MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

Selected official pages for procurement and maintenance review

PRODUCT BRAND

Siemens

PRODUCT MODEL

6ES7336-4GE00-0AB0

Fail-Safe HART Input Module. Relevant section pages: 3, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 258, 259, 260, 261, 287, 288, 289, 290, 291, 292, 302, 307, 308, 309, 310, 311. Adjacent model text on shared pages is outside this product reference.

OFFICIAL SOURCE

Fail-safe signal modules; 07/2013, A5E00085586-11

Siemens original documentation and product reference

Original source PDF page 292 labels Table 9-26 as SM 331; the section and exact order identify SM 336. This original caption is reproduced unchanged.

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

SIEMENS

SIMATIC

Automation System S7-300 ET 200M Distributed I/O Device Fail-safe signal modules

Installation and Operating Manual

Translation of original operating instructions

Preface

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07/2013

A5E00085586-11

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ 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

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, 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.

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Preface

[ID: 431798411]

Purpose of this manual

This reference manual provides a pool of information about the control functions, the functionality and technical specifications of the fail-safe signal modules of a S7-300 system.

Basic knowledge required

Working with this manual requires general knowledge of automation engineering. It is also assumed that you have sufficient knowledge of the *STEP 7* Basic Software, of the S7-300 automation system, and of the ET 200M distributed I/O device.

Scope of this manual

Module	Order number	as of product version
Safety protector	6ES7195-7KF00-0XA0	03
Bus module for safety protector	6ES7195-7HG00-0XA0	01
SM 326; DI 24 x DC 24 V	6ES7326-1BK02-0AB0	01
SM 326; DI 8 x NAMUR	6ES7326-1RF00-0AB0	05
SM 326; DO 8 x DC 24V/2A PM	6ES7326-2BF41-0AB0	01
SM 326; DO 10 x DC 24V/2A	6ES7326-2BF01-0AB0	01
SM 326; F-DO 10 x DC 24V/2A PP	6ES7326-2BF10-0AB0	01
SM 336; AI 6 x 13Bit	6ES7336-1HE00-0AB0	04
SM 336; F-AI 6 x 0/4 ... 20 mA HART	6ES7336-4GE00-0AB0	01

What's new compared to the previous version

This manual was updated and supplemented with the description of:

- Support of PROFINET IO
- the new functions of the SM 326; F-DO 10 x DC 24V/2A PP
- the new functions of the SM 326; DI 24 x DC 24 V
- the new functions of the SM 326; DO 8 x DC 24 V/2A PM
- SIL3/Cat.4/PLe can be achieved without safety protector (see section "Safety protector (Page 321)")

9.3.2 Properties, front view, wiring diagram and block diagram [ID: 6648476043]

Order number

6ES7336-4GE00-0AB0

Properties

SM 336; F-AI 6 x 0/4 ... 20 mA HART has the following properties:

- 6 analog inputs with electrical isolation between channels and the backplane bus
- Input ranges:

  0 to 20 mA

  4 to 20 mA
- Short circuit-proof power supply of 2- or 4-wire transducers by the module
- External sensor supply possible
- Group fault display (SF)
- Safety mode display (SAFE)
- Display for channel-specific fault (Fn)
- Display for HART status (Hn)

  (If you have activated HART communication for a channel and HART communication is running, the green HART status display lights up.)
- Programmable diagnostics functions
- Programmable diagnostic interrupt
- Supports operation in safety mode
- SIL3/Cat.4/PLe can be achieved without safety protector
- HART communication
- Firmware update via *HW Config*
- I&M identification data
- Can be used with PROFINET IO

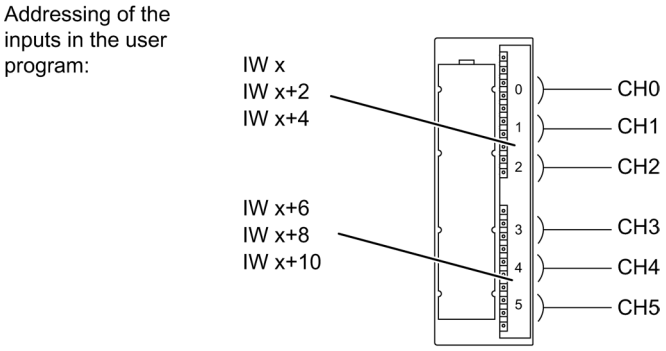
Use of inputs

You can use the inputs as follows:

- Each of the 6 channels for current measurement
  - 0 to 20 mA (without HART utilization)
  - 4 to 20 mA (with/without HART utilization)
- Functional range of HART communication: 1.17 to typ. 35 mA

Address assignment

The following figure shows the assignment of channels to addresses.



x = Module start address

Figure 9-17 Address assignment for SM 336; F-AI 6 x 0/4 ... 20 mA HART

Front view

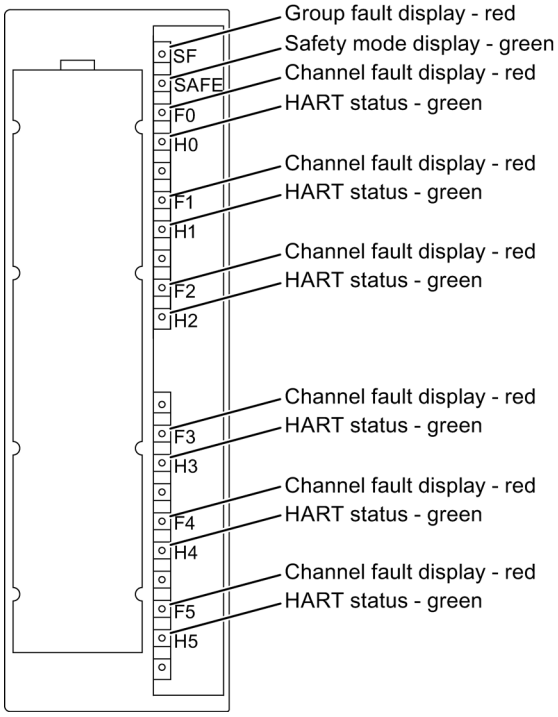


Figure 9-18 Front view SM336; F-AI 6 x 0/4 ... 20 mA HART

Wiring and block diagram

The following figure shows the the wiring and block diagram of SM 336; F-AI 6 x 0/4 ... 20 mA HART. The wiring and block diagrams of analog sensors for the different applications are shown in the next sections.

