AMIKON TECHNICAL DOCUMENTATION

# Installation Instructions

## Siemens 6ES7336-4GE00-0AB0

Fail-Safe HART Input Module

| ANALOG INPUTS | RESOLUTION | HART RANGE | CONNECTOR |
|---|---|---|---|
| **6 current inputs** | **15 bits plus sign** | **4-20 mA** | **20 pins** |

For qualified personnel only. Isolate the equipment and follow the complete manufacturer and site safety procedures. This reference does not replace the approved project design or the full installation manual.

## 01 PREPARATION AND WIRING CHECKS

- Set the unique PROFIsafe destination address before commissioning.
- Use the required SELV/PELV supply provisions.
- Match the exact two-wire or four-wire internal/external supply diagram.
- Protect input resistors and assess externally powered transmitter circuits.
- Calculate the voltage available to each transmitter under the documented circuit conditions.
- Terminate an unused input in a partially used pair with the specified 4-20 mA resistor arrangement.
- Apply HART Gate and field-device write-protection precautions before parameter access.

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.

## 02 ORIGINAL WIRING REFERENCE

Original source PDF pages 244, 41, 42, 43, 46, 47, 245, 246, 249, 250, 251, 252, 259, 260, 261, 302, 307, 308, 309, 310, 311, 3, 241, 242, 243, 247, 248, 258, 287, 288, 289, 290, 291, 292. The following pages retain the original Siemens drawings and printed page numbers.

**Siemens original documentation and product reference**

## 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.

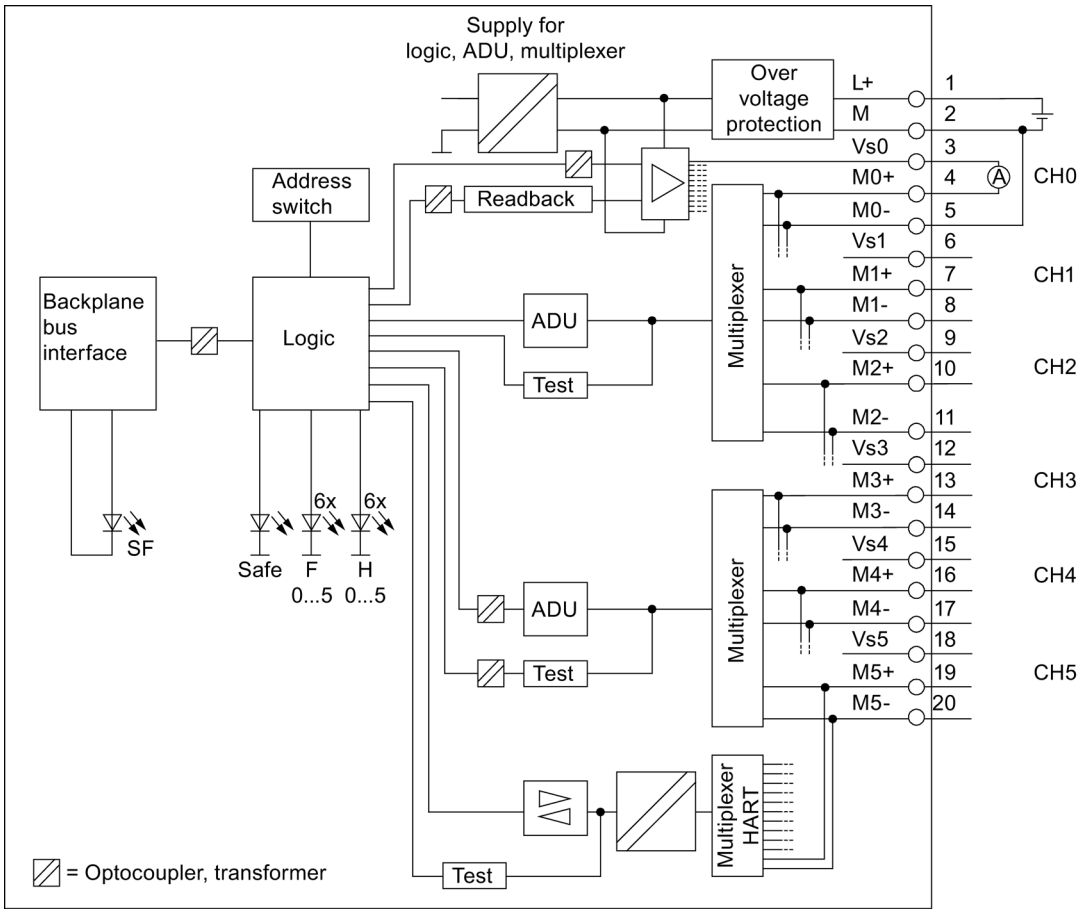



Figure 9-19 Wiring and block diagram of SM 336; F-AI 6 x 0/4 ... 20 mA HART

## 4.3.3 Assigning PROFIsafe Address (F_destination_address) [ID: 431547659]

### Introduction

In order to use

- SM 326; DI 24 x DC 24V (as of order no. 6ES7326-1BK01-0AB0),
- SM 326; DO 8 x DC 24V/2A PM,
- SM 326; F-DO 10 x DC 24V/2A PP and the
- SM 336; F-AI 6 x 0/4 ... 20 mA HART

in safety mode, you must perform the following steps:

1. setting the operating mode "Safety mode" for the SM 326; DI 24 x DC 24V
2. Set the PROFIsafe address = F_destination_address using the address switch before you install the fail-safe signal module.

By contrast to the PROFIsafe address setting, which is based on the start address, there is no correlation between the module start address and the PROFIsafe address for the modules mentioned earlier. You set the module start address in the object properties of the module similar to the addressing of S7-300 standard I/O modules in *STEP 7HW Config*.

### Setting safety mode

Set "Safety mode" in the object properties of the module in SM 326; DI 24 x DC 24V (as of order no. 6ES7326-1BK01-0AB0) in *HW Config*.

The SM 326; DO 8 x DC 24V/2A PM, SM 326; F-DO 10 x DC 24V/2A PP and SM 336; F-AI 6 x 0/4 ... 20 mA HART operate in safety mode only. This module is set up permanently for operation in "safety mode".

### Assigning PROFIsafe addresses

The PROFIsafe addresses (F_source_address, F_destination_address) are assigned automatically to the two F-SMs mentioned earlier when you configure these modules in *STEP 7*. The F_destination_addresses of the FMs are shown in their object properties in *HW Config* and are returned in binary format at the "DIP switch setting" parameters.

You can edit the configured F_destination_address in *HW Config*. It is advisable, however, to use the F_destination_address which is assigned automatically.

## Address switch

The 10-bit DIP switch for addressing is installed in the rear panel of the fail-safe signal modules. This switch is used to determine:

- whether to operate the module in safety mode or in standard mode
- In safety mode: the PROFIsafe address = F_destination_address.

The SM 326; DI 24 x DC 24V is set by default for operation in "standard mode" (all switches are in up position, but you can set all switches to down position, see figure below).

The SM 336; F-AI 6 x 0/4 ... 20 mA HART, SM 326; F-DO 10 x DC 24V/2A PP and SM 326; DO 8 x DC 24V/2A PM will be supplied with a PROFIsafe address of 1 to 1022, which means "safety mode". You can change this, as shown in the figure below.

## Setting the address switch

Verify the correct setting of the address switch *before you start installation*.

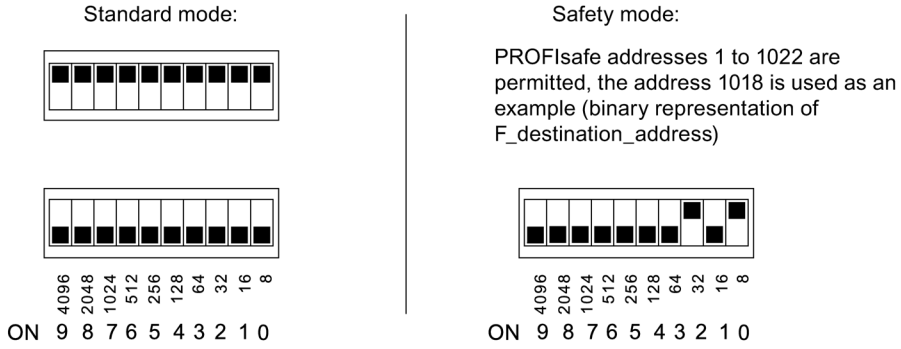



Figure 4-3 Example of address switch (DIP switch) settings

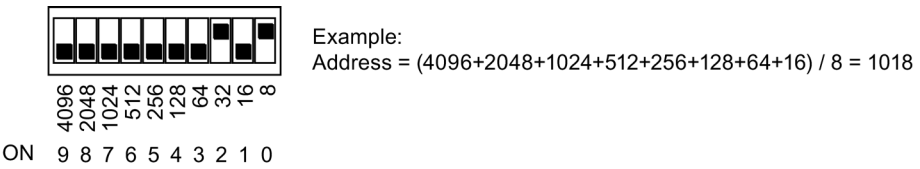



Figure 4-4 Example for calculation of the F_destination_address

### Note

An address switch of the smallest possible dimensions is installed for reasons of space saving. This makes it sensitive to pressure and objects with sharp edges. Always use a suitable tool to manipulate the address switch.

