

MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

Selected official pages for procurement and maintenance review

PRODUCT BRAND

Siemens

PRODUCT MODEL

6ES7332-8TF01-0AB0

Eight-Channel HART Analog Output Module. Relevant section pages: 9, 10, 11, 13, 14, 19, 20, 21, 24, 63, 64, 65, 66, 67, 68, 69, 70. Adjacent model text on shared pages is outside this product reference.

OFFICIAL SOURCE

HART analog modules; 02/2011, A5E00434623-06

Siemens original documentation and product reference

Original Siemens 2011 publication, hosted by the ADEGIS document mirror, not a Siemens website. The manual and later data sheet describe the 350 mA supply-current condition differently; that value is omitted from authored specifications.

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Amikon Limited prepared this independent reference package. Selected manufacturer pages follow with their original content and pagination visible.

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DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

CAUTION

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

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The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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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.

Preface

Purpose of the Manual

This manual describes how to put the HART analog modules of the ET 200M distributed I/O device into operation.

Required basic knowledge

To understand the manual, you require general experience in the field of automation engineering.

The manual's area of application

This manual is valid for the specified components of the ET 200M distributed I/O device.

The manual describes the components based on the data valid at the time of its release. SIEMENS reserves the right of including a Product Information for each new component, and for each component of a later version.

Changes compared to the previous version

Amendments in the PROFINET environment

Approvals

The SIMATIC ET 200M product series has the following approvals:

- Underwriters Laboratories, Inc.: UL 508 registered (Industrial Control Equipment)
- Canadian Standards Association: CSA C22.2 Number 142, (Process Control Equipment)
- Factory Mutual Research: Approval Standard Class Number 3611.

You will find detailed information on these approvals and standards in the Manual Automation System SIMATIC S7-300 Module Data

(<http://support.automation.siemens.com/WW/view/en/8859629>), Chapter "Standards and approvals".

CE Label

The SIMATIC ET 200M product series fulfills the requirements and safety objectives of the following EC directives:

- EC Directive 73/23/EEC "Low-Voltage Directive"
- EC Directive 89/336/EEC "EMC Directive"

System connection

1.1 Overview of the HART analog modules

Overview

The following SIMATIC S7 HART analog modules are described in this chapter:

- SM 331; AI 8 x 0/4...20mA HART (HART analog input module),
order number: 6ES7331-7TF01-0AB0
- SM 332; AO 8 x 0/4...20mA HART (HART analog output module),
order number: 6ES7332-8TF01-0AB0

This manual provides you with the knowledge you required to use the modules as a HART interface:

- An introduction to HART to make it easier to get started with this technology
- A guide to commissioning and operation using an example configuration
- HART-specific parameter assignment and diagnostics
- Technical specifications for the HART analog modules

1.2 ET 200M with HART analog modules

Basic properties

You can operate the HART analog modules as part of the distributed I/O ET 200M with the interface modules:

- as of IM153-2BA00 or as of IM153-2BB00 as link to PROFIBUS DP.
- as of IM153-4BA00 as link to PROFINET IO.

In this application the ET 200M is the HART master for HART devices (intelligent field devices). The IM153-2 directs the commands (for example, parameter assignment) that come from the HART client (for example, PDM or programmed via the data record interface of the HART analog modules) through the HART analog module to the intelligent field devices. The reply comes back the same way. In the figure below, the gray line represents the communication path in an application with PROFIBUS DP.

