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EQUIPMENT MANUAL

SIMATIC

S7-1500 / ET 200MP

Analog output module AQ 8xHART HF
6ES7532-8TF00-0AB0

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SIMATIC

S7-1500/ET 200MP Analog output module AQ 8xHART HF (6ES7532-8TF00-0AB0)

Equipment Manual

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 WARNING
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We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Introduction

Purpose of the documentation

This manual supplements the system manual: Automation system System Manual S7-1500/ET 200MP (<https://support.industry.siemens.com/cs/de/en/view/59191792>)

Functions that relate in general to the systems are described in these manuals.

The information provided in this manual and in the system/function manuals supports you in commissioning the systems.

Conventions

The term "CPU" is used in this manual both for the CPUs of the S7-1500 automation system, as well as for interface modules of the ET 200MP distributed I/O system.

Please also observe notes marked as follows:

NOTE

A note contains important information regarding the product described in the documentation or its handling, or draws special attention to a section of the documentation.

1.1 S7-1500/ET 200MP documentation guide

1.1.1 Information classes S7-1500/ET 200MP



The documentation for the SIMATIC S7-1500 automation system and the ET 200MP distributed I/O system is arranged into three areas.

This arrangement enables you to access the specific content you require. Changes and supplements to the manuals are documented in a Product Information.

You can download the documentation free of charge from the Internet

(<https://support.industry.siemens.com/cs/ww/en/view/109742691>).

Basic information



The System Manual and Getting Started describe in detail the configuration, installation, wiring and commissioning of the SIMATIC S7-1500 and ET 200MP systems.

The STEP 7 online help supports you in the configuration and programming.

Examples:

- Getting Started S7-1500
- S7-1500/ET 200MP System Manual
- Online help TIA Portal

Device information



Equipment manuals contain a compact description of the module-specific information, such as properties, wiring diagrams, characteristics and technical specifications.

Examples:

- Equipment Manuals CPUs
- Equipment Manuals Interface Modules
- Equipment Manuals Digital Modules
- Equipment Manuals Analog Modules
- Equipment Manuals Communications Modules
- Equipment Manuals Technology Modules
- Equipment Manuals Power Supply Modules

General information



The function manuals contain detailed descriptions on general topics relating to the SIMATIC S7-1500 and ET 200MP systems.

Examples:

- Function Manual Diagnostics
- Function Manual Communication
- Function Manual Motion Control
- Function Manual Web Server
- Function Manual Cycle and Response Times
- PROFINET Function Manual
- PROFIBUS Function Manual

Product Information

Changes and supplements to the manuals are documented in a Product Information. The Product Information takes precedence over the device and system manuals.

You can find the latest Product Information on the S7-1500 and ET 200MP systems on the Internet (<https://support.industry.siemens.com/cs/de/en/view/68052815>).

Manual Collection S7-1500/ET 200MP

The Manual Collection contains the complete documentation on the SIMATIC S7-1500 automation system and the ET 200MP distributed I/O system gathered together in one file. You can find the Manual Collection on the Internet.

(<https://support.industry.siemens.com/cs/ww/en/view/86140384>)

Manual Collection fail-safe modules

The Manual Collection contains the complete documentation on the fail-safe SIMATIC modules, gathered together in one file.

You can find the Manual Collection on the Internet.

(<https://support.industry.siemens.com/cs/de/en/view/109806400>)

SIMATIC S7-1500 comparison list for programming languages

The comparison list contains an overview of which instructions and functions you can use for which controller families.

You can find the comparison list on the Internet

(<https://support.industry.siemens.com/cs/ww/en/view/86630375>).

1.1.2 Basic tools

Tools

The tools described below support you in all steps: from planning, over commissioning, all the way to analysis of your system.

TIA Selection Tool

The TIA Selection Tool tool supports you in the selection, configuration, and ordering of devices for Totally Integrated Automation (TIA).

As successor of the SIMATIC Selection Tools, the TIA Selection Tool assembles the already known configurators for automation technology into a single tool.

With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet.

(<https://support.industry.siemens.com/cs/ww/en/view/109767888>)

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to perform commissioning and maintenance activities on various SIMATIC S7 stations as bulk operations independent of TIA Portal.

The SIMATIC Automation Tool offers a wide range of functions:

- Scanning of a PROFINET/Ethernet system network and identification of all connected CPUs
- Assignment of addresses (IP, subnet, Gateway) and device name (PROFINET device) to a CPU
- Transfer of the date and the programming device/PC time converted to UTC time to the module
- Program download to CPU
- RUN/STOP mode switchover
- CPU localization through LED flashing
- Reading out of CPU error information
- Reading the CPU diagnostic buffer
- Reset to factory settings
- Firmware update of the CPU and connected modules

You can find the SIMATIC Automation Tool on the Internet.

(<https://support.industry.siemens.com/cs/ww/en/view/98161300>)

PRONETA

SIEMENS PRONETA (PROFINET network analysis) is a commissioning and diagnostic tool for PROFINET networks. PRONETA Basic has two core functions:

- In the network analysis, you get an overview of the PROFINET topology. Compare a real configuration with a reference installation or make simple parameter changes, e.g. to the names and IP addresses of the devices.
- The "IO test" is a simple and rapid test of the wiring and the module configuration of a plant, including documentation of the test results.

You can find SIEMENS PRONETA Basic on the Internet:

(<https://support.industry.siemens.com/cs/ww/en/view/67460624>)

SIEMENS PRONETA Professional is a licensed product that offers you additional functions. It offers you simple asset management in PROFINET networks and supports operators of automation systems in automatic data collection/acquisition of the components used through various functions:

- The user interface (API) offers an access point to the automation cell to automate the scan functions using MQTT or a command line.
- With PROFlenergy diagnostics, you can quickly detect the current pause mode or the readiness for operation of devices that support PROFlenergy and change these as needed.
- The data record wizard supports PROFINET developers in reading and writing acyclic PROFINET data records quickly and easily without PLC and engineering.

You can find SIEMENS PRONETA Professional on the Internet.

(<https://www.siemens.com/proneta-professional>)

SINETPLAN

SINETPLAN, the Siemens Network Planner, supports you in planning automation systems and networks based on PROFINET. The tool facilitates professional and predictive dimensioning of your PROFINET installation as early as in the planning stage. In addition, SINETPLAN supports you during network optimization and helps you to exploit network resources optimally and to plan reserves. This helps to prevent problems in commissioning or failures during productive operation even in advance of a planned operation. This increases the availability of the production plant and helps improve operational safety.

The advantages at a glance

- Network optimization thanks to port-specific calculation of the network load
- Increased production availability thanks to online scan and verification of existing systems
- Transparency before commissioning through importing and simulation of existing STEP 7 projects
- Efficiency through securing existing investments in the long term and the optimal use of resources

You can find SINETPLAN on the Internet

(<https://new.siemens.com/global/en/products/automation/industrial-communication/profinet/sinetplan.html>).

1.1.3 SIMATIC Technical Documentation

Additional SIMATIC documents will complete your information. You can find these documents and their use at the following links and QR codes.

The Industry Online Support gives you the option to get information on all topics. Application examples support you in solving your automation tasks.

Overview of the SIMATIC Technical Documentation

Here you will find an overview of the SIMATIC documentation available in Siemens Industry Online Support:



Industry Online Support International

(<https://support.industry.siemens.com/cs/ww/en/view/109742705>)

Watch this short video to find out where you can find the overview directly in Siemens Industry Online Support and how to use Siemens Industry Online Support on your mobile device:



Quick introduction to the technical documentation of automation products per video (<https://support.industry.siemens.com/cs/us/en/view/109780491>)



YouTube video: Siemens Automation Products - Technical Documentation at a Glance (<https://youtu.be/TwLSxxRQsA>)

Retention of the documentation

Retain the documentation for later use.

For documentation provided in digital form:

1. Download the associated documentation after receiving your product and before initial installation/commissioning. Use the following download options:
 - Industry Online Support International: (<https://support.industry.siemens.com>)
The article number is used to assign the documentation to the product. The article number is specified on the product and on the packaging label. Products with new, non-compatible functions are provided with a new article number and documentation.
 - ID link:
Your product may have an ID link. The ID link is a QR code with a frame and a black frame corner at the bottom right. The ID link takes you to the digital nameplate of your product. Scan the QR code on the product or on the packaging label with a smartphone camera, barcode scanner, or reader app. Call up the ID link.
2. Retain this version of the documentation.

Updating the documentation

The documentation of the product is updated in digital form. In particular in the case of function extensions, the new performance features are provided in an updated version.

1. Download the current version as described above via the Industry Online Support or the ID link.
2. Also retain this version of the documentation.

mySupport

With "mySupport" you can get the most out of your Industry Online Support.

Registration	You must register once to use the full functionality of "mySupport". After registration, you can create filters, favorites and tabs in your personal workspace.
Support requests	Your data is already filled out in support requests, and you can get an overview of your current requests at any time.
Documentation	In the Documentation area you can build your personal library.
Favorites	You can use the "Add to mySupport favorites" to flag especially interesting or frequently needed content. Under "Favorites", you will find a list of your flagged entries.
Recently viewed articles	The most recently viewed pages in mySupport are available under "Recently viewed articles".
CAX data	The CAX data area gives you access to the latest product data for your CAX or CAe system. You configure your own download package with a few clicks: • Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files • Manuals, characteristics, operating manuals, certificates • Product master data

You can find "mySupport" on the Internet. (<https://support.industry.siemens.com/My/ww/en>)

Application examples

The application examples support you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus on individual products.

You can find the application examples on the Internet.
(<https://support.industry.siemens.com/cs/ww/en/ps/ae>)

Industrial cybersecurity

Due to the digitalization and increasing networking of machines and industrial plants, the risk of cyber attacks is also growing. Appropriate protective measures are therefore mandatory, particularly in the case of critical infrastructure facilities.

Refer to the System Manual (<https://support.industry.siemens.com/cs/de/en/view/59191792>) for general information and measures regarding industrial cybersecurity.

This section provides an overview of security-related information pertaining to your SIMATIC device.

2.1 Cybersecurity information

Siemens provides products and solutions with industrial cybersecurity functions that support the secure operation of plants, systems, machines, and networks.

In order to protect plants, systems, machines, and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial cybersecurity concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For more information on protective industrial cybersecurity measures for implementation, please visit (<https://www.siemens.com/global/en/products/automation/topic-areas/industrial-cybersecurity.html>).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates at all times, subscribe to the Siemens Industrial Cybersecurity RSS Feed under

(<https://new.siemens.com/global/en/products/services/cert.html>).

2.2 Open Source Software

Open-source software is used in the firmware of the I/O modules. Open Source Software is provided free of charge. We are liable for the product described, including the open-source software contained in it, pursuant to the conditions applicable to the product. Siemens accepts no liability for the use of the open source software over and above the intended program sequence, or for any faults caused by modifications to the software.

For legal reasons, we are obliged to publish the original text of the license conditions and copyright notices. Please read the information relating to this on the Internet

(<https://support.industry.siemens.com/cs/ww/en/view/109805059>).

Product overview

3.1 Properties

Article number

6ES7532-8TF00-0AB0

View of the module

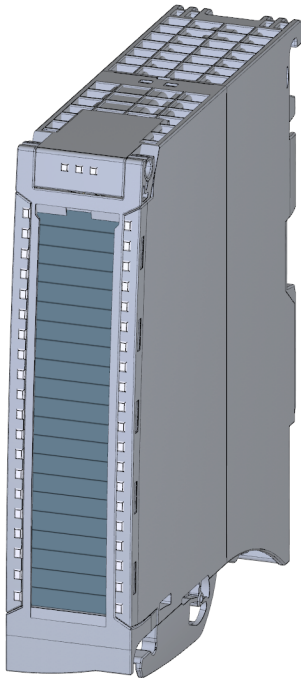


Figure 3-1 View of the AQ 8xHART HF module

Properties

The module has the following technical properties:

- Channel-based selection of 8 analog outputs
- HART communication (Rev. 5 to Rev. 7)
- Up to 8 HART variables directly in the input address area
- Current output selectable by channel:
 - 0 to 20 mA
 - 4 to 20 mA
 - 4 to 20 mA with HART

3.1 Properties

- Resolution: 16 bits including sign
- Configurable diagnostics (per channel)

The module supports the following functions:

Table 3-1 Version dependencies of the module functions

Function	Firmware version of the module	Configuration software	
		STEP 7 (TIA Portal) V18 or higher and V19 HSP 0423	GSD file in STEP 7 (TIA Portal) V18 or higher or STEP 7 V5.5 SP3 or higher
HART communication (Rev. 5 to Rev. 7)	V1.0.0 or higher	X	X
Firmware update	V1.0.0 or higher	X	X
Identification data I&M0 to I&M3	V1.0.0 or higher	X	X
Parameter assignment in RUN	V1.0.0 or higher	X	X
Calibration in runtime	V1.0.0 or higher	X	X
Module-internal Shared Output (MSO)	V1.0.0 or higher	X (PROFINET IO only)	X (PROFINET IO only)
Configurable submodules / submodules for Shared Device	V1.0.0 or higher	X (PROFINET IO only)	X (PROFINET IO only)

You can configure the module with STEP 7 (TIA Portal) and with a GSD file.

Accessories

The following accessories are supplied with the module and can also be ordered separately as spare parts:

- Shield bracket
- Shield terminal
- Power supply element
- Labeling strips
- U connector
- Universal front cover

Other components

The following component can be ordered separately:

Front connectors, including potential jumpers and cable ties

You can find additional information on accessories in the S7-1500/ET 200MP

(<https://support.industry.siemens.com/cs/de/de/view/59191792/en>) system manual.

Connecting

4.1 Wiring and block diagrams

This section contains the block diagram of the module and outlines various connection options.

You can find information on wiring the front connector, establishing a cable shield, etc in the Wiring section of the S7-1500/ET 200MP

(<https://support.industry.siemens.com/cs/de/en/view/59191792>) system manual.

NOTE

- You may use and combine the different wiring options for all channels.
 - Do not insert the potential jumpers included with the front connector!
-

Abbreviations used

Meaning of the abbreviations used in the figures below:

QI _n	Current output channel
L+	Supply voltage connection
M	Ground connection
M _{ANA}	Reference potential of the analog circuit
CHx	Channel or display of the channel status
PWR	Display for the supply voltage

Pin assignment for the power supply element

The power supply element is plugged onto the front connector for powering the analog module. Wire the supply voltage to terminals 41 (L+) and 44 (M). Use terminals 42 (L+) and 43 (M) to loop the potential to the next module.

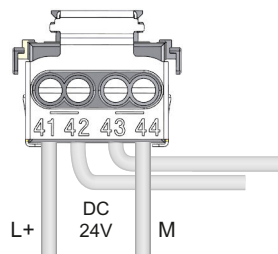


Figure 4-1 Power supply element wiring

Block diagram and terminal assignment for a current output

The following figure shows an example of the pin assignment for current output circuitry.