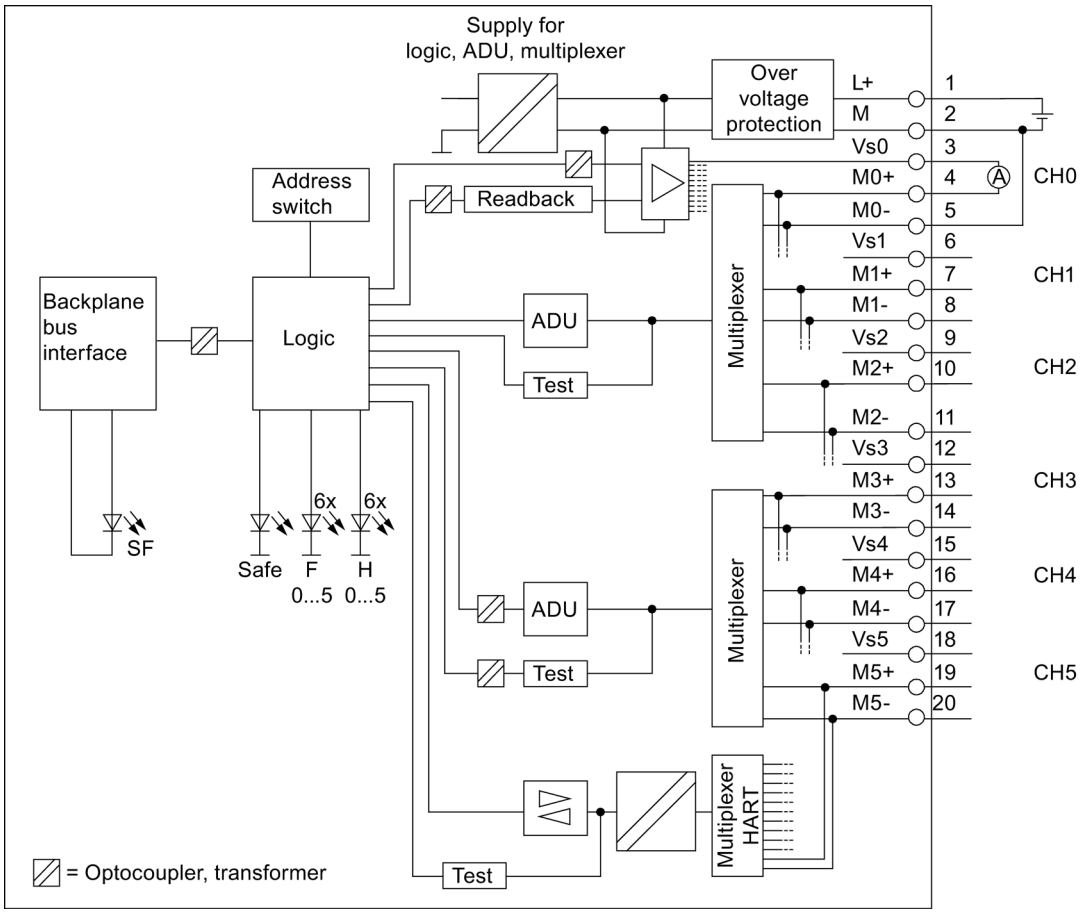


Figure 9-19 Wiring and block diagram of SM 336; F-AI 6 x 0/4 ... 20 mA HART

Channel numbers

The channel numbers are used to uniquely identify the inputs and to assign channel-specific diagnostic messages.

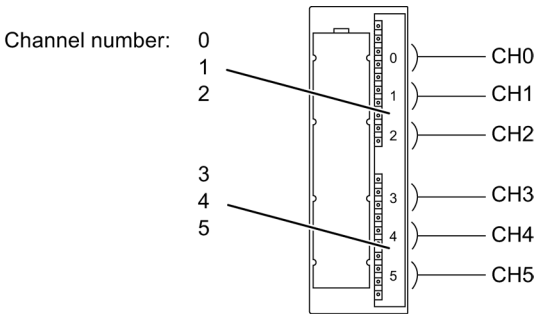


Figure 9-20 Channel numbers SM 336; F-AI 6 x 0/4 ... 20 mA HART

Sensor supply

WARNING

Voltage dips of the power supply are not buffered by the module and, thus, affect the sensor supply.

This can cause the measured value to be false.

You can avoid voltage dips by using a voltage supply according to the NAMUR recommendation (see section "Safe Functional Extra-Low Voltage for Fail-Safe Signal Modules (Page 46)"). Alternatively, use a transducer with an appropriate battery backup or diagnostics.

Recommendation: Internal sensor supply

You are strongly advised to use the short circuit-proof internal sensor supply of the module. This internal sensor supply is monitored and its status is indicated by the Fn LED (see Figure *Front view of SM 336; F-AI 6 x 0/4 ... 20 mA HART*).

Note

The internal sensor supply of the associated channel is switched off in case of an overload of the analog input or short circuit to ground or during power-up in the event of short circuit to L+ to protect the input.

A check is made approximately 1 minute later to determine if the error has gone.

External sensor supply

The figures in section "Auto-Hotspot" show how you can supply power to the sensors via an external sensor supply (for example, from another module).

⚠ WARNING

If there is a short circuit from L+ to Mn+, the input resistors will be destroyed.

You can avoid this problem through proper wiring and use of the internal sensor supply. When an external sensor supply is used, other suitable measures are necessary to protect the input resistors (e.g. fuse on the module).

⚠ WARNING

The **stability** of the external sensor supply must conform to the desired safety requirement class SIL 2, 3. To ensure that the sensor functions problem-free, we recommend one of the following options:

- Use of a **redundant** external sensor supply

  or
- **Monitoring** of the external sensor supply for undervoltage/overvoltage, including shutdown of the sensor supply when a fault is detected (single-channel for SIL 2; dual-channel for SIL 3)

Isolated transducers

The isolated transducers are not bonded to local earth potential. These transducers can be operated with floating potential. Local conditions or interference may cause potential differences U_{CM} (static or dynamic) between the measuring lines M- of the input channels and the reference point of measuring circuit M.

Note

It is advisable to wire M- to M in order to prevent common mode voltages in excess of the permitted value for U_{CM} when operating the equipment in areas subject to heavy EMC interference.

Non-isolated transducers

The non-isolated transducers are bonded to local earth potential. Always interconnect M with earth potential. Local conditions or interference may cause potential differences U_{CM} (static or dynamic) between the locally distributed measuring points.

If common mode voltage exceeds the permitted value for U_{CM}, you must provide for equipotential bonding conductors between the measuring points.

See also

Applications of SM 336; F-AI 6 x 0/4 ... 20 mA HART (Page 247)

9.3.3 Applications of SM 336; F-AI 6 x 0/4 ... 20 mA HART [ID: 56063021707]

Selecting the application

The figure below helps you to select an application based on availability and fail-safe operation requirements. The next pages provide information on the module wiring and parameter settings in *STEP 7*.

Applications 1 and 2 are omitted because the module supports only safety mode.

