181, FD-043).

- Data transfer: Manchester coding
- Data transfer rate 31.25 kbit/s (default setting, cannot be modified).
- Requirements for perfect 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 voltages on the basis of network topology, the cable resistance, and the supply voltage. E.g. DesignMATETM, available via www.fieldbus.org.
- Field device connection via H1 version. The Foundation Fieldbus Power Conditioner is connected to the bus line in the same way (parallel) as a field device. Field devices supplied by additional supply sources have to be connected to these sources as well.
- The maximum power consumption of current consuming devices within H1 networks must be lower than the electric power supplied by the Foundation Fieldbus Power Conditioner.
- Network topologies: Line topology; when using junction boxes or segment barriers, also star, tree or a combination of these topologies.
- Device connections: Typically via short spurs to enable connection/disconnection of the devices without impairing 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 cable length of an H1 segment without repeater: 1,900 m.
- Maximum cable 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 boxes have to be included in the total length calculation.
- Number of field devices 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, however, max. 10 – 14 devices per segment.

- Fieldbus cable: Type A (recommended), only this type is specified for the maximum segment length of 1,900 m.
- Termination: Two terminators per bus segment, typically one at each end of the longest fieldbus cable.
- Bus cable shielding: If shielded cables are used (recommended), the shield is typically only earthed at one single point within the segment (typically near the Foundation Fieldbus power supply). Apart from this, other earthing philosophies are available (refer to AG-181).

2.3.2 High Speed Ethernet (HSE)

HSE is based on standard Ethernet technology. The required components are 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, as for some parts, real-time requirements have to be met. 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 nevertheless 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 to best adapt it 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 (connecting devices) are required (refer to figure "Typical Foundation Fieldbus structure" in chapter "Performance features").
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 the power consumption by ±10 mA at 31.25 kBit/s to generate a typical ± 0.5 V voltage change for power supply with 50 Ohm impedance. This voltage variation 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 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.
- Specific mechanism ensures that never two or more devices simultaneously access the bus.

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 specific 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 (LM). Basic devices (BD) 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 ensures both updating and continuous transmission of the Live List to all other Link Master Devices. 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 have access to the current live list so that they can become the LAS without any loss of information, if required.

2.4.2 Communication control

The communication services of the FF specification define both 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 defined transmission schedule. The pertaining definitions are created by the Foundation Fieldbus system operator during the configuration of the FF system.
The LAS periodically broadcasts a time synchronisation signal (TD: Time Distribution) on the fieldbus so that all devices have exactly the same data link time. In scheduled transmission, the point in time and the sequence of data telegrams are defined in detail.
For this reason, the FF H1 system is also called deterministic fieldbus system.
For each action to be performed (e.g. execution of a function block or transmission of a process value), a defined period is added to the schedule. 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 reception 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 are typically only transmitted when needed, i.e. on request. The transmission of this data is not time-critical. For such communication tasks, the Foundation Fieldbus offers 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 right (token), or until the maximum granted time to use the token has elapsed.
Unscheduled transmission offers two data transmission methods: “Client Server” to adapt device settings, configuration 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 both 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)

The 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 uses the three different VCR types as follows (refer to table).

Client/Server	Report Distribution	Publisher/Subscriber
User communication	Events, alarms, trends	Process data transmission
Setpoint changes, operating data and device data changes, upload/download, alarm value adaptation, remote diagnostics.	Send process alarms to user consoles, transmitting trend data for long term data logging	Transfer process values of sensors and other devices
Unscheduled	Unscheduled	Scheduled

Table 1: Fieldbus Access Sublayer

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 user console 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)

The 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 an 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 characterises 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

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 charts of scheduled data transmission are based on these function blocks. Each block (including the pertaining inputs and outputs) has a definite task. Each FF device is equipped with at least one function block.
The FF specification provides defined function blocks which can be used to describe the typical functions. They are listed below:

AI	Analog Input
AO	Analog Output
DI	Discrete Input
DO	Discrete Output
PID	Proportional/integral/derivative
SC	Signal Characteriser
IS	Input Selector

Table 2: Functionblocks

Transducer blocks

Transducer blocks enhance 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 linearized 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 connections between different function blocks, both internal to the field device 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 from higher-level systems.
View objects are predefined groupings of data and block parameter sets that can be used to group and display the parameters according to their tasks: Process control, configuration, maintenance and 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 fulfil these requirements. They provide all 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 device activities in compliance with the predefined transmission schedule
- Cyclical processing of transmission list (LAS only) within the predefined schedule.

Further tasks performed by the system management:

- Automatic assignment of LAS functions to another Link Master if the active LAS fail.
- Synchronisation of clock 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 at the commissioning during active communication. For this address assignment procedure, special default addresses are reserved allowing accessing the new devices which are not yet configured. A new device is integrated in the communication network after assigning a device tag as well as a new, clear, unambiguous node 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 (refer to figure below). This requires a configuration tool, e.g. the NI-FBUS Configurator by National Instruments.

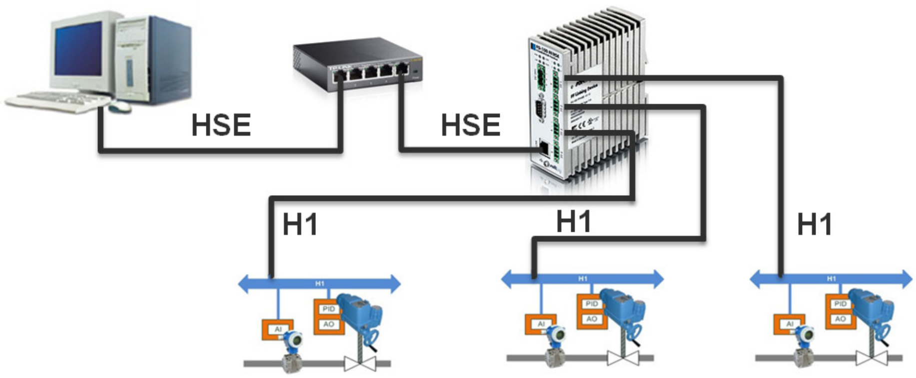


Figure 3: FF-Network

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

Prior to the actual commissioning, the Device Descriptions (DD) for all devices to be configured must be entered using configuration tools. The configuration software must either be able to access the device descriptions in the available libraries, or the device descriptions must be loaded via external data storage devices.

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 inputs and outputs of the corresponding block symbols and define the block behaviour.

The figure below shows an example of 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 by means of the valve..

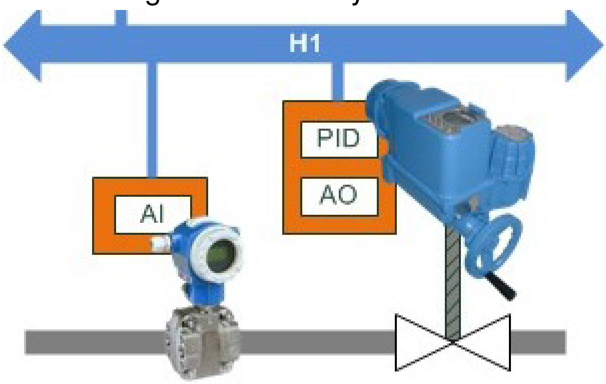


Figure 4: Example for process control

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 DREHMO plug/socket connector, installations with DREHMO 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.

The listed topologies can be combined

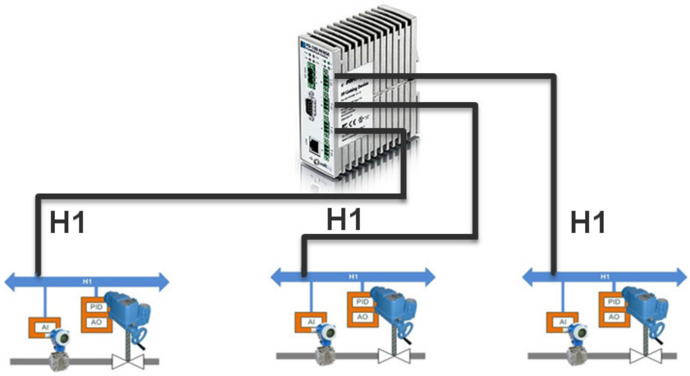


Figure 5: Topologie

1	DCS
2	Trunk
3	Spurs
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.

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

Table 3: Spurlength according number of devices

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.

	Type A (Referenz)	**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 twisted pairs, not shielded
Cross section (nominal)	0,8 mm2 (AWG 18)	0,32 mm2 (AWG 22)	0,13 mm2 (AWG 26)	1,25 mm2 (AWG 16)
Loop resistance (DC current)	44 Ω/km	112 Ω/km	264 Ω/km	40 Ω/km
Impedance 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
Capacitive asymmetry	2 nF/km	2 nF/km	Not specified	Not specified
Recommended network expansion (incl. spur lines)	1 900 m	1 200 m	400 m	200 m

Table 4: Buscable

3 Electrical connection

3.1 General notes

Danger

Danger due to incorrect electrical connection!
Noncompliance can result in death, serious injury or property damage.

- The electrical connection may only be performed by qualified personnel.
- Prior connection, observe general notice in this chapter
- Prior applying voltage, please read the Chapter Commissioning on page 25.

Terminal plan

The terminal plan is included in the delivery. It can be ordered at DREHMO with the serial number (see nameplate).

Protection

For short-circuit protection and for disconnecting the actuator from the mains are fuses and disconnect switches required. The performance characteristics are determined from the nameplate of the actuator.

Cable installation in Accordance with EMC

Due to the susceptibility of signal and bus cables as well as the interferences of motor cables are the following installation regulations valid:

- Lay cables being susceptible to interference or sources to interference must be large distance between each other.
- The interference immunity of signal and bus cables increases if the cables are laid close to the ground.
- If possible, avoid laying long cables and make sure that they are installed in areas being subject to low interference.
- Use shielded cables for connection of remote position transmitters (combined sensor).

Power supply control

For external connection the power supply of the control (Electronics) is 24V DC.

Power supply Foundation Fieldbus

The Foundation Fieldbus requires an own power supply. Because of this requirement suitable power supplies must be provided within the DCS. On each device, a power supply of 9 - 32V DC must be guaranteed. The typical current consumption is 13mA, except during a firmware update is the power consumption 26mA.

3.2 Bus connection using socket connector

Danger

Hazardous voltage

Electric shock possible

- Disconnect device from mains before opening.

Opening the bus terminal compartment

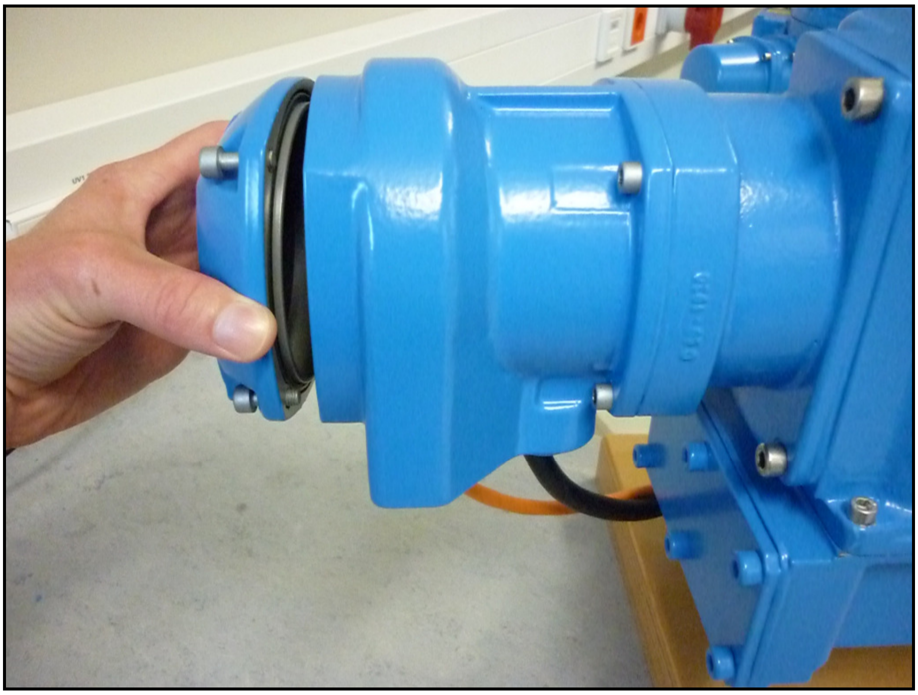


Figure 6: Terminal compartment for Foundation Fieldbus

1. Loosen and remove plug cover.
   The connection board is located behind the plug cover.
2. Insert cable glands suitable for bus cable.
   The protection IP on the name plate is only guaranteed if suitable cable glands are used.
3. Unused cable entries must be sealed with suitable screw plugs.
4. Insert the cable into the cable glands.

Connecting bus cables

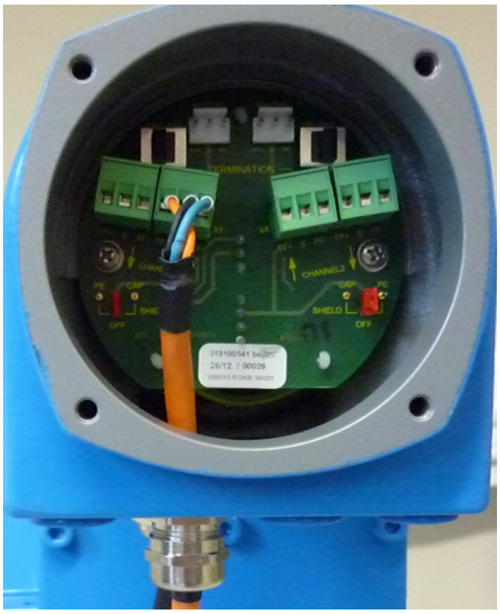


Figure 7: Bus connection board

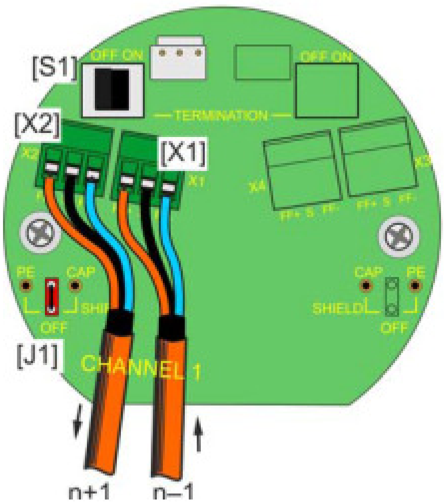


Figure 8: Connection overview

1. Connect the bus cable FF+/FF- from the control system to the incoming terminals X1/X4. For daisy chain topology connect outgoing fieldbus devices to the terminals X2/X5.

Info

Polarity detection

Despite an automatic polarity detection and correction, it is recommended to connect the bus cable according to their polarity to achieve a uniform wiring.

2. When the actuator is the last station in the bus segment, then activate the terminator for the used channel with the associated switches (S1/S2 to ON position).

Info

Terminator
If the terminator is activated, the channel to the next outgoing fieldbus device is interrupted.

3. When the cable comes from control system it must be connected on the SHIELD1/2_IN of the screw terminals X1/X4. For daisy chain topology connect the shields of outgoing cable to the according terminals X2/X5.