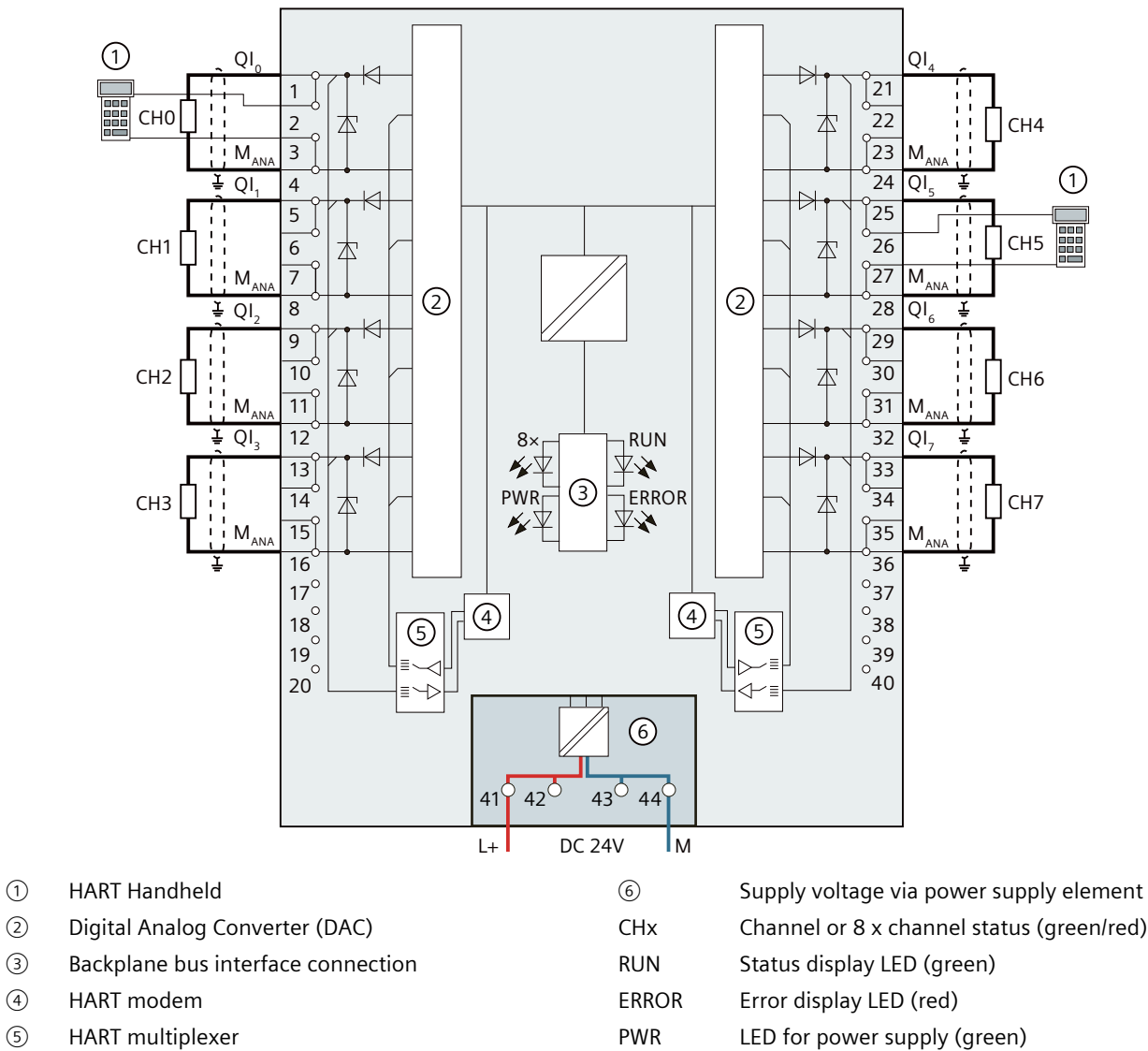


Figure 4-2 Block diagram and terminal assignment for a current output

HART functions

5.1 Use of HART

Definition

"HART" stands for "Highway Addressable Remote Transducer". The HART protocol is a standardized communication protocol for communication with the suitable field devices over a bus system.

HART is a registered trademark of the HART Communication Foundation (HCF), which owns all the rights to the HART protocol.

You can find detailed information about HART in the HART specification.

Advantages of HART

Use of the AQ 8xHART analog module offers you the following advantages:

- Connection compatibility with standard analog modules: Current loop 4 - 20 mA
- The AQ 8xHART analog module is an interface between the S7 system and HART devices
- Communication using the HART protocol
- Communication to field devices with HART functions

Use in the system

The AQ 8xHART analog module is used in the central I/O that is connected to PROFIBUS DP or PROFINET IO.

You can connect a HART field device to any channel:

- The AQ 8xHART analog module functions as HART master, monodrop;
- the HART field devices operate as HART devices.

Typical applications

The following applications are typical:

- Commissioning of field devices (centralized parameter assignment)
- Online modification of field device parameters
- Information, maintenance and diagnostic displays for the field devices
- Integration of configuration tools for field devices via the HART interface

5.2 How HART works

Introduction

The HART protocol describes the physical form of the transfer: transfer procedures, message structure, data formats and commands.

HART signal

The figure below shows the analog signal with the modulated HART signal (FSK method), which consists of sine waves of 1200 Hz and 2200 Hz and has a mean value of 0. It can be filtered out using an input filter so that the original analog signal is available again.

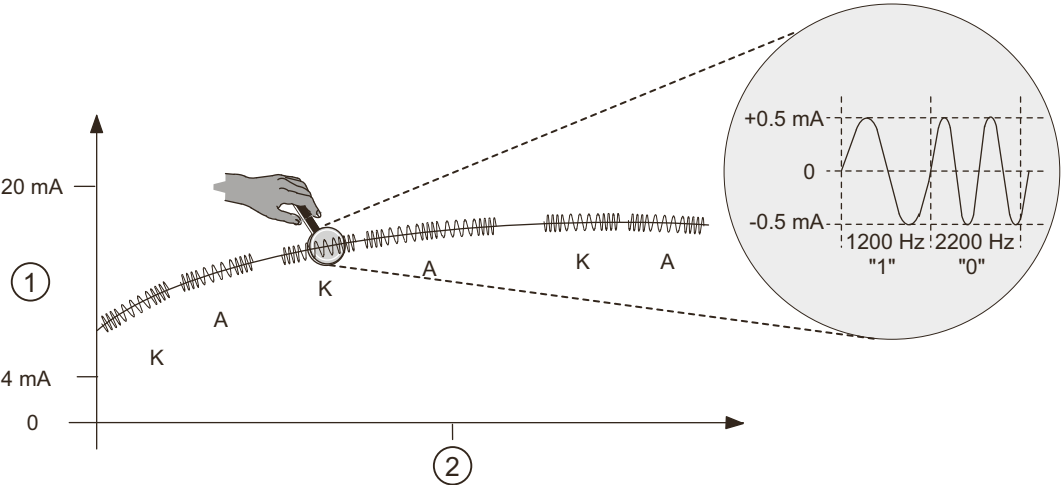


Figure 5-1 The HART signal

①	Analog signal
②	Time (seconds)
K	Command
A	Response

HART communication

The AQ 8xHART HF analog output module processes the HART communication in multiplex mode, i.e. channel-by-channel in succession. With this analog output module, two HART modems are in use. Consequently, the HART commands of the individual channels 0 to 3 and 4 to 7 influence the speed of the HART processing of channels 0 to 3 and 4 to 7.

When HART mode is enabled, the analog module autonomously sends HART commands to the connected field devices. For each channel, commands are always sent time about with any pending external HART commands that are received over the command interface of the module, see section "HART communication interface (Page 23)".

Commissioning a HART field device

Only HART field devices that are set to the short frame address 0 can be operated.

If a HART field device with a different short frame address is connected or a connected field device is reconfigured to a short frame address other than 0 during operation, the module starts a scan of all possible short frame addresses at the next re-establishment of HART communication (command 0 with short frame addresses 1...63).

As soon as the connected field device responds, it is converted to the short frame address 0 (HART command 6) by the module. During the scan, the module reports a HART communication error.

HART commands

The assignable properties of the HART field devices (HART parameters) can be set with HART commands and read by means of HART replies. The HART commands and their parameters are divided into three groups with the following properties:

- Universal
- Common practice
- Device-specific

Universal commands must be supported by all manufacturers of HART field devices and common practice commands should be supported. There are also device-specific commands that apply only to the particular field device.

Examples of HART commands

The following two tables show examples of HART commands:

Table 5-1 Examples of universal commands

Command	Function
0	Read manufacturer and device type - only with this command 0 can field devices be addressed by means of a short frame address
11	Read manufacturer and device type
1	Read primary variable and unit
2	Read current output and percent of range, digitally as floating-point number (IEEE 754)
3	Read up to four pre-defined dynamic variables (primary variables, secondary variables, etc.)
9	For field devices starting from HART Rev. 7, read up to four pre-defined dynamic variables (primary variable, secondary variable, etc.)
13, 18	Read or write tag, descriptor and date (data included in transmission)

Table 5-2 Examples of common practice commands

Command	Function
36	Set upper range value
37	Set lower range value
41	Perform self-test
43	Set the primary variable to zero

Structure of the HART protocol

Each HART frame sent from the analog module to the connected field device (request frame) and each HART frame from the field device (response frame) has the following basic structure.

Table 5-3 Structure of the HART protocol

PREAMBLE	STRT	ADDR	COM	BCNT	STATUS	DATA	CHK
Key:							
PREAMBLE:	Bytes (0xFF) for synchronizing.					5 to 20 bytes depending on parameter assignment	
STRT:	Start character (start delimiter)					1 byte	
ADDR:	Addresses of the field device					1 byte; short address or 5 bytes; long address	
COM:	HART command number					1 byte	
BCNT:	Byte count, number of bytes to follow without checksum					1 byte	
STATUS:	HART device status. Only present for a response frame. see following tables "Structure of HART device status"					1st and 2nd status bytes	
DATA:	Transferred user data / parameters, quantity depending on command					0 ... 230 bytes	
CHK:	Checksum					1 byte	

With the exception of the preamble bytes, this structure is contained in the communication data of the HART command interface. See section AUTOHOTSPOT.

HART replies always contain data. Together with a HART response, the HART device status (1st and 2nd status bytes) is sent. Always evaluate the HART device status. If no error is pending, the HART response is correct.

Structure of HART device status (1st and 2nd status bytes).

Table 5-4 1st status byte

When bit 7 = 1: "Communication error"	
Bit 6 = 1	Parity error
Bit 5 = 1	Overflow
Bit 4 = 1	Framing error
Bit 3 = 1	Checksum error
Bit 2 = 0	Reserved
Bit 1 = 1	Overflow in the receive buffer
Bit 0 = 0	Reserved
When bit 7 = 0: "Specific in line with response frame"	

Table 5-5 2nd status byte

Bit 7 = 1	Device fault
Bit 6 = 1	Configuration changed
Bit 5 = 1	Startup (cold start)
Bit 4 = 1	Additional status information available
Bit 3 = 1	Fixed analog output current setting
Bit 2 = 1	Analog output current saturated

Bit 1 = 1	Secondary variable outside the limits
Bit 0 = 1	Primary variable outside the range

HART-Fast-Mode

The AQ 8xHART HF analog output module supports the processing of HART commands as an SHC sequence ("Successive HART Command").

That is, if the analog output module detects a HART command with set SHC bit for a channel, the complete HART command processing on the HART analog output module is reserved for this channel for approximately 2 s. For all other channels of the analog module, no HART frame processing occurs during this time, see section HART communication interface (Page 23)

NOTE

- During the time a HART channel of the AQ 8xHART HF analog output module is processing an SHC sequence and, thus, the complete HART processing of the module is reserved for this channel, the HART variables of all HART channels are no longer updated. They remain unchanged in terms of value and quality code.
- HART commands for other channels are not processed and are acknowledged correspondingly.

Burst mode

The analog output module AQ 8xHART HF does not support burst mode. HART commands with set burst bit are ignored and are not forwarded to the connected field device.

5.3 Use of HART

System environment for the use of HART

To use an intelligent field device with HART functionality, you require the following system environment:

- Current loop 4 to 20 mA
Connection of field devices to the AQ 8xHART analog module
- **HART system connection:**
The analog module assumes the role of a "master". As such, it receives the commands, e.g. from the HART parameterization tool or as programmed commands of an S7 user program, forwards them to the intelligent field device and returns the responses. Data records that are transferred via the backplane bus serve as the interface of the analog module. The data records must be created and interpreted by the client.

- **HART parameterization tool "Client":**

You can set the HART parameters either using an external handheld terminal (HART handheld) or using a HART parameterization tool (PDM). Both assume the function of a "client".

The parameter assignment tool affects the entire analog module; the HART handheld is connected in parallel to the field device. See pin assignment "HART test connections (terminals 9 to 16)" in the section "Wiring and block diagrams (Page 15)".

PDM (Process Device Manager) is available as a stand-alone unit or integrated in *STEP 7 HW Config*.

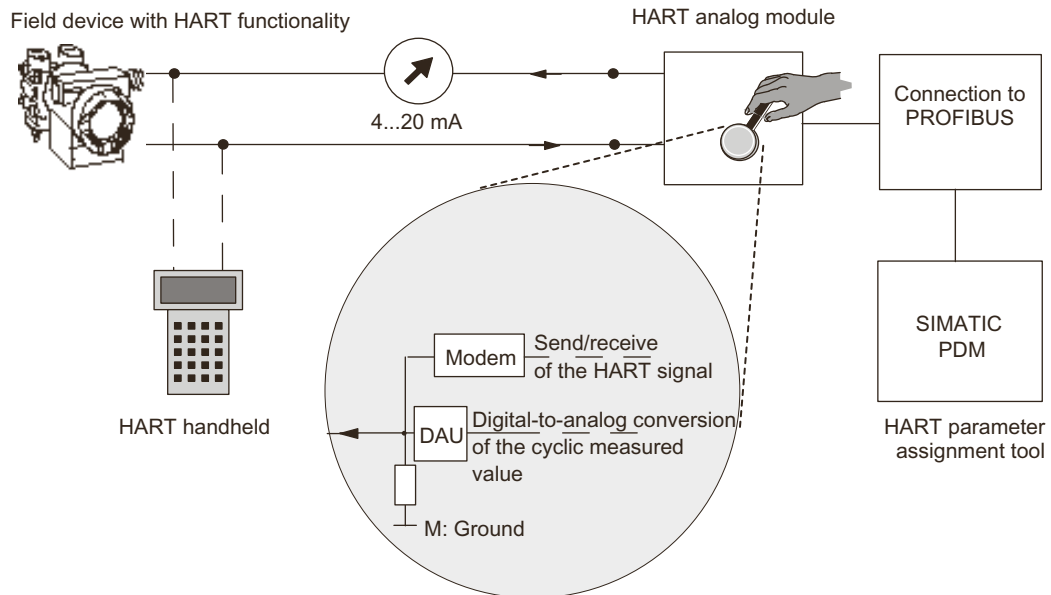


Figure 5-2 System environment for the use of HART

Error management

The two HART status bytes (HART device status) that are transferred with each response of the field device contain error information about the HART communication, HART command and device status.

This information is evaluated by the analog module and made available in the system via the S7 diagnostic alarms.

Configuration/commissioning

You can configure the analog module in the SIMATIC system with STEP 7 or the TIA Portal.

You assign parameters for the individual channels with respect to the actual analog value output and the use of the HART variables in the input address space of the module.

You can configure one field device per channel. By means of this configured field device, the configuration/parameter assignment of the connected field device is then carried out using PDM or the EDD for the S7-1500/ET 200MP.

The analog module can also be configured via a GSD file, both for PROFIBUS DP and PROFINET IO. However, in this case and with the TIA Portal, direct configuration / parameter assignment of the connected field devices is not possible.

Parameter reassignment of the field devices

The HART analog module generally accepts parameter reassignments for field devices. Access rights can only be allocated in the configuration tool.

For parameter reassignment of the field devices connected to the HART analog module, proceed as follows:

1. You start the parameter reassignment of a field device using a HART command that you enter using the SIMATIC PDM configuration tool or as a programmed command in the STEP 7 user program.
2. After you have reassigned the parameters of a HART field device, the corresponding bit is set in the HART device status of the connected field device (in the 2nd status byte).
3. The reconfiguration of the field device causes the HART analog module to issue a "Configuration changed" diagnostic interrupt, if this is enabled. See section "Diagnostics alarms (Page 47)". This diagnostic interrupt is to be regarded as information and not as an error and is automatically deleted again by the analog module after approximately 1 minute.

A diagnostic interrupt can also be triggered, if enabled, when parameter reassignment is carried out with the hand-held device.

5.4 HART communication interface

Data records

The HART commands are sent over data records to the connected field device as "external HART jobs" from the client (e.g. PDM or the STEP 7 user program). The response of the field device is made available again in the system via data records.

HART communication may only be handled by one client (e.g., PDM) per channel. If a channel is handled by several clients, the response made available by the module cannot be allocated to one client with certainty. The analog output module AQ 8xHART does not support client management.

Each client/channel is allocated fixed data records:

Table 5-6 Structure of the data records

Channel	Data record number	
	Request to the field device	Response from the field device
0	80	81
1	82	83
2	84	85
3	86	87
4	88	89
5	90	91
6	92	93
7	94	95

The corresponding data records are transferred to the module with the "WRREC" instruction and read by the module with the "RDREC" instruction.

