DREHMO
VALVE ACTUATORS

A member of the AUMA Group

Additional operating manual

Highway Addressable Remote Transducer (HART)

Operation and servicing instructions

Part. no: 382644
Revision: 1.0
Date: March 23, 2017

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

Table of Contents

1 Safety instructions

This section deals with basic, safety-relevant information relating to DREHMO actuators. We would like to ask you to thoroughly read the instructions prior to working on the actuators.

1.1 Basic information on safety

Standards/directives
DREHMO products are designed and manufactured in compliance with recognised standards and directives. This is certified in a Declaration of Incorporation and an EC Declaration of Conformity. Plant operators or plant manufacturers must ensure that all legal requirements, directives, guidelines, national regulations and recommendations with respect to assembly, electrical connection, commissioning and operation are met at the place of installation.

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 by suitably qualified personnel authorised by the plant operators or plant manufacturers only. Prior to working on this product, the staff must have thoroughly read and understood these instructions as well as the the additional instructions for the integral control 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 to be observed. The plant operators or plant manufacturers are responsible for respect and control of these regulations, standards, and laws.

Commissioning
Prior to commissioning, it is important to check that all settings meet 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.

Operation
Prerequisites for safe and smooth operation:

- Correct transport, proper storage, mounting and installation, as well as careful commissioning.
- Only operate the device if it is in perfect condition while observing these instructions.
- Immediately report any faults and damage and allow for corrective measures.
- Observe recognised rules for occupational health and safety.
- Observe national regulations.
- During operation, the housing warms up and surface temperatures $>60\,^{\circ}\mathrm{C}$ may occur. To prevent possible burns, we recommend checking the surface temperature using an appropriate thermometer and wearing protective gloves, if required, prior to working on the device.

Protective measures
The plant operators or plant manufacturers are responsible for implementing required protective measures on site, such as enclosures, barriers, or personal protective equipment for the staff.

Maintenance
To ensure safe device operation, the maintenance instructions included in this manual must be observed.
Any device modification requires prior consent of the manufacturer.

1.2 Range of application

DREHMO actuators are designed for the operation of gate valves, butterfly valves, and ball valves. If temperatures $>40\,^{\circ}\mathrm{C}$ are to be expected at the valve mounting flange or the valve stem (e.g. due to hot media), please consult the manufacturer. Other applications require explicit (written) confirmation by the manufacturer. The following applications are not permitted, e.g.:

- Industrial trucks according to EN ISO 3691
- Lifting appliances according to EN 14502
- Passenger lifts according to DIN 15306 and 15309
- Service lifts according to EN 81-1/A1
- Escalators
- Continuous duty
- Buried service
- Continuous submersion (observe enclosure protection)
- Radiation exposed areas in nuclear power plants

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.

Information: These instructions apply to the clockwise closing standard version, i.e. the driven shaft turns clockwise to close the valve.

2 Introduction

2.1 Scope

The DREHMO Actuator model i-matic, complies with HART Protocol Revision 7.4. This document explains all the device specific features and documents HART Protocol implementation details (e.g., the Engineering Unit Codes supported). The functionality of this Field Device is described sufficiently to allow its proper application in a process and its complete support in HART capable Host Applications.

2.2 Purpose

This specification is designed to complement other documentation (e.g. the operating manual for DREHMO i-matic) by providing a complete, unambiguous description of this Field Device from a HART Communication perspective.

2.3 Who should use this document?

The specification is designed to be a technical reference for HART capable host application developers, system integrators and knowledgeable end users. It also provides functional specifications (e.g., commands, enumerations and performance requirements) used during Field Device development, maintenance and testing. This document assumes the reader is familiar with HART Protocol requirements and terminology.

2.4 Abbreviations and definitions

Only HART specific abbreviations and definitions are used.

3 Device Identification

Manufacturer Name:	AUMA	**Model Name(s)**	DREHMO i-matic
Manufacturer ID Code:	24700 (0x607C)	**Device Type Code**	58037 (0xE2B5)
HART Protocol Revision:	7.4	**Device Revision**	1
Number of Device Variables:	12		
Physical Layers Supported:	FSK		
Physical Device Category:	Actuator, Current Output, Non-DC-isolated Bus Device		

Additional Information for the Device Identification can be looked up in the local Display:

- Menuetree: Electronic name plate => Control unit
  (refer to the operation manual for DREHMO i-matic for further information)

4 Product Interfaces

The DREHMO i-matic actuator control provides various interfaces for the operation with actuators.

1. **Interface to the actuator**
   This interface contains the mains to energize / de-energize the actuator motor for opening / closing a valve. But it also contains feedback signals from the actuator such as limit switches and torque protection for both directions as well as monitoring signals e.g. for thermal overload protection.
2. **HART interface to the host and DCS**
   Two Connection Types are available as interface between host and DCS: The Connection Type **Actuator** for a low impedance connection (default) and the Connection Type **Current Output** for a high impedance connection.
3. **Local interface to the operator**
   This interface provides a display for diagnosis, operation and setting purposes and a few LED's to indicate the main diagnosis signals. There are also push buttons for local operation. Furthermore there is a Bluetooth interface for communication with DREHMO i-matic Explorer 2, this is a powerful software for diagnosis, operation and commissioning purposes. The actuator itself is also equipped with a hand wheel for operation at power failure. This interface represents the actuator and the DREHMO i-matic actuator controls with all its functions and features to the host / DCS.

4.1 Process Interface

4.1.1 Sensor Input Channels

Device Variable 3, Actual Position
The Device Variable 3 contains the current position of the actuator if a position transmitter is installed in the actuator. Its value ranges from 0% to 100% (0% represents the end position close, 100% represents the end position open).

Device Variable 7, Torque
The Device Variable 7 contains the current torque applied to the valve if combined sensor is installed in the actuator. The torques for open or close direction is representing from 0% – 100%.

Device Variable 9, Analog Input 1
The Device Variable 9 contains the value of the analog input 1 from the base-board. Its value ranges from 0% to 100%, the start and end values can be set using the push buttons and display of the DREHMO i-matic actuator controls.

Device Variable 10, Analog Input 2
The Device Variable 10 contains the value of the analog input 2 from the base-board. Its

value ranges from 0% to 100%, the start and end values can be set using the push buttons and display of the DREHMO i-matic actuator controls.

Device Variable 6, Discrete Signals 1

The Device Variable 6 contains various binary indications representing the status of the actuator and/or the actuator controls:

Byte	Bit	Process data	Description
0	0	Stepping pause active	The actuator stopped during stepping mode operation.
	1	Actuator in stepping mode	The actuator is in the range in which the stepping mode is active.
	2	Cyclic operation active	A stepping mode is parameterized in direction OPEN or CLOSE.
	3	Reserved	-
	4	Actuator running	The power unit of the drive is activated.
	5	Hand wheel operation	An actuator movement without electric power is present.
	6	Running REMOTE	The actuator is in the REMOTE mode and is driven by DCS.
	7	Running LOCAL	The actuator is in LOCAL mode and the power unit is used.
1	0	No REMOTE mode	The actuator cannot be operated from REMOTE, only from LOCAL.
	1	Warnings	Indicates that a warning is active.
	2	Fault	A fault is active, the actuator cannot be operated.
	3	Maintenance required	NAMUR recommendation NE 107, maintenance necessary
	4	Out of specification	NAMUR recommendation NE 107, the actuator is operating outside normal conditions.
	5	Function check	According to NAMUR recommendation NE 107, during self check the output signals are invalid.
	6	Failure	According to NAMUR recommendation NE 107, failure during operation, output signals invalid.
	7	Device ok	According to NAMUR recommendation NE 107, actuator ready for remote control (no warnings and failure).
2	0	Overtemperature tripping	The motor protection triggers by overtemperature.
	1	Phase failure	One phase L1, L2 or L3 is missing.
	2	REMOTE mode	The actuator is in the REMOTE mode and can be controlled by DCS.

Byte	Bit	Process data	Description
	3	LOCAL mode	The actuator can be operated locally from HMI.
	4	Limit Switch OPEN	The actuator is in a position outside the working range or not on position OPEN.
	5	Limit Switch CLOSE	The actuator is in a position outside the working range or not on position CLOSE.
	6	Torque OPEN	The torque measurement provides a greater value than the parameterized tripping torque OPEN.
	7	Torque CLOSE	The torque measurement provides a greater value than the parameterized tripping torque CLOSE.
3	0	Limit OPEN	Final position for OPEN.
	1	Limit CLOSE	Final position for CLOSE.
	2	Setpoint reached	The predefined setpoint is reached.
	3	Not ready REMOTE	The actuator can only be operated with the local controls.
	4	Actuator running OPEN	The power relay controls the drive in direction OPEN.
	5	Actuator running CLOSE	The power relay controls the drive in direction CLOSE.
	6	Warnings	Indicates that a warning is active.
	7	Fault	A fault is active, the actuator cannot be operated.