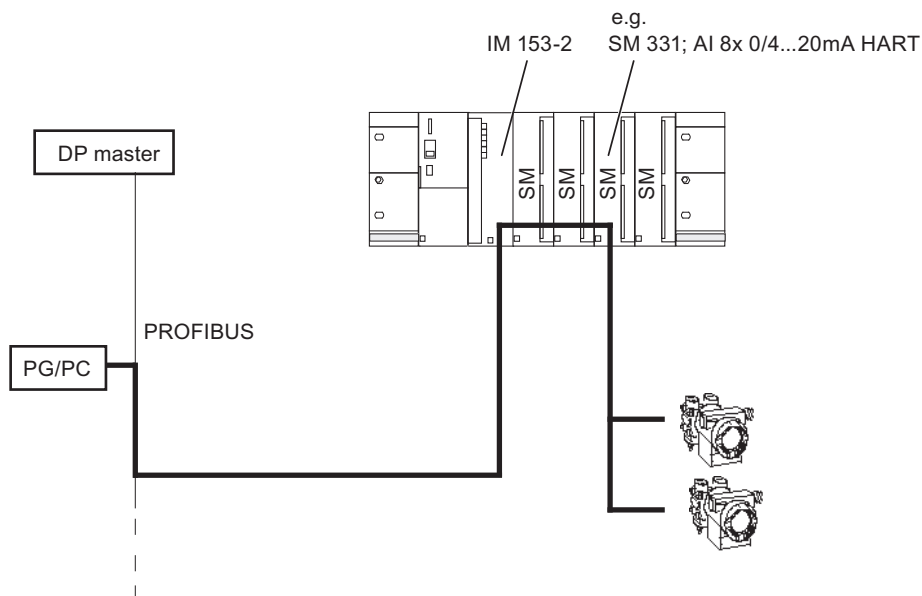


Figure 1-1 Forwarding parameter assignment data with an IM153-2 and HART analog modules

Use with PROFIBUS DP

If you operate the HART analog modules with the PROFIBUS DP interface modules, you can configure the field devices with PDM as of V6.0 + SP3. See section Configuring (Page 36).

All examples listed in this manual refer to the use of modules with PROFIBUS DP interface modules.

Use with PROFINET IO

The use of HART analog modules with PROFINET IO is possible:

- as of STEP 7 V5.4, SP2 and HSP 119 as of V2.2.
- with the latest GSDML file of IM153-4BA00 as of V2.25.

In the event of integration using the GSDML file, HART analog modules are available with 0, 4 or 8 HART auxiliary variables each and will be permanently assigned to the respective address space.

However, you cannot configure HART field devices using PROFINET IO. You cannot use PDM to assign the field device parameters or for a user calibration of the HART analog modules.

See also

For general information on the SIMATIC S7 modules, see the device manual Automation System SIMATIC S7-300 Module Data on the Internet (<http://support.automation.siemens.com/WW/view/en/8859629>). The general information on analog modules provided there is not repeated in this manual.

You can find more information on ET 200M in the SIMATIC manual Distributed I/O Device ET 200M on the Internet. (<http://support.automation.siemens.com/WW/view/en/1142798>)

Product Overview

2.1 Fundamental information on the use of HART analog modules

Overview

The following figure shows where you can use the HART analog modules in the system:

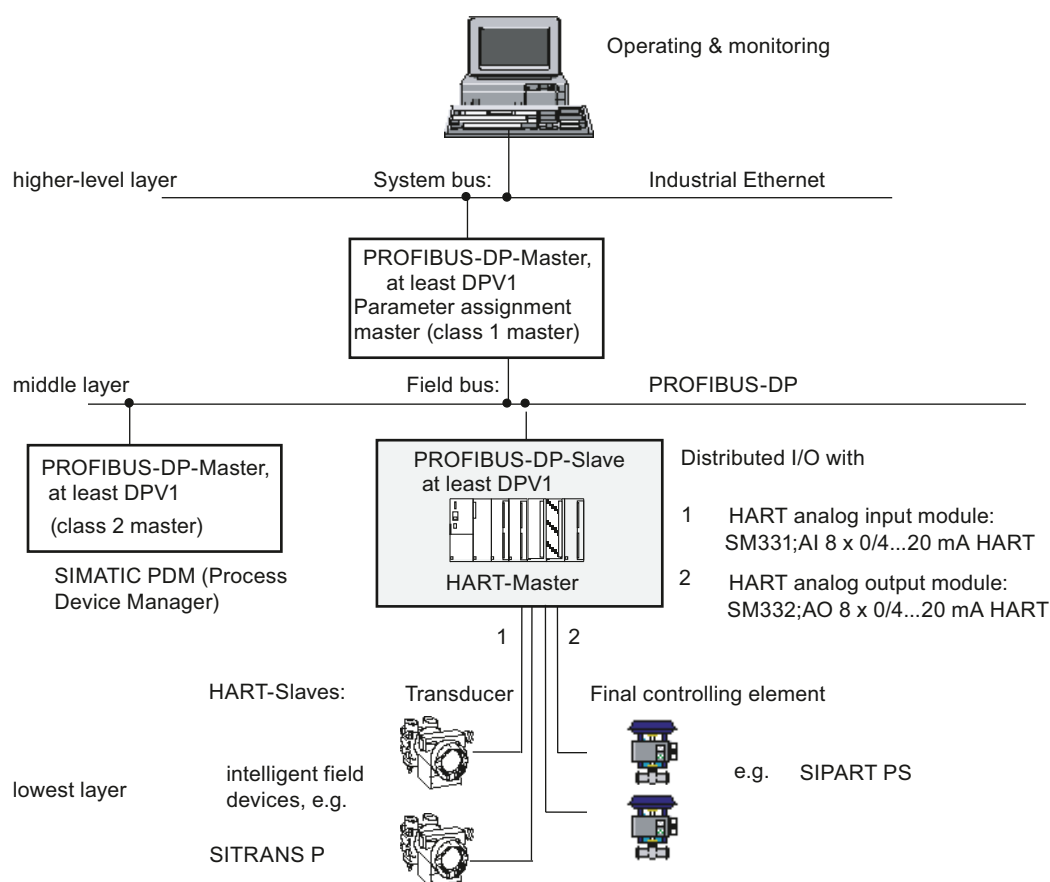


Figure 2-1 Location of HART analog modules in the distributed system

Use in the system

The HART analog modules are used in the distributed I/O connected to the PROFIBUS-DP (see the figure above).

You can connect a field device to each channel of a HART analog module: The module works as the HART master, monodrop; the field devices work as HART devices.

Different SW applications can send or receive data via a HART analog module. They can be compared to clients for which the HART analog module is the server.

2.2 Firmware update via HW Config

Introduction

Based on compatible feature enhancements, you can upgrade the HART modules to the latest firmware version.

The most recent firmware versions are available from your Siemens representative or from the Internet (<http://www.siemens.com/automation/service&support>).

The firmware cannot be updated if the module is in a redundant state.

Requirements

- STEP 7 V 5.4, Service Pack 3 or higher
- The 24 VDC power supply must be connected for the firmware update of the HART analog output module.
- The HART analog module is not being used redundantly during the firmware update.

Updating firmware

1. Select the HART module in HW Config.
2. Select the PLC > Update Firmware menu command.
3. Use the "Browse" button to select the path to the firmware files (*.upd).
4. Click the "Run" button.
 - The module performs the firmware update.

You can find additional information in the STEP 7 Online Help.

NOTICE
It is not permitted to download a firmware version lower than V 3.0.0 to a module with a version $\geq$ V 3.0.0. This will cause the module to malfunction. The module is then considered faulty and must be sent to the manufacturer for repair.

Note

- During the firmware update, OB 83 (Insert/remove module interrupt) and OB 85 (program execution error) are called. If the diagnostic interrupt of the module is enabled, OB 82 is also called during the firmware update. Make sure that the OBs are programmed accordingly.
 - If the SF LED on the module is flashing, the firmware update experienced an error and must be repeated. In this case, the bootloader version Ex.x.x is displayed in the online diagnostics.
-

See also

Internet S7-300 Module Data (<http://support.automation.siemens.com/WW/view/en/7215812>)

2.3.2 Connection of loads or actuators to analog outputs**Introduction**

With the analog output modules you can supply loads and actuators with current.

Lines for analog signals

In the following figure the required connecting lines for the potential connection of the analog output module are not shown.

Please note the generally applicable information on connecting loads/actuators in the manual Automation System SIMATIC S7-300 Module Data on the Internet (<http://support.automation.siemens.com/WW/view/en/8859629>).