Errors during the transfer are indicated at output parameter STATUS.

Errors during interpretation of the request data record are signaled in the corresponding response data record. The faulty request can be read back again using the request data record.

Rules

- After having written a request data record, a client must read the response data record before it may write another request data record.
- The client can evaluate the "processing status" in the response data record: If the "processing status" indicates "successful" or "error," the response data record contains current response data or error displays.
- The response data record must always be read completely because the analog module may modify the data record after the initial reading with "successful" or "error" status. If the processing status in the response data record indicates "successful" or "error", the data record contains current response data or error displays.
- The client may only write a request data record to the module again when it has read the response to the previously written request data record via the corresponding response data record.
If this condition is not fulfilled, the response from the module is overwritten.
- The STATUS component in the response frame (HART device status in the response data) provides information on whether errors have occurred and, if so, which errors.

Each request is stored on a channel-specific basis, and the corresponding request data record is disabled. Another writing of the same request data record is thus not possible and is acknowledged with BUSY.

The disable of the request data record is reset after the termination or completion of the requested HART command.

SHC sequence

If a HART command with a set SHC bit is sent to the module, this channel is reserved for 2 seconds for HART commands. That is, if the module detects a HART command with SHC bit set for a channel, the complete HART interface of the analog module is reserved for this channel for approximately 2 seconds. There is no processing of internal HART requests, and there is no HART command processing for all other channels of the analog module during this time.

Each time a HART command with a set SHC bit is sent, the analog module reserves this channel again for another 2 seconds for HART commands. If a HART command without SHC bit set is detected for this channel or if no other command for this channel occurs within 2 seconds after the previous HART command, the analog module returns to "normal" HART operation. This means all HART channels are processed again.

5.5 HART variables

Introduction

Numerous HART field devices make available additional measured quantities (e.g. sensor temperature).

A maximum of four HART variables supported by the connected field device can be cyclically read per channel with activated HART functionality. The HART variables are read automatically with HART command 3 (for field devices with HART rev. 5 and 6) or with command 9 (for field devices with HART rev. 7 or later).

These four HART variables per channel are always stored in HART variable data record 121 and can be read at any time. See section AUTOHOTSPOT.

Additionally, a maximum of 8 HART variables can be configured directly in the input address space of the AQ 8xHART HF analog output module. The HART variables are assigned to a channel in the properties dialog of the module. The parameter assignment uses parameter data record 140, see section Parameter assignment and structure of the parameter data records (Page 56). This allows you to easily work with process values directly from the field device as input data in the automation device.

Evaluating the multiHART area

You can select the multiHART area via the parameter assignment dialog.

The multiHART area occupies 1 byte in the output area (command) and 6 bytes in the input area (1 byte acknowledgment + 5 bytes HART variable).

You can read all HART variables available in the module via the multiHART area. To do this, you must request a HART variable from the module using the command byte in the output area.

The command byte identifies the requested HART variable (HART variable reference):

HART variable reference	
Bit 4...7: Channel number 0...7	Bit 0...3: Variable identification 1 = Primary 2 = Secondary 3 = Tertiary 4 = Quaternary

The command is acknowledged using the acknowledgment byte in the input area. As soon as the HART variable reference requested using the command can be read, the requested HART variable can be evaluated.

The corresponding HART variable is continually updated by the module as long as you leave the command byte of the multiHART area unchanged.

If an invalid HART variable reference is requested, this is also acknowledged accordingly. The value of the corresponding HART variable is then zero, and the quality code is signaled with 0x37_H (initialization value from analog module).

Example:

The primary variable is to be read from channel 6.

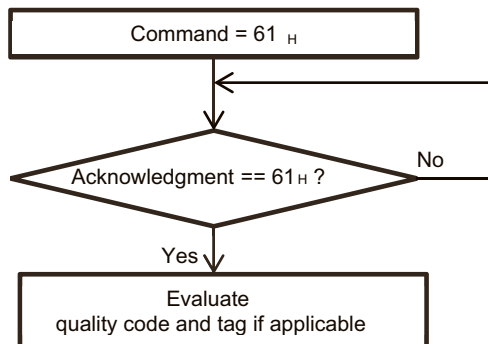


Figure 5-3 Command = 0x61

Address assignment

In as far as you map HART variables in the input address space of the module via parameter assignment or by selecting the corresponding configuration, an additional 40 bytes (8 variables) or 20 bytes (4 variables) is always allocated for the HART variables.

Configuration of HART variables

You can configure up to 8 HART variables for each channel. When configuring, you select these from the four HART variables provided by each channel:

- PV (Primary Variable)
- SV (Secondary Variable)
- TV (Tertiary Variable)
- QV (Quaternary Variable)

When HART mode is enabled, the analog module cyclically reads the variables provided by the connected field devices independently and makes them available in the configured input address space. You specify during parameter assignment which variables are supplied by a field device.

Each HART variable consists of a 4-byte value and a quality code byte.

Quality code

The quality code describes the process status of the corresponding HART variable.

Basic structure of the quality code

Bit	7...6	5...2	1...0
	Quality 0 0: Bad 0 1: Uncertain 1 0: Good 1 1: Good	Sub-status Coded according to "PROFIBUS PA Profile for Process Control Devices"	Limits 0 0: OK 0 1: Low limit 1 0: High limit 1 1: Constant

The quality codes generated by the analog module are based on the HART revision of the field device in use.

Field devices with HART Revision 5 and 6

The quality code is formed exclusively from the 1st and 2nd Status byte (HART device status) of the response frames (HART command 3).

Quality code	Meaning (process status)	Note
80 _H	Value is okay	Applies even when the following bits are set in the 2nd status byte of the HART response frame: - Configuration changed - Startup (cold start) - Fixed analog output current setting
78 _H	Value is uncertain	Applies even when the following bits are set in the 2nd status byte of the HART response frame: - Additional status information available - Analog output current saturated - Secondary variable outside the limits - Primary variable outside the range
84 _H	Response code RC8: Update error	-
24 _H	Response code RC16: Access restricted	Request from field device refused
23 _H	Communication error or HART variable not present in the field device	-
37 _H	Initialization value from analog module	After module startup
00 _H	Initialization value from S7 system	-

Field devices with HART Revision 7 or higher

The quality code is formed from the 1st status byte (HART device status) and the "Device variable status" (DVS) of the response frames (HART command 9).

Quality code	Meaning (process status)	Note
80 _H	Value is okay	-
89 _H	"Good" with "Low limit"	Process status, formed from the "Device variable status" (DVS) of the response frames with corresponding limits (see above).
8A _H	"Good" with "High limit"	
28 _H ...2B _H	"Bad"	

Quality code	Meaning (process status)	Note
68 _H ...6B _H	"Poor accuracy"	Process status, formed from the "Device variable status" (DVS) of the response frames with corresponding limits (see above).
78 _H ...7B _H	"Manual" or "Fixed"	
88 _H ...8B _H	"More device variable state available"	
84 _H	Response code RC8: Update error	-
24 _H	Response code RC16: Access restricted	Request from field device refused
23 _H	Communication error or HART variable not present in the field device	-
37 _H	Initialization value from analog module	After module startup
40 _H	Read alternatively via command 3	-
00 _H	Initialization value from S7 system	-

Parameters/address space

6.1 Output ranges

The default setting of the module is the current output type and a 4 to 20 mA HART output range. If you want to use a different output range, you must reassign the module parameters with STEP 7.

Output type and output ranges

Output type	Output range	Representation of analog values
Current	0 mA to 20 mA 4 mA to 20 mA 4 to 20 mA with HART	See Appendix Representation of output ranges (Page 75) .
Deactivated	-	-

The tables of the output ranges, overflow, overrange, etc. are available in the Appendix Representation of analog values [\(Page 75\)](#).

6.2 Parameters

Parameters of AQ 8xHART HF

The AQ 8xHART HF is available for STEP 7 (TIA Portal) as of V18 and V19 with HSP 0423. In this case, STEP 7 (TIA Portal) checks the configured properties for plausibility during configuration.

However, you can also assign parameters to the module by means of a GSD file and the configuration software of any provider. The module does not check the validity of the configured properties until after the configuration has been loaded.

When you assign the module parameters in STEP 7, you use various parameters to specify the module properties. The following table lists the configurable parameters. The effective range of the configurable parameters depends on the type of configuration. The following configurations are possible:

- Central operation with a S7-1500 CPU
- Distributed operation on PROFINET IO in an ET 200MP system
- Distributed operation on PROFIBUS DP in an ET 200MP system

6.2 Parameters

When assigning parameters in the user program, use the WRREC instruction to transfer the parameters to the module by means of data records; refer to chapter Parameter assignment and structure of the parameter data records (Page 56).

Table 6-1 Configurable parameters and their defaults

Parameters	Range of values	Default setting	Parameter assign- ment in RUN	Scope with configuration software, e.g., STEP 7 (TIA Portal)	
				Integrated in the hardware cata- log of STEP 7 (TIA Portal) as of V18 and V19 HSP 0423 or the PROFINET IO GSD file	GSD file PROFIBUS DP
Diagnostics					
• Missing supply voltage L+	Yes/No	No	Yes	Channel ¹⁾	Module ²⁾
• Wire break	Yes/No	No	Yes	Channel	Module ²⁾
• Short circuit to ground	Yes/No	No	Yes	Channel	Module ²⁾
• Overflow	Yes/No	No	Yes	Channel	Module ²⁾
• Underflow	Yes/No	No	Yes	Channel	Module ²⁾
• HART	Yes/No	No	Yes	Channel	Module ²⁾
Output					
• Output type	Current	Current	Yes	Channel	Channel
• Output range	See section Out- put ranges (Page 29)	4 to 20 mA with HART	Yes	Channel	Channel
• Reaction to CPU STOP	• Turn off • Keep last value • Output substi- tute value ⁴⁾	Turn off	Yes	Channel	Channel ³⁾ • Turn off • Keep last value
• Substitute value	See Representa- tion of output ranges (Page 75)	0	Yes	Channel	--- ³⁾
HART					
• HART preamble bytes	5 .. 20	5	Yes	Channel	Channel
• HART telegram repeti- tions	0 .. 10	5	Yes	Channel	Channel

¹⁾ If you enable diagnostics for multiple channels, you will receive an alarm surge on failure of the supply voltage because each enabled channel will detect this fault.

You can prevent this message burst by assigning the diagnostics function to one channel only.

²⁾ You can set the effective range of the diagnostics for each channel in the user program with data records 64 to 71.

³⁾ You can configure the setting "Output substitute value" and the substitute value in the user program by means of data records 64 to 71.

Short-circuit detection

The diagnostics for short circuit to ground can be configured for the current output type. Short-circuit detection is not possible for low output values; the output current must be above 1 mA.

Open-circuit detection

The diagnostics for open circuit can be configured for the current output type. Open-circuit detection is not possible for low output values; the output currents must therefore be above 200 μ A.

6.3 Declaration of parameters

Settling time depending on activation of HART communication

The settling time without HART communication (x ms) can be found in section "Technical specifications (Page 50)".

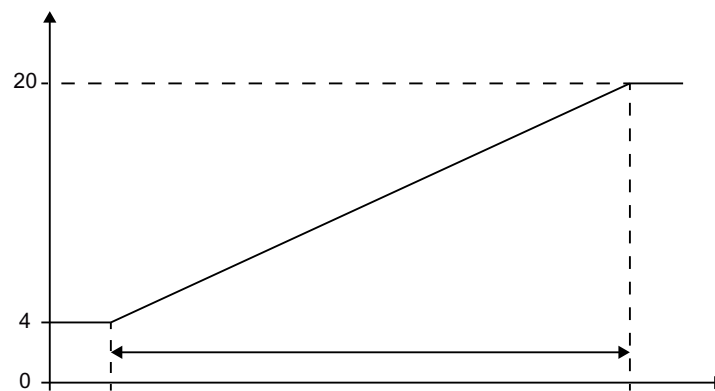


Figure 6-1 Example illustration of settling time without HART communication

If HART communication is activated for the output range, the settling time of the output value can vary (max: 50 ms).

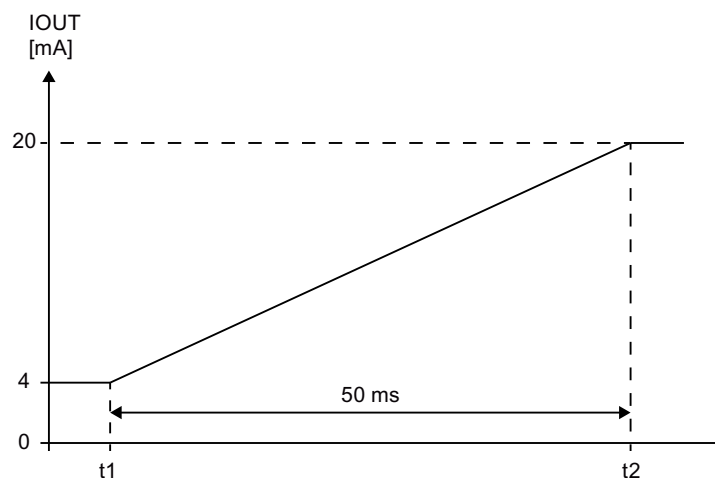


Figure 6-2 Example illustration of settling time with HART communication

Missing supply voltage L+

Enabling of the diagnostics, with missing or too little supply voltage L+.

Wire break

Enabling of the diagnostics if the line to the actuator is broken.

Short circuit to ground

Enabling of the diagnostics if a short-circuit of the output to M_{ANA} occurs.

Overflow

Enabling of the diagnostics when the output value exceeds the overrange.

Underflow

Enabling of the diagnostics when the output value violates the underrange.

HART diagnostics

Enable of following diagnostics:

- HART telegram-specific monitoring
- Status information provided by the connected field device in the HART telegram (HART device status)

Reaction to CPU STOP

Determines the reaction of the output to the CPU going into STOP state.

Substitute value

The substitute value is the value that the module outputs in case of a CPU STOP.

HART preamble bytes

With this parameter you define the number of preambles sent.

HART telegram repetitions

Defines the number of HART telegram repetitions. If the AQ 8xHART HF receives no response or an incorrect response to a HART telegram sent to the field device, the telegram is repeated accordingly. It is thus sent to the field device again.

6.4 HART mapping parameters

A maximum of 8 HART variables can be configured (mapped) in the address space of the module using the HART mapping parameters.

Each HART variable occupies 5 bytes of input data. If you use 4 or 8 HART variables directly in the input range of the I/O module, configure these parameters in the properties dialog box of the I/O module.

With PROFIBUS DP GSD configuration with HART variables, the HART variables cannot be directly configured. The four secondary variables are supplied in ascending channel order in the address space of the module.

When required, this can be changed using data record 140; see section Parameter assignment and structure of the HART mapping parameters (Page 60).

Parameters

Table 6-2 Configurable HART mapping parameters

Parameter		Value range	Default	Configuration in RUN	With GSD file PROFIBUS DP
Variable 1	Channel	0...7	0	Yes	0
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary
Variable 2	Channel	0...7	0	Yes	1
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary
Variable 3	Channel	0...7	0	Yes	2
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary
Variable 4	Channel	0...7	0	Yes	3
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary
The following variables apply only to a configuration with 8 HART variables:					
Variable 5	Channel	0...7	0	Yes	4
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary

6.5 Address space

Parameter		Value range	Default	Configuration in RUN	With GSD file PROFIBUS DP
Variable 6	Channel	0...7	0	Yes	5
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary
Variable 7	Channel	0...7	0	Yes	6
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary
Variable 8	Channel	0...7	0	Yes	7
	Type	• Non • Primary • Secondary • Tertiary • Quaternary	Non	Yes	Secondary

6.5 Address space

6.5.1 Address space

The module can be configured differently in STEP 7; see following table. Depending on the configuration, additional/different addresses are assigned in the process image input and output.

Configuration options of AQ 8xHART HF

You can configure the module with STEP 7 (TIA Portal) or with a GSD file.

When you configure the module by means of the GSD file, the configurations are available under different abbreviations/module names.