Device Variable 8, Discrete Signals 2

The Device Variable 8 contains additional various binary indications representing the status of the actuator and/or the actuator controls:

Byte	Bit	Process data	Description
0	0	Reserved	-
	1	Reserved	-
	2	Reserved	-
	3	Status AnaIn 1	Status channel Analog Input 1.
	4	Reserved	-
	5	DeviceFailure	If an internal error occurs, the actuator does not start or a configuration error exists a device failure appears.
	6	SensorFailure	During self-diagnosis for position and torque measurements a fault has been detected.
	7	CommandNotExecutable	The actuator has an error detected or is in status not ready remote.
1	0	Channel 1 active	Channel 1 is the active operation channel
	1	Reserved	-

Byte	Bit	Process data	Description
	2	Channel 1 Data Ex	Channel 1 is in the data exchange
	3	Reserved	-
	4	Channel 1 FailState	No valid communication via channel 1
	5	Reserved	-
	6	Channel 1 activity	Communication on channel 1
	7	Reserved	-
2	0	Dig. Input 1	Status of digital input 1.
	1	Dig. Input 2	Status of digital input 2.
	2	Dig. Input 3	Status of digital input 3.
	3	Dig. Input 4	Status of digital input 4.
	4	Dig. Input 5	Status of digital input 5.
	5	Dig. Input 6	Status of digital input 6.
	6	Reserved	-
	7	Reserved	-
3	0	Intermediate position 1	Indication of the intermediate position 1
	1	Intermediate position 2	Indication of the intermediate position 2
	2	Intermediate position 3	Indication of the intermediate position 3
	3	Intermediate position 4	Indication of the intermediate position 4
	4	Intermediate position 5	Indication of the intermediate position 5
	5	Intermediate position 6	Indication of the intermediate position 6
	6	Intermediate position 7	Indication of the intermediate position 7
	7	Intermediate position 8	Indication of the intermediate position 8

4.1.2 Actuator Output Channels

Device Variable 2, Setpoint

The Device Variable 2 contains the setpoint for the actuator. In the Connection Type Actuator with Loop Current mode enabled the Device Variable 2 Setpoint is derived from the Loop Current and is only readable through HART Commands. In the Connection Type Actuator with Loop Current Mode disabled and in the Connection Type Current Output the Device Variable 2 Setpoint can be set through Common Practice HART Command 79 or Device Specific HART Command 128.

Device Variable 4, Commands

The Device Variable 4, Commands contains the discrete operation commands for the actuator.

Byte	Bit	Process data	Description
0	0	Command CLOSE	Drives the actuator in direction CLOSE.
	1	Command OPEN	Drives the actuator in direction OPEN.
	2	Command AUTO	Enables the integrated 3-point positioner, and allows driving the actuator via setpoint.
	3	Command STOP	Stops the actuator when a discrete command from remote is released.
	4	Stepping mode	Enables the stepping mode.
	5	Emergency Shutdown (ESD)	Enables emergency shutdown (ESD) of the actuator.
	6-7	Reserved	-
1	0-7	Reserved	-
2	0	Intermediate position 1	Drive the actuator to the parameterized intermediate position 1.
	1	Intermediate position 2	Drive the actuator to the parameterized intermediate position 2.
	2	Intermediate position 3	Drive the actuator to the parameterized intermediate position 3.
	3	Intermediate position 4	Drive the actuator to the parameterized intermediate position 4.
	4	Intermediate position 5	Drive the actuator to the parameterized intermediate position 5.
	5	Intermediate position 6	Drive the actuator to the parameterized intermediate position 6.
	6	Intermediate position 7	Drive the actuator to the parameterized intermediate position 7.
	7	Intermediate position 8	Drive the actuator to the parameterized intermediate position 8.
3	0-7	Reserved -	

In the Connection Type Actuator with Loop Current Mode enabled the Device Variable 4 Commands is fixed to the value **Command setpoint** and is only readable through HART Commands. In the Connection Type Actuator with Loop Current Mode disabled and in the Connection Type Current Output the Device Variable 4 Commands can be set either through Common Practice HART Command 79 or through Device Specific HART Command 128.

Device Variable 11, Additional Commands

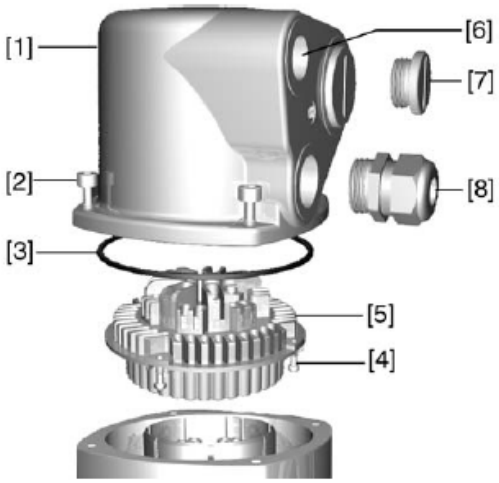
The Device Variable 11, Additional Commands contains further commands for the actuator.

Byte	Bit	Process data	Description
0	0	Reserved	-
	1	Emergency-STOP	Activates the emergency STOP function.
	2	Reserved	-
	3	Fieldbus enable LOCAL CLOSE	The operation of the actuator via the local control in direction CLOSE will be released.
	4	Fieldbus enable LOCAL OPEN	The operation of the actuator via the local control in direction OPEN will be released.
	5	Fieldbus enable LOCAL	The operation of the actuator via the local control will be enabled.
	6-7	Reserved	-
1	0	Fieldbus DOUT 1	Transmitting a digital signal from the DCS to the relay board of the control.
	1	Fieldbus DOUT 2	Transmitting a digital signal from the DCS to the relay board of the control.
	2	Fieldbus DOUT 3	Transmitting a digital signal from the DCS to the relay board of the control.
	3	Fieldbus DOUT 4	Transmitting a digital signal from the DCS to the relay board of the control.
	4	Reserved	-
	5	Reserved	-
	6	Reserved	-
	7	Reserved	-
2	0-7	Reserved	-
3	0-7	Reserved	-

In the Connection Type Actuator with Loop Current Mode enabled the Device Variable 11 Additional Commands can be set through Common Practice HART Command 79. In the Connection Type Actuator with Loop Current Mode disabled and in the Connection Type Current Output the Device Variable 11 Additional Commands can be set either through Common Practice HART Command 79 or through Device Specific HART Command 128.

4.2 Host Interface

Two Connection Types are provided by the DREHMO Actuator controls to link with the Host, either link with the Connection Type Actuator or the Connection Type Current Output. The appropriate Connection Type can be configured through a corresponding switch on the HART board. If the DREHMO Actuator Control is connected to the host as a Low Impedance Device, the Connection Type Actuator has to be configured. In that case the Host Interface is the Analog Input 1 and provides the Setpoint for the DREHMO Actuator Control. If the Actuator Control is connected to the host as a High Impedance Device, the Connection Type Current Output has to be configured. In that case the host interface is the Analog Output 2, which delivers the actual Position of the DREHMO Actuator Control. The HART signals need to be connected at the electrical connection of the terminal compartment.



ID	Beschreibung
1	Cover
2	Screws for cover
3	O-Ring
4	Screws for socket carrier
5	Socket carrier
6	Cable entry
7	Blanking plug
8	Cable gland (not included in delivery!)

Figure 4.1: Hostschnittstelle

Depending on the configured Connection Type, different wiring diagrams are used. Please refer to the wiring diagram attached to the actuator for connection of the HART cabling.

4.2.1 Analog Input 1: Setpoint (Connection Type Actuator)

The wiring diagram shown below is a typical example. The terminal numbers listed in the wiring diagram are also shown on the socket carrier within the connection. The HART wires need to be connected to Ain+ and Ain- (in the example wiring diagram below at XK31 and XK32).