Info

Cable shield
The cable shield is depending on the jumper position J1/J2 connected with the protective conductor or housing or not connected:

OFF	Not connected with housing or protective conductor
PE	Connected via bores with housing
CAP	Capacitive connected via bores with housing

Closing the bus terminal compartment

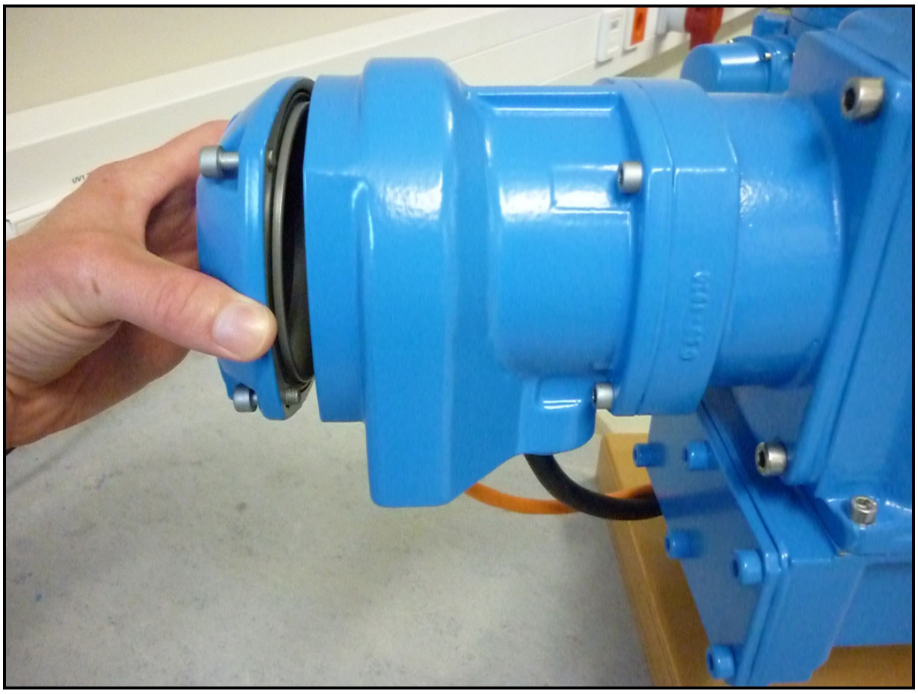


Figure 9: Terminal compartment for Foundation Fieldbus

1. Cleaning the sealing face on plug cover and housing.
2. Apply of acid-free grease (e.g. Vaseline) on sealing faces.
3. Check whether O-ring is in a good condition and afterwards correctly place them.
4. Placing plug cover and fasten bolts evenly crosswise.
5. Fasten cable glands with the specified torque in order to ensure appropriate enclosure protection.

4 Commissioning

4.1 Introduction

Summary of the following chapters

Info

Commissioning software
For demonstrating of commissioning we use tools from National Instruments in this manual. When other tools or control systems are used, please read the operating manual before start with commissioning.

4.2 Installation of Device Description

Device Description

A Device Description (DD) is a collection of files. They allow the interoperability of the i-matic actuator in Foundation Fieldbus control systems. An i-matic actuator supports the Device Description version 4 and 5 (short DD4 and DD5). Due to older versions of control systems, will be offered two versions of the Device Description.

DD - Files

The naming conventions are chosen so, that the filenames consist of two hex values. The first hex value describes the device revision of the i-matic actuator and the second one is the DD-revision. For example the name: 0102.xxx means, that the DD is compatible to first device revision of the i-matic and the number two is the actual develop revision of the DD.
For example a DD4 with the name 0101 includes the following files:

0101.ffo	Binary files of Device Description.
0101.sym	Symbolic text file contains FF records and addresses.

Analog a DD5 consists of these files:

0101.ff5	Binary files of Device Description.
0101.sy5	Symbolic text file contains FF records and addresses.

Common to both DD versions consist this CCF file.

010101.cff	Common File Format contains DD-manufacturer and description of function blocks

Info

DD - compatibility
The COMPATIBILITY_REV parameter indicates which DD device revision is compatible with the DD.

DD - Installation

For install the DD/CFF use the NI-FBUS Interface Configuration Utility.

Info

Installation example
The installation refers to the NI-Configurator from National Instruments.

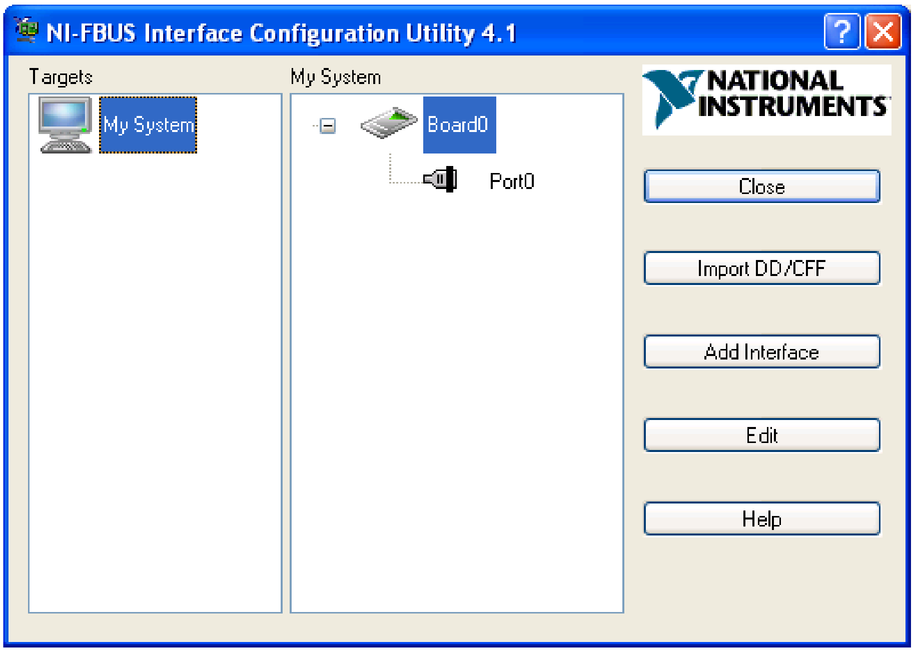


Figure 10: NI-FBUS Interface Configuration Utility

First press the button labelled with „Import DD/CFF“ and then a dialog opens. With the button "Browse ..." can be select the path to the DD. Confirm with the OK-Button and the DD/CFF will installed in the NI-Configurator. Physically the DD and CFF files are copied to the folder: "...\Program_Files\National_Instruments\NI-FBUS\DATA\..."

Info

Use of DD4
Have you DD4 and DD5 installed, the NI-Configurator automatically selects the DD5. If you want to use only DD4, all DD5 files must be removed. The CFF file shouldn’t be removed, because it applies to the DD4 and DD5.

4.3 Network configuration

4.3.1 PD Tag and Node Address

General

After connecting the i-matic actuator the PD Tag and Node Address must be set. Depending on the setting of PD Tag and Node Address the general state of the i-matic actuator will changed (see the following figure).

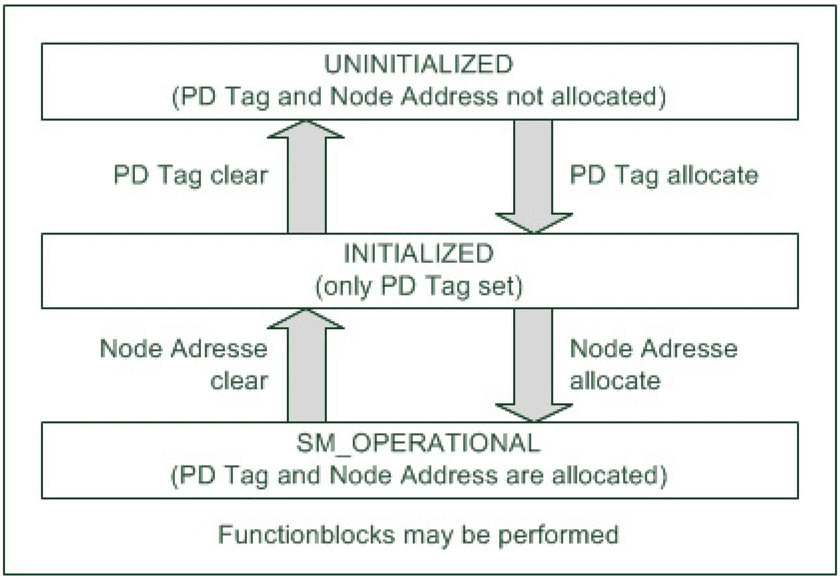


Figure 11: Device status

PD Tag

The PD Tag is a label for the actuator. The Tag consists of max. 32 characters and can be configured by the control system or the LC-Display. The factory default value is „DREHMO i-matic (Serial number)“. For setting a new PD Tag from control system, use the existing control system services specifically for renaming of PD Tags. For this purpose, it is recommended to read the operating manual of the used control system.
For renaming the PD Tag from LC-Display, follow the next steps:

1. First change with ENTER-Button into menu.
2. Now change into submenu: „Actual values/diagnosis“.
3. Then into submenu „interface“:
4. Followed by „Foundation Fieldbus“:
5. In a final step into submenu „PD Tag“.
6. With the ENTER-Button you can edit the value.

Info

Operating mode correct?
If the operating mode REMOTE is active, then it isn't possible to change the parameter value (PD Tag). Therefore, it will be offered to change the operating mode into OFF. After changing this parameter the operating mode is setting back to REMOTE to operate the actuator from control system.

7. The buttons UP-/DOWN modify the characters, the buttons LEFT-/RIGHT select the characters.
8. The new value is saved, when has arrived on the last character (far right) and then press the RIGHT-button.

Node Address

The Node Address is used to address packages in the Foundation Fieldbus. Each device in the bus is assigned with a unique address. The valid address values are between 16 - 247 ($0x10_{hex}$ - $0xF7_{hex}$).
The factory default value for the Node Address is 25 ($0x19_{hex}$).

Info

Same device addresses in network
Are two i-matic actuators with the same addresses in the same Fieldbus Foundation network, keeps one actuator the assigned address and the other changes it to the default address (from 248 – 251 [$0xF8_{hex}$ - $0xFB_{hex]}$). Due to the globally unique Device ID, the actuator can be addressed.

Depending on the device type Basic Device or Link Master are own address ranges defined. Thus, the low addresses are reserved for Link Master and the high addresses for Basic Devices.

Info

Link Master functionality
The Link Master device with the lowest address takes the LAS function.

To specify the address ranges, set the parameters V(FUN) for "First unpolled Node" and V(NUN) for "Number of unpolled Nodes". V(FUN) - 1 defines the highest Link Master Address. V(NUN) defines a range, which won't polled from Link Master. V(FUN) + V(NUN) defines the lowest Basic Device address (see the following figure).

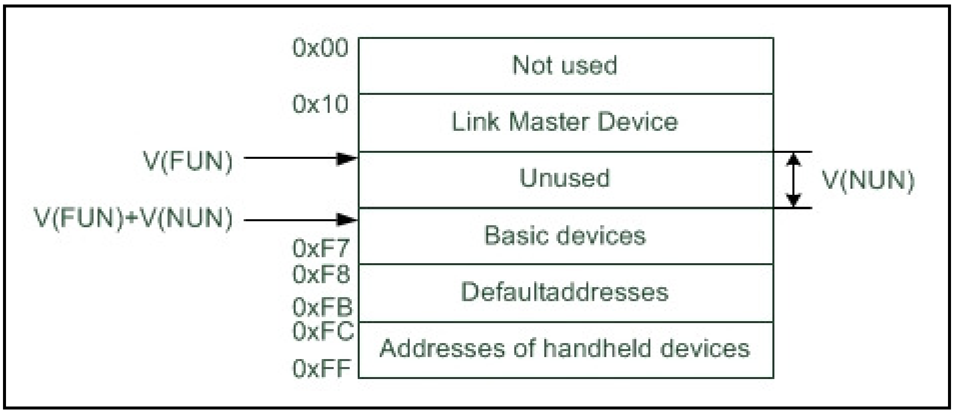


Figure 12: Device address range

The Node Address can be changed in two ways similar as the PD Tag. On the one hand with appropriate control system services. For this it is recommended to read the operating manual of the control system.
On the other hand via LC-Display:

1. First change with ENTER-Button into menu.
2. Now change into submenu: „Actual values/diagnosis“.
3. Then into submenu „interface“:
4. Followed by „Foundation Fieldbus“:
5. In a final step into submenu „ NodeAddress“.
6. With the ENTER-Button you can edit the value.

Info

Operating mode correct?
If the operating mode REMOTE is active, then it isn’t possible to change the parameter value (Node Address). Therefore, it will be offered to change the operating mode into OFF. After changing this parameter the operating mode is setting back to REMOTE to operate the actuator from control system.

7. The buttons UP-/DOWN modify the address.
8. The new value is saved, when the ENTER-button is pressed.

4.4 Functionblocks

List of all Function- (FB) and Transducerblocks (TB).

FB / TB	FB Name	Description
RB	Resource Block FB	Consist all parameters from **Electronic Nameplate** of the i-matic
Positioner_TB	Positioner TB	Drive the actuator
DigitalIn_TB	Digital Input TB	Hardwareinterface for digital Inputs of the i-matic (only for diagnostics)
DigitalOut_TB	Digital Output TB	Hardwareinterface for digital Outputs of the i-matic (only for diagnostics)
AnalogIn_TB	Analog Input TB	Hardwareinterface for analogue Inputs of the i-matic (only for diagnostics)
AnalogOut_TB	Analog Output TB	Hardwareinterface for analogue Outputs of the i-matic (only for diagnostics)
Commiss_TB	Commissioning TB	Consist all parameters from **Parameter** of the i-matic
Diag_TB	Diagnostic TB	Consist all parameters from **Actual values/Diagnosis** and **Oper. data acquisition** of the i-matic
DO_1 … DO_8	Digital Output FB	Digital Inputs of the i-matic
DI_1 … DI_10	Digital Input FB	Digital Outputs of the i-matic
AO_1 … AO_2	Analog Output FB	Analog Inputs of the i-matic
AI_1 … AI_4	Analog Input FB	Analog Outputs of the i-matic
SC_1	Signal Characteriser (SGCR)	Config Intermediate positions
IS_1	Input Selector (ISEL)	With Input Selector you can choose one Output of several Input channel. (Function of multiplexor)
PID_1	Proportional Integral Derivative (PID)	Process controller of the i-matic

Table 5: Functionblocks of i-matic

4.4.1 Operating Commands

With the analogue Outputs of the i-matic (AO-FB) it is possible to set the setpoint. The AO-FB accepted values between 0-100% (0% = valve closed, 100% = valve open).

With the digital Outputs of the i-matic (DO-FB) it is possible to set the commands for OPEN/STOP/CLOSE. The DO-FB accepted the values 0 for OPEN, 1 for CLOSE and 2 for STOP.

4.4.2 Feedback

The analogue feedback values of the actuator you will get from Analogue Input (AI-FB). The same is valid for the digital feedback values from the Digital Inputs (DI-FB).

5 Additional Functions

Additional functions of the Foundation Fieldbus Interface.