The following configurations are possible:

Table 6-3 Configuration options

Configuration	Short designation/ module name in the GSD file	Configuration software, e.g., with STEP 7 (TIA Portal)	
		STEP 7 (TIA Portal) V18 or higher and V19 HSP 0423	GSD file in STEP 7 (TIA Portal) V18 or higher or STEP 7 V5.5 SP3 or higher
1 x 8-channel without value status	AQ 8xHART HF	X	X
1 x 8-channel with value status	AQ 8xHART HF, QI	X	X
1 x 8-channel with value status for module- internal Shared Output with up to 4 sub- modules	AQ 8xHART HF, MSO	X	X

Configuration	Short designation/ module name in the GSD file	Configuration software, e.g., with STEP 7 (TIA Portal)	
		STEP 7 (TIA Portal) V18 or higher and V19 HSP 0423	GSD file in STEP 7 (TIA Portal) V18 or higher or STEP 7 V5.5 SP3 or higher
8 x 1-channel without value status	AQ 8xHART HF, S	X (PROFINET IO only)	X (PROFINET IO only)
8 x 1-channel with value status	AQ 8xHART HF, S QI	X (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel without value status, HART with 4 variables	AQ 8xHART HF, 4 Vari- ablen	X (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel with value status, HART with 4 variables	AQ 8xHART HF, QI 4 Variablen	X (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel without value status, HART with 8 variables	AQ 8xHART HF, 8 Vari- ablen	X (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel with value status, HART with 8 variables	AQ 8xHART HF, QI 8 Variablen	X (PROFINET IO only)	X (PROFINET IO only)
1 x 8-channel with value status, HART, multiHART	AQ 8xHART HF, QI multiHART	X (PROFINET IO only)	X (PROFINET IO only)

Address assignment for HART

Each HART variable occupies 5 bytes of input data. As soon as you map at least one HART variable in the input address space, the addresses are allocated for 4 variables (20 bytes) or 8 variables (40 bytes), depending on the configuration.

When the multiHART area is used, an additional 6 bytes of input address space and 1 byte of output address space is allocated.

Value status (Quality Information, QI)

The value status is always activated for the following module names:

- AQ 8xHART HF, QI
- AQ 8xHART HF, MSO
- AQ 8xHART HF, S QI
- AQ 8xHART HF, QI 4 Variablen
- AQ 8xHART HF, QI 8 Variablen
- AQ 8xHART HF, QI multiHART

An additional bit is assigned to each channel for the value status. The value status bit indicates if the read in digital value is valid. (0 = value is incorrect).

Reference

You can find information on the Shared Input/Output (MSI/MSO) functionality in the section "Module-internal shared input/shared output (MSI/MSO)" of the PROFINET with STEP 7 (<https://support.industry.siemens.com/cs/de/en/view/49948856/en>) Function Manual.

6.5.2 Address space 1 x 8-channel with and without value status

Address space for configuration as 1 x 8-channel AQ 8xHART HF and AQ 8xHART HF QI

The figure below shows the address space assignment with the configuration as 1 x 8-channel module. You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

"QB x" stands, for example, for the module start address output byte x.

"IB x" stands, for example, for input byte x of the value status.

Assignment in the process image output (PIQ) and process image input (PII)

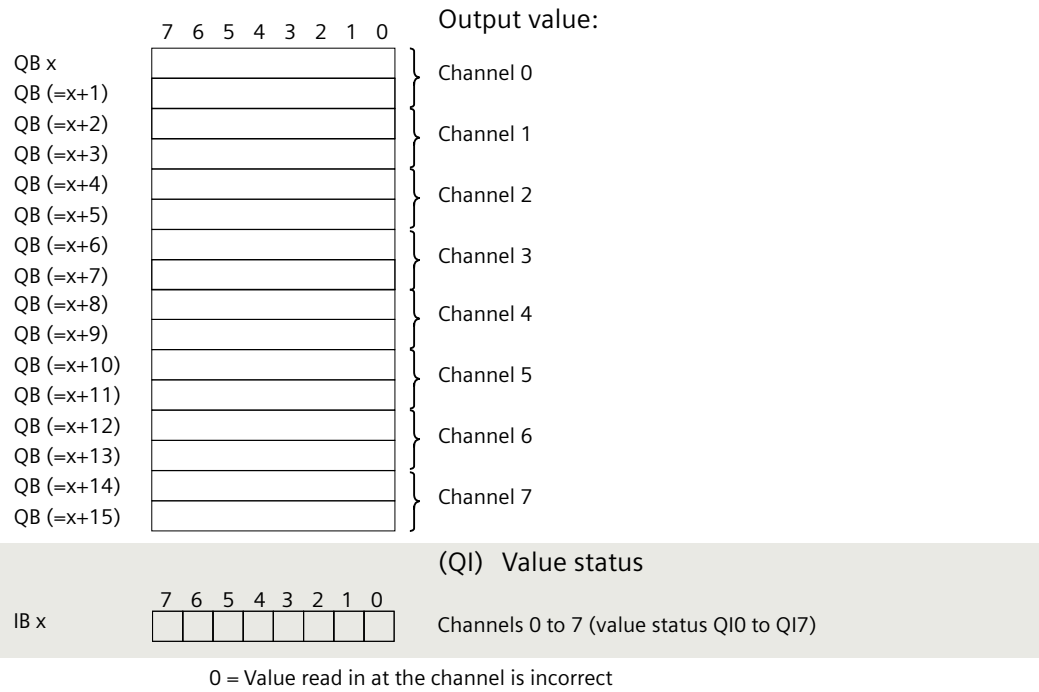


Figure 6-3 Address space for configuration as 1 x 8-channel AQ 8xHART HF with value status

6.5.3 Address space 1x8-channel with value status for MSO

Address space for configuration as 1 x 8-channel AQ 8xHART HF MSO

When configured as 1 x 8-channel module (module-internal shared output, MSO), channels 0 to 7 of the module are copied four times to up to 4 submodules. Channels 0 to 7 are then available with identical input values in different submodules. These submodules can be assigned to up to four IO controllers when the module is used in a shared device. Each IO controller has read access to the same channels.

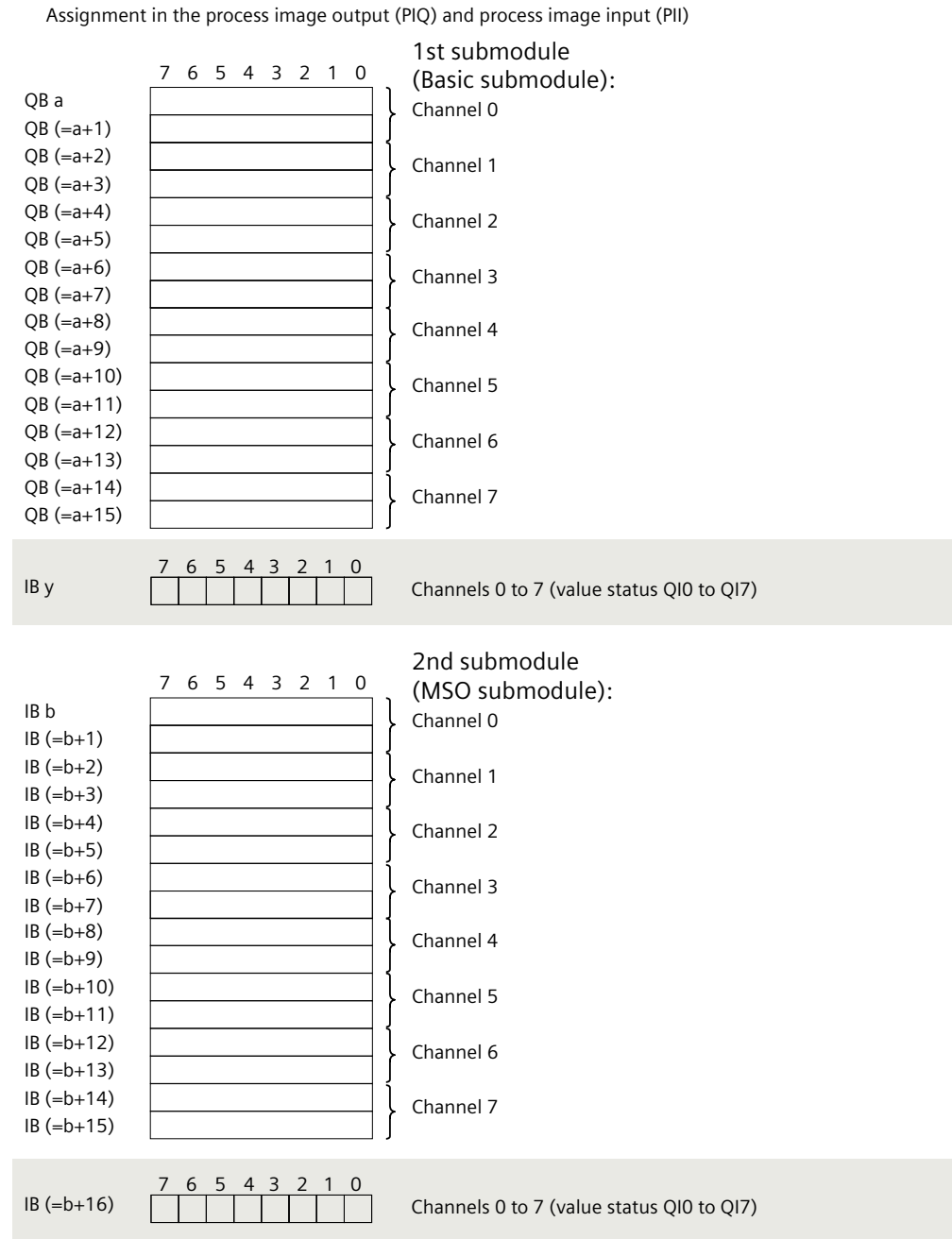
The number of IO controllers depends on the interface module used. Please observe the information in the manual for the particular interface module.

Value status (Quality Information, QI)

The meaning of the value status depends on the submodule on which it occurs. For the first submodule (=basic submodule), the value status 0 indicates that the value is incorrect.

For the 2nd to 4th Submodule (=MSO submodule), the value status 0 indicates that the value is incorrect or the basic submodule has not yet been configured (not ready).

The following figure shows the assignment of the address space with submodules 1 and 2.

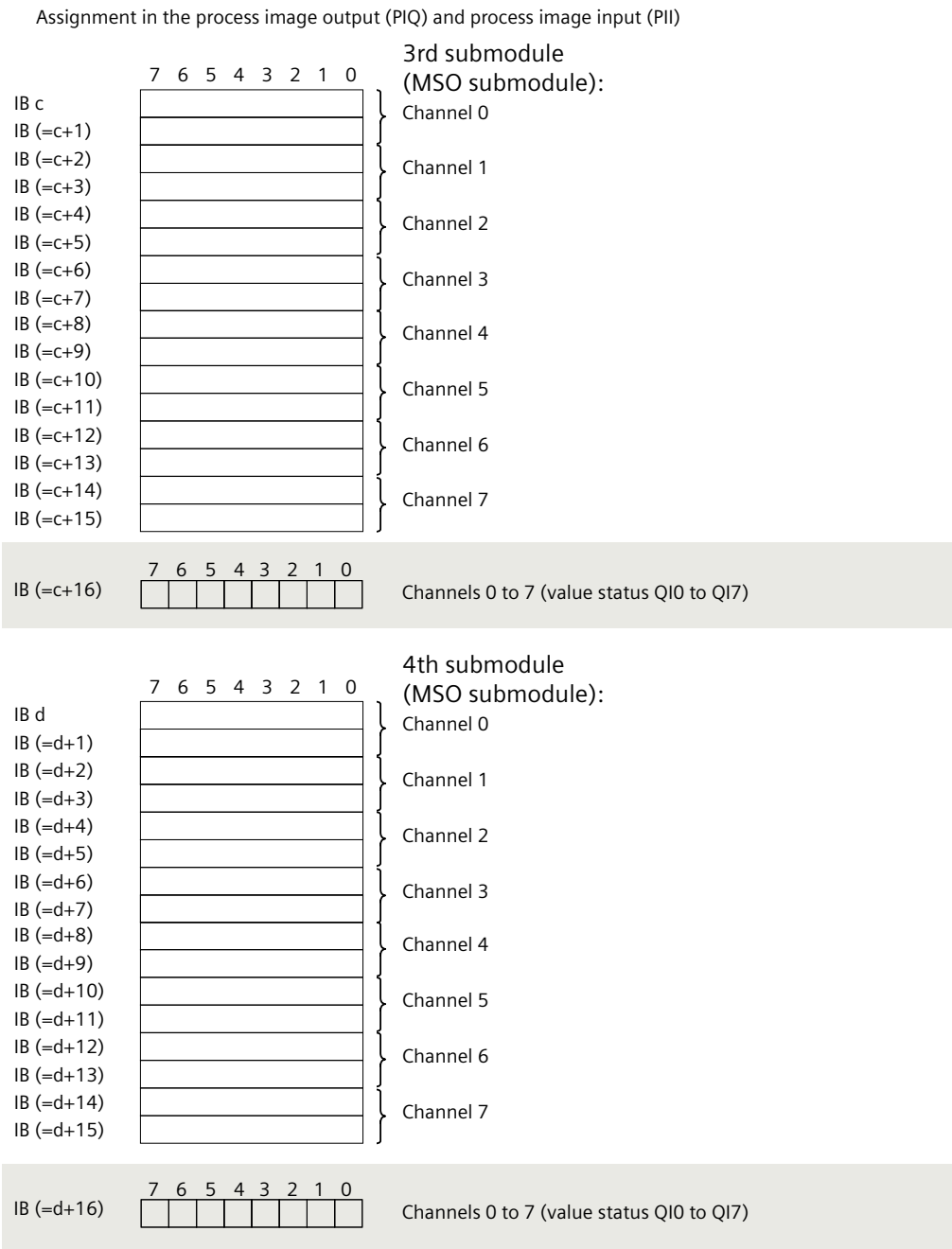


0 = Value read in at the channel is incorrect

Figure 6-4 Address space for configuration as 1 x 8-channel AQ 8xHART HF MSO with value status

6.5 Address space

The following figure shows the assignment of the address space with submodules 3 and 4.



0 = Value read in at the channel is incorrect

Figure 6-5 Address space for configuration as 1 x 8-channel AQ 8xHART HF MSO with value status

6.5.5 Address space 1 x 8-channel with value status and HART with 4 variables

Address space 1 x 8-channel with value status and HART with 4 variables

The figure below shows the address space assignment for the configuration as 1 x 8-channel module with value status. Following are the 4 x HART auxiliary variables.
You can freely assign the start address for the module. The addresses of the channels are derived from the start address.
"QB x" stands, for example, for the module start address output byte x.
"IB x" stands, for example, for the module start address input byte x.

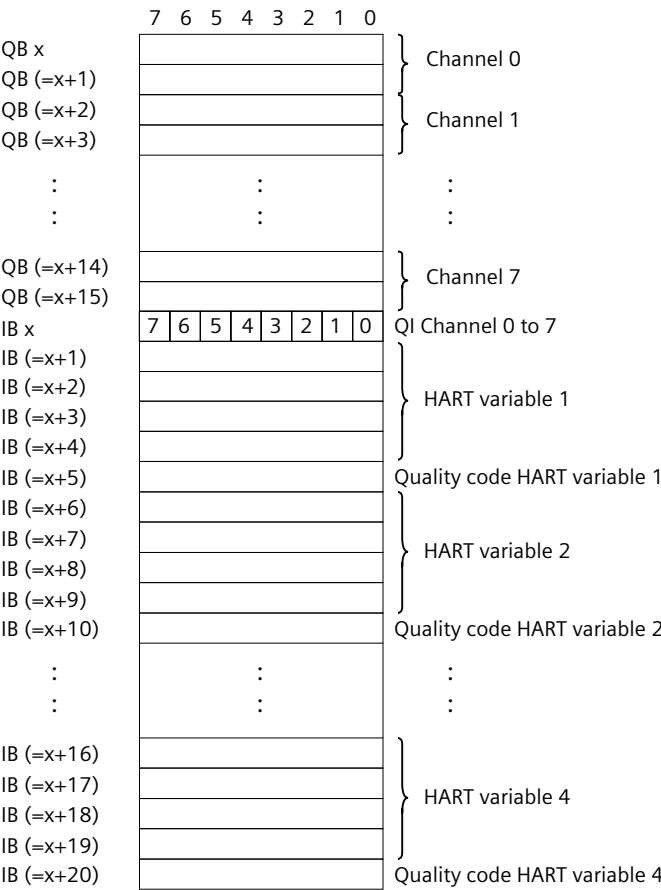


Figure 6-7 Address space for configuration as 1 x 8-channel with value status and HART with 4 variables

6.5.6 Address space 1 x 8-channel without value status and HART with 4 variables

Address space 1 x 8-channel without value status and HART with 4 variables

The figure below shows the address space assignment for configuration as 1 x 8-channel module without value status. Following are the 4 x HART auxiliary variables.