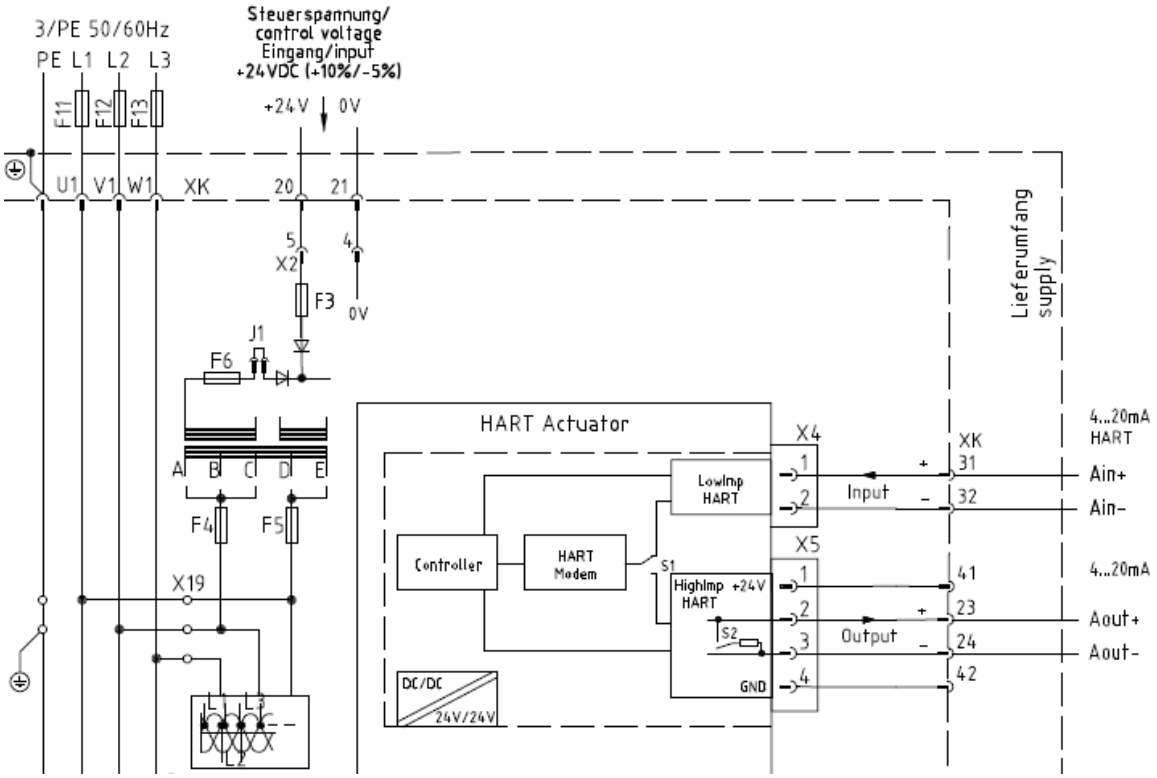


Figure 4.2: Wiring diagram - HART-Interface Actuator

The Analog Input 1 is representing the actuator setpoint in % of maximum travel. This input corresponds to the Primary Variable in the Connection Type Actuator. HART Communication is supported on this loop. A guaranteed linear overrange is provided. Current values are shown in the table below.

	Value (percent of range)	Values (mA or V)
Down	-10 % ± 0.5 %	1.9 to 2.1 mA
Up	-110 % ± 0.5 %	21.9 to 22.1 mA
Maximum current	+120 %	24 mA
Multi-Drop current draw	—	2 mA
Lift-off voltage	—	7 V

4.2.2 Analog Output 1: Position (Connect. type Current Output)

The wiring diagram shown below is a typical example. The terminal numbers listed in the wiring diagram are also shown on the socket carrier within the connection. The HART wires need to be connected to Aout+ and Aout- (in the example wiring diagram below at XK23 and XK24).

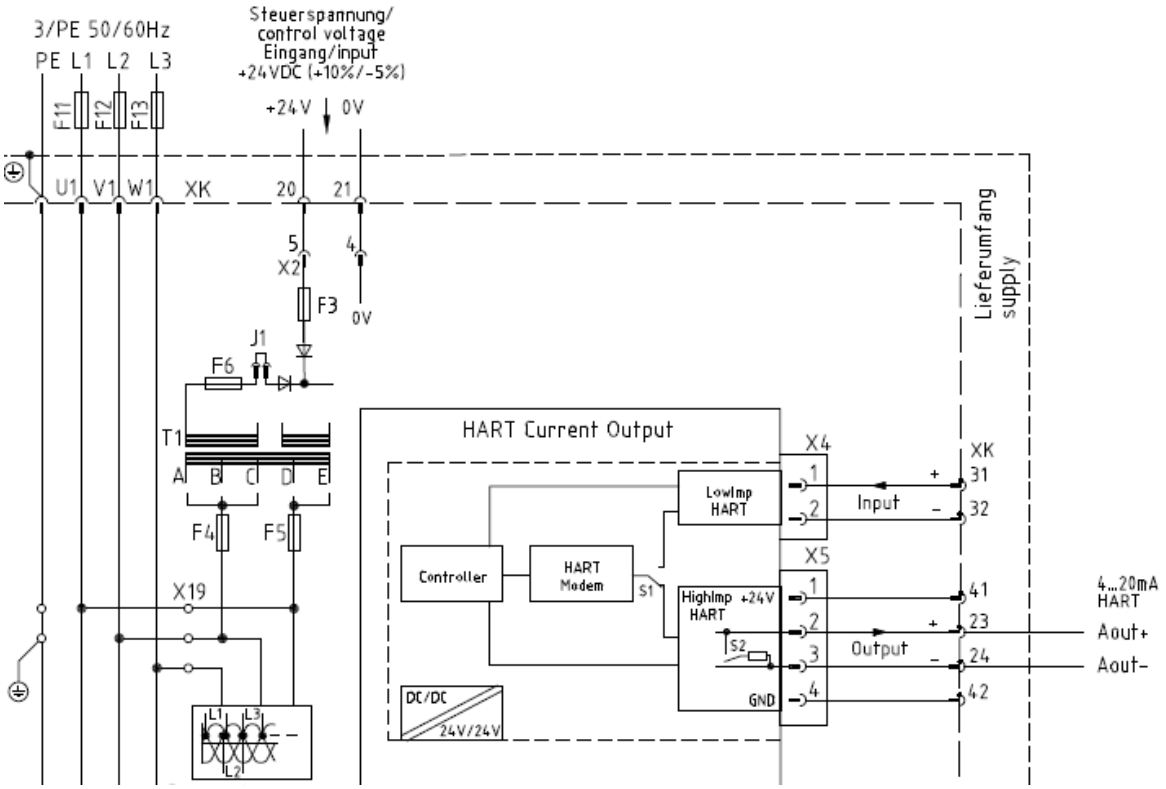


Figure 4.3: Wiring diagram - HART-Interface Current Output

The Analog Output 1 is representing the actuator position in % of maximum travel. This output corresponds to the Primary Variable in the Connection Type Current Output. HART Communication is supported on this loop. A guaranteed linear overrange is provided. Current values are shown in the table below.

	Value (percent of range)	Values (mA or V)
Down	-10 % ± 0.5 %	1.9 to 2.1 mA
Up	-110 % ± 0.5 %	21.9 to 22.1 mA
Maximum current	+120 %	24 mA
Multi-Drop current draw	—	4 mA
Lift-off voltage	—	0 V

4.3 Local Interfaces, Jumpers and Switches

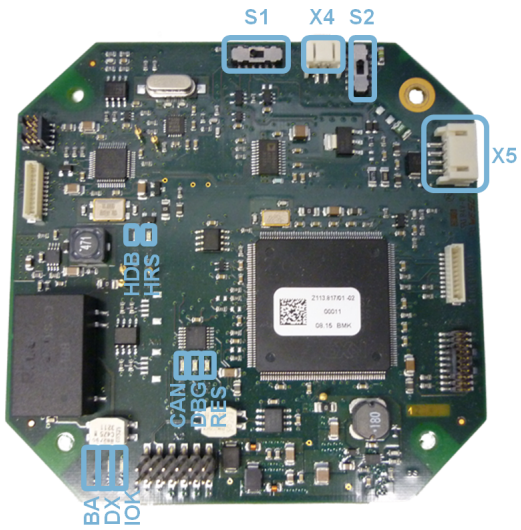
4.3.1 Local Display

A local display is available for diagnostic and configuration purposes. HART specific diagnostic and configuration can be performed in following menus:

- Actual values/diagnosis => Interface => HART
- Parameters => DCS / PLC system => Interface => HART

4.3.2 Internal Jumpers And Switches

An internal switch S1 placed on the HART board is available to configure the Connection type of the Actuator Controls. This switch is accessible for Service only. The internal switch S2 also placed on the HART board can activate an additional resistor of 250 Ω, which is necessary for a wireless HART adapter.



Name	Description
RES	LED RESET
DBG	LED DEBUG
CAN	LED CAN
HDB	LED DEBUG HART Stack
HRS	LED RESET HART Stack
BA	LED Active Buscomm.
DX	LED Data Exchange
IOK	LED Analog Signal occur
X4	Actuator Connection
X5	Current Output and +24 V
S1	Connection Type
S2	WirelessHART Switch

Positio	Description
S1	
Left	Current Output
Right	Actuator
S2	
Top	WirelessHART active / Resistor 250 Ω active
Down	WirelessHART deactive / Resistor of 250 Ω removed

Figure 4.4: HART-Board

5 Device Variables

Twelve Device Variables are implemented.