A variety of tools suitable for activating the address switch are available on the market, for example, the Grayhill DIPSTICK. A ballpoint pen may be employed if used carefully. It is imperative to avoid any burring that would prevent the switch from reaching its home position. Do not use screwdrivers or knives to manipulate the address switch.

## Addressing rules

**⚠ WARNING**

**Rule for PROFIBUS subnets:**

The PROFIsafe destination address and, thus, the switch setting on the address switch of the F-I/O must be unique network-wide* and station-wide** (system-wide). For S7-300 F-SMs and ET 200S, ET 200eco and ET 200pro F-modules, you can assign a maximum of 1022 different PROFIsafe destination addresses.

Exception: The F-I/O in different I-slaves may be assigned the same PROFIsafe destination address, as they are only addressed within the station, that is, by the F-CPU in the I-slave.

**Rules for Ethernet subnets and hybrid configurations of PROFIBUS and Ethernet subnets:**

The PROFIsafe destination address and, thus, the address switch setting on the F-I/O have to be unique only*** within the Ethernet subnet, including all lower-level PROFIBUS subnets, and station-wide** (system-wide). For S7-300 F-SMs and ET 200S, ET 200eco and ET 200pro F-modules, you can assign a maximum of 1022 different PROFIsafe destination addresses.

Exception: The F-I/O in different I-slaves may be assigned the same PROFIsafe destination address, as they are only addressed within the station, that is, by the F-CPU in the I-slave.

The networked nodes of an Ethernet subnet are characterized by having IP addresses with the same subnet address, which means the IP addresses match in those digits that have the value "1" in the subnet mask.

Example:

IP address: 140.80.0.2

Subnet mask: 255.255.0.0 = 11111111.11111111.00000000.00000000

Meaning: Bytes 1 and 2 of the IP address define the subnet; subnet address = 140.80

* A network consists of one or several subnets. "Network-wide" means beyond the boundaries of the subnet.

** "Station-wide" means for one station in *HW Config* (for example, an S7-300 station or I-slave)

*** Across Ethernet subnets, excluding cyclic PROFINET IO communication (RT communication)

## Address inconsistency

A parameter assignment error is generated if addressing is inconsistent, for example, if the module address differs from the address set in *HW Config*. The module does not enter safety mode.

## See also

Assigning PROFIsafe Address (Starting Address of F-SM) (Page 38)

# 5.1 Safe Functional Extra-Low Voltage for Fail-Safe Signal Modules [ID: 431563275]

## PELV

**⚠ WARNING**

Fail-safe signal modules must be operated with safe functional extra low voltage (SELV, PELV). That is, the fail-safe modules may only be exposed to a maximum fault voltage of $V_m$. Rule for all fail-safe signal modules:

$V_m < 60.0$ V

Additional information about PELV is available in the data sheets of the power supply modules to be installed, for example.

All system components which supply electrical power in any form must meet this condition.

Each additional power circuit (24 V DC) installed in the system must be operated with safe functional extra low voltage (SELV, PELV). Refer to the data sheets or contact the manufacturer for information.

You should also note that the sensors and actuators connected to the I/O modules may be connected to an auxiliary power supply. Make sure that such auxiliary power supplies conform to PELV requirements. The process signal of a 24 V digital module may not develop a fault voltage in excess of $V_m$.

**⚠ WARNING**

All power sources such as the internal and external 24 V DC load voltage supplies, and the 5 VDC bus voltage must be galvanically interconnected so that any development of cumulative voltage at the individual voltage sources which may lead to a fault voltage higher than $V_m$ is safely ruled, irrespective of any potential differences.

Make sure that the conductor cross-sections used for the galvanic interconnections are compliant with S7-300 installation guidelines (see the *S7-300 Automation System: CPU 31xC and CPU 31x: installation* Operating Instructions).

The fail-safe signal modules and all their standard components can be operated in standard and safety mode on a single or on several shared power supply modules.

## Power supply requirements for compliance with the NAMUR recommendation

**Note**

Always use power supply modules/units (230 V AC → 24 V DC) with integrated function for power failure backup for the duration of at least 20 ms in accordance with NAMUR recommendation NE 21, IEC 61131-2, and EN 298. Power supply components available (examples):

**S7-400**

- 6ES7407-0KA01-0AA0 for 10 A
- 6ES7407-0KR00-0AA0 for 10 A

**S7-300**

- 6ES7307-1BA00-0AA0 for 2 A
- 6ES7307-1EA00-0AA0 for 5 A
- 6ES7307-1KA00-0AA0 for 10 A

These requirements, of course, also apply to power supply modules/units which are not produced according to S7-300/400 installation technology.