You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

"QB x" stands, for example, for the module start address output byte x.

"IB x" stands, for example, for the module start address input byte x.

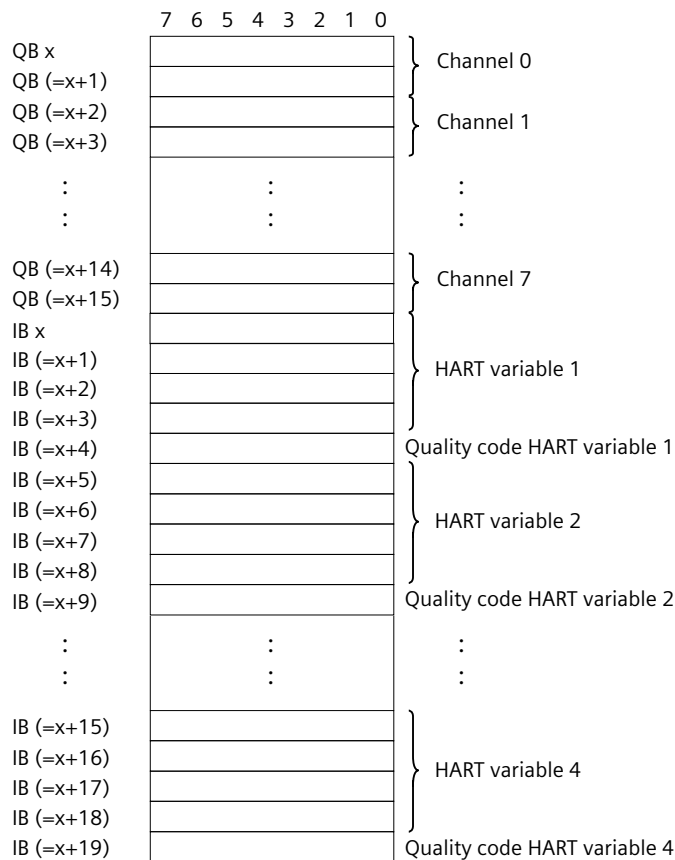


Figure 6-8 Address space for configuration as 1 x 8-channel without value status and HART with 4 variables

6.5.7 Address space 1 x 8-channel with value status and HART with 8 variables

Address space 1 x 8-channel with value status and HART with 8 variables

The figure below shows the address space assignment for the configuration as 1 x 8-channel module with value status. Following are the 8 x HART auxiliary variables. You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

"QB x" stands, for example, for the module start address output byte x.

"IB x" stands, for example, for the module start address input byte x.

Assignment in the process image output (PIQ) and process image input (PII)

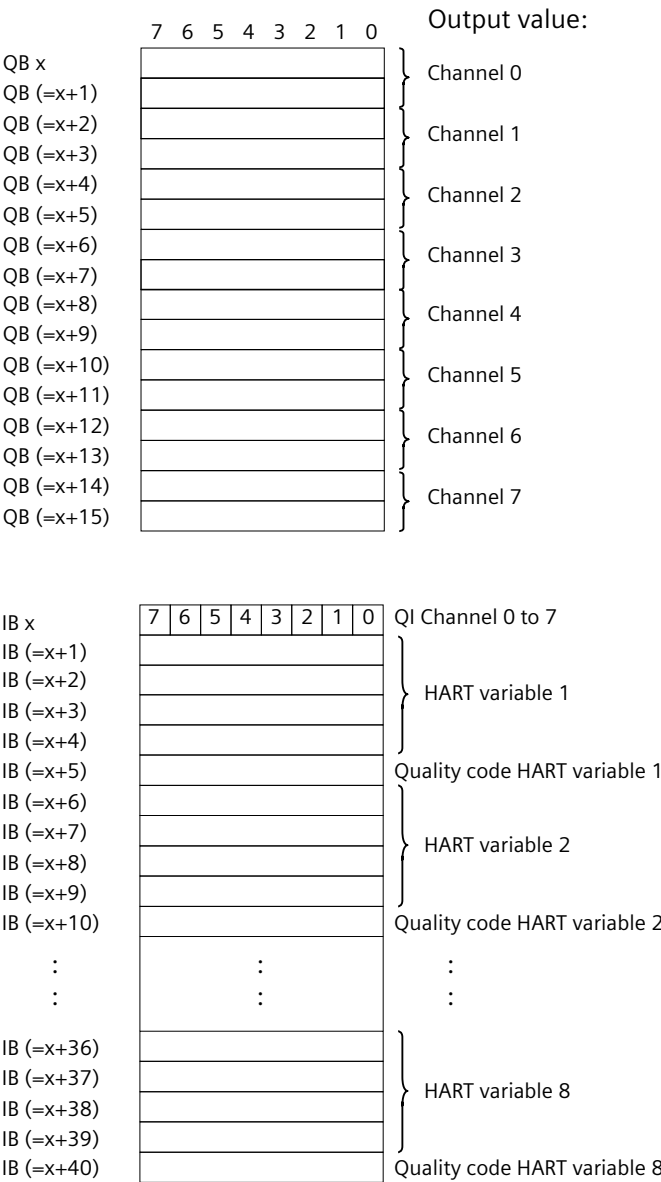


Figure 6-9 Address space for configuration as 1 x 8-channel with value status and HART with 8 variables

6.5.8 Address space 1 x 8-channel without value status and HART with 8 variables

Address space 1 x 8-channel without value status and HART with 8 variables

The figure below shows the address space assignment for configuration as 1 x 8-channel module without value status. Following are the 8 x HART auxiliary variables.

You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

"QB x" stands, for example, for the module start address output byte x.

"IB x" stands, for example, for the module start address input byte x.

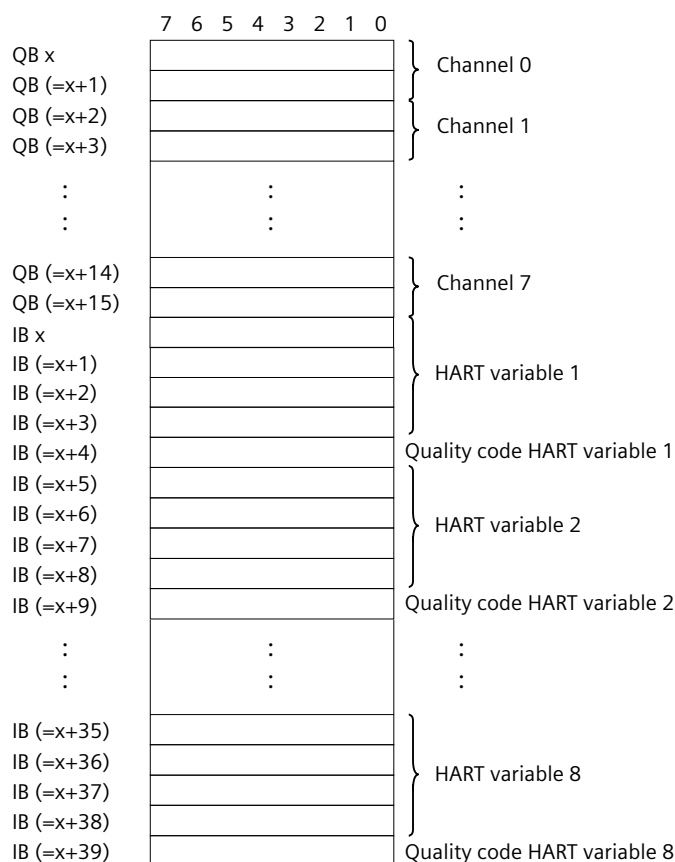


Figure 6-10 Address space for configuration as 1 x 8-channel without value status and HART with 8 variables

6.5.9 Address space 1 x 8-channel with value status and HART and multiHART

Address space 1 x 8-channel with value status and multiHART

The figure below shows the assignment of the address space for configuration as a 1 x 8-channel module with the HART command byte.

The value status, the HART acknowledgment byte and the HART variables are in the address space as of IB x.

You can freely assign the start address for the module. The addresses of the channels are derived from the start address.

"QB x" stands, for example, for the module start address output byte x.

"IB x" stands, for example, for the command byte input byte x.

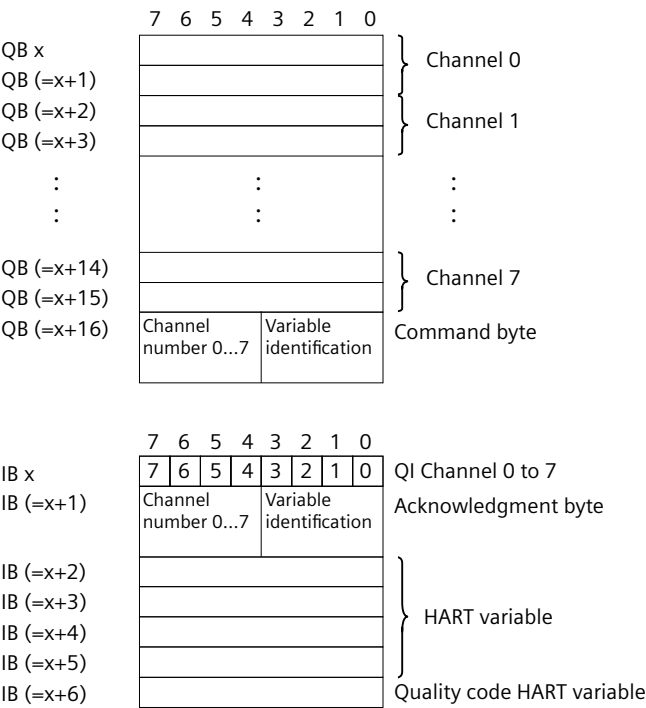


Figure 6-11 Address space for configuration as 1 x 8-channel with value status and multiHART

Interrupts/diagnostic alarms

7.1 Status and error displays

LED displays

The figure below shows the LED displays (status and error displays) of the AQ 8xHART HF.

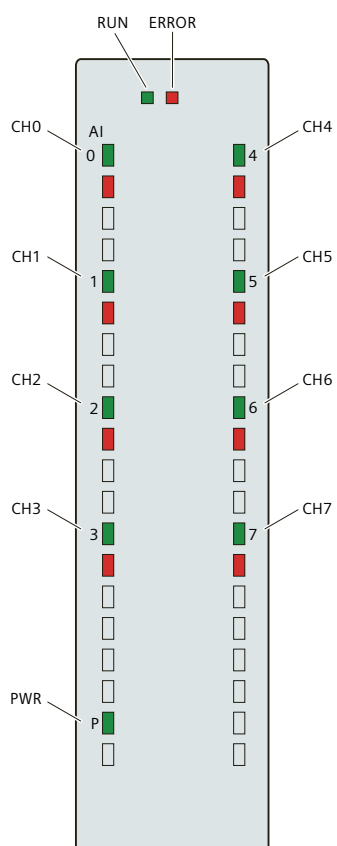


Figure 7-1 LED displays of the AQ 8xHART HF module

Meaning of the LED displays

The following tables explain the meaning of the status and error displays. Remedial measures for diagnostics alarms can be found in section Diagnostics alarms ([Page 47](#)).

RUN and ERROR LED

Table 7-1 Status and error displays RUN and ERROR

LED		Meaning	Remedy
RUN	ERROR		
 Off	 Off	Voltage missing or too low at backplane bus	- Switch on the CPU and/or the system power supply modules. - Verify that the U connectors are inserted. - Check to see if too many modules are inserted.
 Flashes	 Off	The module starts and flashes until the valid parameter assignment is set.	---
 On	 Off	Module is configured	
 On	 Flashes	Indicates module errors (at least one error at one channel, e.g., wire break).	Evaluate the diagnostics data and eliminate the error (e.g., wire break).
 Flashes	 Flashes	Hardware defective	Replace the module.

PWR LED

Table 7-2 PWR status display

LED PWR	Meaning	Remedy
 Off	Supply voltage L+ too low or missing	Check the L+ supply voltage.
 On	Supply voltage L+ is present and OK	---

CHx LED

Table 7-3 Status display of the CHx LED

LED		Meaning
Channel status	Channel error	
 Off	 Off	Channel deactivated or module switched off
 On	 Off	Channel activated and no channel diagnostics available
 Off	 On	- Channel activated and channel diagnostics available - Channel diagnostics and HART channel diagnostics available
 On	 On	Channel activated and only HART channel diagnostics available

7.2 Interrupts

The analog output module AQ 8xHART HF supports diagnostic interrupts.

You can find detailed information on the event in the error organization block with the RALRM instruction (read additional interrupt info) and in the STEP 7 online help.

Diagnostic interrupt

The module generates a diagnostic interrupt at the following events:

- Missing supply voltage L+
- Short circuit to ground
- Wire break
- Overflow
- Underflow
- Parameter assignment error
- HART communication error or error of the HART field device

HART diagnostic messages are generated in parallel and additionally in the case of wire break, short-circuit and overflow/underflow.

7.3 Diagnostics alarms

A diagnostics alarm is generated and the ERROR LED flashes on the module for each diagnostics event. The diagnostics alarms can be read out in the diagnostics buffer of the CPU, for example. You can evaluate the error codes with the user program.

If the module is operated distributed with PROFIBUS DP in an ET 200MP system, you have the option to read out diagnostics data with the instruction RDREC or RD_REC using data record 0 and 1. The structure of the data records is available on the Internet in the "Manual for interface module IM 155-5 DP ST (6ES7155-5BA00-0AB0)"

(<https://support.industry.siemens.com/cs/de/en/view/78324181>).