Device Variable	Name	Classification	Unit Code
0	Input Current	84 (current)	39 (milliamps)
1	Output Current	84 (current)	39 (milliamps)
2	Setpoint	0 (not classified)	57 (percent)
3	Actual Position	0 (not classified)	57 (percent)
4	Commands	0 (not classified)	251(none)
5	Reserved	0 (not classified)	251(none)
6	Discrete Signals 1	0 (not classified)	251(none)
7	Torque	0 (not classified)	57 (percent)
8	Discrete Signals 2	0 (not classified)	251(none)
9	Analog Input 1	0 (not classified)	57 (percent)
10	Analog Input 2	0 (not classified)	57 (percent)
11	Additional Commands	0 (not classified)	251(none)

6 Dynamic Variables

Two Dynamic Variables (PV = Primary Variable, SV = Secondary Variable) are implemented, with specific mapping within every Connection Type. For the Connection Type Actuator the Dynamic Variable Mapping is fixed to:

	Meaning (for Actuator)	Units
PV	Device Vaiable 2: Setpoint	Percent
SV	Device Vaiable 3: Actual Position	Percent

For the Connection Type Current Output the Dynamic Variable Mapping is fixed to:

	Meaning (for Actuator)	Units
PV	Device Vaiable 3: Actual Position	Percent
SV	Device Vaiable 2: Setpoint	Percent

7 Configuration

The parameterization of the HART interface is as follows:

7.1 Parameterization

7.1.1 Menue structure

Menuetree

- ...
- Actual values/diagnosis
  - Interface
    - HART
      - Version
      - Device Identification
      - Plant Identification
      - Communication State
- ...
- Parameters
  - ...
  - DCS / PLC system
  - ...
    - Interface
      - HART
        - Plant Configuration
        - Comm. Config
        - Calibrat. values

7.1.2 Parameter description

Version

APP FW-Version
User level: User
Default value: Vx.xx.xxxx
Description:
Firmware version of application from HART-Board.

IAP FW-Version
User level: User
Default value: Vx.xx.xxxx
Description:
Firmware version of STM-Application (In-Application Program IAP) from HART-Board.

Stack FW-Version
User level: User
Default value: Vx.xx.xxxx
Description:
Firmware version of the HART-Stack.

Device Identification

Manufacturer ID
User level: User
Default value: 24700
Description:
Indicates the company that produced the device. Manufacturer Ids are allocated by the HART Communication Foundation. Only the designated manufacturer may use this ID.

Device ID
User level: User
Default value: 0
Description:
A number unique to a particular field device. This number must be different for every device produced with a given device type.

Expanded Device Type
User level: User
Default value: 58037 (0xE2B5)
Description:
Indicates the type of the device (i.e., the product name). The **Expanded Device Type** indicates the set of commands and data items supported by the field device. This value will be set from the HART Communication Foundation per device..

Device Conn. Type
User level: User
Default value: 7
Description:
Defines the Device Connection Type of the actuator. The default value of the DREHMO actuator is the type: Actuator. The following type exists:
0 = Not defined
1 = Current Input
2 = Current Output
3 = Voltage Input
4 = Voltage Output
5 = Secondary
6 = Transmitter
7 = Actuator
8 = Non-DC Isolated Bus Device
9 = DC Isolated Bus Device

Wireless HART Adapter
User level: User
Default value: 0
Description:
If the parameter "WirelessHART Adapter" is set to value 0 (Disabled), the power supply of 24V for the wireless adapter will be interrupted. Otherwise the voltage is provided when the system is ready for operation.

CurrentOut Resistor
User level: User
Default value: 0
Description:
If the parameter CURRENT OUT RESISTOR has the value 0 (Disabled) the additional resistor is disabled by the switch S2 on the HART module. Otherwise it is enabled.

Device Revision Level
User level: User
Default value: 1
Description:
A whole Number indicating the revision level of command and data item set for this Device Type.

Software Revision Level
User level: User
Default value: 1
Description:
An unsigned integer indicating the revision level of the firmware in the field device. An increment of the revision number must occur for every released version of the field device's firmware.

Hardware Revision Level
User level: User
Default value: 1
Description:
An unsigned integer indicating the major revision level of the hardware in the field device.

Protocol Major Rev. Nr.
User level: User
Default value: 7
Description:
The HART Stack is compatible with Protocol Revision 7.4 (Major Revision 7).

Plant Identification

Date Code
User level: User
Default value: 1900-01-01
Description:
Describes a date code, which only will be written by DCS-System.

Descriptor
User level: User
Default value: ????????????????
Description:
Describes a 16 Byte Device Description value in ASCII format. Via HART will be 12 Byte communicated in ASCII Packet format.

Communication State

Current Flow
User level: User
Default value: 0
Description:
Indicates if the connection type is Actuator and a current source (low impedance) is detected, or when the connection type is Current Output a current sink (high impedance) is detected. If no current signal is detected, the value 0 (no impedance) is reported.

Config. Change Counter
User level: User
Default value: 0
Description:
The Configuration Change Counter must be incremented once for every command received that changes the device configuration. The counter must also be incremented once for every user action that changes the device's configuration or calibration (e.g., from local operator interface). This value is never reset and must be maintained even if power is removed from the device or a device reset is performed.

Config. Changed Bit PM
User level: User
Default value: 0
Description:
If Configuration Change Counter has been incremented, then the Configuration Changed Bit for Primary Master (PM) will be set.

Config. Changed Bit SM
User level: User
Default value: 0
Description:
If Configuration Change Counter has been incremented, then the Configuration Changed Bit for Secondary Master (SM) will be set.

Plant Configuration

Identity Tag
User level: Maintenance
Default value: None
Description:
An 8-character tag assigned by the end user based on location and use of the field

Long Tag
User level: Maintenance
Default value: DREHMO i-matic <serialnumber>
Description:
A 32-character label assigned by the end user based on location and use of the field device. The Long Tag supports ISO Latin-1 characters from DCS.

Message
User level: Maintenance
Default value: None
Description:
During commissioning the configurator write a message into the device for documentation. This process called "As Installed Record Keeping".

Final Assembly Nr
User level: Maintenance
Default value: 0
Description:
The Final Assembly Number is a 24-bit number (0...16.777.215) and will be used for administration of the device in the plant.

Comm. Config

Polling Address
User level: Maintenance
Default value: 0
Description:
Identify unique all devices. The address val-

Req. Msg. Preamble Len.
User level: Maintenance
Default value: 5
Description:
Minimum number of preambles required for the request message from the master to the slave.

Res. Msg. Preamble Len.
User level: Maintenance
Default value: 5
Description:
Minimum number of Preambles required for the response message from the Slave to the Master.

BusAct Timeout
User level: Maintenance
Default value: 15
Description:
The busactivity timeout should be configured in the range 1 to 3600 sec. (default: 15 sec.).

Loop Current Mode
User level: Maintenance
Default value: 1 (Disabled)
Description:
With connection type Actuator and parameter value of Loop Current Mode is enabled (defaultvalue) should the actuator drive by the analog input signal. When parametervalue of Loop Current Mode is disabled the actuator drives with the HART commands OPEN, CLOSE and SETPOINT.

Calibrat. values

AnaIn Current Zero
User level: Maintenance
Default value: 4000
Description:
Reference value for 4 mA, which is used for calculation of the loop current (calibration) from the physical input current.

AnaIn Current Span
User level: Maintenance
Default value: 20000
Description:
Reference value for 20 mA, which is used for the calculation of the loop current (calibration) of the physical input current.

AnaOut Current Zero
User level: Maintenance
Default value: 4000
Description:
Reference value for 4 mA, which is used for calculation of the loop current (calibration) from the physical input current.

AnaOut Current Span
User level: Maintenance
Default value: 20000
Description:
Reference value for 20 mA, which is used for the calculation of the loop current (calibration) of the physical input current.

AnaIn LRV
User level: Maintenance
Default value: 0
Description:
With this function it is possible to set the range of the input current between -250% and +250%.

AnaIn URV
User level: Maintenance
Default value: 100
Description:
With this function it is possible to set the range of the input current between -250% and +250%.

AnaOut LRV

User level: Maintenance
Default value: 0

Description:
With this function it is possible to set the range of the output current between -250% and +250%.

AnaOut URV

User level: Maintenance
Default value: 100

Description:
With this function it is possible to set the range of the output current between -250% and +250%.

7.2 Calibration

7.2.1 Analog Input (Device Category: Actuator)

The calibration of the analog input current for the configuration Actuator (Low Impedance) can be made as follows:

Calibrate 4 mA**:**

1. Set a loop current of 4 mA with a calibrated current source or the distributed control system
2. Send **Request value** from approximately 4 mA (min: 2 mA, max: 6 mA) with Command #45 (Trim Loop Current Zero) or Command #67 (Trim Analog Channel Zero) to the actuator.
3. The actuator calculates the difference between the predetermined current value (request value) and the measured current value (Raw_AI) of 4 mA and saves the result in Parameter **AnaIn Current Zero**.
4. After the calculation the actuator trims the input current and returns the corrected PVAI loop current as result of Command #45 or Command #67.