## Channel numbers

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

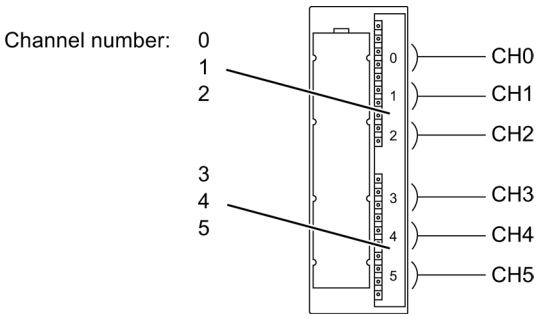



Figure 9-20 Channel numbers SM 336; F-AI 6 x 0/4 ... 20 mA HART

## 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)

## 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.

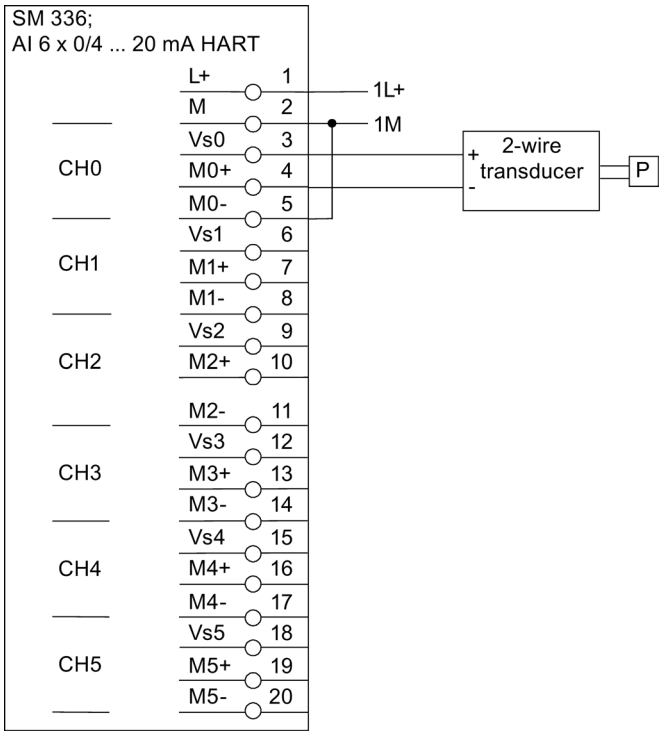



Figure 9-22 2-wire transducer, internal sensor supply

## 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).

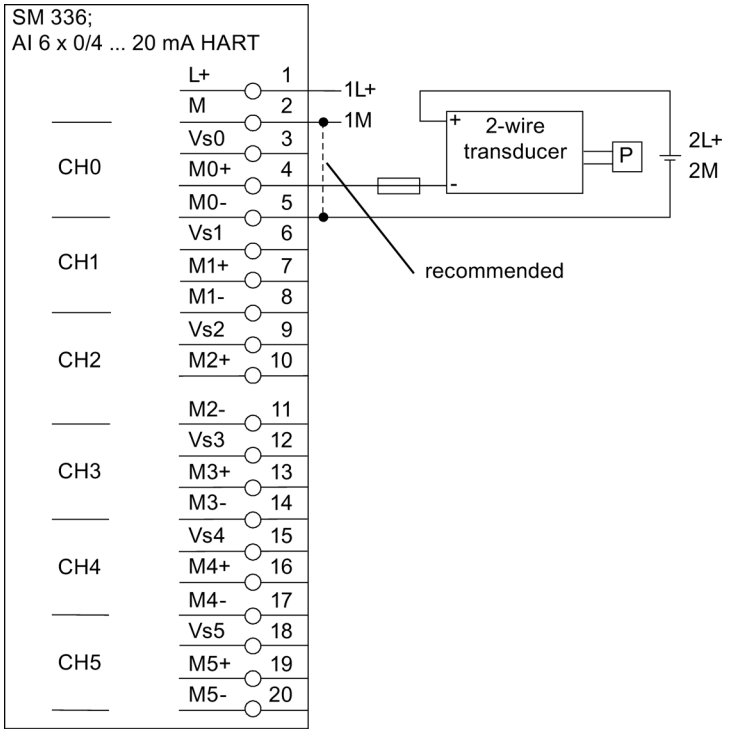



Figure 9-23 2-wire transducer, external sensor supply