Abbreviations used in the following figure

The following abbreviations are used in the figure below:

CHx +	Positive analog terminal (output current)
CHx -	Negative analog terminal (reference potential)
M _{ANA}	Reference potential of the analog circuit
R L	Load impedance
L+	Power supply 24 V DC
M	Grounding terminal
M _{external}	Reference potential of the load circuit
M _{internal}	Reference potential of the control circuit (ground terminal of the IM 153) and the backplane bus
U _{ISO}	Potential difference between M _{ANA} and the ground terminal of the IM 153
Mx+/-	Measuring line (positive / negative)

Connecting Loads to Current Outputs

You must connect loads to CHx + and the reference point of the analog circuit CHx - of a current output.

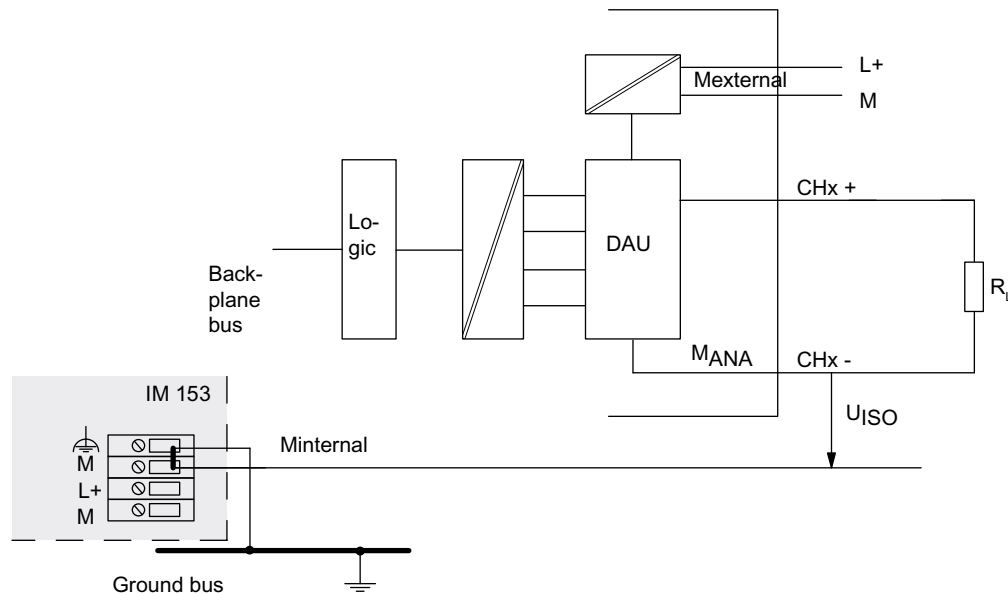


Figure 2-6 Connection of loads to a current output of a HART-AO

2.4 Connecting sensors/actuators in redundant mode

Introduction

Redundant mode is only possible in distributed use. In redundant mode, duplicate HART modules are available and are configured and operated redundantly.

Redundant mode is possible for the HART analog input and output modules. The HART modules have the "Primary Master" and "Secondary Master" parameters for this purpose. This parameter assignment is used to enable simultaneous HART communication to a field device by means of both modules. The module with the lower address is always the "Primary Master".

HART-Fast-Mode is not possible in redundant mode.

Additional information

You can find additional information on the subject of redundancy in the Automation System S7-400H Fault-Tolerant Systems manual on the Internet

(<http://support.automation.siemens.com/WW/view/en/1186523>)

Notes on modules in redundant use

- In redundant mode, additional HART masters, such as handheld, cannot be connected.
- HART-Fast-Mode is not possible in redundant mode.
- User calibration is not possible in redundant mode.
- In redundant mode, the substitute value behavior of the current outputs is set automatically to "zero current and zero voltage" (OCV). However, if the CPU is in STOP mode, a current of around 115 μ A is still output for each channel.
- When HART analog modules are operated in redundant mode, a 2-wire transducer must be connected as a 4-wire transducer and configured as a 4-wire transducer in the HW Config (see Figure Connection of 2-wire transducer). Terminals 10 and 11 on the front panel connector must not be connected. Note the manufacturer-specific features when configuring the field devices.
- In redundant mode, the voltage drop on both modules must be observed. To ensure a sufficient voltage supply for the transducer, the voltage drop on both modules and the voltage drop on the wiring and on the transducer must be observed (series connection). With a sensor current of 22 mA, a voltage drop of approximately 3.3 V occurs on each module. If you are using the circuit with Zener diodes shown below and you replace the modules, note that the voltage drop on the removed module is the Zener voltage (5.1 V) and the voltage drop on the inserted module is 3.3 V.
- Hardware interrupts are not supported by the blocks in the "RedLib" library. If you would like to use hardware interrupts, you must implement the evaluation at the user level. You can find additional information in the STEP 7 Online Help.