5.1 Data Channel

With the Data Channel any parameter and data will be send from control system to the actuator.

5.2 Simulation

With Simulation the Function blocks could be simulated without moving the actuator. This function is useful for commissioning.

5.3 Redundancy

One version of the Foundation Fieldbus Interface is available for Redundancy concept and consists of two Fieldbus Kits (FBK2's) from Softing.

5.4 Firmware Update

The Firmware Update of the Foundation Fieldbus Interface and the FBK's could be done as usual with i-matic Explorer 2 (you find it on our Website).

6 Application Examples

6.1 General Information

Info

Control system for the application examples
All examples are shown with tools from National Instruments. If you use other tools or control systems, please read the operating manual of the control system before you start commissioning.

6.1.1 Reset

Info

Precondition
To control the actuator over Foundation Fieldbus it is recommended to delete the Blockmodel previously. For this set the RESTART parameter with value "Defaults".

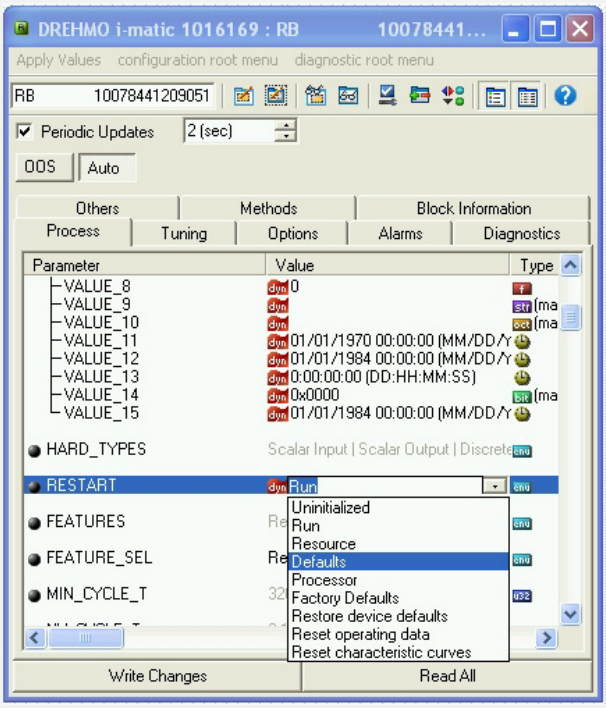


Figure 13: Reset of FBAP

6.1.2 Download of the Function block application

Info

Download

For execute and request the functions blocks by the LAS, transmit the function block application to the actuator. For this purpose run the dialog "Download Project ..." (see following Figure).

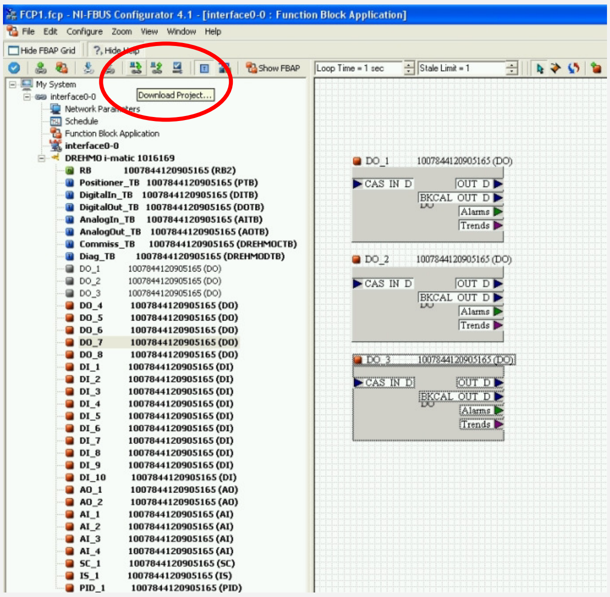


Figure 14: Download the function block application

In the dialog box „Download Configuration" the following options:

- Clear Devices,
- Automatic Mode Handling

are to activate and then start download by press the appropriate button.

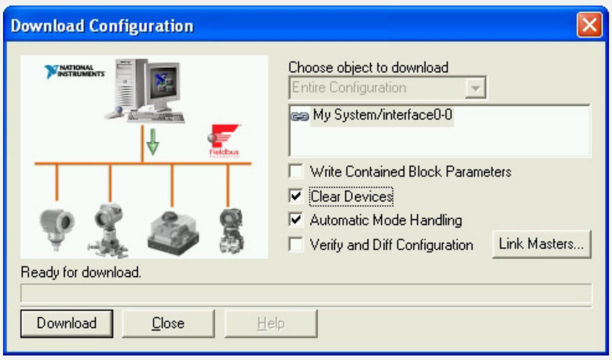


Figure 15: Download Configuration dialog

6.2 Drive the actuator for tests purposes

Application description

The following example demonstrates to drive an i-matic actuator for test purposes by discrete and analogue commands without building a block model.

Info

Precondition
For controlling the actuator via Foundation Fieldbus it is recommended to delete the previously used block model. For this purpose set the parameter RESTART from Resource Block (RB) to the value "Defaults" (see chapter 6.1.1 Reset).

Usage of Positioner_TB

For controlling the actuator's for test purposes without building a block model or executing a block model download use the Postioner_TB.

Info

Set Automatic Bit
If you drive the actuator with setpoint, the AUTO Bit must be set to activate the position controller. For this the parameter PRM_DCS_CTRL_AUTO_BIT is set to „Force enabled" in Commiss_TB. For controlling with discrete commands the parameter is set back to the value „acc. REMOTE".

Drive the i-matic actuator with discrete commands

To drive the actuator with discrete commands from Positioner_TB set the ACTUAL of MODE_BLK parameter to value MAN. For this set Target to value MAN. After a short time the ACTUAL of the MODE_BLK parameter gets the value MAN. Additionally the parameter ACTIVE_CHANNEL gets the value „Channel setpoint_commands not active (MAN)". If you set the FINAL_VALUE_COMMANDS, the actuator drives in OPEN or CLOSE direction or stops with STOP command. In addition the STATUS of FINAL_VALUE_COMMANDS is set to Good_Cascade or Good_NonCascade and the STATUS of FINAL_VALUE_SETPOINT is set to value BAD.

FINAL_VALUE_COMMAND	Description
0x00	CLOSE
0x01	OPEN
0x02	STOP

Table 6: Controls for discrete commands

With the parameter PRIMARY_VALUE_ACTUAL_POSITION it is possible to read the actual position of the actuator. The following figure shows the Positioner_TB with his parameters.

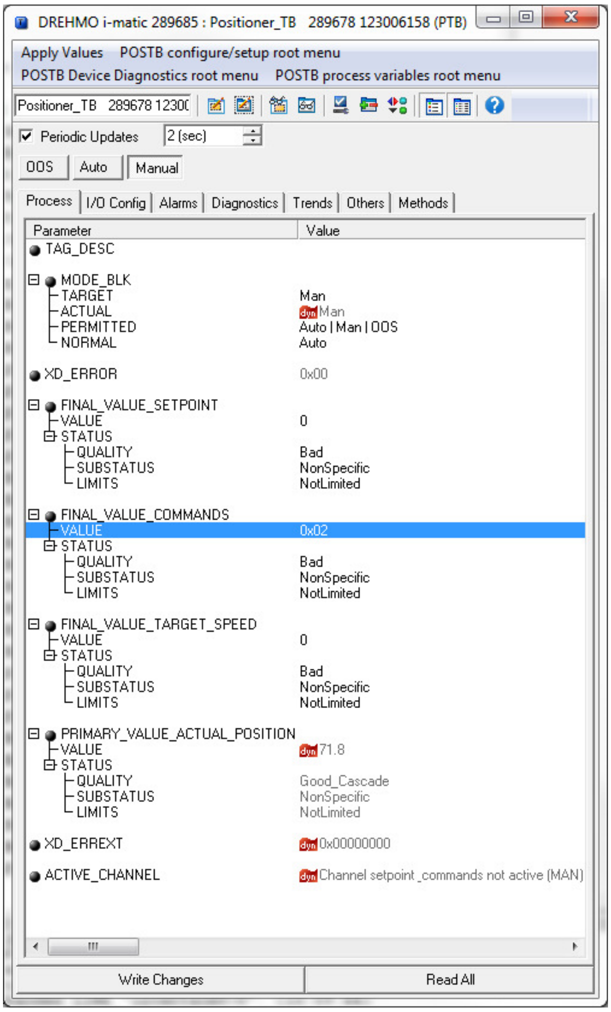


Figure 16: Positioner_TB with parameters

Drive the i-matic actuator with analog commands

To drive the actuator with analogue commands from Positioner_TB set the ACTUAL of MODE_BLK parameter to value MAN. For this set Target to value MAN. After a short time the ACTUAL of the MODE_BLK parameter gets the value MAN. Additionally the parameter ACTIVE_CHANNEL gets the value „Channel setpoint active (MAN)". If you set the FINAL_VALUE_SETPOINT, the actuator controls the actual position to the setpoint position. In addition the STATUS of FINAL_VALUE_SETPOINT is set to Good_Cascade or Good_NonCascade and the STATUS of FINAL_VALUE_COMMANDS is set to value BAD.

FINAL_VALUE_SETPOINT	Description
0 - 100	Setpoint of the actuator

Table 7: Setpoint for analog control

Info

If the actuator doesn't drive
Check the parameter XD_ERROR and XD_ERREXT of the Positioner_TB. Normally the values are 0x00.

6.3 Control via discrete commands (single bit)

Application description

The following example demonstrates how to move the i-matic actuator with the discrete commands OPEN, CLOSE and STOP via Foundation Fieldbus.

Info

Precondition

For controlling the actuator via Foundation Fieldbus it is recommended to delete the previously used block model. For this purpose set the parameter RESTART from Resource Block (RB) to the value “Defaults” (see chapter 6.1.1 Reset).

Info

Reset Automatic Bit

If you drive the actuator with discrete commands it must be configured accordingly. In Commiss_TB the parameter PRM_DCS_CTRL_AUTO_BIT is set to value „acc. REMOTE“ or „Force disabled“.

Design a block model

First, design a block model. For the implementation use three Discrete Output (DO) function blocks (see following Figure). One function block for the signal OPEN, a second for the signal CLOSE and a third for the signal STOP.

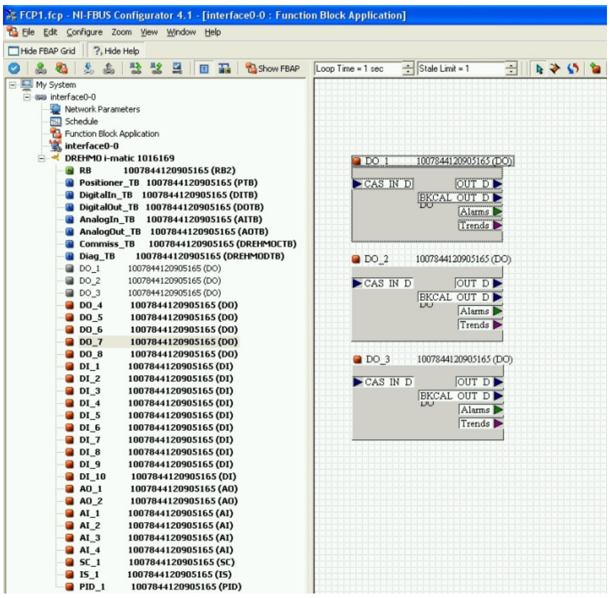


Figure 17: Representation of three DO function blocks

Prior configuration the block status of each function blocks is set to OOS (Out Of Service). For this purpose the TARGET of the parameter MODE_BLK is set to OOS (see following Figure).

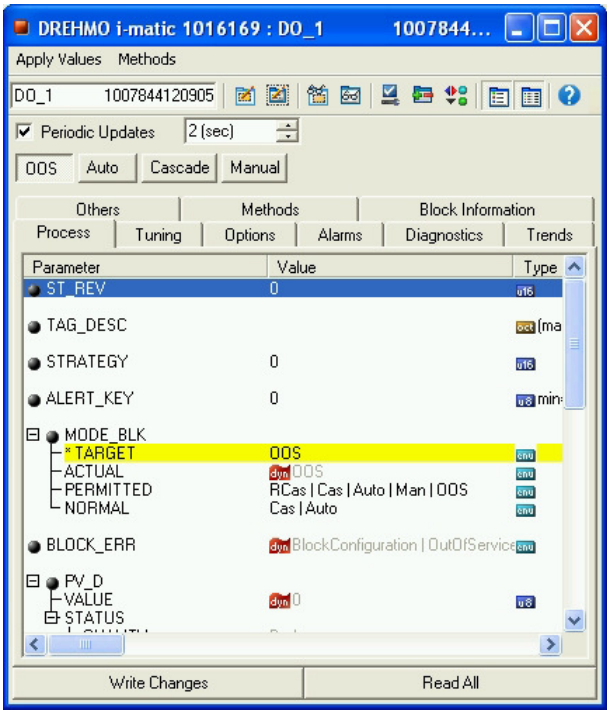


Figure 18: Changing block status

Info

Writing commands/parameters
All commands or modified parameters in NI-Configurator are always transmitted to the device, when pressing the button "Write Changes". If the changes were accepted by the device, the yellow background and the star before the parameter disappear. Read all parameters from the device by clicking the "Read All" button.

After a short time the Actual of parameter MODE_BLK should change to OOS. Then the function block is in OOS state. Subsequently the channels from each functional block to DigitalOut Transducer Block (DOTB) are setting. The following table shows an exemplary assignment of the channels of the functional blocks.

Block	Channel	Description
DO1	Ch fieldbus OPEN	Signal OPEN
DO2	Ch fieldbus CLOSE	Signal CLOSE
DO3	Ch fieldbus STOP	Signal STOP

Table 8: Assignment of channels from all DO FB

The next figure shows the assignment of the channels.

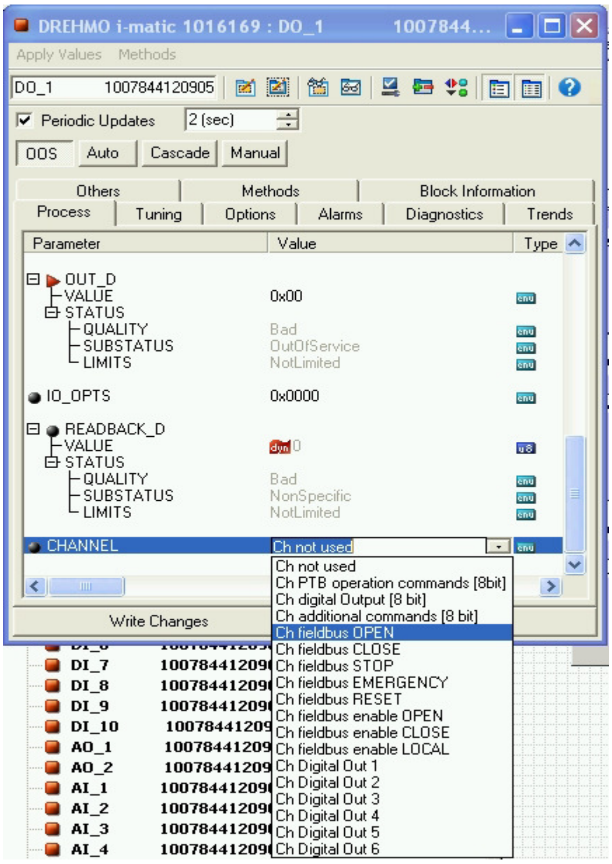


Figure 19: Channel assignment of DO-FB

Now the block configuration is complete and the function block application can be sent to the actuator.