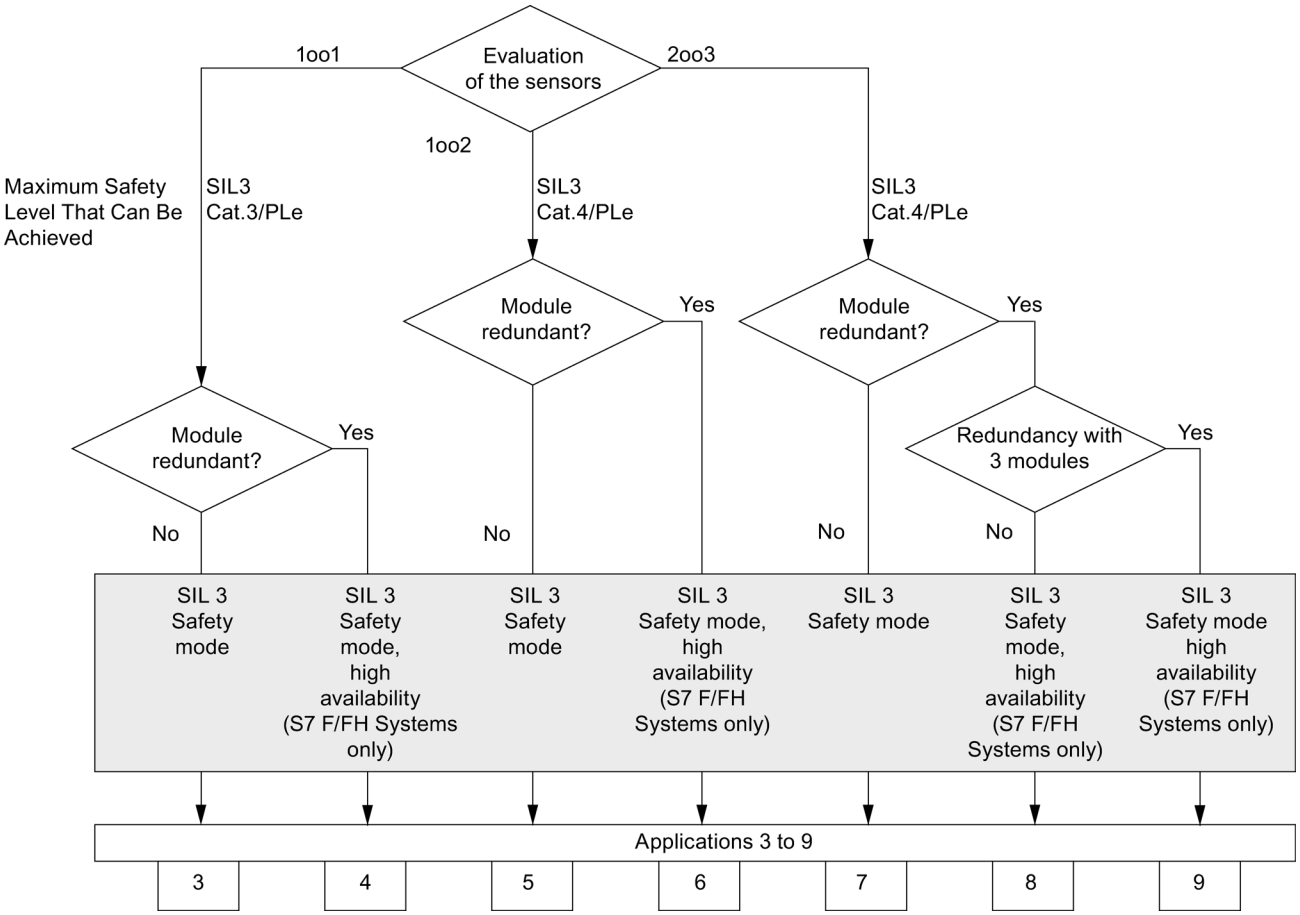


Figure 9-21 Applications

⚠ WARNING

The maximum Safety Integrity Level is determined by the sensor quality and the length of the proof-test interval according to the IEC 61508:2000 standard. If the sensor quality does not meet Safety Integrity Level requirements, always wire redundant sensors and connect them via two channels.

⚠ WARNING

If there is a short circuit from L+ to Mn+, the input resistors will be destroyed.

You can avoid this problem through proper wiring and use of the internal sensor supply. When an external sensor supply is used, other suitable measures are necessary to protect the input resistors (e.g. fuse on the module).

Wiring schemes

Four wiring schemes (A to D or E to H) are available for each application, depending on the type of measurement.

Table 9- 16 Wiring scheme of SM 336; F-AI 6 x 0/4 ... 20 mA HART

Wiring scheme	Measurement type	Channels
A	2-wire transducer, internal sensor supply	0 to 5
B	2-wire transducer, external sensor supply	0 to 5
C	4-wire transducer, internal sensor supply	0 to 5
D	4-wire transducer, external sensor supply	0 to 5
E	2-wire transducer, internal sensor supply with module redundancy	0 to 5, redundancy with 2 modules
F	2-wire transducer, external sensor supply with module redundancy	0 to 5, redundancy with 2 modules
G	4-wire transducer, internal sensor supply with module redundancy	0 to 5, redundancy with 2 modules
H	4-wire transducer, external sensor supply with module redundancy	0 to 5, redundancy with 2 modules

Wiring scheme A: 2-wire transducer, internal sensor supply

Particularity:

- Short circuit between sensor supply voltage Vsn and Mn+ is handled.
- It is possible to detect an undervoltage at the transducer by reading back the sensor supply in the module.

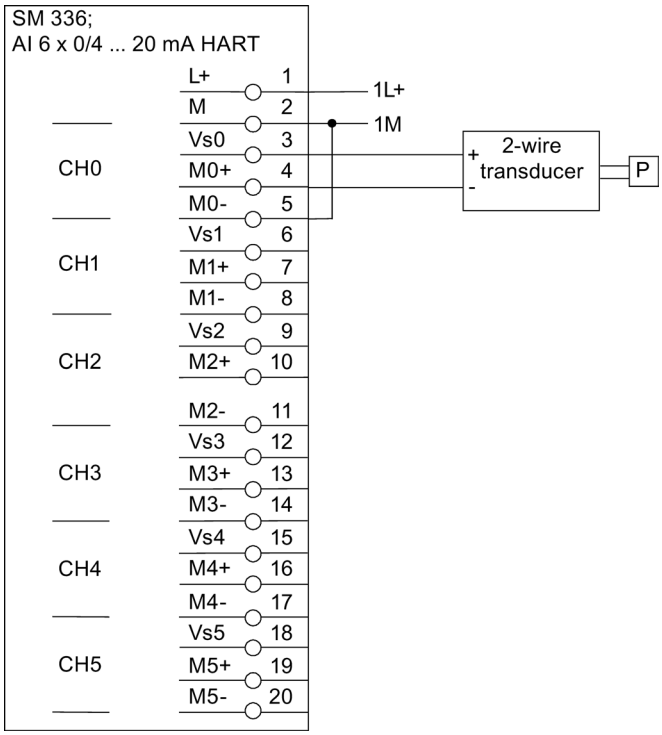


Figure 9-22 2-wire transducer, internal sensor supply

Wiring scheme B: 2-wire transducer, external sensor supply

Particularity:

⚠ WARNING

An undervoltage at the transducer cannot be detected, which means a transducer with undervoltage detection may be required.

Note

1L+ and 2L+ can be fed from one power supply. The maximum permissible common mode voltage U_{CM} must be observed.

⚠ WARNING

Depending on the internal structure of the sensor, a short circuit from 2L+ to Mn+ (sensor with measuring circuit referring to 2M) or from Mn- to 2M (sensor with measuring circuit referring to 2L+) can destroy the input resistors (see documentation for the utilized sensor).

For this reason, a suitable measure must be taken to protect the input resistors (e.g. fuse on the module).