Connection of an actuator to the HART analog output module SM 332

The discrepancy analysis parameter must be available for the HART analog output module.

The following figure shows the connection of an actuator in redundant mode.

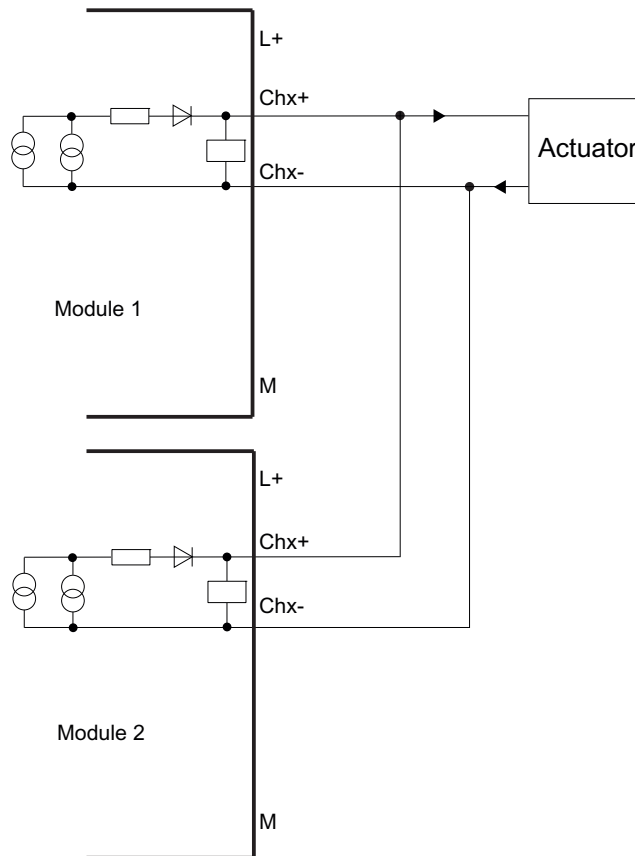


Figure 2-9 Connection of an actuator to the SM 332

Analog output signals

HART analog output modules with current outputs (4 to 20 mA) can be operated redundantly. The value to be output is divided by 2 in the user program or in the "RedLib" redundancy blocks, and each of the two modules outputs its half of the value. If one of the modules fails, the failure is detected and the remaining module outputs the full value.

Note

With this procedure, the output value drops briefly to half, and after the reaction in the program the output value is raised to the correct value.

6.2 HART analog output module SM 332; AO 8 x 0/4...20mA HART (6ES7332-8TF01-0AB0)

Order number

6ES7332-8TF01-0AB0

Properties

- 8 outputs (current)
- Resolution:
 - 15 bits (0..20mA)
 - 15 bits (+ sign) (4..20mA)
- Output type selectable per channel:
 - Current output with HART
 - Current without HART
 - Channel deactivated
- Selection of any output range per channel
 - 0...20 mA (with HART)
 - 4...20 mA (with HART)
- Channel-by-channel parameter assignment through parameter data record 1 or 128 or HART data records 131-138
- Diagnostics (per channel) and diagnostic interrupt (across whole module) configurable
 - Group diagnostics
 - Diagnostic interrupt
- Electrical isolation
 - Channels electrically isolated from IM153 and load voltage L+
- Readback capability of the analog outputs
- The module parameters can be reassigned dynamically channel by channel in RUN mode (CiR-capable)
- Configuring HART variables
- Redundant mode
- Discrepancy analysis for use in the S7-400 H automation system
- Firmware update possible
- Support of:
 - HART fast mode*
 - User calibration*

* The module must be configured as V3.x.