Calibrate 20 mA**:**

1. Set a loop current of 20 mA with a calibrated current source or the distributed control system
2. Send **request value** from approximately 20 mA (min: 18 mA, max: 22 mA) with Command #46 (Trim Loop Current Gain) or Command #68 (Trim Analog Channel Gain) to the actuator
3. The actuator calculates the difference between the predetermined current value (Request value) and the measured current value (Raw_AI) of 20 mA and saves the result in Parameter **AnaIn Current Span**.
4. After the calculation the actuator trims the input current and returns the corrected PVAI loop current as result of Command #46 or Command #68.

Note: The Parameters **AnaIn Current Zero** and **AnaIn Current Span** you will find in menu of the actuator or with i-matic Explorer below the following menu entry:

- Parameters => DCS / PLC system => Interface => HART => Calibrat. values:

The calculation formula for the loop current (PV AI = Primary Value Analog Input) is the following:

$$PVAI = I * \frac{(20-4)}{(\text{Current Span} - \text{Current Zero})} + 4 - \text{Current Zero} * \frac{(20-4)}{(\text{Current Span} - \text{Current Zero})}$$

7.2.2 Analog Output (Device Category: Current Output)

The calibration of the analog output current for the configuration Current Output (High Impedance) can be made as follows:

Calibrate 4 mA**:**

1. Set a loop current of 4 mA with command #40 (Enter/Exit Fixed Current Mode) or command #66 (Enter/Exit Fixed Analog Channel Mode) and measure the loop current with a calibrated current source or the distributed control system
2. Send **Request value** from approximately 4 mA (min: 2 mA, max: 6 mA) with Command #45 (Trim Loop Current Zero) or Command #67 (Trim Analog Channel Zero) to the actuator.
3. The actuator calculates the difference between the predetermined current value (Request value) and the measured current value (Raw_AO) of 4 mA and saves the result in Parameter **AnaOut Current Zero**.
4. After the calculation the actuator trims the output current and returns the corrected PVAO loop current as result of Command #45 or Command #67.

Calibrate 20 mA**:**

1. Set a loop current of 4 mA with command #40 (Enter/Exit Fixed Current Mode) or command #66 (Enter/Exit Fixed Analog Channel Mode) and measure the loop current with a calibrated current source or the distributed control system.
2. Send **Request value** from approximately 20 mA (min: 18 mA, max: 22 mA) with Command #46 (Trim Loop Current Gain) or Command #68 (Trim Analog Channel Gain) to the actuator.
3. The actuator calculates the difference between the predetermined current value (Request value) and the measured current value (Raw_AO) of 20 mA and saves the result in Parameter **AnaOut Current Span**.
4. After the calculation the actuator trims the output current and returns the corrected PVAO loop current as result of Command #46 or Command #68.

Info: Exit the Fixed Current Mode with Command #40 and value **0**.
Note: The Parameters **AnaOut Current Zero** and **AnaOut Current Span** you will find in menu of the actuator or with i-matic Explorer below the following menu entry:

- Parameters => DCS / PLC system => Interface => HART => Calibrat. values:

The calculation formula for the loop current is the following:

$$I = PVAO * \frac{(\text{Current Span} - \text{Current Zero})}{(20-4)} + \text{Current Zero} \breve{} 4 * \frac{(\text{Current Span} - \text{Current Zero})}{(20-4)}$$

8 Status Information

8.1 Device Status

Bit	Device Status	Description
0	Primary Variable Out Of Limits	Is set when Actuator Control is signaling at least one of following events: No setpoint available for Connection Type Actuator Status actual position fo Connection Type Current Output
1	Non Primary Variable Out Of Limits	Is set when Actuator Control is signaling at least one of following events: Status actual position if Connection Type Current Output is set Status AnaIn 1, (identical to Additional Device Status Bit 15.3) Status AnaIn 2, (identical to Additional Device Status Bit 15.2) Torque warning OPEN, (identical to Additional Device Status Bit 5.5) Torque warning CLOSE, (identical to Additional Device Status Bit 5.4)
2	Loop Current Saturated	Is set only in Connection Type Actuator if the Loop Current is below 3.8 mA or above 20.5 mA
3	Loop Current Fixed	Is set if Loop Current is set through HART Command 40 or HART Command 79 or when Loop Current is disabled through Command 6.
4	More Status Available	Is set when Actuator Control is signaling at least one of following events: Fault, (identical to Additional Device Status Bit 0.2) Warning, (identical to Additional Device Status Bit 0.1) Not Ready REMOTE, (identical to Additional Device Status Bit 0.0) Failure, (identical to Additional Device Status Bit 0.6) Function check, (identical to Additional Device Status Bit 0.5) Out of specification, (identical to Additional Device Status Bit 0.4) Maintenance required. (identical to Additional Device Status Bit 0.3)

Bit	Device Status	Description
5	Cold Start	Is set whenever actuator control is performing a Restart (Command #42).
6	Configuration Changed	Is set when at least one of following settings was changed: Calibration (Current Zero or Current Span, Commands #45, #46, #67, #68), Range Conversion (Upper Range or Lower Range Value, Commands #35, 65), Message (Command #17), Tag, Description, Date (Command #18), Final Assembly Number (Command #19), Long Tag (Command #22),
7	Device Malfunction	Is set when the Actuator Control is signaling a failure.

More details for Bits 7, 4, 3, 2, 1, 0 can be obtained with Command #48.

8.2 Extended Device Status

Bit	Device Status	Description
0	Maintenance Required	Is set by actuator control event bit Maintenance required (identical to Additional Device Status Bit 0.3)
1	Device Variable Alert	Is set when the actuator control is signaling at least one of following events: No setpoint available Status actual position Torque warning OPEN (identical to Additional Device Status Bit 5.5) Torque fault OPEN (identical to Additional Device Status Bit 3.4) Torque warning CLOSE (identical to Additional Device Status Bit 5.4) Torque fault CLOSE, (identical to Additional Device Status Bit 3.5) Warning analog input 1 (identical to Additional Device Status Bit 15.2) Warning analog input 2 (identical to Additional Device Status Bit 15.3)
2	Critical Power Failure	Is not signaled by the Actuator Control
3	Failure	Is set by actuator control event Failure (identical to Additional Device Status Bit 0.6)
4	Out Of Specification	Is set by actuator control event bit Out of specification (identical to Additional Device Status Bit 0.4)
5	Function Check	Is set by actuator control event bit Function check (identical to Additional Device Status Bit 0.5)
6	Not used	-
7	Not used	-

More details for bits 7, 4, 3, 2, 1, 0 can be obtained with Command #48.

8.3 Additional Device Status (Command #48)

Command #48 returns 25 bytes of data, with the following status information:

Byte	Bit	Meaning
0: Logical signals	0	Not ready REMOTE
	1	Warning
	2	Fault
	3	Maintenance required
	4	Out of specification
	5	Function check
	6	Failure
	7	Not used (0)
1: Not ready REMOTE 1	0	Movement command rejected
	1	No REMOTE Mode
	2	Interlock LOCAL active
	3	Not used (0)
	4	Not used (0)
	5	Emergency shutdown (ESD) active
	6	Fail safe active
	7	Not used (0)
2: Not ready REMOTE 2	0	OFF mode
	1	LEARN mode
	2	Not used (0)
	3	Not used (0)
	4	Not used (0)
	5	Not used (0)
	6	Not used (0)
	7	Hand wheel operation
3: Fault 1	0	Configuration invalid
	1	Not used (0)
	2	Over temperature tripping
	3	Phase failure
	4	Torque failure OPEN
	5	Torque failure CLOSE
	6	Discrepancy error
	7	Delay run monitoring
4: Fault 2	0	Not used (0)
	1	Not used (0)
	2	Not used (0)
	3	Not used (0)
	4	Phase sequence failure
	5	Collective failure 1
	6	Sensor failure
	7	Rotation monitoring

Byte	Bit	Meaning
5: Warning 1	0	Not used (0)
	1	Not used (0)
	2	Not used (0)
	3	Not used (0)
	4	Torque warning CLOSE
	5	Torque warning OPEN
	6	Not used (0)
	7	Not used (0)
6: Extended Field Device Status (see section: 8.2)	0	Maintenance Required
	1	Device Variable Alert
	2	Critical Power Failure
	3	Failure
	4	Out of specification
	5	Function Check
	6	Not used (0)
	7	Not used (0)
7: Device Operating Modes	0 -7	Not used (0)
8: Standardized Status 0	0	**Device Variable Simulation Active** Set if at least one of Device Variables 1,3,6,7,8,9,10 is overwritten by Command 79
	1	**Non-Volatile Memory Defect** Set through process data: NV-Memory error
	2	**Volatile Memory Defect** Not used (0)
	3	**Watchdog Reset Executed** Not used (0)
	4	**Power Supply Conditions out of Range** Set through process data 24 V internal failure or 24 V external failure.
	5	**Environmental Supply Conditions out of Range** Set through process data: Electronics over temperature
	6	**Electronic Defect** Is set when one of the following process data signal occur: Discrepancy error, Wrong power relays, Systemtesterror, NV-Memory error, Hardware error