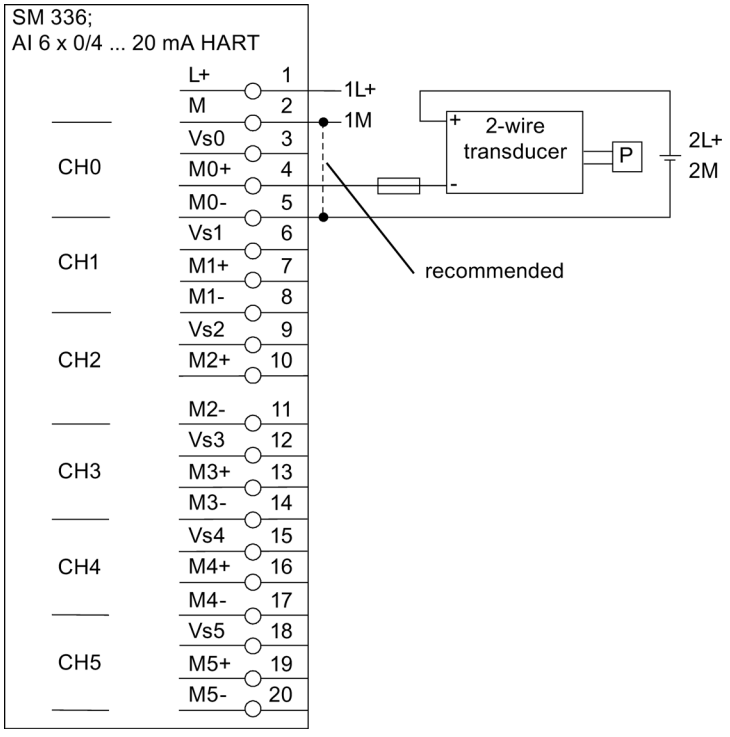


Figure 9-23 2-wire transducer, external sensor supply

Wiring scheme C: 4-wire transducer, internal sensor supply

Particularity:

- Short circuit between sensor supply voltage Vsn and Mn+ is handled.
- It is possible to detect an undervoltage at the transducer by reading back the sensor supply in the module.

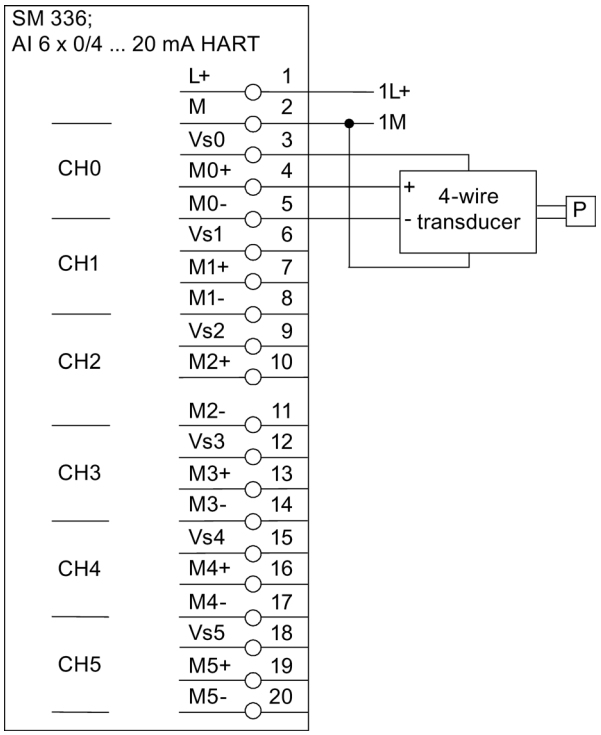


Figure 9-24 4-wire transducer, internal sensor supply

Wiring scheme D: 4-wire transducer, external sensor supply

Particularity:

⚠ WARNING

An undervoltage at the transducer cannot be detected, which means a transducer with undervoltage detection may be required.

Note

1L+ and 2L+ can be fed from one power supply. The maximum permissible common mode voltage U_{CM} must be observed.

⚠ WARNING

Depending on the internal structure of the sensor, a short circuit from 2L+ to Mn+ (sensor with measuring circuit referring to 2M) or from Mn- to 2M (sensor with measuring circuit referring to 2L+) can destroy the input resistors (see documentation for the utilized sensor).

For this reason, a suitable measure must be taken to protect the input resistors (e.g. fuse on the module).

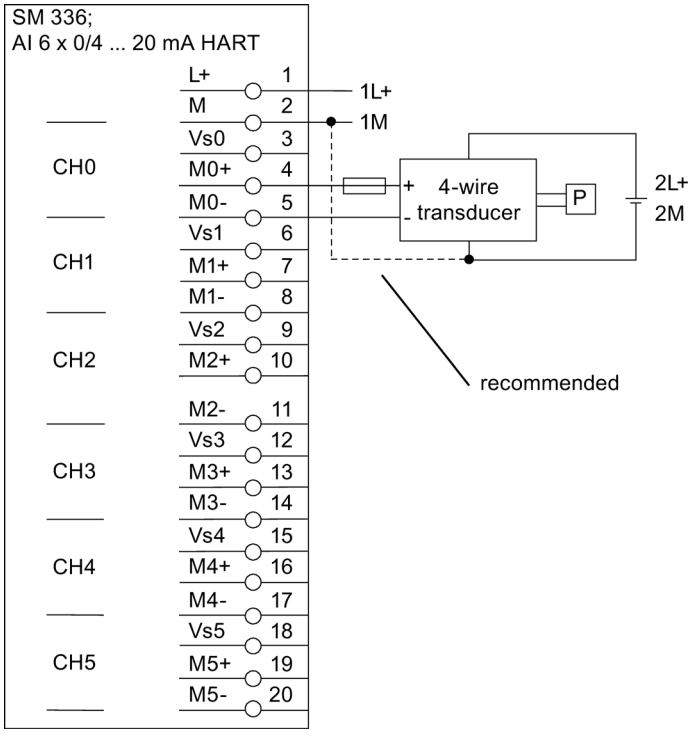


Figure 9-25 4-wire transducer, external sensor supply

9.3.4 Applications and wiring schemes

[ID: 8220065931]

Applications

The following applications are associated with the following wiring schemes:

Application		Wiring schemes							
		A	B	C	D	E	F	G	H
3:	1oo1 evaluation	X	X	X	X				
4:	1oo1 evaluation, transducer not redundant, high availability					X	X	X	X
5:	1oo2 evaluation	X	X	X	X				
	1oo2 evaluation, transducer via 1-channel	X	X	X	X				
6:	1oo2 evaluation, transducer via 1-channel, high-availability, transducer not redundant					X	X	X	X
7:	2oo3 evaluation, high-availability	X	X	X	X				
8:	2oo3 evaluation, high-availability, transducer not redundant					X	X	X	X
9:	2oo3 evaluation with 3 modules	X	X	X	X				

9.3.4.1 Calculation of the residual supply voltage at the transducer [ID: 8807638667]

Calculation of residual supply voltage

Determine the following voltages, according to your wiring scheme, for the purpose of calculating the residual supply voltage:

- Determine the minimum supply voltage (U_{V_min}):

  Power supply, e.g., for SITOP 24 V ±2%

  $U_{V_min} = U_V - |\text{Tolerance}| = 24\ V - 2\% =$ **23.5 V**

  (neglecting the voltage drop at the supply line to the module)