Analog values and resolution

For the representation of the analog values for analog output channels generally and in the current output ranges 0 to 20 mA and 4 to 20 mA in particular, see the corresponding tables in the Automation System SIMATIC S7-300 Module Data

(<http://support.automation.siemens.com/WW/view/en/8859629>) manual.

The resolution of the output value in the case of the HART analog output module is 15 bits (+ sign).

Table 6- 3 Output ranges of the analog output module SM 332; AO 8 x 0/4...20mA HART

Output type	Output range
Current	0 to 20 mA 4 to 20 mA

Default settings

The output type HART is the default setting. There are also default settings for substitute value, diagnostics, interrupts. The HART analog output module uses these settings when no parameter modification is carried out in STEP 7.

Wire break check

Wire break detection is possible for the current output ranges 0/4 to 20 mA; if enabled, a diagnostic interrupt is triggered.

Condition: A minimum output current of $\geq 250 \mu\text{A}$ must be set.

If the output current drops under $250 \mu\text{A}$ when the "Wire break" diagnostic message is pending, the diagnostic message cannot be canceled until the output current is set above $250 \mu\text{A}$ again and the error has been eliminated.

Short-circuit test

Short-circuit detection is possible for the current output ranges 0/4 to 20 mA.

Condition: A minimum output current of 4 mA must be set. Short-circuit detection applies when a load of $< 30 \Omega$ is connected.

Discrepancy analysis

In the discrepancy analysis, the current output by the channel is read back and compared to the current to be output. If the values differ (deviation $> 5\%$), the module behavior is faulty. The module signals "Readback error".

Requirement:

- The module is used redundantly (in IM 153-2BA02). You can specify the two modules that are to be operated redundantly in the "Redundancy" tab.
- Group diagnostics is enabled

Special features for fail-safe behavior

If the HART analog output module is connected to a CPU 4xx as a distributed module, the fail-safe behavior depends on the following configuration:

- Module is configured as 6ES7332-8TF01-0AB0: The outputs are **not** reset during the mode transition from STOP to RUN.
- Module is configured as 6ES7332-8TF00-0AB0 and the outputs are not in the process image: The outputs are reset during the mode transition from STOP to RUN.

Removal and insertion

The HART analog modules support the function "Replace modules during operation". However, the evaluation of the removal and insertion interrupts is only possible on an S7/M7-400 CPU master and an active backplane bus in the ET 200M.

Operation with standard master

In distributed operation with a standard master the following restrictions must be taken into account:

- Parameter assignment with COM PROFIBUS (GSD or type file required)
- Restricted evaluation in the case of removal and insertion

Effect of a falling load voltage on the diagnostic message

When the 24 V load voltage falls under the permissible rated range (< 20.4 V), if loads $> 650 \Omega$ are connected and there are output currents > 20 mA, the output current may be reduced before a diagnostic message is issued.

Readback capability

The analog outputs can be read back in the user data range with a resolution of 8 bits (+ sign). Please note that the read back analog output does not become available until after a conversion time in accordance with the accuracy.

Note

Please note the following on readback capability:

- The range of the readback values does not correspond to the STEP 7 system limits; instead, it indicates the readback value linearly depending on the current output range (see the following table).
- In the case of deactivated or incorrectly assigned channels, the readback value of the channel is written to the value "7FFF Hex".
- In the case of a module that is not configured, the absence of a 24 V load voltage or a module fault, all the readback values are written to the value "7FFF Hex".

Table 6- 4 Readback value representation of the HART analog output module

Readback value		Current output range	
Decimal	Hexadecimal	0 to 20 mA	4 to 20 mA
32348	7E80	23.41 - 23.52 mA	22.72 - 22.81 mA
27648	6C00	20.00 mA	20.00 mA
0	0	0 mA	4 mA
- 6912	E500	-	0 mA

Note

Sufficient accuracy of the readback values is ensured only for measured values > 16#0800.

Terminal diagram

The figure below is the terminal diagram of the analog output module SM 332; AO 8 x 0/4...20mA HART. You will find detailed technical specifications of the analog output module on the following pages.