## 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.

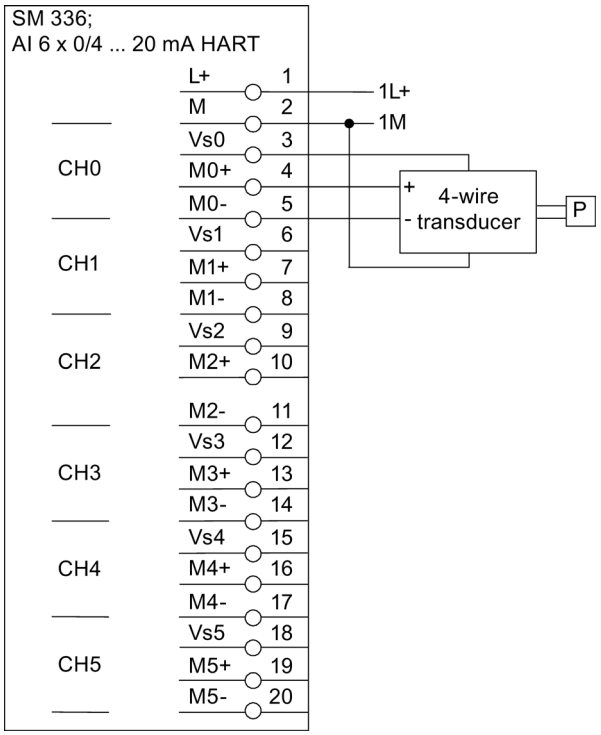



Figure 9-24 4-wire transducer, internal sensor supply

## 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).

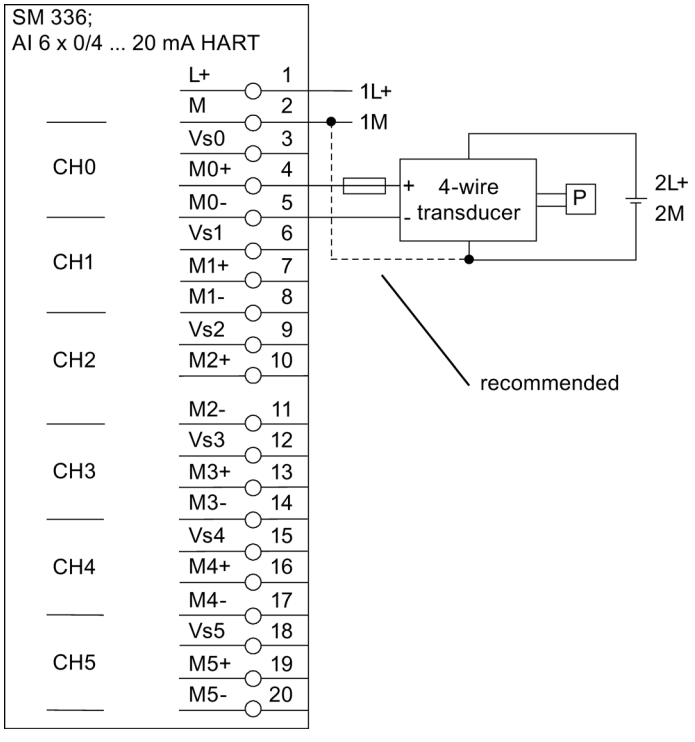



Figure 9-25 4-wire transducer, external sensor supply

### 9.3.4.1 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.

#### 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)

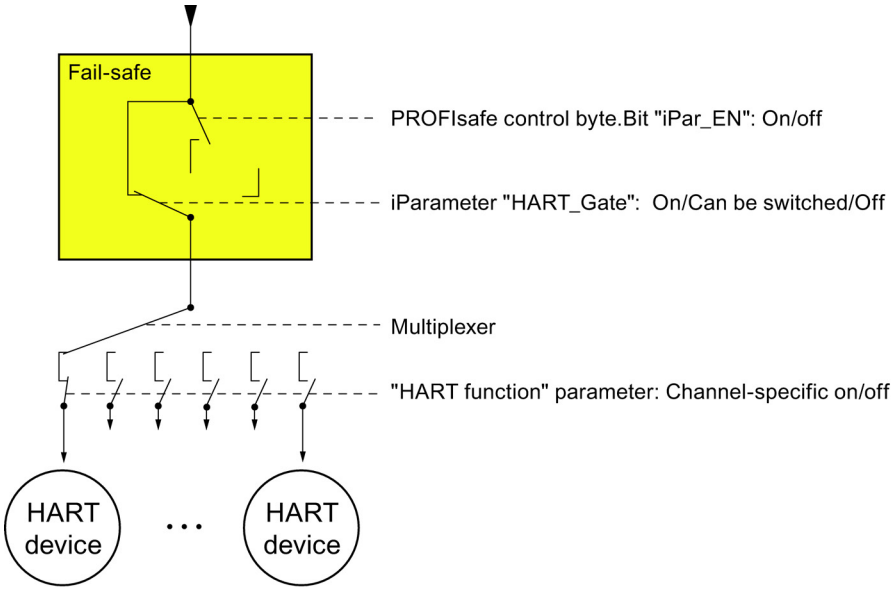
## 9.3.16.6 HART for safety-oriented applications [ID: 7177502475]