Table 7-4 Diagnostics alarms, their meaning and corrective measures

Diagnostics alarm	Error code	Meaning	Remedy
Short circuit to ground	1 _H	Overload at output	Eliminate overload
		Short-circuit of output Q _V to M _{ANA}	Eliminate the short-circuit
Wire break	6 _H	Encoder circuit impedance too high	Use a different actuator type or modify the wiring, for example, use cables with larger cross-section
		Wirebreak between the module and actuator	Connect the cable
		Channel not connected (open)	• Disable the channel ("output type" parameter) • Connect the channel
Overflow	7 _H	The output value set by the user program exceeds the valid rated range/overshoot range.	Correct the output value
Underflow	8 _H	The output value set by the user program undershoots the valid rated range/undershoot range.	Correct the output value

7.3 Diagnostics alarms

Diagnostics alarm	Error code	Meaning	Remedy
Parameter assignment error	10 _H	- The module cannot evaluate parameters for the channel - Incorrect parameter assignment.	Correct the parameter assignment
Load voltage missing	11 _H	Supply voltage L+ of the module is missing	Connect supply voltage L+ to module
Temporarily unavailable	1F _H	The channel is temporarily not available due to online calibration	End online calibration
HART communication error	141 _H	- HART field device is not responding - Timing error - HART field device has not understood the sent command (1st status byte)	- Check the process wiring - Correct the parameter assignment - Set output current ≥ 4 mA - Increase the configured number of repetitions
HART primary variable outside of range	142 _H	- Incorrect parameters in the HART field device - HART field device is at "Primary variable outside the limits" in simulation mode - Incorrect measuring point - Primary variable configured outside the limits	- Check the parameter assignment of the HART device - Correct the simulation - Check whether the correct measuring transducer is connected
HART output current of the field device saturated	143 _H	The output current of the HART field device is saturated: - Incorrect parameters in the HART field device - HART field device is set to a measured value that is too high in simulation mode - Incorrect measuring point	
HART output current of the field device specified	144 _H	The output current of the HART field device has been permanently set: - Incorrect parameters in the HART field device - HART field device is set to a measured value that is too high in simulation mode - Incorrect measuring point	
HART auxiliary variable outside the limits	149 _H	- Incorrect parameters in the HART field device - HART field device is at "Non-primary variable outside the limits" in simulation mode - Incorrect measuring point - Non-primary variable configured outside the limits	

Diagnostics alarm	Error code	Meaning	Remedy
HART additional status information available	145 _H	In the HART device status (in the 2nd status byte), the HART field device identifier for "additional status information available" has been set.	Read status using HART command 48 and eliminate error/cause, if necessary
HART configuration changed (automatically reset by the module after approximately 1 minute)	146 _H	In the HART device status (in the 2nd status byte), the identifier for "reconfiguration" of the HART field device has been set.	If you do not want the reconfiguration to trigger a diagnostic interrupt, the diagnostic interrupt diagnostics must not be enabled.
HART malfunction in the field device	147 _H	In the HART device status (in the 2nd status byte), the field device reports a malfunction.	• Read status using HART command 48 and eliminate error/cause, if necessary • Replace the field device

Technical specifications

8.1 Technical specifications

Technical specifications of the AQ 8xHART HF

Article number	6ES7532-8TF00-0AB0
General information	
Product type designation	AQ 8xHART HF
HW functional status	From FS01
Firmware version	V1.0.0
FW update possible	Yes
Product function	
I&M data	Yes; I&M0 to I&M3
Isochronous mode	No
Prioritized startup	No
Output range scalable	No
Engineering with	
STEP 7 TIA Portal configurable/integrated from version	V18 and V19 with HSP0423
STEP 7 configurable/integrated from version	V5.5 SP3 / -
PROFIBUS from GSD version/GSD revision	V1.0 / V5.1
PROFINET from GSD version/GSD revision	V 2.43 / -
Operating mode	
Oversampling	No
MSO	Yes
CiR - Configuration in RUN	
Reparameterization possible in RUN	Yes
Calibration possible in RUN	Yes
Supply voltage	
Rated value (DC)	24 V
permissible range, lower limit (DC)	19.2 V
permissible range, upper limit (DC)	28.8 V
Reverse polarity protection	Yes
Input current	
Current consumption (rated value)	280 mA; 8x 20 mA with 750 ohm load resistance
Current consumption, max.	370 mA

Article number	6ES7532-8TF00-0AB0
Power	
Power available from the backplane bus	0.6 W
Power loss	
Power loss, typ.	4.8 W; 8x 20 mA with 750 ohm load resistance
Analog outputs	
Number of analog outputs	8
Current output, no-load voltage, max.	30 V
Cycle time (all channels), min.	5 ms; independent of number of activated channels
Output ranges, current	
• 0 to 10 mA	No
• 0 to 20 mA	Yes
• -20 mA to +20 mA	No
• 4 mA to 20 mA	Yes
Connection of actuators	
• for current output two-wire connection	Yes
Load impedance (in rated range of output)	
• with current outputs, max.	750 Ω
• with current outputs, inductive load, max.	10 mH
Cable length	
• shielded, max.	800 m
Analog value generation for the outputs	
Integration and conversion time/resolution per channel	
• Resolution with overrange (bit including sign), max.	16 bit
Settling time	
• for resistive load	3 ms; see additional description in the manual
• for inductive load	3 ms; see additional description in the manual
Errors/accuracies	
Output ripple (relative to output range, bandwidth 0 to 50 kHz), (+/-)	0.02 %
Linearity error (relative to output range), (+/-)	0.02 %
Temperature error (relative to output range), (+/-)	0.002 %/K
Crosstalk between the outputs, max.	-100 dB
Repeat accuracy in steady state at 25 °C (relative to output range), (+/-)	0.02 %
note regarding accuracy	at temperatures below 0 °C, the figures for operating error and temperature error are doubled
Operational error limit in overall temperature range	
• Current, relative to output range, (+/-)	0.2 %

8.1 Technical specifications

Article number	6ES7532-8TF00-0AB0
Basic error limit (operational limit at 25 °C)	
Current, relative to output range, (+/-)	0.1 %
Interrupts/diagnostics/status information	
Diagnostics function	Yes
Substitute values connectable	Yes
Alarms	
Diagnostic alarm	Yes
Diagnoses	
- Monitoring the supply voltage - Wire-break - Short-circuit - Overflow/underflow	Yes Yes Yes Yes
Diagnostics indication LED	
- RUN LED - ERROR LED - Monitoring of the supply voltage (PWR-LED) - Channel status display - for channel diagnostics - for module diagnostics	Yes; green LED Yes; red LED Yes; green LED Yes; green LED Yes; red LED Yes; red LED
Potential separation	
Potential separation channels	
- between the channels - between the channels, in groups of - between the channels and backplane bus - Between the channels and load voltage L+	No 8 Yes Yes
Permissible potential difference	
between different circuits	60 V DC/30 V AC
Isolation	
Isolation tested with	707 V DC (type test)
Standards, approvals, certificates	
Suitable for safety-related tripping of standard modules	No
product functions / security / header	
signed firmware update	Yes
data integrity	No

Article number	6ES7532-8TF00-0AB0
Ambient conditions	
Ambient temperature during operation	
• horizontal installation, min.	-30 °C
• horizontal installation, max.	60 °C
• vertical installation, min.	-30 °C
• vertical installation, max.	40 °C
Altitude during operation relating to sea level	
• Installation altitude above sea level, max.	5 000 m; Restrictions for installation altitudes > 2 000 m, see manual
Dimensions	
Width	35 mm
Height	147 mm
Depth	129 mm
Weights	
Weight, approx.	300 g

Dimension drawing

A

A.1 Dimensional drawing

This appendix contains the dimensional drawing of the module installed on a mounting rail and with a shield bracket. Always observe the specified dimensions for installation in cabinets, control rooms, etc.

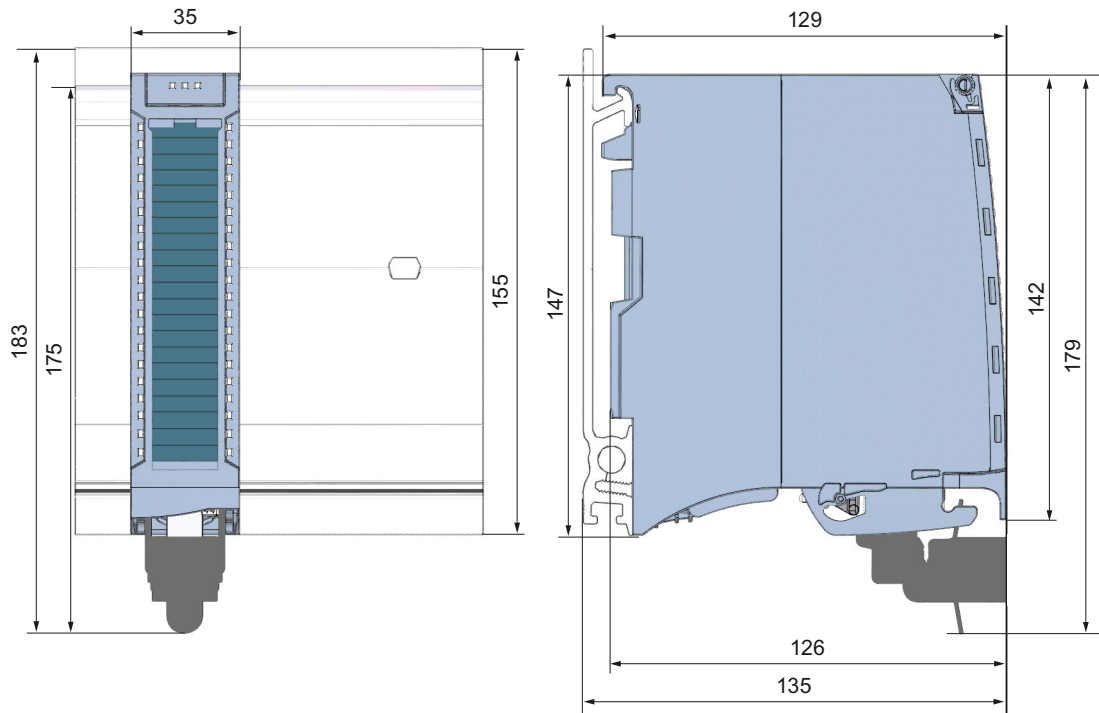


Figure A-1 Dimension drawing of the AQ 8xHART HF module

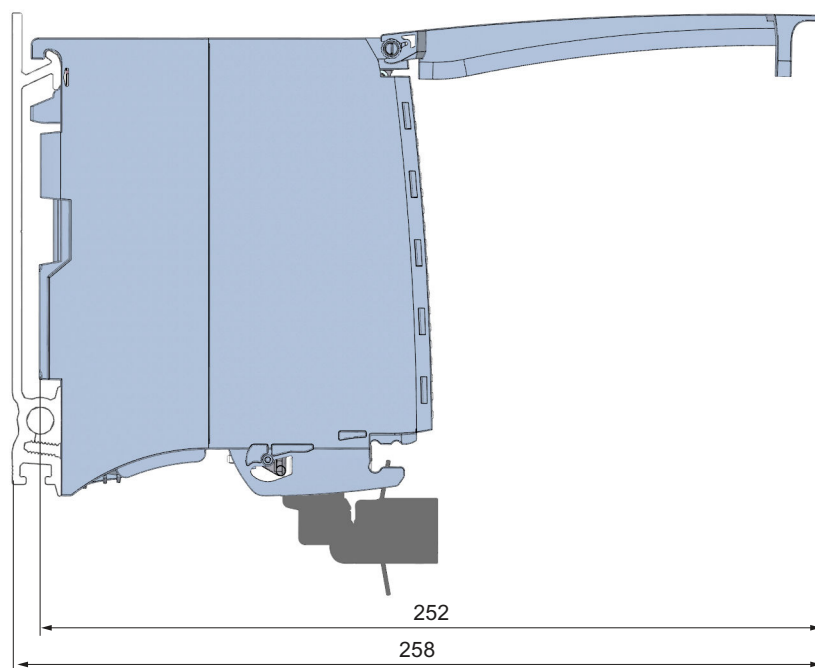


Figure A-2 Dimensional drawing of the AQ 8xHART HF module, side view with open front cover

Parameter data records

B.1 Parameter assignment and structure of the parameter data records

The data records of the module have an identical structure, regardless of whether you configure the module with PROFIBUS DP or PROFINET IO.

Dependencies for configuration with GSD file

When configuring the module with a GSD file, remember that the settings of some parameters are dependent on each other. The parameters are only checked for plausibility by the module after the transfer to the module.

The following table lists the parameters that depend on one another.

Table B-1 Dependencies of parameters for configuration with GSD file

Device-specific parameters (GSD file)	Dependent parameters
Substitute value	Only if Reaction to CPU STOP -> Output substitute value is configured
HART diagnostics	Only for measuring range 4 to 20 mA HART. ¹
Number of HART preamble bytes	Not used for configuration "Address space 8 x 1-channel with value status".
Number of HART repetitions	

¹ Measuring range 4 to 20 mA HART not with configuration "Address space 8x1-channel with value status"

Parameter assignment in the user program

You have the option to configure the module in RUN (e.g. output ranges of individual channels can be changed in RUN without having an effect on the other channels).

Parameter assignment in RUN

The WRREC instruction is used to transfer the parameters to the module using data records 64 to 71. The parameters set in STEP 7 do not change in the CPU, which means the parameters set in STEP 7 are still valid after a restart.

The parameters are only checked for plausibility by the module after the transfer to the module.

Output parameter STATUS

The module ignores errors that occurred during the transfer of parameters with the WRREC instruction and continues operation with the previous parameter assignment. However, a corresponding error code is written to the STATUS output parameter.

The description of the WRREC instruction and the error codes is available in the STEP 7 online help.

Operation of the module behind a PROFIBUS DP interface module

If the module is operated behind a PROFIBUS DP interface module, the parameter data records 0 and 1 are not read back. You obtain the diagnostics data records 0 and 1 with the read back parameter data records 0 and 1. You can find more information in the Interrupts section of the manual for the PROFIBUS DP interface module in GHB Interface module IM 155-5 DP ST (<https://support.industry.siemens.com/cs/de/en/view/78324181>).

Assignment of data record and channel

The channel parameters in data records 64 to 71 are available for 1x 8-channel configuration and are assigned as follows:

- Data record 64 for channel 0
- Data record 65 for channel 1
- ...
- Data record 70 for channel 6
- Data record 71 for channel 7

For configuration 8 x 1-channel, the module has 8 submodules with one channel each. The parameters for the channel are available in data record 64 and are assigned as follows:

- Data record 64 for channel 0 (submodule 1)
- Data record 64 for channel 1 (submodule 2)
- ...
- Data record 64 for channel 5 (submodule 6)
- Data record 64 for channel 6 (submodule 7)
- Data record 64 for channel 7 (submodule 8)

Address the respective submodule for data record transfer.

Data record structure

The figure below shows the structure of data record 64 for channel 0 as an example. The structure is identical for channels 1 to 7. The values in byte 0 and byte 1 are fixed and may not be changed.
Enable a parameter by setting the corresponding bit to "1".

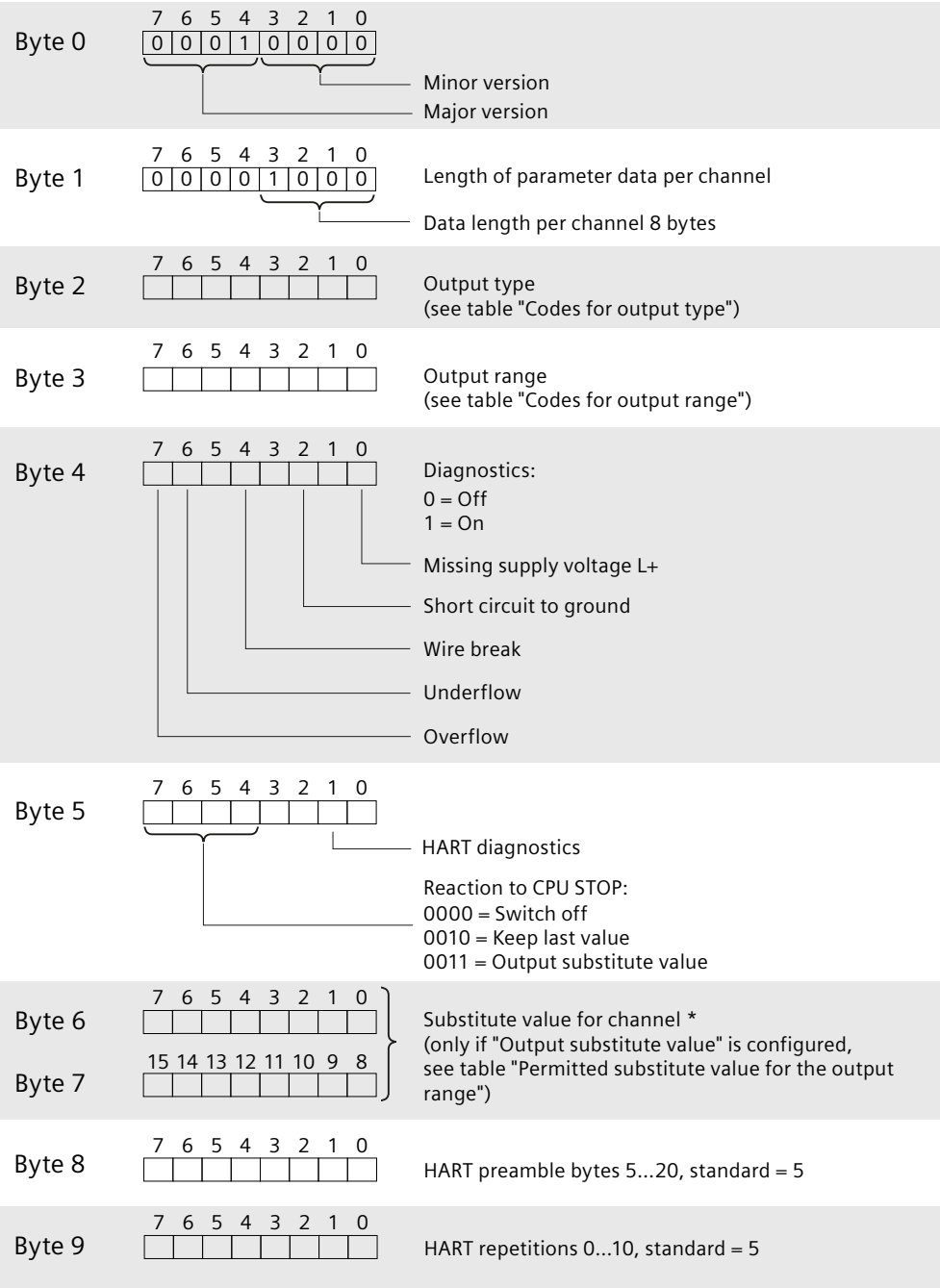


Figure B-1 Data record structure: Bytes 0 to 9

B.1 Parameter assignment and structure of the parameter data records

Output type codes

The following table lists all output types of the analog output module along with their codes. Enter these codes at byte 2 of the data record for the corresponding channel (see the previous figure).