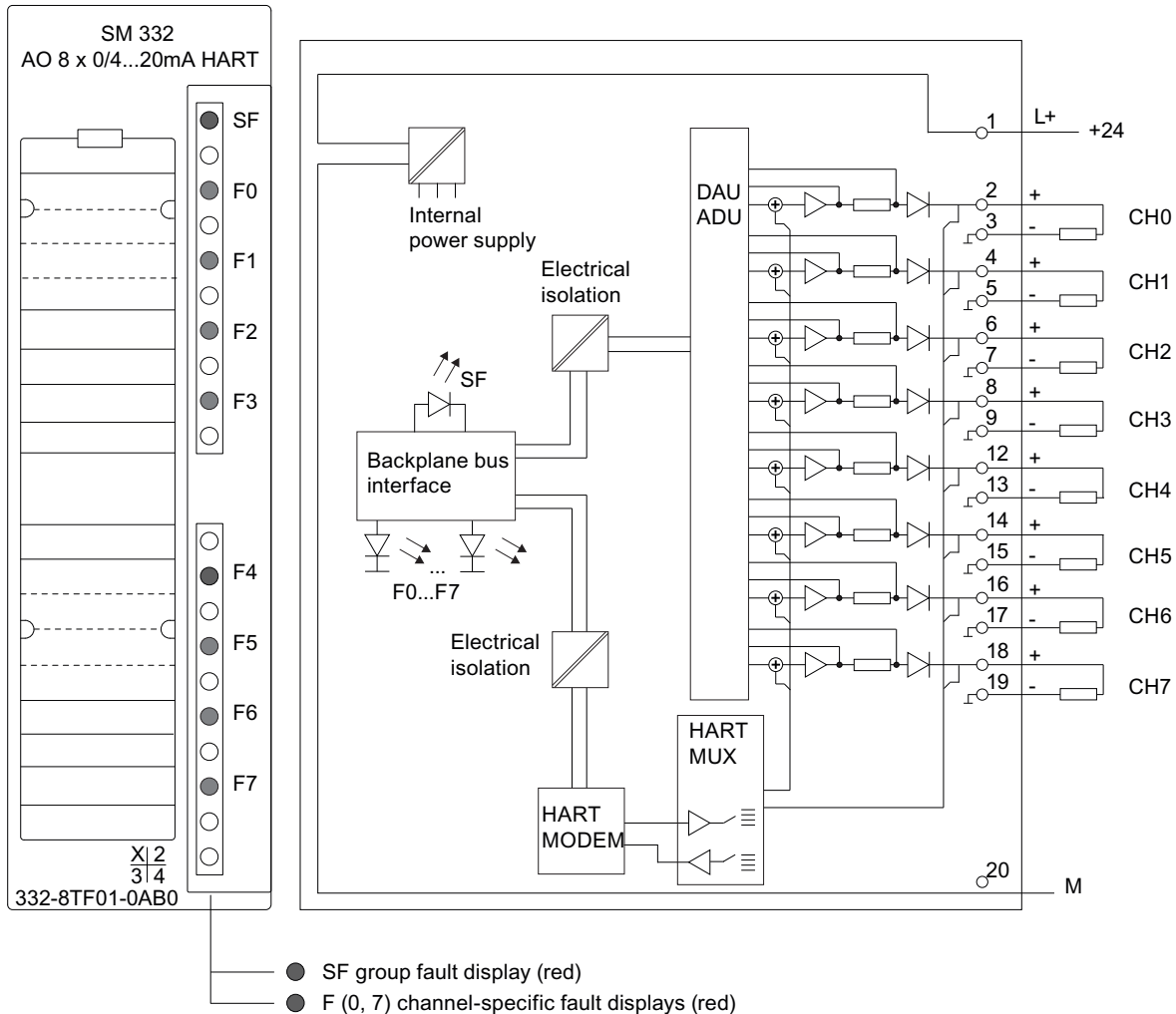


Figure 6-2 Module view and schematic circuit diagram of the SM 332; AO 8 x 0/4...20mA HART

Non-wired output channels

To ensure that non-wired output channels of the analog output module SM 332; AO 8 x 0/4...20mA HART are deenergized, you have to deactivate them. You deactivate an output channel using STEP 7 by means of the "Output" parameter block. Wiring with resistors is not necessary.