### 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**

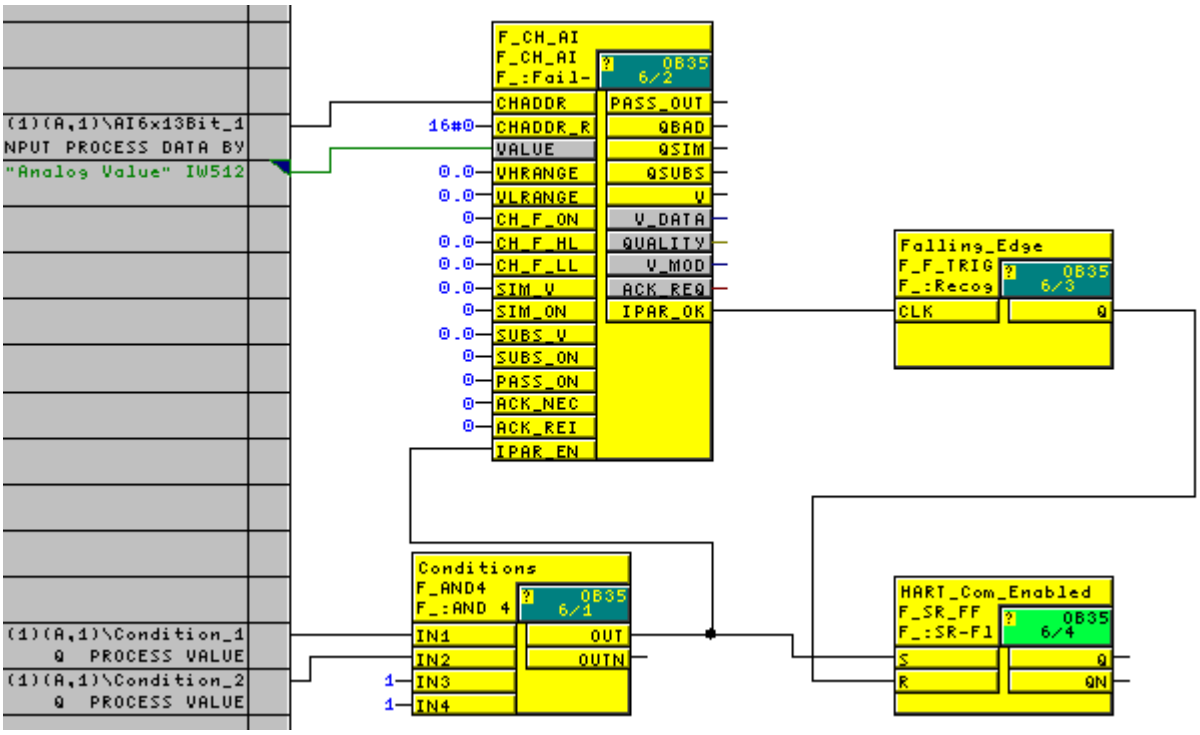



Figure 9-46 Example of enabling HART communication in *S7 F Systems*

**Example of enabling HART communication in S7 Distributed Safety**

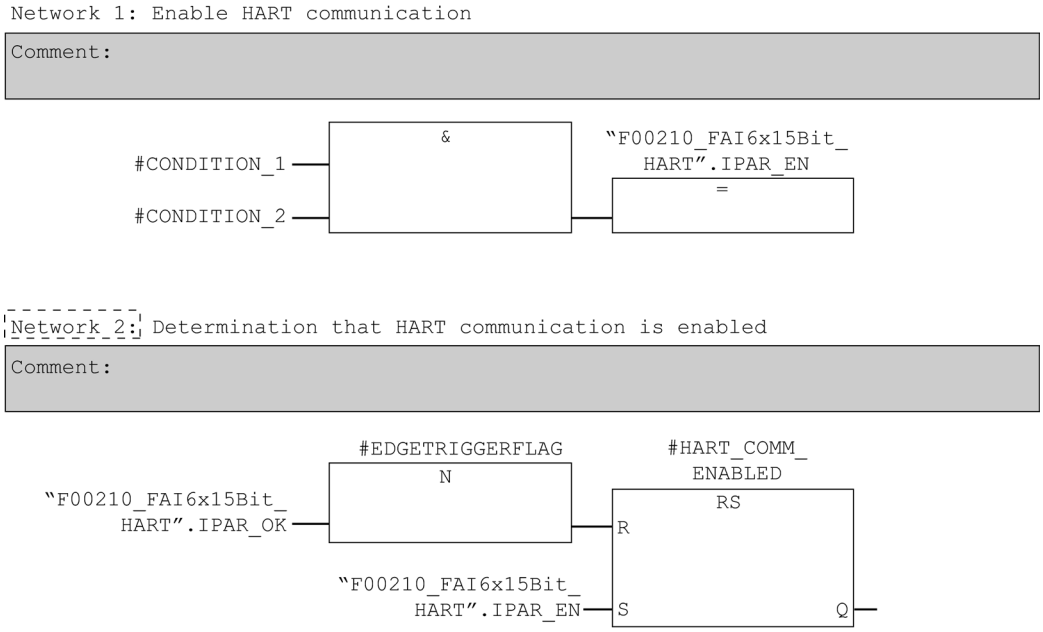



Figure 9-47 Example of enabling HART communication in *S7 Distributed Safety*

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.