- Calculate the maximum voltage drop at the signal line (U_{line}):

  e.g. for copper line 500 m with ∅ = 0.5 mm²; with I_{max} = 25 mA

  $$R_{Line} = \frac{500\ m}{0.5\ mm^2 \times 56\ m/(mm^2\Omega)} \times 2 = 35.7\ \Omega$$

  $U_{Line} = 35.7\ \Omega \times 25\ mA =$ **0.9 V**

- Calculate the voltage drop at the input resistance (U_{Ri}) of the module:
  - With R_{i_max} = 175 Ω; with I_{max} = 25 mA

    $U_{Ri} = 175\ \Omega \times 25\ mA =$ **4.4 V**
  - When Zener diodes are used in a high-availability application, this higher voltage shall be used, taking into account the tolerances.

    e.g., when using Zener diodes with 5.6 V and 6.2 V:

    $U_{Z_5V6} = U_Z + \text{Tolerance} = 5.6\ V + 5\% =$ **5.9 V**

    $U_{Z_6V2} = U_Z + \text{Tolerance} = 6.2\ V + 5\% =$ **6.5 V**

- Determine the voltage drop at the sensor supply:

  $U_{SensorSupply} =$ **0.5 V**

- Determine the voltage drop (U_{Diode}) at the longitudinal diode for disconnection of the sensor supply:

  e.g., for BYV27-100
  - For 2-wire transducer, with I_{max} = 25 mA

    $U_{Diode} =$ **approx. 0.7 V**
  - For 4-wire transducer, with I_{max} = 300 mA

    $U_{Diode} =$ **approx. 0.9 V**

Subtract the voltage drop for the line at the internal resistance and at the diodes from the minimum supply voltage. Proceed according to the wiring scheme for your sensor.

Example for calculating the residual supply voltage in application 3:

Minimum residual voltage (U_{min}) on a 2-wire transducer, non-high-availability application:

$U_{min} = U_{V_min} – U_{line} – U_{Ri} – U_{SensorSupply}$

U_{min} = 23.5 V – 0.9 V – 4.4 V – 0.5 V = **17.7 V**

Example for calculating the residual supply voltage in application 4:

- Minimum residual voltage (U_{min}) on a 2-wire transducer, high-availability application:

  $U_{min} = U_{V_min} – U_{Line} – U_{Diode} – U_{Z_6V2} – U_{Ri} – U_{SensorSupply}$

  U_{min} = 23.5 V – 0.9 V – 0.7 V – 6.5 V – 4.4 V – 0.5 V = **10.5 V**

- Maximum voltage drop (U_{Line}) on the supply line of a 4-wire transducer:

  e.g. for copper line 500 m with ∅ = 1.5 mm²; with I_{max} = 300 mA

  $$R_{Line} = \frac{500\ m}{1.5\ mm^2 \times 56\ m/(mm^2\Omega)} \times 2 = 11.9\ \Omega$$

  U_{Line} = 11.9 Ω × 300 mA = 3.6 V

  Minimum supply voltage (U_{min}) on a 4-wire transducer, high-availability application:

  $U_{min} = U_{V_min} – U_{line} – U_{Diode} – U_{SensorSupply}$

  U_{min} = 23.5 V – 3.6 V – 0.9 V – 0.5 V = **18.5 V**

Determination of maximum load voltage

$U_{LoadSensor} > U_{LoadModule}$

Load voltage for sensor

$U_{LoadSensor} = I_{max} \times R_{Load}$

Load voltage for the module in 4-wire transducer, high-availability application

$U_{LoadModule} = U_{Ri} + U_{Line} + U_{Z_6V2}$

WARNING

The fail-safe performance characteristics of the external components (e.g., transducer, diodes, Zener diodes) are not included in the fail-safe performance characteristics of the module (see technical data of the module). These must be determined and/or taken into account in a safety examination.

WARNING

You must take the following into consideration when selecting Zener diodes for high-availability interconnection of the analog module:

Taking into account the tolerances, the wire break voltage must be greater than the maximum voltage drop on the input resistance of the module. In particular, the residual current must be considered since it affects the measurement result.

For safety reasons, we recommend the use of a variety (diversity) of Zener diodes (common cause error).

For example, you could use the following Zener diodes: 5.6 V (1N4734A) and 6.2 V (1N4735A), or use MTA 6ES7650-1AH51-5XX0 with 6ES7650-1BB51-0XX0 and 6ES7650-1BC51-0XX0 (see Manual " Marshalled Termination Assemblies ET 200M Remote I/O Modules (http://support.automation.siemens.com/WW/view/en/22091986) ").

9.3.5 Applications 1 and 2 [ID: 8219928331]

Applications 1 and 2

Applications 1 and 2 are omitted because the module supports only safety mode.

Diagnostic message	Possible causes of the problem	Corrective measures
HART field device malfunction	Error occurred in the HART field device	• Check parameter assignment • Replace HART field device
HART parameter assignment error	Faulty HART parameters transferred to module (DS 131 – 136)	Correct HART parameter data record
	Error during dynamic parameter reassignment (HART)	• Check the parameter assignment in the user program • Contact SIMATIC Customer Support if necessary
HART communication error	• HART field device does not reply • Signal fault (level, timing, noise)	• Check the process wiring • Check measuring current • Check the current consumption of the field device • Replace sensor • Increase the number of retries • Connect a capacitor of approximately 100 nF in parallel to the sensor

9.3.14 Technical Data - SM 336; F-AI 6 x 0/4 ... 20 mA HART [ID: 8681239435]

Overview

Technical specifications		
Dimensions and weight		
Dimensions W x H x D (mm)	40 × 125 × 120	
Weight	Approx. 350 g	
Module-specific specifications		
Number of inputs		
• One-channel	6	
• Two-channel	3	
Assigned address area		
• In the I/O input area	16 bytes	
• In the I/O output area	4 bytes	
Cable length		
• Shielded and twisted in pairs	Max. 1000 m	
Front connectors	20-pin	
Maximum achievable Safety Integrity Level in safety mode	One-channel	Two-channel
• According to IEC 61508:2000	Max. SIL 3	Max. SIL 3

Technical specifications		
• According to ISO 13849-1:2006 or EN ISO 13849-1:2008	Max. Cat. 3/PLe	Max. Cat. 4/PLe
Fail-safe performance characteristics		
• low demand mode (average probability of failure on demand)	< 1.00E-04	< 1.00E-05
• high demand / continuous mode (probability of a dangerous failure per hour)	< 1.00E-08	< 1.00E-09
Proof-test interval	20 years	
Voltages, currents, potentials		
Rated supply voltage of electronics L+	24 V DC	
• Reverse polarity protection	Yes	
• Power loss ride-through of L+	None	
• Power loss ride-through of internal voltage supply	5 ms	
Electrical isolation		
• Between channels 0/1/2 and 3/4/5, backplane bus, load voltage L+/sensor supply Vs0...5, shield	Yes	
• Between channels 3/4/5 and 0/1/2, backplane bus, load voltage L+/sensor supply Vs0...5, shield	Yes	
• Between backplane bus and channels 0/1/2, channels 3/4/5, load voltage L+/sensor supply Vs0...5, shield	Yes	
• Between load voltage L+/sensor supply Vs0...5 and channels 0/1/2, channels 3/4/5, backplane bus, shield	Yes	
• Between shield and channels 0/1/2, channels 3/4/5, backplane bus, load voltage L+/sensor supply Vs0...5	Yes	
• Between the channels of a potential group	No	
Permitted potential difference		
• Between the potential groups	75 V DC, 60 V AC	
• Between the channels (0/1/2 or 3/4/5) of a potential group	75 V DC, 60 V AC	
Insulation test voltage	370 V AC for 1 min.	
Current consumption		
• From backplane bus	Max. 90 mA	
• From supply voltage L+ (without load)	Typ. 150 mA	