Technical specifications of the SM 332; AO 8 x 0/4...20 mA HART data

Table 6- 5 Technical specifications of the SM 332; AO 8 x 0/4...20 mA HART

Technical	
Dimensions and weight	
Dimensions W x H x D (mm)	40 x 125 x 117
Weight	Approx. 220 g
Module-specific data	
Number of outputs	8
Shielded cable length	Max. 800 m
MTBF	33 years
Temperature range	
- Horizontal installation - Number of outputs that can be used simultaneously (derating)	0 °C to 60 °C to 40 °C: 8 to 60 °C: 4
- Vertical installation - Number of outputs that can be used simultaneously	0 °C to 40 °C 8
Voltages, currents, potentials	
- Rated load voltage - Polarity reversal protection	24 VDC Yes
Electrical isolation	
Between the channels and backplane bus	Yes
Between the channels	No
Between the channels and load voltage L+	Yes
Between the backplane bus and load voltage L+	Yes
Permissible potential difference	
Between M _{ANA} and M _{internal} (U _{ISO})	75 VDC 60 VAC
Between M _{ANA} and M _{external}	75 VDC 60 VAC
Between M _{internal} and M _{external}	75 VDC 60 VAC
Insulation tested with	500 VDC
Current consumption	
From backplane bus	Max. 110 mA
From load voltage L + (given rated load)	Max. 350 mA
Power loss of the module	Typically 6.0 W

6.2 HART analog output module SM 332; AO 8 x 0/4...20mA HART (6ES7332-8TF01-0AB0)

Technical	
Analog value generation	
Output value	
• Resolution (including the overshoot range)	15 bits (0...20 mA) 15 bits (+ sign) (4...20 mA)
• Cycle time (all channels)	AO mode: 10 ms HART mode: 50 ms
• Settling time	AO mode at different loads: • Resistive load: 0.1 ms • Inductive load (10 mH): 0.5 ms HART mode: 40...50 ms
• Input of substitution values	Yes, configurable
Interference suppression, error limits	
Crosstalk attenuation between the outputs	> 70 dB
Operational limit (temperature range, relative to the output range)	± 0,2 %
Intrinsic error limit (operating error limit at 25°C relative to the output range)	± 0,1 %
Temperature error, relative to the output range	± 0.002%/K
Linearity error, relative to the output range	± 0,01 %
Repeatability in transient state at 25 °C, relative to the output range	± 0,05 %
Output ripple at 0 Hz to 50 kHz, relative to the output range	± 0,02 %
Status, interrupts, diagnostics	
Interrupts	
• Diagnostic interrupt	Configurable
Diagnostic functions	
• Group error display	Red "SF" LED
• Channel error display	Red LED (F) per channel
• Diagnostic information readable	Possible
Monitoring functions	
Readback value	
• Resolution (including the overshoot range)	8 bits (0...20 mA) 8 bits (+ sign) (4...20 mA)
• Cycle time (all channels)	AO mode: 10 ms HART mode: 50 ms
• Operating error limit	± 1 %
• Intrinsic error limit	± 0,8 %
• Wire break as of output value	Yes > 250 µA
• Short circuit	< 30 Ω as of 4 mA

Technical	
HART communication*	
• Monodrop/multidrop operation	Monodrop only
• Primary/secondary master	Primary master only **
Actuator selection data	
Output ranges (rated values)	
Current	0 to 20 mA 4 to 20 mA
Load impedance (in the nominal range of the output)	
• At current outputs Resistive load Inductive load	Max. 750 Ω Max. 10 mH
Current output	
• No-load voltage	Max. 24 V
Destruction limit against voltages applied from outside	
Voltages	Max. + 60 V / - 0.5 V
Connection of actuators	
• For current output 2-wire connection	Yes
* HART communication requires an output current of at least 1.17 mA.	
** In redundant mode, the module with the higher address is the secondary master.	

See also

Overview of the parameters of the HART analog modules (Page 45)