Info

Download of the function block application

For execute and request the functions blocks by the LAS, transmit the function block application to the actuator. For this purpose run the dialog "Download Project ..." (see 6.1.2 Download of the Function block application).

Drive the i-matic actuator

For moving the actuator in direction OPEN select the corresponding DO function block with the channel “Ch fieldbus OPEN”. For move the actuator in manual mode the ACTUAL of the MODE_BLK parameter must be set to MAN. For this you must set the TARGET to MAN as previously described. After a short time the ACTUAL of the MODE_BLK parameter should get the value of MAN.

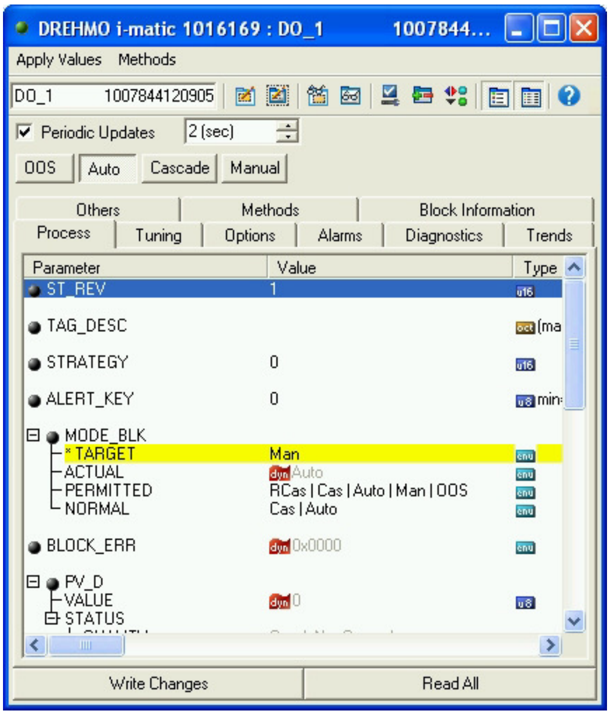


Figure 20: Manual Mode of the DO-FB

In this mode it is possible manually to set the discrete output. The OUT_D (Discrete Output) value must be changed from $0x00_{hex}$ to $0x01_{hex}$. After a short time for sending the command, the actuator should move in direction OPEN.

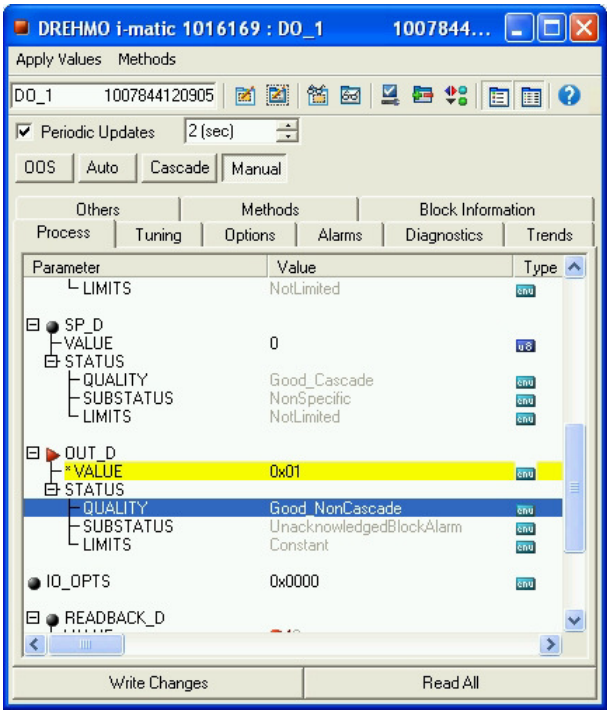


Figure 21: Set the OUT_D parameter

Valid values for the OUT_D parameters are:

OUT_D Value	Description
0x00$_{hex}$	Reset output
0x01$_{hex}$	Set output

Table 9: Description of the valid OUT_D values

This procedure of set / reset of the outputs is applies analogue to the other discrete functional blocks (DO). The actual position can be read in parameter PRIMARY_VALUE_ACTUAL_POSITION from the Positioner_TB.

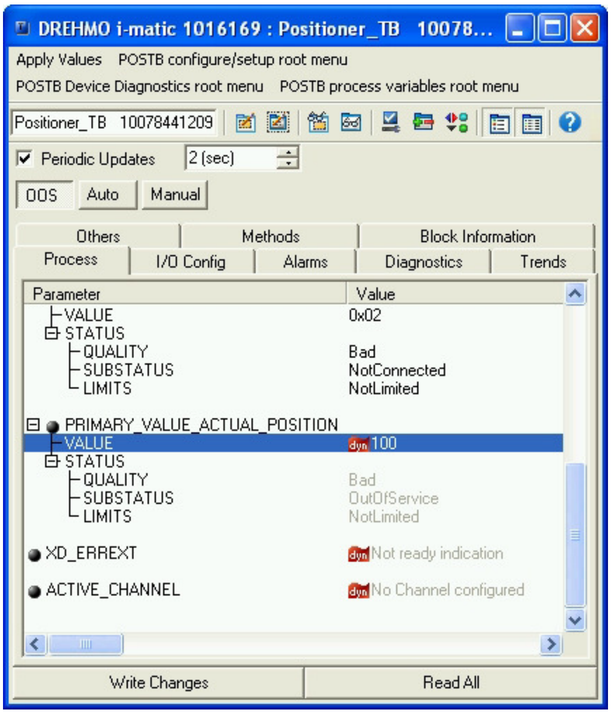


Figure 22: Actual position value of the actuator

The percentage values have the following meanings:

Actuator pos.	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 10: Values definition the drive position

Info

If the actuator doesn't move
If this case occurs then it will have different causes, on the one hand the actuator is already fully opened and it can't be moved in the OPEN direction. For CLOSE direction it applies analogue. On the other hand, when the STOP signal is set the actuator can't be moved. The STOP signal has always a higher priority than the OPEN or CLOSE commands.

Another possible cause could be, if before the actuator is moved in OPEN direction and the output of the DO function block isn't reset, then it isn't possible to move the actuator in the CLOSE direction with the other DO function block.

Another possible cause is an error in the configuration of the DO-FB, when the parameter BLOCK_ERR_DESC_1 signals an error. It could be corrected if the block will be reconfigured.

A final cause of the error could be that the actuator is not switched to the mode REMOTE. It signals when the parameter XD_ERROR in Positioner_TB has the value "General Error" and the XD_ERREXT has the value "Not ready indication". To solve this change the mode in REMOTE on HMI of the actuator.

6.4 *Control via discrete commands (multi bit)*

Application description

The following example demonstrates how to move the i-matic actuator with the discrete commands OPEN, CLOSE and STOP in one FB via Foundation Fieldbus.

Info

Precondition
For controlling the actuator via Foundation Fieldbus it is recommended to delete the previously used block model. For this purpose set the parameter RESTART from Resource Block (RB) to the value “Defaults” (see chapter 6.1.1 Reset).

Info

Reset Automatic Bit
If you drive the actuator with discrete commands it must be configured accordingly. In Commiss_TB the parameter PRM_DCS_CTRL_AUTO_BIT is set to value „acc. REMOTE“ or „Force disabled“.

Design a block model

First, design a block model. For the implementation use one Discrete Output (DO) function block (see following Figure). This block control the signal OPEN, CLOSE and STOP.

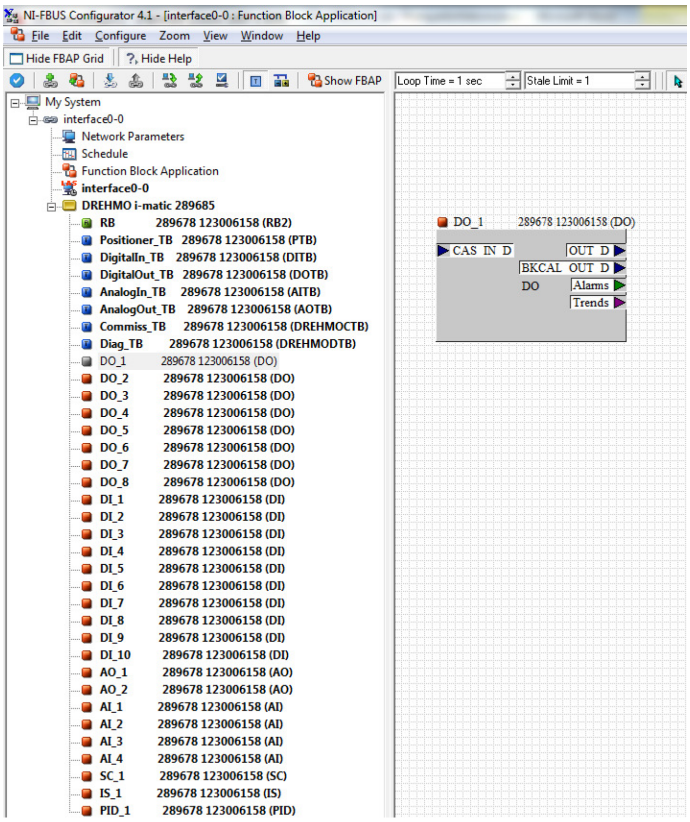


Figure 23: Representation of one DO-FB

Prior configuration the block status of each function blocks is set to OOS (Out Of Service). For this purpose the TARGET of the parameter MODE_BLK is set to OOS (see following Figure).

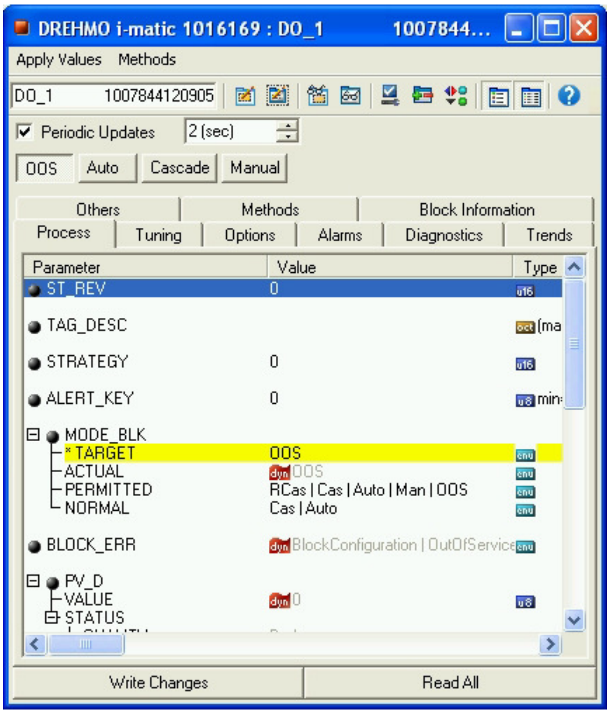


Figure 24: Changing block status

Info

Writing commands/parameters
All commands or modified parameters in NI-Configurator are always transmitted to the device, when pressing the button "Write Changes". If the changes were accepted by the device, the yellow background and the star before the parameter disappear. Read all parameters from the device by clicking the "Read All" button.

After a short time the Actual of parameter MODE_BLK should change to OOS. Then the function block is in OOS state. Subsequently the channels from each functional block to DigitalOut Transducer Block (DOTB) are setting. The following table shows an exemplary assignment of the channels of the functional blocks.

Block	Channel	Description
DO	Ch PTB operation commands [8bit]	Multibit signal

Table 11: Assignment of channel to one DO-FB

The next figure shows the assignment of the channels.

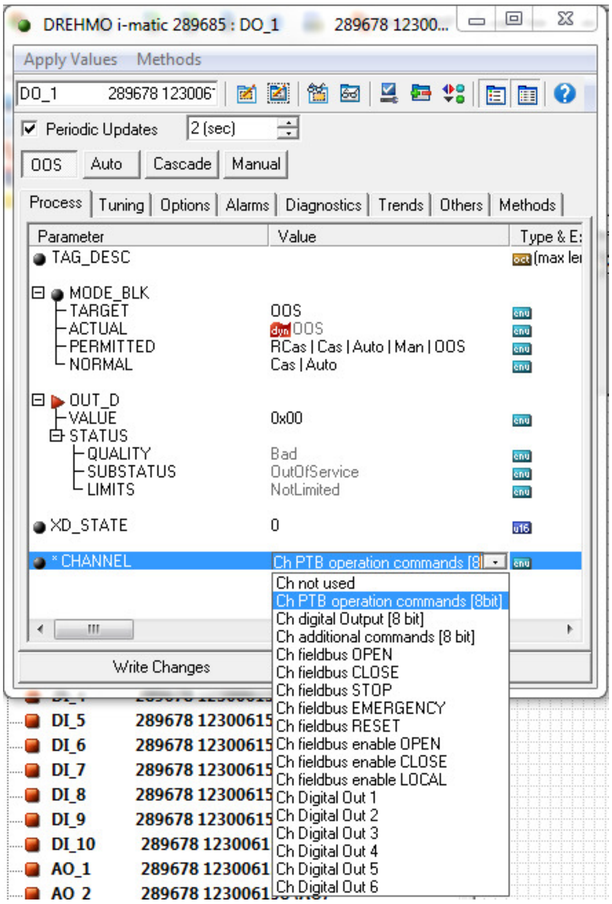


Figure 25: Channel assignment of DO-FB

Now the block configuration is complete and the function block application can be sent to the actuator.

Info

Download of the function block application

For execute and request the functions blocks by the LAS, transmit the function block application to the actuator. For this purpose run the dialog "Download Project ..." (see 6.1.2 Download of the Function block application).

Drive the i-matic actuator

For moving the actuator in direction OPEN select the DO function block. For move the actuator in manual mode the ACTUAL of the MODE_BLK parameter must be set to MAN. For this you must set the TARGET to MAN as described previously. After a short time the ACTUAL of the MODE_BLK parameter should get the value of MAN.

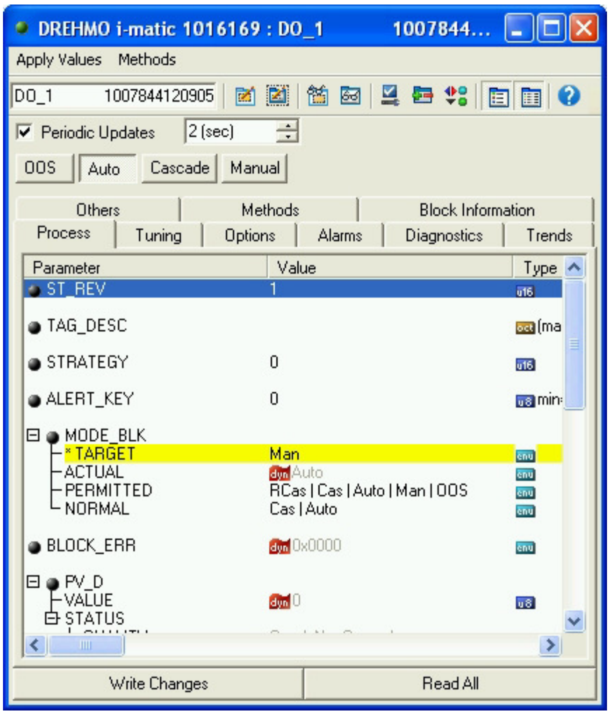


Figure 26: Manual Mode of the DO-FB

In this mode it is possible manually to set the discrete output. The OUT_D (Discrete Output) value is default $0x02_{hex}$ for STOP the actuator. If it chooses the value $0x00_{hex}$ for CLOSE the actuator drives in close direction. If the value changed to value $0x01_{hex}$ for OPEN the actuator drives in open direction.