Table B-2 Code for the output type

Output type	Code
Deactivated	0000 0000
Current	0000 0010

Codes for the output ranges

The table below contains all output ranges of the analog output module with their codes. Enter these codes at byte 3 of the data record for the corresponding channel (see the previous figure).

Table B-3 Output range code

Output range for current	Code
0 mA to 20 mA	0000 0001
4 mA to 20 mA	0000 0010
4 to 20 mA with HART	0000 0110

Valid substitute values

The following table lists all output ranges for the valid substitute values. Enter these substitute values at bytes 6 and 7 of the data record for the corresponding channel (see the previous figure). You can find the binary representation of the output ranges in section Representation of analog values in the current output ranges (Page 76).

Table B-4 Valid substitute value for the output range

Output range	Valid substitute value
4 mA to 20 mA	-6912 ... +32511
0 mA to 20 mA	0 ... +32511

B.2 Parameter assignment and structure of the HART mapping parameters

Structure of data record 140

Data record 140 has a total length of 20 bytes (for configuration with 4 variables) or 40 bytes (for configuration with 8 variables).
Using the parameters of data record 140, you can configure/map up to eight HART variables of the individual channels in the input address space of the module, provided that the corresponding configuration has been selected, see "HART mapping parameters (Page 33)".

Header information

The figure below shows the structure of the header information.

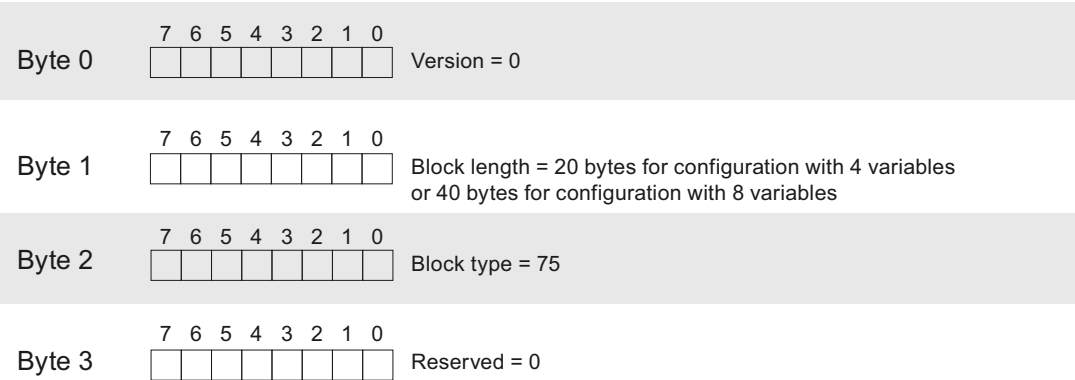
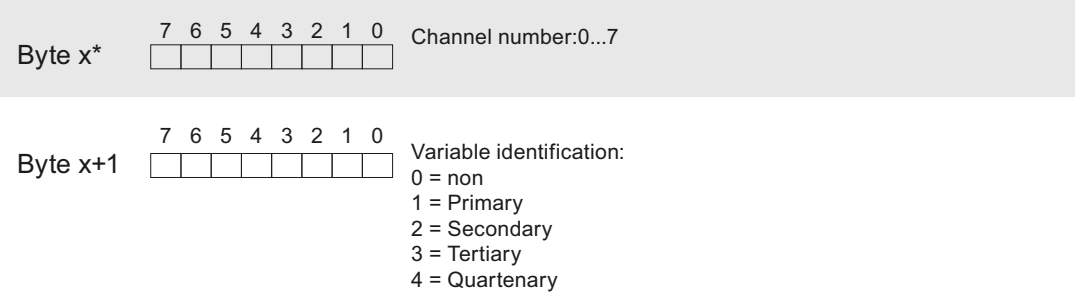


Figure B-2 Header information

Parameters

The following figure shows the parameter assignment of the eight HART variables 1...8.



* $x = 4 + (\text{HART variable} - 1) * 2$; with HART variable 1...8

Figure B-3 Parameters

NOTE**Memory area**

Allocation of the memory area based on the configuration of the HART variables:

- You can choose from the following options:
 - None:
Only analog values 8 words
 - 8 HART:
8 words + 5x8 bytes input address area
 - 4 HART:
8 words + 5x4 bytes input address area
 - 1 multiHART:
8 words + 6 bytes input address area +1 byte output address area
- At least one HART variable has been configured not equal to 0 = "non":
The memory area is allocated for 4 or 8 variables depending on the configuration with 4 or 8 HART variables.

B.3 Error when transferring the data record

Error when transferring the data record

The module always checks all values of the transferred data record. The module applies the values from the data record only when all values have been transmitted without errors.

The WRREC instruction for writing data records returns corresponding error codes when errors occur in the STATUS parameter, see also the description of the "STATUS" parameter in the STEP 7 online help).

The following table shows the module-specific error codes and their meaning for the parameter data records.

Error code in STATUS parameter (hexadecimal)				Meaning	Remedy
Byte 0	Byte 1	Byte 2	Byte 3		
DF	80	E0	01	Unspecified error.	-
DF	80	E0	02	Wrong version in the header information.	Correct the version of the parameter blocks.
DF	80	E0	03	Wrong length in the header information	Correct the length of the parameter blocks.
DF	80	E1	00	Unspecified error.	-
DF	80	E1	01	Reserved bit set	Check the parameters of the module.
DF	80	E1	02	Invalid diagnostics enable bit set for operating mode.	Check the parameters of the module.

B.3 Error when transferring the data record

Error code in STATUS parameter (hexadecimal)				Meaning	Remedy
Byte 0	Byte 1	Byte 2	Byte 3		
DF	80	E1	05	Invalid coding set for measuring range / measurement type / output range / output type.	Check the parameters of the module.
DF	80	E1	16	Invalid measurement type / output type.	Check the parameters of the module.
DF	80	E1	17	Invalid measuring range / output range	Check the parameters of the module.
DF	80	E1	32	Invalid value for length of HART preamble	Check the parameters of the module.
DF	80	E1	33	Invalid channel for HART variable	Check the parameters of the module.
DF	80	E1	34	Invalid type (primary, secondary, etc.) for HART variable	Check the parameters of the module.
DF	80	E1	35	Invalid value for HART repetitions	Check the parameters of the module.

HART operating data records

C.1 HART operating data records

Reading/writing data in RUN

HART operating data records are transferred to the module with the "WRREC" instruction and read from the module with the "RDREC" instruction.

Errors during the transfer are indicated at output parameter STATUS of the "WRREC" or "RDREC".

The following HART operating data records are available:

Data record number	Description	Length (bytes)	Writable	Readable
80	HART request Channel 0	240	Yes	Yes
81	HART response Channel 0	240	No	Yes
82	HART request Channel 1	240	Yes	Yes
83	HART response Channel 1	240	No	Yes
84	HART request Channel 2	240	Yes	Yes
85	HART response Channel 2	240	No	Yes
86	HART request Channel 3	240	Yes	Yes
87	HART response Channel 3	240	No	Yes
88	HART request Channel 4	240	Yes	Yes
89	HART response Channel 4	240	No	Yes
90	HART request Channel 5	240	Yes	Yes
91	HART response Channel 5	240	No	Yes
92	HART request Channel 6	240	Yes	Yes
93	HART response Channel 6	240	No	Yes
94	HART request Channel 7	240	Yes	Yes
95	HART response Channel 7	240	No	Yes
121	HART variables	160	No	Yes
131	HART parameters Channel 0	8	Yes	Yes
132	HART parameters Channel 1	8	Yes	Yes
133	HART parameters Channel 2	8	Yes	Yes
134	HART parameters Channel 3	8	Yes	Yes
135	HART parameters Channel 4	8	Yes	Yes
136	HART parameters Channel 5	8	Yes	Yes
137	HART parameters Channel 6	8	Yes	Yes

Data record number	Description	Length (bytes)	Writable	Readable
138	HART parameters Channel 7	8	Yes	Yes
148	HART directory	25	No	Yes
149	HART feature data	3	No	Yes

C.2 HART directory (DS 148)

Structure of the HART directory

Byte	Meaning	Comment
0	Profile Revision Number	= 2, 0 (Revision 2.0)
1		
2	Index of Client Management	= 255 (not relevant)
3	Number of Clients	= 1
4	Number of Channels	= 8
5	Write Read Index Offset	= 1 (The response to a request data record is made with the data record number of the request data record + 1)
6	Index of HMD Feature Parameter	= 149
7	Index of HMD Module Parameter	= 255 (not relevant)
8	Start Index of Burst Buffer Area	= 255 (not relevant)
9+n	Index of HMD Channel Parameter (Channel n)	= 131+n
9+n+4	Index of HART Client Channel Message Data	= 80+(2*n) The HART request data records cannot be configured. Data records starting from data record number 80 (80, 82, 84, 86, 88, 90, 92, 94) are always used.

C.3 HART feature data (DS 149)

Structure of the HART feature data

Byte	Meaning	Comment
0	Byte 0	= 0x62 Bit 1 = 1: "Parameter check result is given with a read response" Bit 5 = 1: "compact format is supported"
1	Byte 1	= 0
2	Max Length Data Unit	= 230 (maximum length of the HART request data)

C.4 HART variable data record (DS 121)

The AI 8xHART HF analog module supports a maximum of 4 HART variables per channel, which are read cyclically, provided they are supported by the connected field device. Depending on the configuration with 4 or 8 variables, a total of 16 or 32 HART variables, respectively, are made available for reading in the HART variable data record 121. Each HART variable consists of a 4-byte real value and a quality code byte. See section 4.4.1 "Quality code".

Structure of the HART variable data record

Byte	Meaning	
Channel 0		
0...3	Value	Primary Variable (PV)
4	Quality code	
5...8	Value	Secondary Variable (SV)
9	Quality code	
10...13	Value	Tertiary (TV)
14	Quality code	
15...18	Value	Quartenary (QV)
19	Quality code	
Channel 1		
20...39	HART variables same as for Channel 0	
Channel 2		
40...59	HART variables same as for Channel 0	
Channel 3		
60...79	HART variables same as for Channel 0	
Channel 4 (only for configuration with 8 variables)		
80...99	HART variables same as for Channel 0	
Channel 5 (only for configuration with 8 variables)		
100...119	HART variables same as for Channel 0	
Channel 6 (only for configuration with 8 variables)		
120...139	HART variables same as for Channel 0	
Channel 7 (only for configuration with 8 variables)		
140...159	HART variables same as for Channel 0	

If HART is not enabled or the respective HART variable is not supplied from the connected field device, the corresponding variable = 0 and the QC = 0x37 (initialization value from the analog module).

C.5 HART-specific settings (DS 131 to DS 138)

HART communication is available using standard parameter assignment (see Parameters (Page 29)).

You can specify additional HART-specific settings on a channel-specific basis using data records 131 to 138.

The parameters assigned with STEP 7 are not changed permanently in the CPU, which means the parameters assigned with STEP 7 are valid again after a restart.

Every new parameter assignment of the analog module resets the HART-specific settings back to the initial values from the parameter data record (0...7).

Channel	Data record number
0	131
1	132
2	133
3	134
4	135
5	136
6	137
7	138

Structure of the HART-specific settings

Byte 0	7 6 5 4 3 2 1 0 1 0 0 0 0 0 0 0	Bit 7 is reset after evaluation of the data record by the module
Byte 1	7 6 5 4 3 2 1 0 0 0 0 0 0 1 0 1	Offset for manufacturer-specific parameter according to HART specification
Byte 2	7 6 5 4 3 2 1 0 □ □ □ □ □ □ □ □	Number of HART repetitions (0...10, default = 5) Initial value from the data record 0 ... 7
Byte 3	7 6 5 4 3 2 1 0 □ □ □ □ □ □ □ □	Number of HART preamble bytes (0, 5...20, 255) * Initial value from the data record 0 ... 7
Byte 4	7 6 5 4 3 2 1 0 0 0 0 0 0 0 0 0	Field device mode according to HART specification
Byte 5	7 6 5 4 3 2 1 0 0 0 0 0 0 0 0 0	Client timeout in s (1 ... 255 s) Initial value = 60 s
Byte 6	7 6 5 4 3 2 1 0 0 0 0 0 0 0 □ □ 1 = Switch on HART 0 = Switch off HART 1 = Primary master 0 = Secondary master	Initial value corresponding to HART activation from the data record 0 ... 7 Always as primary master
Byte 7	7 6 5 4 3 2 1 0 0 0 0 0 0 0 0 0	Reserved

Figure C-1 Settings

* When the number of HART preamble bytes = 0, the number of preamble bytes requested by the connected field device are used, but no fewer than 5.
When the number of HART preamble bytes = 255, then 20 preamble bytes are used.

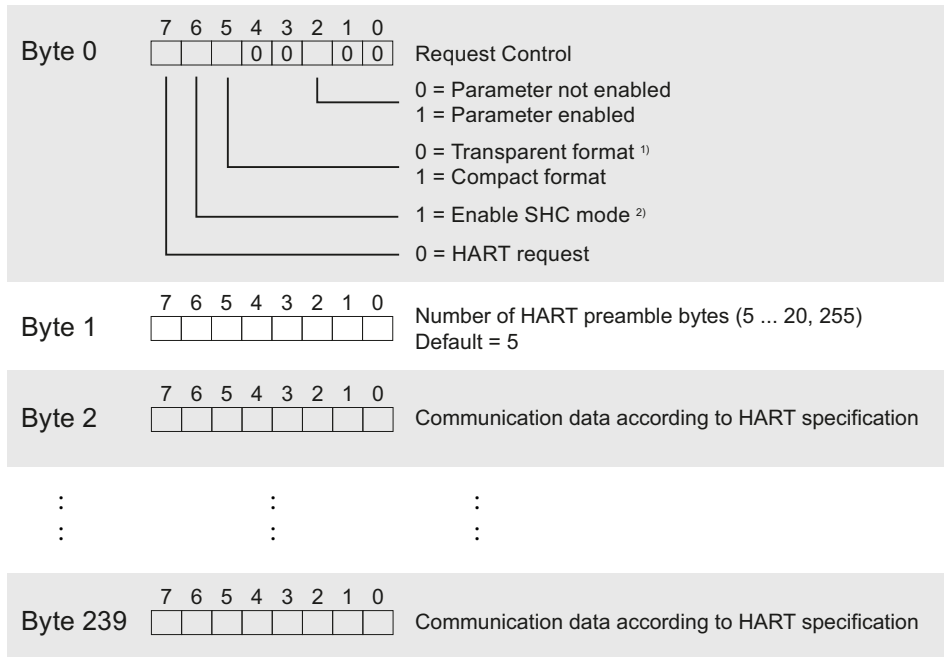
C.6 HART request and response data records (DS 80 to DS 95)

HART commands are processed on a channel-specific basis via a separate command interface with one request data record and one response data record in each case.

Channel	Data record number	
	Request to the field device	Response from the field device
0	80	81
1	82	83
2	84	85
3	86	87
4	88	89

Channel	Data record number	
	Request to the field device	Response from the field device
5	90	91
6	92	93
7	94	95

Structure of the request data records 80, 82, 84, 86, 88, 90, 92, 94



- 1) HART commands are processed by the analog module in transparent message format and in compact message format. However, the response data from the module is always made available in transparent message format.
- 2) When a sequence of HART commands in the form of an SHC sequence is processed, this affects all other channels with activated HART. See HART communication interface ([Page 23](#)), SHC sequence.