Technical specifications	
Common-mode voltage (CMV)	
• Permitted common mode voltage between the inputs (U_{CM})	75 V DC, 60 V AC
• Permitted common mode voltage between the inputs and M	75 V DC, 60 V AC
Power loss of the module	4.5 W, typical
Analog value generation	
Measuring principle	DELTA-SIGMA
Integration/conversion time	
• Configurable	Yes
• Integration time At 50 Hz At 60 Hz	 20 ms 16.67 ms
• Response time per channel pair At 50 Hz At 60 Hz	 25 ms 22 ms
• Basic response time	50 ms
• Resolution, including overrange	15 bits + sign
Smoothing of measured values (per channel)	Yes, assignable
Level	Time constant
• None	1 × conversion cycle time
• Weak	4 × conversion cycle time
• Medium	16 × conversion cycle time
• Strong	64 × conversion cycle time
Conversion cycle time = (basic response time + N × response time per channel pair) (N = number of active channel pairs)	
• At 50 Hz, all channel pairs active	125 ms
Acknowledgment time (DAT - Device Acknowledgement Time)	100 ms
Noise suppression, error limits	
Interference voltage suppression for f=n × (f1±0.5%), (f1=interference frequency)	
• Common-mode interference (U_{CM} ≤ 60 V AC)	Min. 70 dB
• Series-mode interference (peak value of interference < rated value of input range)	Min. 40 dB
Crosstalk between inputs	Min. 70 dB
Operational limit (across the temperature range, relative to measuring range end value of 20 mA)	± 0.2% (40 µA)

Technical specifications	
Basic error limit (operational limit at 25 °C, relative to full-scale value 20 mA)	± 0.1%
Temperature error (relative to full-scale value 20 mA)	± 0.002%/K
Linearity error (relative to full-scale value 20 mA)	± 0.01%
Repeatability (in steady state at 25 °C, relative to full-scale value 20 mA)	± 0.015%
Influence of a HART signal superimposed on the input signal (relative to the full-scale value 20 mA, in addition to the basic error)	
• 20 ms integration time	± 0.12%
• 16.67 ms integration time	± 0.12%
Status, Interrupts, Diagnostics	
Interrupts	
• Process interrupt	No
• Diagnostic interrupt	Yes, assignable
Diagnostics functions	Yes, assignable
• Indication of safety-oriented operation	Green LED (SAFE)
• Channel fault display	Red LED (F0...5)
• Group fault display	Red LED (SF)
• HART status display	Green LED (H0...5)
• Diagnostic information can be read out	Yes
Fail-safe values can be switched to	Configurable in safety program
Sensor supply output	
• Number of outputs	6
Output voltage	
• Loaded	Minimum L+ (-0.5 V)
Output current	
• Rated value	300 mA
• Approved range	0 to 300 mA
Additional (redundant) infeed	With external additional elements, see wiring schemes
Short-circuit protection	Yes, electronic
• Operating value	Typ. 1 A
• Permitted aggregate current of outputs	1.8 A
Shutdown at input	Typ. 35 mA
Sensor selection data	
Input range (rated values)/input resistance	
• Current	Typ. 150 Ω Max. 175 Ω

Technical specifications	
Permitted input current for current input (destruction limit)	Max. 40 mA
Safeguarding against short circuit in case of external sensor supply	e.g., melting fuse 62 mA FF
Signal sensor connection	
For current measurement	
• As 4-wire transducer	Possible
• As 2-wire transducer	Possible
HART communication	
Monodrop/multidrop operation	Monodrop operation
Primary/secondary master	Primary or secondary master *
Impedance of an input channel for HART communication.	100 – 150 Ω For operation with an external secondary master (e.g. communicator), an external load may be necessary to achieve a total impedance of 230 – 600 Ω.
Functional range of HART Communication	1.17 to typ. 35 mA
HART shutdown threshold	1.17 mA
Protocol version	5 to 6
Protection against overvoltage	
Protection of supply voltage L+ from surge stress according to IEC 61000-4-5	
Up to degree of severity 2	No external protective elements required
• Symmetrical (L+ to M)	± 0.5 kV; 1.2/50 µs
• Asymmetrical (L+ to PE, M to PE)	± 1 kV; 1.2/50 µs
Degree of severity 3 and higher	External protective elements required
• Symmetrical (L+ to M)	± 1 kV; 1.2/50 µs
• Asymmetrical (L+ to PE, M to PE)	± 2 kV; 1.2/50 µs
Protection of shielded signal lines (inputs) from surge stress according to IEC 61000-4-5	
Up to degree of severity 3	No external protective elements required
• Asymmetrical (shield to PE)	± 2 kV; 1.2/50 µs
To achieve failure criterion A according to IEC 61000-4-5..., the repetition factor for HART communication must be set at a value greater than 0.	
* In redundant operation, the module with the higher start address is automatically the secondary master.	

Note

The maximum cable lengths currently specified in this manual ensure against functional impairment, even without more precise examination of the boundary conditions. If the boundary conditions, such as EMC, cable type, cable routing, etc. are examined more closely, longer cables can be used for all F-SMs.

9.3.15 Parameters of analog input module F-AI 6 x 0/4 ... 20mA HART

[ID: 7100376075]

Table 9- 26 Parameters of module SM 331; F-AI 6 x 0/4...20mA HART

Parameters	Range of values	Default	Parameter type	Effective range
F-parameters				
F_Source_Address		Dependent on the F-CPU used	Static	Module
F_destination_address	1 to 1022	—		
DIP switch position (9.....0)	0000000001 To 1111111110	—		
F_Monitoring_Time (ms)	1 to 65535	2500		
Module parameters				
Diagnostic interrupt	Activated/deactivated	Deactivated	Static	Module
Behavior after channel faults	Passivate the entire module/Passivate the channel	Passivate the entire module		
HART_Gate	Off/On/Can be switched	Off		
Interference frequency suppression	50 Hz/60 Hz	50 Hz		
Evaluation of the sensors	1oo1 evaluation, 1oo2 evaluation / deactivated	1oo1 evaluation		Channel
Measuring range	4..20 mA / 0..20 mA	4...20 mA		
F-wire break detection	Activated/deactivated	Activated		
Smoothing	1, 4, 16, 64 conversion cycles	1 conversion cycle		
Discrepancy time (ms)	0 to 30000	150		
Tolerance window %, absolute	0.2 to 20	2,5		
Tolerance window %, relative	0.2 to 20	2,5		
Standard value	MAX/MIN	MIN		
HART				
HART function	On/off	Off	Static	Channel
HART repetitions	0 to 255	10		
HART group diagnostics	On/off	Off		

9.3.15.3 Deactivate one channel of a channel pair for 1oo1 evaluation [ID: 7760926091]

If you want to use only one channel of a channel pair (for 1oo1 evaluation), connect the unused channel to a resistance. Select the resistance to achieve a current between 4 and 20 mA.