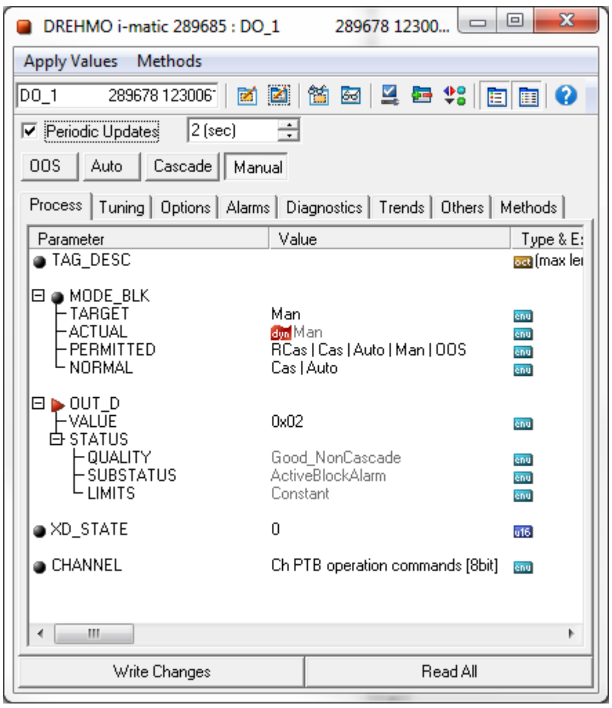


Figure 27: Set the OUT_D parameter

Valid values for the OUT_D parameters are:

OUT_D Value	Description
0x00hex	Signal CLOSE
0x01hex	Signal OPEN
0x02hex	Signal STOP

Table 12: Description of the valid OUT_D values

The actual position can be read in parameter PRIMARY_VALUE_ACTUAL_POSITION from the Positioner_TB.

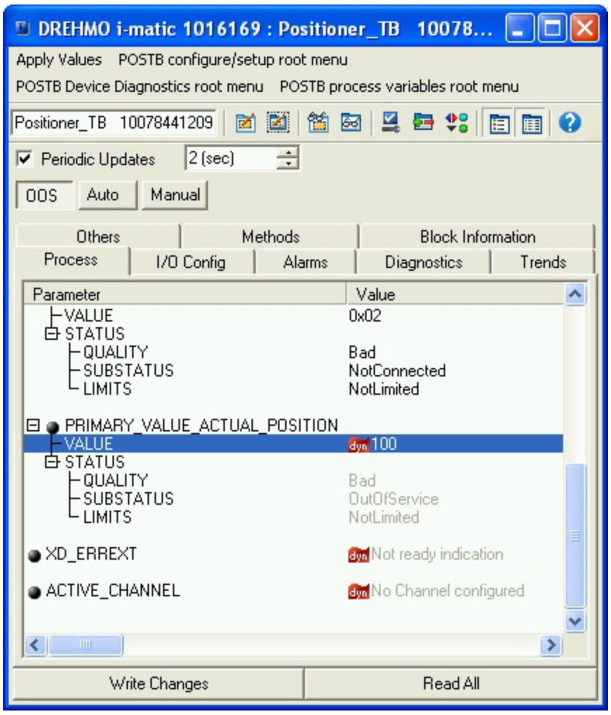


Figure 28: Actual position value of the actuator

The percentage values have the following meanings:

Actuator pos.	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 13: Values definition the drive position

Info

If the actuator doesn't move

If this case occurs then it will have different causes, on the one hand the actuator is already fully opened and it can't be moved in the OPEN direction. For CLOSE direction it applies analogue. On the other hand, when the STOP signal is set the actuator can't be moved. The STOP signal has always a higher priority than the OPEN or CLOSE commands.

Another possible cause could be, if before the actuator is moved in OPEN direction and the output of the DO function block isn't reset, then it isn't possible to move the actuator in the CLOSE direction with the other DO function block.

Another possible cause is an error in the configuration of the DO-FB, when the parameter BLOCK_ERR_DESC_1 signals an error. It could be corrected if the block will be reconfigured.

A final cause of the error could be that the actuator is not switched to the mode REMOTE. It signals when the parameter XD_ERROR in Positioner_TB has the value "General Error" and the XD_ERREXT has the value "Not ready indication". To solve this change the mode in REMOTE on HMI of the actuator.

6.5 Control via analog setpoint (without Automatic-Bit)

Application description

The following example demonstrates how to move the i-matic actuator with the analogue command setpoint via Foundation Fieldbus. The Automatic-Bit is preconfigured in the actuator.

Info

Precondition
For controlling the actuator via Foundation Fieldbus it is recommended to delete the previously used block model. For this purpose set the parameter RESTART from Resource Block (RB) to the value “Defaults” (see chapter 6.1.1 Reset).

Info

Set Automatic Bit
If you drive the actuator with analogue commands it must be configured accordingly. In Commiss_TB the parameter PRM_DCS_CTRL_AUTO_BIT is set to value „Force enabled“.

Design a block model

First, design a block model. For the implementation use only the Function Block Analog Output (see following Figure). The Function Block is linked with the appropriate channel.

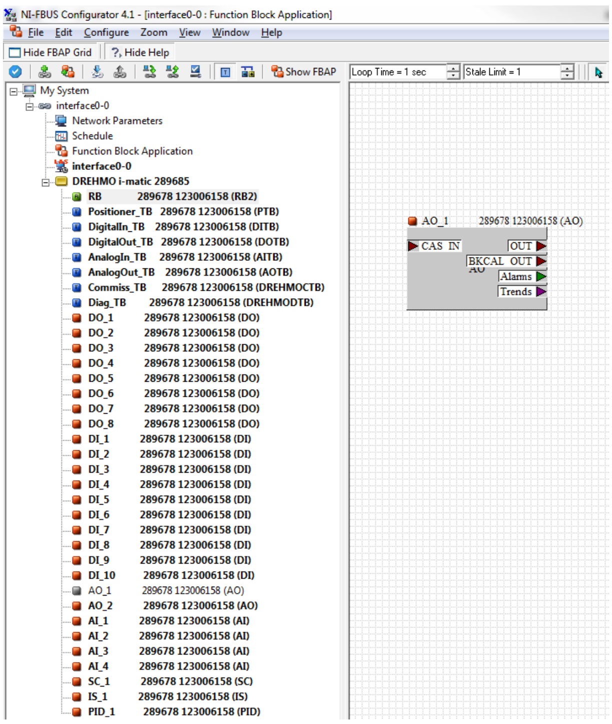


Figure 29: Representation of the AO-FB

Prior configuration the block status of the Function block is set to OOS (Out Of Service). For this purpose the TARGET of the parameter MODE_BLK is set to OOS (see following figure).

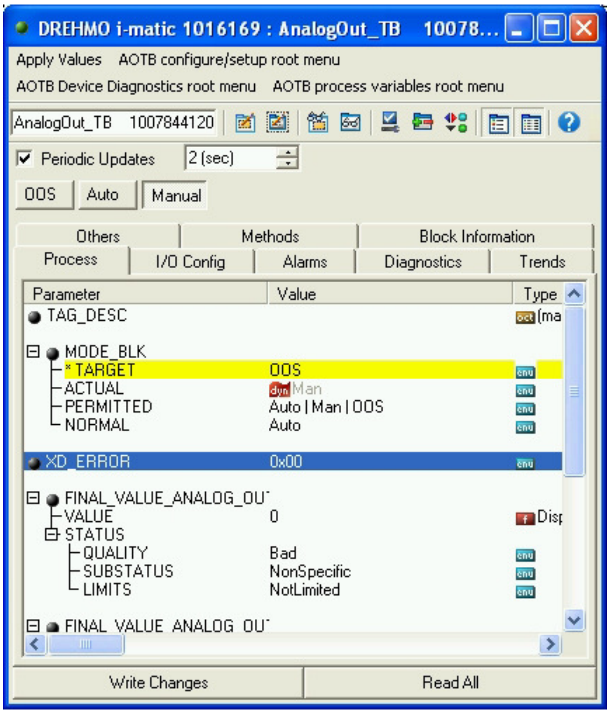


Figure 30: Changing block status

Info

Writing commands/parameters

All commands or modified parameters in NI-Configurator are always transmitted to the device, when pressing the button "Write Changes". If the changes were accepted by the device, the yellow background and the star before the parameter disappear. Read all parameters from the device by clicking the "Read All" button.

After a short time the Actual of MODE_BLK parameter should change to OOS. Then is the Function Block in the OOS state.

Subsequently, the channel of the AO function block must be assigned. The following table shows an exemplary assignment of the channel for the function block.

Block	Channel	Description
AO	Ch_Setpoint	Setpoint Signal

Table 14: Assignment of the channel from AO-FB

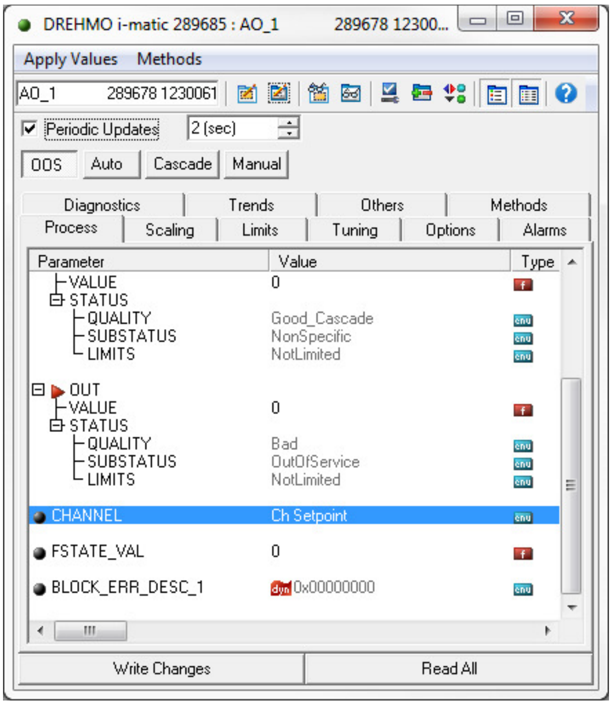


Figure 31: Channel assignment of AO-FB

Info

Alternative channel assignment
The configuration of the channels can be performed via Foundation Fieldbus methods.

Now the block configuration is complete and the Function Block Application can be sent to the actuator.

Info

Download of the function block application
For execute and request the functions blocks by the LAS, transmit the function block application to the actuator. For this purpose run the dialog "Download Project ..." (see 6.1.2 Download of the Function block application).

Drive the i-matic actuator

For moving the actuator via the signal Position Setpoint a value between 0 und 100 percent is set to the output of the AO-Function Block. For this purpose the ACTUAL of the MODE_BLK parameter is set to MAN. First occupy the value of the TARGET with MAN. After a short time, the ACTUAL of the parameter MODE_BLK should change the value in MAN.

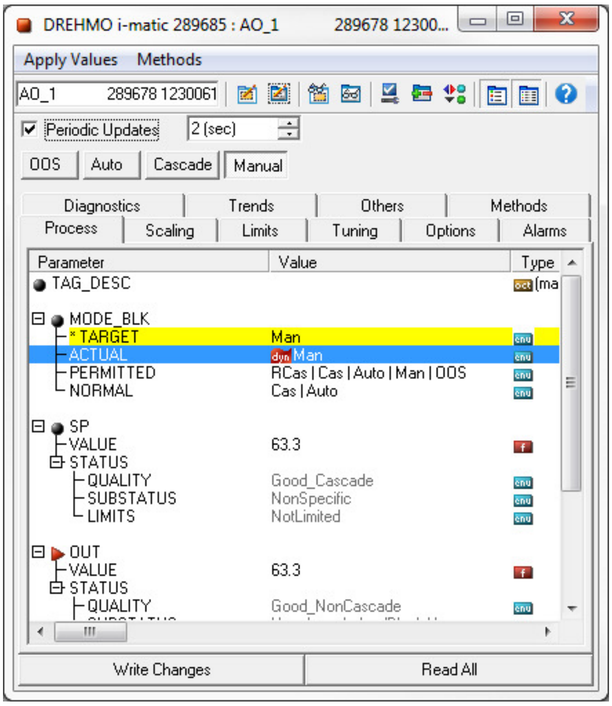


Figure 32: Manual mode from AO

In MAN mode you can insert a percentage value on the OUT parameter of the AO Function Block and the actuator moves. Insert the following values as described in the following table and see as the actuator moves.

OUT Value	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 15: Analogue control of the actuator

The following figure shows the input of the setpoint on AO-Function block.

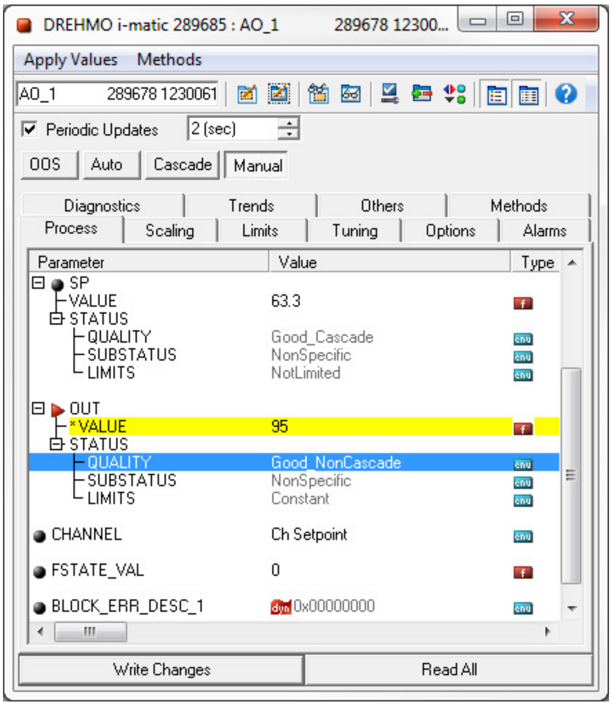


Figure 33: Setpoint input from AO-FB

The actual position can be read in parameter PRIMARY_VALUE_ACTUAL_POSITION from the Positioner_TB.