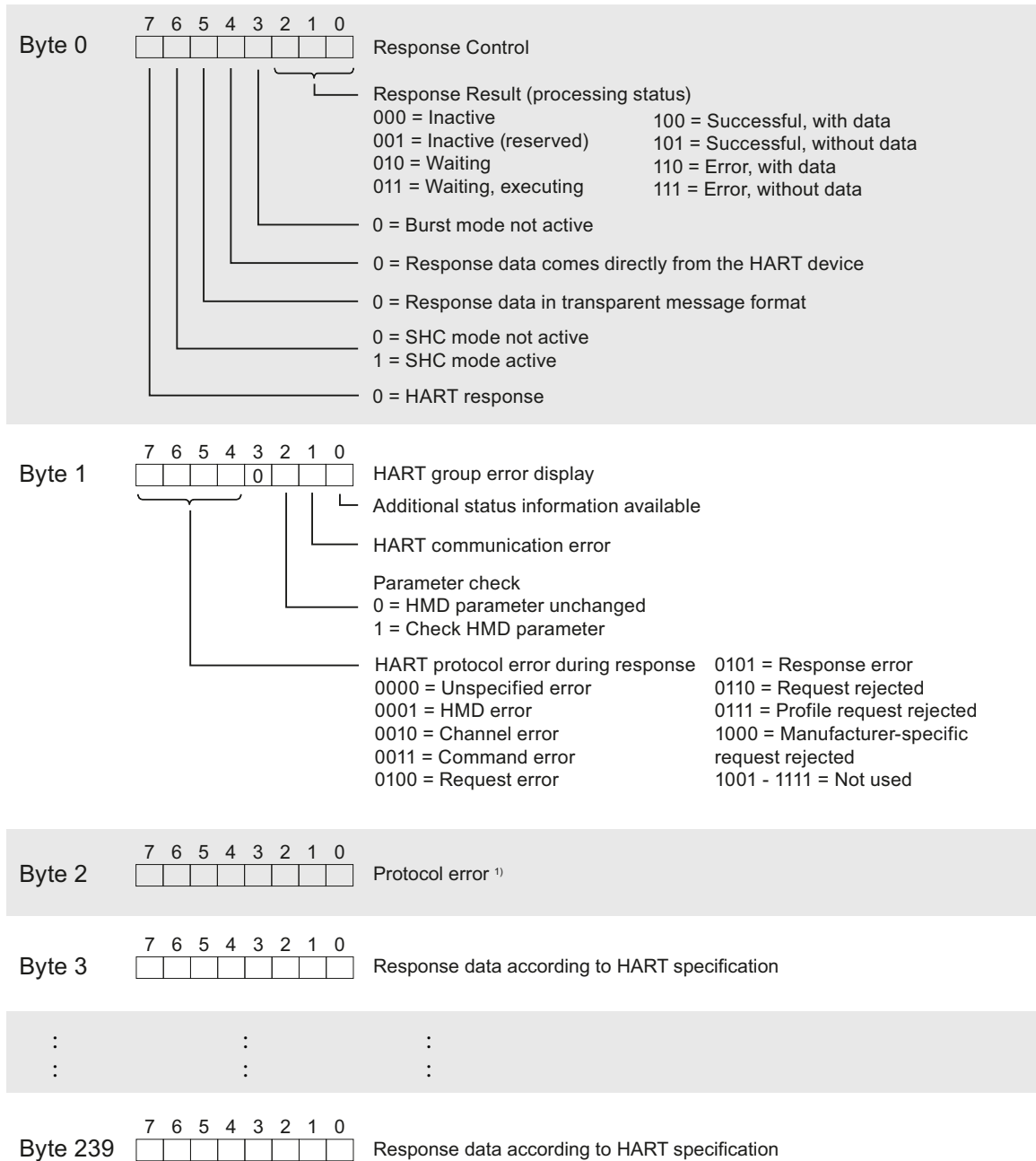
Figure C-2 Request data record

NOTE

When "Number of HART preamble bytes" = 255, the number of preambles set with the parameters is used. The default setting is five. You can reconfigure the number of preamble bytes using the parameters and HART-specific settings (see section HART-specific settings (DS 131 to DS 138) ([Page 66](#))).

Structure of the response data records 81, 83, 85, 87, 89, 91, 93, 95

In case of response error



1) See table: "HART protocol error during response" coding

Figure C-3 Response data record in case of response error

In case of response error

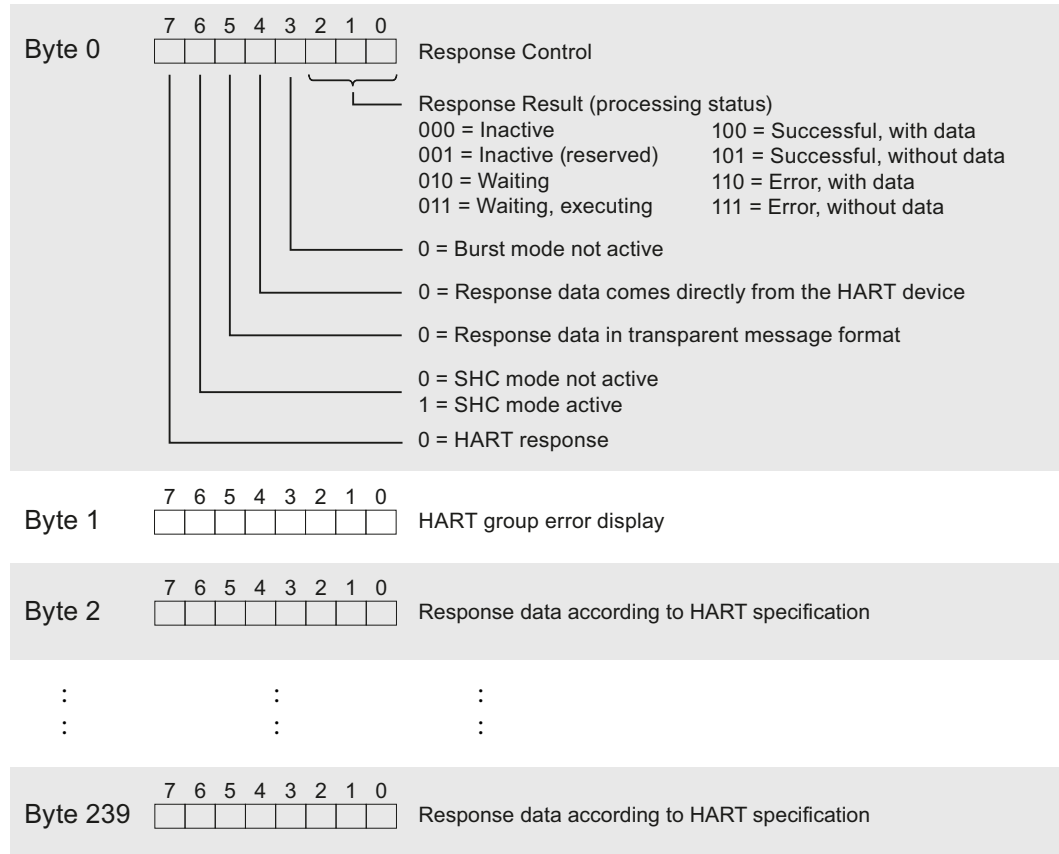


Figure C-4 Response data record in case of response error

Table C-1 "HART protocol error during response" coding

HART protocol error during response	Meaning	Explanation
0	Unspecified error	Always 0
1	HMD error	0: Not specified 1: Internal communication error 2: Parameter assignment error 3: HW fault 4: Wait time expired 5: HART timer expired 6...127: Reserved 128...255: Manufacturer-specific
2	Channel error	0: Not specified 1: Line fault 2: Short-circuit 3: Open line 4: Low current output 5: Parameter assignment error 6...127: Reserved 128...255: Manufacturer-specific

HART protocol error during response	Meaning	Explanation
3	Command error	0-127: HART protocol, Bit 7 = Always 0
4	Query error	Bit 0 = 0: Reserved Bit 1 = 1: Receive buffer overflow Bit 2 = 0: Reserved Bit 3 = 1: Checksum error Bit 4 = 1: Framing error Bit 5 = 1: Overflow error Bit 6 = 1: Parity error Bit 7 = 1: Reserved
5	Response error	Bit 0 = 1: GAP timeout Bit 1 = 1: Receive buffer overflow Bit 2 = 1: Timeout Bit 3 = 1: Checksum error Bit 4 = 1: Framing error Bit 5 = 1: Overflow error Bit 6 = 1: Parity error Bit 7 = 1: Reserved
6	Query rejected	0: Unspecified 1: Compact format not supported 2: SHC not supported 3: Impermissible command 4: No resources 5...127: Reserved 128...255: Manufacturer-specific
7	Profile query rejected	0: Not specified (not supported)
8	Manufacturer-specific query rejected	0: Not specified (not supported)

Example of HART programming (HART command interface)

For HART channel 0, the command 01 is to be sent in transparent message format to the HART field device with address "2A 2F 00 59 D3".

A positive edge at input 4.0 of a digital input module leads to the writing of the HART command.

The following assumptions are made:

- The identification number of the hardware component of the AQ 8xHART HF analog module is 266 (10A_H).
- The data record is stored in DB80: starting from address 0.0, length of 11 bytes.
- In this example, DB80 (request data record for channel 0) consists of 11 bytes.

Symbol	Address	Data type	Comment
T_DS80	I 4.0	Bool	Button of DS80
M_PF_WR	M 104.0	Bool	Positive edges auxiliary flag WRREC
M_WR_Done	M 51.0	Bool	Flag =1 : Data record was transferred
M_WR_Busy	M 51.1	Bool	Flag =1 : Writing has not yet finished

Symbol	Address	Data type	Comment
M_WR_Error	M 51.2	Bool	Flag =1 : An error occurred when writing.
MD_WR_Status	MD 93	DWord	WRREC block status or error information
DB80	DB80	DB80	The data record is stored in DB80:

SCL	Explanation
"R_TRIG_DB" (CLK:="T_DS80", Q=>"M_PF_WR");	
WHILE "M_PF_WR" DO	
"WRREC_DB" (REQ := TRUE,	
ID := 266,	Identification number of the hardware component
INDEX := 80,	Data record number 80
LEN := 11,	Data record length 11 bytes
DONE => "M_WR_Done",	Done= True: Data record was transferred
BUSY => "M_WR_Busy",	BUSY= True: Writing has not yet finished
ERROR => "M_WR_Error",	ERROR = True: An error occurred when writing.
STATUS => "MD_WR_Status",	Block status or error information
RECORD := P#DB80.DBX0.0 BYTE 11	Data record with length of 11 bytes (must correspond to the exact length that is to be transferred)
);	
IF ("M_WR_Done"	Exit loop immediately if data record was transferred or an error occurred.
OR "M_WR_Error") THEN	
EXIT;	
;	
END_IF;	
;	
END_WHILE;	

Table C-2 DB80: Transparent message format

Byte	Initial value (hex)	Comment (Hex)
0	00	Req_Control (00 = Transparent message format. 40 = Transparent message format with SHC sequence)
1	05	Number of preamble bytes (05-14)
2	82	Start character (02 = Short Frame with command 0) (82 = Long Frame with other commands)
3	2A	Address (with command 0, the address is exactly 1 byte long and has the value 0.)
4	2F	
5	00	
6	59	
7	D3	

Byte	Initial value (hex)	Comment (Hex)
8	01	Command (CMD)
9	00	Length in bytes
10	0D	Checksum (CHK) (calculated starting from byte 2 "Start character" up to the next to last byte)

A HART command can also be sent in compact message format. In this case, the data that is transferred via DB 80 is reduced to 4 bytes.

Table C-3 DB80: Compact message format

Byte	Initial value (hex)	Comment (Hex)
0	20	Req_Control (20 = Compact message format. 60 = Compact message format with SHC sequence)
1	05	Number of preamble bytes (05-14)
2	01	Command (CMD)
3	00	Length in bytes

You can learn when the response from the field device was received by cyclically reading data record DS81 for HART channel 0. The response is always supplied in transparent message format.

Symbol	Address	Data type	Comment
T_DS81	I 4.1	Bool	Button of DS81
M_PF_RD	M 104.1	Bool	Positive edges auxiliary flag RDREC
M_RD_Done	M 49.0	Bool	Flag = True : New data record was received and is valid
M_RD_Busy	M 49.1	Bool	Flag = True : Reading has not yet finished.
M_RD_Error	M 49.2	Bool	Flag = True : An error occurred when reading
MD_RD_Status	MD 100	DWord	RDREC block status or error information
MW_RD_Len	MW104	Word	The read length of the data record
DB81	DB81	DB81	The read data record is stored in DB81

SCL	Explanation
<pre> "R_TRIG_DB_1" (CLK:="T_DS81", Q=>"M_PF_RD"); WHILE "M_PF_RD" DO "RDREC_DB" (REQ:=TRUE, ID:=266, INDEX:=81, MLLEN:=255, VALID=>"M_RD_Done", BUSY=>"M_RD_Busy", ERROR=>"M_RD_Error", STATUS=>"MD_RD_Status", </pre>	Identification number of the hardware component Data record number 81 Maximum length in bytes of the data record information to be read New data record was received and is valid BUSY = True: Reading has not yet finished. ERROR = True: An error occurred when reading Block status or error information

```
        LEN=>"MW_RD_Len",           Read length of the data record
        RECORD:=P#DB81.DBX0.0 BYTE  Data record
255
        IF ("M_RD_Done"
OR "M_RD_Error") THEN             Exit loop immediately if data record was trans-
                                   ferred or an error occurred.
            EXIT;
        ;
        END_IF;
    ;
END_WHILE;
```

As long as "0x03" is in byte 0 of DB81, the response has not been received from the field device. Positive response data that you can evaluate is available from the field device as soon as bit 2 = 1 in byte 0.

If there are errors in the response data, see the "HART group fault display" tables in byte 1 or "HART protocol error during response" in byte 2 of the field device response.

Representation of analog values

D.1 Representation of analog values

Introduction

This appendix describes the analog values for all output ranges supported by the AQ 8xHART HF analog module.

Measured value resolution

Each analog value is written left aligned to the tags. The bits marked with "x" are set to "0".

Table D-1 Resolution of the analog values

Resolution in bits including sign	Values		Analog value	
	dec	hex	high byte	low byte
16	1	1 _H	Sign 0 0 0 0 0 0 0	0 0 0 0 0 0 1

D.2 Representation of output ranges

The following tables contain the digitalized representation of the output ranges. The resolution is 16 bits.

Table D-2 Unipolar output ranges

Value dec.	Output value in %	Data word																Range
		2 ¹⁵	2 ¹⁴	2 ¹³	2 ¹²	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰	
32511	117.589	0	1	1	1	1	1	1	1	x	x	x	x	x	x	x	x	Maximum output value*
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overshoot range
27649	100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Rated range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Minimum output value**

* When values > 32511 are specified, the output value is limited to 117.589%.

** When values < 0 are specified, the output value is limited to 0%.

D.3 Representation of analog values in the current output ranges

The tables below list the decimal and hexadecimal values (codes) of the possible current output ranges.

Table D-3 Current output range 0 to 20 mA

Values			Current output range	Range
	dec	hex	0 mA to 20 mA	
>117.589%	>32511	>7EFF	23.52 mA	Maximum output value
117.589%	32511	7EFF	23.52 mA	Overshoot range
	27649	6C01		
100%	27648	6C00	20 mA	Rated range
75%	20736	5100	15 mA	
0.003617%	1	1	723.4 nA	
0%	0	0	0 mA	
<0%	<0	<0	0 mA	Minimum output value

Table D-4 Current output range 4 to 20 mA

Values			Current output range	Range
	dec	hex	4 mA to 20 mA	
>117.589%	>32511	>7EFF	22.81 mA	Maximum output value
117.589%	32511	7EFF	22.81 mA	Overshoot range
	27649	6C01		
100%	27648	6C00	20 mA	Rated range
75%	20736	5100	16 mA	
0.003617%	1	1	4 mA + 578.7 nA	
0%	0	0	4 mA	
	-1	FFFF	4 mA - 578.7 nA	Undershoot range
-25%	-6912	E500	0 mA	
<-25%	<-6912	<E500	0 mA	Minimum output value