Byte	Bit	Meaning
	7	**Device Configuration Locked** Not used (0)
9: Standardized Status 1	0 -7	Not used (0)
10: Analog Channel Saturated	0	**Analog Channel 0** Set if Loop Current is below 3.8 mA or above 20.5 mA
	1-7	Not used (0)
11: Standardized Status 2	0 -7	Not used (0)
12: Standardized Status 3	0 -7	Not used (0)
13: Analog Channel Fixed	0	**Analog Channel 0** Set if Loop Current is fixed by Commands #40, #66, #79 or if Loop Current is disabled by Command #6
	1-7	Not used (0)
14: Warning 2	0	Electronics over temperature
	1	Not used (0)
	2	Not used (0)
	3	24V external failure
	4	24V internal failure
	5	Collective failure 2
	6	Not used (0)
	7	Configuration invalid
15: Warning 3	0	Not used (0)
	1	Not used (0)
	2	Status Analog Input 1
	3	Status Analog Input 2
	4	Systemtesterror
	5	Warning duty duration
	6	Not used (0)
	7	Runtime Monitoring
16: Warning 4	0	Not used (0)
	1	Not used (0)
	2	Status AnaIn 1
	3	No setpoint available
	4	Not used (0)
	5	Fail safe active
	6	Not used (0)
	7	Not used (0)
17: Failure (NAMUR)	0	Not used (0)
	1	Not used (0)
	2	Not used (0)
	3	Not used (0)
	4	Not used (0)

Byte	Bit	Meaning
	5	Not used (0)
	6	Not used (0)
	7	Collective failure 1
18: Maintenance Req. (NAMUR)	0	Maintenance required
	1	Thermal aging
	2	Mechanical aging
	3	Limit valve stroke
	4	Accum. operation cycles
	5	Actual op. cycles/h
	6	Not used (0)
	7	Not used (0)
19: Out of specification 1 (NAMUR)	0	24V external failure
	1	Not used (0)
	2	Not used (0)
	3	Not used (0)
	4	Not used (0)
	5	Not used (0)
	6	Not used (0)
	7	Collective failure 2
20: Out of specification 2 (NAMUR)	0	Status actual position
	1	Status AnaIn 1
	2	Not used (0)
	3	Not used (0)
	4	Not used (0)
	5	Not used (0)
	6	Not used (0)
	7	Not used (0)
21: Out of specification 3 (NAMUR)	0	Not used (0)
	1	Not used (0)
	2	Not used (0)
	3	Not used (0)
	4	Not used (0)
	5	Not used (0)
	6	Not used (0)
	7	Not used (0)
22: Out of specification 4 (NAMUR)	0	Not used (0)
	1	Not used (0)
	2	Not used (0)
	3	Not used (0)
	4	Not used (0)
	5	Not used (0)
	6	Not used (0)
	7	Not used (0)

Byte	Bit	Meaning
23: Function check 1 (NAMUR)	0	Not used (0)
	1	No REMOTE mode
	2	Not used (0)
	3	Hand wheel operation
	4	Emerg. shutdown (ESD) active
	5	Not used (0)
	6	Int. positioner disabled
	7	Interlock LOKAL
24: Function check 2 (NAMUR)	0	Not used (0)
	1	Not used (0)
	2	Not used (0)
	3	Not used (0)
	4	Not used (0)
	5	Not used (0)
	6	Not used (0)
	7	Not used (0)

Additional Device Status Byte 0 Bits 0-6 will set Device Status Bit 4 **More Status Avail.**.
Additional Device Status Byte 0 Bit 1 will set Device Status Bit 7 **Device Malfunction**.

9 Universal Commands

Command	Description
#3	Returns PV and SV for a total of 14 bytes of response data (see section 7).
#14	Units for sensor limits and minimum span are fixed as percent.
#48	Returns 25 bytes of data (refer to section 9.3).

10 Common-Practice Commands

10.1 Supported Commands

The following common-practice commands are implemented:

Command	Description
#33	Read Device Variables
#35	Write Primary Variable Range Values
#40	Enter/Exit Fixed Current Mode
#42	Perform Master Reset
#45	Trim Loop Current Zero
#46	Trim Loop Current Gain
#50	Read Dynamic Variable Assignments
#54	Read Device Variable Information
#59	Write Number of Response Preambles
#60	Read Analog Channel and Percent of Range
#62	Read Analog Channels
#63	Read Analog Channel Information
#65	Write Analog Channel Range Values
#66	Enter/Exit Fixed Analog Channel Mode
#67	Trim Analog Channel Zero
#68	Trim Analog Channel Gain
#70	Read Analog Channel Endpoint Values
#72	Squawk
#73	Find Device
#79	Write Device Variable
#89	Set Real-Time Clock
#90	Read Real-Time Clock
#95	Read Device Communication statistics
#523	Read Condensed Status Mapping Array

Command #42 Perform Master Reset is performing a Cold Start of the actuator control. During Startup procedure Actuator Control is not available for HART Communication.

10.2 Burst Mode

This Field Device does not support Burst Mode.

10.3 Catch Device Variable

This Field Device does not support Catch Device Variable.

11 Device-Specific Commands

The following device-specific commands are implemented:

Command	Description
#128	Write Operation Command
#130	Read Input Data
#131	Read Software Version
#132	Reset to Factory Defaults
#133	Reset Operational Data
#134	Reset HART Configuration
#160	Read Parameter
#161	Write Parameter
#162	Read Process-Variable

11.1 Command #128: Write Operation Command

In Connection Type Actuator the actuator can be operated through HART Command 128 while Loop Current Mode is disabled. In Connection Type Current Output the actuator can be operated through HART Command 128 without any restriction to the Loop Current Mode. Any length excepting 0 and 3 is allowed for Command #128.

Data Request

Byte	Format	Description
0	Bitstring	Commands Bit 0 - CLOSE Bit 1 - OPEN Bit 2 – AUTOMATIC Bit 3 – unused Bit 4 – Stepping mode Bit 5 - Emergency Shutdown (ESD) Bit 6 to 7 - unused * OPEN and CLOSE together or 0x00 stops the actuator
1	Unsigned- 8	Reserved
2-3	Unsigned-16	Setpoint (0.0 % to 100.0 %) => (value = 0 to 1000)

Byte	Format	Description
4	Bitstring	Additional Commands Bit 0 - Fieldbus enable LOCAL Bit 1 - Fieldbus enable LOCAL OPEN Bit 2 - Fieldbus enable LOCAL CLOSE Bit 3 to 5 unused Bit 6 - Emergency-STOP Bit 7 - unused
5	Bitstring	Intermediate positions Bit 0 - Field. Interm. Pos 1 Bit 1 - Field. Interm. Pos 2 Bit 2 - Field. Interm. Pos 3 Bit 3 - Field. Interm. Pos 4 Bit 4 - Field. Interm. Pos 5 Bit 5 - Field. Interm. Pos 6 Bit 6 - Field. Interm. Pos 7 Bit 7 - Field. Interm. Pos 8
6	Unsigned-8	Reserved
7	Bitstring	Digital Outputs 2 Bit 0 - Fieldbus DOUT 1 Bit 1 - Fieldbus DOUT 2 Bit 2 - Fieldbus DOUT 3 Bit 3 - Fieldbus DOUT 4 Bit 4 to 7 - unused

For Multiport Valve Function Byte 5 is coding the multiport valve operation commands. For further Information please refer to operating manual for i-matic - see Operating_Instruction_DREHMO matic_EN.pdf.

Data Response

The received Request Data of Command 128 will be replied with same length and content.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
3	Error	Passed Parameter Too Large
5	Error	Too Few Data Bytes Received
16	Error	Access restricted (not allowed in actual operating mode)

11.2 Command #130: Read Input Data

Through HART Command 130 **Read Input Data** up to 32 Bytes of the process representation input can be read from the actuator control.

Data Request

Byte	Format	Description
0	Byte	Number of Process Representation Input Bytes to be read. Maximum 32 Bytes.