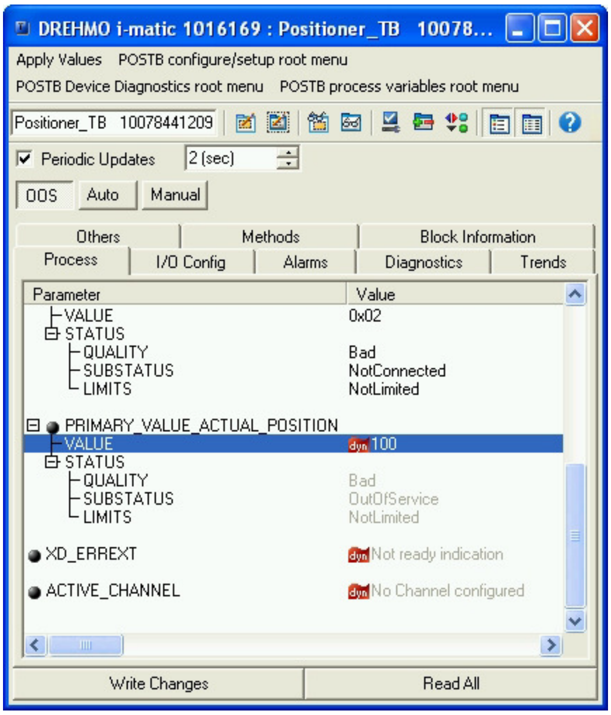


Figure 34: Actual position

The percentage values have the following meanings:

Actuator pos.	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 16: Value definition of actuator position

Info

If the actuator doesn't move
If this case occurs then it will have different causes, on the one hand the actuator is already fully opened and it can't be moved in the OPEN direction. For CLOSE direction it applies analogue.

Another possible cause is an error in the configuration of the AO-FB, when the parameter BLOCK_ERR_DESC_1 signals an error. It could be corrected if the block will be reconfigured.

A final cause of the error could be that the actuator is not switched to the mode REMOTE. It signals when the parameter XD_ERROR in Positioner_TB has the value "General Error" and the XD_ERREXT has the value "Not ready indication". To solve this change the mode in REMOTE on HMI of the actuator.

6.6 Control via analog setpoint (with Automatic-Bit)

Application description

The following example demonstrates how to move the i-matic actuator with the analogue command setpoint via Foundation Fieldbus. The automatic-Bit will be set by a DO-Function block.

Info

Precondition
For controlling the actuator via Foundation Fieldbus it is recommend to delete the previously used block model. For this purpose set the parameter RESTART from Resource Block (RB) to the value "Defaults" (see chapter 6.1.1 Reset).

Info

Deactivate the Automatic Bit
In this case the parameter PRM_DCS_CTRL_AUTO_BIT in Commiss_TB should set to value „Force disabled".

Design a block model

First, design a block model. For the implementation use the Transducer Blocks AnalogOut_TB, DigitalOut_TB and the Function Blocks Analog Output (AO) and Discrete Output (DO) (see following figure). A configurable output from the AnalogOut_TB is set to Position Setpoint. From DigitalOut_TB is a configurable output set to the Signal AUTOMATIC. Subsequently the Function Blocks are linked with the appropriate channel.

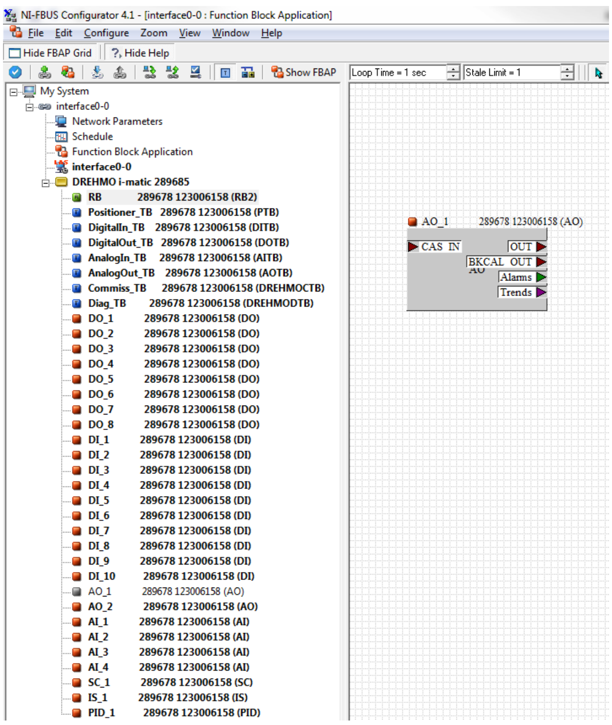


Figure 35: Representation of AOTB, DOTB, AO and DO

Prior configuration the block status of each Function- and Transducer Blocks is set to OOS (Out Of Service). For this purpose the TARGET of the parameter MODE_BLK is set to OOS (see following figure).

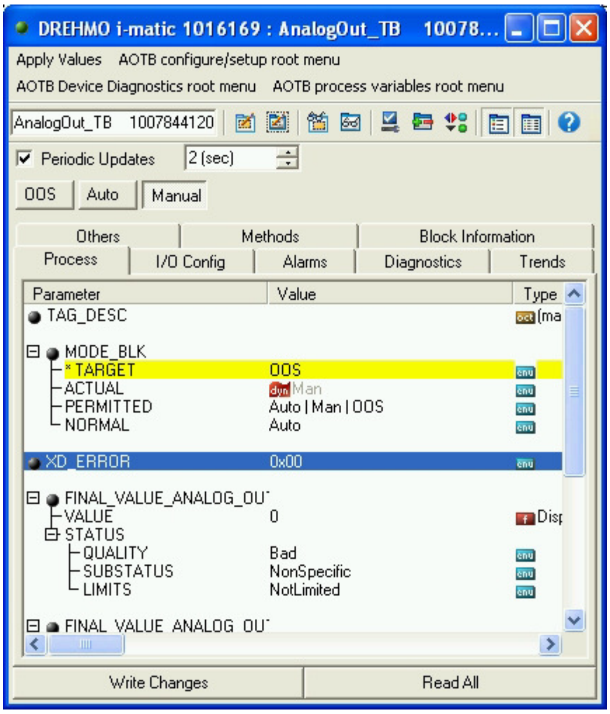


Figure 36: Changing block status

Info

Writing commands/parameters

All commands or modified parameters in NI-Configurator are always transmitted to the device, when pressing the button "Write Changes". If the changes were accepted by the device, the yellow background and the star before the parameter disappear. Read all parameters from the device by clicking the "Read All" button.

After a short time the Actual of MODE_BLK parameter should change to OOS. Then is the Function Block in the OOS state.
Subsequently, the configurable outputs of Transducer Blocks AOTB and DOTB can be set as shown in the following tables. First, the output of the AnalogOut_TB.

Parameter	Value	Description
CFG_AOUT_1	Fieldbus setpoint position	Position setpoint

Table 17: Assignment of the config. output from AOTB

The following figure shows the assignment of the channels “Fieldbus setpoint position” of the AOTB.

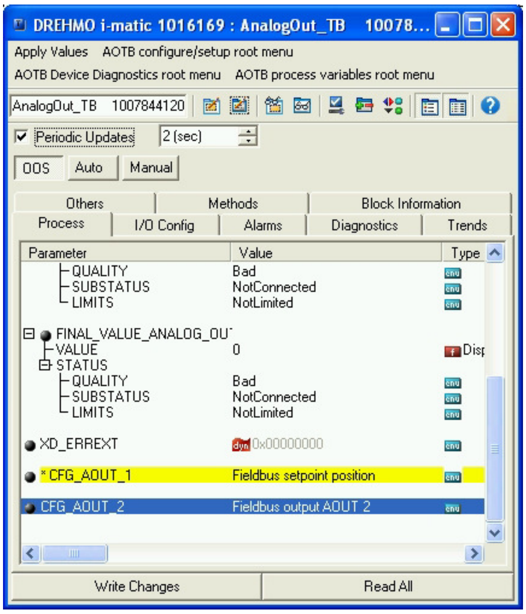


Figure 37: Assignment of the config. output from AOTB

Followed by the configurable output of the DigitalOut_TB.

Parameter	Value	Description
CFG_DOUT_1	Fieldbus SETPOINT	Signal AUTOMATIC

Table 18: Assignment of the config. output from DOTB

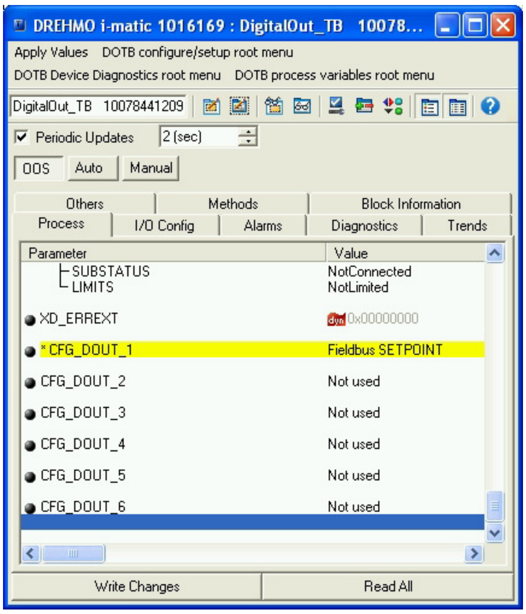


Figure 38: Assignment of the config. output from DOTB

After the Transducer Blocks are assigned with the correct signals, the corresponding channel can be configured to the Function Blocks. The first example is shown at the AO Function Block. Based on selecting the configurable output CFG_AOUT_1 of AnalogOut_TB is the associated channel "Ch AnalogOut1" in the AO Function Block to select. The following figure shows the selection of the channel.

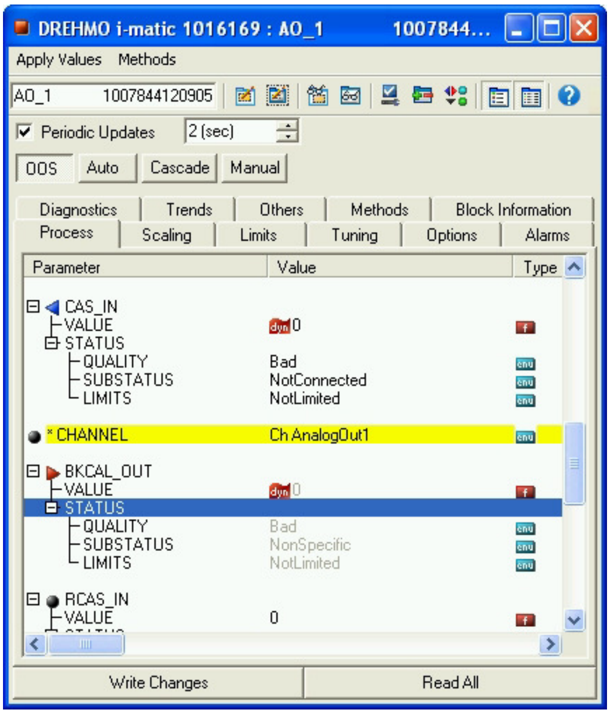


Figure 39: Channel assignment of the AO-FB

Now the block configuration is completed and the Function Block Application can be downloaded to the actuator.

Info

Alternative channel assignment

The configuration of the channels can be performed via Foundation Fieldbus methods.

For the DO Function Block select the corresponding channel "Ch DigitalOut 1”. This is the associated channel for the configurable output CFG_DOUT_1 of the DigitalOut_TB.

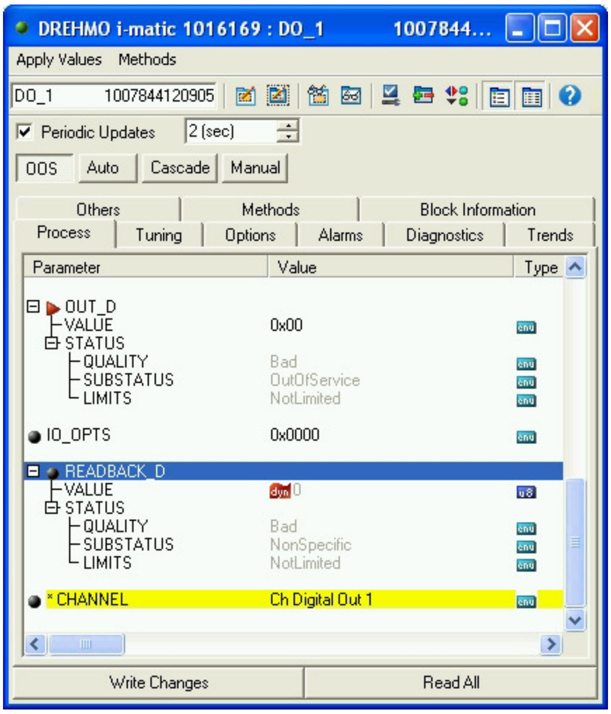


Figure 40: Channel assignment of the DO-FB

Now the block configuration is complete and the Function Block Application can be sent to the actuator.

Info

Download of the function block application

For execute and request the functions blocks by the LAS, transmit the function block application to the actuator. For this purpose run the dialog "Download Project ..." (see 6.1.2 Download of the Function block application).

Drive the i-matic actuator

For moving the actuator via the signal Position Setpoint is set the signal AUTOMATIC in the DO Function Block before. Subsequently the actuator can be moved via any percentage value on the output of the AO Function Block. When you want to configure both Function Blocks, they must be set into the block mode MAN. For this purpose the ACTUAL of the MODE_BLK parameter is set to MAN. As described above, the value of the TARGET is occupied with MAN. After a short time, the ACTUAL of the parameter MODE_BLK should change the value in MAN. This process is to repeat for the AO- and DO- Function Block.

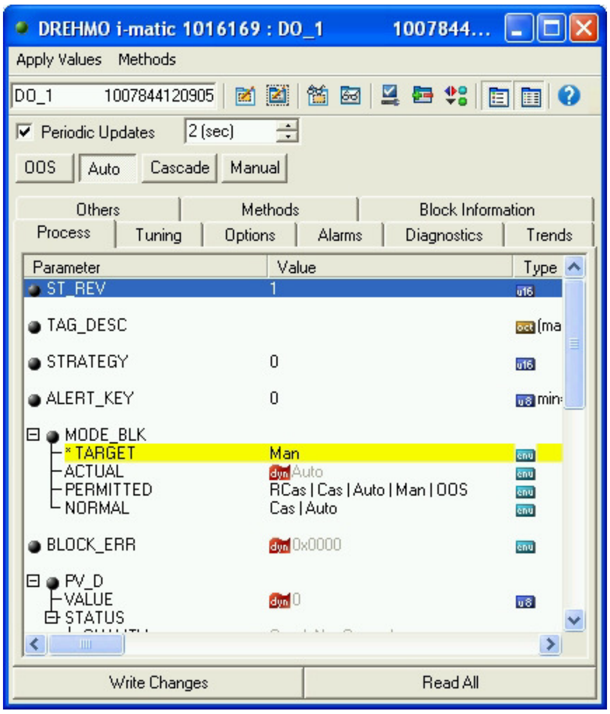


Figure 41: Manual mode of the DO

First activate the signal AUTOMATIC. For this purpose set the parameter OUT_D from $0x00_{hex}$ to the value $0x01_{hex}$.