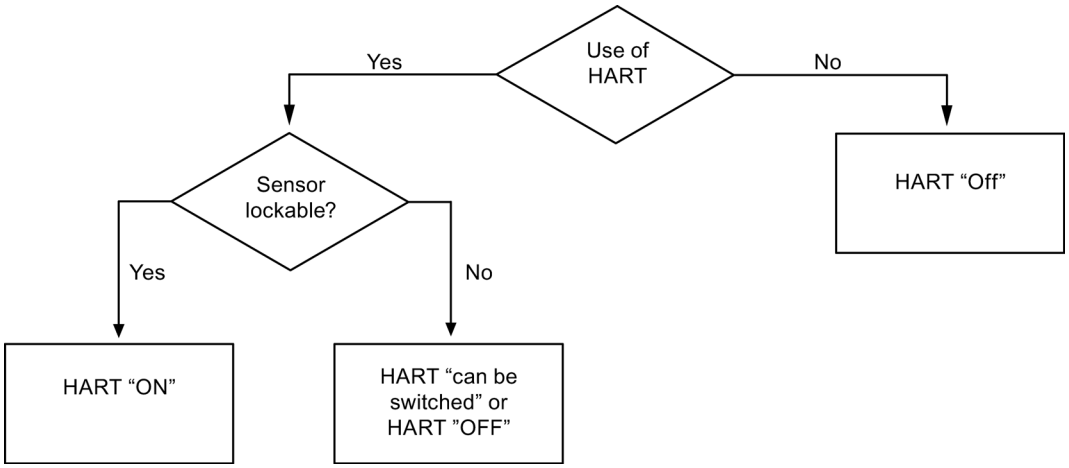
## "HART function" parameter

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.