Data Response

Byte	Format	Description
0	Bitstring	Operating modes Bit 0 - OFF mode Bit 1 - LOCAL mode Bit 2 - REMOTE mode Bit 3 - No REMOTE mode Bit 4 - LEARN mode Bit 5 - Service mode Bit 6 to 7 - Not used
1	Bitstring	Operating messages Bit 0 - Actuator running Bit 1 - Actuator running OPEN Bit 2 - Actuator running CLOSE Bit 3 - Stepping mode active Bit 4 - Actuator in stepping range Bit 5 - Stepping pause active Bit 6 - Setpoint reached Bit 7 - Not used
2	Bitstring	Actuator position Bit 0 - Limit Switch OPEN Bit 1 - Limit Switch CLOSE Bit 2 - Limit Switch reached Bit 3 - Limit Signal OPEN Bit 4 - Limit Signal CLOSE Bit 5 - Limit OPEN Bit 6 - Limit CLOSE Bit 7 - Not used

Byte	Format	Description
3	Bitstring	Torque overload Bit 0 - Torque OPEN Bit 1 - Torque CLOSE Bit 2 - Torque Signal OPEN Bit 3 - Torque Signal CLOSE Bit 4 - Torque Signal Bit 5 - Torque Failure OPEN Bit 6 - Torque Failure CLOSE Bit 7 - Torque Failure
4	Bitstring	Torque warning Bit 0 - Torque warning OPEN Bit 1 - Torque warning CLOSE Bit 2 - Torque warning Bit 3 - Torque Signal warning OPEN Bit 4 - Torque Signal warning CLOSE Bit 5 - Torque Signal warning Bit 6 to 7 - Not used
5	Bitstring	Device status Bit 0 - Not used Bit 1 - Emerg. shutdown (ESD) active Bit 2 - Fail safe active Bit 3 - Emergency-STOP Bit 4 - Int. positioner disabled Bit 5 - Interlock LOKAL active Bit 6 - Interlock REMOTE active Bit 7 - Hand wheel operation
6	Bitstring	Device status Bit 0 - Running LOCAL Bit 1 - Running LOCAL OPEN Bit 2 - Running LOCAL CLOSE Bit 3 - Running REMOTE Bit 4 - Local STOP Bit 5 - Find Device Bit 6 to 7 - Not used
7	Bitstring	Intermediate positions Bit 0 to 7 - Intermediate position 1 to 8
8-9	Unsigned-16	Actual position Byte 8 - Actual position (High-Byte) Byte 9 - Actual position (Low-Byte)
10	Unsigned-8	Torque value Byte 10 - Torque actual value

Byte	Format	Description
11	Bitstring	Actuator faults Bit 0 - Delay run monitoring Bit 1 - Rotation monitoring Bit 2 - Run-time monitoring Bit 3 - Run-time monitoring OPEN Bit 4 - Run-time monitoring CLOSE Bit 5 - Over temperature tripping Bit 6 to 7 – Not used
12	Bitstring	General faults Bit 0 - Collective failure 1 Bit 1 - Collective failure 2 Bit 2 - Movement Command rejected Bit 3 to 7 – Not used
13	Bitstring	Electronic faults Bit 0 - Configuration invalid Bit 1 - Device Key invalid Bit 2 - Discrepancy error Bit 3 - Wrong power relay Bit 4 - RTC not set Bit 5 - Torque of Gear / thrust unit Bit 6 - Torque valve OPEN Bit 7 - Torque valve CLOSE
14	Bitstring	Electronic faults Bit 0 - Hardware error Bit 1 - HW Interface error Bit 2 - Systemtest error Bit 3 - Sensor failure Bit 4 - Range overflow Bit 5 - Nomansland Bit 6 - Position calibration error Bit 7 - Torque calibration error
15	Bitstring	Electronic faults Bit 0 - Electronics over temperature Bit 1 - Battery module fault Bit 2 - NV-Memory error Bit 3 to 7 - Not used
16	Bitstring	Electronic faults Bit 0 - Phase failure Bit 1 to 3 - Phase 1 / 2 / 3 failure Bit 4 - Phase sequence failure Bit 5 - Not used Bit 6 - 24V internal failure Bit 7 - 24V external failure

Byte	Format	Description
17	Bitstring	Maintenance faults Bit 0 - Maintenance required Bit 1 - Limit valve stroke Bit 2 - Accumulated operation cycles Bit 3 - Actual operation cycles/hour Bit 4 - Dynamic maintenance Bit 5 - Mechanical aging Bit 6 - Thermal aging Bit 7 – Not used
18	Unsigned-8	Dynamic maintenance Byte 18 - Dynamic Consumption variable
19	Bitstring	Out of Specification Bit 0 - Not used Bit 1 - Not used Bit 2 - Not used Bit 3 - Not used Bit 4 - Not used Bit 5 - Warning duty cycle value Bit 6 - Not used Bit 7 - Not used
20	Bitstring	Fieldbus communication Bit 0 - Channel 1 activity Bit 1 - Channel 2 activity Bit 2 - Channel 1 DataEx Bit 3 - Channel 2 DataEx Bit 4 - Channel 1 active Bit 5 - Channel 2 active Bit 6 - Channel 1 CLEAR Bit 7 - Channel 2 CLEAR
21-22	Unsigned-16	AnalogIn1 Byte 21 - AnaIn1 (High-Byte) Byte 22 - AnaIn1 (Low-Byte)
23-24	Unsigned-16	AnalogIn2 Byte 23 - AnaIn2 (High-Byte) Byte 24 - AnaIn2 (Low-Byte)
25	Unsigned-8	DigitalIn (High-Byte) Byte 25 - Not used

Byte	Format	Description
26	Bitstring	DigitalIn (Low-Byte) Bit 0 - Dig. Input 1 Bit 1 - Dig. Input 2 Bit 2 - Dig. Input 3 Bit 3 - Dig. Input 4 Bit 4 - Dig. Input 5 Bit 5 - Dig. Input 6 Bit 6 to 7 - Not used
27	Bitstring	Diagnosis Bit 0 - Status actual position Bit 1 - Status AnaIn 1 Bit 2 - Status AnaIn 2 Bit 3 - No Setpoint available Bit 4 - Status Fieldbus Channel 1 Bit 5 - Status Fieldbus Channel 2 Bit 6 - Signal loss Interface Analog In1 Bit 7 - Signal loss Interface Analog In2
28	Bitstring	Partial Stroke Test Bit 0 - Reserved Bit 1 - Reserved Bit 2 - Reserved Bit 3 - Reserved Bit 4 to 7- Not used
29-31	RESERVED	-

Command-Specific Response Codes

Byte	Format	Description
0	Success	No Command-Specific Errors

11.3 Command #131: Read Software Version

Read version of actuator control software in ISO Latin 1 format.

Data Request

Byte	Format	Description
None	-	-

Data Response

Byte	Format	Description
0-19	Latin 1	Software version of actuator control

Command-Specific Response Codes

Byte	Format	Description
0	Success	No Command-Specific Errors

11.4 Command #132: Reset to Factory Defaults

Restore factory defaults for actuator control parameters, including factory setting for HART specific parameters. The DREHMO i-matic actuator control is additionally performing a Device Reset, as described in Command 42 Perform Master Reset.

Data Request

Byte	Format	Description
None	-	-

Data Response

Byte	Format	Description
None	-	-

Command-Specific Response Codes

Byte	Format	Description
0	Success	No Command-Specific Errors
8	Error	Update Failure

11.5 Command #133: Reset Operational Data

Reset the Operational Data of the actuator control to Zero. The Operational Data are the valve stroke, motor operation time, position tripping's and operation cycles.

Data Request

Byte	Format	Description
None	-	-

Data Response

Byte	Format	Description
None	-	-

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

11.6 Command #134: Reset HART Configuration

Resets following HART specific parameters to their default values:

Parameter	Default Value
Current Zero for Loop Current Calibration	4 mA
Current Span for Loop Current Calibration	20 mA
Primary Variable Lower Range Value	0 %
Primary Variable Upper Range Value	100 %
Identity Tag	None
Long Tag	Serial number of the Actuator Control
Message	None
Date Code	1. Jan. 1901
Descriptor	None
Final Assembly Number	0
Polling Address	0x00
Loop Current Mode	Enabled
Device Variable 5 / 11	0
Device Variable 4	Set Setpoint Command (Actuator operated from analog current)
Configuration Change Counter / Configuration Changed Bits	0
Analog Channel Fixed	FALSE
Communication Statistics Counter	0

Note

- Minimum Number of Preambles for Response message will not be reset
- Cold Start Bit will not be set
- The Actuator Control will not be reset

Data Request

Byte	Format	Description
None	-	-

Data Response

Byte	Format	Description
None	-	-

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

11.7 Command #160: Read Parameter

Read Configuration Parameter from the actuator control. The Parameter ID is composed of:

- Parameter ID = Slot * 256 + Index + 2000 (Parameter Base Address)

To get Parameter IDs see Operating manual for i-matic
(Operating_Instruction_DREHMO_i-matic_EN.pdf)

Data Request

Byte	Format	Description
0-1	Unsigned-16	Parameter ID

Data Response

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2-(n+1)	Octet String	Parameter Value (Length n depending on Parameter)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
2	Error	Invalid Selection
16	Error	Access Restricted

11.8 Command #161: Write Parameter

Write Configuration Parameter to the Actuator. The Parameter ID is composed of:

- Parameter ID = Slot * 256 + Index + 2000 (Parameter Base Address)

To get Parameter ID's see Operating manual for i-matic (Operating_Instruction_DREHMO_i-matic_EN.pdf).