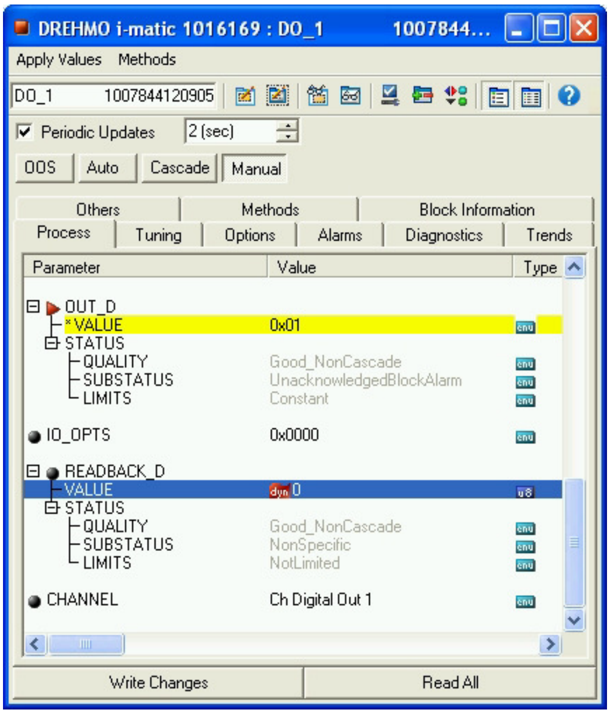


Figure 42: Set signal AUTOMATIC

After activated the signal AUTOMATIC, it is possible to move the actuator with an analogue position value. For this you can insert a percentage value on the OUT parameter of the AO Function Block and the actuator moves. Insert the following values as described in the following table and see as the actuator moves.

OUT Value	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 19: Analog control of the actuator

The following figure shows as the actuator moves to 50% of the length of the path.

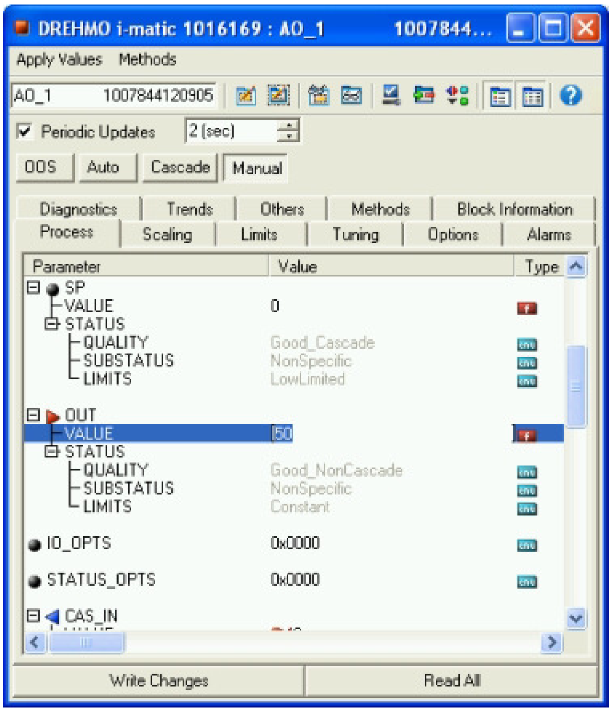


Figure 43: analogue control of the position setpoint

During the drive of the i-matic actuator the actual position can be read in parameter PRIMARY_VALUE_ACTUAL_POSITION from the Positioner_TB.

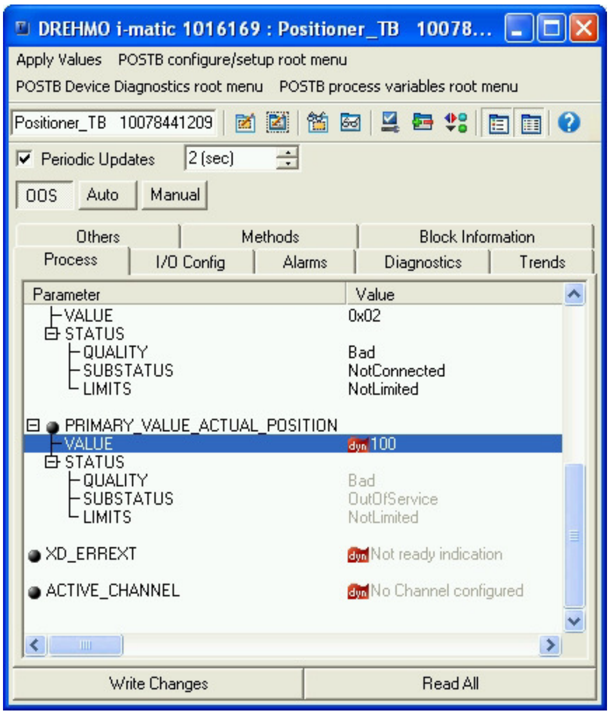


Figure 44: Actual position value of the actuator

The percentage values have the following meanings:

Actuator pos.	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 20: Values definition of the actuator position

Info

If the actuator doesn't move

If this case occurs then it will have different causes, on the one hand the actuator is already fully opened and it can't be moved in the OPEN direction. For CLOSE direction it applies analogue.

Another possible cause is an error in the configuration of the AO-FB, when the parameter BLOCK_ERR_DESC_1 signals an error. It could be corrected if the block will be reconfigured.

A final cause of the error could be that the actuator is not switched to the mode REMOTE. It signals when the parameter XD_ERROR in Positioner_TB has the value "General Error" and the XD_ERREXT has the value "Not ready indication". To solve this change the mode in REMOTE on HMI of the actuator.

6.7 Control with „Lock Local Control“

Application description

The following example demonstrates how to move the i-matic actuator with the analogue command setpoint via Foundation Fieldbus. The automatic-Bit will be set by a DO-Function block.

Info

Precondition
For controlling the actuator via Foundation Fieldbus it is recommend to delete the previously used block model. For this purpose set the parameter RESTART from Resource Block (RB) to the value “Defaults” (see chapter 6.1.1 Reset).

Info

Deactivate the Automatic Bit
In this case the parameter PRM_DCS_CTRL_AUTO_BIT in Commiss_TB should set to value „Force disabled“.

Design a block model

First, design a block model. For the implementation use the Transducer Blocks AnalogOut_TB, DigitalOut_TB and the Function Blocks Analog Output (AO) and Discrete Output (DO) (see following figure). A configurable output from the AnalogOut_TB is set to Position Setpoint. From DigitalOut_TB is a configurable output set to the Signal AUTOMATIC. Subsequently the Function Blocks are linked with the appropriate channel.

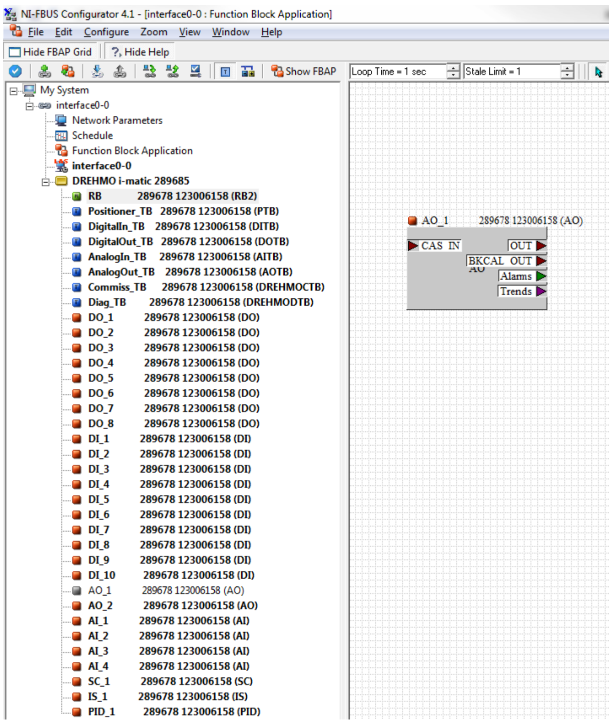


Figure 45: Representation of AOTB, DOTB, AO and DO

Prior configuration the block status of each Function- and Transducer Blocks is set to OOS (Out Of Service). For this purpose the TARGET of the parameter MODE_BLK is set to OOS (see following figure).

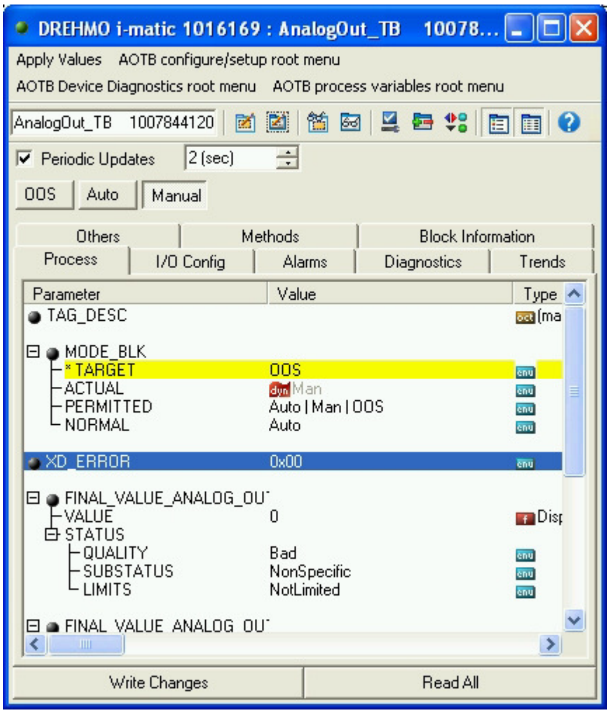


Figure 46: Changing block status

Info

Writing commands/parameters

All commands or modified parameters in NI-Configurator are always transmitted to the device, when pressing the button "Write Changes". If the changes were accepted by the device, the yellow background and the star before the parameter disappear. Read all parameters from the device by clicking the "Read All" button.

After a short time the Actual of MODE_BLK parameter should change to OOS. Then is the Function Block in the OOS state.

Subsequently, the configurable outputs of Transducer Blocks AOTB and DOTB can be set as shown in the following tables. First, the output of the AnalogOut_TB.

Parameter	Value	Description
CFG_AOUT_1	Fieldbus setpoint position	Position setpoint

Table 21: Assignment of the config. output from AOTB

The following figure shows the assignment of the channels "Fieldbus setpoint position" of the AOTB.

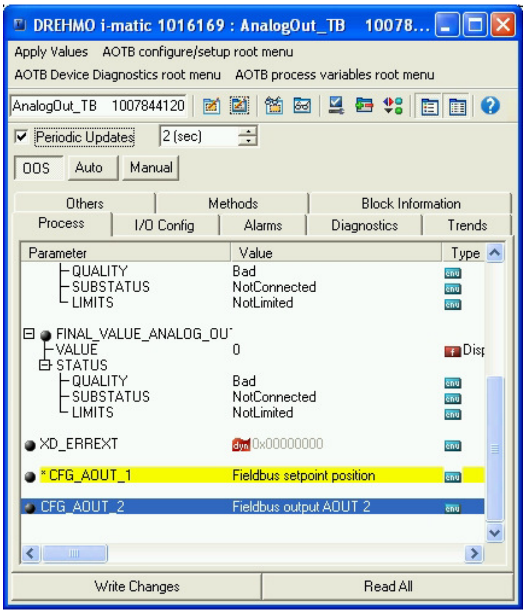


Figure 47: Assignment of the config. output from AOTB

Followed by the configurable output of the DigitalOut_TB.

Parameter	Value	Description
CFG_DOUT_1	Fieldbus SETPOINT	Signal AUTOMATIC

Table 22: Assignment of the config. output from DOTB

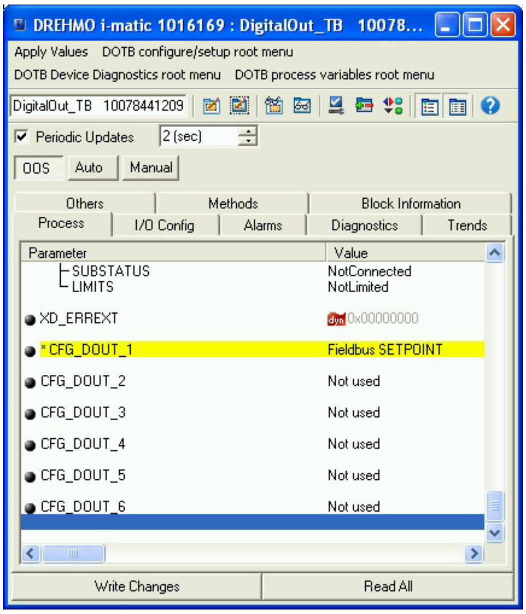


Figure 48: Assignment of the config. output from DOTB

After the Transducer Blocks are assigned with the correct signals, the corresponding channel can be configured to the Function Blocks. The first example is shown at the AO Function Block. Based on selecting the configurable output CFG_AOUT_1 of AnalogOut_TB is the associated channel "Ch AnalogOut1" in the AO Function Block to select. The following figure shows the selection of the channel.

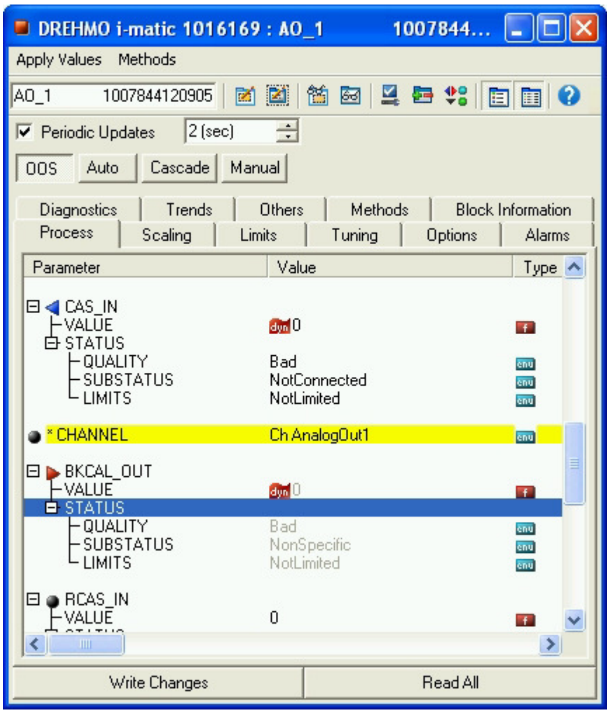


Figure 49: Channel assignment of the AO-FB

Now the block configuration is completed and the Function Block Application can be downloaded to the actuator.

Info

Alternative channel assignment

The configuration of the channels can be performed via Foundation Fieldbus methods.

For the DO Function Block select the corresponding channel "Ch DigitalOut 1”. This is the associated channel for the configurable output CFG_DOUT_1 of the DigitalOut_TB.