9.3.16 HART basics

9.3.16.1 What is HART? [ID: 6877785099]

The HART function enables you to also operate the analog modules with digital communication options. The HART protocol has emerged as the de facto standard protocol for communication with intelligent field devices: HART is a registered trademark of the "HART Communication Foundation" (HCF), who owns all rights for the HART protocol.

Note

The SM 336; F-AI 6 x 0/4 ... 20 mA HART module supports the HART protocol version 5 to 6.

9.3.16.2 Properties of HART [ID: 6877777547]

What are the advantages of HART?

The use of HART analog modules offers the following advantages:

- Connection-compatible to analog modules: current loop 4 to 20 mA
- Additional digital communication via the HART protocol
- HART requires less power, important for use in hazardous areas
- Numerous field devices with HART functions currently in use

What are typical HART applications?

- Commissioning of field devices (central parameter assignment)
- Field device parameters can be changed online
- Information, maintenance and diagnostic displays for field devices

⚠ WARNING
The HART protocol is not safety-oriented!

Transparent message data - Format

The module supports the *transparent message data* format. Using *SIMATIC PDM*, you therefore have direct access to the HART field device for the commands and replies.

Each module is equipped with a common HART modem for the 6 channels. In other words, with *SIMATIC PDM* you can only directly access one channel of the module at any one time (multiplexes of the channels). It is not possible to simultaneously directly access another channel of the same analog module.

See also

HART for safety-oriented applications (Page 307)

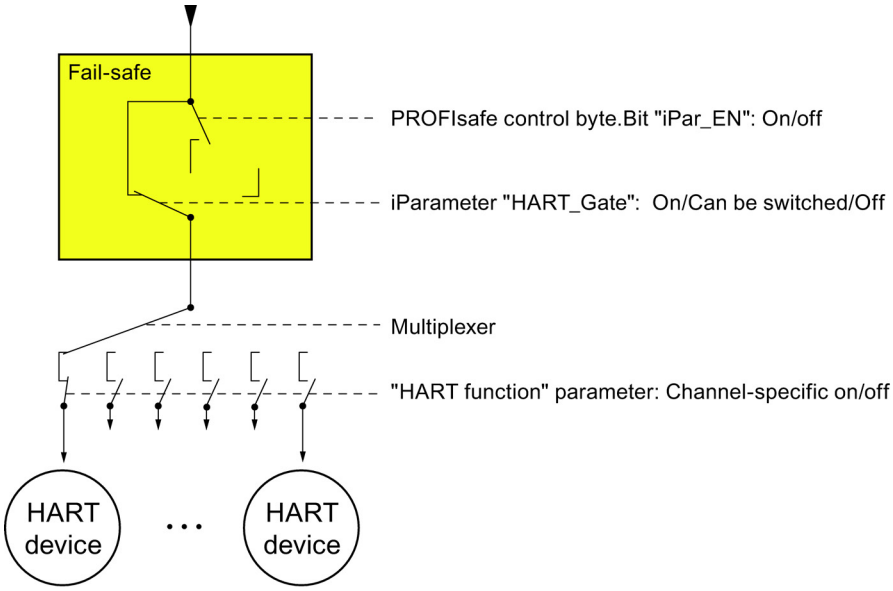
9.3.16.6 HART for safety-oriented applications [ID: 7177502475]

Introduction

You assign the HART function in *HW Config* with the following parameters.

"HART_Gate" parameter

You use the "HART_Gate" parameter to enable the HART function (HART communication) for the *module*. The "HART_Gate" parameter acts as a module-wide *fail-safe* "main switch".



The following parameters of "HART_Gate" can be assigned:

- **"On"**: HART communication is enabled.
- **"Can be switched"**: The HART communication can be activated and deactivated from the safety program (*S7 Distributed Safety* or *S7 F Systems*), provided the module is in RUN mode. This means that the HART communication with HART field devices can be activated and deactivated during operation of the F-CPU (e.g. for maintenance purposes).

  If you set the IPAR_EN variable of the F-I/O DB or of the F_CH_AI F-channel driver to "1" in the safety program, HART communication is enabled for the module. If the setting is "0", HART communication is disabled. The module acknowledges the enabled or disabled HART communication with variable IPAR_OK = "1" or "0" in the F-I/O DB or in the F_CH_AI F-channel driver.

  Do not enable the HART communication until the status of your system allows the parameters of the associated HART field device to be safely reassigned.

  If you want to evaluate the "Enable HART communication" status in your safety program, e.g., for the purpose of programming interlocks, you must generate the information as follows:

  Set (primarily) the "Enable HART communication" signal if you enable the HART communication via IPAR_EN = 1. Reset the "Enable HART communication" signal with a falling edge of the IPAR_OK variable.

  This is necessary to ensure that the information is properly available even if communication errors occur while the HART communication is enabled with IPAR_EN = 1. Only change the status of IPAR_EN during this evaluation if there is no passivation due to a communication error or F-I/O/channel fault (PASS_OUT = 0).

  If you are using redundantly configured modules in *S7 F Systems*, you must set the IPAR_ENR variable of the F_CH_AI F-channel driver to "1" to enable the HART communication to the redundant HART field device. The redundantly configured module acknowledges the enabled or disabled HART communication with variable IPAR_OK = "1" or "0" in the F_CH_AI F-channel driver.

⚠ WARNING

For module channels with HART devices *without* write protection, the following applies to an SIL 2/3 application: as soon as you open the HART_Gate, the input values of the channels must be checked for plausibility, e.g. by performing a comparison with the equivalent value of another module in the user program. Optionally, the module can also be taken out of the safety function of the system for this time.

⚠ WARNING

Note that the opening of the HART_Gate is jumpered by a connected HART communicator.