Data Request

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2-(n+1)	Octet String	Parameter Value (Length varies from 1 to n)

Data Response

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2-(n+1)	Octet String	Parameter Value (Length varies from 1 to n)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
2	Error	Invalid Selection
5	Error	Too few data bytes received

11.9 Command #162: Read Process-Variable

Read Process-Variable from the actuator control (e.g. Diagnostic Data). The Process Variable ID is composed of:
Process Variable ID (Input):

- Starts with Process Variable Input Base Address: 1000
- The area is between adress 1000 and 1499
- First, second, and third digits minus the base address define the byte ID
- Fourth / last digit defines the bit ID
- Example: Processdata ID = 1080
  => Processdata ID - base address = 1080 - 1000 = 0080
  => Byte: 8 , Bit: 0, Actual position
-

Process Variable ID (Output):

- Starts with Process Variable Input Base Address: 1500
- The area is between adress 1500 and 1999
- First, second, and third digits minus the base address define the byte ID
- Fourth / last digit defines the bit ID
- Example: Processdata ID = 1501
  => Processdata ID - base address = 1501 - 1500 = 0001
  => Byte: 0 , Bit: 1, Command CLOSE

Data Request

Byte	Format	Description
0-1	Unsigned-16	Process-Variable ID

Data Response

Byte	Format	Description
0-1	Unsigned-16	Process-Variable ID
2-(n+1)	Octet String	Process Variable Value (Length n depending on Variable)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
2	Error	Invalid Selection
5	Error	Too Few Data Bytes Received

12 Tables

12.1 Unit Codes supported

(Subset of HART Common Table 2, Unit Codes)

Unit Code	Description
39	milliampere
57	Percent

13 Performance

13.1 Sampling Rates

Device Variable Changes are instantaneously available for HART Communication.

13.2 Power-Up

Power up procedure for the actuator control takes approximately 25 seconds. During this period, the device will not respond to HART commands. Fixed-current mode is cancelled by power loss if Current Mode is enabled. Simulation of Device Variables through Command 79 is cancelled by power loss.

13.3 Reset

Command 42 (Device Reset) causes the device to reset its microprocessor. The resulting restart is identical to the normal power up sequence (refer to above section Power-Up).

13.4 Self-Test

The self-test procedure is a part of the power-up procedure (refer to above section Power-Up).

13.5 Command Response Times

Unit Code	Description
Minimum	100 ms (Testtool FrameAlyst)
Typical	200 ms (Testtool FrameAlyst)
Maximum	500 ms (Testtool FrameAlyst)

13.6 Busy and delayed Response

Busy and Delayed-Response is not used.

13.7 Long Messages

The largest data field used is in the response to Command 9: 71 bytes including the two status bytes.

13.8 Non-Volatile Memory

EEPROM is used to hold the device's configuration parameters. New data is written to this memory immediately on execution of a write command.

13.9 Modes

The Fixed Current Mode is implemented. The Fixed Current Mode is entered if loop was fixed with Command 40 or if Device Variable 0 Input Loop Current was overwritten with Command 79 or if Loop Current was disabled by Command 6. Whether Loop Current is enabled or disabled, the Fixed Current Mode is automatically cleared by power loss or reset. The Actuator can be operated in the Connection Type / Device Category Actuator through HART Interface Loop Current or through HART Command 128. Using the Connection Type / Device Category Current Output the Actuator can be operated through HART Command 128 only. In addition the Actuator Control supports alternative operating modes (e.g. through other interfaces). Alternative operating mode is indicated in the Command 48 Data (Bytes Not Ready REMOTE 1 and Not Ready REMOTE 2).

13.10 Write Protection

Write-protection is not provided.

13.11 Damping

Damping affects only the loop current and is fixed to 40 milliseconds.

14 Capability Checklist

Characteristics	Description
Manufacturer, model and revision	DREHMO GmbH , DREHMO i-matic , rev. 2
Device type	Actuator or Current Output
HART revision	7.4
Device Description available	Yes
Number and type of sensors	1 (internal analog to digital converter)
Number and type of actuators	1
Number and type of host side signals	1: 4 - 20mA analog
Number of Device Variables	12
Number of Dynamic Variables	2
Mappable Dynamic Variables	No
Number of common-practice commands	24
Number of device-specific commands	9
Bits of additional device status	200
Alternative operating modes	Yes
Burst mode	No
Write-protection	No

15 Default Configuration

Parameter	Default value
Lower Range Value	0
Upper Range Value	100
PV Units	%
Sensor type	None
Number of wires	2
Damping time constant	40 ms (Loop Current Only)
Fault-indication jumper	None
Write-protect jumper	None
Number of response preambles	5

16 Technical Data

Features and functions	
Control and feedback signals	Via HART interface Device category **Actuator**: • Analogue 4–20 mA setpoint with digital HART communication Device category **Current Output**: • Analogue 4–20 mA position feedback signal with digital HART communication
Status indications via HART interface	In combination with device category **Actuator**: • Analogue output signal for position feedback galvanically isolated position feedback 0/4–20 mA (load max. 500 Ω)
Wiring diagram (basic version)	Device category: **Actuator**: • IMC00X-XX-N1-XXX Device category: **Current Output**: • IMC00X-XX-N2-XXX Device category: **Current Output + WirelessHART**: • IMC00X-XX-N3-XXX

Setting/programming the HART interface	
Setting the HART address	The HART address is set via HART command 6 or alternatively via the display of i-matic control (default value: 0)

General HART interface data	
Communication protocol	HART according to IEC 61158 and IEC 61784 (CPF 9)
Network topology	Point-to-point wiring
Communication signal	HART, baud rate 1.2 kbit/s Device category: **Actuator** • FSK (Frequency Shift Key) modulated to 4−20 mA set-point signal • Input impedance: 250 Ω. The impedances of other HART devices connected (parallel or in series) must be within the HART specification • Point-to-point wiring • Signal range: 4 −20 mA • Operating range: 2 mA − 22 mA • Minimum operating voltage: 7 V (at 22 mA) • Integrated reverse polarity protection Device category: **Current Output**: • FSK (Frequency Shift Key) modulated to 4 −20 mA position feedback signal • Input impedance: 40 kΩ. The impedances of other HART devices connected (parallel or in series) must be within the HART specification • Point-to-point or multidrop wiring • Short-circuit-proof current output
HART cable specification	Refer to HART specification
Power supply	Internal power supply of HART interface via actuator controls (apart from HART supply voltage, no other supply required)
Device identification	Manufacturer Name: AUMA Manufacturer ID: 24700 (0x607C) HART protocol revision: 7.4 Number of device variables: 12 Model Name: DREHMO i-matic Device Type Code: 58037 (0xE2B5)

Supported HART commands	• Universal Commands • Common Practice Commands: – Command 33 (Read Device Variables) – Command 40 (Enter/Exit Fixed Current Mode) – Command 42 (Perform Device Reset) – Command 45 (Trim Loop Current Zero) – Command 46 (Trim Loop Current Gain) – Command 50 (Read Dynamic Variable Assignments) – Command 72 (Squawk) – Command 73 (Find Device) – Command 89 (Set Real-Time Clock) – Command 90 (Read Real-Time Clock) – Command 95 (Read Device Communication Statistics)
Supported HART commands	• Device Specific Commands: – Command 128 (Write Operation Command) – Command 131 (Read Software Version) – Command 132 (Reset to Factory Default) – Command 133 (Reset Operational Data) – Command 134 (Reset HART Configuration) – Command 160 (Read Parameter) – Command 161 (Write Parameter) – Command 162 (Read Process Data)

Commands and signals of the HART interface	
Output data	Device category **Actuator**: • Loop Current Mode activated: Analogue 4 – 20 mA control signal for position setpoint • Loop Current Mode deactivated: Digital HART commands for position setpoint (0 – 100.0 %) or for discrete operation in directions OPEN and CLOSE Device category **Current Output**: • Loop Current Mode activated: Analogue 4 – 20 mA output signal for position feedback signal (point-to-point wiring) Digital HART commands for position setpoint (0 – 100.0 %) or for discrete operation in directions OPEN and CLOSE • Loop Current Mode deactivated: Analogue output signal for position feedback signal fixed to 4 mA (multidrop wiring) • Digital HART commands for position setpoint (0 – 100.0 %) or for discrete operation in directions OPEN and CLOSE
Feedback signals	• End positions OPEN, CLOSED • Actual position value • Actual torque value, requires magnetic limit and torque transmitter (MWG) in actuator • Selector switch in position LOCAL/REMOTE • Running indication (directional) • Torque switches OPEN, CLOSED • Limit switches OPEN, CLOSED • Manual operation by hand wheel or via local controls • Analogue (2) and digital (4) customer inputs • Device Status information – Field Device Status – Device Specific Status – Extended Device Status Information – Standardized Status – Analog Channel Saturated – Analog Channel Fixed

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