# 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

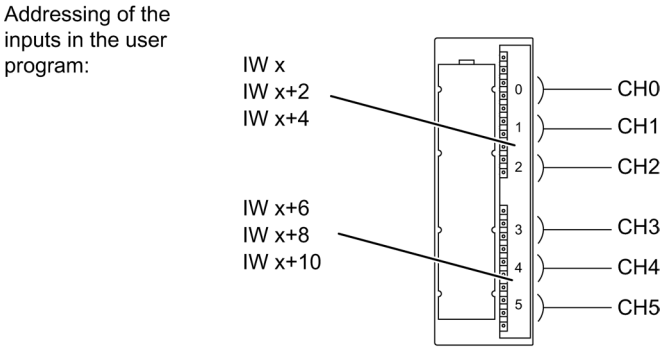
## Use of inputs

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

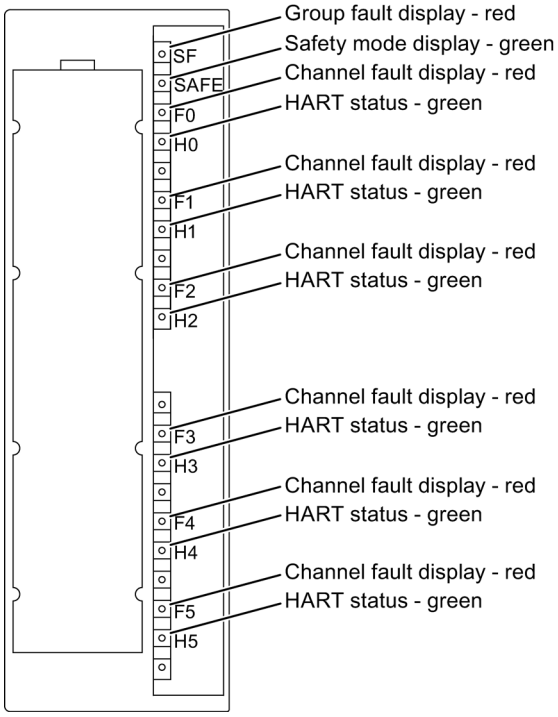



Figure 9-18 Front view SM336; F-AI 6 x 0/4 ... 20 mA HART

## 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.

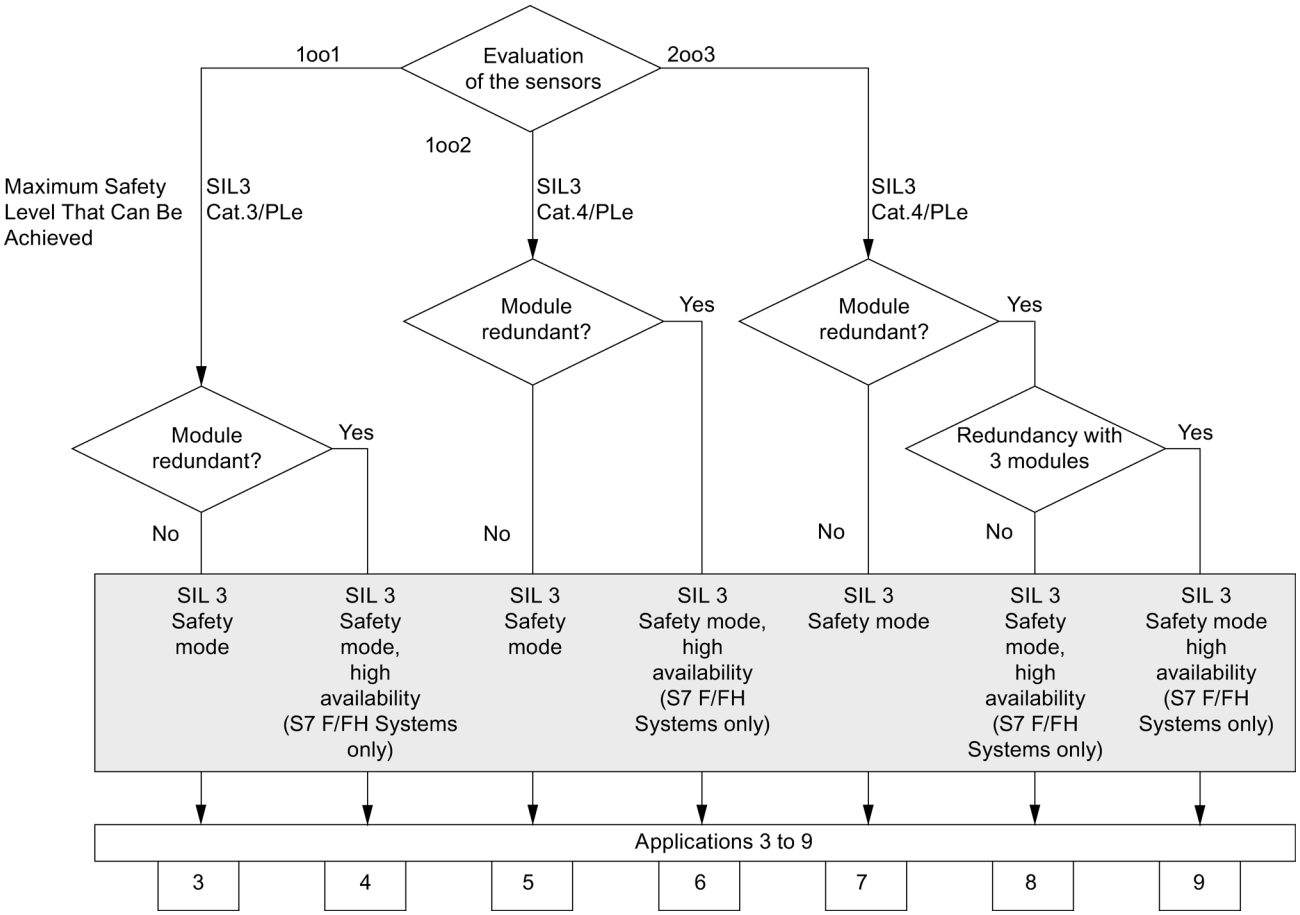



Figure 9-21 Applications

**⚠ 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 |

## 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 | | | | |

| Diagnostic message | Possible causes of the problem | Corrective measures |
|---|---|---|
| HART field device malfunction | Error occurred in the HART field device | • Check parameter assignment<br>• 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<br>• Contact SIMATIC Customer Support if necessary |
| HART communication error | • HART field device does not reply<br>• Signal fault (level, timing, noise) | • Check the process wiring<br>• Check measuring current<br>• Check the current consumption of the field device<br>• Replace sensor<br>• Increase the number of retries<br>• 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<br>At 50 Hz<br>At 60 Hz | <br>20 ms<br>16.67 ms |
| • Response time per channel pair<br>At 50 Hz<br>At 60 Hz | <br>25 ms<br>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)<br>(N = number of active channel pairs) | |
| • At 50 Hz, all channel pairs active | 125 ms |
| Acknowledgment time<br>(DAT - Device Acknowledgement Time) | 100 ms |
| **Noise suppression, error limits** | |
| Interference voltage suppression for f=n × (f1±0.5%),<br>(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<br>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<br>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 | | |