Example of enabling HART communication in S7 F Systems

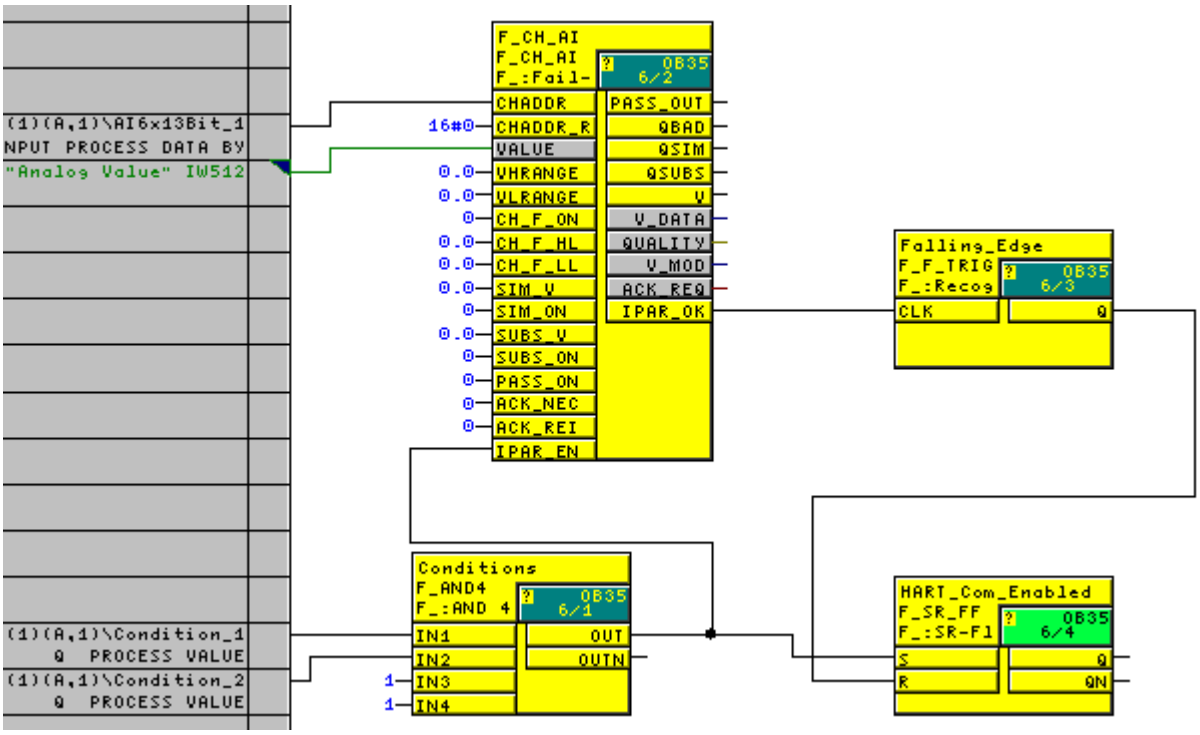


Figure 9-46 Example of enabling HART communication in *S7 F Systems*

Example of enabling HART communication in S7 Distributed Safety

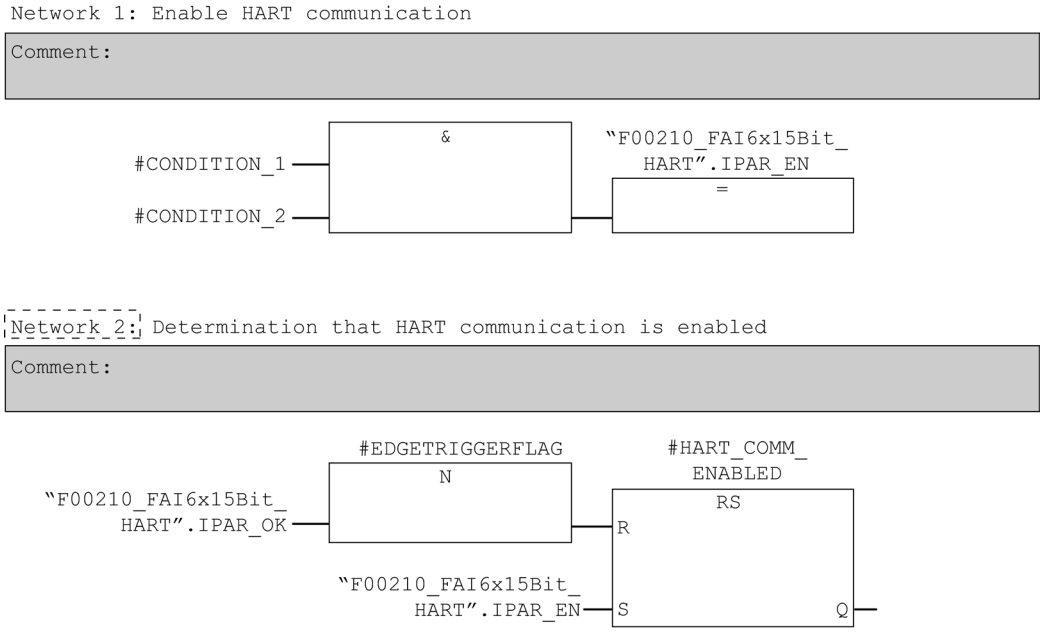


Figure 9-47 Example of enabling HART communication in *S7 Distributed Safety*

For additional information about the F-I/O DB, refer to the *S7 Distributed Safety, Configuring and Programming* manual. For additional information about the F_CH_AI F-channel driver, refer to the *S7 F/FH Systems, Configuring and Programming* manual.

- **"Off"**: HART communication is disabled.

Note

HART diagnostics is only available when HART is activated. This also applies to *PCS 7* maintenance stations.

However, the module diagnostics is always available.

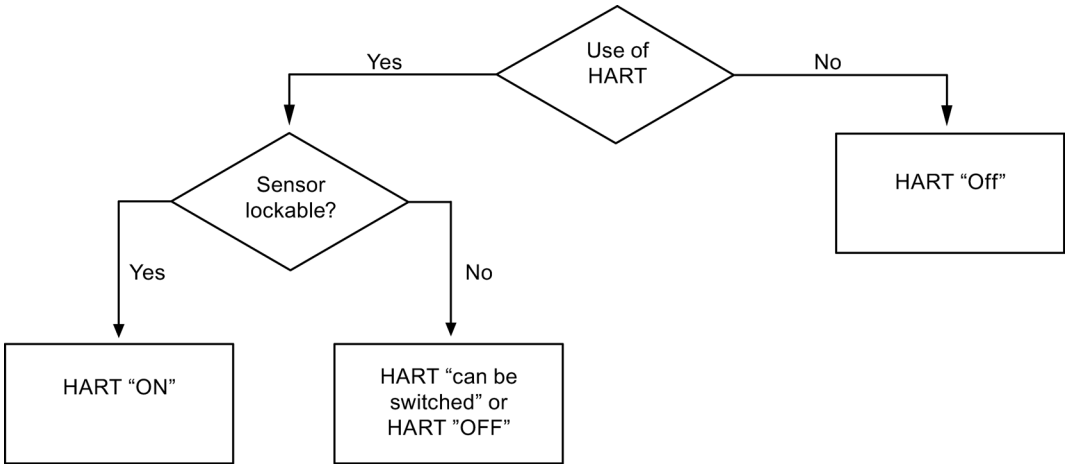
"HART function" parameter

You use the "HART function" parameter to enable or disable HART communication with the HART field device **for the relevant channel** of the module. The parameter is *not safety-oriented*, i.e., it cannot be used for *fail-safe shutdown* of HART communication.

The "HART function" parameter can only be assigned if the "HART_Gate" parameter = "On" or "Can be switched".

Activating HART according to the sensor used

The use of HART communication in safety-oriented applications is dependent on the HART-capable sensors you are using. The following figure shows the HART communication parameter assignment as a function of the sensor:



WARNING

As soon as a sensor does not comply with the required specifications, it can be used as a guideline (configure HART "can be switched").

Note

In the case of dual-channel interconnection of sensors, observe the notes in the chapters in which the application examples are described.