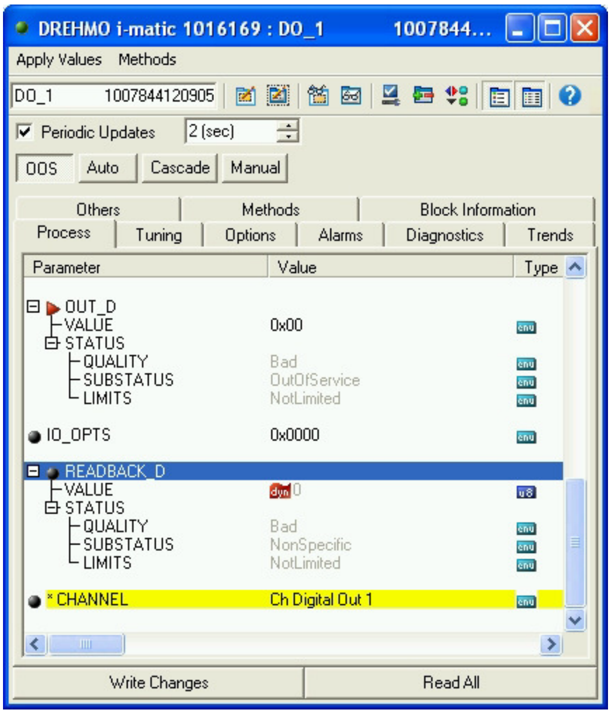


Figure 50: Channel assignment of the DO-FB

Now the block configuration is complete and the Function Block Application can be sent to the actuator.

Info

Download of the function block application

For execute and request the functions blocks by the LAS, transmit the function block application to the actuator. For this purpose run the dialog "Download Project ..." (see 6.1.2 Download of the Function block application).

Drive the i-matic actuator

For moving the actuator via the signal Position Setpoint is set the signal AUTOMATIC in the DO Function Block before. Subsequently the actuator can be moved via any percentage value on the output of the AO Function Block. When you want to configure both Function Blocks, they must be set into the block mode MAN. For this purpose the ACTUAL of the MODE_BLK parameter is set to MAN. As described above, the value of the TARGET is occupied with MAN. After a short time, the ACTUAL of the parameter MODE_BLK should change the value in MAN. This process is to repeat for the AO- and DO- Function Block.

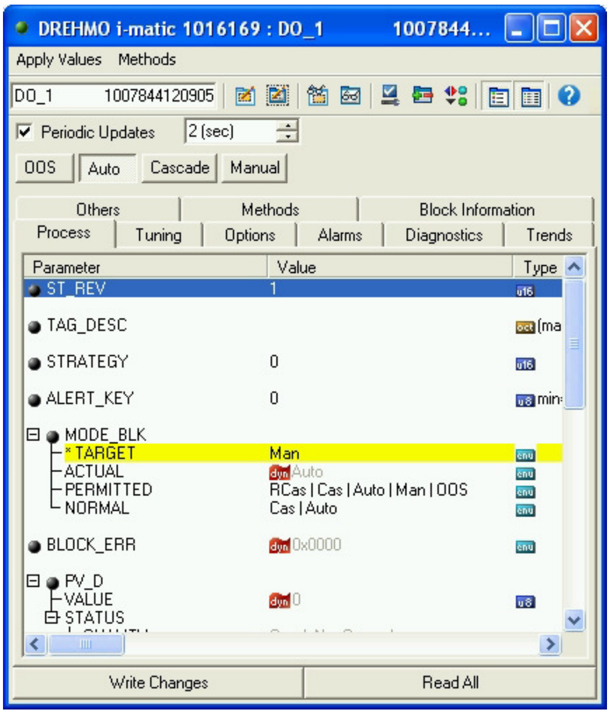


Figure 51: Manual mode of the DO

First activate the signal AUTOMATIC. For this purpose set the parameter OUT_D from $0x00_{hex}$ to the value $0x01_{hex}$.

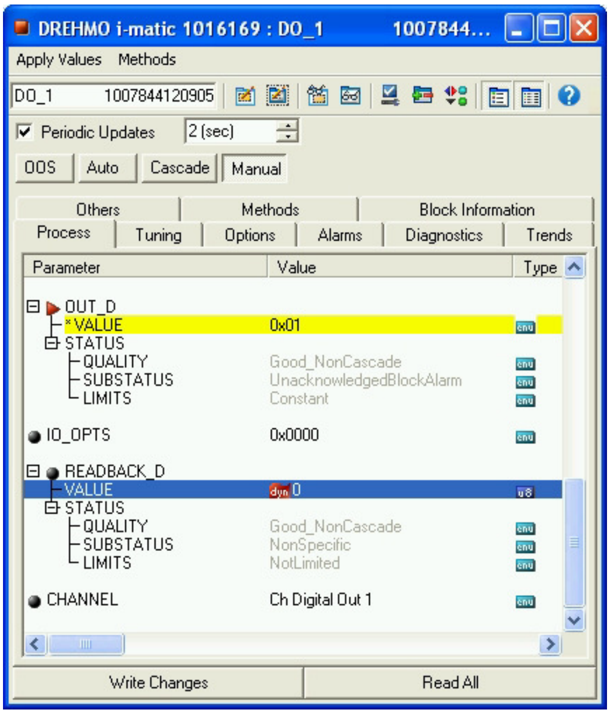


Figure 52: Set signal AUTOMATIC

After activated the signal AUTOMATIC, it is possible to move the actuator with an analogue position value. For this you can insert a percentage value on the OUT parameter of the AO Function Block and the actuator moves. Insert the following values as described in the following table and see as the actuator moves.

OUT Value	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 23: Analog control of the actuator

The following figure shows as the actuator moves to 50% of the length of the path.

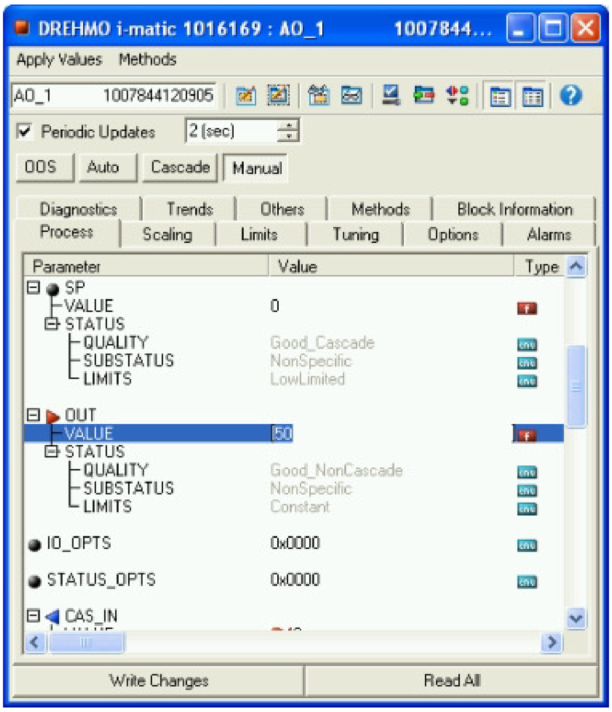


Figure 53: analogue control of the position setpoint

During the drive of the i-matic actuator the actual position can be read in parameter PRIMARY_VALUE_ACTUAL_POSITION from the Positioner_TB.

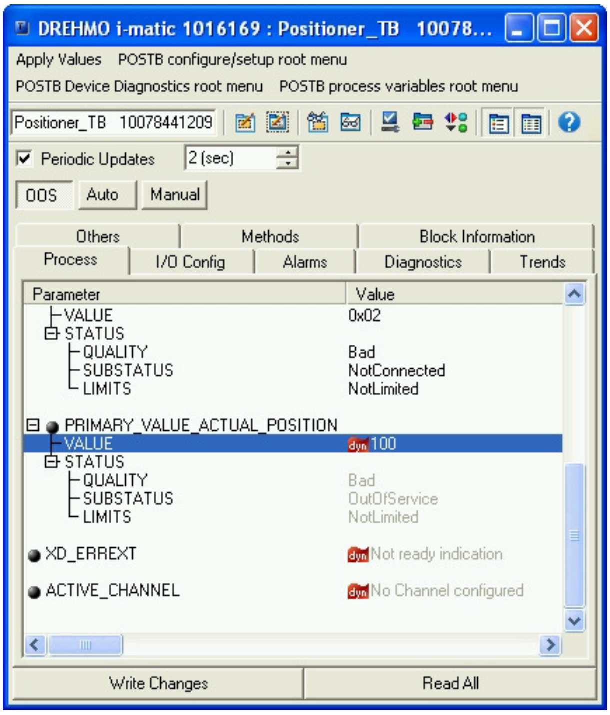


Figure 54: Actual position value of the actuator

The percentage values have the following meanings:

Actuator pos.	Description
0	Actuator fully closed
1-99	Percentage indication of the open actuator
100	Actuator fully opened

Table 24: Values definition of the actuator position

Info

If the actuator doesn't move

If this case occurs then it will have different causes, on the one hand the actuator is already fully opened and it can't be moved in the OPEN direction. For CLOSE direction it applies analogue.

Another possible cause is an error in the configuration of the AO-FB, when the parameter BLOCK_ERR_DESC_1 signals an error. It could be corrected if the block will be reconfigured.

A final cause of the error could be that the actuator is not switched to the mode REMOTE. It signals when the parameter XD_ERROR in Positioner_TB has the value "General Error" and the XD_ERREXT has the value "Not ready indication". To solve this change the mode in REMOTE on HMI of the actuator.

7 Description Foundation Fieldbus-Board

7.1 Notifications (optical signals)

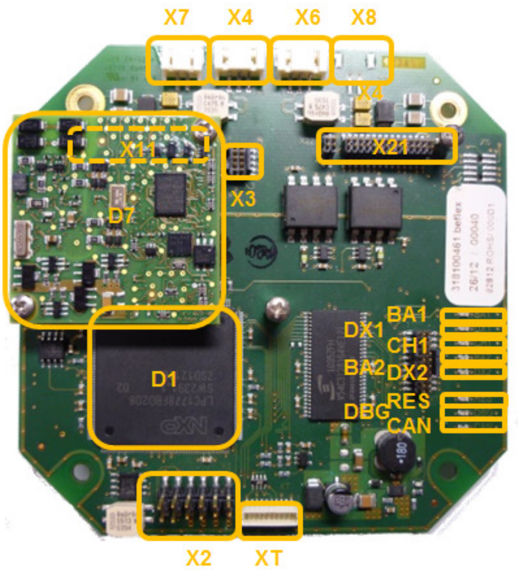


Figure 55: FF - Baugruppe

Name	Description
RES	LED RESET
DBG	LED DEBUG
CAN	LED CAN
BA1	LED Active Comm. Channel 1
DX1	LED Data Exchange Channel 1
CH1	LED Channel 1 active
BA2	LED Active Comm. Channel 2
DX2	LED Data Exchange Channel 2
D7	FBK2 from Softing
X4	FF-Bus Channel 1
X6	FF-Bus channel 2

8 Technical data

Configuration of the i-matic Foundation Fieldbus interface	
Setting the Node Address	Setting the Node Address via the Foundation Fieldbus while using a control system service of a configuration software for the Foundation Fieldbus (e.g. NI-Configurator).
Configurable feedback signals	Configurable feedback signals from the Analog Input (AI) and Discrete Input (DI) Function Blocks with channels and associated Transducer Blocks. This is possible by using the Device Description and specific configuration software for the Foundation Fieldbus (e.g. NI-Configurator).
Parameterization of the i-matic actuator	Set of parameters either via the LC-Display of the i-matic actuator or with specific configuration software for the Foundation Fieldbus (e.g. NI-Configurator).

General information of the i-matic Foundation Fieldbus interface		
Communication protocol	Foundation Fieldbus H1 (31,25 kbit/s) In accordance with IEC 61158 and IEC 61784-1	
Physical Layer	113	Standard-power signalling, bus-powered, non I.S.
	115	Standard-power signalling, bus-powered, energy limited (Ex nL)
	511	Low-power signalling, bus-powered, FISCO I.S.
Network topology	Point-to-Point, Bus with Spurs, Daisy Chain, Tree-topology (Device internal spur length: 0.36 m)	

Transmission medium	Two-wire copper cable for data transmission / power supply in accordance with: • ISA S50.02-1992 ISA Physical Layer Standard or. • IEC 61158-2:2000 (ed. 2.0), Part 2: Physical Layer specification and service definition • Recommendation: Use the cable type A (shielded and twisted)
Transmission rate	31,25 kbit/s
Device voltage	9 – 32V DC
Current consumption	• Normal mode: ca. 13 mA at +24V DC • During Firmware update: max. 26 mA at +24V DC
Cable length	• Maximum 1900m (when using the cable type A) • Maximum 9500m (when using maximum 4 repeaters)
Number of devices	Maximum 32 devices per segment A total of 240 addressable devices Typical device number: 6-15 devices per segment
Communication services	• Publish/Subscriber for transmission of process data • Client/Server for configuration • Report Distribution for transmission of alarm signals
Link Master functionality	The i-matic own Link Master functionality. Link Master devices can take over the Link Active Scheduler (LAS) function for coordinate the bus communication.
Polarity	The Foundation Fieldbus connection of the i-matic provides automatic detection and correction of polarity.

Functional Blocks of the i-matic Foundation Fieldbus interface		
Functional Blocks for output signals	8x	Discrete Output Function Blocks (DO) for discrete output signals, e.g.: OPEN/ CLOSE/ STOP, Emerg. shutdown, Interlock OPEN/ CLOSE, Intermediate positions, AUTOMATIC, Digital customer outputs
	2x	Analog Output Function Blocks (AO) for analogue output signals, e.g.: Position Setpoint, Analog customer outputs
Functional blocks For feedback signals	10x	Discrete Input Function Blocks (DI) for discrete feedback signals, e.g.:

		Final position OPEN/ CLOSE, Drive travels OPEN/ CLOSE, Intermediate positions, Torque indication OPEN/ CLOSE, Collective failure 1 / 2, Hand wheel-/Local-/Remote Mode, Digital customer inputs
	4x	Analog Input Function Blocks (AI) for analogue feedback signals, e.g.: Actual position, Torque value, Analog customer inputs
Other Function Blocks	1x	Resource Block (RB2) Description of the Device Information.
	1x	Signal Characterizer (SC) for conversion of analogue signals.
	1x	Input Selector (IS) for selecting the analogue input signals.
	1x	Proportional Integral Differential (PID) for modulating applications.
Transducer Blocks for output signals	Each one Transducer Block (DOTB, AOTB) as connection block between discrete and analogue outputs	
Transducer Blocks for input signals	Each one Transducer Block (DITB, AITB) as connection block between discrete and analogue inputs.	
Other Transducer Blocks	1x	Positioner Transducer Block (PTB) a connection block for control.
	1x	Commissioning Transducer Block (DREHMOCTB) for parameterization of the i-matic actuator.
	1x	Diagnostic Transducer Block (DREHMODTB) for monitoring and diagnosis of the i-matic actuator.
Number of Function Blocks	27	
Number of link objects	68	
Number of VCRs	72	

Function blocks and their execution times [ms]	
Discrete Output (DO)	30
Discrete Input (DI)	20
Analog Output (AO)	30
Analog Input (AI)	30
Signal Characterizer (SC)	40
Input Selector (IS)	30
Proportional Integral Differential (PID)	40

Nameplate of the i-matic Foundation Fieldbus interface	
Manufacturer ID	$0x000131_{hex}$
Device type	$0x0007_{hex}$
Device revision	$0x01_{hex}$
Device ID	0001310007—iM-(serial. nr. device)-(serial. nr. FF-module)
DD revision	$0x01_{hex}$
CFF revision	$0x010101_{hex}$
ITK revision	6.0.1

* We reserve the right to alter data according to improvements.
** Earlier versions of this document become invalid with this publication.

Notice

Notice

Notice

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